Optimization Theory and Methods

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CAMEA 中国高质量MBA教育认证 AACSB ACCREDITED EQUIS ACCREDITED

- Mixed-Integer Optimization for *Portfolio Management*.
- Two-Stage Game Theory Model for *Scheduling Coast Guard Patrol*.
- Queuing and Simulation Models for *Energy Audit Program*.
- Queuing and Simulation Models for *Car Queues* through a Security Gate.
- Discrete Event Simulation to Reduce *Healthcare-Associated Infections*.
- Network Optimization based Auction for *Improving School Meals in Chile*.
- Solving Railroad Blocking Problem at Four Major US *Railroads*.
- Queuing Networks for *Improving Capacity and Lead Times* at IBM.
- *Modeling Overview*.

- **Mixed-Integer Optimization for Portfolio Management,** Grantham, Mayo, Van Otterloo and Company LLC (1999).
  - Investment management firm with $26 billion on assets.
  - **Aim:** Create a portfolio that resembles a target portfolio, and
    - ✓Has small number of assets and small number of transactions.
    - ✓Has high returns, high liquidity and low transaction costs.
  - Modelled as a mixed-integer quadratic optimization problem.
  - Solved with a FORTRAN model using CPLEX optimizer.
  - Helped the firm keep existing clients' business and also launch two new funds successfully ($1.1 billion in a year).
  - Reduced annual transaction costs by $4 million.

- **Two-Stage Game Theory Model for Scheduling Coast Guard Patrol ,** United States Coast Guard (USCG 2013).
  - Challenges from potential terrorists within the maritime environment: Intent to blow up US oil tankers.
  - Two-Stage Model using Attacker-Defender Stackelberg Game Framework.
  - Defender problem approximated using a mixed-integer linear optimization formulation.
  - Java + CPLEX implementation.
  - Validated through human-subject experiments and simulations.
  - Already deployed in the Port of Boston, and considered a success by USCG; Efforts underway to deploy in New York.

- **Queuing and Simulation Models for Energy Audit Program,** Florida Power and Light Company(1981).
  - Offers for energy audits at residential customers' homes.
  - Aim is to determine the right number of mails offering customer audits and the right level of auditor staffing to serve the anticipated demand.
  - Multi-server queuing model and a discrete event simulation model programmed in FORTRAN.
  - Performance evaluated in terms of 1) average wait, 2) maximum wait, 3) backlog size, and 4) auditor utilization.
  - Model was successfully deployed and company used model recommendations to decide staffing and mailing levels.

- **Queuing and Simulation Models for Car Queues through a Security Gate,**

  Westinghouse Hanford Company(1989).

  - An average of 7 buses and 285 private vehicles entered the gate each morning. Average 2 guards on duty.
  - Queue overflow onto adjacent highway causing major traffic safety issues.
  - Alternatives were more guards or more traffic channels.
  - A discrete event simulation using queuing formulas built using manually collected data.
  - Recommendation of utilizing parallel channels was made.
  - Success during a brief trial period ensured that the change became permanent.

- **Discrete Event Simulation to Reduce Healthcare-Associated Infections,**

  Cook County Hospital, Chicago IL (2009).

  - Healthcare-Associated Infections (HAIs) responsible for 2 million infections and 100,000 deaths annually in the US.
  - Discrete event simulation used to model the interaction between pathogens, patients and visitors in ICU.
  - Models of process by which they enter an ICU, interact with health-care workers and with each other, infect, become infected, are cured, and are discharged.
  - Both hand-hygiene and isolation of the infected reduce HAI rates, reduce capacity and increase costs. And they interact!
  - Hand hygiene found to be more cost effective than isolation.

- **Network Optimization based Auction for Improving School Meals in Chile,**

  The Government of Chile(2002).

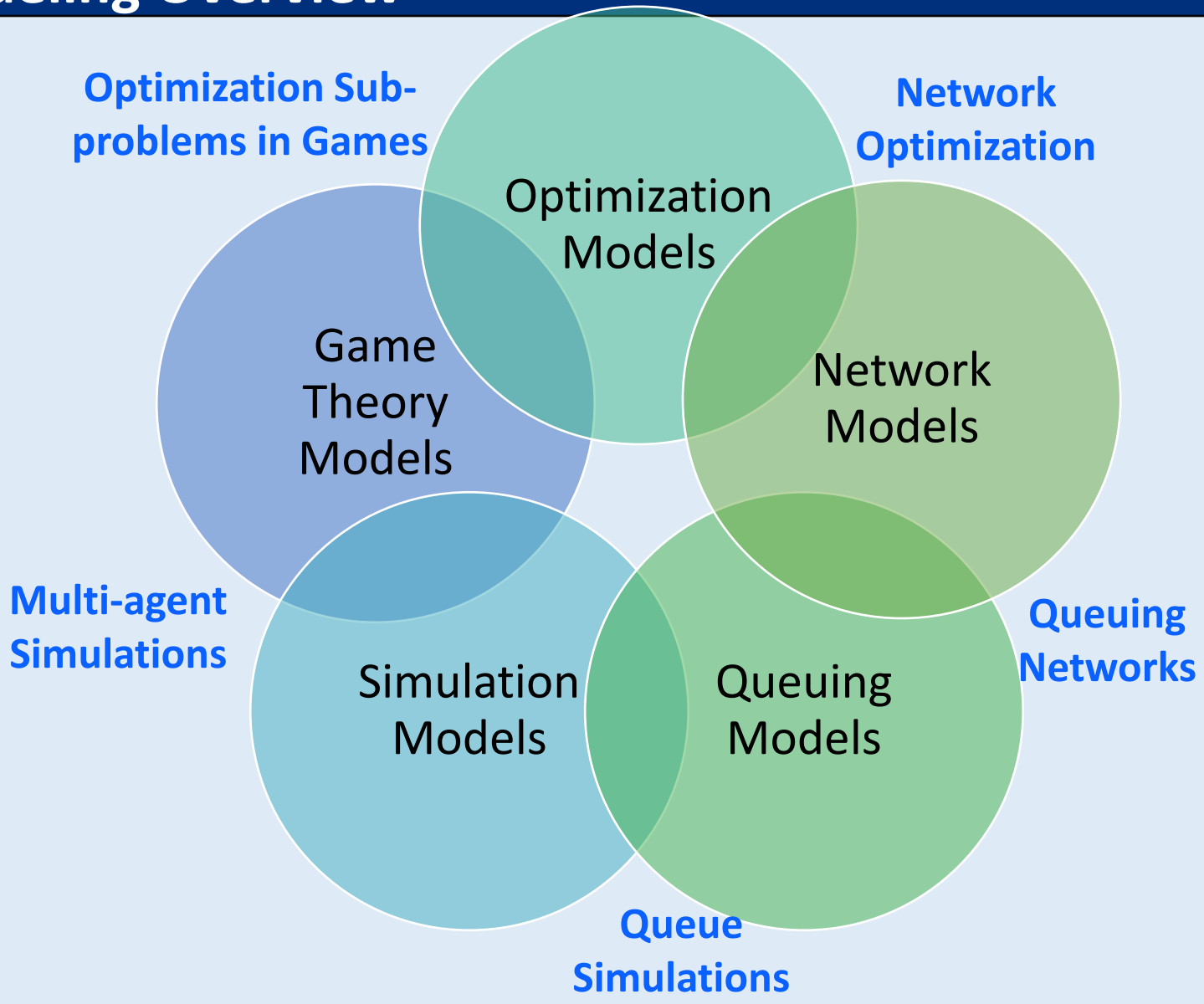
  - Spends $180 million a year to feed 1.3 million students from low-income families.
  - Manual process of awarding meal contracts was inefficient.
  - Designed a single-round sealed-bid combinatorial auction.
  - Developed a network-based integer linear optimization model with >10,000 binary variables. Found optimal solution.
  - Improved price-to-quality ratio of meals. Saved $40 million annually (equivalent to cost of feeding 300,000 children).
  - Successful test in 1997. Completely automated from 1999 onward.

- **Solving Railroad Blocking Problem at Four Major US Railroads,** three major freight companies in US: CSX Transportation, Norfolk Southern Corporation, and Burlington Northern Santa Fe Railway(2007).
  - A major challenge is to classify shipments into blocks, at railroad yards, to be transported together over the network.
  - Developed a multicommodity-flow, network-design and routing problem.
  - Solved using very large-scale neighborhood search heuristics.
  - Implemented at all three railway companies now.
  - Projected to save several hundred million dollars annually.

↳ Queuing Networks for Improving Capacity and Lead Times at IBM

- **Queuing Networks for Improving Capacity and Lead Times at IBM,** IBM's semiconductor manufacturing factories in New York(2010).
  - Silicon wafers proceed through 500 to 1000 fabrication, inspection and test steps using multimillion dollar machines.
  - Two objectives are high utilization of machines to reduce costs and shorter lead times to expedite time to market.
  - Developed and implemented Enterprise Production Planning and Optimization System (EPOS): an advanced queuing network model for capacity planning.
  - Improved factory output by 8%. Saved >1500 sq. ft. of factory floor space. Saved >$700,000 operating expenses per year. Reduced future capital needs by >$30 million.

↳ Modeling Overview



Objective：

Key Concepts：