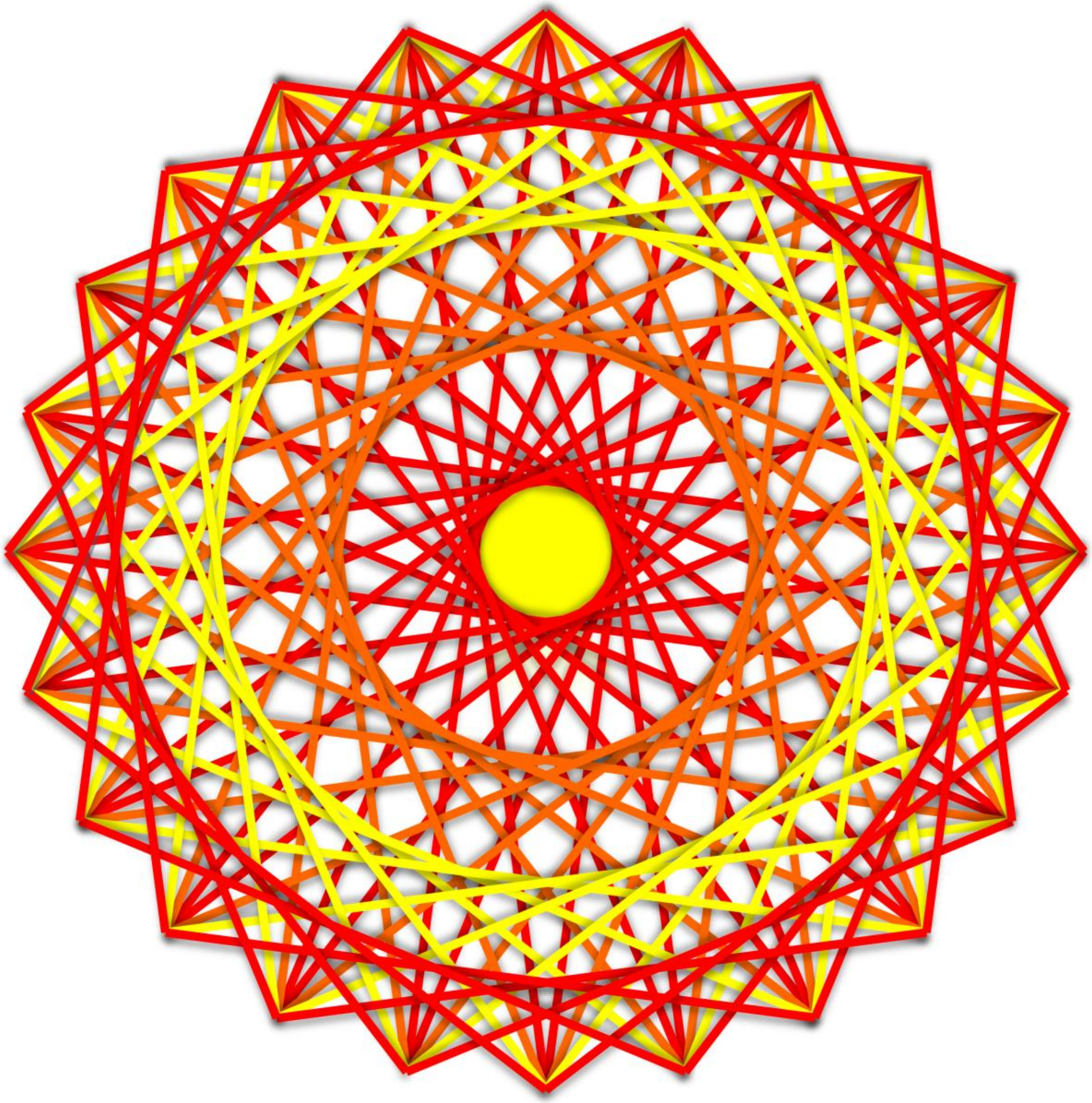

CAARMS24 Speaker Abstracts

Institute for Advanced Study & Princeton University

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ORFE Operations Research & Financial Engineering

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Democratizing National-Scale Genomic Data Analysis through Innovation

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Precision Medicine holds the promise of individualizing medical treatment in part by incorporating an individual's genomic data within the treatment plan. To advance precision medicine, the National Cancer Institute is one of several NIH institutes investing in the development of cloud base analysis platforms that supports multi-omics and heterogeneous data analysis capable of driving our national precision medicine research agenda. In this talk, Dr. Dean will introduce national computational initiatives to advance large scale genomic analysis with an emphasis on initiatives lead by Seven Bridges including the Cancer Genomics Cloud, recent genomic analysis standards and the graph genome.

Biography

Dr. Dennis A. Dean, II is a Director at Seven Bridges where he leads the scientific team in the Cambridge Office. He is responsible for the success of his team members across commercial, government, and internal projects. He leads collaborative outreach with the US Food and Drug Administration (FDA), the US Department of Veteran Affairs Million Veteran Program (MVP), and oversees several projects with large pharmaceutical companies.

Dr. Dean trained as a research fellow in medicine at Harvard Medical School and Brigham and Women's Hospital in the Program for Sleep Epidemiology and the Program for Sleep and Cardiovascular Medicine. He earned his PhD in biomedical engineering and biotechnology and M.S. in computer science from the University of Massachusetts. He earned his B.S. in computer science from SUNY, Empire State College. Dr. Dean was born in New York City and raised in the South Bronx.

Transverse Transport in Topological Magnetic Materials

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Spintronics couples the quantum spin of the electron with that of the quantum charge in order to realize new emergent and collective phenomena that have possible applications in next generation logic and memory devices. In recent years, the field of spintronics is heavily focused on topological characteristics in both real and momentum space. This was partly due to the experimental discovery of graphene in 2004 and the use of the 2-D physics in quantum hall systems and the explanation of the 3-D analogues. This has led to the now well-known Dirac semi-metal (3-D graphene) and the Weyl semimetal which both show momentum-space degenerate energy crossings that are protected by symmetry with properties related to relativistic phenomena. In the case of real space, the magnetic structure can form topological structures called skyrmions that can be packed very densely and manipulated with current densities that are much smaller than magnetically trivial textures. In this talk, I will briefly introduce electronic band theory and then the transport formalisms that are used to calculate physical properties of these topological systems. Lastly, I will end with some real-world examples that displays exotic transport phenomena.

Biography

Jacob Gayles was born and raised in the San Francisco Bay Area. He received his BS (2011) in physics from the California State University Northridge and PhD (2016) in physics from Texas A&M. He has carried out his PhD thesis research at the University of Johannes Guttenberg in Mainz. His PhD thesis in spintronics was titled: “Dzyaloshinkii-Moryia Interaction and Hall Effects in Bulk Chiral Magnets from First Principle Calculations.” Currently, he is a post-doctoral fellow at the Max Planck Institute for Chemical Physics of Solids, where he has been since 2017. His research interests delve into areas of spintronics that make use of topology in real space, momentum space and phases space and the related heat and electrical transport in these systems.

Solving Multi-Objective Optimization via Model-Based Stochastic Search

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For general multi-objective optimization problems, we propose a new performance metric called domination measure to measure the quality of a solution, which can be intuitively interpreted as the size of the portion of the solution space that dominates that solution. As a result, we reformulate the original multi-objective problem into a stochastic single-objective one and propose a model-based approach to solve it. We show that an ideal version algorithm of the proposed approach converges to a representative set of the global optima of the reformulated problem. We also investigate the numerical performance of an implementable version algorithm by comparing it with numerous existing multi-objective optimization methods on popular benchmark test functions.

Biography

Joshua Hale was born and raised in Sylacauga, Alabama. He received his Bachelor of Industrial and Systems Engineering degree with summa cum laude honors from Auburn University in 2011. After completing his undergraduate degree he started his doctoral work at the University of Illinois. In 2013 he transferred to Georgia Institute of Technology where he received a Doctor of Philosophy in Industrial and Systems engineering in 2017. He is currently an operation research engineer in the supply chain intelligence and analytics group at Intel Corporation in Phoenix, Arizona. During his tenure at Intel he has worked on several strategic projects in inventory planning, analytics strategy, and factory operations. His research interests include simulation optimization and integer optimization, with a focus on supply chain applications.

Assimilating Data into Physical Models

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Dealing with data is arguably the challenge of our times. The aim is to tease as much information as we can from the available data related to a particular physical situation. This can be in the service of making predictions about how that system will behave in the future, or in understanding its inner workings. The burgeoning area of data science tends to emphasize the profusion of data and downplay their provenance. But data come from distinct sources, and that matters. There are data from computational runs of models based on underlying physical laws and data from observations in the real world. Both understanding and prediction are significantly enhanced if these are treated as different sources of information. Data assimilation (DA) is the mathematical subject that takes this viewpoint and has the objective of gaining optimal information by combining the data from these sources in intelligent ways. At the core of DA lies a tension between nonlinearity and dimension. Most approaches have been developed to work in general and thus ignore the potential advantages presented by the structure of a particular physical situation. I will look at this issue in the context of assimilation into ocean and se-ice models.

Biography

Christopher K.R.T. Jones is the Bill Guthridge Distinguished Professor of Mathematics at the University of North Carolina at Chapel Hill. The main thrust of his research is the use of dynamical systems as a tool for solving problems that originate in applications; in particular the use of dynamical systems methods in the study of nonlinear wave motion in neuroscience and optics, ocean dynamics and, more recently, climate. His recent work has included contributions to the area of Data Assimilation, with a particular focus on assimilating data in ocean and sea-ice models. He is currently Director of the Mathematics and Climate Research Network.

Parametric Analysis of Renal Failure Data using the Exponentiated Odd Weibull Distribution

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In this work, we analyze renal failure data from patients with *mesangio-proliferative-glomerulo-nephritis* (MPGN) which was modeled by Vikse *et al.* (2002) non-parametrically using the Kaplan-Meier curve. In their work, they showed that the clinical variables, large increase serum creatinine (LISC) and systolic blood pressure >160 mmHg (SBP>160), and morphological variables, benign nephrosclerosis Present (BNP) and interstitial score group 5-6 (IS5-6) were part of the variables which indicated progression to end-stage renal failure (ESRF). Though survival curves associated with these variables may be difficult to model by existing parametric distributions in literature. Therefore, we introduce a four-parameter Odd Weibull extension, the exponentiated Odd Weibull (EOW) distribution which is very versatile in modeling lifetime data that its hazard function exhibits ten different hazard shapes as well as various density shapes. Basic properties of the EOW distribution are presented. Our results show that the EOW distribution is very convenient and reliable to analyze the MPGN data since it provides an excellent fit for the variables LISC, SBP>160, BNP, and IS5-6. Furthermore, advantages of using the EOW distribution over the Kaplan-Meier curve are discussed. Comparisons of the EOW distribution with other Weibull-related distributions are also presented.

Biography

Channon Mdziniso was born and raised in Swaziland, Southern Africa and received her BS in Mathematics and Computer Science from the University of Swaziland (2009) and a MA in Mathematics from Marshall University, WV (2012). She received her PhD in Mathematical Sciences with a Statistics concentration from Central Michigan University (2018). Her PhD thesis in Probability and Statistics was titled: "Generalization of the Odd Pareto and Odd Weibull Distributions". She will begin her work as a Data Science Assistant Professor at Bloomsburg University of Pennsylvania this fall. Her research focuses on developing statistical models using probability distributions, data mining, and machine learning techniques, with applications in other areas of study.

Functional Transcendence via Model Theory

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There is no agreed upon definition of a special function. However one can think of special functions as particular mathematical functions that have more or less established names and notations due to their importance in mathematical analysis, functional analysis, physics, or other applications. This talk focuses on the following fundamental question, which naturally arises in the study of special functions: given a collection of special functions are there any non-trivial algebraic relations among them? Functional transcendence is the study of the nonexistence of such non-trivial algebraic relations. As an example, it can be proven that there are no non-trivial algebraic relations between log x and exp x. This is a special case of a theorem due to Ax which reduces all algebraic relations between functions and their exponentials to very simple linear relations among the functions. Using ideas from model theory - a branch of mathematical logic - far reaching generalizations of Ax's theorem involving other special functions have been conjectured and in many cases proved. In this talk, I will explain these ideas and also discuss progress made on some of those problems.

Biography

Joel Nagloo was born and raised in Mauritius, where he completed his undergraduate studies in Mathematics in 2006. He received an MSc in Pure Mathematics from Imperial college London (2010) and received his PhD in Mathematics with commendation for research excellence from the University of Leeds (2014). His PhD thesis was titled: "Model theory, Algebra and Differential equations". He moved to the US in 2014, as a Visiting Assistant Professor in Mathematics at the Graduate Center of the City University of New York (CUNY). In 2016, he was appointed Assistant Professor of Mathematics and Computer Science at Bronx Community College of CUNY. In 2017 he was awarded a National Science Foundation grant to support his work that aim to furthering the interaction between mathematical logic, number theory and Differential/Difference Equations.

A Promenade in Time-Frequency Analysis

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Time-frequency analysis seeks to study functions or signals in both space and frequency. In this talk I will focus on one time-frequency tool: the Weyl-Heisenberg or Gabor systems. I will give a brief introduction to the theory of Gabor frames and will survey some easily stated yet unresolved open problems in this area.

Biography

Kasso Okoudjou was born and raised in Benin, where he completed his undergraduate studies in Mathematics in 1996. He moved to the US in 1998, and earned a Ph.D. in Mathematics, and an M.S. in Electrical Engineering at Georgia Tech in 2003 working under the supervision of Chris Heil. From 2003 to 2006 he was H.C. Wang Assistant Professor of Mathematics at Cornell University. In 2006 he was appointed Assistant Professor of Mathematics at the University of Maryland College Park, where he is now Professor. He was also the Associate Chair for Undergraduate Studies from 2016 to 2018. During the academic year 2018 – 2019, he will be a Martin Luther King Visiting Professor of Mathematics at the Massachusetts Institute of Technology. He also held visiting positions at visiting the University of Osnabruck, and the Technical University of Berlin as a Senior Humboldt Researcher, and was a Research Member at the MSRI in 2017. His research interests include applied and pure harmonic analysis especially time-frequency and time-scale analysis, frame theory, and analysis and differential equations on fractals.

Lyapunov Arguments in Optimization

Ashia Wilson

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This talk is about Lyapunov functions and how they are used to obtain upper bounds for most algorithms in optimization. I will discuss the viewpoint of algorithms as discrete-time dynamical systems and show how numerical analysis techniques and Lyapunov functions can be used to obtain novel methods.

Biography

Ashia Wilson is a postdoctoral researcher at Microsoft New England. She received her doctorate in Statistics at the University of California Berkeley advised by Benjamin Recht and Michael Jordan, with undergraduate degrees from Harvard. Her work focuses on designing and analyzing optimization algorithms for machine learning tasks, as well as studying and the connections between machine learning and dynamical systems.

Special Classes of Matrices and their Combinatorial Structures

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Combinatorial matrix theory studies the intrinsic properties of matrices viewed as arrays of numbers rather than just as algebraic objects. The combinatorial structure of a matrix refers to the location of its zero and nonzero entries. This subdiscipline of matrix theory studies the relationship between the combinatorial structure of a matrix and other properties such as its spectrum, eigenvectors, Jordan structure, etc. In this talk, I will introduce the notion of an eventual property of a matrix, give some examples and share some of what we know about some of these special classes of matrices.

Biography

Ulrica Wilson was born in Massachusetts while her father was in graduate school. She grew up in Birmingham, AL and went to Spelman College. She received her PhD from Emory University, doing her thesis in algebra, specifically non-commutative rings After doing two postdocs, joined the faculty at Morehouse College. She is currently an associate professor there and is also the Associate Director of Diversity and Outreach for the The Institute for Computational and Experimental Research in Mathematics (ICERM) at Brown University.