Research Overview

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About Me

- PhD in Operations Research, University of California, Berkeley, 2004
- Research Associate, HP Labs, 2003
- Assistant Professor, University of Arizona, The Ohio State University, 2004-2008
- Associate Professor, The Ohio State University, University of Washington, 2009-2016
- Associate Professor, NU-IEMS, September 2018 -

Decision Making Under Uncertainty

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- Applications in a wide variety of fields:
  Supply chain & logistics, homeland security, social networks, energy, finance

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  - Automate decision-support processes, sensitivity (what-if) analysis

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- Goals:
  1. *Efficiency*: minimizing cost
  2. *Efficacy*: quick and sufficient distribution
  3. *Equity*: fairness in terms of supply allocation and response times

Case Study

Disaster preparedness for the threat of hurricanes in the Southeastern part of the United States (Rawls and Turnquist, 2010)

Model Analysis

- The proposed risk-averse modeling approach provides
  - A wide range of solutions that consider the **trade-offs** between multiple criteria
  - Inclusion of **different opinions** of multiple decision makers on the relative importance of criteria
- Compared to its risk-neutral counterpart:
  - Better solutions in terms of equity and/or responsiveness
  - Compromises from the expected total cost objective

Computational Results

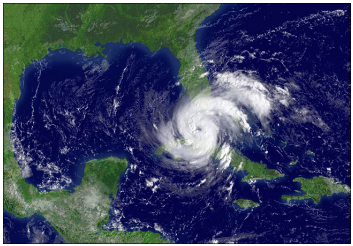
- Intel(R) Xeon(R) CPU E5-2630 processor at 2.40 GHz and 32 GB of RAM using Java and Cplex 12.6.0.
- 1 hour time limit
- Risk level: $\alpha = 0.05$

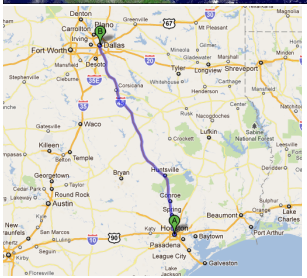
	Existing Methods	Proposed Methods
# Scenarios	Time (s)	Time (s)
300	900.71	393.36
400	1992.63	744.18
500	2117.53	979.09
800	*	763.25

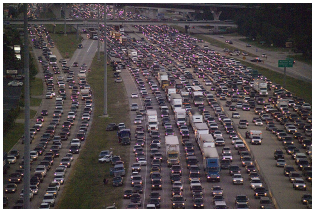
$*$: Instances hit the time limit with no feasible solution.

Noyan, Merakli* and K., "Two-stage Stochastic Programming under Multivariate Risk Constraints with an Application to Humanitarian Relief Network Design," minor revision, *Math Prog*, 2018.

Disaster Preparedness: Hurricane Rita







- Cars ran out of fuel during evacuation
- Caused third worst traffic jam in history, 100-mile long, 2.5 mil stuck in cars
- First-stage: Pre-position supplies and determine stocking levels of supply (fuel/meals/water/medical kits)
- Second-stage: Distribution of supplies following the aftermath

Gao*, Chiu, Wang* and K., Optimal Refueling Station Location and Supply Planning for Hurricane Evacuation," *TRR*, 2010.

Homeland security budget allocation problem

- Multiple risk criteria: property losses, fatalities, air departures, average daily bridge traffic.
- Urban areas: NYC, Chicago, SF, DC, LA, Seattle, Philly, Boston, Houston, Newark
- Allocate limited budget to the urban areas to limit the misallocation of funds (risk) under each criteria
- Benchmarks: RAND allocation and Government allocation by DHS's Urban Areas Security Initiative

Influence Maximization Problem

- Spread of information/disease/threat in a network.
- Identify a few influencers to maximize spread.

Conclusions

- Complex systems require advanced mathematical models and solution methods
- Need to explicitly handle uncertainty, and large decision space (e.g., catastrophic disasters, sharing economy, autonomous vehicles, drone delivery)
- Large-scale stochastic mixed-integer optimization models and methods are highly effective

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- Large-scale stochastic mixed-integer optimization models and methods are highly effective
- These projects are funded by National Science Foundation Grants:
  - Mixed-Integer Programming Approaches for Risk-Averse Multicriteria Optimization
  - CAREER: Mixed-Integer Optimization under Joint Chance Constraints
  - Stochastic Mixed-Integer Optimization: Polyhedral Theory, Large-Scale Algorithms and Computations
  - Mixed-Integer Optimization for Multi-Item, Multi-Echelon Production and Distribution Planning

Research Team

- Dinakar Gade, PhD - SABRE
- Minjiao Zhang, PhD - Kennesaw State University
- Pelin Damci-Kurt, PhD - Lightning Bolt Solutions
- Saumya Goel, MS - Bank of America Merrill Lynch
- Xiao Liu, PhD - United Airlines
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Selected Research Awards:
INFORMS Computing Society Prize, George Nicholson Student Paper Prize