**BISMARK SINGH**

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## Academic Appointments

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|---|---|
| 2024 - | Associate Professor, School of Mathematical Sciences, University of Southampton, UK. |
| 2022-24 | Assistant Professor, School of Mathematical Sciences, University of Southampton, UK. |
| 2019-22 | E14 Researcher, Department of Mathematics, University of Erlangen-Nuremberg, Germany. |
| 2016-19 | Postdoctoral Appointee, Discrete Math & Optimization, Sandia National Laboratories, US. |
| 2017 | E13 Researcher, Institute of Operations Research, Karlsruhe Institute of Technology, Germany. |
| 2011-16 | Research/Teaching assistant, Mechanical Engineering and Integrative Biology, The University of Texas at Austin, US. |

## Education

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|---|---|
| 2023 | Habilitation, Mathematics, University of Erlangen-Nuremberg, Germany. |
| 2016 | PhD, Operations Research & Industrial Engineering, The University of Texas at Austin, US. |
| 2013 | MSc, Operations Research & Industrial Engineering, The University of Texas at Austin, US. |
| 2011 | B.Tech., Chemical Engineering, Indian Institute of Technology IIT Delhi, India. |

## Third-party Funding (selection)

≈€360,000 of competitively secured funding

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|---|---|
| 2022-25 | PI: German Research Foundation DFG (€115,310). |
| 2021 | PI: Bavarian State Ministry for Science and Art (€10,000). |
| 2020-21 | PI: Bavarian-Czech Academic Agency (€14,893). |
| 2020 | co-PI: European Open Science Cloud, Horizon 2020 (€44,160). |
| 2018 | PI: Laboratory Directed Research and Development, Sandia National Laboratories ($80,000). |

## Awards & Honors (selection)

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| 2024 | Distinguished Research Fellowship, TU Dresden, Germany. |
| 2023 | Mathematics Young Investigator Award. |
| 2023 | UK-Italy Trustworthy AI Visiting Researcher Programme, The Alan Turing Institute, UK. |
| 2023 | Visiting Fellowship, Scientific and Technological Research Council of Turkey TÜBİTAK. |
| 2019 | IISE Health Systems Best Track Paper Award (2nd place) |
| 2016 | Utility Variable-Generation Integration Group Academic Award, US. |
| 2016 | Warren & Alice Meyer Endowed Scholarship in Engineering, The University of Texas at Austin, US. |
| 2014 | INFORMS Doing Good with Good OR Paper Award (Finalist) |
| 2013 | INFORMS Interactive Sessions Competition (2nd place). |

## Selected Publications

*my supervised student; full publication lists:

1. B. Singh and S. Rebennack. "Release immediately or sequentially? Strategies for allocating scarce therapeutic resources during disease outbreaks". *IISE Transactions* (2025). DOI: 10.1080/24725854.2025.2525918
2. C. Schmitt* and B. Singh. "Quadratic optimization models for balancing preferential access and fairness: Formulations and optimality conditions". *INFORMS Journal on Computing* (2024). DOI: 10.1287/ijoc.2022.0308
3. B. Singh, L. Oberfichtner*, and S. Ivliev. "Heuristics for a cash-collection routing problem with a cluster-first route-second approach". *Annals of Operations Research* (2022). DOI: 10.1007/s10479-022-04883-1
4. B. Singh and B. Knueven. "Lagrangian relaxation based heuristics for a chance-constrained optimization model of a hybrid solar-battery storage system". *Journal of Global Optimization* (2021). DOI: 10.1007/s10898-021-01041-y
5. D. Duque, D. P. Morton, B. Singh, Z. Du, R. Pasco, and L. A. Meyers. "Timing social distancing to avert unmanageable COVID-19 hospital surges". *Proceedings of the National Academy of Sciences* (2020). DOI: 10.1073/pnas.2009033117

36 publications, 13 in-review; 55 invited seminars, 33 conference talks, 6 key talks.

University of Southampton

# Description of the research group

**Bismark Singh**

*Keywords*: mathematical optimization, heuristics, discrete optimization, fairness, resource allocation, public service systems.

**About me**: I am an Associate Professor in the Operational Research group at the School of Mathematical Sciences, University of Southampton, UK. I lead a young, internationally connected research group focused on the theory and applications of discrete and stochastic optimization.

Before 2022, I was at the Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany, where I received my habilitation in mathematics and led the chair's efforts in the multi-institute "METIS" research collaboration with the Institute of Energy and Climate Research, Techno-economic Systems Analysis (IEK-3) at the Jülich Forschungszentrum. The METIS project develops open-source tools for large-scale energy system optimization; see more here and technical details here.

Before 2019, I worked in the Discrete Math & Optimization division at Sandia National Laboratories (under the US Department of Energy) on large-scale stochastic optimization models for the national power grid. I hold a PhD in Operations Research from The University of Texas at Austin, US.

**Team**: My team is academically diverse, with members spanning a variety of interdisciplinary scientific backgrounds. Current and past members include BSc and MSc students, PhD students, postdoctoral researchers, and academic visitors. We work on a wide range of topics in discrete and stochastic optimization, often motivated by applications in healthcare, energy systems, and public policy. In addition, I maintain active collaborations with colleagues in Germany, India, Turkey, and the US. The chosen candidate for the SPEcies scholarship will work directly under my supervision and be integrated into this active and diverse research environment.

**Research Activities**: My research is situated at the intersection of mathematical optimization and intelligent algorithm design, with a focus on real-world problems that are computationally hard. Many of these problems arise in public infrastructure planning, energy systems, and the fair allocation of scarce resources.

A central theme is the development of efficient heuristics and metaheuristics for large-scale discrete and stochastic optimization models. I am particularly interested in models where fairness or equity must be balanced with performance or efficiency—for example, in undesirable facility location problems governed by fairness, recently explored in our works published in the *INFORMS Journal on Computing* (2024 and 2025). These problems are $\mathcal{NP}$-hard and exhibit rich combinatorial structure, making them ideal testbeds for evolutionary computation and related approaches.

The SPECIES scholarship candidate will contribute to this line of research, with a particular focus on designing, implementing, and benchmarking heuristics and hybrid algorithms. This includes both problem-specific strategies and general-purpose frameworks. There are opportunities for collaboration, publication, and sustained engagement in my broader research program. Please feel free to contact me directly for any questions.

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## Description of the work to be carried out by the student

This project is motivated by two recent publications in the *INFORMS Journal on Computing*—Schmitt and Singh (2024) and Schmidt and Singh (2025)—which study a class of resource-allocation and facility-location models governed by proportional fairness. These problems arise in contexts such as public service delivery, emergency response, and infrastructure planning, where the goal is to ensure equitable access across competing users.

The underlying optimization models are both *rich in structure*—featuring non-convex objectives, nonlinear fairness measures, and combinatorial feasibility constraints—and *computationally difficult*, even for moderate instance sizes. While our existing work provides theoretical foundations and heuristics towards solutions, we are interested in solving these problems and extensions at much larger scales. This remains a significant challenge.

The aim of this project is to develop evolutionary algorithms tailored to this problem class. The student will explore and implement metaheuristics such as genetic algorithms, evolutionary strategies, or hybrid variants incorporating local search, problem-specific repair mechanisms, and intelligent initialization. Emphasis will be placed on leveraging the mathematical structure of the models to guide search heuristics and improve convergence.

Depending on background and interest, the student may also study benchmark generation, performance metrics for fairness-based optimization, or parameter tuning techniques. Prototype code and test instances are available to support early development (see the GitHub pages of the referenced articles).

**Required qualifications**: Good knowledge of a modeling language such as (at least one of) Pyomo, GAMS, Gurobi, etc. is required. Programming skills (in any language) are also required. Depending on the project chosen, some existing code is available. A background in discrete optimization is preferred. Candidates with good knowledge of at least one of classical probability theory, combinatorics, or theoretical computer science are especially encouraged. An extensive background in energy management or healthcare is *not* required.

**What we offer**: We offer an opportunity to be part of a young, self-motivated, and performance-driven research group, with an active interest in high-quality publications. The chosen candidate will be directly supervised by me at Southampton and will have the opportunity to develop a long-term collaboration and early-career publications. The candidate will be a co-author or lead author on any publications resulting from the project.

## Other information

Assistance in finding accommodation within Southampton can be arranged.

At the University of Southampton, students have access to a wide range of professional development and skills training to become the next generation of research leaders tackling critical projects for the future. We leverage these opportunities to maximize the impact of our research. Our impact track record is exemplary, with more than 30 years of experience in impact activities, and a research group supported by over 120 industrial partners, including defense (DSTL, Boeing Defense UK), aerospace (European Space Agency, Airbus, Rolls Royce), and infrastructure (Heathrow, BT, National Health Service). We are the largest Operations Research (OR) group in the country. Our QS ranking in 2021 was $7^{\text{th}}$ in the UK and $33^{\text{rd}}$ worldwide for OR. 98% of all mathematical research in OR was rated internationally excellent or world-leading by the most recent UK government research assessment exercise.

Additional funding within the student-assistant remuneration policies of the University may be offered (about £300 a month), depending on the scope of the project and other grant activity; however, this is not guaranteed.