Institute of SCIENCE TOKYO

# Research Digest
# Mathematical Optimization
## Mathematical approach to pursue the best

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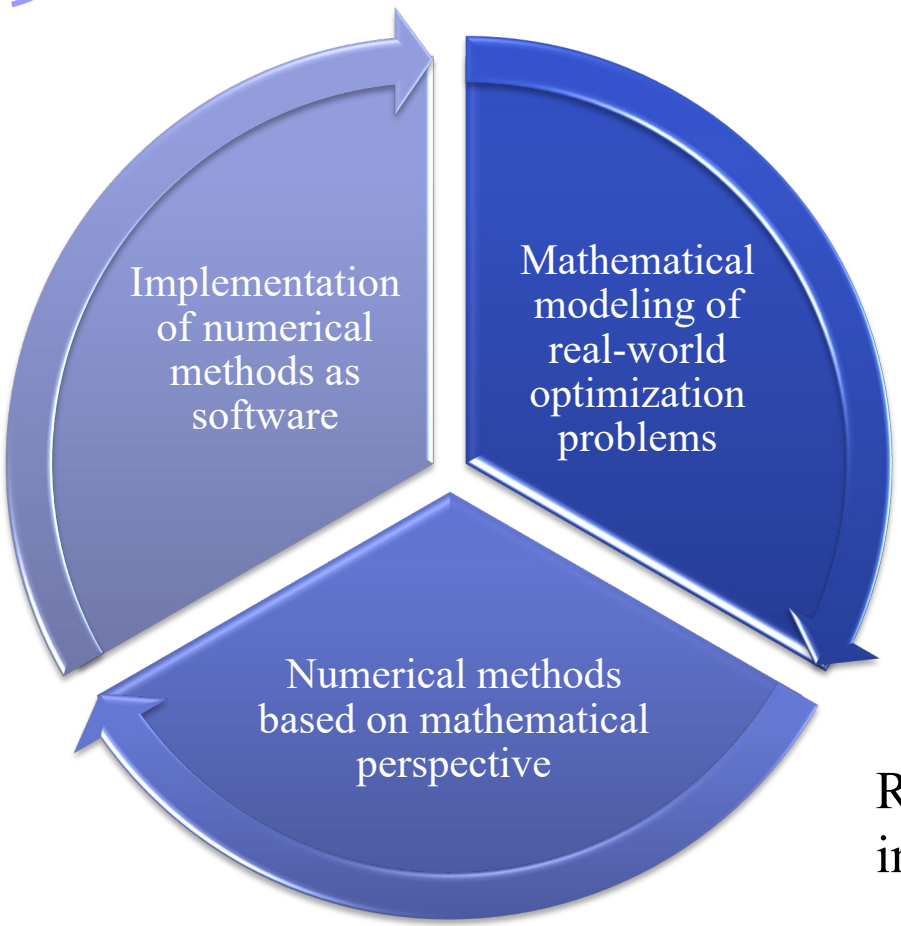
# Choosing the best for you

Many fruits

The best mix juice

- Lots of "optimization problems" in our daily lives
  - How to store as much as possible on the shelves?
  - What is the best route to explore all the sightseeing spots?
- Solve them with a mathematical approach !!

# Three key approaches

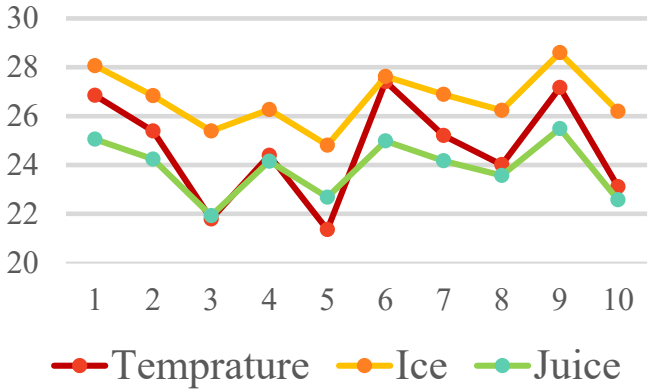


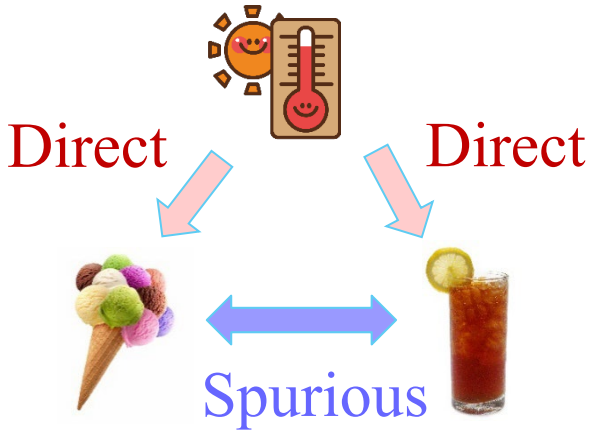

Recent research will be introduced from the next slide

# Projected gradient method for log optimization problem

- Related to graphical modeling in statistics
  - Relation between data
  - Genetic data
  - etc…

$$\begin{aligned} \min &: C \bullet X - \mu \log\det X + \rho \bullet |X| \\ \text{s.t.} &: \mathcal{A}(X) = b,\ X \succ O \end{aligned}$$

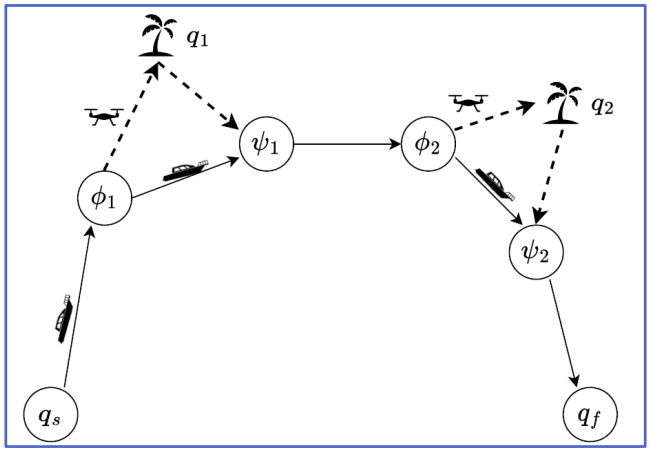



- Numerical method based on gradient method

# Routing problem with drones

- Drone: fast but limited flight
- Ship : slow but long range
- Utilizing different vehicles, attain the shortest time

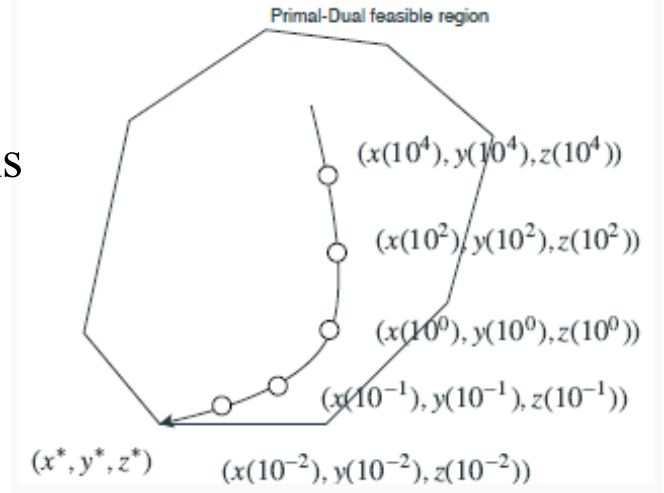



- Mixed-integer second-order cone programming
- Algorithm based on separation of mixed-integer part and second-order cone programming part

# Inexact interior-point methods

- Linear Programming $\min c^T x \text{ s.t. } Ax = b, x \geq 0$
- Linear system $M\Delta x = r$ is bottleneck in interior-point methods
- Allow small error $||M\Delta x - r|| \leq \epsilon$ to reduce time
- Controlling $\epsilon$ is important

- Fundamental theoretical base
  for solving various optimization problems



# Routing problem of emergency cars

- Road congestion
- Other various aspects

# Research keywords

- Mathematical Optimization
- Continuous Optimization
- Nonlinear Optimization
- Semidefinite Programming
- and applications to solve practical problems

# Research Concept