NIGERIAN ASSOCIATION OF MEDICAL PHYSICISTS (NAMP)

in collaboration with

NIGERIAN NUCLEAR REGULATORY AUTHORITY (NNRA) & NIGERIA ATOMIC ENERGY COMMISSION (NAEC)

13th Medical Physics Annual Scientific Conference & Workshop Abuja 2024

Theme:

MEDICAL PHYSICS: Improving Medicine, Shaping the Future of Healthcare

Mon 4th to Fri. 8th Nov. 2024

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ABOUT

NIGERIAN ASSOCIATION OF MEDICAL PHYSICISTS

i. To promote and develop to the highest standards, the application of the methods and concepts of physics in medicine, biology and related sciences through clinical services,education and research

ii. To encourage professional interest in training and safety in the application of Physics in medicine.

iii. To prepare and disseminate technical information, scholarships, scientific resources related to Medical Physics and related fields to members.

iv. To promote cooperation in scientific research, development and education within the field of medical physics.

v. To promote scientific exchanges on medical physics and related fields of science.

vi. To recommend standards for education, training and accreditation programmes within the field of medical physics.

vii. To initiate and/or support in approved centres and institutions, research and educational programs in medical physics.

viii. To promote certification of medical physicists.

ix. To develop the field of medicine and healthcare in the country through the application of concepts of physics.

x. To be the voice of Nigerian medical physicists in the international community.

His Excellency,
ASIWAJU BOLA AHMED TINUBU
President, Federal Republic of Nigeria

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Coordinating Minister of Health and Social Welfare
Federal Republic of Nigeria

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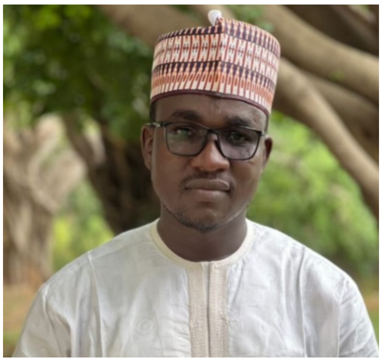

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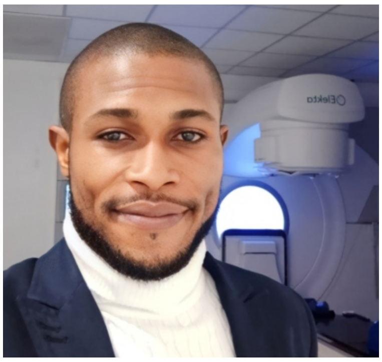

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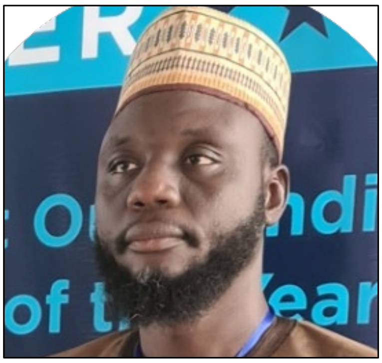

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Keynote Speaker

Prof. Wil Ngwa
Professor of Global Health,

Wilfred Ngwa is a global oncology researcher and medical physics expert who is developing technologies that integrate with radiation therapy to reduce cancer treatment times and costs. He is a professor of global health at Rutgers Global Health Institute and a professor in the Department of Radiation Oncology at Rutgers Cancer Institute of New Jersey and Robert Wood Johnson Medical School. He also is a Rutgers Presidential Faculty Scholar.

The broad aim of Ngwa's research and global collaboration is to increase access to cancer treatment and reduce health disparities, particularly in low- and middle-income countries.

He leads a research group that is developing low-cost approaches and technologies that can substantially reduce treatment times and costs and that can be implemented in resource-poor settings. One such technology incorporates artificial intelligence and smart radiotherapy biomaterials, such as nanoparticle drones that can be injected intravenously and will emit missile-like electrons when activated by photon beams during radiation therapy. This process is designed to increase damage to cancerous tumors while minimizing toxic effects on body tissues. This technology also can be programmed to sustainably deliver cancer-fighting immunotherapy drugs in resource-effective and measurable ways. This research is supported by the National Institutes of Health and industry partners and is in clinical translation.

Ngwa's overall research program is designed to address many types of cancer, and he is leading studies related to treating prostate, breast, and cervical cancers in Nigeria, South Africa, Tanzania, and the United States. Since 2019, he has been the chair of The Lancet Oncology commission on cancer in sub-Saharan Africa. He also is an external adviser to the U.S. presidential administration's Cancer Cabinet, convened by President Joe Biden to help establish and make progress on the administration's reignited Cancer Moonshot initiative, and he is a co-chair of the U.S. Cancer Moonshot 2.0 Lancet Oncology commission. He is editor of IOP Publishing's scientific series in global health and radiation oncology and an editorial board member for Journal of Global Oncology, Frontiers in Oncology, and ecancermedicalscience.

He is the founding director of the Global Health Catalyst Summit, designed to catalyze high-impact international collaborations and initiatives to eliminate health-related disparities in the U.S. and globally.

Ngwa is originally from Cameroon, where he studied physics and computer science at the University of Buea, receiving a bachelor of science degree. He earned his master's and doctoral degrees from University of Leipzig in Germany then completed postdoctoral education and training in radiation oncology at MD Anderson Cancer Center at the University of Texas and at Brigham and Women's Hospital, Dana-Farber Cancer Institute, and Harvard Medical School.

Prof. Wil Ngwa is the Keynote Speaker at the 2024 Medical Physics Conference, Nigeria

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0.983333. These classifiers display good accuracy, recall, and F1-score metrics. Additionally, the Extra Tree Classifier exceeds others, attaining the maximum score of 0.991667, and exhibiting outstanding accuracy. The Decision Tree, Random Forest, and Ada Boost Classifiers display impressive performance, albeit with slightly lower scores. Conversely, the KNN Classifier displays substantially worse performance compared to other models, as indicated by its lowest score. This model also had impressive precision and sensitivity and was then deployed using Heroku platform and then made into a mobile application. With the application's machine learning algorithms, the input health data can be accurately analyzed to provide insights about the likelihood of the presence or progression of chronic kidney disease (CKD). This mobile application produced thorough diagnosis reports that summarized the findings of the analysis and provided helpful suggestions. Through a dedicated dashboard, users can use this application to track and monitor critical indications of kidney health over time. With the help of this tool, users will be able to see patterns in their health metrics and take proactive steps to properly manage the condition.
Keywords: Chronic kidney disease, Machine learning, Training dataset, Testing dataset, Mobile application, Random forest classifier, Classification accuracy.

Implementation of Knowledge Graph for Disease Diagnosis Using Large Language Model (LLM)

Abdulkadir A. Shehu, Akinyemi Tobi, Williams I. Charles, Ayanda A. Jeremiah, Ojo Peter, AttehOluwaseun, Akolapo A. Ameen, Esan Damilola, Dada O. Michael and Awojoyogbe O. Bamidele
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Abstract
This study explores the Graph Data Modeler (GDM) which combine the integration of Knowledge Graphs (KGs) with Large Language Models (LLMs) to enhance diagnostic accuracy. GDM uses patient data and knowledge graphs insights to make accurate predictions. Graph Data Modeler (GDM) employs a two-stage approach; Building a domain-specific knowledge graph and integrating the graph with an LLM for informed patient analysis. By leveraging the structured information within Knowledge Graphs (KGs) and the advanced language understanding capabilities of Large Language Models (LLMs), we aim to create a robust system for disease diagnosis.Our approach involves using Knowledge Graphs (KGs) to provide context and background knowledge, which Large Language Models (LLMs) then utilize to interpret and analyze patient data more effectively. This combination allows for a more nuanced understanding of complex medical conditions, leading to better diagnostic outcomes. The integration also offers an explainable diagnostic pathway, making it easier for healthcare professionals to understand and trust the AI's recommendations. The Model was trained and evaluated using Patient Profile Dataset, Knowledge Graphs (KGs) was used to test the performance of the model, The following result was achieved using the first three tested diseases: Fever 175 (50.14%) was YES & 174 (49.86%) was NO, Cough 182 (52.15%) was YES & 167 (47.85%) was NO, Fatigue: 242 (69.34%) was YES & 107 (30.66%) was NO. This experimental results demonstrate that this hybrid system (GDM) significantly improves diagnostic accuracy compared to using LLMs alone. By grounding the diagnostic process in established medical knowledge, we reduce the risk of errors and enhance the reliability of automated diagnosis systems. This research represents a step forward in the development of AI-augmented diagnostic tools, with the potential to transform healthcare delivery.
Keywords: Knowledge graphs, large language model, Graph data modeler, Patient profile dataset

Derivation of Fredholm Integrals of the First Kind Based on Bloch NMR Flow Equation for Digital Molecular Magnetic Resonance Imaging

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Abstract
The Bloch NMR equation is fundamental to understanding nuclear magnetization in the presence of diffusion, relaxation, and magnetic fields. However, it becomes particularly complex when applied to fluid mixtures with varying diffusion coefficients and relaxation properties. This complexity necessitates advanced mathematical techniques for deriving accurate analytical solutions. In this study, we derive the Fredholm integrals of the first kind based on these analytical solutions to the Bloch MRI equation for relaxation time. Using Tikhonov regularization, the ill-posed equation is turned into a well-posed integral form, allowing for stable solution, providing a robust mathematical framework for interpreting NMR signals in heterogeneous systems. Numerical simulations show that using regularized least-squares approach help to stabilize the solution and help to reconstruct high-quality MRI images. These integrals offer a new perspective on the inverse problem of reconstructing molecular dynamics and interactions from observed NMR data. This solution is crucial for generating detailed relaxation time distribution which provides vital insights into tissue microstructure that enhances diagnostic capabilities in clinical MRI.

Keywords: Fredholm integrals, Bloch NMR equation, Analytical solutions, Magnetic Resonance Imaging (MRI), Relaxation times, Inverse problem

Derivation of Fredholm Integrals of the First Kind in terms of Analytical Solutions to Bloch Nuclear Magnetic Resonance (NMR) Flow Equation and Relaxometric Tissue Profiles

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Abstract
The Bloch NMR equation is fundamental to understanding nuclear magnetization in the presence of diffusion, relaxation, and magnetic fields. However, it becomes particularly complex when applied to fluid mixtures with varying diffusion coefficients and relaxation properties. This complexity necessitates advanced mathematical techniques for deriving accurate analytical solutions. In this study, we derive the Fredholm integrals of the first kind based on these analytical solutions to the Bloch MRI equation for relaxation time. Using these solutions as a modified kernel distribution function and Tikhonov regularization providing accurate estimates of the T_1 and T_2 maps, a Python algorithm has been developed for interpreting NMR signals in heterogeneous systems with useful outputs. This is particularly useful in developing improved methods for multidimensional correlation magnetic resonance imaging (MRI) for general tissue diagnosis. Furthermore, this method offer a new perspective on the inverse problem of reconstructing molecular dynamics and interactions from observed NMR relaxometric data distribution which provides vital insights into tissue microstructure that enhances diagnostic capabilities in clinical MRI.
Keywords: Fredholm integrals, Bloch NMR equation, Analytical solutions, Magnetic Resonance Imaging (MRI), Relaxation times, Inverse problem

Evaluation of Tumorgrowthtoolkit: A Python Package for Simulation and Analysis of Tumor Growth Using Numerical Solvers for Partial Differential Equation

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Abstract
This work analyses the dynamics of tumour growth using the Tumour Growth Toolkit (TGT), a Python-based software tool developed to simulate and evaluate tumour behaviour through mathematical models built in Partial Differential Equations (PDEs). Tumour development, driven by biological, chemical, and physical processes, has historically been explored through experimental approaches, but mathematical models have emerged as key tools for understanding and forecasting tumour dynamics. The TGT employs numerical solvers to simulate spatiotemporal tumour evolution, providing visualization of growth parameters and treatment interventions. This research analyses TGT's potential to handle real-world medical datasets, execute large-scale computations, and integrate into broader workflows, which are necessary for its application in medical physics and personalized medicine. The toolkit's computational efficiency is also examined, considering the resource-intensive nature of PDE-based simulations. Using a dataset including image data in nifti format, the study effectively simulated tumour progression, demonstrating the shift from the beginning to ultimate tumour state. For a timesteps of 360, the simulation took just 34 seconds to be executed. Furthermore, the tumour grows to an effective volume after 0.71 seconds and the cells start breaking up at the centre thereafter. TGT's capacity to blend data-driven and physics-based models holds promise for more precise tumour modelling, aiding in tailored treatment methods and boosting radiation outcomes. This work emphasises TGT's potential to promote cancer research by offering a strong platform for simulating tumour progression and enabling the development of viable therapeutic options. The Tumour development Toolkit (TGT) offers a sophisticated framework for simulating and studying tumour development dynamics, which could dramatically alter how physicians and researchers understand and treat cancer progression. Which can be demonstrated in personalised treatment planning for improved decision-making, support for image-guided therapies and predictive oncology.
Keywords: Tumour Growth Toolkit, Python framework, tumour behavior, mathematical models, Partial Differential Equations.