DEL AND BETH KIMBLER LECTURE SERIES

NOV 03, FRIDAY **10 AM-11:15 AM** **LOCATION: CMC 147**

WITH ALPER ATAMTÜRK
PH.D., GEORGIA INSTITUTE OF TECHNOLOGY, 1998
PROFESSOR AND DEPARTMENT CHAIR
EARL J. ISAAC CHAIR IN THE SCIENCE AND ANALYSIS OF DECISION MAKING
DEPARTMENT OF INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH
UNIVERSITY OF CALIFORNIA-BERKELEY

KNOW YOUR SPEAKER

ALPER ATAMTURK IS THE EARL J. ISAAC CHAIR IN THE SCIENCE AND ANALYSIS OF DECISION MAKING, PROFESSOR, AND CHAIR OF THE DEPARTMENT OF INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH AT THE UNIVERSITY OF CALIFORNIA, BERKELEY. HE SERVES AS THE BERKELEY SITE DIRECTOR OF THE NATIONAL ARTIFICIAL INTELLIGENCE INSTITUTE FOR ADVANCES IN OPTIMIZATION, DIRECTOR OF BERKELEY COMPUTATIONAL OPTIMIZATION LAB, CO-EDITOR OF MATHEMATICAL PROGRAMMING, ASSOCIATE EDITOR FOR DISCRETE OPTIMIZATION, MATHEMATICAL PROGRAMMING COMPUTATION, AND JOURNAL OF RISK. HE IS A FELLOW OF THE INSTITUTE FOR OPERATIONS RESEARCH AND MANAGEMENT SCIENCE AND A VANNEVAR BUSH FACULTY FELLOW OF THE US DEPARTMENT OF DEFENSE. HE RECEIVED THE FARKAS PRIZE FROM THE INFORMS OPTIMIZATION SOCIETY. HE SERVES AS AN ADVISOR TO A NUMBER OF COMPANIES, UNIVERSITIES, AND GOVERNMENT AGENCIES.

TITLE: "SPARSE ESTIMATION: CLOSING THE GAP BETWEEN L0 AND L1 MODELS"

ABSTRACT

ABSTRACT: SPARSE STATISTICAL ESTIMATORS ARE INCREASINGLY PREVALENT DUE TO THEIR EASE OF INTERPRETABILITY AND SUPERIOR OUT-OF-SAMPLE PERFORMANCE. HOWEVER, SPARSE ESTIMATION PROBLEMS WITH AN L0 CONSTRAINT, RESTRICTING THE SUPPORT OF THE ESTIMATORS, ARE CHALLENGING (TYPICALLY NP-HARD, BUT NOT ALWAYS) NON-CONVEX OPTIMIZATION PROBLEMS. CONSEQUENTLY, ACADEMICS AND PRACTITIONERS COMMONLY TURN TO CONVEX L1 PROXIES, SUCH AS LASSO AND ITS VARIANTS, AS A REMEDY. ALTHOUGH THE L1 MODELS ARE SOLVED FAST, THEY MAY LEAD TO BIASED AND/OR DENSE ESTIMATORS AND REQUIRE SUBSTANTIAL CROSS-VALIDATION FOR CALIBRATION.

IN THIS TALK, WE FOCUS ON TWO ESTIMATION PROBLEMS: I) SPARSE REGRESSION AND II) SPARSE AND SMOOTH SIGNAL RECOVERY. THE FIRST ONE IS KNOWN TO BE NP-HARD; WE SHOW THAT THE SECOND ONE IS EQUIVALENT TO A SUBMODULAR MINIMIZATION PROBLEM AND, HENCE, IT IS POLYNOMIALLY SOLVABLE. FOR BOTH PROBLEMS, WE DERIVE A SEQUENCE OF STRONG CONVEX RELAXATIONS. THESE RELAXATIONS ARE BASED ON THE IDEAL (CONVEX-HULL) FORMULATIONS FOR RANK-ONE/PAIRWISE QUADRATIC TERMS WITH INDICATOR VARIABLES. THE NEW RELAXATIONS CAN BE FORMULATED AS CONIC QUADRATIC OR SEMIDEFINITE OPTIMIZATION PROBLEMS IN AN EXTENDED SPACE; THEY ARE STRONGER AND MORE GENERAL THAN THE STATE-OF-THE-ART MODELS WITH THE REVERSE HUBER PENALTY AND THE MINIMAX CONCAVE PENALTY FUNCTIONS. FURTHERMORE, THE PROPOSED RANK-ONE STRENGTHENING CAN BE INTERPRETED AS AN UNBIASED, NON-SEPARABLE, NON-CONVEX, SPARSITY-INDUCING REGULARIZER, WHICH DYNAMICALLY ADJUSTS ITS PENALTY ACCORDING TO THE SHAPE OF THE ESTIMATION ERROR FUNCTION WITHOUT INDUCING BIAS FOR SPARSE ESTIMATES. COMPUTATIONAL EXPERIMENTS WITH BENCHMARK DATASETS SHOW THAT THE PROPOSED CONIC FORMULATIONS ARE SOLVED FAST AND RESULT IN NEAR-OPTIMAL ESTIMATORS FOR NON-CONVEX L0-PROBLEMS. MOREOVER, THE RESULTING ESTIMATORS OUTPERFORM L1 APPROACHES FROM A STATISTICAL PERSPECTIVE, ACHIEVING HIGH PREDICTION ACCURACY AND GOOD INTERPRETABILITY.

THIS TALK IS BASED ON JOINT WORK WITH ANDRES GOMEZ & SHAONING HAN.

UNIVERSITY of SOUTH FLORIDA

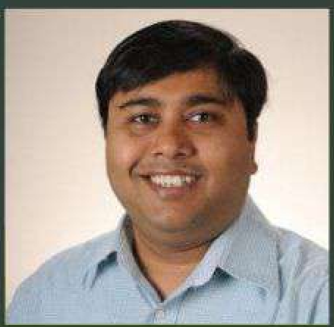
INDUSTRIAL AND MANAGEMENT SYSTEMS ENGINEERING SEMINAR

INFORMS USF

UNIVERSITY OF SOUTH FLORIDA

DEL AND BETH KIMBLER LECTURE SERIES

OCT 27, FRIDAY **10 AM-11:15 AM** **LOCATION: MICROSOFT TEAMS**



WITH SANTANU S. DEY
PROFESSOR
H. MILTON STEWART
SCHOOL OF INDUSTRIAL
AND SYSTEMS ENGINEERING,
GEORGIA INSTITUTE OF
TECHNOLOGY

KNOW YOUR SPEAKER

SANTANU S. DEY IS A PROFESSOR AND DIRECTOR OF DOCTORIAL RECRUITING AND ADMISSIONS IN THE H. MILTON STEWART SCHOOL OF INDUSTRIAL AND SYSTEMS ENGINEERING AT GEORGIA INSTITUTE OF TECHNOLOGY. DR. DEY'S RESEARCH INTERESTS ARE IN THE AREA OF NON-CONVEX OPTIMIZATION, AND IN PARTICULAR MIXED INTEGER LINEAR AND NONLINEAR PROGRAMMING. HIS RESEARCH IS PARTLY MOTIVATED BY APPLICATIONS OF NON-CONVEX OPTIMIZATION PROBLEMS ARISING IN AREAS SUCH AS ELECTRICAL POWER ENGINEERING, PROCESS ENGINEERING, CIVIL ENGINEERING, LOGISTICS, AND STATISTICS. DR. DEY HAS SERVED AS COUNCIL MEMBER-AT-LARGE FOR MATHEMATICAL OPTIMIZATION SOCIETY, HAS SERVED AS THE VICE CHAIR FOR INTEGER PROGRAMMING FOR INFORMS OPTIMIZATION SOCIETY (2011-2013), AND HAS SERVED ON THE PROGRAM COMMITTEES OF MIXED INTEGER PROGRAMMING WORKSHOP 2013 AND INTEGER PROGRAMMING AND COMBINATORIAL OPTIMIZATION 2017, 2020. HE CURRENTLY SERVES ON THE EDITORIAL BOARD OF COMPUTATIONAL OPTIMIZATION AND APPLICATIONS, MOS-SIAM BOOK SERIES ON OPTIMIZATION, AND IS AN ASSOCIATE EDITOR FOR MATHEMATICAL PROGRAMMING A, MATHEMATICS OF OPERATIONS RESEARCH AND SIAM JOURNAL ON OPTIMIZATION. HE HAS PREVIOUSLY SERVED AS AN AREA EDITOR FOR MATHEMATICAL PROGRAMMING C AND ASSOCIATE EDITOR OF INFORMS JOURNAL ON COMPUTING. HE HAS WON THE INFORMS NICHOLSON STUDENT PAPER COMPETITION, A IBM FACULTY AWARD, THE CLASS OF 1969 TEACHING FELLOW AT GEORGIA TECH, THE NSF CAREER AWARD, THE INFORMS ENERGY NATURAL RESOURCES AND ENVIRONMENT BEST PAPER AWARD, AND THE INFORMS OPTIMIZATION SOCIETY BALAS PRIZE. HE HAS BEEN A DIVERSITY FELLOW AT GEORGIA TECH, AND HAS HELD THE FOUTS FAMILY JUNIOR PROFESSORSHIP, THE A. RUSSELL CHANDLER III PROFESSORSHIP, AND THE ANDERSON-INTERFACE PROFESSORSHIP AT GEORGIA TECH

TITLE: SENSITIVITY ANALYSIS FOR MIXED BINARY QUADRATIC PROGRAMS: COMPLEXITY, STRUCTURE, AND COMPUTATION

ABSTRACT

WE BEGIN BY MOTIVATING THE NEED FOR CONDUCTING SENSITIVITY ANALYSIS FOR MIXED BINARY QUADRATIC PROGRAMS (MBQPS) WITH RESPECT TO CHANGING RIGHT-HAND-SIDES (RHS) WITH VARIOUS APPLICATIONS FROM THE POWER SYSTEMS OPTIMIZATION. WE THEN ANALYZE THE FORMAL COMPLEXITY QUESTION OF CONDUCTING SENSITIVITY ANALYSIS FOR MBQPS: WE SHOW THAT EVEN IF THE OPTIMAL SOLUTION OF A GIVEN MBQP IS KNOWN, IT IS NP-HARD TO ACHIEVE A TWO-SIDED (A, B)-APPROXIMATION OF THE ABSOLUTE VALUE OF THE CHANGE IN OBJECTIVE FUNCTION VALUE WITH RESPECT TO CHANGES IN RHS (FOR ANY FIXED VALUE OF 0 <A< B). NEXT WE EXAMINE THE ALGORITHMIC CHALLENGES OF PRODUCING GOOD DUAL BOUNDS FOR MBQPS WITH RESPECT TO CHANGING RHS. WE LEVERAGE SAM BURER'S COMPLETELY-POSITIVE (CPP) REFORMULATION OF MBQPS BY EXAMINING ITS DUAL, THE SO-CALLED CO-POSITIVE (COP) PROBLEM, AND USE THIS DUAL TO OBTAIN BOUNDS WITH RESPECT TO CHANGING RHS. WE SHOW THAT STRONG DUALITY HOLDS BETWEEN THE CPP REFORMULATION AND ITS COP DUAL IF THE FEASIBLE REGION IS BOUNDED OR IF THE OBJECTIVE FUNCTION IS CONVEX. WHEN THE FEASIBLE REGION IS UNBOUNDED AND THE OBJECTIVE FUNCTION IS A NON-CONVEX QUADRATIC, WE SHOW EXAMPLES WHERE THERE IS A NON-ZERO DUALITY GAP. WE NEXT SHOW THAT THE SET OF OPTIMAL SOLUTIONS OF THE COP DUAL IS AT LEAST M, WHERE THE ORIGINAL MBQP HAS M CONSTRAINTS. THE CHOICE OF OPTIMAL SOLUTION OF THE DUAL AFFECTS THE QUALITY OF BOUNDS WE OBTAIN WHEN CHANGING THE RHS. FINALLY, WE PROVIDE AN ALGORITHMIC APPROACH TO FIND ''BEST VALUES' OF OPTIMAL DUAL SOLUTIONS AND PRESENT PRELIMINARY COMPUTATIONAL RESULTS ON SENSITIVITY ANALYSIS FOR MBQPS.

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INDUSTRIAL AND MANAGEMENT SYSTEMS ENGINEERING SEMINAR

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Del and Beth Kimbler Lecture Series
@Industrial and Management Systems Engineering

Design, calibration, and optimization of pandemic alert systems

Dave Morton
Professor of Industrial Engineering and Management Sciences (IEMS) at Northwestern University

Biography

Dave Morton is the Walter P. Murphy Professor of Industrial Engineering and Management Sciences (IEMS) at Northwestern University. His research interests include stochastic and large-scale optimization with applications in public health, security, and energy systems. Prior to joining Northwestern, he was on the faculty at the University of Texas at Austin and worked as a Fulbright Research Scholar at Charles University in Prague. He is a Fellow of INFORMS.

Abstract

During the COVID-19 pandemic, governments worldwide developed staged-alert systems to monitor data streams and trigger changes in intervention policies. However, many tracked unreliable data indicators, used heuristic policy triggers, failed to articulate measurable goals, and were implemented and communicated inconsistently. Beginning in April 2020, we worked closely with local officials in Austin, Texas to develop and maintain the COVID-19 alert system that guided public communications and policy decisions. Over a two-year period, the system was instrumental in preventing overwhelming healthcare surges, minimizing socioeconomic disruption, and contributing to Austin's significantly lower COVID-19 mortality rate than comparable cities across the US. In this talk, we will describe a data-driven modeling framework, and stochastic optimization model, for designing pathogen alert systems that can ensure consistent situational awareness, provide policy guideposts that reduce uncertainty and decision complexity, and enhance public trust and policy adherence.

CMC 147

11:00 am—12:30 pm

Friday, October 6, 2023

INFORMS USF

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COLLEGE OF ENGINEERING

Del and Beth Kimbler Lecture Series
@Industrial and Management Systems Engineering

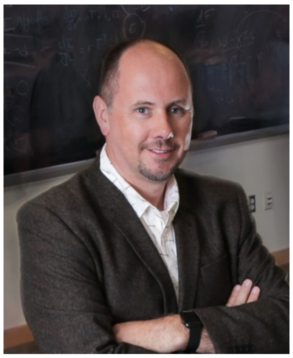
Evolutionary Therapy

Alexander R.A. Anderson

Integrated Mathematical Oncology Department, Moffitt Cancer & Research Institute

Tampa, FL, USA

Biography



Alexander R. A. Anderson, PhD is Founding Richard O. Jacobson Chair of the Integrated Mathematical Oncology (IMO) Department and Director of the Center of Excellence for Evolutionary Therapy at Moffitt Cancer Center. For the last 20 years he has been developing mathematical models of many different aspects of tumor progression and treatment that require a tight dialogue between theory and experiment. Due to his belief in the crucial role of mathematical models in cancer research he moved his group to the Moffitt Cancer Center in 2008 to establish the IMO department. Since his arrival, cancer treatment has become a significant driver of his research and using mathematical models that connect our basic science understanding of a given cancer with clinical translation. This has led to the development of evolutionary therapies that seek to control cancer rather than eradicate it. Through smart treatment scheduling and dosing, with combination therapies as well as microenvironment targeted treatments, he has developed novel treatments for prostate, breast, ovarian, lung and skin cancer. As director for the 1st center of Evolutionary Therapy he has helped facilitate 8 active evolutionary clinical trials at Moffitt that use mathematical models as part of their decision process. One of these trails is the Evolutionary Tumor Board (ETB), which consists of an integrated team of clinical physicians, evolutionary biologists, and mathematicians. The ETB provides guidance on optimal evolution based treatment strategies for individual patients by rigorously formulating and

Abstract

Our current approach to cancer treatment has been largely driven by finding molecular targets, those patients fortunate enough to have a targetable mutation will receive a fixed treatment schedule designed to deliver the maximum tolerated dose (MTD). Cancers are complex evolving systems that adapt to therapeutic intervention through a suite of resistance mechanisms, therefore whilst MTD therapies generally achieve impressive short-term responses, they unfortunately give way to treatment resistance and tumor relapse. The importance of evolution during both tumor progression, metastasis and treatment response is becoming more widely accepted. However, MTD treatment strategies continue to dominate the precision oncology landscape. Here we discuss evolutionary therapy, a proactive therapeutic approach that changes and evolves with the tumor being treated. Due to the dynamic feedback between changing treatments and the evolving tumor, mathematical models are essential to drive treatment switch points and predict appropriate dosing and drug combinations. We will consider the importance of using treatment response as a critical driver of subsequent treatment decisions, rather than fixed MTD strategies that ignore it. We will also consider using mathematical models to drive treatment decisions based on limited clinical data. Through the integrated application of mathematical and experimental models as well as clinical data we will illustrate that, evolutionary therapy can drive either tumor control or extinction. Our results strongly indicate that the future of precision medicine shouldn't only be in the development of new drugs but rather in the smarter evolutionary, and model informed, application of preexisting ones.

CMC 147
11:00am-12:30pm
Friday, September 1, 2023

INFORMS USF

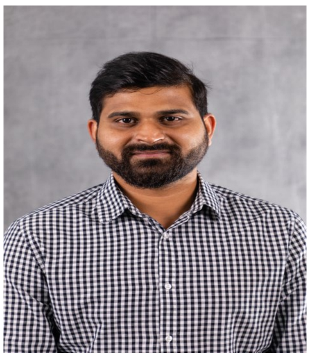
USF UNIVERSITY OF SOUTH FLORIDA COLLEGE OF ENGINEERING

Del and Beth Kimbler Lecture Series
@Industrial and Management Systems Engineering

A provably stable neural network Turing Machine-Towards Trustworthy AI

Assistant Professor in the Department of Computer Science and Engineering at the University of South Florida (USF)

Biography



Dr. Ankur Mali is an assistant professor in the Department of computer science and Engineering at the University of South Florida (USF), where he directs the trustworthy knowledge drive artificial intelligence (TKAI) laboratory. Before joining USF, he completed his Ph.D. under Prof. Clyde Lee Giles from The Pennsylvania State University in 2022. He works at the intersection of language, memory, and computation—spanning Natural Language Processing (NLP), linguistics, and formal language theory. He also works on designing learning algorithms and computational architectures guided by theories of the brain. These architectures focus on solving challenges such as continual/lifelong learning, learning with minimal supervision, RL, and sparsity (both in computer vision and natural language processing). In particular, he has proposed several knowledge-guided interpretable deep learning systems that generate fair, accountable, and trustworthy information. Furthermore, he has also designed approaches to investigate the mysterious success of deep learning in recognizing natural language from a theoretical and empirical perspective.

Abstract

Artificial intelligence's remarkable advancement, especially deep learning-based intelligent systems, has achieved human-level performance in various domains. Although state-of-the-art (SOTA) Neural networks (NNs) such as recurrent neural networks (RNNs) and transformers are known to be Turing-complete, this result relies on infinite precision in the hidden representation, positional encoding for transformer models, and unbounded computation time. Furthermore, there needs to be a more theoretical understanding of the mysterious success of these black-box systems under constrained resources.
In this talk, I will draw a connection between formal methods, linguistic theory, and Neural network architectures and show the theoretical limits of modern-day NNs. Later I will show how one can extract and insert rules in this black-box system, such that the underline system is explainable by design and extraction. Furthermore, I will talk about our recent theoretical work in constructing the smallest NN that can simulate a Turing Machine in real time with bounded precision in weights. Finally, using orbital stability, we show that solutions built by our models are always stable, which is a crucial step in designing robust, stable neuro-symbolic models that can generalize to unseen distribution.

ENC 2004
11:00am-12:15pm
Monday, April 17th, 2023

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