Operations Research I: Models & Applications
Course Summary and Future Directions

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Road map

- **Summary and discussions**.
- Preview of the next course.

Types of programming problems

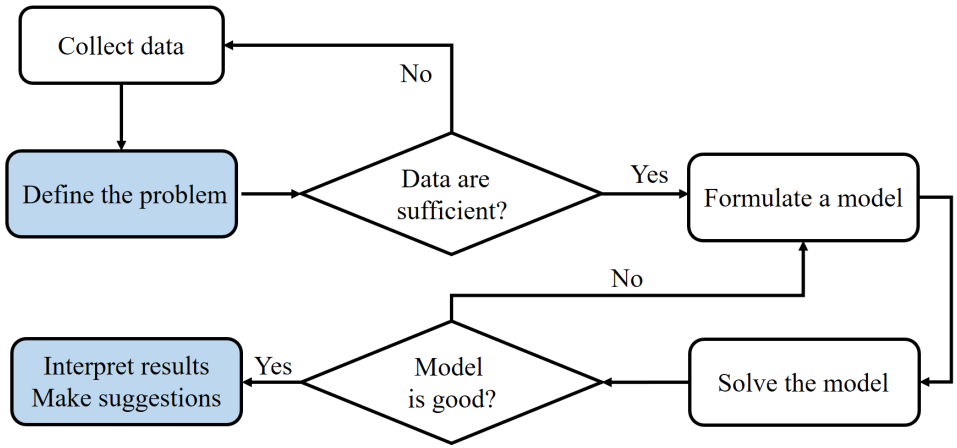
Objective function and constraint	Variables	
	All continuous	Some integral
All linear	Linear programming	Integer programming
Some nonlinear	Nonlinear programming	Nonlinear integer programming

Typical applications

Objective function and constraint	Variables	
	All continuous	Some integral
All linear	**Linear programming** Resource allocation Production planning	**Integer programming** Machine scheduling Facility location
Some nonlinear	**Nonlinear programming** Product pricing Inventory	**Nonlinear integer programming** Advanced problems

Let us get back to basics

- As we use mathematical programming to support business decision making, what difficulties may weface?
  - Issue selection.
  - Data collection.
  - Team formation.
  - Model interpretation.
  - Decision making.
- What else?



Clopening

- **Clopening**: A company assigns an employee to (1) work late at night to close a store and (2) get up early to prepare for opening the store.[1]
- This practice is applied on low-paid employees in Starbucks, McDonald's, Walmart, etc.
- Workers hate it.

[1] O'Neil, C. (2017). *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*. Great Britain: Penguin Books.

Clopening

- This policy was reported and discussed.
- In 2014, these companies announced that they would adjust their scheduling policies and promised to add constraints into their model to eliminate clopenings.
- A year later, follow-up reports revealed that Starbucks broke the promise. It even **cannot eliminate the clopenings**.
- "I consider scheduling software one of the more appalling **weapons of math destruction**." (O'Neil, 2017)

Clopening

- Why would clopening appear in a schedule proposed by personnel scheduling software?
- Why was clopening still there after one year?
- May people prevent big data and operations research from being "weapons of math destruction"? How?

Road map

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- **Preview of the next course**.

What else do we need?

- We already know how to formulate a problem into a mathematical program.
  - We also know how to solve it with MS Excel solver.
- This is not enough if:
  - We want to fine tune the solver to enhance performance.
  - We want to deal with problems that a solver cannot solve.
  - We want to solve a specific problem in a more satisfactory way.
  - We want to build our own solver.

Algorithms

- We need to study **algorithms**.
  - An algorithm is a systematic way to solve a problem.
- We will learn **how to solve** large-scale linear, integer, nonlinear programs.
  - The **simplex method** that solves linear programs.
  - The **branch-and-bound algorithm** that solves integer programs.
  - The **gradient descent** and **Newton's method** that solve nonlinear programs.

More than algorithms

- We will use a more powerful solver, **Gurobi**.
- We will learn how to write Python (or other programming languages) to invoke Gurobi to solve problems.
  - Much more powerful and flexible than MS Excel solver.
  - An option
- We will see another case study.
  - The problem is solved by a solver.
  - The problem is also solved by a self-developed algorithm.
  - The solution qualities are compared.

That's all. See you in the next course!