# AKHILESH SONI

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## Career Summary

Ph.D. candidate in operations research with expertise in mathematical modeling, optimization, and machine learning.

## Education

**University of Wisconsin-Madison** *Aug 2023 (expected)*
Ph.D. in Industrial & Systems Engineering (Operations Research)
Thesis: "Discrete optimization methods for scheduling and matrix completion"

**University of Wisconsin-Madison** *May 2022*
M.S. in Computer Science, GPA: 3.82/4.0

**University of Wisconsin-Madison** *Dec 2019*
M.S. in Industrial & Systems Engineering, GPA: 3.69/4.0

**Indian Institute of Technology (IIT) Dhanbad, India** *May 2017*
B.Tech., Major: Mechanical Engineering, Minor: Financial Management, GPA: 9.32/10

## Skills

- **Technical strengths:** Linear, discrete, stochastic & non-linear programming ■ Combinatorial optimization ■ Monte Carlo simulation ■ Time-series forecasting ■ Hypothesis testing ■ Predictive & Statistical modeling
- **Languages:** Python ■ Java ■ Julia ■ AMPL ■ Matlab
- **Tools:** Emacs ■ UNIX ■ Version Control ■ Gurobi ■ High-throughput computing ■ LaTeX ■ PyTorch ■ Scikit-learn ■ NumPy ■ Pandas ■ Jupyter ■ Prophet ■ AWS ■ SQL ■ Arena ■ MS Office

## Work Experience

**University of Wisconsin Madison**

- *Research Assistant*, Collaboration with American Family Insurance *2020-Present*
  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 that integrates 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 new 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 *2018-2020*
  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% (≈ $ 10MM) improvement in net present value over greedy heuristic.
- *Teaching Assistant*, Operations Research-Deterministic Modeling *Spring, 2020*
  - Conducted weekly discussion sections, created quizzes, and graded assignments and tests. Rating: 4.7/5

**Amazon.com**

- *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 optimization 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 fulfilment in the network with Lagrangian decomposition.
  - Achieved a reduction of 75% in solution time with the decomposition approach.

**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 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., Rigterink,F. (2020) Mixed-integer linear programming for scheduling unconventional oil field development, *Optimization and Engineering*
- Soni, A., Atakans, S., Regional decomposition for network design using Lagrangian relaxation (*In-preparation*)
- Soni, A., Linderoth, J., Luedtke, J., Pimentel-Alarcón, D., Binary matrix completion (*In-preparation*)

## Conference Presentation

**Mixed Integer Programming Workshop**

- 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**

- Integer programming approach to subspace clustering with missing data *Mar 2022*
- Integer programming approach to subspace clustering with missing data *Oct 2022*

**NeurIPS, Optimization and Machine Learning Workshop**

- Integer programming approach to subspace clustering with missing data *Dec 2021*

## Academic Projects

- **Case study on facility planning:** Evaluated different supply chain configurations for a fabric manufacturing firm. Reduced the working capital and lead time by 54% and 18% respectively.
- **Soccer analytics:** Worked with a soccer dataset of 20 seasons to predict outcome of a soccer match. Achieved 60% accuracy by training neural network on a subset of features selected by a random forest model.
- **Temporal resource allocation for COVID-19:** Proposed a multi-stage stochastic program for the ventilator relocation problem and used stochastic dual dynamic programming algorithm to solve the model.

## 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

## Service

- Reviewer: Annals of Operations Research
- President of INFORMS UW-Madison Chapter, 2021-2022

## References

- Prof. Jeff Linderoth, Industrial & Systems Engineering, UW-Madison, linderoth@wisc.edu
- Prof. Jim Luedtke, Industrial & Systems Engineering, UW-Madison, jim.luedtke@wisc.edu