

# Abstracts for Data to Quantum Workshop

**Osemeke U. Osokogu**, ELSEVIER

*Title:* Elsevier, Data Science and Africa: redefining the link

*Abstract:* In Africa, there are many socioeconomic and developmental problems. They include ineffective agricultural practices leading to hunger, extreme poverty, poor health and water shortage. Specifically, adverse drug reactions (ADRs) cause a lot of complications and death because of the marketing and use of substandard drugs among other reasons. Although the World Health Organization (WHO) maintains a global database (VIGIBASE) of reports of suspected ADRs that can be analysed to quickly yield new information about drug safety issues, reports from Africa comprise as little as  $< 1\%$  of global reports. Perhaps advancements in data science represent an opportunity to improve capture of ADRs in Africa. Data science is a relatively new field that generally comprises data capture, processing, cleaning, model building, data visualization and interpretation of results. While this process may work seamlessly in the developed world, lack of (or inadequate) data in many parts of the developing world including Africa remains a limitation. Elsevier, a global information analytics company has developed tools and platforms for quickly generating (new) information about adverse drug reactions; QUOSA is an example. Are there opportunities for customizing currently available tools to improve capture of data regarding ADRs in Africa? Success in this regard may lead to the capture of more and better reports about (new) ADRs in Africa. Consequently, the quality of lives of people may improve appreciably.

**Kareljan Schoutens**, QuSoft

*Title:* Many-body strategies for multi-qubit gates

*Abstract:* The standard method for implementing algorithms for quantum computation is through quantum circuits. Such circuits typically contain quantum gates (such as Toffoli, Fredkin, and  $n$ -qubit generalizations thereof) involving more than a single or two qubits. These multi-qubit gates can be decomposed into 1- and 2-qubit gates, but this is not necessarily the most efficient strategy. We present a framework for quantum control directly at the level of multiple qubits. A concrete example is a protocol for a gate called iSWAP $_n$ , using a linear qubit array with so-called Krawtchouk couplings.

**Maris Ozols**, QuSoft

*Title:* Quantum software from quantum states

*Abstract:* One of the hallmarks of quantum computation is the storage and extraction of information within quantum systems. Recently, Lloyd, Mohseni and Rebentrost created a protocol to treat multiple identical copies of a quantum state as "quantum software", specifying a quantum program to be run on any other state. We expand on their results, providing protocols for running more complex quantum programs specified by several different states. Our protocols can be used to analyze the relationship between different states (for example, deciding whether states are orthogonal) and to create new states (such as coherent linear combinations of two states). We also outline the optimality of Lloyd et al.'s original protocol, as well as our new protocols.

This talk is based on joint work with Shelby Kimmel, Cedric Yen-Yu Lin, Guang Hao Low, and Theodore Yoder (<https://dx.doi.org/10.1038/s41534-017-0013-7>).

**Marivate Vukosi**, CSIR Modelling and Digital Science

*Title:* Exploring Data Science for Social Impact

*Abstract:* In the pursuit of public service, governments have to oversee many complex systems. In recent years, data-driven methodologies have been adopted as tools to oversee and enhance service delivery.

In this presentation, I discuss some of the ways in which Data Science can be used to improve public services. This improvement will be through developing products that address those specific needs as well as how Data Science can assist in enabling ecosystem for the development of data driven decision making. I present a number of use-cases we have looked at covering, public safety, utilities and energy.

**Nikolaos Vasiloglou**, Ismion Inc

*Title:* Privacy, Security, and Ethics in Data Science

*Abstract:* When a data scientist works on a public dataset she/he is focusing on the scientific side of the problem. In many cases though data contains private and sensitive information that the data scientist might not even be allowed to see. In the first part of this talk we will explore methods and techniques of automatic preprocessing of the data that allow the data scientist to create models without direct access to private and sensitive data. In the second part we will explore the biases that ML algorithms can have that raise ethical issues. How do you check that your classifier is not a racist?

**David Stern**, University of Reading

*Title:* African data: an opportunity to lead!

*Abstract:* Data Science has been put forward as the next big thing with the exponential growth of data and computing power offering the promise of huge rewards for those who can make sense of the data. Big data offers the promise of improved efficiencies and scaling which is attracting the interest across both the private and public sector. This talk will start by looking at how data is shaping the agriculture sector. Internationally, precision agriculture is showing how data can revolutionise farming but how can this be relevant to African smallholder farmers? An interesting case will be presented related to FUMA Gaskiya, a farmer federation in Niger, who is trying to put data at the heart of the support to their 17000 farmers. This example will be used to pose a question of how African data can be thought of from the ground up. We will pose the challenge of whether an African youth empowered with appropriate data skills could not only aid development but also lead the way to a more human centred approach to data. The talk will finish by challenging the audience to think differently about the place of data skills in education.

**Zachariah Mmbasu**, African Maths Initiative

*Title:* Engaging school kids with real world data

*Abstract:* Teaching and learning of statistics has evolved tremendously over the years owing to the availability of real world data, and availability of technological tools like computers and software for visualisations and data analysis. All these enable us to overcome barriers and challenges that school teachers would face in their effort to transform teaching and learning of statistics using data. We share about our experience working with school kids during our maths camps and in schools where we get them to explore real world data using numerous tools to form and cultivate conceptual knowledge. For example during our maths camps, students' knowledge acquisition do not depend on the instructors but students assume active roles in constructing statistics knowledge with guidance from the facilitators. Moreover, instead of concentrating on lengthy and repetitive calculations, students focus learning and understanding the important statistical concepts. Throughout our initiatives, we have always made efforts to create more opportunities to change the pedagogy of teaching mathematical sciences in terms of methods and materials used from giving importance to routine computations and procedural knowledge to giving more attention to in cultivating students' conceptual knowledge through data.

**Charles M. Macal**, Argonne National Laboratory

*Title:* Agent-Based Modeling of Artificial Societies Meets Big Data

*Abstract:* Societal systems, consisting of the various social and technical infrastructures required for society to function, are facing major challenges. Global urbanization, increasing pressures on resources, environmental disruptions, and social dislocations are a few of the factors that make the future increasingly uncertain. New, science-based methods are needed to understand likely futures and society's prospects for making the world a better place. Agent-based modeling (ABM) and simulation techniques enable us to study and understand these systems from various levels of abstraction, looking at

individual actors and their collective behaviors, as well as system-level perspectives. ABM is a recent approach to modeling systems comprised of autonomous, interacting agents from the bottom-up, made possible by recent advances in computational modeling and software and the availability of new data at increasing levels of granularity-i.e., Big Data. The number and breadth of applications for agent-based modeling and simulation are truly remarkable and continue to grow. Applications range across virtually all disciplines in the natural, social and physical sciences as well as engineered systems. These include modeling urban traffic congestion to modeling stock market, from predicting the spread of an epidemic in an urban environment to understanding the adoption of a new solar technology, and many others. ABM is particularly well-suited to modeling people's behavior, connecting micro-level social interactions with collective emergent system outcomes. A common reason for modeling a system as an ABM is to explicitly consider agent learning and adaptation, modeled as agent behaviors. Complex adaptive systems, emergent behavior, and self-organization are a few of the notions modeled by ABM. Big data, the Internet of Things, and quantum information offers the possibility of revolutionizing how we think of, and model society, understand the effects of interventions, and effect optimal designs for the future.

**Danny Parsons**, Oxford University

*Title:* Using data for development: cases in climate and corruption

*Abstract:* Information on climate is hugely important for many areas of development including agriculture, renewable energy and health. Each African country has a national meteorological service (MET service) which collects climatic data from a set of weather stations across its country. However, in most countries the stations are sparsely location. Even in places where data are available, the quality of the data can be questionable with many gaps (missing values). One possible solution to both these issues is to evaluate the use of estimates from satellite data to fill in data where it is not available. The first part of this talk will present recent initiatives using both ground station and satellite data including efforts in collaboration with EUMETSAT to train MET service staff across Africa in utilising satellite data. The second half of this talk focuses on public procurement. Public procurement - or government contracting - is critical to development, accounting for as much as 50% of government spending in developing countries. In addition, a large share of international aid is allocated through government procurement systems. Documentation on bribery cases show that procurement is highly prone to corruption. Corruption is difficult to detect or measure, however, with the increased availability of large public procurement datasets and new methodologies for analysing such data for detecting 'red flags' in contracts there is an opportunity for better responses in the fight against corruption. This talk will report on the challenges of working with open procurement data from Tanzania, and initiatives aimed at empowering a wider community to participant in the use of public procurement data.

**Abdulmajid Osumanu**, University of Waterloo

*Title:* Kitaev model for mirror bicrossproduct Hopf algebras and its tensor network representation

*Abstract:* In topological quantum computation, information is encoded in nontrivial loops of the underlying lattice surface. The primary model for such a phenomena is the fault-tolerant quantum computation by Kitaev. Here the ground state suppresses errors in the quantum system. Originally defined in terms of finite groups, different mathematical structures have been used to construct different but equivalent Kitaev models. Notable is Drinfeld's quantum double. Recent works have shown how semi-dualization can give rise to the bicrossproduct quantum group from the quantum double. This was specifically used in the Chern-Simons formulation of 3d gravity and the semi-dualization is associated to passing to different regimes. In this talk using this semi-dualization, we show there is a Kitaev model for the corresponding mirror bicrossproduct and we also provide the definition of the ground state of the new Hamiltonian in terms of a tensor network representation. In addition, we will explain why this model has richer structures compared to the quantum double's.

**Ernest Mwebaze**, Makerere University

*Title:* Leveraging computational techniques to automate expert tasks

*Abstract:* Artificial Intelligence and data science offer unique opportunities to transform alternate data sources and obtain interesting solutions particularly to address problems in low-resourced countries like

those in Africa. A key problem is the lack of experts across all fields. In this talk I will highlight some of the examples of interesting problems that can be solved by computational techniques, the unique and alternate data sources that can be leveraged to address these problems and the lessons we have learned in doing this. A common solution to most of these problems is to automate a critical expert task. Some of the topics I will cover will be in Agriculture, e.g. automating the diagnosis task using images and crowdsourcing surveillance data from small-holder farmers, in health, e.g. in automating lab diagnosis of malaria, in transport e.g. estimating speed and congestion in Kampala. Most of the work we do is targeted towards a particular client so I will also highlight some of the experiences we have had dealing with the consumers of these technologies.

**Yabebal Fantaye**, AIMS-South Africa

*Title:* Cheap Deep Learning

*Abstract:* The artificial intelligence revolution is driven by breakthroughs in computing infrastructures, data collection, and algorithms. Despite the abundant self learning materials and open source codes in machine learning in particular deep learning, many of the students and small businesses in Africa are not actively participating in harnessing the AI revolution to solve local challenges as well as become key players in the innovation space. My personal experience in teaching in Ethiopia and elsewhere in the continent showed me that partly this is because of not having access to computing infrastructures and a lack of guidance aimed particularly to local situations in Africa. In this talk I will discuss the tests I carried out in using free satellite images, Raspberry Pi, Arduino sensors and mobile phones to help solve some of the challenges I observed. I will also discuss the unexpected advantages gained by using low powered and highly exposed computing resources to build a more comprehensive data science teaching.

**Prosper Ngabonziza**, Max-Planck-Institute for Solid State Research

*Title:* Topotronics: From the Physics of Quantum Materials to Nanoscale Electronics in Quantum Devices

*Abstract:* Topotronics or “Topological Electronics” is a newly developing concept for the electrical control of geometrically protected quantum phenomena in topological insulators (TIs), for achieving dissipationless electronics and technical breakthroughs in future electronic devices and solid-state quantum information technologies. In this presentation, I will first discuss the basic concepts of topological quantum computation; and then I will focus on the material science and the physics of superconductor-topological insulator hybrid devices. I will demonstrate how in-situ characterization of topological insulator nanomaterials using several, complementary surface analysis techniques, enable to investigate topological surface states without exposing the samples to ambient conditions. Subsequent electronic transport measurements prove that the Fermi level remains in the band gap for in-situ capped thin films, whereas for uncapped samples there is degradation of the surface states in transport experiments. I will discuss our experimental efforts on inducing superconductivity into TI thin films by the proximity effect from superconducting Niobium (Nb). Gate-tunable Josephson junctions have been realized that provide insight into the prospects of using topological insulator-superconductor hybrid devices towards Majorana detection and topological quantum computation