Bismark Singh

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Interests

Mathematical optimization under uncertainty; development of algorithms to solve large-scale stochastic optimization models, in particular with chance-constraints; applications to public health policy and renewable energy

Recent Experience

Department of Mathematics, Friedrich-Alexander-Universität, Erlangen, Germany *11/19-*

Discrete Math & Optimization, Sandia National Laboratories, Albuquerque, USA *9/17-9/19*

Institute of Operations Research, Karlsruhe Institute of Technology, Germany *4/17-9/17*

Ph.D., Operations Research & Industrial Engineering *12/2016*

Operations Research, *The University of Texas at Austin, USA*
Dissertation: "Optimal spatiotemporal resource allocation in public health and renewable energy"
advisors: Prof. David Morton; co-advisor: Prof. Lauren A. Meyers

Awards

Research Grants

€4,993	Bavarian-Czech Academic Agency PI: "Fairly allocating vaccines for COVID-19"	*2021*
€9,900	Bavarian-Czech Academic Agency PI: "Optimal decision making for COVID-19"	*2020*
€44,160	European Open Science Cloud (EOSC) Secretariat co-PI: "Optimal spatiotemporal antiviral release under uncertainty"	*2020*
$80,000	Sandia National Laboratories PI: "Chance-constrained optimization for critical infrastructure protection"	*2018*
$5,000	American Public Power Association PI: "Quantifying and managing wind power variability"	*2015*

Key Scholarships

$2,000	Utility Variable-Generation Integration Group Academic Scholarship	*2016-17*
$2,500	Warren A. and Alice L. Meyer Endowed Scholarship in Engineering	*2015-16*
$1,850	Women in Engineering Program Participant Scholarship, UT Austin	*2014*

Honors

2nd place	IISE Health Systems Best Track Paper Award, "Optimization based decision-support tools for influenza pandemic preparedness"	*2019*
Finalist	INFORMS Doing Good with Good OR, Student Paper Competition, "Optimizing vaccine allocation for pandemic influenza"	*2014*

Key Contributions

- *3 supervised Masters thesis*
- *17 peer-reviewed, 6 in-review publications; 5 peer-reviewed conference proceedings;* (see here:)
- *27 invited seminars, 7 chaired conference sessions, 15 conference talks, 9 posters*
- *Committee Member, INFORMS History & Traditions Committee, 5 essays.* .

Description of the research group
Bismark Singh

Keywords: stochastic programming, chance constraints, discrete optimization, public health, energy management, mathematical modeling

Background: The METIS (Methods and Models for Energy Transformation and Integration Systems) project is a cooperation of the Jülich Research Center, the RWTH Aachen University (Germany) and the Friedrich-Alexander-Universität Erlangen-Nürnberg. This project aims to develop simulation and optimization tools to analyze energy markets in Germany and Europe.

Team: We are a young team. I am a postdoctoral researcher within the Department of Mathematics and the newly-founded Department of Data Science at the Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany. Here, I am leading our department's efforts in the METIS research collaboration with the Institute of Energy and Climate Research, Techno-economic Systems Analysis (IEK-3) at the Jülich Forschungszentrum (Jülich Research Center). Currently, we have one Masters student working on this project, and one other student has graduated with his Masters thesis on this project. See a preprint of the work corresponding to the thesis here: http://www.optimization-online.org/DB_HTML/2021/03/8293.html. The team at the IEK-3 consists of several scientists with PhDs and PhD students. The chosen candidate would directly work within this collaboration under my supervision.

Research activities: Before my move to Germany, I was in the Discrete Math & Optimization division at Sandia National Laboratories (SNL) — one of the largest US research laboratories under the US Department of Energy — from 2016-19 working on large-scale stochastic optimization models with data from the US electrical grid. From 2011 to 2016, I was at The University of Texas at Austin, USA.

My research focuses on development of algorithms and heuristics for large-scale stochastic and deterministic optimization models. Often, but not always, my research is motivated by applications, including (i) critical infrastructure resiliency, (ii) renewable energy management, and (iii) pandemic response. In this regard, I first work on formulating diverse and relevant societal problems as mathematical models, and second, on developing novel algorithmic methods towards their solution. A recent example of this is our work on the question of relaxing and reinstating lock-downs for COVID-19, at the interface of optimization and epidemiology, published in the *Proceedings of the National Academy of Sciences*. The student would also have an opportunity, but is not obliged to, to collaborate on other existing works within his/her capacity,

Please feel free to contact me directly for any questions.

Description of the work to be carried out by the student

The selected candidate would work directly within the realm of the above-mentioned METIS project. **Description**: Stochastic programs rely on a number of scenarios that form the input data of the optimization model. Large numbers of scenarios can result in poor computational performance due to the correspondingly large optimization model. Thus, aggregation or clustering methods for scenarios are often used. These methods work by picking out representative scenarios from a pool of scenarios, and/or defining a fewer number of new scenarios that are equally representative of the pool of scenarios (there are standard methods available to accomplish this aggregation). However, this improved computational performance comes at a price of reduced accuracy, or an error, in the corresponding optimization model's objective function. The aim of this proposal is to test the computational performance of these "aggregated" scenarios and determine performance gaps.

To this end, the student would perform several computational experiments to determine the quality of the approximations. Analytical estimation of the errors can also be carried out.

This work finds application in several areas such as energy system planning, allocation of scarce medical resources in a pandemic, and developing highly reliable contracts to deliver goods.

Existing work: In collaboration with scientists at the Jülich Research Center, we have developed approximations for stochastic optimization models that rely on a fewer number of scenarios. Specifically, we have at our proposal both an aggregation method and the optimization model we seek to test it on. The chosen candidate can, thus, directly begin active research.

Required qualifications: An extensive background in scenario generation or aggregation is *not* required, and some existing code is available. Good knowledge of a modeling language such as (at least one of) Pyomo, GAMS, Gurobi, etc. is required. A background in discrete optimization is required as well.

What we offer: We offer an opportunity to form part of a young, self-motivated, and performance-driven research group, with an active interest in high-quality publications. The chosen candidate would be involved in active collaboration with the Jülich Research Center, and actively supervised by the advisor at FAU. The candidate would be a co-author or lead-author on any publications resulting from the project.

Other information

Assistance in finding accommodation within Erlangen-Nuremberg can be arranged. If a physical stay is not possible due the pandemic restrictions, the collaboration takes place virtually.

Nuremberg has a population of about half a million, is the the second-largest Bavarian city and the fourteenth-largest municipality in Germany. It is a dynamic and active city that offers a mix of traditional sites and an economic hub with companies such as Diehl, Adidas, and Siemens in the neighborhood.

Additional funding within the student-assistant remuneration policies of FAU can be offered (about 400 euros a month).