AKHILESH SONI

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Career Summary

Applied Scientist at Amazon with a focus on mathematical modeling and optimization for vehicle routing problems.

Education

University of Wisconsin-Madison   **Madison, WI**

– Ph.D. in Industrial & Systems Engineering (Operations Research)   *Aug 2023*
Thesis: "Discrete optimization methods for scheduling and matrix completion"
– M.S. in Computer Science, GPA: 3.82/4.0   *May 2022*
– M.S. in Industrial & Systems Engineering, GPA: 3.69/4.0   *Dec 2019*

Indian Institute of Technology (IIT) Dhanbad   **Dhanbad, IN**

– B.Tech. in Mechanical Engineering (Hons), GPA: 9.32/10   *May 2017*

Skills

- **Technical strengths:** Linear, discrete, stochastic & non-linear optimization ▪ Combinatorial optimization ▪ Simulation modeling ▪ Time-series forecasting ▪ Supervised & unsupervised learning

- **Languages:** Python ▪ Java ▪ Julia ▪ AMPL ▪ MATLAB

- **Tools:** Emacs ▪ UNIX ▪ Version Control ▪ Gurobi ▪ High-throughput computing ▪ LaTeX ▪ PyTorch ▪ Scikit-learn ▪ NumPy ▪ Pandas ▪ Matplotlib ▪ Jupyter ▪ AWS ▪ SQL ▪ Prophet ▪ Arena ▪ MS Office ▪ PyCharm

Work Experience

Amazon.com

- *Applied Scientist*, Surface Research Science   *Sep 2023-Current*
  - Apply advanced mathematical modeling techniques such as column generation, metaheuristics, and decomposition methods to solve large-scale vehicle routing problems.
  - Collaborate with cross-functional teams to understand complex business requirements and translate them into scalable models and algorithms.

- *Research Scientist Intern*, Graph representation learning for network design   *June 2021-Aug 2021*
  - Developed an end-to-end framework consisting of a graph neural network and a multilayer perceptron to learn network topology and predict the probability of path selection by a network design model.
  - Achieved a reduction of 55% in solution time by using estimated probabilities to prune the path search space of the mixed-integer optimization model.

- *Research Scientist Intern*, Regional decomposition for network design   *May 2020-Aug 2020*
  - Devised a regional decomposition technique for solving a large-scale middle-mile network design problem, leveraging local structure of the network with Lagrangian decomposition.
  - Achieved a reduction of 75% in solution time with the decomposition approach.

University of Wisconsin-Madison

- *Research Assistant*, Collaboration with American Family Insurance   *Sep 2020-Aug 2023*
  Integer programming-based methods for subspace clustering and matrix completion problems:
  - Built a unified mixed-integer programming framework (MISS-DSG) for the subspace clustering problem, integrating the use of Benders decomposition and column generation.
  - MISS-DSG outperforms state-of-the-art methods by 5-20% in low-affinity and high-missing data regimes.
  - Proposed novel integer-programming formulations for the low-rank binary matrix completion problem, and derived an explicit description for the convex hull of matrix element in the decomposition.

- *Research Assistant*, Collaboration with ExxonMobil Corporation   *Sep 2018-May 2020*
  Mixed-integer linear programming for crew scheduling in shale oil field:

- – Developed a rolling horizon framework for crew scheduling based on mixed-integer programming, and derived a new family of valid inequalities to strengthen LP relaxation of the formulation.
  - – Proposed approach resulted in 4-6% ($\approx$ $ 10MM) improvement in net present value over greedy heuristic.
- • *Teaching Assistant*, ISyE 323-Operations Research   *Jan 2020-May 2020*
  - – Conducted weekly discussion sections, created quizzes, and graded assignments and tests. Rating: 4.7/5

Schneider National
- • *Supply Chain Engineering Intern*, Time series forecasting for truckload rates   *June 2019-Aug 2019*
  - – Developed a cost forecasting model to predict carrier freight rates in the spot market in the USA.
  - – Achieved an improvement of 15% in accuracy over the existing model using an additive regression model.

Publications

- • Soni, A., Linderoth, J., Luedtke, J., Pimentel-Alarcón, D. (2021) Integer programming approach to subspace clustering with missing data, *OPT2021: 13th Annual Workshop on Optimization for Machine Learning, NeurIPS*.

- • Soni, A., Linderoth, J., Luedtke, J., Pimentel-Alarcón D. (*Accepted with minor revisions*) Integer programming approach to subspace clustering with missing data, *Informs Journal on Optimization*.

- • Soni, A., Linderoth, J., Luedtke, J., Rigterink,F. (2021) Mixed-integer linear programming for scheduling unconventional oil field development, *Optimization and Engineering (22), pp 1459–1489*.

- • Soni A., Stagner J. A., Ting D. S.-K. (2017) Adaptable wind/solar powered hybrid system for household wastewater treatment, *Sustainable Energy Technologies and Assessments (24), pp. 8–18*.

- • Soni A., Singh S.N. (2017) Experimental analysis of geometrical parameters on the performance of an inline jet plate solar air heater, *Solar Energy (148), pp. 149–156*.

- • Kumar B., Soni A., Singh S. N. (2018) Effect of geometrical parameters on the performance of chevron type plate heat exchanger, *Experimental Thermal and Fluid Science (91), pp. 126–133*.

- • Soni, A., Linderoth, J., Luedtke, J., Pimentel-Alarcón, D., Binary matrix completion (*In-preparation*)

Conference Presentation

Mixed Integer Programming Workshop
- • Regional decomposition for network design   *Oct 2023*
- • Integer programming approach to high-rank matrix completion   *May 2021*
- • Mixed integer programming for unconventional oil field development.   *May 2020*

INFORMS Annual Conference & INFORMS Optimization Society
- • Mixed integer programming for unconventional oil field development.   *Oct 2020*
- • Integer programming approach to subspace clustering with missing data   *Mar 2022*
- • Regional decomposition for network design   *Oct 2023*

NeurIPS, Optimization and Machine Learning Workshop
- • Integer programming approach to subspace clustering with missing data   *Dec 2021*

Conference on Integer Programming and Combinatorial Optimization
- • Binary matrix completion over GF(2)   *June 2023*

Graduate Coursework

- • *Industrial & Systems Engineering*: Intro to Optimization, Linear programming, Integer programming, Engineering models for supply chain, Stochastic modeling, Simulation modeling, Stochastic programming, ML in Action

- • *Computer Science & Maths*: Algorithms, Nonlinear programming, Matrix methods in machine learning, Combinatorial optimization, Mathematical foundations of machine learning, Dynamic programming, Real analysis

Academic Achievements

- • Spotlight presentation, Optimization and machine learning workshop, NeurIPS, 2021
- • Travel grant for mixed-integer programming workshop, 2021

- Recipient of Vinod K & J. Gail Sahney Scholarship at UW-Madison, 2020
- Recipient of Mitacs Fellowship to intern at University of Windsor, Canada, 2016
- Among top 0.01% students in India to clear IIT-JEE exam in 2013

Service

- Reviewer: Optimization Letters, Operations Research
- Vice-President of INFORMS UW-Madison Chapter, 2020-2021
- President of INFORMS UW-Madison Chapter, 2021-2022

References

- Prof. Jeff Linderoth, Dept. of Industrial & Systems Engineering, UW-Madison, linderoth@wisc.edu
- Prof. Jim Luedtke, Dept. of Industrial & Systems Engineering, UW-Madison, jim.luedtke@wisc.edu
- Dr. Golbarg Kazemi Tutunchi, Amazon, tutung@amazon.com