UNIVERSITY OF ZULULAND

A NODE FOR AFRICAN THOUGHT

BYMEDICAL & SCIENTIFIC TECHNICAL LABS

2025 FACULTY OF SCIENCE, AGRICULTURE AND ENGINEERING

ANNUAL POSTGRADUATE SYMPOSIUM

Advancing Interdisciplinary Knowledge for a Sustainable and Digitally Driven Africa

PROGRAMME

The Faculty of Science, Agriculture and Engineering Annual Postgraduate Symposium, hosted by the Department of Computer Science

DATE: 16 October 2025 | TIME: 07h30 – 16h00 | VENUE: Prof Bonginkosi Emmanuel Blade Nzimande Engineering Building, Richards Bay Campus

Preface

It is a pleasure to welcome you to the 2025 Faculty of Science, Agriculture and Engineering Annual Postgraduate Symposium of the University of Zululand, 16 October 2025. This symposium is hosted by Department of Computer Science. under the theme 'The Advancing Interdisciplinary Knowledge for a Sustainable and Digitally Driven Africa. The main aim of the symposium is to create a platform for students and researchers across the Faculty of Science, Agriculture and Engineering to showcase their work, exchange ideas, and engage in meaningful dialogue around diverse challenges and innovative solutions relevant to local and global contexts.

2025 Departmental Organising Committee Members

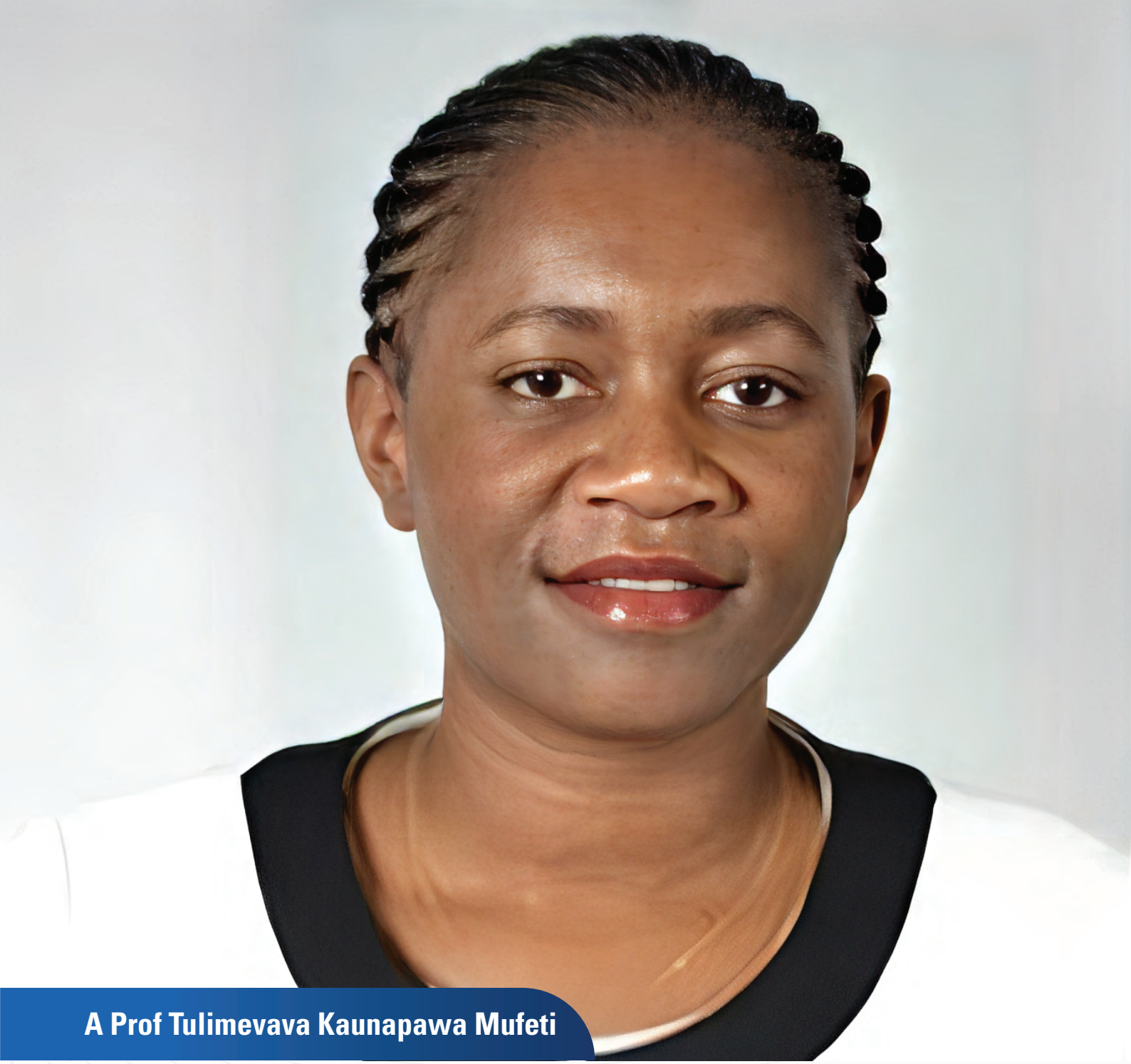
1. Prof Innocent Moyo
2. Prof Matthew Adigun
3. Prof Alfredo Terzoli
4. Dr Paul Tarwireyi (Chair)
5. Dr Derek Fish
6. Mrs Ijeoma Ezeji
7. Mrs Nombuso Sibeko
8. Ms Sizakele Mathaba
9. Mr Sakhile Fatyi
10. Ms Karen Enslin
11. Mr Skhumbuzo Zwane
12. Mr Thami Ndlovu
13. Ms Happy Zulu
14. Ms Buyi Magubane
15. Mr Sunday A. Ajagbe

Session Chairs

1. Dr P Tarwireyi
2. Dr MS Mathenjwa
3. Prof ST Madlala
4. Prof R Pullabhotla
5. Prof MO Adigun
6. Dr K Phinzi
7. Dr ML Mathunjwa
8. Dr PN Biyela
9. Prof M Matadi
10. Dr NF Masikane
11. Dr N Sibanda
12. Ms AS Sibisi

Programme Director: Mrs Nombuso Sibeko

Key Note Speaker: Prof Tulimevava Mufeti



A Prof Tulimevava Kaunapawa Mufeti

Tulimevava Kaunapawa Mufeti is an Associate Professor in the Department of Computing, Mathematical and Statistical Sciences at the University of Namibia. She has served in various leadership roles at UNAM, including Associate Dean of the School of Computing, Head of Departments of Computer Science and Information Systems, eLearning Coordinator and Project Manager: Development of a University Management System. She holds a PhD in Information Systems from Rhodes University and has over two decades of experience in teaching, research, and curriculum development.

Her research focuses on computing education, e-learning, and the role of ICT in socioeconomic development. She has published on accreditation of computing programs, ICT integration in higher education, and cybersecurity education in Africa. In 2017, she was awarded a Fulbright Visiting Scholar grant, to collaborate with Eastern Michigan University on curriculum development in computing education.

Beyond academia, she serves as Chairperson of the Board of Directors of the Communications Regulatory Authority of Namibia (CRAN). She also provides technical assistance across public and private sectors and has extensive expertise in managing donor-funded research projects.

2025 FACULTY OF SCIENCE, AGRICULTURE AND ENGINEERING

ANNUAL POSTGRADUATE SYMPOSIUM

Advancing Interdisciplinary Knowledge for a Sustainable and Digitally Driven Africa

Prof Bonginkosi Emmanuel Blade Nzimande Engineering Building, Theatre Hall

Time	Symposium activity
07:30 - 08:30	Arrival
	Registration and Poster Setup
08:30 - 08:35	Welcome by the FSAE Deputy Dean Research and Innovation: Prof I Moyo
08:35 - 08:45	Opening address by FSAE Dean – Prof KC Lehloenya
08:45 - 09:30	Introducing the Keynote Speaker: Dr P Tarwireyi (Chair) **Keynote address - Prof Tulimevava Mufeti**
09:30 - 10:00	**Tea/ coffee break (foyer)**

Breakaway/ Parallel Sessions

	Breakaway Session 1A **Venue: Theatre Hall** **Chair: Dr P Tarwireyi**	**Breakaway Session 1B** **Venue: Computer Lab 1** **Chair: Dr MS Mathenjwa**	**Breakaway Session 1C** **Venue: Computer Lab 2** **Chair: Prof ST Madlala**	**Breakaway Session 1D** **Venue: Classroom 1** **Chair: Prof R Pullabhotla**	**Breakaway Session 1E** **Venue: Classroom 2** **Chair: Prof MO Adigun**	**Breakaway Session 1F** **Venue: Introductory Laboratory 01** **Chair: Dr K Phinzi**
10:00 – 10:15	**Sunday Ogundipe** 10: Ultrahigh sensitivity and selectivity of Co3O4 nanostructure towards liquefied petroleum gas	**Mussa Phiri** 13: Metaheuristic Optimized Detection of Firmware Malware Using Audio Data	**Lethokuhle Sithole** 100: Determination of radionuclides in boreholes and river water samples collected from areas near the University of Zululand	**Mpumelelo Mkhwanazi** 159: Investigation of Power System Blackouts and Prevention Strategies	**Siyabonga Ntshalintshali** 139: Effect of Seed Priming on Bambara Groundnut Under Salinity Stress	**Sthembile Sithole** 64: Evaluation of Lessertia frutescens and Echinacea purpurea hepatotoxic effects using HepG2/C3A spheroids and Wistar rats

10:15 – 10:30	**Qiniso Siyabonga Ntshangase** 50: Copper-Based Sulfide Nanomaterials for Photocatalytic Degradation of Methylene Blue	**Mfundo Zuma** 68: Investigation of Photon Shielding Properties of Silicate Glass Systems from 1 to 15 MeV Using Phy-X/PSD, XCOM, and GEANT4 Simulations	**Mlondi Chili** 9: Advanced oxidation process for the degradation of chlorobenzene using TiO2 catalysts	**Sibahle Mthembu** 39: An Assessment of Food Safety and Hygiene Practices Amongst Food Vendors at a rural-based University	**Lindokuhle Makhunga** 15: Identification of Prevalent Gastrointestinal Nematodes in Zulu Sheep in the Kwa-Mthethwa Community	**Siphukuthula Mbhamali** 121: Insight into the role of p-Coumaric acid as an antioxidant for heavy metal (vanadium) stress tolerance in soybean
10:30 – 10:45	**Lungelo Sibongakonke Zuma** 31: Sentiment Analysis for Isizulu Text	**Mmeli Gwebu** 52: Thermal and mechanical properties of waste tyre/polypropylene blends and their applications	**Lungelo Chabaku** 124: Exploring Transit Method for Exoplanet Detection	**Moeketsi Mohlakoana** 87: A Comprehensive Review of Essential Visual Skills in Combat Sports	**Nompilo Masinga** 16: Structure-function analysis of Mycobacterium tuberculosis drug target cytochrome P450 125 (CYP125) enzyme family	**Nozipho Mbuyazi** 73: An ethno-botanical survey of indigenous plants used by smallholder farmers for small ruminant parasitic infestations in KwaMthethwa rural area, KwaZulu-Natal
10:45 – 11:00	**Amanda Dludla** 58: Coagulation-flocculation process in water treatment using cellulose nanocrystals-pva- graphene oxide composite beads	**Nosihle Msabala** 77: Investigation of X-rays and Gamma-ray Shielding Properties of Heavy Metal Oxide Glass Materials	**Dumile Gumede** 14: Assessing the performance of Wi-Fi student networks at the University of Zululand Kwa-Dlangezwa CaSabmpus	**Bongeka Mfeka** 155: Investigating the Knowledge, Utilization, and Perceptions of Indigenous Foods in Non-Profit Food Service Establishments in Empangeni, KwaZulu-Natal	**Michael Ojo** 67: In vitro antioxidant and hypoglycaemic potentials of Ptaeroxylon obliquum and Bauhinia bowkeri stem bark extract	**Sisonke Sentane** 84: Spatio-temporal analysis of July 2024 Storms over Western Cape, South Africa
11:00 – 11:15	**Muzomuhle Mlotshwa** 12: Systematics study of Octupole bands in rotating even-even nuclei to reveal rigid or soft Octupole shape	**Mpilonhle Rwarinda** 33: Visual and Sonified Chest X-rays for Multimodal Deep Learning-Based Respiratory Disease Classification	**Thabo Nhlenyama** 131: First-Principles Study of Brittleness in FCC Iridium	**Mpilo Ndumiso Shange** 72: Experiences of pregnant women regarding the use of traditional medicine (isihlambezo) at King Cetshwayo District in KwaZulu-Natal	**Thembelihle Ndlovu** 74: Effect of morula leaves supplementation on grass hay utilization by sheep	**Casandra Mbazima** 61: Evaluation of the effect of Senecio serratuloides and Strychnos madagascariensis extracts on the absorption and hepatic metabolism of metformin, rosiglitazone, glyburide, atorvastatin
11:15 – 11:30	**Karabo Ngobese** 24: Optimizing Automatic Speech Recognition for Low-Resource Languages: A Case Study on isiZulu	**Ntuthuko Ngwane** 79: Radiation shielding properties of Tm3+ doped borotellurite glass	**Nkosikhona Gcaba** 133: A Study of Polar Cap Absorption (PCA) and Its Impact on High Frequency (HF) Radio Communication	**Nokufika Zindela** 54: The Influence of Information Sources on Nutrition Knowledge and Eating Behaviours of Students at the University of Zululand	**Siphamandla Sokhela** 83: Assessing Waste Disposal and Sanitation States for Off-Campus University of Zululand Students in KwaDlangezwa	**Skhumbuzo Lungisani Ndwandwe** 135: The estuarine mud crab, Neosarmatium africanum, as a potential bio-indicator of metal contamination in the Mhlathuze Estuary

11:30 – 11:45	**Unarine Sadike** 126: A global perspective of the SWAT model in hydrological studies: A systematic review	**Musa Shange** 152: Application of Metal-Organic Frameworks to Facilitate the Combination of Checkpoint Blockade Immunotherapy with Photodynamic Therapy	**Ndzalama Pearl Kubayi** 147: Microplastic Contamination in Soil: A Systematic Review of the Influence of Anthropogenic, Climatic, and Environmental Conditions Due to Traffic and Accumulation	**Sifundile Maphumulo** 102: The Prevalence of Behavioural Non-Communicable Diseases Risk Factors Among Black Africans in Peri-Urban Community In South Africa	**Mndeni Mtshali** 91: Analysing climate variability and its influence on water Availability in UMhlathuze, KwaZulu-Natal, South Africa	**Fezeka Ndlazi** 163: Whole Genome Sequence Analysis of Escherichia coli O18ab:H11 from South African Beef Reveals Multiple Antimicrobial Resistance Genes, Virulence Factors, and an Uncommon Sequence Type
11:45 – 12:00	**Ntokozo Cebekhulu** 17: Structural and optical properties of rare earth (Sm3+)-doped hematite nanostructures	**Mxolisi Bonisanani** 95: Homomorphism in groups, rings and modules	**Nokuthula Mhlongo** 71: The Lie Symmetry Analysis of Time-Fractional Black–Scholes Equations with Market Anomalies	**Ncomi Lukhele** 105: Impact of Weight Status on Hemodynamic Parameters and Aerobic Fitness in School-Aged Children: A Study in a Rural School Community	**Senzo Zwane** 150: Insecticidal efficacy of leaf-derived Sclerocroton integerrimus (aqueous, n-hexane, dichloromethane, and ethanol) extracts against the pineapple pests	**Sibusile Samkelisiwe Zulu** 92: Evaluating the performance of weather forecasting models in predicting weather events over Durban, KwaZulu-Natal
12:00 – 12:15	**Francisco Olambo** 118: Oleylamine capped ZnS for efficient sono- and photo-catalytic dye degradation	**Blessing Nhlozi** 80: Trends of Thermal Structure in the MLT Region Using SABER Observations Over Sutherland	**Siyanda Mbuyazi** 164: Survival analysis of student dropout in STEM	**Nokubonga Mkhwanazi** 96: Perceptions of Nurse Managers Regarding Paperless Record Keeping in Public Hospitals in eThekwini and King Cetshwayo Districts, KwaZulu-Natal	**Nontobeko Zwane** 149: The impact of temperature and gibberellic acid on the germination of three Strychnos species	**Nhlakanipho Zulu** 69: Genetic Diversity and Population Structure of the South African Bosvelder Sheep: Insights for Sustainable Breeding in a Digitally Driven Africa
12:15 – 12:30	**Khulekani Manqele** 75: The role of hydrogen in the migration of strontium implanted into SiC.	**Sphesihle Ngwenya** 146: Design of a Solar-Powered Dynamic Wireless Charging System for Electric Vehicles in South Africa	**Ntando Madiba** 157: Optimizing Renewable Energy Integration in Power Grids Using Battery Energy Storage Systems (BESS)	**Nonkululeko Mathe** 104: A Review of the Essential Visual Skills Required for Netball: Beyond 20-20 Optometry	**Nkosingiphile Nomfundo Bhengu** 63: Identification of Prevalent Gastrointestinal Nematodes in Indigenous Chickens at the University of Zululand	**Nokwanda Lucia Khondowe** 11: Effect of vermicompost on the growth and yield of Solanum retroflexum and Solanum scabrum
12:00 **12:30- 13: 30**	**Poster Judging / Display in Foyer Commences** **Lunch**					

Session 2	Breakaway Session 2A Venue: Theatre Hall Chair: Dr ML Mathunjwa	Breakaway Session 2B Venue: Computer Lab 1 Chair: Dr PN Biyela	Breakaway Session 2C Venue: Computer Lab 2 Chair: Prof M Matadi	Breakaway Session 2D Venue: Classroom 1 Chair: Dr NF Masikane	Breakaway Session 1E Venue: Classroom 2 Chair: Dr N Sibanda	Breakaway Session 1F Venue: Introductory Laboratory 01 Chair: Ms AS Sibisi
13:30 – 13:45	**Ntuthuko Blessing Ngema** 53: Air Pollution Assessment Using Active Moss Biomonitoring, NAA, and ICP-OES in northern KwaZulu-Natal (South Africa)	**Siboniso Khethani Nyawo** 98: Global comprehensive review on subsurface water contamination and dynamic hydrogeochemical mechanisms: Nutrients and Trace metals	**Asande Lungelo Zikalala** 36: IsiZulu Information Retrieval System for UNIZULU	**Bashiru Makhaye** 137: Indigenous Climate Change Adaptation Strategies Used by Small-Scale Cattle Farmers in South Africa	**Khethiwe Ndlazi** 65: Evaluating the physiological and biochemical responses of maize (Zea mays L.) seedlings to Pseudomonas rhodesiae L312 strain (NL2019) inoculation under drought stress	**Nomathemba Mbatha** 153: A genome wide data mining and structural analysis of potential therapeutic target flavodoxins in gastrointestinal pathogens
13:45 – 14:00	**Qiniso Mthethwa** 30: Malicious PDF detection based on machine learning with evaluation of feature selection	**Manqoba Sithole** 37: Evaluating Deep Learning for Indigenous Medical plant identification	**Secret Els** 136: Enhanced Sonodynamic and Chemotherapy of Breast Cancer via Targeted and pH-Activated Delivery of Porphyrin and Chemotherapeutic Drugs Using a Library of Metal-Organic	**Thobani Masondo** 141: Investigating The Biochemical Interplay Between Pregnancy Complications and Maternal Cardiometabolic Health Through Systematic Review and Clinical Analysis	**Bonakele Mzimela** 145: Applications of nano-Metal-Organic Frameworks in direct Radiodynamic therapy	**Ntokozo Magutshwa** 94: Effect of heat stress and honey supplementation on physiological parameters, blood chemistry and behavioural responses of indigenous chickens
14:00 – 14:15	**Lukusa Cimanga** 158: Microplastics in uMhlathuze River: Investigating the Extent of Contamination and Its Impact on Freshwater Ecosystems	**Luyanda Mpanza** 43: Effectiveness of Machine Learning Algorithms in Real-Time Credit Card Fraud Detection	**Sakhile Ndawo** 148: Studying all Tolman metrices on Eistein Gauss Bonnet gravity	**Simphiwe Xulu** 138: The role of civil society organisations in co-management agreements between Phinda Private Game Reserve and selected communities, KwaZulu-Natal, South Africa	**Nosipho Dlamini** 123: Spatio-temporal analysis of recent trends and cut-off lows development over Durban, KwaZulu-Natal	**Nokulunga Sithole** 165: Mapping heatwave vulnerability over KwaZulu-Natal using remote sensing and Analytic Hierarchy Process
14:15 – 14:30	**Sifiso Mthalane** 20: Effect of strontium oxide on radiation attenuation properties of boro-tellurate glass systems at high radiation energies	**Lindani Cele** 162: Science Student Enrolment Patterns Over Time at University	**Nosihle Gcaleka** 41: AI-Driven Network Traffic Optimization for enhanced Resource Efficiency	**Senamile Zungu** 144: Systematic review: Applications of Porphyrin-based Nano-Metal Organic Frameworks in the Combination of Photodynamic Therapy with Immunotherapy	**Siyanda Mntambo** 130: Efficacy of fish effluent as an organic nutrient source for groundnut (Arachis hypogaea L.) production	**Thabile Shozi** 142: Systematic review: Applications of Nano-Metal Organic Frameworks in the Combination of Photodynamic Therapy with Chemotherapy

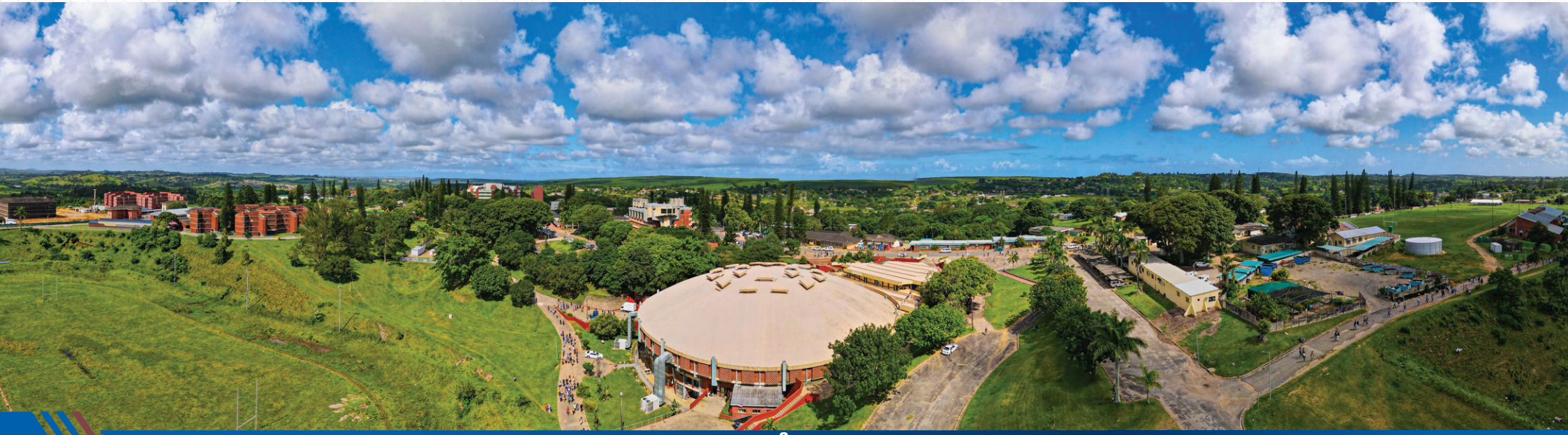
14:30 -14:45	**Lungani Gcabashe** 48:Exploring the Accumulation of isiZulu Text Material from public Facebook pages to Train Large Language Model	**Phakamani William Sibeko** 56: Comparative Analysis of Machine Learning and Deep Learning for Intrusion Detection in IoT Networks	**Lwazi Zulu** 44: A LIME-Based Approach for Enhancing Interpretability in Facial Recognition		**Sizwe Perfect Mthimkhulu** 97: Satellite Remote Sensing of Macadamia Orchards and its Response to KwaZulu-Natal Climate Dynamics	**Zizipho Mamfengu** 81: Abundance and Biomass of Sandprawn Kraussillichirus kraussi in Richards Bay Harbour.
14:45 – 14:55	**Closing plenary session:** Prof Fon					
14:55 – 15:30	Choir					
15:30 – 16:00	Awarding of prizes – Overall winner & 2 runners up (2nd & 3rd places) (Honours, MSc & Doctoral paper and poster categories) by the FSAE Dean – **Prof KC Lehloenya**					
16:00-16:10	Closure and vote of thanks – Prof P Mudali					
Day Complete / departure						

Note of thanks

Dear delegates and attendees

On behalf of the UNIZULU, Department of Computer Science and the Faculty of Science, Agriculture and Engineering, we extend our heartfelt gratitude for your active participation in the 2025 Faculty of Science, Agriculture and Engineering Annual Postgraduate Symposium hosted on **16 October 2025** at UNIZULU, Richards Bay Campus

2025 Faculty of Science, Agriculture and Engineering Annual Postgraduate Symposium Organising Committee



2025 FSAE Symposium Posters

Paper ID	Paper Title	Author Name
18	Convection and its Effect in Stellar Pulsation	Thembeka Ntombela
19	IoT-Based smart irrigation system: enhancing water management in smart agriculture	Sabelo Zikhali
23	Perceptions and factors affecting utilisation of indigenous foods among students at the University of Zululand	Ntando Hlatshwayo
25	Automating the creation of IsiZulu academic domain corpus	Nonjabulo Khuzwayo
26	Detecting GPS Spoofing	Nokwabelwa Majola
27	Emotion Detection from IsiZulu Text	Mthokozisi Mathonsi
28	Comparative Analysis of Overfitting Deep Learning Models and Statistical Methods for Financial Prediction	Msizi Kunene
29	Sentiment Analysis for Low Resource Languages (IsiZulu) in South Africa	Thokozani Sibiya
32	Exploring the Collection of Isizulu Textual Material from Libraries to Bridge the Language Gap in LLMs	Nsindiso Ngubane
34	Using Large Language Models (LLMs) to Generating Medical Discharge Summaries	Luyanda Hlongwana
35	Evaluating Blockchain Scalability for Secure IoT Data in Healthcare	Anele Langa
38	LLMs for Understanding Low-Resource languages: An Empirical Study of isiZulu, isiXhosa, and Sepedi	Amukelani Majola
40	Assessing the impact of AI-powered password cracking on cybersecurity: Effectiveness, Implications, and Potential countermeasures	Thandokuhle Manukuza
42	Evaluation of the Effect of Feature Selection Techniques on Machine Learning Algorithms For Phishing Detection.	Sphamandla Njokweni
46	The Impact of Integrating Explainable Artificial intelligence For Anomaly Detection on Blockchain Transactions	Kamogelo Matabane
47	Exploring The Collection of Isizulu Text Material From Youtube User Comments to Train Large Language Models	Nombuso Mnqayi
49	Exploring isiZulu Corpus development from newspapers to train large languages models	Mpilo Buthelezi
51	Detection of respiratory diseases in chest sounds using audio-based techniques and machine learning	Nomonde Ntuli
55	An Enhanced Transformer-based Model for Translating South African Languages using BART.	Simangaliso Buthelezi
57	Synthesis and characterization of functionalized cellulose-based PVA-Zinc oxide composite membrane for water remediation applications.	Ntombenhle Mchunu
59	Evaluation of Sentiment Detection in English and isiZulu Using Transformer Models	Vumani Ntuli
60	A comparative study of traditional versus hybrid model optimization techniques for efficient edge AI execution.	Simphiwe Masuku
62	Student profiles and factors affecting the performance of first year Consumer Sciences students at the University of Zululand.	Corrie Du Preez
67	In vitro antioxidant and hypoglycaemic potentials of Ptaeroxylon obliquum and Bauhinia bowkeri stem bark extracts	Michael Ojo
70	Effect of nitrogen, phosphorus, and potassium and compost tea manure on Solanum tuberosum vegetative and tuber phenomics	Nokukhanya Ntuli

76	Microplastic contamination in a relatively pristine estuary: A case study of uMlalazi Estuary, South Africa	Mlando Mthembu
78	Exploring Lie Group Symmetries in Difference-Based Black Scholes Equation.	Andrew Mochaki
82	Investigating The Potential of Contemporary Menu Adaption in South African Indigenous and Cultural Food	Phomolo Nkholise
85	Student Perceptions on Enhancing the Delivery of Physical Activity Programs in a Semi-Rural University	Silindokuhle Radebe
87	Mathematical Modelling of Malari Transmission Dynamics: Explicit Solutions and Control Strategies	Lindokuhle Ncebo Mbuyisa
88	Exploring the Accumulation of isiZulu digital material from publishers, for large language models (LLMs) training	Nosipho Ngubande
89	Investigating Cellulose-Based Conductive Hydrogels for Potential Application in Energy Storage.	Dumisani Doctor Simelane
93	Effects of High Intensity Interval Training and Indigenous Games on Physical Fitness and Health Related Outcomes on Young Overweight and Obese women	Thabiso Nosipho Mantengu
99	Determining Radon Exhalation Rates from a Gold Mine Tailing by Using Gamma Ray Spectroscopy Technique.	Sthembokuhle Sthembokuhle
101	Applications of Wedderburn Theorems	Bongani Ngcobo
103	Synthesis and Surface Modification of Titanium Dioxide Pigments with Multifunctional Properties for Coating Applications	Sfundo Msezane
106	High resolution airborne based detection of illegal dumpsites and diagnosis of contributing factors in selected areas of uMhlathuze local municipality	Nomcebo Sokhela
107	Investigating Quantum Entanglement for PET scan enhancement	Nontuthuko Shezi
108	Water quality monitoring of Mzingazi lake at Richards Bay using Google Earth Engine	Siyanda Hlatshwayo
109	Design and Implementation of a Remotely-Controlled and Autonomous Electric vehicle	Oluwafemi E. Oni
110	Investigation of Silver and Cesium Migration and Structural Evolution in 6H-SiC Following Helium, Silver and Cesium Co-Implantation and High-Temperature Annealing	Nhlakanipho Mantengu
111	Functorial Perspectives on Algebraic Structures	Nosimilo Khululiwe Mvelase
112	A Mathematical model of removing contaminant from fluids stream.	Nhlanhla Masindane
113	On the Lattice Structure of Classes of R-Modules Closed Under Specific Closure Properties	Asande Mbuso Mpontshane
114	Dynamical Systems Analysis of Dark Energy in Cosmology	Nomvelo Khumalo
115	Microbial Contaminants in Agricultural Catchments: A Cross-Regional Review of Drivers, Risks, and Responses	Khodani Chauke
116	Experiences of first year student nurses regarding Work Integrated Learning at the selected clinical facilities in King Cetshwayo District at KwaZulu-Natal	Siboniso Siboniso
117	The Impact Of Climate Change On Surface Runoff In The City Of Cape Town, Western Cape South Africa	Zanele Moyana
119	Spatiotemporal dynamics of land use and land cover changes and rainfall trends in Molopo River catchment, South Africa	Nomvelo Mchunu
120	Assessing the Impact of Climate Change on Surface Runoff in Gqeberha, Eastern Cape	Asanda Mnguni
122	Characterization of proton-induced defects in SnO2 using positron annihilation technique.	Dineo Motjope
125	Microplastic Pollution in Marine Ecosystems: A Comprehensive Review of Causes, Transportation and Impacts	Siphesihle Zulu

127	Optimizing Culture Conditions of a Kombucha tea SCOBY isolate for Bioflocculant Production, Characterization, and its Application in Wastewater Treatment and Dye Removal	Nokwazi Mbhele
128	Evaluating the historical changes in groundwater storage using GRACE Groundwater Subsetting Tool (GGST) in Mhlathuze catchment.	Busisiwe Ngcobo
129	The effect of egg weight on egg quality characteristics of layer chickens	Fortune Thabethe
132	Exact Models in Einstein-Gauss-Bonnet gravity	Bongani Vezi
134	Occurrence, bioaccumulation and risk assessment of microplastics in Mzingazi Lake.	Zibuyile Mabaso
140	GC-MS Profiling, Antimicrobial Evaluation and Molecular Docking Studies of Sclerectoron integerrimus Leaf Extracts from n-Hexane Fraction.	Kuhlukuthula Sibongakonke Ngema
151	Examining The Impact of Social Media Marketing on Guest Preferences in Rural Lodges and Guesthouses.	Azande Siphephile Mjadu
154	The effect of habitat-heterogeneity on macrobenthic community diversity in the Mlalazi Estuary.	Zamani Eugene Ngcobo
156	Enhancing Smart Grid Stability using Real-Time Demand Response and Energy Storage Systems Integration	Khondani Conjwa
160	Low-Cost Demonstration Platform for Phasor Measurement Unit Applications in Power Systems.	Anelisa Mantshi
161	Design and Modeling of 12 pulse Thyristor Converter Systems for Transient Stability Control	S'thobile Mdluli
166	Evaluating the microbial diversity and characteristics of kombucha fermented using Cyclopia genistoides	Evelyn Madoroba

Homomorphism in groups, rings and modules

Mxolisi Bonisanani

Abstract

This project investigates the concept of homomorphisms within the framework of abstract algebra, focusing specifically on groups, rings, and modules. Homomorphisms are fundamental structure-preserving maps that enable the transfer of algebraic information between different algebraic systems by respecting the operations that define these structures. In groups, homomorphisms preserve the group operation; in rings, they maintain both addition and multiplication; and in modules, they respect both addition and scalar multiplication. Through an exploration of homomorphisms, this project examines essential notions such as kernels, images, and the role they play in characterizing algebraic structures and establishing isomorphisms. The study further highlights key theorems—such as the isomorphism theorems—that arise naturally from homomorphic mappings. By analysing examples and properties across groups, rings, and modules, the project demonstrates the unifying power of homomorphisms in understanding and classifying algebraic objects, as well as their applications in more advanced algebraic theories.

Exploring isiZulu Corpus development from newspapers to train large languages models

Mpilo Buthelezi

Abstract

This work aimed to support the development of a digitally inclusive Africa by collecting a high-quality isiZulu text corpus from isiZulu newspapers to support the training of Large Language Models (LLMs). There had been an increasing demand for African language resources in Natural Language Processing (NLP), and this research sought to bridge the gap of underrepresented African languages, with a focus on isiZulu. The collection of isiZulu datasets was expected to contribute towards the accurate training of machine learning applications. The collection involved the extraction and scraping of data from the *Isolezwe* website using Python, as well as the receipt of documents sent directly by the editors of *Ilanga* newspaper. The initial evaluation focused on text data size, isiZulu language quality, and the structural diversity of the isiZulu texts. After the collection process was completed, the text corpus was cleaned and pre-processed to prepare the data for model training. This ensured that the dataset was linguistically consistent, free from noise, and suitable for computational use. Ultimately, the cleaned corpus provided a reliable foundation for future NLP applications and the development of isiZulu-ready Large Language Models (LLMs). The expected outcome of the research work is a sustainable, domain rich corpus that can support large language Models training. One challenge is the interaction with the newspaper editor, not always easy. The posted news per day is close to 75.67KB which is time consuming.

Keywords: newspaper, isiZulu, Low-resource languages, Large Language Models (LLMs), Corpus development, Data cleaning, Text preprocessing, African languages

An Enhanced Transformer-based Model for Translating South African Languages using BART

Simangaliso Buthelezi

Abstract

Fine-tuning Large Language Models has proven successful for many tasks in Natural Language Processing (NLP), with this study focusing on fine-tuning Bidirectional and Auto-Regressive Transformers (BART) model for machine translation task. Neural Machine Translation (NMT) requires an extensive parallel corpus to achieve optimal results, which is sometimes unavailable for minority languages. This paper proposes to enhance NMT by fine-tuning BART for South African languages translation. The goal of this study has been translating to isiZulu and isiXhosa, which are considered as low-resourced languages. The translation pairs utilized in this study to fine-tune the model are English-isiZulu and English-isiXhosa. This study fine-tunes the mBART50 model using Autshumato dataset, with 18, 000 parallel sentences utilized to train the model. The fine-tuned model shows an improved performance achieving a BLEU score of 20.41 and 10.44 for English-isiZulu and English-isiXhosa translation pairs. The encouraging outcomes of the fine-tuned mBART model arise from successful transfer learning facilitated by pre-training on a varied dataset, supporting the model to understand complicated language representations.

Keywords: Transformer model, South African Languages, BART, isiZulu language Structural and optical properties of rare earth (Sm3+)-doped hematite nanostructures

Samarium (Sm3+)(0-6%) doped hematite (α-Fe2O3) nanostructure were synthesized using the hydrothermal method and characterized to evaluate structural and optical modifications

Ntokozo Cebekhulu

Abstract

X-ray diffraction confirmed the rhombohedral structure of α-Fe2O3 in the 3RC spacing group with reduced crystallite size upon the (Sm3+) doping. Transmission electron microscopy revealed morphology changes from spherical particles to nanorods with increasing dopant concentration. Fourier transform infrared spectroscopy verified Fe-O bonding and indicated a shift in the transmittance due to Sm3+ incorporation. Ultraviolet-visible spectroscopy analysis shows a progressive band gap narrowing from 2.23 eV to 1.81 eV as Sm3+ content increased, enhancing light absorption. The observed structural and optical transformations suggest the potential of Sm3+-doped α-Fe2O3 for improved performance in optoelectronic and sensing applications. This work is more based in the gas sensing application.

Science Student Enrolment Patterns Over Time at University

LR Cele

Abstract

This study examines enrolment patterns among science students at a South African university from 2005 to 2019, focusing on socioeconomic, demographic, and institutional factors influencing changes over time. Using administrative data from the University of KwaZulu-Natal, variables such as gender, race, academic performance, and financial aid status were analysed. A quantitative research design employed descriptive statistics, cross-tabulations, and logistic regression to assess trends and predict science enrolment based on key determinants. Descriptive analyses revealed variations by demographic group and field of study, while logistic regression results showed significant associations between enrolment and socioeconomic status, prior academic achievement, and access to financial support. Model selection via backward elimination and stepwise methods retained only statistically significant predictors. Diagnostics, including the variance inflation factor, the Hosmer–Lemeshow test, and ROC (Receiver Operating Characteristic) and AUC (Area Under the Curve) analysis, confirmed the model's robustness. Findings highlight persistent disparities in science participation among historically disadvantaged groups and emphasise the influence of financial aid, school background, and gender. The study recommends targeted policy interventions, improved resource allocation, and institutional strategies to promote equitable access, retention, and success in science education.

Keywords: science enrolment, socioeconomic status, ROC, AUC, logistic regression, higher education.

Themes: Higher Education Access and Equity; Data-Driven Educational Policy; STEM Education Development

Exploring Transit Method For Exoplanet detection

Chabaku L

Abstract

The discovery of exoplanets has revolutionized modern Astronomy and the way we perceive planetary motion and our planetary system with the transit method being one of the most effective techniques in detecting exoplanets. This study focuses on the principles, applications and challenges of transit method in identifying exoplanets. Moreover, it focuses on exoplanet discoveries done by using this technique which measures the decrease in brightness of the host star as a planet passes in front of it. We will be examining our current state of knowledge in exoplanet detection using multiple methods but mainly focusing on transit method and highlighting the advantages of using it. The goal of this research is to investigate transit method and detect exoplanets while also examining its biases and limitations. Furthermore, the study explores the fundamentals of telescope operations. The examination reveals that transit method has been very useful in detecting thousands of exoplanets including potential habitable environments. We also discussed the role of current and future missions which is Transiting Exoplanet Survey Satellite (TESS), in improving our knowledge and understanding of Exoplanetary system.

Keywords: transit, exoplanets, baises, Transiting Exoplanet Survey Satellite(TESS)

Microbial Contaminants in Agricultural Catchments: A Cross-Regional Review of Drivers, Risks, and Responses

Chauke Khodani

Abstract

Water scarcity for irrigation has increasingly driven reliance on wastewater to conserve freshwater as a limited resource, particularly in water-scarce countries. However, wastewater often exhibits increased levels of microbial and nutrient contamination, posing significant risk to the environment and human health, with a variation depending on the region's ability to treat and reduce water contamination. To fully understand the global microbial status and nutrient leaching in irrigation water, it is crucial to evaluate the concentration and distribution of microbial contaminants and nutrients impacting surface water, soil, and crops, along with the public health risks associated with utilizing such water for agricultural irrigation. This review assessed water quality for irrigation using total coliforms, fecal coliforms, and E. coli as indicators for microbial contamination, together with nutrient leaching (nitrates) into the soils. A total of 152 papers were adopted: 60 from ScienceDirect, 21 from SpringerLink, 18 from MPDI, 9 from Taylor & Francis, 6 from Wiley, 3 from Scientific Research, and 32 from other journals. Findings reveal that insufficient and inadequate proper wastewater treatment plants in regions like Africa and Asia, coupled with intensive farming, pesticides, industrial sewage, and waste effluent, are the main source of elevated microbial contamination and nutrient leaching. In contrast, Europe and North and South America have demonstrated low microbial concentrations in surface water used for irrigation, due to advanced wastewater facilities and strict regulations. Climate change variation showed that increased temperatures, and heavy precipitation pollute the environment with microbes, especially in dry regions, through surface runoff and the growth of microbes caused by temperature increase. Excessive fertilizer application in China, exceeding 300 kg/ha, has led to significant nitrate leaching, whereas African countries, applying less than 25 kg/ha, exhibit comparatively low leaching rates. Therefore, alternatives to reduce microbial and nutrient contamination globally include improving wastewater management, applying best management practices in agriculture, and implementing strict policies for wastewater discharge.

Key words: Irrigation water quality, microbial contamination, nutrient leaching, total coliform, fecal coliform, Escherichia coli (E. coli). Soil.

Advanced oxidation process for the degradation of chlorobenzene using TiO_2 catalysts

MMH Chili

Abstract

The highly toxic, chemically stable, and oxidation-resistant pollutant, chlorobenzene, has attracted significant attention in water treatment research in recent decades. Its widespread use in industries such as pharmaceuticals and pesticides has led to environmental contamination arising from its improper disposal and bioaccumulation within water sources. However, traditional water treatment attempts have reportedly produced harmful carcinogenic by-products, such as furans and dioxins. In this study, a catalyzed ozonation advanced oxidation process (AOP) was investigated for the degradation of chlorobenzene into environmentally benign products. This approach leverages the high oxidation potential of ozone (2.07 V), precisely calibrated for maximum efficiency, in combination with titanium dioxide (TiO_2), a versatile and promising metal oxide catalyst via an adapted sol-gel method. Anatase phase TiO_2 powders were synthesized at pH 3, 7, and 11. X-ray diffraction (XRD) analysis confirmed the presence of characteristic anatase diffraction peaks for catalysts prepared at pH 3 and pH 7. However, TiO_2 synthesized at pH 11 was found to be amorphous, as indicated by the absence of clear diffraction peaks, likely due to limitations in the adapted synthesis method. This would be targeted for refinement in future work. Fourier Transform Infrared (FT-IR) spectroscopy identified the expected TiO_2 functional groups, while Transmission Electron Microscopy (TEM) revealed agglomerated TiO_2 with average particle sizes of 8.21 nm for pH 3 synthesized catalysts, and 11.88 nm for pH 7 synthesized catalysts. Catalytic ozonation experiments were performed over 24-hour periods, with sample aliquots collected at 3, 6, 12, 18, and 24-hour intervals. The ozonation products were analyzed using Gas Chromatography–Mass Spectrometry (GC-MS), which revealed that ozonation under pH 3 synthesized TiO_2 achieved a 38.90% conversion of chlorobenzene, while ozonation under pH 7 synthesized TiO_2 achieved 95.71% conversion after 12 hours, with product selectivity towards ethyl hexanoate (18.23%).

Keywords: AOP, TiO_2, Catalysts, Chlorobenzene, conversion, selectivity.

Investigation of Power System Blackouts and Prevention Strategies

Khodani Conjwa

Abstract

Power systems are critical infrastructures that underpin modern society, with far-reaching impacts on economic stability, technological advancement, and daily life. Despite advanced protection schemes designed to prevent disruptions, power grids remain vulnerable to emergencies and cascading failures that can lead to widespread blackouts. These events, often triggered by faults, cyberattacks, or extreme weather, highlight persistent gaps in system resilience. This research presents a comprehensive investigation into the phenomenon of power system blackouts, with particular focus on understanding their root causes, analyzing their propagation patterns, and evaluating effective prevention strategies. The study examines several historically significant blackout events, including the 1965 Northeast blackout that revolutionized grid reliability standards, the 2003 Italy blackout that demonstrated the risks of international grid interdependencies, and the 2015 Ukraine blackout that revealed new vulnerabilities in the digital era of power systems. Each case study provides unique insights into different failure modes and their systemic impacts. To complement the theoretical analysis, the research employs advanced simulation techniques using DigSILENT PowerFactory to model cascading failures in a standardized IEEE 9-bus test system. The simulation framework systematically evaluates the effectiveness of various mitigation strategies under different fault scenarios. Special attention is given to quantifying performance improvements in key stability metrics such as voltage recovery time, and cascade propagation limits.

Keywords: energy system security; power system emergency; power system blackout; power system cascading events; emergency management; power system stability; smart grids; frequency protection; power system protection; power outages

Exact Models in Einstein-Gauss-Bonnet Gravity

Bongani Vezi Dlamini

Abstract

This research in its initial stage, explores the location of exact solutions followed by the construction of stellar models in Einstein-Gauss-Bonnet (EGB) gravity. We solve the system of EGB modified field equations through integration using the ad hoc technique in which we assign one gravitational potential to find the other potential. The incorporation of the Gauss-Bonnet term in the EGB field equations assists in comparing the effectiveness and physical admissibility between the EGB models (for higher-dimensional gravity or modified theory of relativity) and the Einstein models (for General Relativity). General Relativity (GR) is extended to higher-dimensional gravity by incorporating the extra curvature terms. We analyze the developed stellar models through a process of fine-tuning the selected parametric space of constants until a desired plausible model emerges. The findings of this research contribute to providing a profound understanding of the behavior and nature of the interior of the star. The unearthed cosmological mysteries provide a vivid understanding of how the universe operates.

Key words: General Relativity, Modified Theory of Relativity, Einstein-Gauss-Bonnet gravity, Exact Solutions

Spatio-temporal analysis of recent trends and cut-off lows development over Durban, KwaZulu-Natal

Nosipho C. Dlamini

Abstract

Cut-off lows (COLs) are unique weather systems cold-cored low-pressure areas that form in the mid to upper levels of the atmosphere. They often break away from the main westerly winds and bring intense weather conditions. In coastal cities like Durban, KwaZulu-Natal, these systems have been linked to severe events such as heavy rainfall, strong winds, floods, and damage to infrastructure. This study investigates how these systems behaved over Durban, how often they occurred, how strong they were, and whether larger climate patterns like El Niño and the Indian Ocean Dipole had any influence. To do this, we drew from a range of data sources including weather records from the South African Weather Service, National Oceanic and Atmospheric Administration and climate tools from Koninklijk Nederlands Meteorologisch Instituut. We used Geographic Information Systems (Arc GIS) to map where COLs tend to happen and applied statistical methods such as the Mann-Kendall test and Sen's Slope estimator to understand trends in their frequency and strength over time. The results show that COLs mostly occur in autumn and early winter, and that they are becoming more intense likely due to rising sea surface temperatures and changes in atmospheric circulation. These patterns raise concerns about increasing flood risks and other impacts for Durban. This research offers valuable insights that can improve local weather forecasting, strengthen early warning systems, and support better planning for climate adaptation and disaster risk reduction in Durban and similar coastal cities.

Keywords: Cut-off Lows (COLs), floods, Durban, Indian Ocean Dipole, Mann–Kendall test

Coagulation-flocculation process in water treatment using cellulose nanocrystals (CNC)-polyvinyl (PVA)- graphene oxide (GO) composite beads

Dludla Amanda

Abstract

This study examines the effectiveness of CNC-PVA-GO composite beads in improving coagulation and flocculation process in water treatment. Cellulose was extracted from sugarcane bagasse (SCB) followed by hydrolysis using sulfuric acid to obtain CNCs. The reactivity of cellulose nanocrystals (CNCs) with contaminants was improved by performing carboxylation and amination. To further enhance their interaction abilities, the CNCs were quaternized. Hydrophobization of graphene oxide (GO) was used to improve its compatibility with the composite structure. The composite beads, which offer a special blend of mechanical strength and adsorption ability, were created by combining cellulose nanocrystals (CNC), polyvinyl alcohol (PVA), and graphene oxide (GO). Thermogravimetric analysis (TGA), X-ray diffraction (XRD), and Fourier- transform infrared spectroscopy (FTIR) were used to determine the thermal and structural characteristics of the composite beads. FTIR data verified the existence of functional groups which improve the beads' capacity to absorb contaminants. XRD study revealed crystalline changes that suggested enhanced stability in structure, while TGA showed strong thermal resistance for practical uses. The effectiveness of the composite beads in eliminating contaminants and turbidity from contaminated water with methylene blue was evaluated in laboratory tests using jar test, which revealed significantly improved results compared to conventional materials such as aluminium sulphate. The possibility of CNC-PVA-GO composite beads as a novel and sustainable approach to efficient water treatment is demonstrated by this study, which promotes more investigation into renewable resources for pollution control.

Keywords: Coagulation, flocculation, cellulose nanocrystals, graphene oxide.

Student Perceptions on Enhancing the Delivery of Physical Activity Programs in a Semi-Rural University

Corrie Du Preez

Abstract

Adequate facilities and effective delivery of physical activity programs are essential for promoting active lifestyles among university students, especially in semi-rural contexts where structural barriers can hinder participation. This study investigated student perceptions and recommendations for enhancing the delivery of physical activity programs at the University of Zululand, a semi-rural South African institution. Using a mixed-methods design, quantitative data were collected from 328 full-time students via semi-structured questionnaires, while qualitative insights were drawn from 23 semi-structured interviews with purposively selected participants. Quantitative findings indicated moderate satisfaction with the marking and maintenance of sports facilities ($M = 3.20$, $SD=1.21$, $p = .004$), but neutral perceptions regarding changing room conditions ($M = 2.98$, $SD=1.29$, $p = .787$) and lighting ($M = 2.76$, $SD= 1.24$, $p = .001$). Perceptions of communication from the university's Sport and Recreation Services regarding plans and budgets were also low ($M = 2.88$, $SD=1.02$, $p = .036$). Qualitative data supported these results, highlighting limited awareness of available programs, insufficient staff support, and a shortage of qualified coaches. Participants consistently recommended improved infrastructure, enhanced promotional strategies, greater recognition of student athletes, and increased transparency in communication. These findings underscore the need for targeted institutional reforms to enhance visibility, accessibility, and support within university sport and recreation programs. The study offers practical guidance for institutional policy reform to strengthen the delivery of physical activity programs in semi-rural, under-resourced higher education institutions, ultimately fostering a more active, engaged, and healthier student population.

Keywords: Perceptions, university physical activity programs, student recommendation, programs visibility

Enhanced Sonodynamic and Chemotherapy of Breast Cancer via Targeted and pH-Activated Delivery of Porphyrin and Chemotherapeutic Drugs Using a Library of Metal-Organic

Secret Els

Abstract

Treating deep-seated tumours remains a major clinical challenge due to the toxicity and the development of cancer cell resistance to standard therapies. We have designed a multifunctional nanoplatform for a synergistic combination of sonodynamic therapy (SDT) and chemotherapy which will be activated by the acidic tumour microenvironment (TME) to release sonodynamic therapy and chemotherapy agents, and then by external ultrasound to generate reactive oxygen species (ROS). Our methodology involves synthesis of a zirconium-based nano metal-organic framework (Zr-MOF) to co-encapsulate a porphyrin sonosensitiser (PSS) and the chemotherapy drug doxorubicin (DOX). The nano system is then surface-functionalised with a pH-degradable carbohydrate polymer for enhanced stability and active tumour targeting. The therapeutic action is controlled by a dual-trigger mechanism. First, the acidic TME initiates the release of DOX and the PSS, after which a focused ultrasound activates the PSS to generate cytotoxic ROS. We will validate the functionality of the nanosystem in multiple stages. The initial stage involves characterisation with FTIR, NMR, UV-Vis, and HR-TEM to confirm its structure, payload encapsulation, and morphology. Next, *in vitro* studies using MCF-7 breast cancer cells will verify nanoparticle uptake, pH-responsive drug release, and cytotoxicity via the MTT assay. Lastly, the system's efficacy and safety will be evaluated in an MCF-7 murine xenograft model, by assessing tumor grown in athymic nude mice, with their regression tracked by high-frequency ultrasound. This study aims to overcome the limited penetration depth of conventional PDT. By giving clinicians precise control over where and when the drug is activated, our approach is designed to improve the therapeutic effect on cancer and reduce damage to healthy tissue. This work could create a more potent and adaptable platform for treating deep-seated solid tumours.

Keywords: Metal-Organic Framework (MOF); Sonodynamic Therapy (SDT); Combination Therapy; pH-Responsive Drug Delivery; Doxorubicin; Breast Cancer; Porphyrin; Tumour Microenvironment (TME); Ultrasound; Reactive Oxygen Species (ROS).

A Study of Polar Cap Absorption and Its Impact On High Frequency (HF) Radio Communication

Gcaba N

Abstract

Significant space weather phenomena known as Polar Cap Absorption (PCA) events are brought on by increased ionization in the ionospheric D-region, which is primarily brought on by energetic solar protons connected to Solar Energetic Particle (SEP) events. Increased Cosmic Noise Absorption (CNA) from this ionization can significantly weaken high-frequency (HF, 3-30 MHz) radio waves, impairing or stopping communication entirely in polar areas. Using Riometer data from the University of Calgary and solar proton flux measurements from GOES satellites, this study examines PCA events that occurred between June 15 and 22, 2006, a period characterized by intense SEP activity. While GOES data measure the flux of protons with energies greater than or equal to 10 MeV, riometer observations offer a ground-based measure of CNA that acts as a stand-in for D-region ionization. The analysis determines the PCA onset times, durations, and intensity thresholds by establishing a correlation between CNA enhancements and changes in proton flux. With PCA events causing up to [insert quantitative measure, e.g., X dB] of absorption over several hours, the results demonstrate a strong temporal and quantitative correlation between increased CNA and elevated solar proton flux. These results show that SEP-driven ionization directly affects the dependability of HF radio communication in polar areas. The study encourages the creation of better space weather forecasting and PCA characterization models, which can guide mitigation plans for HF radio link-dependent polar operations like aviation.

Exploring the Accumulation of isiZulu digital material from publishers, for large language models (LLMs) training

Lungani Gcabashe

Abstract

This research focuses on exploring the possibility of accumulating isiZulu textual digital material from publishers. The material, structured as a clean and reliable isiZulu corpus, will be in future used for large language models (LLMs) training. The work addresses the underrepresentation of African languages such as isiZulu in natural language processing (NLP) tools. The study uses a mixed method approach of qualitative and quantitative methods, a qualitative method is used to Identify isiZulu publishers and asking them to use their isiZulu material in the development of large language models and a quantitative method is used by collecting digital material from publishers. This involves identifying and collecting isiZulu materials from publishers, cleaning raw text data by removing noise such as URLs, ISBNs and other noisy elements. A tool called langdetect is used to detect, identify isiZulu and remove text in other languages. IsiZulu digital material is available from publishers and it can be collected. Cleaning and preprocessing process is required, to ensure language consistency and usability. The cleaning and preprocessing pipeline successfully filtered and made a reliably cleaned isiZulu text, which can be used for LLMs training. Some publishers may be unwilling to share and allow to use their content for research. Existing isiZulu NLP tools are very few and with limited capabilities, making preprocessing difficult. Recommendations includes creating a platform where publishers will share a digital cop of their work. This platform might also encourage other language experts to contribute material and expertise to help ensure that low resourced languages such as isiZulu are better represented in the digital world.

AI-Driven Network Traffic Optimization for enhanced Resource Efficiency

Nosihle Gcaleka

Abstract

The increasing growth of internet usage and digital usage has put a strain on traditional network infrastructures, especially during peak usage times. Institutions and enterprises such as Higher Education Institutions (HEIs), financial institutions, and healthcare institutions are experiencing service degradation and poor Quality of Service (QoS) due to high traffic volumes, congestion, slow response times, and resource bottlenecks. In HEIs, for instance, at the University of Zululand (UNIZULU), when a large number of students access online platforms such as e-learning platforms and ITS, the system becomes overwhelmed and experiences system timeouts, website crashes, and unreliable service delivery. Traditional network Management techniques cannot handle these challenges. This study proposes a novel, intelligent, and multi-layered AI framework for real-time, multi-objective network traffic optimization. This framework integrates network classification, prediction, and optimization into a single Artificial Intelligence (AI) system. Raw traffic data is processed through a classification module where a hybrid approach is used, which includes Convolutional Neural Networks (CNNs), Self-Organizing Maps (SOM), and Ant Lion Optimization (ALO) [CNN+SOM+ALO]. This hybrid classification model will balance latency, accuracy, and resource usage. A prediction module uses Long Short-Term Memory (LSTM) networks to predict peak traffic patterns to support proactive network management. Finally, an optimization module will use ALO and Quantile Regression Deep Q-Networks (QRDQN) to enable dynamic resource allocation and intelligent routing, especially during peak demand. The study will be evaluated in a simulated environment using Cisco Packet Tracer, focusing on scalability, responsiveness, and adaptability under varying traffic loads. The expected outcomes include enhanced network performance, reduced congestion, and improved quality of services. This research aims to contribute to sustainable digital development by addressing important performance challenges in modern networks. It offers a scalable, AI-driven solution for real-time traffic optimization that supports Africa's Digital Transformation agenda.

Assessing the performance of Wi-Fi student networks at the University of Zululand Kwa-Dlangezwa Campus

Gumede D.P

Abstract

This study evaluated the performance and coverage of the student Wi-Fi network at the University of Zululand's KwaDlangezwa campus. The research adopted a mixed-methods approach, combining site surveys, performance testing, and user feedback to assess signal strength, coverage, and student satisfaction. The key objectives were to examine coverage limitations, analyze signal strength and network capacity, and evaluate user experiences. Findings from an online survey revealed widespread dissatisfaction with the current Wi-Fi service. Students identified several campus locations including the library, LT lecture halls, and East residences as persistent problem areas with weak and unreliable connections. Signal strength analysis using the Wi-Fi analyzer tool (Vistumbler) confirmed poor coverage, with received signal strength indication (RSSI) values ranging from -100 dBm to -64 dBm across these sites. Network performance tests using iPerf further highlighted the network's limitations. In TCP mode, tests between a smartphone client and a desktop server showed average throughput as low as 439 Kbps in the library, with 12 retransmissions indicating unstable connections. UDP tests simulating real-time traffic showed high jitter (90.9 ms) and significant packet loss (68%), suggesting poor suitability for applications such as video conferencing or online lectures. The findings highlighted the need for urgent improvements in Wi-Fi infrastructure to support academic activities. Although detailed network upgrade recommendations were beyond the project scope, the results strongly advocated for targeted enhancements to ensure consistent, high-quality internet access across the campus.

Keywords: Wi-Fi, signal strength, network performance, user satisfaction, KwaDlangezwa

Thermal and mechanical properties of waste tyre/polypropylene blends and their applications

Mr Mmeli Gwebu

Abstract

The increasing concern for environmental sustainability has prompted research into recycling and reusing waste materials to reduce their negative impact on the ecosystem. This thesis investigates the thermal and mechanical properties of blends composed of waste tyre rubber and polypropylene, exploring their potential applications. The study encompasses an analysis of the composite material's thermal stability, mechanical strength, and the influence of varying waste tyre proportions. Furthermore, the practical applications of these blends in industries such as construction, automotive, and manufacturing were evaluated. The compositions of the blends were prepared separately using two different sizes of WTR (30 Mesh and 60 Mesh) with varying proportions of polypropylene (e.g., PP100, PP20/WTR80, PP40/WTR60, PP50/WTR50, PP60/WTR40, PP80/WTR20 (wt.%) by melt mixing in a Brabender Rheomix (University of Free State, Polymer Science Research Laboratory). Thermal properties were analysed using techniques such as Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) to assess melting behaviour, crystallinity, and thermal stability. Mechanical properties, including tensile strength, impact resistance, and flexural modulus, were evaluated using universal testing machines according to ASTM standards. Morphological studies were conducted using Scanning Electron Microscopy (SEM) to examine the dispersion and interaction between waste tyre particles and polypropylene matrix. X-ray diffraction (XRD) analysis was employed to study the crystalline structure and phase composition of the blends. The results showed that Waste Tyre Rubber (WTR)/ Polypropylene (PP) blends offer a dual advantage of improved mechanical performance while reducing the environmental impact associated with waste tyre disposal. The results of this research contribute to a deeper understanding of waste tyre/polypropylene blends, fostering innovation in recycling and sustainable materials.

Keywords: Polypropylene, waste, tyre, Polymer Blends

Perceptions and factors influencing consumption of indigenous foods by students at the University of Zululand

Ntando Hlatshwayo

Abstract

Dietary patterns in KwaZulu-Natal are shifting from traditional indigenous diets to processed, Western-style meals due to globalized food systems. This change has raised concerns about the declining consumption of traditional foods, which are often viewed as "old-fashioned" or “poor man’s food”. The restricted availability and accessibility of indigenous foods further hinder students’ ability to maintain traditional eating habits. This study aimed to understand the perceptions and factors influencing the consumption of indigenous foods among students at the University of Zululand. A pragmatic philosophy was adopted, utilizing a mixed-methods approach with a convergent parallel design to explore factors influencing indigenous food consumption among University of Zululand students in KwaDlangezwa. The study employed focus group discussions (FGDs) for qualitative insights. The target population consisted of undergraduate students from the Nursing, Human Movement, and Consumer Science departments. A purposive and snowball sampling strategy was used to select 30 students (10 from each department). Ethical clearance was obtained from the University of Zululand Research Committee, and informed consent was secured from participants to ensure an understanding of the study’s purpose and confidentiality. The findings indicated that the consumption of indigenous foods among students at the University of Zululand was declining due to a combination of negative perceptions, such as viewing them as “old-fashioned or poor man’s food,” and practical barriers like limited availability and accessibility. The results also highlighted a preference for more convenient, processed, and Western-style foods, even among students from rural backgrounds. Key factors identified included convenience, peer influence, and the extensive marketing of Westernized diets. This dietary shift underscored a significant challenge in preserving cultural heritage and promoting healthy dietary practices in the face of a globalized food system. The study concluded that University of Zululand students, despite often coming from rural backgrounds, were increasingly abandoning indigenous foods for processed alternatives. This trend was driven by perceptions of traditional foods as outdated and by their limited accessibility. The dietary shift was linked to potential negative impacts on student health and the erosion of invaluable cultural heritage. The research underscored the urgent need for targeted interventions to reverse this trend.

Using Large Language Models (LLMs) to Generating Medical Discharge Summaries

Luyanda Hlongwana

Abstract

Clear and concise hospital discharge summaries help reduce the workload of healthcare providers and make patient information easier to access. This study explores how advanced language models can automatically create structured summaries from unstructured clinical notes, using the MIMIC-III dataset, which includes real, de-identified hospital data. Two transformer-based models, Llama and T5, are tested to produce short, clear, and medically accurate summaries. So far, the Llama model has been fine-tuned with lora and tested on a portion of discharge notes, showing strong results. The summaries include key details like patient information, diagnoses, hospital stay length, medications, procedures, and follow-up instructions. Evaluating Llama summaries using common language processing metrics ROUGE. It scored a ROUGE-1 of 0.7864, showing strong word overlap with human-written summaries. The ROUGE-2 score of 0.6863 indicates good phrase accuracy, and the ROUGE-L score of 0.7864 confirms the summaries maintain similar structure to the originals. The Flesch Reading Ease Score of 66 suggests the summaries are moderately easy to read, suitable for clinical use. The T5 model is still being prepared for fine-tuning and will be tested using the same approach for comparison. The goal is to identify which model creates better summaries for medical record systems. This research advances clinical Natural Language Processing (NLP) by showing how language models can turn complex medical notes into clear, useful summaries. These could improve clinical decision-making and patient record management, making healthcare more efficient.

Effect of morula leaves supplementation on grass hay utilization by sheep

T. Ndlovu

Abstract

Ruminants need a continuous supply of nutrients throughout their lives to maintain high production standards. Yet, during winter, the accessibility and quality of forage decline, leading to nutrient shortages for ruminants, particularly in terms of energy, water, and proteins. This poses as a problem for smallholder farmers in rural areas because of their lack of access to the expensive supplementary feed. Literature confirmed that people have used leaves from indigenous trees to supplement their animals. This study investigated the nutritive value and digestibility of hay supplemented with graded levels of marula leaves. The study was conducted at the University of Zululand analytical laboratory where the chemical composition (DM, ASH, OM, NDF, ADF, HEM, ADL, CELL) and the in vitro digestibility were determined to evaluate the digestibility parameters (APD, TD, NDFD, ADFD, HEMD, MY). The results revealed that morula leaves had the lowest ($P<0.05$) DM, followed by hay supplemented with 30% morula leaves (91.33%). This meant that morula leaves (26.33) showed the highest ($P<0.05$) moisture content followed by hay supplemented with 30% morula leaves (8.77). Supplemented diets H+30% had the highest ($P<0.05$) NDF, ADF, hemicellulose and ADL (74.39%, 43.72%, 30.67% and 31.20% respectively) compared to the other supplemented treatments. Among the treatments, the highest protein was observed in Morula leaves (16.04%), H+30% (9.38%), H+20% (6.68%), H+10% (4.65%) and the lowest was seen in Hay (2.30%). Morula leaves (18.26%) had highest cellulose followed by H+30% (15.24%) which can be related with plant defence mechanism against herbivores. For in vitro digestibility M1 and H+30% had the highest ($P<0.05$) TD of 69.31% and 58.31% respectively. In conclusion, supplementing dried morula leaves at graded proportions to the basal diet of natural pasture hay improved nutrient composition and nutrient digestibility.

Keywords: Nutritional value, in vitro digestibility, feed potential, small-scale farmers.

Effect of vermicompost on the growth and yield of Solanum retroflexum and Solanum scabrum

N.L. Khondowe

Abstract

Solanum retroflexum and Solanum scabrum are important traditional leafy vegetables (TLVs) consumed in many rural African communities, valued for their high nutritional content and ability to thrive under harsh conditions. Vermicompost is an organic and eco-friendly fertilizer that can be easily produced in rural areas. It provides a sustainable way to enhance the growth, yield, and nutritional quality of these vegetables, while reducing reliance on chemical fertilizers and contributing to improved food security and sustainable agricultural systems. A pot experiment was conducted to evaluate the effect of vermicompost application on the growth and yield of S. retroflexum and S. scabrum in a greenhouse at the University of Zululand. The study used a completely randomised design with five vermicompost application rates (0, 2, 4, 6, and 8 t ha^{-1}) replicated eight times. Data were collected on growth parameters including stem diameter, plant height, number of branches and leaves, leaf area, and leaf chlorophyll content. The marketable and non-marketable yields (fresh and dry biomass) were also determined. The data were subjected to general analysis of variance (ANOVA), and the means were separated using Tukey's test at 5% significance level. Most parameters measured increased significantly ($p < 0.05$) with an increase in vermicompost application rate, with the highest values recorded for the 8 t ha^{-1} vermicompost treatment. Solanum retroflexum yielded higher than S. scabrum irrespective of vermicompost rate due to its higher number of branches and small, but numerous leaves. The study suggests that vermicompost application significantly improves growth and yield in these two Solanum species. It is recommended that this study be repeated under field conditions and at higher application rates to find the optimum rate.

Keywords: Huckleberry; neglected; organic fertilizer; sunberry; Traditional leafy vegetables (TLVs); underutilized crops

Dynamical Systems Analysis of Dark Energy in Cosmology

Khumalo Nomvelo

Abstract

This study investigates dark energy dynamics through dynamical systems theory in FLRW cosmology. We analyze the complete geometric structure of homogeneous, isotropic universes, deriving all connection coefficients and curvature tensors to establish the fundamental evolution equations. The research identifies three characteristic behaviours of cosmic acceleration: stable solutions corresponding to the cosmological constant, tracking behaviour in quintessence scenarios, and unstable configurations in phantom energy models. Using phase-space compactification techniques, we demonstrate how different dark energy formulations leave distinct imprints on cosmological evolution. Our approach provides a rigorous mathematical framework to confront theoretical predictions with observational data from supernovae, cosmic microwave background, and large-scale structure surveys. The results offer new insights into the universe's accelerating expansion while addressing persistent challenges like the cosmic coincidence problem. This work establishes dynamical systems theory as a powerful tool for analysing competing dark energy models considering next-generation astronomical surveys.

Keywords: Dark energy, Cosmological dynamics, Phase-space analysis, Cosmic acceleration, FLRW cosmology.

Automating the creation of IsiZulu academic domain corpus

Nonjabulo S Khuzwayo

Abstract

The development of structured, domain-specific corpora remains a constant challenge in Natural Language Processing, mainly for low-resource languages such as isiZulu. Academic texts such as theses, dissertations, and module guides contain rich linguistic data that can significantly contribute to corpus creation. However, the physical processing and annotation of these documents are time-consuming, and the lack of automated tools limits the scalability of linguistic resource development. This study aims to contribute to a sustainable and digitally inclusive Africa by designing and evaluating a prototype system that automates the processing of isiZulu academic documents. The system implements two NLP workflow architectures. A linear pipeline, where tasks are executed sequentially, and a parallel pipeline, where tasks such as tokenization, lemmatization, stemming, named entity recognition, part-of-speech tagging, and translation are executed concurrently. Using a web-based interface, academic documents are uploaded, processed, and stored as annotated corpora. The method integrates rule-based and statistical components to support language detection, metadata extraction, preprocessing, and linguistic annotation. Initial results indicate that the parallel pipeline significantly reduces overall processing time while maintaining comparable annotation accuracy to the linear approach. The linear pipeline, however, offers clearer traceability and better error handling, which may be advantageous in iterative research or educational contexts. This work supports interdisciplinary progress in linguistics, digital humanities, and computer science by addressing the practical gap in tools for processing isiZulu academic content. It provides a foundational step toward inclusive digital language resources, enabling more equitable access to computational tools and preserving linguistic diversity in the digital era. The findings inform future developments in African language technology and contribute to the broader goal of advancing linguistic data science for sustainable development across the continent.

Microplastic Contamination in Soil: A Systematic Review of the Influence of Anthropogenic, Climatic, and Environmental Conditions Due to Traffic and Accumulation

Ndzalama Pearl Kubayi

Abstract

Microplastics (MPs) pollution is a global environmental challenge resulting from plastic mismanagement. While a lot of research is centered on aquatic systems, terrestrial environments are comparatively less studied. Anthropogenic sources and industrial activities discharge MPs into the soil, and environmental conditions influence their pathways. This review aims to bridge knowledge gaps by evaluating the occurrence, transportation, accumulation, and environmental consequences of MPs contamination across various land use classes while accounting for the influence of environmental, geologic and climatic factors. A systematic literature search was conducted using Scopus, Web of Science, and Google Scholar databases and search engines, with 146 studies included. The analysis revealed that MPs contamination is pervasive throughout agriculture and industrial sectors, mostly due to sewage sludge, plastic mulching, landfill leachate, tire degradation fragments, and urban runoff. Climatic conditions like precipitation intensity, aridity, and temp fluctuations significantly impact MPs transportation, deposition, and degradation. Soil factors such as texture, permeability, and organic content also play a major role in MPs buildup and possible groundwater infiltration. A multiscale approach integrating soil science, hydrology, climate science, and waste management is essential to effectively address microplastic contamination in soils. The persistence and mobility of MPs pose a serious risk to soil health, groundwater quality and agricultural productivity, with implications for ecosystem resilience and human food security. Standard methodology for sampling, characterization, and quantification is crucial, considering regional climatic features and geological heterogeneity. Harmonising research protocols and mitigation frameworks for sustainable farming practices and industrial waste management requires long-term monitoring and global collaborations.

Keywords: Microplastics (MPs), soil ecosystems, traffic, transportation, climatic, anthropogenic.

Evaluating Blockchain Scalability for Secure IoT Data in Healthcare Theme: Advancing Interdisciplinary Knowledge for a Sustainable and Digitally Driven Africa

Langa A.

Abstract

The expanding use of Internet of Things (IoT) devices in healthcare across Africa presents significant opportunities to enhance patient care, data collection, and medical services. However, this digital growth also brings major data security and privacy concerns. This study explores blockchain technology as a decentralised and tamper-proof way to protect healthcare data generated by IoT to support sustainable and secure digital healthcare systems in Africa. The study used a simulation-based analysis to assess the performance, scalability, and efficiency of both public and private blockchain architectures. Four leading platforms, Ethereum, Bitcoin, Hyperledger Fabric, and Corda, were tested across various healthcare data exchange scenarios that reflect real-world IoT deployments. The simulation focused on two main outcome areas: scalability, which measures how each blockchain handles increasing transaction volumes and node participation without performance degradation, and efficiency, assessed through core performance metrics such as latency, throughput, and stale rate. These metrics indicate how fast, reliable, and secure each blockchain is in processing healthcare data. The results indicated that private blockchains, especially Hyperledger Fabric and Corda, offer better performance in terms of low latency, with the latency for Hyperledger Fabric being 0.07 seconds with a throughput of 1000 transactions per second, and for Corda, it is 0.2 seconds with a throughput of 500 transactions per second, additionally both Hyperledger and Corda reported a 0% stale rate this is affirming their advantage in data confidentiality compared to public blockchains. The findings suggest that private blockchains provide a practical and secure foundation for real-time healthcare data exchange in African settings. Beyond healthcare, these platforms demonstrated capabilities that offer a scalable digital trust model applicable to other public service sectors, such as education and civil administration. This research supports broader goals of digital innovation and emphasizes the importance of interdisciplinary approaches in developing sustainable, resilient, and secure digital infrastructures across Africa. Future research should aim to develop integrated frameworks that incorporate blockchain solutions tailored to Africa's unique infrastructure and healthcare needs. Studies might also explore the integration of blockchain with emerging technologies like edge computing or AI to enhance data processing and security. Additionally, real-world pilot projects and long-term research in African healthcare settings could provide valuable insights into adoption challenges, policy issues, and long-term effects.

Impact of Weight Status on Hemodynamic Parameters and Aerobic Fitness in School-Aged Children: A Study in a Rural School Community

Lukhele, N.P

Abstract

Maintaining a high level of physical activity provides significant health benefits for children, particularly in enhancing cardiorespiratory fitness and maintaining a healthy weight. This study aimed to investigate the impact of weight status on children's hemodynamic parameters and aerobic fitness levels. This cross-sectional study included 350 rural primary school children (146 boys and 204 girls) aged 11–13 years, randomly selected from two schools in the King Cetshwayo District, KwaDlangezwa area of KwaZulu-Natal. The anthropometric measurements recorded included height, weight, waist circumference, and hip circumference, with percentiles calculated using Cole's Lambda, Mu, and Sigma method. Additionally, skinfold measurements were obtained at four sites (biceps, triceps, subscapular, and suprailiac). Hemodynamic measurements included systolic blood pressure, diastolic blood pressure, and heart rate. Aerobic fitness was assessed using the 20 m shuttle run test, which evaluated speed, level, and age. The healthy group demonstrated significantly lower ratios in several measurements compared to those of the overweight group, i.e., the VO2max was 6% higher (<0.001), the waist-to-hip ratio was 6% lower (<0.001), the body fat percentage was 16% lower (<0.001), the waist circumference was 12% lower (<0.001), and the resting heart rate was 3% lower ($p \leq 0.055$). Differences in systolic and diastolic blood pressure were also observed, with the systolic pressure 2% lower ($p \leq 0.116$) and the diastolic pressure 3% lower ($p \leq 0.086$) in the healthy group. The study revealed a significant association between body weight status, aerobic fitness, and blood pressure parameters. Conducted in rural primary schools in KwaDlangezwa, KwaZulu-Natal, the research highlights notable correlations among weight status, aerobic competence, and blood pressure (BP) in children aged 11 to 13 years. The findings indicate that children with a healthy body weight showed higher VO2max levels and a reduced risk of developing childhood obesity and hypertension, unlike their overweight or obese peers, who displayed lower aerobic fitness and higher blood pressure.

Keywords: aerobic fitness; hemodynamic factors; children; obesity; body composition; weight

Microplastics in uMhlathuze River: Investigating the Extent of Contamination and Its Impact on Freshwater Ecosystems

Cimanga Lukusa

Abstract

Microplastics (MPs) are an emerging pollutant of global concern, with potentially profound implications for aquatic ecosystems and human health. This study investigates the occurrence, distribution, and ecological implications of microplastics in the uMhlathuze River, KwaZulu-Natal, South Africa — a water body that supports domestic, industrial, and agricultural activities. Water and riverbed sediment samples were collected from multiple sites representing upstream, midstream, and downstream zones, across both wet and dry seasons. Standardized density separation and visual identification methods were applied, with polymer types confirmed through Fourier Transform Infrared Spectroscopy (FTIR). Microplastic abundance was quantified in items per litre (water) and items per kilogram dry weight (sediment). Preliminary results reveal widespread contamination, with higher concentrations observed downstream of industrial and urban areas. Seasonal variation indicates elevated MPs counts during the wet season, suggesting runoff-driven transport from surrounding land uses. Sediment samples exhibited a higher retention of MPs, indicating potential long-term accumulation. The dominant morphotypes were fibres and fragments, with polyethylene and polypropylene as the most common polymers, reflecting consumer plastics and packaging sources. Potential ecological impacts include reduced feeding efficiency in benthic organisms, altered sediment properties, and bioaccumulation risks through the food web. The findings underline the urgent need for integrated pollution management strategies, encompassing improved waste management, industrial discharge control, and public awareness. This study provides the first comprehensive baseline on microplastics in the uMhlathuze River, contributing to the broader discourse on freshwater MPs pollution in sub-Saharan Africa and informing future risk assessments and mitigation policies.

Keywords: Urbanisation, uMhlathuze River, Industrial discharge, Domestic runoff, Freshwater, Pollution.

Occurrence, bioaccumulation and risk assessment of microplastics in Mzingazi Lake, South Africa

Z Mabaso

Abstract

Microplastic (MP) contamination is an emerging environmental concern in freshwater ecosystems, where it can adversely affect water quality and aquatic biodiversity. Quantifying MP levels and understanding their potential ecological risks is particularly important for systems such as Mzingazi Lake in KwaZulu-Natal, where site-specific data are limited. This study aimed to assess the seasonal occurrence, composition, and potential ecological hazards of MPs in Mzingazi Lake. Physico-chemical parameters were measured in eight sites, before the collection of water (1L), sediment (500g) and tissue (triplicates) samples. In water and sediment samples, microplastics were extracted using the density separation method (ZnCl), tissues were digested with (KOH) and microplastics were extracted using (ZnCl). Physico-chemical parameters were relatively uniform, with temperature from 26.6–27.15 °C, pH 7.245–7.370, salinity 96.25–100.55 ppt, Dissolved oxygen (0.10–0.50 mg/L) was low, and turbidity 45.50–47.24 NTU) moderately high. MPs were visually identified under a dissecting microscope and categorized into fragments and films. Percentage contribution by type showed that fragments accounted for 36.09% and films for 63.91% of total MPs across all sites. MP concentrations ranged from a minimum of 0.67 particles/L at Site 4 to a maximum of 18.17 particles/L at Site 6 and average of 29.47 particles/L. Sites with notably higher MP abundance (Sites 6, 8, and 7) were located near inflows and settlement areas, suggesting urban runoff and circulation patterns as key contributors. Data analysis included descriptive statistics and one-way ANOVA to compare MP abundance between sites. Pollution Load Index (PLI) values, using Site 4 as baseline, indicated Site 6 was heavily polluted (PLI = 5.23), Sites 8 and 7 moderately polluted (PLI = 2.37 and 2.07), and remaining sites low in pollution (PLI < 2). Potential sources include household waste disposal, fishing activities, and stormwater inflow. Polymer Hazard Index (PHI) values were not calculated due to the absence of FTIR polymer identification. These results provide the first seasonal baseline for MP contamination in Mzingazi Lake, highlight high-risk zones, and form a foundation for seasonal comparisons to assess temporal changes in pollution and related ecological risks.

Optimizing Renewable Energy Integration in Power Grids Using Battery Energy Storage Systems (BESS)

Madiba N

Abstract

The burning of fossil fuels to generate electricity continues to gradually decrease due to the adoption of Renewable Energy Sources (RES). The use of RESs is expected to reduce the contribution of greenhouse gases into the atmostphere. RES technologies are increasingly favored by environmentalists and policymakers for their cost competitiveness and environmental benefits. However, their efficiency and reliability are limited by intermittency and variability. For example, solar generation produces no electricity during periods without sunlight (e.g., cloudy or rainy days), and wind generation halts during calm conditions.To address these limitations, battery energy storage systems (BESS) play a critical role by storing surplus energy generated during low-demand periods and discharging it during peak demand. This research investigates strategies to optimize the integration of RES using BESS, while enhancing grid reliability and overall performance. Various optimization algorithms are evaluated to determine the optimal sizing, placement, and operation of BESS under different grid conditions, with a major focus on managing the battery's state of charge (SoC) to maximize energy efficiency. The research employs MATLAB/Simulink to simulate the IEEE 9-bus test system, incorporating realistic load profiles and renewable generation scenarios. Results demonstrate that optimized BESS deployment can significantly reduce power fluctuations, improve grid reliability, and enhance overall grid performance.

Keywords: energy storage system, renewable energy source, intermittency, Battery energy storage system, State of Charge.

Effect of heat stress and honey supplementation on physiological parameters, blood chemistry and behavioural responses of indigenous chickens

Magutshwa N

Abstract

Indigenous chickens also known as village chicks, are mainly kept by local communities in Africa and other countries for food. They are reared under extensive production systems to scavenge for feed where they are often exposed to higher temperatures especially during summer and recently extreme temperatures due to global warming hence the suffering. This study investigated the effect of honey supplementation on heat stress Potchefstroom koekoek chickens on rectal temperature, body weight, feed conversion rate, blood chemistry and behavioural responses. Chickens (42 15-weeks old) were housed in two temperature-controlled rooms, R1 (T- 36 ˚C) and R2 (T- 38˚C) and the third group as a control (environmental temperature). Each group was divided into two groups, one drinking water with honey and the other section with chicks drinking water only. Heat exposure was implemented at 8:00am-10:00am for 2 hours daily over a period of 4 weeks. Natural honey 20ml was added in every 1 litre of water daily for supplementation. Temperature and honey supplementation had an effect ($P<0.05$) on the amount of time the birds spent eating, walking, foraging, wing spreading, wing flapping and lying down. Honey supplementation reduced the amount of time spent by chickens laying down and standing behaviour at environmental temperature, 36˚C and 38˚C.Temperature and honey supplementation had an effect ($P<0.05$) on feed intake, weight gain and feed conversion ratio. Honey supplementation increased the feed conversion ratio at 36˚C and 38˚C.Temperature and honey supplementation had an effect ($P<0.05$) on the total protein, uric acid and triglyceride of indigenous Potchefstroom koekoek chickens. Temperature above 30 ˚C can have a negative effect on chickens' performance by reducing vital parameters such as body weight gain and total proteins. In conclusion heat stress is the enemy of poultry production, mitigation strategies are required as soon as possible. Honey is one of the best natural supplements we have to reduce the impact of heat stress on chickens.
Keywords: Heat stress, honey, Potchefstroom koekoek, Indigenous chickens, temperature, environmental, supplementation.

LLMs for Understanding Low-Resource languages: An Empirical Study of isiZulu, isiXhosa, and Sepedi

Amukelani Majola

Abstract

The Large Language Models (LLMs) have demonstrated significant efficacy in natural language processing (NLP); yet, they remain insufficiently researched for low-resource South African languages. This research is grounded in an empirical study that examines isiZulu within the broader analysis of LLM performance on isiZulu, isiXhosa, and SePedi. The model refined for the study is a pre-trained distilbert-base-uncased on the custom-label isiZulu dataset encompassing subjects of science, geography, and technology. A methodology for evaluation was established to address linguistic and cultural relevance in low-resource contexts, encompassing accuracy, precision, recall, and F-1 Score. The final evaluation of the labeled isiZulu dataset yielded an accuracy of 87.7%, precision of 23.9%, recall of 29.5%, and an F-1 score of 26.3%, indicating substantial classification confidence while highlighting the need for enhancement in fine-grained semantic representation. These results demonstrate the viability of adapting LLM to isiZulu by focused fine-tuning, while highlighting the limitations of token alignment and generalization. This research provides labelled resources, evaluation methodologies, and optimized model checkpoints for isiZulu. To finalize the comparative analysis of South African languages, subsequent efforts will broaden the methodology to include isiXhosa and Sepedi

Detecting GPS Spoofing

Nokwabelwa Majola

Abstract

The manipulation of GPS signals through spoofing presents a growing challenge to the reliability, accuracy and safety of navigation systems that are widely used in sectors such as transportation, aviation, autonomous technologies, and agriculture. Spoofing attacks involve broadcasting misleading signals to deceive GPS receivers, leading to potential operational failures. With Africa's increasing dependence on digital systems, there is a pressing need for adaptable, cost-efficient solutions that do not rely on expensive hardware infrastructure. This research focuses on exploring and comparing various machine learning techniques to identify GPS spoofing activities. It assesses unsupervised techniques including Isolation Forest, One-Class SVM, K-Means, DBSCAN, and Principal Component Analysis in conjunction with thresholding, as well as supervised techniques like Random Forest, Logistic Regression, Decision Tree, Naive Bayes, and K-Nearest Neighbors. A working environment to utilize the actual GPS data is Python-based. To assess performance, the models are analyzed using several metrics such as accuracy, precision, recall, F1-score, detection probability, processing time and memory efficiency. Early findings indicate that Random Forest performs strongly in terms of accuracy, while unsupervised models like One-Class SVM and Isolation Forest are more suited for detecting previously unseen attack patterns. The findings of this study contribute to the development of lightweight and scalable GPS spoofing detection mechanisms. By proposing solutions that are accessible and suitable for systems in resource-limited environments, the research directly supports the creation of secure, reliable digital platforms. This aligns with the broader goal of fostering sustainable technological advancement within a digitally driven African context.

A Review of the Indigenous Climate Change Adaptation Strategies Used by Small-Scale Cattle Farmers in South Africa

Makhaye B.C

Abstract

Climate change poses significant threats to agricultural systems, with small-scale livestock farmers in rural South Africa among the most vulnerable. Increasing temperatures, erratic rainfall, droughts, and livestock diseases threaten productivity, food security, and household resilience. Indigenous knowledge systems, developed over generations, provide locally adapted and sustainable approaches that can enhance climate resilience. This review evaluates the indigenous climate change adaptation strategies that small-scale cattle farmers in South Africa use and examines the challenges affecting their application. The study adopts a desktop research approach, drawing on 29 peer-reviewed publications and reports. The review identifies three key categories of adaptation strategies: livestock management (selective breeding, herd mobility, and disease control); crop and pasture management (mixed farming, forage conservation, and rotational grazing); and water management techniques (rainwater harvesting and strategic watering points). While these strategies are vital in sustaining livelihoods, farmers face barriers such as climate-related market disruptions, institutional and regulatory constraints, and socio-cultural challenges. Limited knowledge or inadequate technical capacity hinders correct implementation. The findings highlight the need for policymakers, extension services, and other stakeholders to strengthen the dissemination of indigenous adaptation knowledge and provide targeted training for practical application. Integrating indigenous practices with scientific innovations, improving market access, and enhancing institutional support could significantly improve resilience. The study recommends future research to assess the effectiveness of current strategies and develop innovative, context-specific solutions that address the complex realities of small-scale cattle farming in the face of climate change.

Keywords: climate change, indigenous strategies, livestock, policy, small-scale cattle farmers

Identification of Prevalent Gastrointestinal Nematodes in Zulu Sheep in the Kwa-Mthethwa Community, KwaZulu-Natal Province

L.G Makhunga

Abstract

Zulu sheep are a resilient indigenous breed in South Africa which plays a crucial role in the livelihoods of rural farmers due to their adaptability to harsh environmental conditions. Indigenous sheep are known as grazing animals, but their grazing habits expose them to gastrointestinal nematode (GIN) infections, these nematodes feed on the blood of the host and absorbs nutrients which can reduce productivity and cause economic losses. The aim of this study was to identify the prevalent GIN species in Zulu sheep in the Kwa-Mthethwa community, KwaZulu-Natal Province. In this study Fecal samples were collected from 18 sheep across three small-scale farms and taken to the laboratory for analysis using sugar flotation solution, fecal egg count, and fecal culture techniques. Results indicated that there is no statistically significant difference in egg per gram (EPG) counts across sex and age groups ($p > 0.05$), though lambs showed the highest mean EPG, suggesting increased susceptibility. The most prevalent nematode identified was *Haemonchus contortus* (99%), followed by *Trichostrongylus* spp. (93%), *Teladorsagia* spp. (49%), and *Oesophagostomum* spp. (22%). The dominance of *H. contortus* is due to its high fecundity and adaptability to warm, humid conditions which are the conditions of the Kwa-Mthethwa Community. The findings highlight the need for targeted control strategies, particularly focusing on lambs, and emphasize sustainable parasite management practices to reduce infection rates and enhance livestock productivity in communal farming systems.

Abundance and Biomass of Sandprawn *Kraussillichirus kraussi* in Richards Bay Harbour

Mamfengu Z

Abstract

Estuaries are dynamic and productive ecosystems that play a crucial role in biodiversity support and nutrient cycling. *Kraussillichirus kraussi* is a burrowing shrimp known as an ecosystem engineer through sediment bioturbation that aerates sediment and regenerates nutrients. However, *Kraussillichirus kraussi* faces increasing threats from anthropogenic activities, including habitat modification, sediment contamination, and overharvesting as bait. In particular, the Richards Bay area is earmarked for industrial and agricultural growth, coupled with a growing human population in the coming years. Therefore, the present study aims to assess the abundance and biomass of *Kraussillichirus kraussi* in Richards Bay Harbour, KwaZulu-Natal, to better understand its spatial distribution, habitat preferences, and the magnitude of disturbance in this area. *Kraussillichirus kraussi* sampling was conducted from three sites using a quadrat method. Site 1 and 3 are proximal to the small craft harbour and are both separated by a water body. Additionally, Site 1 is also adjacent to a stream, whose pollution status is unknown. Site 2, separated from Site 1 and 3 by a road, and is relatively unaffected by the same factors in Site 1 and 3. Sediment samples were also collected and analysed for grain size and total organic content (TOC). Biomass and abundance results were presented using ABC curves.The substrate in all three sites was dominated by medium and fine sand which was greater than 80%, while TOC ranged from 20% to 22%. ABC curve results showed that Sites 1 and 2 had higher biomass relative to abundance, indicating low disturbance, whereas Site 3 exhibited higher abundance than biomass, suggesting severe disturbance. This may be attributed to local overharvesting of *Kraussillichirus kraussi* for bait and potential sediment contamination. Regulating bait harvesting and monitoring sediment quality are essential to reduce human impacts and protect *K. kraussi* and estuarine health.

The role of hydrogen in the migration of strontium implanted into SiC

K. B. Manqele

Abstract

Silicon carbide (SiC) has been proposed as a primary coating layer within tri-structural isotropic (TRISO) fuel particles due to its unique properties that enhance the fuel's ability to retain fission products (FPs) during both normal reactor operation and accident conditions. While TRISO particles successfully retained most FPs, the release of key radioactive elements such as cesium (Cs), silver (Ag), and strontium (Sr) remains a challenge, prompting numerous studies to understand their diffusion mechanisms in SiC. SiC wafers were implanted with 300 keV Sr ions to a fluence of 2×10^{16} ions/cm² at room temperature (RT) and 350 °C. Subsequently, the Sr-implanted samples were co-implanted with 15 keV H ions to a fluence of 1×10^{17} ions/cm², also at RT and 350 °C. The Stopping and Range of Ions in Matter (SRIM) software was used to simulate the depth profiles of Sr and H. The simulations confirmed that the implanted ions have overlapping depth profiles, enabling a clear investigation of their synergistic effects. All samples were then annealed under vacuum to simulate reactor operating temperatures. The samples were characterized using Raman spectroscopy, transmission electron microscopy (TEM), and Rutherford backscattering spectrometry (RBS). The results showed that Sr implantation at RT created a 200 nm thick amorphous layer, while implantation at 350 °C produced a less defective structure. Co-implantation with H at RT induced the formation of graphite crystals within the pre-existing amorphous SiC layer. In contrast, H implantation at 350 °C reduced the overall damage in the SiC due to dynamic defect recovery at elevated temperature. Critically, Sr loss was observed after H implantation at RT and subsequent annealing. However, H implantation at 350 °C resulted in no measurable Sr loss, even after annealing. These findings suggest that low-temperature H implantation enhances the release of Sr from SiC, while higher implantation temperatures promote the trapping of Sr within the SiC matrix.

Investigation of Silver and Cesium Migration and Structural Evolution in 6H-SiC Following Helium, Silver and Cesium Co-Implantation and High-Temperature Annealing

N.M. Mantengu

Abstract

In nuclear fuels, thin-film diffusion barriers are essential to prevent the release of radioactive fission products (FPs). During the fission process in the fuel kernel, various FPs are generated concurrently with helium (He). Helium is known to form bubbles in SiC, and the formation of these bubbles can have detrimental effects on the integrity of SiC, which serves as the primary diffusion barrier in nuclear fuel. Therefore, this study investigates the effect of helium on the migration of selected FPs—specifically silver (Ag) and cesium (Cs)—as well as the associated microstructural changes in single-crystalline 6H-SiC at high temperatures. Three sets of samples were prepared: in the first set, 360 keV Ag ions were implanted into 6H-SiC to a fluence of 2×10^{16} ions/cm^2. In the second set, some Ag-implanted samples were co-implanted with 200 keV Cs ions to the same fluence (2×10^{16} ions/cm^2). In the third set, the co-implanted (Ag+Cs) samples were further implanted with 17 keV He ions to a fluence of 1×10^{17} ions/cm^2. All implantations were carried out in vacuum at room temperature. Following implantation, all samples were annealed at 1100 °C for 5 hours in a vacuum tube furnace. The thickness of the damaged region in SiC before and after annealing, along with the migration behavior of Ag and Cs, was examined using Rutherford backscattering spectrometry (RBS) channeling, transmission electron microscopy (TEM), and Raman spectroscopy. The results revealed that He implantation significantly enhanced the migration of both Ag and Cs in 6H–SiC.

Low-Cost Demonstration Platform for Phasor Measurement Unit Applications in Power Systems

AH Mantshi

Abstract

A Phasor Measurement Unit (PMU) is an advanced monitoring device used in power systems to measure voltage and current phasors in real time, including their magnitudes and phases at the fundamental power system frequency. It also measures the frequency and the rate of change of frequency (ROCOF) at its installation points. The value of PMUs lies in their ability to enhance real-time monitoring, protection, and control by providing accurate, high-resolution measurements of system conditions. However, their high-cost limits accessibility for academic institutions and small-scale power system applications. This study presents the design and implementation of a cost-effective demonstration platform that addresses both the expense and limited availability of commercial PMUs, aiming to support hands-on learning, facilitate research, and improve power system monitoring.

Keywords: Low-Cost PMU, Synchrophasor, Power Systems Monitoring, Educational Platform

Assessing the impact of AI-powered password cracking on cybersecurity: Effectiveness, Implications, and Potential countermeasures

Mr Thandokuhle Lungelo Manukuza

Abstract

The increase growth of Artificial Intelligence(AI) poses serious new challenges to cybersecurity, specifically within password security. This research investigate the effectiveness and implication of AI-Powered password cracking methods, using a deep learning models and assessing their potential impact on users. The aim is to focus in cybersecurity study of password cracking using the AI-Powered models to analyse their performance comparing to traditional techniques. For this research the dataset of password leaked is used to train sql_model_tf.h5 which is AI-Powered and Brutal-force simulation to predict and crack common passwords pattern. The leaked password dataset is obtained on the well know site of leaked password “Rock You”. Expected results are to reveal a major increase in success rates for cracking passwords when using AI-Powered password cracking technique compared to brute- force technique. The study will be aiming to suggests practical countermeasures that will decrease the success rate expected of password cracking by AI-Powered. The mitigation ways proposed for the expected result are to introduce passwordless system, multi-factor authentication and lastly propose the use of a strong password with more than 16 characters. As the investigation is on going it clear highlight that’s the findings of the research at the end will enforce an urgent need for updating security practices and educational ways to improve on safety of password as it a first defence on any system.

Keywords: Artificial Intelligence, cybersecurity, Brutal-force attack, password cracking.

The Prevalence of Behavioural Non- Communicable Diseases Risk Factors Among Black Africans in Peri-Urban Community In South Africa

Sifundile Zamazulu Maphumulo

Abstract

Non-communicable diseases (NCDs) are a leading cause of mortality in South Africa, with their burden influenced by lifestyle, living conditions, ethnicity, and gender. A cross-sectional study (N=100; n=50 males, n=50 females; mean age 25.15 ± 5.98) followed the WHO STEPwise approach which ensured systematic data collection. Standardized self-reported questionnaires were used to gather data on key behavioural risk factors, including tobacco use, physical activity, and dietary behaviours. The data collection was conducted over a four-month period, during which participants first completed qualitative questionnaires to provide insights into their lifestyle behaviours. Physical inactivity emerged as the most prevalent risk factor (20%), followed by tobacco use (17%) and poor nutrition (14%). Smoking rates were significantly higher among males compared to females (26% vs. 8%; P = 0.04), and among younger participants (≤25 years) compared to older ones (24.56% vs. 6.97%; P = 0.01). Poor nutrition was also more common in younger individuals (P = 0.05). While females reported lower smoking rates, they exhibited higher levels of physical inactivity than males (23% vs. 14%). The findings highlight the persistent prevalence of modifiable behavioural risk factors for NCDs among young adults in South Africa, with distinct age and gender-related patterns. Targeted interventions addressing physical inactivity, tobacco use, and poor nutrition, particularly among males and younger individuals, are essential for reducing the long-term burden of NCDs. Gender-sensitive and age-specific public health strategies may improve lifestyle behaviours and contribute to more effective NCD prevention.

A Mathematical model of removing contaminant from fluids stream.

Nhlanhla Mnotho Masindane

Abstract

This study presents the development and analysis of a mathematical model for the removal of contaminants from a fluid stream via adsorption. The transport of contaminants is described using the advection–diffusion equation and kinetic equation. To simplify the model, we assumed that the fluid is incompressible with constant velocity and a uniform cross-sectional area of the stream. Analytical methods, including the method of separation of variables and the travelling wave transformation, are used to obtain approximate solutions for specific cases. Then the full model is solved numerically using a finite difference method. The effects of flow velocity, diffusion coefficient, and reaction rate on breakthrough curves are examined, providing insights into the rate and efficiency of contaminant removal.

Structure-function analysis of *Mycobacterium tuberculosis* drug target cytochrome P450 125 (CYP125) enzyme family

Nompilo Masinga

Abstract

Tuberculosis, the deadliest human lung disease caused by *Mycobacterium tuberculosis*, continues to be a global health threat, and finding new drugs and drug targets seems an ongoing battle. The cytochrome P450 CYP125A1 enzyme of *M. tuberculosis* H37Rv, which is involved in cholesterol metabolism, is a well-established target for drug development. Research is ongoing to identify new compounds that target this enzyme. Understanding the structure-activity relationship of CYP125 family members is crucial for developing a specific and efficient inhibitor. In this direction, this study analyzed 21 crystal structures of CYP125 family enzymes, unraveling the factors responsible for substrate specificity and the amino acids that play a key role in catalysis. One of the unique features of CYP125A1 is its active site cavity shape, which determines the specificity of substrates and inhibitors. The active site cavity is shaped like a letter box, lined by hydrophobic residues, and it transitions into a funnel-like shape with a progressive narrowing as it approaches the heme. Due to this shape, the cholesterol and cholest-4-en-3-one serve as substrates, but not androstenedione, as the former molecules have an alkyl side chain that extends down the narrow funnel channels, interacting with the heme iron. Different binding patterns were observed for substrates and indole-derived inhibitors. Both type I and type II interactions were observed with the non-azole P450 inhibitor LP10 and indole-derived compounds, where the side chain of the indole-derived compound determined the type of interaction. This study provides a comprehensive understanding of the structure-function analysis of P450 enzymes and the interactions of CYP125A members with various ligands. Our findings pave the way for designing new and specific CYP125A1 inhibitors that will ultimately be developed into novel anti-TB drugs.

Potential Link Between Maternal Complication and Cardiometabolic Disorders: Clinical Data Synthesis

Thobani L. Masondo

Abstract

Pregnancy complications such as preeclampsia, diabetes mellitus, and hypertension are recognised as early detector of the increased long-term cardiometabolic risk in mothers. In fact, women experienced hypertensive disorders of pregnancy have been shown to have two-three-fold cardiovascular disease (CVD) risk compared to those without these commobidities. Thus, there is a need to assess clinical outcomes linking pregnancy complications and cardiometabolic disorders. To accomplish this, the current study retrieved clinical trial data from the World Health Organization's International Clinica Trial Registry Platform (ICTRP) reporting on pregnancy-related disorders and interventions targeting cardiometabolic outcomes. Such data was supplemented by a systematic review through the use of PubMed and other major search engines like Cochrane Library reporting on clinical studies reporting on pregnancy complications and cardiomtebolic outcomes. The clinical trial data revealed the abnormal levels of metabolic components like total cholesterol and hyperglycemia, which are consistent with a state of diabetes and dyslipidemia are seen in pregnant mothers at increased risk of hypertension and CVD. The results also show that non-modifiable risk factors like age can influence the incident of CVD in pregnant mothers already showing impaired metabolic function. The current study improves our understanding on the interplay between pregnancy complication and maternal cardiometabolic health. This information remains essential to inform future biomarker discovery, risk stratification, and targeted interventional strategies to improve long-term outcome for pregnant women.

A comparative study of traditional versus hybrid model optimization techniques for efficient edge AI execution

Simphiwe Masuku

Abstract

The growing demand for intelligent applications on edge devices has created a need for AI models that are not only accurate but also lightweight and fast enough to run on limited hardware. Traditional optimization techniques such as pruning, quantization, and knowledge distillation have long been used to reduce model size and speed up inference. However, these methods alone are often not enough to meet the performance requirements of modern edge AI workloads. Hybrid optimization approaches, which combine multiple techniques or adapt them to specific hardware constraints, offer a promising alternative. In this research, we compare traditional optimization methods with hybrid approaches for deploying object detection models efficiently on edge devices. Using SSD MobileNetV2 trained on the COCO 2017 dataset, we built a modular training pipeline featuring a custom training loop with real SSD loss, adaptive learning rate scheduling, and built-in visualization tools for debugging and performance tracking. We then applied both traditional techniques and hybrid strategies, including mixed-precision training and anchor-level optimizations, to evaluate their impact on model accuracy, size, and inference speed. Our results show that while traditional techniques can effectively reduce model size and computation cost, hybrid approaches deliver better overall trade-offs. In particular, hybrid methods achieved up to 35% faster inference on edge hardware while maintaining competitive accuracy. This study demonstrates the value of combining traditional and hybrid optimization strategies to bridge the gap between research-grade models and practical edge deployments. By providing a structured, reproducible workflow, it also offers a clear pathway for future work in efficient AI execution on constrained devices.

The Impact of Integrating Explainable Artificial Intelligence For Anomaly Detection on Blockchain Transactions

Kamogelo Matabane

Abstract

Fraud detection in the financial world is critical, as it involves keeping transactions trustworthy and safer mostly on blockchain systems. Blockchain commonly operates without a central authority, prompting them to be prime target of scams, money laundering and hacks. Machine learning models have shown great capabilities for detecting and identifying fraudulent activities, but they operate in “black box” nature limiting interpretability and reduced user trust. Explainable Artificial Intelligence techniques provide solutions to these issues by providing details into model decisions. Existing studies have made progress in detecting fraudulent transaction on blockchain datasets and increasing transparency of how machine learning models make decisions .However, the performance of integrating this Explainability methods into fraud detection models in blockchain systems is underexplored .This study conducted a thorough analysis of the performance of integrating SHAP and LIME explainability methods on Machine Learning models for fraud detection on Ethereum dataset before and after applying explainability on Random Forest and XGBoost ,both Machine learning models achieved an accuracy of 98% in detecting fraudulent transactions ,we also investigated one of the performance metrics for Explainable Artificial Intelligence consistency. The dataset used contained 9840 transactional records of Ethereum blockchain. We hypothesized that integrating Explainable Artificial intelligence on detecting fraudulent detection doesn’t significantly affect the performance of Artificial intelligence models on Ethereum dataset .The experiment demonstrated that integrating explainable artificial intelligence on Machine learning models does not directly affect Machine learning model performance, but it introduces increased CPU overhead ,latency and throughput reduction, with results showing that Random forest with lime had high latency of 14.67 sec and 145.2511 sec for experiment 1 & 2 respectively and the lowest throughput .These findings address the underexplored understanding of the performance trade-offs introduced when integrating explainable techniques such as LIIME and SHAP into blockchain-based fraud detection models.

A Review of the Essential Visual Skills Required for Netball: Beyond 20-20 Optometry

Nonkululeko Mathe

Abstract

Many sports place demands on vision and certain visual skills, and this has long been acknowledged. Among all activities, athletic performance places some of the highest demands on the visual system. Sports vision's fundamental component is the growth and improvement of an athlete's visual ability. To identify a variety of visual skills essential to netball players. Studies were obtained from the following databases: EBM Reviews, Current Contents, Science Direct, Google Scholar, CISTI Source (1993–June 2021), SportDiscuss (1975–June 2021), Cochrane Database of Systematic Reviews, PubMed (1966–June 2021), and international e-catalogues. A keyword search yielded MeSH headings; “visual skills, “hand-eye coordination”, “peripheral vision”, “eye movements”, “netball vision”, “netball rules”, “reaction time”, “speed of recognition”, “accommodation facility,” “visual memory”, “discriminating efficiency”, “visual endurance”, “motor learning” and “cognitive function” which were combined and exploded. This study used 65 full-text English-language papers from 90 citations found through electronic searches. 40 Articles remained after removing duplicates and reviewing the full-text versions. The evidence in this study reveals that, although current research still frequently concentrates on visual skills, there is a need to narrow this attention to the requirements of a certain sport. Additionally, identifying the visual abilities necessary for netball, enables talent identification, effective training, and testing of these abilities.

Keywords: Vision in Sport, Visual Skills, Visual Ability, Netball Vision, Talent Identification

Emotion Detection From IsiZulu Text

Mthokozisi Mathonsi

Abstract

Emotions are feelings that people experience in response to different things such as thought, events, or social interactions. Detecting emotions in text using Natural Languages Processing (NLP) is the process of identifying and classifying emotions expressed within a written text. While significant progress has been made in high-resource languages like English, low-resource languages such as isiZulu are often underrepresented due to the scarcity of high-quality labelled datasets. This study builds an emotion detection system for isiZulu using a dataset of about 17 000 samples labelled with six emotions: anger, fear, joy, love, sadness and surprise. The dataset was cleaned by removing bad entries (like blank or invalid text) and prepared labels for classification. Two approaches were tested: zero-shot classification using the pre-trained model ‘sentence-transformers/LaBSE’ model and fine-tuning the same model with a special ‘WeightedTrainer’ to handle uneven class sizes, especially for less common emotions (fear, surprise, anger). Fine-tuning used a small learning rate (2e-5), batch size of 16, and stopped early after 8 rounds to avoid overtraining. The fine-tuned model performed much better than the zero-shot (accuracy ~0.30, F1-score ~0.27), reaching am accuracy of ~0.75, precision of ~0.73, recall of ~0.75, and F1 scores of ~0.74, with F1-score above 0.50 for less common emotion. This work improves emotion detection for isiZulu and shows how fine-tuning can help low-resource languages, with options to try oversampling or other models like ‘masakhane/afriberta_large’ in the future

A genome-wide data mining and structural analysis of potential therapeutic target flavodoxins in gastrointestinal pathogens

Mbatha, N

Abstract

To perform a genome wide analysis of flavodoxins in gastrointestinal pathogens from the genera *Helicobacter*, *Salmonella*, *Shigella*, *Campylobacter* and *Yersinia*.
Step 1: Species and its genome database information: KEGG
Step 2: Genome data mining and identification of flavodoxins: NCBI
Step 3: Phylogenetic analysis of flavodoxin: MAFFT, Trex web, ITOL
Step 4: Analysis of conservation of amino acids: PROMALS3D
Step 5: Flavodoxin modeling: PROTEIN DATA BANK, SWISS MODEL, PYMOL

Helicobacter had total number of flavodoxins 830 out of 837, *Campylobacter* had 822 flavodoxin out of 877, *Salmonella* had 674 flavodoxins out of 713 sequences analysed, *Yersinia* had 142 out of 143, then *Shigella* with 78 flavodoxins out of 81. Conservation amongst all 2546 flavodoxins was low. *Helicobacter* flavodoxins to other *Helicobacter* flavodoxins had low conservation. *Salmonella* and *Campylobacter* showed lower conservation, *Yersinia* had the second most conserved flavodoxins. *Shigella* showed the highest conservation. All genera, *Helicobacter*, *Campylobacter*, *Yersinia*, *Shigella* and *Salmonella* share a common ancestor based on phylogenetic tree. Modelled protein structures show that *Helicobacter*, *Campylobacter*, *Salmonella*, *Yersinia* and *Shigella*, all have comparable protein secondary structures (alpha helices and beta sheets). Structural analysis showed *Shigella* had the highest percentage identity, *Campylobacter* had the lowest percentage identity among individual genera. Total number of sequences analysed were 2651, flavodoxins found were 2546, *Campylobacter* had the highest number of flavodoxins, *Shigella* had the lowest number of flavodoxins, *Shigella* had the highest conservation, *Campylobacter* had the lowest conservation, *Campylobacter* had the lowest percentage identity, *Shigella* had the highest percentage identity, amongst all the genus 6 helix and 6 beta sheets were the most common, all pathogens come from the common ancestor. Annotation of flavodoxins, molecular docking to dock FMN molecule within the flavodoxin.

Evaluation of the effect of *Senecio serratuloides* and *Strychnos madagascariensis* extracts on the absorption and hepatic metabolism of metformin, rosiglitazone, glyburide, atorvastatin

Mbazima C

Abstract

Diabetes mellitus, a persistent metabolic condition, poses a significant threat to global human health. Available therapies to treat diabetes and hyperlipidemia are associated with adverse effects. Therefore, there is a need for alternative management strategies that are both cost-effective and safe. Several studies have demonstrated the ability of *Senecio serratuloides* and *Strychnos madagascariensis* to regulate blood glucose levels, improve insulin sensitivity, and protect insulin-secreting pancreatic beta cells. The assessment of the interaction between these plants and crucial cytochrome P450 enzymes is imperative to guarantee their compatibility with conventional diabetes hyperlipidemia medications. This evaluation aims to determine the efficacy, safety, and the suitability of *Senecio serratuloides* and *Strychnos madagascariensis* to as potential therapeutic interventions for the management of this persistent metabolic disorder. Extracts were harvested in Northern Kwa-Zulu Natal and processed in the department of Botany. Subsequently, the extracts underwent characterization through LC-MS analysis. The inhibitory effects of the herbal extracts and compounds on the seven CYPs enzymes were evaluated using the Vivid™ assay. The LC-MS analysis was conducted to establish the fundamental fingerprint of plant extracts. The glyburide and rosiglitazone strongly inhibited CYP450 at 10 µM, while Atorvastatin strongly inducted CYP450 across all concentrations. However, metformin demonstrated moderate inhibition at 10 µM.In vitro the combination of atorvastatin with metformin interfered with the hepatic metabolism of atorvastatin, revealing strong inhibition of CYP3A4, the key enzyme responsible for atorvastatin's hepatic metabolism. To fully elucidate the effect of metformin on the pharmacokinetic profile of atorvastatin, further experiments are required.

Insight into the role of p-Coumaric acid as an antioxidant for heavy metal (vanadium) stress tolerance in soybean

Siphukuthula Thanduxolo Mbhamali

Abstract

Soybean (Glycine max L.) is one of the highest produced food legumes crops globally, providing protection against kidney disease, lowering of concentration of plasma cholesterol in blood, antioxidant effects, and anti-obesity effects. However, its production is threatened by numerous factors including heavy metal toxicity, a major constraint to agricultural productivity and food security. Vanadium, a naturally occurring heavy metal, has become a remarkable environmental pollutant due to industrial emissions, use of fertilizers, fossil fuel combustion, and mining. It causes severe degradation of land, interruption of fundamental processes in plants and subsequent induction of oxidative stress which poses a significant yield loss. In response to oxidative stress, plants may activate various defences, such as antioxidant systems. p-Coumaric acid (p-CA) is one of the antioxidants, naturally synthesized by plants during oxidative stress. In this study an experiment was conducted to investigate the role of p-Coumaric acid as an antioxidant, in enhancing tolerance of soybean plants grown under heavy metal (vanadium) stress. The experiment employed a randomized complete block design (RCBD) with four treatments: Control,100 µM p-CA, 275 µM V_2O_5 and a combination of 100 µM p-CA & 275 µM V_2O_5 respectively with each treatment replicated 11 times (11 x 4=44). The plants were treated for 14 days, every second day until they reached the V3 stage of growth. The results revealed that p-CA reduced plant growth, biomass, and elevated the levels of $O_2^{\bullet-}$ and cell death. Similarly, V_2O_5 restricted plant growth, biomass and significantly increased $O_2^{\bullet-}$ and cell death levels. Application of p-CA on vanadium stressed plants, interestingly improved plan growth, biomass and reduced the $O_2^{\bullet-}$ and cell death. These findings showed that p-Ca can improve antioxidant capacity and defence responses in soybean seedlings to vanadium stress.

Keywords: Antioxidant, cell death, superoxide, oxidative stress

Optimizing Culture Conditions of a Kombucha tea SCOBY isolate for Bioflocculant Production, Characterization, and its Application in Wastewater Treatment and Dye Removal

Nokwazi Mbhele

Abstract

The attention given to bioflocculants increase annually due to their biodegradable properties, and they are environmentally friendly for both the living and none-living spp. In this study a yeast bioflocculant-producing microorganism isolated from Kombucha tea SCOBY was used to produce, characterise, and apply in wastewater treatment and dye removal. It was screened for bioflocculant producing potential after cultivation using a production medium at 30 °C for 72 hours. At 160 rpm against 4 g/L kaolin clay suspension. The isolate that showed the highest flocculating activity was further identified using 16S rRNA molecular sequencing method as Schizosaccharomyces pombe MH595429.1, with 68.77% similarities. The optimized culture conditions showed positive results of 2% inoculum size, glucose (carbon source), and yeast extract (nitrogen source), at pH 4, temperature of 35 °C, shaking speed at 160 rpm as well as time course for extraction and purification of a bioflocculant. The flocculating activity was stimulated with 1% Na+ solution. From scanning electron microscope showed a rod shape gram positive yeast microorganism. After 84 hours of fermentation a bioflocculant yield of 3.4 g/L was recovered in 1 L of fermented broth. Chemical extraction method was used to obtain a cream white purified bioflocculant of 2.578 g/L. The produced bioflocculant showed 7.23% total sugar, 70.47% protein, and 22.30% uronic acid content. Using Fourier transform infrared (FT-IR) displayed the presence of carbonyl, amino, and hydroxyl group. The produced bioflocculant was heat stable supported by Thermogravimetric analysis which observed thermal stability from 0 – 700˚C. Tendele coal mine, vulindlela wastewater and umkomazi wastewater were used for removal efficiency of COD, BOD, P, and N. Dye removal efficiency was observed using malachite green, nigrosine, methylene blue and crystal violet. Schizosaccharomyces pombe show great potential of replacing the use of chemical flocculants in industries.

Keywords: Bioflocculant; kombucha tea SCOBY; Schizosaccharomyces pombe MH595429.1; molecular sequencing, optimization

An ethno-botanical survey of indigenous plants used by smallholder farmers for small ruminant parasitic infestations in KwaMthethwa rural area, KwaZulu Natal

Mbuyazi N

Abstract

Small ruminant production is crucial for rural livelihoods, providing food, income, and cultural value. Goats and sheep are resilient to harsh environments and integrate well into farming systems, yet the sector faces major challenges, particularly gastro-intestinal nematode infestations (GIN). These parasites reduce productivity, cause health problems, and lead to economic losses. Limited veterinary services, high drug costs, and growing drug resistance drive farmers to use African ethnoveterinary medicine (AEVM), relying on indigenous plants. However, the application of AEVM is often limited by insufficient scientific validation, lack of standardization, and limited access to modern veterinary drugs. This highlights the need for further research to explore, document, and optimize the use of ethnomedicinal plants. This study surveyed the use of indigenous plants for controlling parasitic infestations in small ruminants by smallholder farmers in rural kwaMthethwa. It was hypothesized that farmers in this area do not utilize plant-based treatments for livestock diseases. A structured questionnaire was used to collect data, and purposive sampling was employed to target all livestock-owning households within the ward. The results showed that most ($P<0.05$) respondents were male, and 98% reported having used ethnoveterinary remedies. About 20% of the farmers relied primarily on these remedies for treatment. Twenty-five plant species were identified for use against ecto and endoparasites and were classified by species and botanical families. In conclusion, while farmers in kwaMthethwa possess valuable knowledge of AEVM, further scientific validation is essential to ensure their safety, efficacy, and standardized use of these plants in smallholder farming systems

Keywords: Smallholder farmer, Gastro-intestinal nematodes, African ethno-veterinary medicine, Medicinal plants, Veterinary medicine, Parasitic infestations

A Survival Analyses of Dropout of students on Stem

Mbuyazi S

Abstract

This study investigates the timing and determinants of dropout among students enrolled in Science, Technology, Engineering, and Mathematics (STEM) programmes at the University of KwaZulu Natal, the aiming to inform targeted retention strategies in rural higher education contexts. Using anonymised student records from the Student Management Information System (SMIS) covering 2005 to 2019, survival analysis applies techniques, including the Kaplan-Meier estimator, Log-rank test, Cox proportional hazards model, and accelerated failure time models were applied to model time-to-dropout and identify key risk factors. The dependent variable was time-to-dropout in semesters, with dropout defined as not completing the enrolled STEM programme. Independent variables included gender, age, race, high school mathematics score, first-year GPA (Grade Point Average), funding status, and home location. Of the 38 630 students, 35.06% students dropped out during the study period, with higher dropout hazards observed among male students, those without financial aid, and students from rural backgrounds. The median survival time was shorter for students with low first-year GPAs and no NSFAS or bursary funding. Findings highlight the first year of study as a critical risk period, underscoring the decisive roles of early academic performance and financial support in retention. The study concludes that survival analysis is a powerful approach for identifying time-sensitive dropout risks and recommends early intervention programmes, targeted academic support, and expanded funding opportunities to improve STEM retention rates in historically disadvantaged institutions.

Keywords: dropout, STEM, survival analysis, higher education, South Africa, retention
Themes: Education and Learning, Data Science and Statistics, Socioeconomic Development

Mathematical Modelling of Malaria Transmission Dynamics: Explicit Solutions and Control Strategies

Mbuyisa Lindokuhle Ncebo

Abstract

Malaria remains a major public health challenge in tropical and subtropical regions despite ongoing control efforts. Understanding the interaction between human hosts and mosquito vectors is essential for designing effective interventions. This study develops and analyses deterministic compartmental models—SEIR-type for humans and SEI-type for mosquitoes—incorporating key epidemiological factors such as infection, recovery, immunity loss, vector biting rates, and parasite development. Using the Lie symmetry method, the study will derive explicit solutions to the nonlinear governing equations, enabling a detailed analysis of equilibrium states, transient dynamics, and disease prevalence. Stability will be examined through linearization and Lyapunov techniques, with particular focus on the influence of control measures such as insecticide-treated nets, indoor residual spraying, larval habitat reduction, and timely treatment. Analytical thresholds and numerical simulations will assess intervention effectiveness in reducing the basic reproduction number (R_0) and promoting disease elimination. By integrating epidemiological modelling with symmetry analysis, the research aims to enhance theoretical understanding and provide practical guidance for malaria control policy.

Keywords: Malaria Transmission Modelling; Lie Group Symmetry; Disease Control Strategies

The effect of egg weight on egg quality characteristics of layer chickens

L. Mchunu

Abstract

Eggs are an important source of nutrients for humans, providing many essential components required for physiological functions, growth, and development. Egg weight directly affects the profitability and economic efficiency of poultry operations therefore, commercial poultry farmers often focus on breeding hens that lay larger eggs. This study aimed to investigate the effect of egg weight on different quality characteristics of eggs from the Hy-Line Brown layer breed used at the University of Zululand. A total of 15 eggs were randomly collected once a week for a period of three weeks and then transported to the Department of Agriculture's Analytical Laboratory for evaluation of both internal and external quality traits. Eggs were then weighed and grouped based on their weights as follows: small eggs (< 50g - 55g), medium eggs (55g - 65g), and large eggs (> 65g). All measurements for both internal and external characteristics were conducted after eggs were weighed and grouped. Data were analysed using the Statistical Package for the Social Sciences (SPSS) to determine the effect of egg weight on egg quality parameters. The results showed that large eggs had the highest mean values for egg length, albumen width, albumen weight, and shell weight ($P < 0.05$). Albumen height and length were similar for both medium and large eggs ($P < 0.05$). Shell thickness, yolk diameter, and yolk index were not significantly related to egg weight ($P > 0.05$). In conclusion, egg weight significantly influenced several external and internal quality traits such as the length of the egg, shell weight, albumen width, and weight. It is recommended that hens producing medium to large eggs be selected to increase the edible contents of eggs without compromising shell quality.

Keywords: Egg length, albumen weight, yolk height, Haugh units, shell thickness, shell weight.

Spatiotemporal dynamics of land use and land cover changes and rainfall trends in Molopo River catchment, South Africa

Nomvelo N. Mchunu

Abstract

Human-driven land use and land cover change (LULCC) is a key driver of environmental transformation, influencing water availability, ecosystem function, and agricultural productivity. In the semi-arid Molopo River catchment, these changes are closely linked to rainfall variability. This study examined LULC dynamics from 2004 to 2024 and projected changes to 2034, alongside rainfall trends, using Landsat 4–5 TM and Landsat 8 OLI-TIRS imagery. LULC classification was performed in ArcGIS Pro, with accuracy assessed via error matrices, kappa statistics, and ground control points. Future LULC was modelled using the QGIS Molusce plugin, while rainfall trends were analysed using the Mann–Kendall test.
The findings reveal that Between 2004 and 2024, barren land decreased by −4.31% and bushland by 4.24%, while vegetation increased by 3.54% and grassland by 4.07%. Agriculture declined by −1.13%, while built-up areas expanded substantially by 2.05%. Water bodies showed a marginal net gain (+0.61 km²; +0.01%). Rainfall analysis indicated a weak, non-significant annual decline, but a significant spring decrease ($\tau = -0.382$; $p = 0.0013$; −0.050 mm/year) and a moderate, non-significant summer decline, with slight, insignificant positive trends in autumn and winter. Declining spring and summer rainfall critical for crop growth and recharge likely intensified vegetation stress and bushland loss, while cool-season stability may have supported limited regrowth. The findings stress the joined effect of anthropogenic stresses and variability in climate on catchment dynamics. In arid and semi-arid lands, there should be integrated land and water management plans towards creating a balance between development and sustainability of ecological systems.

Keywords: Molopo river catchment; LULC change; Rainfall trends; Arc GIS pro; QGIS

Synthesis and characterization of functionalized cellulose-based PVA-Zinc oxide composite membrane for water remediation applications

Ntombenhle Philisiwe Mchunu

Abstract

The rising concern over water contamination by heavy metals, especially cadmium (Cd^{2+}), has prompted the development of sustainable and effective remediation materials. This study reports the synthesis and characterization of a functionalized cellulose-based polyvinyl alcohol (PVA)-zinc oxide (ZnO) composite membrane aimed at efficient water purification. Cellulose nanocrystals (CNCs) were extracted from sugarcane bagasse and functionalized through carboxylation and amination to enhance adsorption capacity. The functionalized CNCs were then hybridized with PVA and ZnO nanoparticles modified with ferric chloride ($FeCl_3$) to produce a novel membrane material with high surface area and abundant active sites for cadmium binding. Characterization techniques including Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), and thermogravimetric analysis (TGA) confirmed the successful functionalization and structural integrity of the composite membrane. Adsorption studies revealed strong performance in cadmium removal under varying conditions of pH, concentration, contact time, and material dosage. This eco-friendly composite demonstrates great potential for scalable water treatment applications, offering a promising alternative to conventional heavy metal remediation methods.

Keywords: cellulose nanocrystals, PVA, zinc oxide, cadmium removal, water remediation, adsorption, sustainable materials

Design and modelling of 12-pulse thyristor-based converter system for transient stability control

S'thobile Mdluli

Abstract

Inherently susceptible to various types of disturbances (faults). Such disturbances can be categorised into: (a) short-term, (b) long-term, (c) large short-term, and (d) small short-term events. This paper specifically addresses transient instability in power systems. Transient stability refers to the ability of synchronous generators to maintain synchronism and continue operating at a constant rotational speed following large and sudden disturbances, such as short-circuits or abrupt load changes. High Voltage Direct Current (HVDC) transmission systems—particularly those employing thyristor-based Line-Commutated Converters (LCC)—play a significant role in enhancing power system stability due to their inherent advantages. These include high active power controllability, efficient long-distance power transmission, and the capability to interconnect asynchronous AC networks. A major contribution of HVDC systems to transient stability improvement lies in their ability to provide voltage support and damp power oscillations. Furthermore, advanced protection and control strategies integrated into HVDC systems ensure reliable operation of the power network during fault conditions.
This paper seeks to analyses the role of LCC-HVDC topology in improving overall power system stability, with a specific focus on its impact on transient stability enhancement. The study also evaluates the dynamic response of the power system under fault-induced disturbances, highlighting the performance benefits of LCC-HVDC integration.

Investigating the Knowledge, Utilization, and Perceptions of Indigenous Foods in Non-Profit Food Service Establishments in Empangeni, KwaZulu-Natal

B.C. Mfeka

Abstract

Indigenous foods are playing an important role in offering nutrition, preserving cultural heritage, and promoting environmental sustainability. regardless the presence of indigenous foods in Southern Africa, their use has decreased due to adoption of western diets, negative attitudes towards these foods, insufficient knowledge, and limited agricultural investment. In South Africa, especially in KwaZulu-Natal, NGOs, including schools, clinics, and community feeding programs, play a significant role in fighting food insecurity by supplying regular meals to vulnerable populations. Nevertheless, indigenous foods continue to be underutilized in non-profit food service settings, where menus predominantly feature maize, bread, and processed meats, with minimal or no representation of indigenous vegetables such as amaranth leaves, pumpkin leaves, cowpeas, and Bambara. This study aims to investing the knowledge, utilization, and perceptions regarding the use of indigenous foods by NGOs in Empangeni area. A quantitative descriptive survey was carried out to gather data from chefs, managers, administrators, supervisors, and owners engaged in the daily operations or strategic decision-making processes within non-profit food service organizations in Empangeni, specifically focusing on NGOs for this research. Purposive sampling was used to select relevant NGOs in Empangeni. Data collection involved structured questionnaires featuring both closed and open ended questions that addressed knowledge, utilization, and perception patterns. Descriptive statistics will summarise the quantitative data, while thematic analysis will be applied to qualitative responses. A total of 25 non-profit establishments participated, comprising 14 NGOs, 3 schools, 2 community kitchens, 1 orphanage, 1 old age home, and 1 guest lodge. The majority respondents 75% stated that they were knowledgeable about indigenous foods, while 58% reported that they prepared indigenous foods rarely or sometimes. Schools and orphanages indicated a more consistent use of these foods compared to NGOs. Training deficiencies were evident, with over 80% participants lacking adequate training. Regardless these challenges, participants valued indigenous foods and recommended gardens, farmer partnerships, and awareness campaigns to enhance inclusion. The research highlights a gap between awareness and practical use of indigenous foods in non-profit food service establishments. The results advocates for specialized training, improved supplier networks, and supportive policies to promote the integration of indigenous foods, which will be able to enhance the dietary diversity, food security, and cultural preservation within NGOs in Empangeni.

Key words: Indigenous foods; Food security; Non-profit food service; Knowledge and perceptions; Utilization

The Lie Symmetry Analysis of Time-Fractional Black–Scholes Equations with Market Anomalies

Nokuthula Hloseni Mhlongo

Abstract

This research examines the Lie symmetry structure of the time-fractional Black–Scholes equation in the presence of market anomalies, including memory effects, volatility clustering, and liquidity constraints. Traditional Black–Scholes models assume constant volatility and perfectly efficient markets—assumptions that frequently fail in real-world financial contexts. By incorporating Caputo fractional derivatives, the model captures non-local dynamics and historical dependencies in asset pricing. Through Lie symmetry analysis, invariant transformations are identified, similarity reductions are performed, and exact or approximate solutions to the fractional partial differential equation are derived. A comprehensive literature review and comparative analysis highlight how symmetry methods improve the analytical tractability of complex financial models while providing valuable insights into anomalous market behaviours. The findings contribute to the advancement of more realistic and generalisable pricing models, better suited to the complexities of evolving financial systems.

The Impact Of Social Media Marketing On Guest Preference In Rural Lodges And Guesthouses

Mjadu AS

Abstract

Digital marketing plays a vital role in hospitality by helping businesses engage audiences, promote destinations, and enhance guest experiences (Ibrahim & Aljarah, 2023). Rural lodges and guesthouses often struggle to effectively utilize social media marketing, which can hinder their ability to attract and retain customers. One concern is the lack of a clear social media strategy, which can lead to a disjointed and ineffective online presence (Hays, 2017). Although 77% of travellers rely on social media for trip planning (Parikka, 2017), these establishments often lack digital skills, resources, and the ability to create appealing content. The aim of this study was to examine how social media marketing influences guest preferences in rural lodges and guesthouses, offering a low-cost way to boost visibility, showcase unique offerings, and build guest relationships. This study used a mixed-methods approach with online surveys and interviews. Purposive sampling will target 100 guests and 10 owners or managers with -social media experience. Survey data will be analysed using SPSS, while interviews will undergo thematic analysis. Survey results show that most respondents were female and over 60% were young travellers. Social media photos and online reviews had the strongest impact on bookings, while influencer posts and company responses were less influential. Authentic reviews and quality images not only guided choices but also encouraged repeat visits and recommendations, highlighting the value of a credible online presence. Limited internet access and low digital marketing skills among staff remain key challenges. As this study is still ongoing, broader research is needed to validate these insights. Due to genuine evaluations and high-quality photos, social media has a significant impact on reservations, visitor experiences, and return business in rural hospitality. However, lodges are unable to completely profit due to inadequate connectivity and a lack of expertise in digital marketing. Increasing online interaction and tackling these issues may increase the number of visitors, but more studies with a bigger sample size are required to validate these findings.

Enhancing Smart Grid Stability using Real-Time Demand Response and Energy Storage Systems Integration

Mkhwanazi MW

Abstract

A smart grid is a distribution network designed to provide stable and reliable energy to end users. It enables two-way communication between the utility and the end user, unlike traditional grids, which use one-way communication. Smart grids allow power plants to communicate in real time with distribution networks, substations, and customers. With this connectivity, the grid can be monitored and controlled in real time, improving its ability to adapt to changes in demand and supply. However, smart power grids are becoming increasingly unstable due to rising electricity demand and the growing integration of renewable energy sources. This research focuses on smart grid technology with the aim of understanding how energy storage systems and real-time demand response can be integrated to improve grid stability. Stability refers to the ability of the system to maintain normal operating conditions during or after disturbances. Demand response shifts loads from peak hours to off-peak periods during high electricity demand, while battery energy storage systems store excess or unused energy and discharge it when required. Studies highlight the importance of optimal placement, control algorithms, and sizing of batteries to maximize grid stability. In this research, the smart grid will be modelled using a suitable distribution network as a test system in MATLAB, DIgSILENT, or other appropriate software. The system will be subjected to disturbances to analyze its behavior during and after such events. Battery energy storage systems and real-time demand response will then be introduced to enhance smart grid stability. Performance evaluation will be based on stability metrics.

Keywords: smart grids, stability, demand response, battery energy storage system

Perceptions of Nurse Managers Regarding Paperless Record Keeping in Public Hospitals in eThekwini and King Cetshwayo Districts, KwaZulu-Natal

Mkhwanazi N

Abstract

The nursing record inaccuracy and illegibility, which emanate from the handwritten nursing records remain a problem in a number of hospitals in KwaZulu-Natal and countrywide. Paperless record keeping has long been introduced in many African countries, however very few health facilities have managed to fully adopt it. The aim of the study is to investigate the nurse managers' perceptions regarding paperless nursing record-keeping in the selected paperless and paper-based public hospitals in KwaZulu-Natal. A combination of qualitative, explorative, and descriptive design methodology will be used. The study was guided by the Theory of Goal Attainment by Imogene King. The study population consisted of nurse managers of the paper-based public hospitals in the King Cetshwayo District and those in the paperless public hospitals in eThekwini. In-depth semi-structured interviews will be used to collect data in eThekwini and King Cetshwayo hospitals. The study sample will comprise 30 nurse managers, including four additional participants to confirm data saturation. Collected data will be audio-recorded, and field notes will be taken. Data will be analyzed thematically, using Colizzi's phenomenological method. The study is expected to reveal factors that contribute to the non- usage of electronic records in selected hospitals in KwaZulu-Natal. These factors might include financial constraints, lack of technological knowledge, infrastructures and legalities around the keeping of electronic patients' records. On completion, data analysis will reveal the perceptions of the nurse managers in terms of the usage of paper based and paperless record keeping. Conclusions and recommendations will be logically derived and supported by evidence.

Keywords: Perceptions, nurse managers, paperless records, electronic records.

Perceptions Of Nurse Managers Regarding Paperless Record Keeping In Public Hospitals In Ethekwini And King Cetshwayo Districts, KwaZulu-Natal

Mkhwanazi N

Abstract

The nursing record inaccuracy and illegibility, which emanate from the currently used handwritten nursing record keeping remains a problem in KwaZulu Natal and country wide. Paperless record keeping has long been introduced in many African countries, however very few health facilities have managed to fully adopt paperless record keeping. Aimed at understanding the nurse managers' perceptions regarding paperless nursing record-keeping in the selected paperless and paper-based public hospitals in KwaZulu-Natal. A qualitative, explorative, descriptive design was used. The study was guided by the Theory of Goal Attainment by Imogene King. The study population consisted of nurse managers of the paper-based public hospitals in the King Cetshwayo District and those in the paperless public hospitals in eThekwini of KwaZulu-Natal. In-depth semi-structured interviews will be used to conduct interviews with nursing managers of paperless public hospitals in eThekwini District and in the paper based public hospitals in the King Cetshwayo District. Data will be collected until saturation is reached. The anticipated study participants will be 30 nurse managers, including four additional participants to confirm data saturation. Collected data will be audio-recorded, and field notes will be taken. Data will be analyzed thematically, using Colizzi's phenomenological method. The findings of this study anticipate revealing factors mitigating to the non- usage of the electronic records keeping in various hospitals in KwaZulu-Natal in the selected districts where the study will be conducted. These factors might range from financial constraints, lack of technological knowledge, infrastructures and legalities around the keeping of electronic patients' records. The study finding will ascertain the anticipated factors. On completion, the researcher will make conclusions about the phenomenon including making recommendations for improvement of migrating to the implementation of the use of electronic records keeping in the health care facilities in KwaZulu-Natal.

Keywords: Perceptions, nurse managers, paperless records, electronic records.

Student profiles and factors affecting the performance of first year Consumer Sciences students at the University of Zululand

Mkhwanazi, SAF

Abstract

Understanding student characteristics and factors that influence academic success is critical in higher education (Briones et al. 2022). Al Husaini et al. (2022) found that personal qualities, socioeconomic background, psychological well-being, and institutional environment impacted academic performance. According to Foster et al. (2020), many first-year university students experience difficulties adjusting to the demands of higher education which can adversely affect their academic performance and future career prospects. This study aimed to describe student profiles and factors affecting academic performance of first-year Consumer Sciences students at the University of Zululand. This will enable the Department to develop appropriate intervention strategies. A descriptive cross-sectional survey design was used to collect data by means of an online questionnaire using Google Forms. Thus far 90 purposively sampled first-year Consumer Sciences students completed the survey. Students were approached during selected classes, given a consent form to complete after which they were provided with the link to complete the survey. This paper shares insights from preliminary results. Most (98%) students are from KwaZulu-Natal, with 58% from rural areas. Study choice was mainly influenced by parents or siblings, teachers, and employment or entrepreneurship opportunities. 48% of students stay on campus which could explain why only 43% indicated that they have internet access all the time. It is concerning to see that only 47% of students have access to computers. Only 43% of students passed all first semester modules and stated that challenges with accommodation, internet access and health affected their performance. Most (80%) students expressed that they require academic support, as well as support managing their finances and time. The Department in collaboration with other structures, such as the Writing Centre, and appointing of tutors can provide students with academic support to improve performance and transition from school to university and a digitally driven society.

Systematics study of Octupole bands in rotating even-even nuclei to reveal rigid or soft Octupole shape

M Mlotshwa

Abstract

The systematic study of octupole bands in rotating even-even nuclei provides valuable insights into octupole deformation, especially in distinguishing between rigid and soft modes. Octupole-deformed nuclei—often exhibiting pear-shaped geometries—are typically characterised by alternating-parity rotational bands, which reflect strong octupole correlations and significantly influence nuclear structure and collective motion. This study explores how nuclear rotation modifies these octupole features, aiming to classify the deformation type and assess its rotational stability. Experimental γ-ray spectroscopy data, primarily sourced from the National Nuclear Data Center (NNDC), are analysed across a wide range of even-even nuclei, with a focus on the A ≈ 240 mass region where octupole effects are most pronounced. The new parameter-free method based on Coriolis decoupling is developed. This approach addresses limitations from in conventional alignment-based techniques that rely on Harris parameters, which often limits structural signatures due to parameter dependency. The proposed method enables consistent and unbiased interpretation of rotational band behaviour without fitting constraints. The findings demonstrate clear, systematic signatures of octupole deformation across multiple isotopes. In particular, the method distinguishes between nuclei exhibiting stable, rigid octupole shapes and those with more dynamic, soft deformations. The results contribute to a deeper understanding of reflection-asymmetric shapes and their evolution with angular momentum. These observations have implications for theoretical nuclear models, particularly those describing collective excitations in exotic nuclei. The study recommends the broader adoption of parameter-free analysis techniques in nuclear structure research and encourages the continued integration of experimental data with refined theoretical frameworks. Such approaches may bridge the gap between known and unexplored regions of the nuclear chart, furthering our knowledge of fundamental nuclear symmetries and their manifestations.

Assessing the Impact of Climate Change on Surface Runoff in Gqeberha, Eastern Cape

Asanda Mnguni

Abstract

Climate change continues to alter rainfall patterns and intensify hydrological extremes across South Africa, threatening urban infrastructure, water resources, and livelihoods. This study focuses on Gqeberha, a coastal city in the Eastern Cape, to assess the effects of climate change on surface runoff. The city has experienced increasing flood events and periods of water scarcity, highlighting the need for adaptive water resource planning. Using historical climate data, projected rainfall scenarios, and hydrological modelling, the study evaluates how climate variability influences surface runoff generation. The goal is to provide insight into flood risks, water catchment dynamics, and inform resilient urban planning strategies. While centred on Gqeberha, the research also provides valuable methodology and recommendations applicable to other regions, including KwaZulu-Natal, which faces similar climate-induced challenges. This work supports sustainable land and water management in the context of climate change.

Keywords: Climate Change, Surface Runoff, Gqeberha, Hydrological Modelling, Flood Risk, Water Resources

Exploring isiZulu Corpus development from newspapers to train large languages models

Nombuso Mnqayi

Abstract

This work aims to support the development of a digitally inclusive Africa by exploring the collection a high-quality of isiZulu text corpus gathered from isiZulu newspapers, in supporting the training of large language models (LLMs). There is an increasing demand for African language resources in Natural Language Processing (NLP), this research bridge the gap of underrepresented African languages (focusing on isiZulu language). This collection of isiZulu datasets will hopefully help to accurately train machine learning applications. The collection involves the extraction, scrapping from iSolezwe website using python and sent document by editors of Ilanga news, The initial evaluation focuses on text data size, IsiZulu language quality and structural diversity of the IsiZulu texts. After the process of collection is completed the text corpus will be cleaned, Pré-processed to prepare the data for model training. The expected outcome of the research work is a sustainable, domain-rich corpus that can support large language Models training. One challenge is the interaction with the newspaper editor, not always easy. The posted news per day is close to 75.67KB which is time consuming.

Keywords: newspaper, isiZulu, Low-resource languages, Large Language Models (LLMs), Corpus development, Data cleaning, Text preprocessing, African languages

Performance of fish effluent as an organic nutrient source for groundnut (*Arachis hypogaea* L.) production

Siyanda Mntambo

Abstract

Groundnut production is important for food security and the main source of income for most poor resource farmers in Africa; however, the production is faced with soil toxicities through overuse and traditional fertilizer application which tend to be expensive for some farmers as such they use the soil without fertilizers, and it is known that sandy soils have low level of nutrients. Using fish effluent as a source of nutrients has a potential to be a sustainable cheap alternative to synthetic fertilizers in crop production especially for poor resource farmers. This study focused on evaluating the performance of catfish and tilapia effluents on the Agro-morphological growth, yield, and nutrient composition of groundnut (*Arachis hypogaea* L.). An experiment was conducted in a greenhouse using 10-litre pots filled with sandy soil from Manguzi, each planted with one seed of the groundnut cultivar Manguzi.The pots were subjected to four different irrigation treatments tilapia (*Oreochromis niloticus)* effluent, catfish (*Clarias gariepinus)* effluent, and NPK 2:3:4 (30) fertilizer solution) plus a control (distilled water) ,The experiment was conducted using 64 groundnut plants arranged in a completely randomized design with the four treatments 16 replicates for each. Results showed that both fish effluents significantly improved plant height, leaf number, biomass, and pod yield compared to the control. Tilapia effluent produced the highest pod yield with high number of groundnuts, representing a higher increase over the control. No significant differences were observed between catfish and tilapia effluent in most key growth parameters. These findings suggest that fish effluent can serve as a viable and eco-friendly nutrient source for groundnut cultivation.

Keywords: Aquaponics; organic fertilizer; *Arachis hypogaea*; nutrient recycling; sustainable agriculture; legume production

Exploring Lie Group Symmetries in Difference-Based Black Scholes Equation

Mr Andrew W.H Mochaki

Abstract

This study explore the application of Lie group symmetry analysis to the difference based Black-Scholes equation, aiming to uncover invariant structures and derive the solutions that preserve the equation's fundamental properties. In this study, we investigate the Lie group symmetries associated with difference-based Black-Scholes equation. We derive their solutions by solving a difference equation on a four-point uniform and orthogonal grid using Dorodnitsyn's method, as described in. We use a modified version of Levi's technique, as explained in to investigate the array of point symmetries inherent in the discrete Black-Scholes equation. Four Lie point symmetries obtained using Dorodnitsyn's method. We demonstrated that two differential's point symmetries are preserved by the difference equation on the uniform and orthogonal mesh. And two Lie point symmetries obtained using modified version of Levi's technique and thus the difference scheme is invariant under one-dimensional group of Lie point transformations.

Keywords: Lie Group Symmetry; Black-Scholes Equation; Difference equations.

A Comprehensive Review of Essential Visual Skills in Combat Sports

Moeketsi Robert Mohlakoana

Abstract

Athletic performance places significant demands on the visual system, and the role of vision in sport has long been recognised. In combat sports, where rapid decision-making and precise movements are essential, visual skills play a crucial role in enhancing performance and maintaining a competitive advantage. This review aims to provide a comprehensive analysis of the essential visual skills required in combat sports and to explore evidence-based training methods to optimise these abilities. A systematic search was conducted across multiple databases, including PubMed, CrossRef, Google Scholar, ResearchGate, Scopus, SPORTDiscus, ScienceDirect, Wolters Kluwer, Semantic Scholar, Elsevier, the Cochrane Database of Systematic Reviews, and OpenAthens. The search utilised MeSH terms such as “sport,” “sport vision,” “combat sport,” “vision in combat sport,” “depth perception,” “eye-hand coordination,” “accommodation facility,” “fixation skill,” “saccadic eye movements,” “visual skills,” “reaction time,” “peripheral awareness,” “visual memory,” “concentration,” and “visual perception.” The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed, and after removing duplicates and screening full-text articles, 56 studies were selected for analysis. Both hardware (e.g., visual acuity, depth perception) and software (e.g., reaction time, visual memory) visual skills are essential in combat sports. Elite athletes tend to excel in these areas, and targeted training such as stereoscopic drills, reaction exercises, and virtual reality can sharpen them further, enhancing precision, tactical execution, and competitive advantage. Combat sport coaches and practitioners should prioritise comprehensive visual skills training that develops both hardware (e.g., visual acuity, depth perception, fixation) and software (e.g., reaction time, visual memory, hand-eye coordination) abilities. Implementing targeted interventions such as stereoscopic exercises, reaction drills, and sport-specific simulations can enhance athletes’ ability to process visual cues, anticipate opponents’ actions, and respond with precision, ultimately providing a decisive advantage in high-pressure competitive environments.

Characterization of proton-induced defects in SnO_2 using positron annihilation technique.

D Motjope

Abstract

In this work a two-component density functional theory is employed in the modelling of defects in proton-induced tin-oxide (SnO_2) semiconductors. Since defects are localized, the local density approximation (LDA) is used which is derived from the two-component Density Functional Theory. Although LDA gives a good approximation of positron lifetimes and electron-positron annihilation momentum density, it does not consider the variation nature of the electron density. This has an unintended consequence of having over estimated annihilation rates or lower positron lifetimes compared to experimental values. This deficiency in LDA is corrected by using the generalized gradient approximation (GGA) which considers the variation nature of electron density. The accumulation of annihilation spectrum using coincidence setup, is utilized to allow for the determination of annihilation parameters, S and W. The spectrum consists of positron annihilations at defect sites as well as annihilations in the bulk (defect-free region). It also consists of annihilations of positrons with core electrons (high momentum electrons). The low and high momentum distribution of electrons are used to characterize the Doppler broadening which tells us about the quantity of radiation- induced defects in SnO_2 in terms of calculating S-parameter, which is the ratio of the annihilation centroid area to the total area of the annihilation curve. Calculated S parameters are then compared with the experimentally obtained S parameters. The nature of the defect is theoretically obtained from the annihilation rates or equivalently from the calculated positron lifetimes in SnO_2.

Keywords: positron annihilation, Doppler broadening, Local density approximation, positron lifetime, S-parameter

The Impact Of Climate Change On Surface Runoff In The City Of Cape Town, Western Cape South Africa

Zanele Moyana

Abstract

Climate change is increasingly altering hydrological systems around the world, particularly through its effects on rainfall patterns and surface runoff. This study investigates the impact of climate change on surface runoff in the City of Cape Town, a region vulnerable to both droughts and floods due to its Mediterranean climate. Using downscaled climate data and hydrological modeling, the research assesses projected changes in rainfall and temperature and how these changes influence surface runoff from 2020 to 2025. Cape Town has experienced severe climate-induced water stress, most notably during the Day Zero crisis, which revealed the city's reliance on surface water and the urgency for adaptive water management. Rising temperatures are expected to increase evapotranspiration and reduce soil moisture, while shifting rainfall patterns may lead to erratic runoff, with increased flood risks during heavy rainfall and water shortages during prolonged dry spells. The study applies rainfall-runoff modeling tools to simulate future runoff scenarios and provide insight for sustainable water resource planning in the face of climate uncertainty. Findings from this research are intended to support climate adaptation strategies for urban water security in Cape Town and similar water-stressed cities.

Keywords: Climate Change, Surface Runoff, Cape Town, Rainfall Patterns, Hydrological Modeling, Water Security.

Effectiveness of Machine Learning Algorithms in Real-Time Credit Card Fraud Detection

L.N Mpanza

Abstract

The escalation of credit card fraud, driven by the proliferation of digital financial transactions, demands the implementation of effective real-time detection systems. Conventional rule-based fraud detection techniques frequently prove insufficient, as they do not swiftly adapt to changing fraudulent strategies, leading to significant financial losses and diminished consumer confidence. This study assesses machine learning methods to determine the most effective models for balancing detection accuracy and computational latency in real-time fraud detection contexts. This study employed a publicly accessible dataset consisting of more than 550,000 anonymised European credit card transactions sourced from Kaggle. Five machine learning algorithms—Logistic Regression, Random Forest, Support Vector Machine (SVM), K-Nearest Neighbors (KNN), and XGBoost—were chosen due to their proven efficacy and prevalent use in the literature on fraud detection. Prior to evaluating the models, data preparation was conducted, encompassing feature scaling and division into training and test sets. The models were subsequently assessed utilizing accuracy, precision, recall, F1-score, and latency criteria. Experimental results demonstrated that Random Forest and XGBoost attained the maximum accuracy, both at 99.98%, illustrating their remarkable efficacy in detecting fraudulent transactions. Logistic Regression demonstrated the minimal latency, with an average reaction time of 0.0005 seconds, rendering it optimal for real-time applications necessitating prompt decision-making. Latency is essential in real-time fraud detection to reduce delays in transaction verification, hence improving user experience and thwarting fraudulent transactions in high-volume settings. K-fold cross-validation substantiated the reliability and generalizability of the assessed models. The results indicate that ensemble techniques such as Random Forest and XGBoost yield enhanced accuracy, whereas Logistic Regression presents significant benefits for latency-sensitive applications. This study guides financial institutions and e-commerce platforms in choosing suitable machine learning models to efficiently balance accuracy and latency, thereby enhancing fraud detection efficacy and consumer confidence.

Investigation of X-rays and Gamma-ray Shielding Properties of Heavy Metal Oxide Glass Materials

N. Msabala

Abstract

Exposure to high levels of ionizing radiation poses serious health risks, especially for workers in medical, industrial, and nuclear environments. Traditional shielding materials like lead have significant drawbacks, including toxicity and environmental concerns. This study focuses on developing lead-free heavy metal oxide glass materials that offer effective X-ray and gamma-ray attenuation while maintaining transparency, structural durability, and cost efficiency. In this work, the radiation shielding parameters of the glass system, with the chemical composition $xBi_2O_3-(55-x)B_2O_3-15BaO-10ZnO-18SiO_2-2Nd_2O_3$ (x = 15, 20, 25, 30, and 35 mol%) was investigated. The radiation shielding properties were investigated through simulations using XCOM software over a photon energy range of 0.03 to 0.3 MeV. The results show that increasing Bi_2O_3 content significantly increases the mass attenuation coefficient (MAC), indicating better shielding performance compared to similar glass compositions reported in the literature.

Synthesis and Surface Modification of Titanium Dioxide Pigments with Multifunctional Properties for Coating Applications

SN Msezane

Abstract

Titanium dioxide (TiO_2) is a widely used white pigment known for its excellent optical properties, chemical stability, and non-toxic nature. However, the growing demand for environmentally responsive and protective coatings has driven research into advanced surface engineering of TiO_2, aligned with sustainability goals. This study reports the synthesis of TiO_2 pigment powders via the sol-gel method, followed by systematic surface modification to impart multifunctional properties. Their performance was compared with commercially available pigments. Unmodified and modified TiO_2 samples were characterized using advanced analytical techniques such as, Ultraviolet-visible (UV-Vis) spectroscopy, X-ray diffraction (XRD) Fourier-transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA), transmission electron microscopy (TEM), scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX). The study emphasized the comparison between synthesized and commercial TiO_2 pigments, particularly focusing on crystalline structure and thermodynamic stability. Surface modification using silane coupling agents and metal oxides (SiO_2, Al_2O_3, ZrO_2) enhanced hydrophobicity, light scattering, and significantly reduced photocatalytic activity, which helps prevent degradation of coating binders. Controlling the photocatalytic activity of TiO_2 pigments is crucial for reducing VOC emissions, improving indoor air quality, and enabling self-cleaning and anti-fouling surface functionalities. The findings highlight the potential of sol-gel synthesized and functionally modified TiO_2 pigments to replace or enhance existing commercial pigments in sustainable coating systems, offering improved environmental resilience and durability.

Keywords: Titanium dioxide, Metal oxides, Modified TiO_2, Pigments and Surface coating.

Effect of SrO on radiation attenuation properties of boro-tellurate glass systems at a high energy region

S. Mthalane

Abstract

In the present study, the radiation shielding properties of five glass compositions 40SrO–30B_2O_3–10TeO_2–20Bi_2O_3, 35SrO–30B_2O_3–10TeO_2–25Bi_2O_3, 30SrO–30B_2O_3–10TeO_2–30Bi_2O_3, 25SrO–30B_2O_3–10TeO_2–35Bi_2O_3, and 20SrO–30B_2O_3–10TeO_2–40Bi_2O_3, were investigated using Phy-X/PSD software, and validated through GEANT4 simulations. The mass attenuation coefficients (MAC), linear attenuation coefficients (LAC), and effective atomic numbers of the glasses were determined across the energy range of 1–15 MeV. Results showed that increasing the Bi_2O_3 while decreasing SrO content enhances the radiation shielding capability of the glasses. Additionally, the half-value layer (HVL), and tenth-value layer (TVL), were evaluated, revealing that glasses with higher Bi_2O_3 concentrations attenuate a greater amount of photons with smaller thicknesses. 20SrO–30B_2O_3–10TeO_2–40Bi_2O_3 glass demonstrated superior radiation shielding performance and can be used in both nuclear and medical applications.

Microplastic contamination in a relatively pristine estuary: A case study of uMlalazi Estuary, South Africa

MM Mthembu

Abstract

Estuaries are among the most biologically productive aquatic resources. However, they are vulnerable to both traditional (e.g. metals) and emerging contaminants such as microplastics, which can impact overall water quality. Assessing the extent of microplastic contamination and its relationship with environmental parameters, particularly within protected areas like the uMlalazi Estuary in KwaZulu-Natal where data is limited, is essential for maintaining estuarine health. This study aimed to assess the seasonal occurrence and distribution of microplastics in water and sediment uMlalazi Estuary. Physicochemical parameters, sediment organic content (TOC), and grain size were measured monthly from nine sampling sites using a YSI multiprobe, loss-on-ignition, and dry sieving methods, respectively. Water samples (20L triplicates) collected during summer, were filtered using vacuum filtration and Whatman filter paper, and examined under a dissecting microscope based on shape and colour. Salinity ranged from 1.3 to 16.89 between October and February, while turbidity peaked in February (116.4 NTU), likely due to heavy rainfall. The substrate in the upper estuary (Sites 9 to 7) consisted of muddy sand with higher TOC (23.89%), while the middle-lower estuary (Sites 6 to 2) was dominated by sand and lower TOC (12.74%). Microplastic concentrations ranged from 4 to 33 particles/L, with the highest abundance at Site 2 (lower reaches) and the lowest at Site 9 (upper reaches). Most microplastics were fibres (87%) and films (13%), with white being the most common colour, followed by black, blue, and red. Likely sources include fishing activity and domestic runoff. The Contamination Factor and Pollution Load Index (PLI) values indicated a minimal ecological risk. However, further sediment analysis and integration of other indices (i.e. Potential Ecological Risk Index) are recommended to have a holistic view of water quality in uMlalazi Estuary.

An Assessment of Food Safety and Hygiene Practices Amongst Food Vendors at a rural-based University

Lukhele A

Abstract

Food safety and public health are threatened by the rising incidence of foodborne illnesses across the world (World Health Organisation 2020). Kamboj, Gupta, Bandral, Gandotra and Anjum (2020) highlighted that most research has solely concentrated on food safety and hygiene procedures in formal food businesses whereas Manoharan and Rangaswamy (2024) revealed that a significant information gap still exists about the knowledge, attitudes, and behaviours of food vendors in informal settings. The aim of this study was to assess the knowledge, attitudes, and practices of food vendors regarding food safety and hygiene at a rural-based university. This research contributes to advancing interdisciplinary knowledge for sustainable and digitally driven Africa through enhancing food safety awareness and public health outcomes. A mixed method approach was used to collect data from 10 informal food vendors around Kwadlangezwa campus who were selected purposively. Data was collected using structured questionnaire to assess vendor`s knowledge and attitudes, an observational checklist to document food handling practices, and interviews to identify factors influencing food vendor`s handling practices. Descriptive data analysis was conducted using Microsoft Excel. Most food vendors interviewed were between the ages of 21 and 45 years, both male and female black participants. Sixty percent of the food vendors had received food safety training, while the remaining vendors gained knowledge through experience, peer advice, and online sources. Due to water shortages only 40% of respondents were observed washing hands consistently, although most vendors acknowledged the importance of hand hygiene. In addition, knowledge about separating raw and cooked foods and cleaning surfaces was expressed but none of the vendors practiced proper storage principles. All participants faced challenges with waste disposal due to lack of bins and irregular collection. The results show that the participants understand the value of food safety and hygiene but face environmental and infrastructural barriers which hinders practice. There is a need for formal training, improved infrastructure and better waste management, to support vendors in implementing food safety practices effectively.

Malicious PDF detection based on machine learning with evaluation of feature selection

Mthethwa QA

Abstract

The rise of using Portable document format, more commonly known as PDF files encourage the cybercriminals to impose malicious code. PDF provides a resilient file structure that promote the embedding of different types of content such as JavaScript. This allows attackers to insert malicious code as well as other hidden intention within the victims. Traditional signature-based antivirus tools struggle to keep up with the increasing sophistication of these threats, especially as attackers employ obfuscation, encryption techniques to evade detection. To migrate the malicious PDF this study proposes to ensemble learning classifiers which are MLP, RF, BNet and NB using Evasive-PDFMal2022 dataset which is previously used by other researchers. The first experiment utilises all features of the datasets which are 'pdfsize', 'metadata size', 'pages', 'xref Length', 'title characters', 'isEncrypted', 'embedded files', 'images', 'text', 'header', 'obj', 'endobj', 'stream', 'endstream', 'xref', 'trailer', 'startxref', 'pageno', 'encrypt', 'ObjStm', 'JS', 'Javascript', 'AA', 'OpenAction', 'Acroform', 'JBIG2Decode', 'RichMedia', 'launch', 'EmbeddedFile', 'XFA', 'Colors'. And the second experiment use the important features which are 'pdfsize', 'metadata size', 'pages', 'xref Length', 'title characters', 'isEncrypted', 'images', 'text', 'header', 'obj', 'endobj', 'stream', 'endstream', 'xref', 'trailer', 'startxref', 'pageno', 'encrypt', 'ObjStm', 'JS', 'Javascript' the study then compared the result to evaluate the effective model to detect malicious PDF The model was assessed using metrics such as accuracy, precision, recall, F1-score, and AUC to determine their effectiveness. The results for first experiment RF and BNet model outperform by 99.24%. And for second experiment the results are less than the result for first experiment. The findings underscore the efficiency of ensemble learning classifiers in identifying malware within PDF file and emphasize the potential of utilizing all features of the PDF as sustainable approach to PDF malware detection.

Satellite Remote Sensing of Macadamia Orchards and its Response to KwaZulu-Natal Climate Dynamics

S. P. Mthimkhulu

Abstract

This his study investigates the impact of climatic variability on macadamia orchards in KwaZulu-Natal, South Africa, using Sentinel-2 satellite data from 2019 to 2023. The research employs eight vegetation indices namely: Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), Standardized Precipitation Evapotranspiration Index (SPEI), Vegetation Condition Index (VCI), and Normalized Difference Infrared Index (NDII) to assess climate-induced changes. Monthly average soil temperature and precipitation data from the Climate Engine and Modern Retrospective Analysis for Research Application (MERRA) model, alongside evapotranspiration (ET) data from the Global Land Data Assimilation System (GLDAS), were utilized to evaluate vegetation water stress. The analysis reveals that higher NDVI values (e.g., 0.65 at UVS in 2021) align with vegetative growth phases, with Farm 1 at La Chagra showing significant impact from the 2019 strong El Niño event (NDVI drop to 0.42), while Farm 2 at Umhlathuze Valley Sugar (UVS) experienced lesser effects (NDVI 0.58). This is consistent with ERA-5 rainfall data, recording the lowest precipitation at 178 mm/day in April 2019, recovering to 260 mm/day by March 2020, with a peak of 285 mm/day in 2022. The Sequential Mann-Kendall (SQ-MK) and inter-annual Mann-Kendall trend tests indicate a notable NDVI decline during El Niño years (2019-2020), reflecting reduced vegetation health (VCI min 0.35 at La Chagra). A strong in-phase relationship between climatic parameters (e.g., ET at 4.2 mm/day in 2019) and NDVI underscores the close interaction between climate and macadamia growth. These findings highlight the potential of remote sensing and Random Forest models to enhance management practices and resilience against climate variability in KwaZulu-Natal’s macadamia farming.

Keywords: Satellite Remote Sensing, Google Earth Engine, Climate data, Vegetation index Mann-Kendall, Random Forest

Analysing climate variability and its influence on water Availability in UMhlathuze, KwaZulu-Natal, South Africa

Mndeni Mtshali

Abstract

South Africa is vulnerable to climate variability, especially in regions like uMhlathuze, KwaZulu-Natal, where socioeconomic activities rely heavily on stable hydrological conditions. This study investigates the influence of climate variability on water availability in the uMhlathuze, catchment by analysing trends in key hydroclimatic variables temperature, rainfall, evaporation transpiration, and relative humidity over a ten-year period (2015–2024). The study employs a quantitative approach using, data sourced from the ERA5 Land dataset available within Climate Engine and Department of Water and Sanitation (DWS). Statistical analyses, uses the Mann-Kendall trend test to detect monotonic trends, and correlation analysis were applied to examine relationships between climate variables and their temporal variability. Microsoft Excel and KNMI Climate Explorer are employed to evaluate the relationship between selected climate variables and large-scale teleconnection patterns such as the El Niño–Southern Oscillation and Indian Ocean Dipole. Assessment of extreme weather impacts is validated using drought and heatwave metrics, including Standardized Precipitation Evapotranspiration Index. This study contributes to the development of localised adaptation strategies and underscores the need for integrated water resource management in climate-vulnerable regions. The study support progress toward several Sustainable Development Goals, including clean water access, food security, and climate resilience.

Keywords: Climate variability, water availability, uMhlathuze, El Niño–Southern Oscillation, KNMI Climate Explorer, DWS

Functorial Perspectives on Algebraic Structures

Nosimilo K. Mvelase

Abstract

This project uses category theory to examine algebraic structures, including rings, groups, and modules, with an emphasis on functors and natural transformations. The objective is to show how category-theoretic tools provide a conceptual and unifying framework for comparing and analyzing various algebraic systems. In order to uncover profound structural linkages, important categorical concepts including adjoint functors, colimits, and limits are investigated. These ideas are then extended to homological algebra, where projective, injective, and flat modules, as well as Ext and Tor functors, are examined. While acknowledging their limits, a comparative analysis demonstrates the benefits of functorial approaches over classical methods. In the end, this study demonstrates how categorical abstraction can be used to clarify diU'icult algebraic concepts and create linkages between diU'erent mathematical fields.

Keywords: Category theory, Functorial methods, Morphisms, Algebraic structures (rings, groups, and modules), Homological algebra, Derived categories, and Triangulated categories.

Determining Radon Exhalation Rate from a Gold Mine Tailing by Using Gamma Ray Spectroscopy Technique

S.S Ntshangase

Abstract

Radon (Rn) is a decay product of radium (Ra), which is a member of the uranium (U) decay chain. The physical and chemical properties of radon such as colorless, odorless, and tasteless radioactive nature make it difficult to detect without special equipment. Radon has three well-known isotopes, Radon-222, Thoron-220, and Actinon-219, which are found from the decay series of uranium isotopes U-238, U-236, and U-235, respectively. The three isotopes of radon Rn-222, Rn-220, Rn-219 have a half-life of 3.82 days, 55.8 seconds, and 3.98 seconds, respectively. Radon is among the leading contributors to ionizing radiation and it has been identified as a health hazard for mankind. Few studies have examined radon exhalation from gold mine tailings, where uranium is present as a secondary mineral, despite a large body of study on radon emissions from uranium mine tailings. Furthermore, little is known about how environmental factors like moisture content and particle size distribution affect exhalation rates. The concentrations and distributions of radionuclides are crucial for monitoring environmental pollution caused by natural radioactivity, providing valuable information for environmental monitoring. This study seeks to investigate the exhalation rate of radon from a gold mine tailing by using gamma ray spectroscopy specifically HPGe detector to measure gamma radiation and to develop a technique to accurately validate radon exhalation. A total of four soil samples will be collected from a mine tailing dump located in Pongola, Northern KwaZulu Natal 218.9km from the University of Zululand, KwaDlangezwa Campus. The samples will be used to determine the radon exhalation rates in soil samples collected from different sites in the mine tailing. These samples will be analyzed using a Sodium Iodide (NaI(Tl)) detector at the Modern African Nuclear Detector Laboratory at the University of Zululand, along with proton-induced X-ray emission (PIXE) and Rutherford backscattering spectrometry techniques at iThemba Labs.

Applications of nano-Metal-Organic Frameworks in direct Radiodynamic therapy

Mzimela B

Abstract

Cancer remains the leading cause of death worldwide. The main cancer treatment methods, such as surgery, chemotherapy, and radiotherapy, face many drawbacks, including scarring, damage to healthy cells, and metastasis. Photodynamic therapy (PDT), which utilizes light to activate photosensitizers (PSs) and generate reactive oxygen species, leading to cancer cell death, has been explored in clinical trials due to its high selectivity for cancer cells, thereby minimizing toxicity to healthy cells. PDT, however, has drawbacks, including restricted light penetration, low solubility, aggregation of PSs, and poor cancer cell and tumor target specificity of PSs, which can cause systemic toxicity and limit the clinical use of PDT. Radiodynamic therapy (RDT) is a new method that uses radio-sensitizing agents (RS), which are activated by X-ray radiation to target and eliminate neoplastic cells. RDT eliminates PDT's challenge of low-light penetration. Nano-metal organic frameworks (nMOFs) are a class of molecular organometallic hybrid nanomaterials that have shown potential in nanomedicine as drug delivery systems due to their exceptionally high porosity. Despite the potential, several challenges need to be overcome for their widespread applications. A review of the recent progress on the application of nMOFs in direct RDT is presented with perspectives on the current state and proposal of prospects for further development for cancer treatment using RDT and combination therapies thereof. A systematic literature search is reported following the PRISMA guidelines. The search was conducted on Google, Scopus, PubMed, and Google Scholar using keywords like direct and indirect RDT, nMOFs, cancer therapy, and X-ray. The search was restricted to articles in English, and search results were screened using other inclusion and exclusion criteria. This review consolidates available information on the applications of nMOFs in direct RDT, to inform clinical translation and practice, policy, and identifies key areas for further research and potential opportunities for innovations.

Keywords: direct radiodynamic therapy; indirect radiodynamic therapy; nano-metal-organic frameworks; cancer therapy; photodynamic therapy; penetration depth; in vitro; in vivo; x-ray; radiosensitizer.

Studying All Tolman Metrices In Einstein-Gauss-Bonnet Gravity

Sakhile Ndawo

Abstract

All Tolman metrics are systematically examined in this work using the Einstein Gauss Bonnet (EGB) gravity framework. By using the Gauss Bonnet term, the classical Tolman solutions which were first developed in General Relativity for static, spherically symmetric fluid spheres are expanded to incorporate higher-curvature corrections. By analysing regularity, energy conditions, causality, and stability, we provide a physical analysis of each solution, emphasizing the impact of the Gauss Bonnet coupling on spacetime geometry and matter profiles. The findings yield generalized interior solutions that are pertinent to strong-field gravitational phenomena and higher-dimensional compact objects.

Whole Genome Sequence Analysis of *Escherichia coli* O18ab:H11 from South African Beef Reveals Multiple Antimicrobial Resistance Genes, Virulence Factors, and an Uncommon Sequence Type

Fezeka Ndlazi

Abstract

Globally, the emergence of antimicrobial resistant bacteria poses a public health challenge because infections become challenging to treat due to ineffective antimicrobials, which leads to treatment failure and increased mortality. Antimicrobial resistant *Escherichia coli* poses a challenge to human health as some strains are zoonotic and they are found in diverse environments. In South Africa, there is limited information on the antimicrobial resistance, virulence factors, sequence types, and serotypes of *E. coli* from beef. This study aimed to use whole genome sequence analysis to evaluate antimicrobial resistance, virulence factors, sequence types, and serotypes of *E. coli* from beef in KwaZulu Natal province, South Africa. For this purpose, *E. coli* was isolated using classical microbiological methods and confirmed using Matrix Assisted Laser Desorption Ionization Time of Flight – Mass Spectrometry. The confirmed *E. coli* was whole genome sequenced at a commercial sequencing facility using the ONSO system, followed by bioinformatics analysis. Multilocus sequence typing assigned the *E. coli* to ST7106, and to our knowledge, this has not been previously reported in South Africa. ResFinder identified *aadA1*, *blaTEM*, and *tet(B)* antimicrobial resistance genes, which are associated with aminoglycoside, beta-lactam, and tetracycline resistance respectively. VirulenceFinder revealed multiple virulence genes such as *AslA*, *csgA*, f*imH*, *lpfA*, *nlpI*, *terC*, *terC*, *yehA*, *yehB*, *yehC*, *yehD*, and *hlyE,* which indicates pathogenicity fitness of the *E. coli* that has potential to produce toxins, form biofilms, and invade the host. The *E. coli* belonged to serotype O18ab:H11. This study revealed *E. coli* with resistance genes from different classes, diverse virulence genes, and an uncommon sequence type, which may be a threat to human health. This highlights the necessity for routine surveillance and monitoring to prevent outbreaks and protect public health. Future studies should evaluate the risk of *E. coli* from this study by comparing Single Nucleotide Polymorphisms with clinical isolates.

Keywords: Pathogenic *Escherichia coli*; antimicrobial resistance; whole genome sequencing; sequence type; virulence genes; beef-based products

Evaluating the physiological and biochemical responses of maize (Zea mays L.) seedlings to *Pseudomonas rhodesiae* L312 strain (NL2019) inoculation under drought stress

K.S Ndlazi

Abstract

Drought stress significantly limits maize (*Zea mays* L.) productivity. The use of microorganism bioinoculant as the biological mitigation strategy for drought stress has shown to enhance plant stress resilience. In particular, *Pseudomonas rhodesiae* L312 demonstrated to possess biocontrol traits under in vitro characterization. This study investigated the physiological and biochemical responses of maize seedlings (cultivar LAKE 711) inoculated with the L312 strain under drought conditions. A total of 576 seeds were divided into treated (inoculated with 7.84×10^6 cells/mL of L312) and untreated groups. Four treatment setups were employed: Control (80% irrigation), Drought-stressed, Control + L312, and Drought-stressed + L312. Drought stress was applied in cycles of 3, 5, and 7 days, each followed by a one-day recovery period. After 30 days of growth in a controlled environment, physiological parameters including leaf area, shoot and root length, biomass, chlorophyll content, and cell death content were assessed. Biochemical analyses included reactive oxygen species (ROS) markers, osmolytes, and phytochemical content. Results indicated that the L312 strain significantly improved relative water content, leaf area, chlorophyll levels, biomass, and shoot length in drought-stressed maize plants. A notable downregulation of O_2^-, H_2O_2, MDA, and cell death levels was observed in L312-inoculated plants and the well-watered control, while drought-stressed plants without inoculation exhibited increases in these stress indicators. Furthermore, the L312 strain enhanced proline accumulation, while reducing total phenolic and flavonoid contents in inoculated plants, in contrast to the non-treated group, which showed the opposite trend. Although phytochemical levels were not elevated in the L312-inoculated plants, the findings suggest the activation of alternative defense mechanisms. Overall, these results underscore the potential of *P. rhodesiae* L312 in mitigating drought-induced damage in maize and highlight the need for further research into the underlying molecular adaptive pathways.
Keywords: Drought stress, Maize seedlings, Reactive oxygen species, Biocontrol agent, *Pseudomonas rhodesiae*, Physiological parameters, and Biochemical parameters

Effect of morula leaves supplementation on grass hay utilization by sheep

T. Ndlovu

Abstract

Ruminants need a continuous supply of nutrients throughout their lives to maintain high production standards. Yet, during winter, the accessibility and quality of forage decline, leading to nutrient shortages for ruminants, particularly in terms of energy, water, and proteins. This poses as a problem for smallholder farmers in rural areas because of their lack of access to the expensive supplementary feed. Literature confirmed that people have used leaves from indigenous trees to supplement their animals. This study investigated the nutritive value and digestibility of hay supplemented with graded levels of marula leaves. The study was conducted at the University of Zululand analytical laboratory where the chemical composition (DM, ASH, OM, NDF, ADF, HEM, ADL, CELL) and the in vitro digestibility were determined to evaluate the digestibility parameters (APD, TD, NDFD, ADFD, HEMD, MY). The results revealed that morula leaves had the lowest ($P<0.05$) DM, followed by hay supplemented with 30% morula leaves (91.33%). This meant that morula leaves (26.33) showed the highest ($P<0.05$) moisture content followed by hay supplemented with 30% morula leaves (8.77). Supplemented diets H+30% had the highest ($P<0.05$) NDF, ADF, hemicellulose and ADL (74.39%, 43.72%, 30.67% and 31.20% respectively) compared to the other supplemented treatments. Among the treatments, the highest protein was observed in Morula leaves (16.04%), H+30% (9.38%), H+20% (6.68%), H+10% (4.65%) and the lowest was seen in Hay (2.30%). Morula leaves (18.26%) had highest cellulose followed by H+30% (15.24%) which can be related with plant defence mechanism against herbivores. For in vitro digestibility M1 and H+30% had the highest ($P<0.05$) TD of 69.31% and 58.31% respectively. In conclusion, supplementing dried morula leaves at graded proportions to the basal diet of natural pasture hay improved nutrient composition and nutrient digestibility.

Keywords: Nutritional value, in vitro digestibility, feed potential, small-scale farmers.

The estuarine mud crab, Neosarmatium africanum, as a potential bio-indicator of metal contamination in the Mhlathuze Estuary

Skhumbuzo L. Ndwandwe

Abstract

Ecotoxicology is a field of science that assesses the impact of contaminants on terrestrial and aquatic environments using biological processes such as the biochemical and physiological changes of a sentinel species. Research on the impact of local industries and other human activities on the health of the Mhlathuze Estuary, South Africa, is limited, and the appropriate bioindicators that can be used for monitoring are scarce. It is crucial to identify species that qualify by responding to various bioassessment, bioaccumulation and biomarker tests. Therefore, this study was initiated to increase the use of local species as indicators, such as Neosarmatium africanum which is known for its wide abundance and large body size. Water, sediment and crab samples collected from Mhlathuze Estuary were analysed for a suite of metals (Al, As, Cd, Co, Cu, Ni, Mn, Fe, Pb and Zn) using ICP-OES. Osmolality and AChE were analysed in the tissues of crabs exposed to Cu, Mn and a mixture. In addition, an interview survey was conducted in local communities regarding local consumption of N. africanum to highlight a possible threat to public health from biomagnification. Neosamatium africanum showed the ability to bioaccumulate and bioconcentrate metals with each tissue, i.e., digestive gland, carapace, gill, gonad and pincer, showing different concentrations. Essential metals such as Cu significantly accumulated in the digestive gland, while non-essential metals such as Al, As, Cd and Pb were significantly stored in hard tissues such as the pincer. N africanum also showed seasonal variation, with higher concentrations observed in the dry seasons (winter and autumn). The studied species also showed the correlation of metal concentration in media and tissues. The concentration of Cd in the gonad was positively correlated to dissolved water. In contrast, the concentration of essential metals such as Co, Cu and Zn in tissues showed no correlation with the concentration in the sediment and water. This indicates either the regulation of essential metals in the crab or that it inhibits accumulation at elevated concentration of non-essential metals. This study noted increased haemolymph and reduced AChE activity following exposure to a mixture of Cu and Mn, which was a reflection of the metal state and synergistic effects of metals in the natural environment. Most metals found in N. africanum tissues exceeded the permissible limits recommended by the WHO and FAO, except for Cobalt (Co), Manganese (Mn) and Nickel (Ni). The pincer, which happens to be the preferred tissue among consumers, exhibited high metal concentrations. As a result, locals consuming N. africanum harvested from the Mhlathuze Estuary face potential multiple health risks. In conclusion N. africanum exhibited good characteristics to be a bioindicator of environmental disturbance caused by metal poising.

Evaluating the historical changes in groundwater storage using GRACE Groundwater Subsetting Tool (GGST) in Mhlathuze catchment

Busisiwe Ngcobo

Abstract

Since 2002, National Aeronautics and Space Administration's Gravity Recovery and Climate Experiment (GRACE) allows scientists of various disciplines to analyse and map changes in total water storage globally. While various tools have been developed for processing and visualizing GRACE data, the GRACE Groundwater Subsetting Tool (GGST) is specifically crafted to assist regional stakeholders and decision makers in groundwater resource management (MacStraw et al., 2021). GGST transforms raw GRACE data to remove anomalies and enhance resolution with an aim to support the identification and characterization of long-term storage changes in selected regions. GGST is useful in data-poor areas or regions where trends may be concealed by noise from well data. GRACE has proved to be an effective tool for characterizing groundwater storage changes in large regions (Famiglietti et al., 2011; Rodell and Famiglietti., 2002; Syed et al., 2009). Tethys Platform was the one used when building the GGST web application. The platform is the web application development framework for the rapid deployment of end-user-focused tools that follow modern, consistent, scalable, cross-platform, reusable, web programming paradigms (Jones et al., 2014; Swain et al.,2016). The platform is open-sourced and allows anyone to observe and use the GGST as a decision support system to ensure sustainable usage of groundwater. This research project show that for the time range analysed, groundwater storage in Mhlathuze catchment has been exploited as revealed by analysis. The resulting groundwater data are in the form of groundwater storage changes over time. A better understanding of groundwater storage changes helps water managers to respond more effectively to drought and agricultural demand in selected regions and thereby sustainably manage groundwater resources (MacStraw et al., 2021).

Keywords: Grace Groundwater Subsetting Tool (GGST), groundwater storage changes, web application, Mhlathuze South Africa.

Applications Of Wedderburn Theorems

Ngcobo, Bongani Sydwell S'fundo

Abstract

Wedderburn's theorems provide a complete classification of semisimple rings, showing that they decompose into finite direct products of matrix rings over division rings. This project examines their role in describing semisimple and Artinian rings, with emphasis on how module theory, particularly simple and semisimple modules enables such decompositions. The theory is developed alongside concrete examples, including modules over integers, polynomial rings, and matrix rings, to demonstrate the passage from abstract results to explicit constructions. These illustrate how the structure of a ring is reflected in its module behaviour. Connections are drawn to representation theory and number theory, focusing on applications such as the classification of group algebras and central simple algebras. The integration of theory, examples, and applications underscores the enduring impact of Wedderburn's work and its relevance to modern algebra.

The effect of habitat-heterogeneity on the macrobenthic community diversity in the Mlalazi Estuary

Ngcobo ZE

Abstract

Estuaries are highly productive ecosystems that support a diverse array of fauna and flora. The Mlalazi Estuary (ME) is characterised by a dynamic interaction between riverine and marine ecosystems, resulting in different habitats that serve as essential nursery grounds for estuarine invertebrate species, including macrobenthic communities. Despite its national and ecological significance, several knowledge gaps persist regarding the estuary's ecosystem functioning, particularly in relation to macrobenthic diversity and the environmental drivers that influence it, such as habitat-heterogeneity. This study aimed to evaluate the effect of habitat-heterogeneity on macrobenthic community diversity in Mlalazi Estuary. The study assessed macrobenthic diversity across three habitat-types: mangrove forests, Phragmites areas and tidal flats. Species diversity was quantified using the Shannon-Wiener index, while multivariate statistical analyses were employed to explore relationships between habitat-heterogeneity, environmental variables and macrobenthic community composition. Preliminary results indicated that nutrient concentrations were highest in the Phragmites sites, followed by the tidal flat and lowest in the mangrove habitats. Salinity and sediment composition emerged as the most important environmental variables in shaping macrobenthic community structure, given their high variability across the sites. Polychaetes dominated at all sites, reflecting their tolerance to a broad range of environmental conditions. Among the habitat types, the mangrove forests recorded the highest species diversity, followed by the tidal flats and then the Phragmites dominated sites. The elevated diversity in the mangrove habitats is likely attributed to the complex root structures, which create a variety of microhabitats and ecological niches that support a broader range of macrofaunal species. The significance of this study lies in its contribution to understanding the intricate relationships between habitat-heterogeneity and macrobenthic community structure. These insights are crucial for improving our knowledge of ecosystem functioning in the Mlalazi Estuary and can inform the development of effective management and conservation strategies for the estuarine ecosystem.

GC-MS Profiling, Antimicrobial Evaluation and Molecular Docking Studies of Sclerocroton integerrimus Leaf Extracts from n-Hexane Fraction

Ngema, KS

Abstract

Antimicrobial resistance (AMR) presents a significant threat to global health, compromising the effectiveness of existing antibiotics and intensifying infection-related morbidity and mortality worldwide. Given the critical need for alternative antimicrobial agents, medicinal plants have gained attention owing to their diverse bioactive secondary metabolites that exhibit multi-targeted antimicrobial activity with potentially fewer side effects than conventional antibiotics. This study investigates the antimicrobial potential of Sclerocroton integerrimus (duiker berry), a traditional plant native to the coastal regions of KwaZulu-Natal, South Africa, which is currently used as a mouthwash for oral and toothache treatment, through in silico molecular docking analysis against Pseudomonas aeruginosa and Staphylococcus aureus. The research involves the extraction of bioactive lipophilic compounds from S. integerrimus leaves using n-hexane solvent, followed by phytochemical profiling through gas chromatography-mass spectrometry (GC-MS) and Fourier transform infrared spectroscopy (FTIR) analysis to characterise the chemical constituents. Computational studies employ PyRx with AutoDock Vina for docking, Open Babel for ligand preparation, and Discovery Studio for visualisation and interaction analysis. The results showed that a total number of 100 compounds were detected after being extracted with n-hexane; only twelve compounds were identified; which were >2% of the % area peak value. The FTIR analysis of extract confirmed the presence of bioactive phytochemical constituents, including hydroxyl, aliphatic hydrocarbons, carbonyl, ether, and unsaturated groups within the n-hexane extract. Furthermore, the phytochemical compounds identified by GC-MS were analysed in silico molecular docking studies to determine the binding affinity between ligands and proteins (Pseudomonas LasR and the twinned 3.35 Å structure of S. aureus gyrase). In conclusion, S. integerrimus possesses potential for alternative medicinal plant for therapeutical utilization, and further research is needed to explore its use in the treatment of chronic diseases.

Keywords: antimicrobial resistance, S. aureus, P. *aeruginosa, GC-MS, FTIR, S. integerrimus, phytochemicals, molecular docking*

Air Pollution Assessment Using Active Moss Biomonitoring, NAA, and ICP-OES in northern KwaZulu-Natal (South Africa)

Ntuthuko Blessing Ngema

Abstract

Air pollution is a growing environmental and health concern, particularly in regions with limited infrastructure for monitoring air quality. In northern KwaZulu-Natal, South Africa, the lack of permanent monitoring stations makes it difficult to assess pollution levels and identify emission sources. This study aims to evaluate airborne trace elements using active moss biomonitoring combined with Neutron Activation Analysis (NAA) and Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Pre-cleaned moss samples enclosed in mesh bags will be deployed at 15 locations representing varying pollution exposures, including industrial zones, mining areas, traffic routes, and residential regions. The moss bags exposed period is three months to accumulate airborne contaminants. After retrieval, samples will be dried, homogenized, and prepared for laboratory analysis. Elemental analysis will be conducted at the Frank Laboratory of Neutron Physics (FLNP), Joint Institute for Nuclear Research (JINR), Dubna, Russia. NAA will enable high-sensitivity multi-element detection of trace metals and other pollutants, while ICP-OES will quantify selected heavy metals, providing additional elemental information and serving as a cross-validation method. Data will be analysed using statistical comparisons and multivariate techniques such as Principal Component Analysis (PCA) to distinguish emission sources and evaluate spatial differences in pollutant accumulation. This approach will help identify pollution hotspots and potential contributors to air quality degradation. The study demonstrates that active moss biomonitoring, combined with advanced analytical techniques like NAA and ICP-OES, offers a cost-effective and scalable solution for assessing air pollution in areas with limited monitoring infrastructure. Findings from this research will provide critical data to support policymakers and environmental managers in designing targeted interventions to improve air quality and protect public health in northern KwaZulu-Natal.

Evaluating the microbial diversity and characteristics of kombucha fermented using *Cyclopia genistoides*

S.C. Ngema

Abstract

Kombucha is a functional, slightly acidic, and naturally carbonated drink that is produced through fermentation of tea leaves using symbiotic culture of bacteria and yeast (SCOBY) and a carbon source such as sugar. The increasing popularity of kombucha is due to the associated health benefits such as antimicrobial, antioxidant, and probiotic properties. It is important to make use of local South African substrates such as *Cyclopia genistoides* to make kombucha for sustainable food production and socio-economic reasons. There is limited understanding of microbial diversity and dynamics during production of kombucha made using *Cyclopia genistoides,* yet microorganisms play a central role during fermentation. Therefore, the aim of this study was to investigate the microbial diversity of kombucha made from *Cyclopia genistoides* using both culture-dependent and culture-independent methods. Kombucha samples were collected during the fermentation intervals starting from day 0 to day14. For culture-dependent methods, classical microbiological methods were used, followed by confirmation of identity using PCR amplification, and sequence analysis of the bacterial 16S rRNA gene, and fungal ITS regions. Metagenomics was used as the culture- independent method for evaluating microbial diversity. This paper discusses the physico-chemical parameters, predominant microbial flora in kombucha made using *Cyclopia genistoides,* and their potential role and health benefits. Such information is important for developing an optimum SCOBY, standardization of process for making kombucha, which may lead to additional functional benefits and potential commercialization.

Keywords: Kombucha, microbial diversity, metagenomics, *Cyclopia genistoides,* culture-dependent methods

Optimizing Automatic Speech Recognition for Low-Resource Languages: A Case Study on isiZulu

Karabo Ngobese

Abstract

Automatic Speech Recognition (ASR) models have demonstrated great results for high-resource languages and have transformed how people interact with technology. ASR has become part of our everyday lives, from voice command-based applications to educational platforms. Despite this success, low-resource languages like isiZulu still remain underrepresented. This study investigates the effectiveness of transfer learning from linguistically related languages. In this study, isiXhosa and isiZulu are used. This is because they are part of the Nguni language family and share phonological and grammatical features. Two models are explored, the Whisper Small and Whisper Medium. In the first phase of the experiments, the models are trained only on the isiZulu dataset and then they are evaluated to get the baseline performance of the models when trained only on the isiZulu dataset. In the second phase of the experiments, the models are pretrained on the isiXhosa dataset, then they are finetuned on the target isiZulu dataset. For the Whisper Small model, it achieved a WER of 28.88% and a CER of 17.59%, while the Whisper Medium model achieved a WER of 11%and a CER of 3.44%, which is a significant decrease from the baseline results. The results show that both models benefited from being pretrained on the isiXhosa data.

Experiences of first year student nurses regarding Work Integrated Learning at the selected clinical facilities in King Cetshwayo District at KwaZulu-Natal

Ngomane S.L

Abstract

The transition from theoretical learning in the classroom to practical application in the clinical environment is a critical phase in the education and training of student nurses. This transition is done through Work Integrated Learning, which aims at bridging the gap between theory learned from the classroom and real-life clinical practice. First-year student nurses face complex challenges, where most clinical facilities are of high burden of diseases and inequality in terms of training needs for students. The aim of the study is to explore the experiences of first year student nurses regarding Work Integrated Learning at the selected clinical facilities in King Cetshwayo District at KwaZulu-Natal. A qualitative phenomenology research design will be used in the study guided by Benner's Novice to Expert (BNE) theory. The study population will consist first year nursing students from selected clinical facilities. A Semi-structured interview will be used to collect data, audio recorded, and field notes will be taken. The anticipated study participants will be 30 first year nursing students who have been exposed to WIL. Data saturation will be determined by no new data emanating from the participants. Colaizzi's descriptive phenomenological method of data analysis will be used in this study. The findings of this study are expected to guide the development of more comprehensive pre-clinical training programs to better equip student nurses with the knowledge and skills required during WIL. Once the study is completed, the researcher will be able to make conclusions about the phenomenon and make recommendations to improve collaboration between nurse educators and healthcare professionals in clinical areas where student nurses are placed for WIL to have a comprehensive pre-clinical training program to equip student nurses.

Keywords: experiences, student nurses, transition, Work Integrated Learning, and nurse educators.

Exploring the Collection of Isizulu Textual Material from Libraries to Bridge the Language Gap in LLMs

Nsindiso Ngubane

Abstract

This research aims explore the collection of isizulu textual material from the libraries across South Africa, starting from the library at the University of Zululand. The exploration will produce an initial isizulu corpus that would be digitized to store these text that would be used train Large Language Models. This study is a component of a larger group research effort, which sees five participants exploring different environments in which to collect Isizulu text material. This research relies fundamentally on the use of Optical Character Recognition (OCR) software and a good flatbed scanner to digitize the content of isiZulu books in libraries. Python programs is used to clean and process the scanned isiZulu text material. An evaluation of the potential of South African libraries for collecting large amount of good quality isiZulu text, complete with estimation of the possible number of words and, possibly, recommendations to researchers to make the collection process good and efficient. Some of the materials are protected by copyright. Machines used to scan physical books are not always able to produce clear images. OCRs are also not working well with Isizulu texts, being optimized for other languages.

Keywords: Facial Recognition; RONI; LIME; Explainable AI; VGG-16; LFW Dataset; Dlib

Radiation shielding properties of Tm^{3+} doped borotellurite glasses

Ntuthuko Ngwane

Abstract

Our research focuses on simulating the radiation shielding properties of 5 glass samples composed of B_2O_3, TeO_2, Bi_2O_3, LiF, and Tm_2O_3. The chemical formula for these glasses (59–x) B_2O_3–30TeO_2–xBi_2O_3–10LiF–1Tm_2O_3, where x= 0,5,10,15 and 20. The simulations were carried out using three software programs: Phy-X/PSD, NIST XCOM, and Geant 4. The shielding parameters studied include the mass attenuation coefficient (MAC), Linear Attenuation Coefficient (LAC), Half-Value Layer (HVL), Tenth-Value Layer (TVL), Mean Free Path (MFP), and Effective atomic (Z_eff) for photon energies ranging from 0 to 15 MeV. The results were compared and evaluated to understand the effectiveness of the glass as radiation shielding materials. Comparable results were obtained across all three simulation tools. The findings indicated that the samples with higher bismuth oxide content exhibited greater attenuation coefficients, demonstrating enhanced radiation shielding capabilities.

Design of a Solar-Powered Dynamic Wireless Charging System for Electric Vehicles in South Africa

Ngwenya, S.A.

Abstract

This study presents the design and evaluation of a solar-powered dynamic wireless charging system for electric vehicles , aimed at addressing South Africa's transport and energy challenges. EV adoption in the country is hindered by limited charging infrastructure, range anxiety, and reliance on an unstable, coal-based electricity grid. The proposed system integrates solar photovoltaic generation with dynamic wireless power transfer, enabling EVs to receive power while in motion through transmitter coils embedded along selected road sections. This approach reduces battery size requirements and extends vehicle range without the need for lengthy charging stops. The methodology involved the mathematical modelling of the dynamic wireless power transfer system and simulation in Ansys Maxwell to analyze electromagnetic behavior and power transfer efficiency. Inductive coupling was selected due to its proven safety, high efficiency, and resilience under various environmental conditions. The coil geometry and compensation circuits were optimized to maintain high transfer efficiency over extended air gaps and to tolerate lateral or angular misalignment between transmitter and receiver. Solar PV output was modelled using South African solar irradiation data to ensure realistic performance evaluation, accounting for seasonal variations, panel orientation, and maximum power point tracking control. Future work will include detailed electromagnetic simulations to assess power output and efficiency as functions of coil distance and alignment under dynamic motion. Hardware prototyping will be undertaken to demonstrate both static and dynamic wireless charging using a renewable energy source integrated with inductive coupling technology. The prototype will incorporate safety features such electromagnetic field shielding to comply with international standards (SAE J2954). Field testing will validate performance under real-world conditions, and an economic feasibility analysis will evaluate scalability for deployment along major South African transport corridors.

Keywords: Electric vehicle, dynamic wireless power transfer, solar photovoltaic, inductive charging, South Africa.

First-Principles Study of Brittleness in FCC Iridium
Nhlenyama, T.N

Abstract

Iridium (Ir) and Nickel (Ni) both crystallize in the face-centered cubic (FCC) structure, yet exhibit markedly different mechanical responses. Nickel is well known for its ductility, whereas iridium shows pronounced brittleness at ambient conditions, despite possessing outstanding density, corrosion resistance, and high-temperature stability. In this study, we perform first-principles calculations based on density functional theory (DFT) to investigate the fundamental origins of brittleness in FCC iridium, with FCC nickel serving as a comparative reference. Structural optimization, elastic constants, and mechanical property indices were evaluated for both metals to assess stability and deformation behavior. Both Ir and Ni satisfy the Born stability criteria, confirming mechanical stability; however, significant differences are evident in their Pugh's ratio (B/G) and Poisson's ratio values. For Ni, the B/G ratio exceeds the ductility threshold, while Ir falls well below, indicating strong brittleness. Similarly, Ni exhibits positive Cauchy pressure, characteristic of metallic bonding and enhanced slip system activity, whereas Ir shows negative Cauchy pressure, reflecting more directional, covalent-like bonding. Electronic structure analyses, including density of states (DOS) reveal that in Ir, the d-band is more localized with limited overlap at the Fermi level, reducing metallic character and electron mobility under shear stress. In contrast, Ni's d-band exhibits greater delocalization and metallic bonding, facilitating dislocation motion and ductility. The higher shear modulus and lower Poisson's ratio of Ir further corroborate its resistance to plastic deformation. These comparative findings highlight that the brittleness of FCC Ir is primarily rooted in its electronic structure and directional bonding, unlike the metallic and ductile nature of Ni. This work provides a fundamental understanding that can guide alloying strategies to enhance iridium's ductility while maintaining its exceptional physical and chemical properties for extreme-environmental applications.

Trends of Thermal Structure in the MLT Region Using SABER Observations Over Sutherland

Blessing Mvana Nhlozi

Abstract

The Mesosphere and Lower Thermosphere (MLT) region of the upper atmosphere is an essential atmospheric layer that significantly influences energy exchange, atmospheric dynamics, and space weather interactions. Comprehending the temperature of the MLT is essential, as this region acts as a critical interface between Earth's atmosphere and outer space, with its temperature directly affecting several physical and environmental processes. Moreover, the MLT temperature data interprets the vertical transfer of energy and momentum in the atmosphere. The Thermosphere Ionosphere Mesosphere Energetics Dynamics/Sounding of the Atmosphere using Broadband Emission Radiometry (TIMED/SABER) instrument is a crucial observational tool for examining the MLT area, offering long-term temperature observations to analyze trends and fluctuations in atmospheric parameters. The primary objective of this research is to examine the trend and variability of the thermal structure in the MLT region utilizing data collected by the TIMED/SABER satellite in Sutherland, South Africa. A deep learning model is employed to simulate and elucidate the long-term thermal structure trends in the MLT, employing realistic external forces such as solar cycle variability, El Niño-Southern Oscillation, Quasi-Biennial Oscillation (QBO), yearly cycle, and semiannual cycle. The Mann-Kendall and Sequential Mann-Kendall nonparametric trend test methods are employed to extract trends. The aim is to characterize regional variability in response to solar and anthropogenic influences. Results reveal altitude-dependent cooling trends, with statistically significant long-term cooling observed in the 56–80 km and 100–107 km ranges, while the 90–100 km layer remains dynamically unstable with no clear trend. Seasonal cycles are prominent, with cold-point shifts and temperature anomalies linked to transient dynamical processes. A physics-informed LSTM model successfully captures seasonal variability and underlying trends, offering a physically consistent forecast of near-future temperature evolution.

Evaluation of The Effect of Feature Selection Techniques on Machine Learning Algorithms For Phishing Detection

Sphamandla Njokweni

Abstract

Phishing attacks continue to pose a significant threat to online users by replicating legitimate websites to steal sensitive information such as usernames, passwords, credit card numbers, bank account details, and personal identification information. Machine learning algorithms have been widely applied to phishing detection. However, the presence of a large number of features in phishing datasets can increase model complexity, computational cost, and reduce interpretability. To address this, feature selection techniques are commonly employed. Despite their importance, limited research has been conducted to evaluate the effect of feature selection on the performance of machine learning models. This study investigates the impact of PCA and RFE on the performance of SVM and KNN classifiers in phishing detection. The goal of the experiment was to identify the model that achieves the highest accuracy, precision, and F1 score. The experiments were conducted using a dataset consisting of 4,898 phishing websites and 6,157 legitimate websites, with the phishing data sourced from Kaggle.com. The results show that the combination of the KNN model with PCA achieved an accuracy of 93.62%, while the SVM model with PCA reached an accuracy of 93.40%. These findings demonstrate that integrating feature selection techniques like PCA can enhance phishing detection performance compared to models without feature selection, offering a more efficient and accurate approach than those previously reported

Keywords : Machine learning, phishing detection, Feature Selection, PCA, RFE

Effect of Seed Priming on Bambara Groundnut Under Salinity Stress

S Ntshalintshali

Abstract

Salinity is a major abiotic stressor limiting the productivity of legume crops, especially in arid and semi-arid regions. Bambara groundnut (*Vigna subterranea* L.), a climate-resilient legume, holds great promise for food and nutritional security but remains underutilized and poorly studied under saline conditions. This study investigated the impact of magnesium nitrate [$Mg(NO_3)_2$] seed priming on the morphological, physiological, and biochemical responses of two Bambara groundnut genotypes (BGN-14 and BGN-25) under salinity stress. Seeds were primed with 0.03% $Mg(NO_3)_2$ and exposed to 200 mM NaCl, with treatments including “control”, “primed”, “salt-stressed”, and “primed + salt” conditions. The results revealed that salinity significantly impaired plant growth, reduced relative water content (RWC), chlorophyll and carotenoid levels, and increased oxidative damage through superoxide radical accumulation and cell death. However, $Mg(NO_3)_2$ priming significantly enhanced growth parameters, photosynthetic pigment concentration, water retention, and antioxidant activity, particularly in the “primed + salt” treatment. Notably, BGN-14 exhibited greater photosynthetic resilience and root-level antioxidant activity, while BGN-25 showed superior water conservation and shoot-based antioxidant responses. The study highlights nitrate priming as a low-cost, effective strategy to mitigate salinity-induced damage in Bambara groundnut, with genotype-specific mechanisms contributing to stress tolerance.

Keywords: Seed priming, Salinity stress, Bambara groundnut, Nitrate, Antioxidants

Convection and its effect in Stellar Pulsation

Ntombela TXA, Dr Getachew Mengistie

Abstract

The study of the pulsations of stars is a valuable tool for investigating their internal structure. These pulsations measure small changes in brightness of the star's surface, also they can be divided into various modes according to how they move through the star. The proper identification of these modes is done using a procedure known as mode identification which is crucial in asteroseismology to infer fundamental properties of stars, such as mass, radius, age, and internal structure. Modes are usually identified under ideal conditions, e.g., stars with purely radiative envelopes. Nevertheless, there are many pulsating stars, such as δ Scuti, γ Doradus, and red giants that have convection as a dominant process in their visible outer layers. Convective interaction with pulsation is complex and changes the frequencies and damping rates. Neglecting this effect may result in the failure of mode identification and biased inferences of stellar interior structure. The present study attempts to establish a new mode identification formula that can consider the effects of convection on non-radial pulsation. Using models that account for the transfer of both radiative and convective energy, the study investigates the way in which convection alters the frequency and shape of pulsations. Computer models, including models of stars and stellar oscillations, will also be used to study these phenomena with codes like MESA (Modules for Experiments in Stellar Astrophysics) and GYRE to simulate realistic stellar shapes and their oscillation frequencies.

Keywords: non-radial pulsations, convection, mode identification, pulsating stars, asteroseismology.

Copper-Based Sulfide Nanomaterials for Photocatalytic Degradation of Methylene Blue

Qiniso Siyabonga Ntshangase

Abstract

The removal of dyes from natural water is essential to address the challenges of water insecurity and the destruction of aquatic life. Semiconductor nanomaterials are promising photocatalysts with tunable band-gap sizes for decolorization of dyes in natural waters. In this study, we synthesize copper sulfide and copper indium sulfide nanoparticles from a single-source precursor through colloidal approaches. Copper (II) benzaldehyde thiosemicarbazone, copper (II) diethyl dithiocarbamate, and Indium (III) diethyl dithiocarbamate were used as single-source precursors to fabricate Cu2- XS and CuInS2 nanomaterials by the hot-injection method. XRD, TEM, SEM, and HR- TEM were used to characterize the nanomaterials. Hexagonal Cu2S nanoplates, irregular-shaped Cu1,8S, and spherical CuS phases of copper sulfide nanoparticles were obtained, each achieved by altering the synthetic conditions, such as the precursor, temperature, and capping agent system. Optical studies were conducted using UV-VIS and Photoluminescence spectroscopy, and all the materials show a blue shift in their absorption band. Semiconductor nanomaterials exposed to a light source with suitable wavelengths create an electron-hole pair on the band gap of a material, which reacts with a dye to enhance the degradation process. The trend from copper- rich phase (Cu2S) to sulfur-rich phase (CuS) is proportional to the photodegradation efficiency of methylene blue, due to the increase in band-gap size. Ternary CuInS2 also shows the best performance under UV light. Methylene blue degrades faster in basic (pH = 11) conditions. The concentration of hydrogen peroxide and photocatalyst amount are proportional to the rate of degradation. UV-VIS spectroscopy was used to measure the concentration of dye in a time interval in the presence of a photocatalyst and hydrogen peroxide. Copper sulfides and copper indium sulfides nanomaterials serves as potential photocatalyst towards degradation of synthetic dyes.

Keywords: Water treatment, Semiconductors, Copper-based sulfides, Single-source precursor, Hot-injection, Photodegradation, Methylene Blue.

Detection of respiratory diseases in chest sounds using audio-based techniques and machine learning

Ntuli, N

Abstract

Respiratory diseases, such as Chronic Obstructive Pulmonary Disease (COPD), asthma, and tuberculosis, have become major health concerns, and early detection is crucial for improving patient outcomes. This research provides additional information on the tools needed to accurately assess chest sounds, which are used to identify respiratory diseases based on existing evidence. It aims to offer further details about audio-based techniques for detecting respiratory conditions. Specifically, the focus is on feature extraction, including frequency, time domain, accuracy, precision, recall, F1 score, and machine learning methods, to help distinguish and classify normal and abnormal sounds, such as wheezes, crackles, or rhonchi. The dataset collected in Kaggle ICBHI 2019 contains both chest sounds and text documents for each patient. JAudio and VS Studio will be used to generate results. First, insert wav files into JAudio to extract features, then use VS Studio to create a model. Further studies are needed to standardize the approach and validate its use in clinical practice. Regarding the results, analysis is still ongoing, and outcomes are not yet available. Nonetheless, this research will present findings using various audio-based techniques to extract features from recorded chest sounds obtained through different methods, such as a stethoscope and a mobile microphone. Results will include percentages for accuracy, precision, recall, and F1 score.

Keywords: Chronic Obstructive Pulmonary Disease, chest sounds, audio-based techniques, respiratory diseases.

Effect of nitrogen, phosphorus, and potassium and compost tea manure on *Solanum tuberosum* vegetative and tuber phenomics

Nokukhanya Nomcebo Ntuli

Abstract

Solanum tuberosum also known as potatoes, belongs to the Solanaceae family. People normally consume it cooked, fried or baked, or use it for medicinal purposes. Availability of sufficient nutrients in the soil is crucial for maximized potato yield. Thus, the aim of this study was to quantify the vegetative and tuber phenomics variation of *Solanum tuberosum* when subjected to various NPK and manure application rates. Twenty-five Hertha potato seeds were planted in each plot, spaced at 45cm apart, and replicated three times. The experiment employed a randomized complete block design, where different fertilizers (NPK 2:3:2 (22), NPK 2:3:4 (30), poultry, and sheep manure) were randomly applied to each plot. Vegetative traits were recorded at 10, 20, 30, and 40 days after sowing (DAS), whilst tuber traits were recorded at harvest stage. Analysis of variance, correlation matrix, biplot analysis, and agglomerative hierarchical cluster analysis were conducted on vegetative and tuber phenomics. Application of poultry manure and NPK 2:3:2 (22) resulted in the highest vegetative and tuber growth of S. tuberosum. Also, positive correlation was observed among traits, whereas total number of flowers correlated negatively with other traits due to nutrient competition between flower production and plant growth. However, future research should evaluate long-term impacts of poultry manure and NPK 2:3:2 (22) under varying environmental conditions and crop varieties.

Keywords: Solanum tuberosum, nitrogen, phosphorus, potassium, manure

Evaluation of Sentiment Detection in English and isiZulu Using Transformer Models

Vumani Jeffrey Ntuli

Abstract

With the growing presence of digital communication, sentiment analysis has become a vital task in understanding public opinion. However, the majority of sentiment detection tools focus on high-resource languages such as English, leaving African languages like isiZulu underrepresented due to limited annotated data. This research conducts a comparative evaluation of transformer-based models for sentiment detection on both English and isiZulu texts, with a particular focus on tweets. The study benchmarks multilingual models such as XLM-RoBERTa and mBERT, alongside AfroXLM-R, a model pre-trained on African languages. A translation-based augmentation approach is explored, where isiZulu tweets are translated into English to assess its effect on model performance. Evaluation is conducted using accuracy, precision, recall, and F1-score metrics to assess classification effectiveness across models and preprocessing methods. Results show that translation significantly improves accuracy for general-purpose multilingual models: XLM-RoBERTa improved from 34% to 84%, while mBERT increased from 31% to 82%. In contrast, AfroXLM-R achieved 85% accuracy without translation, outperforming other models on raw isiZulu input. The findings highlight translation as a useful enhancement for non-specialized models, while emphasizing the value of developing language-specific models for low-resource languages. This study contributes a practical comparative framework for sentiment detection in African languages, bridging the gap between multilingual NLP and indigenous language resources. It also supports the adoption of hybrid methods combining translation and specialized models for better coverage and accuracy.

Keywords: Sentiment Analysis, isiZulu, Transformer Models, Low-Resource Language, Machine Translation, AfroXLM-R

Global comprehensive review on subsurface water contamination and dynamic hydrogeochemical mechanisms: Nutrients and Trace metals

Siboniso Khethani Nyawo

Abstract

Nutrients and trace metals contamination is the prime issue of the world population due to their toxicity, which results in adverse health problems. In this paper, we systematically review the current scenario of nutrients and trace metals pollution of the subsurface water in various regions worldwide, addressing their detailed sources of pollution, dynamic geochemical characteristics and hydrogeochemical processes controlling their distribution in groundwater. Nutrients including nitrate, sulphate, phosphate and fluoride were considered for the analysis, whereas in trace metals, this analysis favoured arsenic, lead, chromium, cadmium and mercury. The results of the literature were assessed from Scopus, Google Scholar, ResearchGate, Science.gov, Web of Science, Semantic Scholar, Taylor Francis and through Google browser of another database to assess the contamination level in subsurface water under different responsible mechanisms. The results of the literature indicated that the highest contamination of these nutrients and trace metals occurred in Africa(12 countries), Asia(5 countries), Europe (4 countries) and America (3 countries). GIS tool (ArcMap) was used to localise the points of regions experiencing contamination at an elevated mean concentration. Hence, the data was then considered in reference to WHO (2017) recommendable standard specification. The contamination is sourced from both geogenic and anthropogenic activities due to the change of redox potential, particularly, volcanic eruption rocks which marked an exchangeable carbonate, silicate-bound, and Fe/Mn oxyhydroxides minerals to release the sorbed nutrients and trace metal content, respectively. This contamination dominantly favoured anthropogenic inputs including agricultural activities, combustion of fossil fuels, gold and lead-zincmining, landfill leaching, and industrial chemical discharges. As (V), $PbCO_3$, Cr (VI), Cd (II) and Hg (II) were the dominant trace metal species in the subsurface water. High nutrients and trace metals were dominantly characterised by pH-induced desorption, redox- dependent, pH-competitive ion exchangeand dissolution and precipitation of minerals. For nutrient like nitrate, these mechanisms were assisted by ammonification and nitrification. The review highlights the significant knowledge gabs that may aid in developing applicable activities for preventing the spread of nutrients and trace metals pollution in the subsurface water.

Keywords: Groundwater contamination. Nutrients association. Hazardous trace metals. Sources of contamination. Subsurface geochemistry

Ultrahigh sensitivity and selectivity of Co_3O_4 nanostructure towards liquefied petroleum gas

S.A. Ogundipe

Abstract

Liquefied petroleum gas (LPG) is versatile for its domestic, commercial, and industrial applicability. In spite of its tremendous usefulness, exposure to LPG is associated with several hazards including explosion, poisoning and environmental air pollution. This makes real-time detection and monitoring of LPG a crucial issue. Among various materials for gas sensing, semiconducting metal oxides have demonstrated excellent performance towards various hazardous gases owing to their large surface area. In this study, Co_3O_4 nanostructures were prepared via hydrothermal route for extremely selective detection of LPG. The materials were prepared from two different cobalt salts using NH_3 and NaOH alternately for precipitation. It was observed from the SEM that the samples possess distinct morphologies. The XRD results indicated the spinel structure of the samples, XPS showed the presence of Co^{3+} and Co^{2+}. The samples also underwent HRTEM and BET surface area analysis. The fabricated Co_3O_4-based sensors were exposed to SO_2, CO_2, H_2, LPG, and H_2S successively at various operating temperatures. The sample prepared from the reaction of $CoCl_2$ and NH_3 exhibited extremely high response of 1180 towards 10,000 ppm of LPG at 225 °C operating temperature with a very short response time of 24 seconds. The sensor experienced difficult gas desorption in LPG sensing leading to its poor recovery. However, its recovery in the detection of other gases was good. In addition to high sensitivity to LPG concentrations, the sensor demonstrated good stability and repeatability. Next in performance was the sample prepared from the reaction of $Co(CH_3CO_2)_2$ and NH_3 which exhibited better recovery. While the sensors demonstrated potentials for industrial LPG monitoring, there is need for improvement with respect to their recovery. This improvement is aimed to be achieved in future studies by doping or compositing with other metal oxides. The poisoning effect of H_2S on the sensors was also observed.

Keywords: LPG sensing, gas adsorption, surface area, metal oxide semiconductor.

In vitro antioxidant and hypoglycaemic potentials of *Ptaeroxylon obliquum* and *Bauhinia bowkeri* stem bark extracts

Michael C. Ojo

Abstract

Diabetes mellitus and its complications continue to rise worldwide, with no absolute cure currently available. Targeting antioxidant and anti-hyperglycaemic pathways, represents a promising therapeutic intervention. This study evaluated the antioxidant and anti-hyperglycaemic potential of *Ptaeroxylon obliquum* (*P. obliquum*) and *Bauhinia bowkeri* (*B. bowkeri*) stem bark. Hexane, dichloromethane (DCM), and 70 % ethanol extracts were prepared through sequential extraction. Total phenolic and total flavonoid contents, antioxidant capacity, enzyme inhibition (α-amylase, α-glucosidase and dipeptidyl peptidase-IV (DPPIV)) and glucose uptake in C2C12 cells were assessed. The result demonstrated that the hexane and ethanol crude extract of *B. bowkeri* had the highest flavonoid (3.26 mg/g) and phenolic (0.16 mg/g) contents, respectively. The ethanol extract also exhibited the most effective scavenging activities (IC50 values) against DPPH (37.0 µg/ml), and ABTS (16.0 µg/ml), as well as metal chelation (25.0 µg/ml). The hexane extract of *B. bowkeri* exhibited strong nitric oxide radical (IC50: 80.0 µg/ml) and hydroxyl radical (IC50: 1.0 µg/ml) scavenging activities.
The DCM extract of *P. obliquum* demonstrated the highest total antioxidant capacity (0.58 mg/g), strongest α-amylase (IC50: 6.60 µg/ml) and α-glucosidase (IC50: 203.22 µg/ml) inhibitory activities. With respect to DPPIV, all the crude extracts, except the hexane and DCM extracts of *B. bowkeri* displayed similar inhibitory activity. Specifically, the hexane extract of *P. obliquum* exhibited the strongest inhibition, with the lowest IC50 (4.09 µg/ml) which is comparable to the ethanol extract of *B. bowkeri* (4.10 µg/ml). Furthermore, the DCM and ethanol extracts of *P. obliquum* and *B. bowkeri* were very effective in enhancing glucose uptake in C2C12 cell lines. In conclusion, extracts of both plants demonstrated strong invitro antioxidants and anti-hyperglycaemic activities, supporting their potential as promising scaffolds for antidiabetic drug development and warranting further investigation.

Keywords: Hypoglycaemia, antioxidants, α-glucosidase, α-amylase, DPP-IV

Oleylamine capped ZnS for efficient sono- and photo-catalytic dye degradation.

Olambo F. L.

Abstract

Water contamination by synthetic dyes, predominantly due to the rising challenges in the treatment of industrial wastewater, has posed significant health challenge to living things including humans. These dyes are resistant to available treatment modalities. In recent time, advanced oxidative processes in degradation of dyes have emerged as a promising alternative treatment modality. This study aims to investigate the influence of oleylamine capping on the properties of ZnS nanoparticles for sono- and photo-catalytic degradation of synthetic dyes. This research entailed the synthesis of oleylamine-capped ZnS nanoparticles via a simple solvothermal method at 250 °C. The application of oleylamine capping agent resulted in a material displaying unique physical properties and morphology. The synthesized nanoparticles were characterized using powder X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), photoluminescence (PL), and UV-Vis spectroscopy methods. The sono- and photo-catalytic effectiveness of oleylamine-capped ZnS nanoparticles was evaluated by monitoring the decolourization of methylene blue in aqueous solution upon exposure to ultrasound and UV light respectively. The UV-Vis spectrometer reveals that the synthesized ZnS absorbs light energy in the ultraviolet range, with photoluminescence emission exhibiting a blue shift, marked by peaks at roughly 423, 485, and 534 nm. The influence of many parameters, such as initial dye concentration, catalyst dosage, pH, and the presence of hydrogen peroxide, was analyzed. Oleylamine-capped ZnS demonstrated improved degradation of methylene blue at pH 11 in both sonocatalytic and photocatalytic processes.

Keywords: Oleylamine capped ZnS, solvothermal, sonocatalytic degradation, photocatalytic degradation, synthetic dyes.

Metaheuristic Optimized Detection of Firmware Malware Using Audio Data

Mussa I. Phiri

Abstract

The rapid evolution of technology brings not only progress but also increased security risks. Firmware, which is a critical software component that controls the hardware of the device and provides instructions for how a device should operate has become increasingly important as the number of internet-connected devices grows. Unfortunately, IoT devices lack robust security features, making firmware and system components vulnerable to attack by cyber adversaries. This study addresses this critical issue by harnessing machine learning (ML) models for firmware malware detection using audio features. To enhance the performance of base ML models, metaheuristic algorithms are employed, seeking the most optimal solutions to this pertinent problem. Through an innovative approach, an image dataset is transformed into audio, with audio features including MFCCs, spectral centroids, and spectral contrast extracted to train machine learning models. Notably, the Light Gradient Boosting Machine (LGBM) model achieves an initial accuracy of 98.86%, which improves commendably to 99.39% post-Genetic Algorithm (GA) optimisation and 99.30% post-Particle Swarm Optimization. The Support Vector Machine (SVM) demonstrates an initial accuracy of 98.43%, further advances to 99.13% following GA optimization. The Extreme Gradient Boost achieves an initial accuracy of 98.34%, which escalated to 99.13% post-Genetic Algorithm (GA) Optimization. Remarkably the biggest performance boost is obtained when using the Particle Swarm Optimisation (PSO) which introduces an additional boost of up to 1.28% in accuracy. The experiments highlight the impact optimisation algorithms in enhancing the accuracy of base machine learning models. Metaheuristic methods strengthen firmware malware detection and offer a solid basis for advancing cybersecurity in the rapidly evolving landscape of technology and IoT systems.

Investigating The Potential of Contemporary Menu Adaption in the South African Indigenous and Cultural Foo

Phomolo, P

Abstract

South Africa has a rich and diverse cuisine, it is not a secret that South African cultural is deep rooted in their indigenous food, as the world becomes increasingly interconnected, the people's eating habits changes and that lead to changes in menu development. Drawing attention to the indigenous food is not only advantageous to people's health, but also economically advantageous to the local restaurants. Restaurants that use indigenous ingredients plays a significant role in preserving the South African culture and the potential for its incorporation has not yet been explored. The aim of this study is to explore contemporary menu adaption that preserve the South African indigenous foods in local restaurants. This study uses mixed method. A survey was used to collect data from 30 establishment, the managers that works at the back and at the front of the house that works at different local restaurants were sampled purposively. Open and closed ended questions were used to collect data. This ongoing study examines the potential of contemporary menu adaption in the South African indigenous and cultural food in local restaurant, although data collection is still in progress. The early findings from the collected data indicate that most restaurant owners are knowledgeable about the South African indigenous ingredients, however, two major challenges emerge: Consumer demand for indigenous food is limited and there is a scarcity of the ingredients, and the high cost of indigenous ingredients also pose significant barriers. The result of this ongoing study clearly shows that the restaurant owners know about the indigenous ingredients, but the problem is how these ingredients are scarce and there's limited consumer demand. These initial insights underscore the need for strategies to stimulate consumer interest and address the supply chain constraints surrounding indigenous ingredients. Further research is necessary to fully understand the dynamics surrounding indigenous food in restaurants.

Visual and Sonified Chest X-rays for Multimodal Deep Learning-Based Respiratory Disease Classification

Mpilonhle Rwarina

Abstract

Timely and accurate diagnosis of respiratory diseases such as COVID-19, pneumonia, and tuberculosis is essential for effective clinical management and public health intervention. While deep learning models trained on chest X-ray images have achieved notable diagnostic success, their reliance on visual features alone limits interpretability and robustness particularly in cases involving ambiguous or degraded images. This study introduces a novel cross-modal classification framework that integrates visual and auditory representations of chest X-rays to enhance diagnostic performance. Grayscale X-ray images are first pre-processed and sonified by mapping pixel intensities into one-dimensional waveforms, which are subsequently converted into spectrograms using Fourier-based transformations. A dual-branch deep neural network is employed: a ResNet-18 architecture extracts spatial features from the image stream, while a 1D convolutional network processes auditory features from the spectrogram stream. These features are combined via an attention-based fusion mechanism that dynamically weights visual, audio, and combined embeddings to produce a unified representation. A fully connected layer then classifies the respiratory condition into one of four categories: COVID-19, pneumonia, tuberculosis, or normal. The model was trained and evaluated on a balanced dataset using cross-entropy loss, accuracy, and F1-score as performance metrics. This work aims to contribute to the emerging field of multimodal medical AI and suggests that sonification can serve as a viable secondary modality, especially in settings where visual data alone may be insufficient.

Spatio-temporal analysis of July 2024 Storms over Western Cape, South Africa

Sisonke Sentane

Abstract

Storms are complex weather phenomena characterized by intense winds, heavy rainfall, and severe weather conditions. This study presents a spatio-temporal analysis of the July 2024 storms in the Western Cape, South Africa an area increasingly vulnerable to extreme weather events. It investigates storm frequency, intensity, and underlying atmospheric dynamics by integrating diverse datasets, including temperature and precipitation records from the South African Weather Service, satellite imagery from NOAA GOES and EUMETSAT MSG, and ERA5 reanalysis data. A quantitative methodology combining remote sensing and numerical modelling was employed to examine storm patterns from 2017 to 2024. Data were processed using Microsoft Excel, Google Earth Engine, and QGIS, with the Mann-Kendall test applied to assess long-term trends. The findings indicate that the July 2024 storm exhibited higher spatial coverage and rainfall intensity than previous years, with significant atmospheric instability and moisture convergence playing key role. Temporal trend analysis revealed an upward shift in short-duration, higher intensity events across several municipalities. This research enhances understanding of storm variability, improves forecasting models and informs disaster risk management strategies.

Keywords: Spatio-temporal analysis, Storms, July 2024, Atmospheric dynamics, Western Cape

Experiences of pregnant women regarding the use of traditional medicine (isihlambezo) at King Cetshwayo District in KwaZulu-Natal

M Shange

Abstract

The prevalence of herbal medicine (isihlambezo) use is on the rise worldwide, more especially amongst pregnant women. There are few scientific studies about its safety for pregnant women and their babes, regardless of possible teratogenic effects that may result in fatalities amongst pregnant women, who continue to consume isihlambezo. The study aimed at exploring and describing the experiences of pregnant women regarding the use of isihlambezo. A qualitative descriptive phenomenology research design was used to conduct this study. The study was guided by the Dorothy Johnson Behavioral System Model. Face-to-face individual unstructured interviews conducted with 10 participants (n=10), with an additional two participants (n=2) to ensure data saturation was reached. All participants were purposefully sampled to participate in the study. Colaizzi Phenomenological analytic method was used to analyse the data. Twelve (n=12) interviews were conducted to women who have used isihlambezo. Several themes and sub-themes emerged from the study, which consisted of myths about isihlambezo, traditional and cultural beliefs, indication and effects of isihlambezo and economic impact on the use of isihlambezo. The study revealed that most pregnant women consume traditional herbal medicine (isihlambezo) for various reasons, such as financial affordability, cultural beliefs and benefits of isihlambezo to them and their unborn babies despite unknown side effect that might be caused by its use. This qualitative study discovered that most pregnant women consume traditional herbal medicine (isihlambezo) during pregnancy due to various contributing factors despite the unknown safety of isihlambezo to the health of pregnant women and their unborn babies. It is recommended that consideration of developing guidelines on how to incorporate the traditional healers in maternal healthcare for their learning and safety prescriptions of these traditional herbal medicines to pregnant women.

Application of Metal-Organic Frameworks to Facilitate the Combination of Checkpoint Blockade Immunotherapy with Photodynamic Therapy

Shange MG

Abstract

This study aims to investigate the triple combination therapy of photodynamic therapy (PDT), immunotherapy (IMT) and metal organic framework (MOFs) for synergistic efficacy in tumour microenvironment. However, challenges such as limited immune cell infiltration and inefficient photosensitizer delivery have constrained the clinical success of this combination. The MOFs are used as carriers of immunotherapeutic agent (immune adjuvant R837 and immune checkpoint blockage INCB23460) together with porphyrin-based photosensitizer of PDT. The Hf-MOFs will be prepared by solvothermal method and will be characterized by FTIR, SEM, HRTEM, XRD and BET. This will be followed by preparation of porphyrins by Lindsey method and will be characterized by FTIR, NMR, Infrared (IR) Spectroscopy and UV-Vis spectroscopy techniques. The porphyrins will be encapsulated in the MOFS alongside therapeutic agents, then followed by capping with dextran carbohydrate, then functionalized with peptides. The functionalised-capped MOFs containing photosensitizer, R837 and INCB23460(material) will be characterized by HRTEM, FTIR, UV-Vis. The in-vitro studies will be conducted in 96 well plate under difference concentration material with an aid of MTT to evaluate the liability of the material to kill both cancerous and normal cells. The formazan formed will be dissolved, followed by absorbance measurement then the obtained graph will be used to measure the cytotoxicity of the material in cells at different concentration. The in-vivo will be conducted in mice under the supervision of a specialist, after application of the cancer on mice the MRI will be used to measure the tumour size until it reaches 10mm diameter. Once 10mm diameter is reached, the material will be applied to the tumour and MRI will be used to measure tumour size every day. The tumour regression is expected until cancer is eradicated

Investigating Quantum Entanglement for PET scan enhancement

N. Shezi

Abstract

Positron Emission Tomography (PET) imaging uses positron-emitting radioisotopes and detector systems to visualize metabolic processes through 511 keV annihilation photons. Recent advances in quantum physics have shown the potential of quantum entanglement phenomena in the MeV range to enhance medical imaging. Current PET systems face limitations in spatial resolution and contrast, which affect early cancer detection accuracy. The quantum entanglement properties of annihilation photons offer an opportunity to improve imaging performance beyond traditional limits, potentially transforming diagnostic capabilities. This research uses Geant4 Monte Carlo simulations to model and reproduce quantum-entangled PET results. It examines various detector systems and radioisotopes through computational modeling. A systematic analysis of annihilation photon energies, momenta, and correlation patterns explores how quantum entanglement impacts imaging accuracy. All simulations were performed at the MANDELA laboratory, University of Zululand. The results show significant potential for quantum entanglement to advance medical imaging and cancer diagnosis. The study highlights improved imaging accuracy and diagnostic power, creating new opportunities for nuclear medicine research and clinical practice, with implications for better early cancer detection through quantum-enhanced PET imaging systems.

Systematic review: Applications of Nano-Metal Organic Frameworks in the Combination of Photodynamic Therapy with Chemotherapy

Thabile Shozi

Abstract

Cancer treatment remains challenging due to its complexity, metastasis, and drug resistance. Conventional therapies like chemotherapy, surgery, and radiation have limitations, including systemic toxicity and tumor recurrence. Photodynamic therapy (PDT) offers a promising alternative by using light-activated photosensitizers (PSs) to generate reactive oxygen species (ROS) which induce cancer cell death. However, PDT faces issues, such as metastasis, limited light penetration and tumor hypoxia. Chemotherapy (CT) uses cytotoxic chemical drugs to kill cells but also harms healthy cells, causing severe side effects. Nanoscale metal-organic frameworks (nMOFs) have emerged as versatile nanocarriers in cancer therapy, owing to their high porosity, surface area, and biocompatibility. Non-porphyrin-based nMOFs have shown great potential as co-delivery platforms for PSs and CT agents. These NMOFs can target specific cellular organelles and disrupt cancer cell metabolism, enhancing PDT efficacy. Multifunctional nMOFs facilitate co-delivery of multiple drugs, improving tumor targeting and synergistically enhancing antitumor effects. This review consolidates recent studies on non-porphyrin nMOFs as co-delivery platforms for combined PDT and CT, highlighting their potential to overcome conventional therapy limitations. A literature search was conducted on Google, Scopus, PubMed, and Google Scholar, following PRISMA reporting guidelines, selecting peer-reviewed studies from the past decade focused on this combination, excluding non-combination and porphyrin-based nMOFS. The current state of research was analyzed to elucidate synthesis, mechanisms of action, tumor targeting, in vitro and in vivo study outcomes, clinical trials, and clinical case studies. This paper will describe the state-of-the-art nMOF nanoconjugate systems that have been synthesized and used for combination of PDT and CT, showcasing their respective anticancer efficacy in in-vitro, in-vivo studies, and their clinical translation. It also discusses advantages and disadvantages of non-porphyrin-based nMOFs in the combinations of PDT and CT, and proposing directions for future clinical translation.

Keywords: nano-metal organic frameworks; combination therapy; photodynamic therapy; chemotherapy; synergistic antitumor effects; tumor targeting; in vitro and in vivo; clinical trials; clinical case studies.

Comparative Analysis of Machine Learning and Deep Learning for Intrusion Detection in IoT Networks

Phakamani W. Sibeko

Abstract

The Internet of Things (IoT) networks face an increasing number of complex cyber threats, demanding an effective intrusion detection systems (IDS) capable of adapting to evolving attack patterns. This research investigates the comparative performance of machine learning (ML) and deep learning (DL) models for intrusion detection using both structured tabular data and image-transformed traffic data. Specifically, we evaluate traditional ML models such as Random Forest and XGBoost against deep learning models including Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks. The study utilizes the NSL-KDD dataset for tabular data and transforms the CICIoV2024DecimalCSV network traffic into image representations using pixel-mapped flow-based encoding. A CNN feature extractor based on VGG16 is developed to process over 1.2 million benign and 184 482 malicious traffic images. Each model is assessed using accuracy, precision, recall, F1-score, and GPU utilization metrics to determine efficiency and practicality in real-world IoT deployments. Results show that while ML models are faster and more interpretable on tabular data. CNN-based methods demonstrate superior accuracy and robustness when trained on image-based data, effectively capturing spatial-temporal features indicative of complex cyberattacks. The research also explores optimization techniques, such as batch processing and multi-threaded data loading, to address computational challenges with large-scale image-based datasets. This study underscores the potential of integrating image-based analysis into IDS frameworks and advocates for hybrid solutions that blend the interpretability of ML with the detection strength of deep neural networks. The proposed methodology contributes to a scalable, intelligent defense mechanism for IoT infrastructures and cyber-physical systems.

Keywords: Deep Learning, Machine Learning, Intrusion Detection, Internet of Things

Sentiment Analysis for Low Resource Languages (IsiZulu) in South Africa

Thokozani innocent Sibiya

Abstract

Sentiment Analysis is an important task in Natural Language Processing (NLP), it deals with the classification of opinion expressed in text into negative, positive and neutral, yet it poses significant challenges for low-resource and morphologically rich languages like IsiZulu. This is due to the lack of annotated corpora, linguistic complexity and language specific tools. This study directly addresses these challenges by investigating effective data augmentation techniques and identifying a suitable machine learning model for IsiZulu sentiment classification. This study overcome resource scarcity through data augmentation by implementing synonym replacement and back translation to synthetically expand the training corpus. It also developed custom sub-word embeddings to address morphological intricacies using the fastText model. Subsequently, this study conducted a rigorous comparative analysis using two traditional machine learning (Linear SVM, XGBOOST) models and two deep learning (Bi-LSTM, Text CNN). The models were evaluated on standardized test set to ensure valid comparison. The results conclusively showed that deep learning models are significantly more effective, with CNN achieving state of the art Macro-F1 of 0.91, followed by Bi-LSTM at 0.88. These models outperformed the best traditional model, the Linear SVM with 079, and XGBOOST model (0.70). The findings of this study indicate that existing models fail due to an inability to handle morphology and a lack of data; a combination of synonym replacement and back-translation proves effective for augmentation; and deep learning models, particularly CNNs, are most suitable for the task. The resulting framework offers a robust blueprint for developing effective sentiment analysis tools for isiZulu and other low-resource languages, contributing to greater linguistic inclusion in AI.

Keywords: sentiment analysis, low-resource languages, data augmentation, fastText embeddings, machine learning, deep learning.

Investigating cellulose-based conductive hydrogel for potential application in energy storage.

Dumisane Simelane

Abstract

Cellulose is an organic substance found in the cell walls of plants, animals and some microorganisms. Plant biomasses contain cellulose, lignin and hemicellulose together. Sugarcane bagasse was used to extract cellulose due to its high percentage composition, around 40-50%, using alkaline treatment. Cellulose derivatives like cellulose nanocrystals (CNCs) can be used to synthesise conductive hydrogels using polyaniline (PANI) and polypyrrole (PPy) as conductive polymers through a simple in-situ polymerization method. This study investigates the conductivity of these composites at fixed portions of CNCs with different polymer percentage compositions of 10%, 30%, 50% and 70% for possible applications in energy storage devices, like supercapacitors, sensors, composites, drug delivery systems, etc. PANI-CNCs and PPy-CNCs composites also show stretching ability and self-healing characteristics. The conductivity of these composites will be characterized by cyclic voltammetry (CV) and a four-point probe to determine the specific conductivity for each component, also to predict which application(s) might be suitable for each component based on their conductivity.

Determination of radionuclides in boreholes and river water samples collected from areas near the University of Zululand

Sithole LS

Abstract

Water is a vital natural resource essential for sustaining life, supporting agriculture, and enabling industrial activities. In many rural and peri-urban areas of South Africa, access to clean and safe water remains a persistent challenge. Communities often rely on boreholes and rivers for domestic use; however, while chemical and biological water quality is routinely monitored, radiological contaminants, particularly naturally occurring radionuclides, receive far less attention. These radionuclides originate from the Earth's crust, which naturally contains uranium-238 ,thorium-232, and potassium-40 occurred naturally. These elements can be released into the environment through geological processes, eventually leaching into groundwater and river systems. Over time, the ingestion or exposure to water containing radionuclides may pose a risk to human health, especially if the levels exceed international safety limits.This study investigated the concentration and distribution of radionuclides and radon in water samples collected from five locations: Makhanya borehole, Niwe borehole, University of Zululand tap water, Umhlathuze River, and Niwe tap water, all within the Umhlathuze Municipality, KwaZulu-Natal. Measurements were carried out using gamma-ray spectroscopy with a NaI(Tl) scintillation detector and a RAD7 radon detector. This research seeks to identify and quantify the presence of radionuclides in the collected samples and assess their compliance with internationally recognised safety standards.

Evaluating Deep Learning for Indigenous Medical plant identification

Manqoba Slindokuhle Sithole

Abstract

The identification of medicinal plants is essential for preserving indigenous knowledge and supporting traditional healthcare, particularly in under-resourced communities. However, current identification methods are often manual, time-consuming, and inaccessible, hindering the transmission of traditional medicinal knowledge. This research investigates the use of deep learning for identifying South African medicinal plants from leaf images, with the goal of enhancing access to ethnobotanical information and promoting health literacy. A review of existing systems was conducted to understand current approaches and limitations. A custom dataset containing 19 classes of medicinal plant species was used to fine-tune a MobileNetV2 convolutional neural network. The model was linked to a metadata CSV file to retrieve and display plant names, medicinal uses, and related traditional practices. The model was trained over five epochs and evaluated using both validation and test datasets. It achieved a training accuracy of 97.50%, a validation accuracy of 71.25%, and a test accuracy of 70.09%, with loss values of 0.2621 (training), 1.0445 (validation), and 1.0708 (test). These results highlight MobileNetV2's balance between accuracy and efficiency, making it suitable for real-world applications. A test case involving *Isiqungu sehlathi* (*Dietes bicolor*) correctly identified the plant and retrieved culturally significant uses, including ritual cleansing following a family death. The study concludes that MobileNetV2 is a practical model for indigenous medicinal plant identification. Future work should focus on building user-friendly interfaces, expanding the dataset to include more plant species and parts, and comparing performance across different deep learning models to improve accuracy and user experience.

Keywords: Deep Learning, Medicinal Plant Identification, MobileNetV2, Indigenous Knowledge, Ethnobotany, Image Classification, Traditional Medicine

Mapping heatwave vulnerability over KwaZulu-Natal using remote sensing and Analytic Hierarchy Process

Nokulunga B. Sithole

Abstract

South Africa is one of the regions experiencing the impacts of extreme weather events such as droughts, floods and heatwaves due to climate change. With several recent extreme heatwaves in KwaZulu-Natal (KZN) province in South Africa, heat is increasingly being recognised as a disaster risk. However, to date there is minimal assessment of heat vulnerability in KZN. Assessing geographic variability in heatwave vulnerability forms the source for planning appropriate targeted adaptation approaches. This study examines the vulnerability of heatwave over the KZN for the period of 2016-2024. Vulnerability factors were evaluated, integrated temperature trends (2016-2024), utilizing secondary Sentil-2 remote sensing data obtained via the Google Earth Engine platform. The vulnerability assessment considered various biophysical and meteorological indicators, including land surface temperature (LST), vegetation cover (NDVI), land use as background to the occurrence and vulnerability of heatwaves. The Analytic Hierarchy Process was employed to allocate weights to these indicators according to their relative importance, established through expert evaluation and record analysis. These physical factors were then integrated to create a heatwave vulnerability map with accurate spatial resolution. The resulting map highlights areas of high, moderate, and low vulnerability, offering essential hotspots for disaster risk mitigation and climate adaptation strategies. The temperature trends and the results are further correlated with Ocean-atmospheric circulation indices over this region. The study findings will assist policymakers, urban planners, and public health officials in developing focused strategies to mitigate the negative impacts of heatwaves in KZN.

Keywords: Heatwave, vulnerability, maximum temperature, mapping, KwaZulu-Natal

Evaluation of *Lessertia frutescens* and *Echinacea purpurea* hepatotoxic effects using HepG2/C3A spheroids and Wistar rats

Sithole S

Abstracts

The global use of herbal medicines and supplements is rising, yet many remain untested and poorly regulated, posing risks such as hepatotoxicity. This study examines the potential liver toxicity of two widely used herbal immune boosters, *Lessertia frutescens* (LF) and *Echinacea purpurea* (EP), using HepG2-derived C3A liver spheroids and Wistar rats. Female Wistar rats were divided into control, EP (130 mg/kg BW), and LF (12 mg/kg BW) groups (n=6 each), treated for 21 days. *In vitro*, HepG2-C3A liver spheroids were treated with EP (100 µg/mL) and LF (130 µg/mL) for 14 days. Liver function was assessed through serum and media analysis for enzymes associated with hepatotoxicity, and gene expression was evaluated using hepatotoxicity PCR arrays and TaqMan probes. *In vivo*, LF and EP increased serum ALT, AST, adenylate kinase, and cholesterol levels in Wistar rats. *In vitro*, EP significantly reduced AST activity ($p=0.0093$), while both EP ($p=0.0325$) and LF ($p=0.0001$) decreased ALT activity. EP also significantly lowered cholesterol levels ($p=0.0427$). PCR arrays showed decreased expression of efflux transporters (ABCC2, ABCC3) and CYP1A2, with upregulation of SLC2A3 and casp3. EP and LF exhibited potential hepatotoxic effects *in vitro*, impairing metabolic functions in treated spheroids. Interestingly, these effects were not evident in rats within the treatment period. However, altered gene expression of major efflux and transporter proteins was demonstrated in both models. Therefore, the HepG2/C3A liver spheroid model may be more sensitive for early hepatotoxicity detection, but further long-term *in vivo* studies and molecular analyses are needed to confirm these findings.

High resolution airborne based detection of illegal dumpsites and diagnosis of contributing factors in selected areas of uMhlathuze local municipality, KwaZulu Natal

Nomcebo N. Sokhela

Abstract

Illegal dumping has become a growing concern in both rural and urban areas, including the uMhlathuze Local Municipality in KwaZulu-Natal, South Africa. It poses serious risks to the environment, public health, and local development. This study explores how high-resolution airborne imagery can be used to detect and map illegal dump sites in the municipality. It also looks at contributing factors that might influence where these sites are located. A mixed-method approach was used, combining spatial data from GIS, population statistics, and field surveys with qualitative data gathered through interviews and questionnaires with local residents. Key spatial factors examined include distance to roads, land use, slope, and population density. Community perspectives helped uncover additional drivers such as lack of awareness, limited access to proper waste disposal services, and weak enforcement of waste regulations. The study shows that airborne imagery is a useful and cost-effective tool for identifying illegal dump sites and understanding their spread. The findings can help local authorities improve waste management strategies and promote cleaner, safer environments.

Keywords: Illegal dumping, waste management, GIS, airborne imagery, community perceptions, uMhlathuze Local Municipality.

Assessing Waste Disposal and Sanitation States for Off-Campus University of Zululand Students in KwaDlangezwa

Siphamandla Sokhela

Abstract

The rapid increase in student populations at higher education institutions has led to a growing demand for off-campus student accommodations. However, many of these accommodations do not meet the necessary standards for sanitation services and waste management systems, particularly in rural areas such as KwaDlangezwa, where the University of Zululand is located. This study investigates the state of sanitation and household waste management practices in off-campus student housing in KwaDlangezwa. The research employs a descriptive qualitative case study design, using purposive sampling to select various housing structures and key informants, including students, landlords, cleaning staff, and municipal officials. Data were collected through observations, interviews, structured checklists, and photographs, and analyzed thematically with the aid of NVivo software. The study adheres to ethical guidelines, ensuring participants' consent, privacy, and confidentiality. The findings reveal significant challenges in waste management and sanitation, with inadequate infrastructure, irregular waste collection, and poor living conditions in many off-campus accommodations. These issues not only affect students' health and well-being but also pose environmental risks. The study concludes by offering recommendations for policy interventions and practical strategies that stakeholders such as universities, local municipalities, and landlords can adopt to improve the provision of essential services in off-campus student housing. This research contributes to the discourse on sustainable living for students and highlights the need for collaboration between all involved parties to ensure proper waste management and sanitation.

Keywords: off-campus student accommodation, sanitation, waste management, University of Zululand, KwaDlangezwa, student housing, environmental sustainability, public health, rural universities, municipal services

A global perspective of the SWAT model in hydrological studies: A systematic review

Unarine Sadike

Abstract

Soil and Water Assessment Tool (SWAT) is a vital tool for hydrological modelling. It is frequently used to simulate management operations in watersheds, sediment transport, streamflow, and nutrient cycling. This paper aimed to explore the effectiveness of the SWAT model application in hydrological studies globally. A systematic literature review technique and quantitative content analysis were undertaken to understand the use of the SWAT model in hydrological studies. Scopus database, Web of Science database and Google Scholar search engine was used to find relevant literature review articles related to SWAT application in hydrological studies using a search term query. The findings indicate that the SWAT model is mostly applied in land use land cover changes assessment, erosion and sediments studies as well as assessment of surface runoff simulation. The Absence or scarcity of data and poorly gauged basins is a main limitation in the application of the SWAT model. Climate change and human activities are the key drivers that affect surface runoff, non-point source pollution, changes in land use land cover, as well as sediment yield. This review highlights that improved consistency; and the incorporation of the SWAT model with machine learning and remote sensing methods may improve predictive accuracy, especially when addressing the challenges caused by the absence of ground-observed data for validation and calibration. This would lead to more dependable and effective modelling in watershed management.

Keywords: Climate change, watershed management, land use land cover change, hydrological modelling, and SWAT model.

The role of civil society organisations in co-management agreements between Phinda Private Game Reserve and selected communities, KwaZulu-Natal, South Africa

Simphiwe Lindinkosi Ricardo Gcina Xulu

Abstract

This study investigates the role of Civil Society Organisations (CSOs) in the implementation of co-management agreements between Phinda Private Game Reserve, a privately owned Protected Area and two neighbouring communities in KwaZulu-Natal, South Africa. It highlights the historical and socio-political context of land dispossession under colonial and apartheid regimes, which excluded indigenous communities from land ownership and conservation efforts. The land dispossessions and exclusion of African communities from participating in the management and use of resources necessitated the land reform programme which the democratic government implemented. Post-apartheid land reform initiatives introduced co-management to balance conservation objectives with socio-economic development, aligning with global sustainability goals. Using a mixed-methods approach, the research evaluates the contributions of CSOs in facilitating agreements, promoting community participation, and building local capacity. Findings reveal significant challenges, including limited community awareness, unequal power dynamics, and operational inefficiencies within CSOs. While co-management frameworks have potential, they often fall short in ensuring meaningful participation and equitable distribution of benefits. The study underscores the need for enhanced transparency, inclusive governance, and alignment of conservation initiatives with community priorities to maximise the impact of co-management agreements.

Keywords: Civil Society Organisations, Co-management, Natural resources management, Land reform

IsiZulu Information Retrieval System for UNIZULU

Asande Lungelo Zikalala

Abstract

Indigenous languages have always been underrepresented in the educational sector, especially in higher education sector. For example, English remains the main language used for communication, this limit indigenous students in term of learning and getting information. Even though the initiatives have begun in Southern Institutions of higher learning. This challenge remains an issue. This study addresses the issue by developing a digital IsiZulu information retrieval system aimed to reduce language barrier and inclusivity at University of Zululand (UNIZULU). A RAG system is used with fine-tunned models which support IsiZulu language. The RAG mechanism scraps relevant, up-to-date information from the university website and pulls real-time data from targeted predetermined knowledge sources. To enhance IsiZulu query interpretation, two models were fine-tunned using the same domain-specific question-answering dataset. The *sentence-transformers/distiluse-base-multilingual-cased-v2* was used for semantic vector embedding and the *google/flan-t5-base* was used text-to-text generation. The results indicate that the increase in language interpretation and text generation, as the model increments from 50.20% similarity to 62.79% with relative accuracy score 26.67% started in 4.36% and reduces hallucinations during query-answering process. The models indicate that dynamic datasets integration and, the increase in data, increases the performance toward the specific task. Furthermore, the research and its models can be used for future references as the proposed approach can be adopted by other institutions to develop such RAG systems for integration within their premises.

Keywords*: RAG, information retrieval systems, text-to-text generation, hallucination*

IoT-Based smart irrigation system: enhancing water management in smart agriculture

Sabelo Celimpilo Zikhali

Abstract

Water in South Africa (KwaZulu-Natal) is livelihood for a majority of the population and can never be underestimated. Between 2030 and 2040, the rural population was expected to grow by 17%, increasing the pressure on natural resources. Due to population growth, water scarcity had become the biggest challenge that farmers faced. This project mainly focuses on IoT based smart irrigation system which helps to reduce water wastage, improve food productivity, reduce manual work (traditional irrigation), and save the time of farmers. Unfortunately, research shows that freshwater supplies are already struggling to meet the needs of a growing population to tackle food security and water shortages. However, farming issues still hold back progress. A smart irrigation system is proposed to reduce water waste, increase productivity, and enable irrigation without human intervention to avoid human error. Human error can lead to low productivity. The actual aim is to develop an automated, smart irrigation system that maintains water and healthy plant conditions using IoT-based technology. The irrigation system uses Arduino Uno to control the entire system, for pump Relay Modules are used to control water to it, and moisture plays a crucial role in sensing the water from the soil to ensure the life of plants in the farm. DSRM is used as the method since this is a real-world problem, through developing and evaluating innovative technological solutions. The irrigation system successfully managed to fight against water wastage in rural areas. There is no more manual irrigation and human intervention since the system works without human assistance. Food production increases as expected. The proposed Self-watering IoT system is a scalable, energy-efficient, flexible, and user-friendly solution that facilitates better farming and encourages people to use water in agriculture to improve food productivity. With this sustainable technology, people can use every drop of water profitably.

The Influence of Information Sources on Nutrition Knowledge and Eating Behaviours of Students at the University of Zululand

Zindela, NA

Abstract

University students are at a stage where they develop lifelong eating habits and make independent food choices. However, these choices are often shaped by nutrition information sources and socio-economic factors. Many of these sources lack credibility, leading to misinformation and poor dietary practices. This study investigated how different sources of information influenced students' nutrition knowledge and eating behaviours. A quantitative cross-sectional pilot study was conducted with 40 students from all faculties, using voluntary convenience sampling. A self-administered online questionnaire collected demographic and economic data, as well as information on participants' nutrition information sources, nutrition knowledge, and eating behaviours. Data were analysed using IBM SPSS version 29. A total of 40 students, 33% male and 67% female, with an average age of 21 years participated in the pilot study. Most (88%) obtained nutrition information from the internet, books, and social media. Participants knew what constitutes a balanced diet, understood that skipping meals is unhealthy, and reported reading labels before purchasing. They were aware that not all fats are harmful and that water is essential. Regarding eating behaviour, 68% consumed at least 3 meals daily and were not keen on snacking. Half consumed fast food 2–3 times weekly for convenience. Food choices were influenced mainly by knowledge (58%), with family and friends also playing a role. Most perceived their dietary practices as moderate, but acknowledged that exposure to various information sources improved both their knowledge and eating behaviour, encouraging healthier decisions over time. Students' exposure to multiple nutrition information sources improved their knowledge and eating habits, though fast food remains common among this population group. Therefore, it is recommended that universities use digital platforms to promote healthy, quick meal options.

Keywords: Nutrition awareness, Dietary behaviour, Food choice influences, Digital information sources, Health literacy

A LIME based approach for enhancing interpretability in facial recognition

Lwazi Lindelani Zulu

Abstract

Facial Recognition is one of the most widely used systems globally. They are mostly used in our mobile phones, surveillance cameras, access systems and in banks. But they function as black boxes leaving users unaware of how these models make decisions. This lack of transparency raises ethical concerns, particularly in sensitive applications like law enforcements. Explainable AI techniques were employed to provide insight into the decision-making process of the model and improve users trust. This study aims to improve the explainability of facial recognition models by automatically segmenting Region of Non-Interest (RONI) using Dlib, thereby enhancing the clarity and relevance of post-hoc interpretability techniques such as LIME. Dlib's face detector is used to identify faces in images and convert images to grayscale for face detection and segment the RONI with the same size and channels as the input image. VGG16 model without the top layers using pre-trained ImageNet weights is created, and fine tuning occur for better results which only uses up to 60 epochs to train. The methodology of this study includes, data collection, data preprocessing, model training, explainability then results. Our experiment results show that segmenting the RONI improve interpretability of XAI methods and LIME no longer generated superpixels corresponding to background features. The model accuracy (%), Recall (%), precision (%), f1-score (%) resulted in 91, 89, 91, and 90 respectively. It is recommended to use a more diverse datasets with high quality images to prevent Dlib from decreasing the data even more and tools like Mediapipe FaceMesh can be used for better results.

Keywords: Facial Recognition; RONI; LIME; Explainable AI; VGG-16; LFW Dataset; Dlib

Design and Implementation of a Remotely-Controlled and Autonomous Electric Vehicle.

Nombuso Zulu

Abstract

Automatic driving is emerging as a key technology that has the potential to completely transform mobility and transportation sector going forward, because of the substantial advancement in sensing gadgets and wireless connectivity, as well as the dependable use of collision avoidance technology. In addition to being viewed as an alternative towards enormously increasing emissions caused by internal combustion engine (ICE) vehicles and their exhaust systems, autonomous electric vehicles are becoming a necessity due to their intelligent automated features that improves traffic safety, lowering the number road accidents and their ease of use when compared to manually operated vehicles. This report outlines the design and implementation of a remotely controlled and autonomous electric vehicle with the goal of incorporating automation of sensors, remote communication along with the obstacle avoidance algorithm on the vehicle prototype to demonstrate electric propulsion viability in autonomous electric cars. The design of the prototype involves dual mode of operation (manual and automatic). The design layout incorporates the use of Arduino board, three ultrasonic sensors positioned in the car's front and sides to identify any obstacle in its path. The L289N motor driver is the intercessor, controlling the DC motors using prompt from Arduino for manoeuvring. The created obstacle avoidance algorithm allows the automobile prototype to navigate safely on its own by identifying and reacting to impediments within a predetermined 35 cm radius, while a smartphone application control unit offers a detailed operator oversight. In the end, the design system for the prototype has to show viability of electric propulsion for small vehicles along with its application in smart mobility. In addition to providing a cost-effective, practical educational tool for students to comprehend autonomous Arduino programing and smart systems, the conceptualization and implementation of an AEV prototype may additionally serve as a basis for future studies in automated vehicles.

Genetic Diversity and Population Structure of the South African Bosvelder Sheep: Insights for Sustainable Breeding in a Digitally Driven Africa

Zulu, N.S

Abstract

The Bosvelder sheep, developed in 2009 through strategic crossbreeding of Bapedi, White Dorper, and Van Rooy sheep, represents a promising indigenous resource for sustainable livestock production in Southern Africa. This study assessed the genetic diversity and population structure of the Bosvelder breed to inform breed standards, conservation, and selection programs. Blood samples (n = 189) were collected from Bosvelder (n = 133) and ancestral breeds Bapedi (n = 21), White Dorper (n =15) and Van Rooy (n = 20) using FTA cards and genotyped using 60k Beadchip SNP markers. Data analysis included quality control using an individual call rate threshold of 0.90 (resulting in 146 individuals) and SNP call rate of 0.90 with minor allele frequency (MAF ≥ 0.05), yielding 57,174 SNPs across 26 autosomes and the X chromosome. Population structure and genetic diversity were analyzed using R Studio packages, whereas within-breed signatures of selection were detected using the Integrated Haplotype Score (iHS) method. Principal Component Analysis and Admixture analysis confirmed significant genetic contribution from Bapedi and White Dorper sheep with region-specific variations noted. Within-population selection scans (iHS) identified 45 genomic regions under selection particularly on chromosomes 10 and 18, associated to traits such as polledness, fertility, parasite resistance, and carcass muscling. These findings support the role of genomic tools in characterizing indigenous breeds and aligning breeding goals with sustainability, digital integration, and climate resilience in Africa. Future work will expand reference populations and integrate breeder history for deeper insights into ancestral signatures.

Keywords: Genetic diversity, crossbreeding, genomics, developed breed, South Africa

Microplastic Pollution in Marine Ecosystems: A Comprehensive Review of Causes, Transportation, and Impacts,

Siphesihle N. Zulu

Abstract

Microplastics (MPs) have become a significant environmental issue, notably in marine ecosystems, where their presence threatens biodiversity and ecosystem processes. This review looks at existing literature on microplastics' distribution, sources and effects in marine ecosystems. MPs are the plastic particles within the dimension range of 1μm to 5mm, discharge the oceans through multiple pathways, including wastewater effluent, industrial activities, and direct littering. Due to their resilience to degradation, they continue in marine ecosystems, accumulating in both surface waters and deep-sea sediments. The consumption of microplastics by various marine animals, including plankton and large mammals, is well-documented, leading to physical harm, exposure to related toxins, and trophic transfer within food webs. Moreover, MPs act as carriers for persistent organic pollutants, exacerbating their ecological threat. Despite growing concern, practical steps to mitigate microplastic pollution are limited, and comprehensive, large-scale solutions are urgently needed. The current review highlights the necessity of coordinated research efforts and new management policies to mitigate the microplastic pollution crisis and preserve marine ecosystems for future generations.

Keywords: Microplastics, marine environment, ecosystem, pollution.

Evaluating the performance of weather forecasting models in predicting weather events over Durban, KwaZulu-Natal

Sibusile S. Zulu

Abstract

Accurate weather forecasting is essential for effective planning and disaster risk reduction, particularly in regions such as Durban, KwaZulu-Natal, which are prone to both rapid urban development and climate variability. This study evaluates the performance of the Unified Model (UM), European Centre for Medium-Range Weather Forecasts (ECMWF), and Global Forecast System (GFS) in predicting weather events. Durban is a coastal city characterised by complex atmospheric dynamics influenced by both land-sea interactions and regional climate systems. The research assesses the accuracy and reliability of short- to medium-range forecasts by comparing model outputs with observed meteorological data from the South African Weather Service. Statistical metrics such as Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Bias are employed to quantify model performance based on forecast versus observed. By examining the strengths and limitations of each model, the research provides insights into their suitability for operational forecasting in the region. Ultimately, the goal is to support improvements in forecast reliability that can benefit a range of weather-sensitive sectors in Durban, including agriculture, water resource management, public health, and disaster preparedness. Recommendations are made for enhancing forecast accuracy through model refinement, localised calibration, and the integration of real-time observational data. The findings of the study reveals that higher-resolution models, the Unified Model, offer greater accuracy in capturing localised weather phenomena, while global models like ECMWF and GFS provide more consistent performance for medium-range forecasts.

Keywords: Weather forecasting, forecast model evaluation, model performance, climate variability, forecast accuracy

Sentiment Analysis in IsiZulu Text

Lungelo Sibongakonke Zuma

Abstract

Sentiment analysis is one of the important elements of natural language processing. This is a modern technique used for opinion mining through input text and is primarily employed in businesses, healthcare, and other organizations that rely on clients' feedback for improvement. High-resource languages have been used to obtain the best model, while low-resource languages like isiZulu have been underexplored, and this is due to the lack of datasets and linguistic diversity. This study aims to optimize a multilingual transformer model in performing sentiment analysis in isiZulu text. We first performed a zero-shot on the XLM-RoBERTa model to see it baseline performance and then fine-tuned it using Low-Rank Adaptation(LoRA) with a custom-labelled dataset consisting of 20,605 isiZulu text samples. The zero-shot performance was compared against the fine-tuned results, analysing metrics including precision, recall, and F1-score. The fine-tuned model achieved a significant improvement in performance, having an accuracy of 70% compared to zero-shot, with an accuracy of 47% clearly showing the effectiveness of LoRA-based fine-tuning. Our findings provide insight into the effectiveness of using the LoRA fine-tuning technique on transformer models for low-resource languages like isiZulu.

Investigating the photon shielding factors of the silicate glass system from 1 MeV up to 15 MeV, Using the Phys-X/PSD, X-COM, and GEANT4 simulations

M. N. Zuma

Abstract

This study investigates the radiation shielding capabilities of specific silicate glass systems (S1–S4) across photon energies ranging from 1 to 15 MeV. Using Phy-X and XCOM software, key shielding parameters were estimated, including the mass attenuation coefficient (MAC), linear attenuation coefficient (LAC), half-value layer (HVL), tenth-value layer (TVL), mean free path (MFP), and effective atomic number (Zeff). The glasses exhibited maximum photon shielding performance at 1 MeV, with LAC values of 0.18398 cm^{-1}, 0.17842 cm^{-1}, 0.17696 cm^{-1}, and 0.14718 cm^{-1} for S1 through S4, respectively. The LAC was observed to decay exponentially with increasing energy, while the MAC began to decrease exponentially around 4 MeV. These reductions in shielding effectiveness are attributed to increased Al_2O_3 content and decreased CaO content within the glass matrix. Additionally, HVL and TVL were analysed in relation to material density. As density decreased from 2.90 to 2.76 g/cm^3, HVL increased correspondingly, with values at 1 MeV measured as 3.76758 cm (S1), 3.88481 cm (S2), 3.91705 cm (S3), and 3.97937 cm (S4). The HVL also increased significantly with photon energy, nearly tripling between 1 and 15 MeV. These results provide a comprehensive assessment of silicate glasses as potential materials for high-energy radiation shielding applications, highlighting their energy-dependent attenuation behaviour and compositional influence on shielding performance.

Application of Porphyrin-based nMOFs in Combination of Photodynamic Therapy with Immunotherapy

Senamile Zungu

Abstract

Due to its non-invasiveness and the ability to activate an immune response, photodynamic therapy (PDT) has emerged as a promising anticancer modality. It uses light, oxygen and a photosensitizer (PS) to generate reactive oxygen species (ROS), which causes cell death. Immunotherapy (IMT) includes approaches that induce the innate immune system, and those that block the tumour microenvironment (TME) immunosuppression, to eradicate cancer cells and prevent their recurrence. Combining PDT with IMT is a promising approach to inhibit tumour growth and metastasis. The combination has shown synergistically enhanced immune stimulation and the ability to overcome TME immunosuppression. Porphyrin-based nanoscale metal organic frameworks (PnMOFs) combine their porosity and the photosensitizing ability of the porphyrins integrated in their structure to make them ideal delivery systems for IMT drugs while generating ROS. This review reports on their application as delivery systems for the combination of PDT with IMT, due to their high loading capacity, biocompatibility, and the ability to generate ROS, and the enhancement of their efficacy against tumour growth, metastasis and recurrence. The review was conducted to evaluate the efficacy and safety of porphyrin-based nMOFs in the combination of PDT with IMT by consolidating the published research on their design, application, in vitro and in vivo studies. A comprehensive search was conducted across PubMed, Scopus and Google Scholar using the PRISMA guidelines. Findings show that porphyrin-based nMOFs enhance PDT by overcoming tumour hypoxia through oxygen generation and enhances immune response by promoting immunogenic cell death, synergising with immunotherapy. The multi-functionality and adaptability of porphyrin-based nMOFs provides a potent theragnostic tool, potentially shifting the paradigm in clinical practice. The contribution of this study is consolidating reported knowledge on the combination of PDT with IMT. It suggests that future studies should focus on technologies with high light penetration, and the development of targeted delivery systems.

Keywords: combination therapies; photodynamic therapy; immunotherapy; porphyrin-based nano-metal-organic frameworks; tumour target specificity; metastasis; recurrence; tumour microenvironment immunosuppression; innate immunity stimulation; checkpoint blockage immunotherapy

Systematic review: Application of Porphyrin-based nMOFs in Combination of Photodynamic Therapy with Immunotherapy

Senamile Zungu

Abstract

Due to its non-invasiveness and the ability to activate an immune response, photodynamic therapy (PDT) has emerged as a promising anticancer modality. It uses light, oxygen and a photosensitizer (PS) to generate reactive oxygen species (ROS), which causes cell death. Immunotherapy (IMT) includes approaches that induce the innate immune system, and those that block the tumour microenvironment (TME) immunosuppression, to eradicate cancer cells and prevent their recurrence. Combining PDT with IMT is a promising approach to inhibit tumour growth and metastasis. Despite their individual limitations, the combination has shown synergistic effects in preclinical studies, with enhanced immune response and the ability to overcome TME immunosuppression. Porphyrin-based nanoscale metal organic frameworks (nMOFs) combine their porosity with the photosensitizing ability of porphyrins integrated in their structure. This makes them ideal delivery systems for IMT drugs while generating ROS due to the integrated porphyrins. This review reports on their application as delivery systems for the combination of PDT with IMT, due to their high loading capacity, biocompatibility, and the ability to generate ROS, which can enhance their efficacy against tumour growth, metastasis and recurrence. The review was conducted to evaluate the efficacy and safety of porphyrin-based nMOFs in the combination of PDT with IMT by consolidating the published research on their design, application, in vitro and in vivo studies. A comprehensive search was conducted across PubMed, Scopus and Google Scholar using the PRISMA guidelines. Findings show that porphyrin-based nMOFs enhance PDT by overcoming tumor hypoxia through oxygen generation and enhances immune response by promoting immunogenic cell death, synergising with immunotherapy. The multi-functionality and adaptability of porphyrin-based nMOFs provides a potent theragnostic tool, potentially shifting the paradigm in clinical practice. The review suggests that future studies should focus on technologies with high light penetration, and the development of delivery systems that are specific.

Keywords: combination therapies; photodynamic therapy; immunotherapy; porphyrin-based nano-metal-organic frameworks; tumour target specificity; metastasis; recurrence; tumour microenvironment immunosuppression; innate immunity stimulation; checkpoint blockage immunotherapy

The impact of temperature and gibberellic acid on the germination of three *Strychnos* species

Nontobeko Shokahle Zwane

Abstract

This study explores how temperature and gibberellic acid (GA_3) influence the germination of three *Strychnos* species—*S. gerrardii*, *S. madagascariensis*, and *S. spinosa*—and assesses their seed storage behaviour. Two germination experiments were conducted: one with dried, stored seeds and another with freshly harvested seeds. Seeds were subjected to five temperature conditions (15 °C, 26 °C, 39 °C, and alternating 15/39 °C), with and without GA_3 treatment. Key germination parameters measured included germination percentage, germination rate index (GRI), mean germination time (MGT), and time to 50% germination (T_{50}). The first trial showed complete germination failure, accompanied by fungal infection, indicating seed inviability likely due to desiccation damage during storage. The second trial achieved 100% germination across all species under optimal conditions. Germination rates were significantly influenced by temperature ($p < 0.05$), with 26 °C resulting in the highest germination and shortest MGT for all species. GA_3 had a minor effect on speeding up germination but did not significantly improve the final germination percentages. The findings show *Strychnos* seeds are recalcitrant, sensitive to drying, and unsuitable for standard storage. *Strychnos gerrardii* germinated quickly and uniformly, highlighting its potential as a rootstock. The study emphasises sowing immediately after harvest and recommends further research on pre-sowing treatments and alternative storage options.

Keywords: *Strychnos* species, Gibberellic acid, Temperature, germination

Insecticidal efficacy of leaf-derived *Sclerocroton integerrimus* (aqueous, n-hexane, dichloromethane, and ethanol) extracts against the pineapple pests

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Abstract

Dysococcus brevipes (Hemiptera: Pseudococcidae), *Diaspis bromeliae* (Hemiptera: Diaspididae), and *Dolichotetranychus floridanus* (Acarina: Tenuipalpidae) are the most destructive pests of pineapple crops worldwide. Historically, the management of these pests has relied on synthetic agrochemicals, a costly, dangerous, and environmentally detrimental solution for farmers. The use of plant-derived biopesticides has garnered attention for their potential as eco-friendly and cost-effective options. This study evaluates the insecticidal efficacy of ethanol, n-hexane, dichloromethane and aqueous leaf extracts from *S. integerrimus* in controlling mealybugs and scales. The laboratory experiment was laid in a randomized complete design, with 6 treatments (n-hexane, DCM, ethanol, aqueous extracts, synthetic chemical (vydate L) and distilled water replicated three times. Different concentrations of *S. integerrimus* leaf extracts were prepared at 10%, 15%, and 30%. A synthetic pesticide, vydate L, was used as a positive control at a concentration of 3.5 mL per 500 mL of water, while distilled water served as the negative control. The bioassay results demonstrated that *S. integerrimus* leaf extracts caused insect mortality rates up to 94% across different solvents and concentrations, particularly at 30% w/v after 48 to 72 hours. The n-hexane and ethanol extracts of *S. integerrimus* showed the highest mortality rates (91-94%) at higher concentrations and longer exposure times, while aqueous extracts performed moderately (up to 95%). Mortality was lowest in the negative control (0% w/v) treatments. The synthetic chemical (vydate L) achieved mortality rates above after 24 hours. These findings support the potential of *S. integerrimus* leaf extracts as an effective approach for managing *D. bromeliae* on Queen pineapple.

Keywords: Synthetic chemical, bio-pesticide, pest, pineapple, *S. integerrimus*

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