國立臺北大學自然資源與環境管理研究所
107 學年度第二學期『環境系統分析專題』

課程講義(11)：整數規劃、網路模式與專案管理
Integer Programming, Network Models, and Project Management

- INTEGER PROGRAMMING
  - □ Characteristics of Integer Programming: Integer Decision Variables
    - ⇨ General Integer vs. Binary Integer
    - ⇨ Mixed Integer Programming and Binary Integer Programming
  - □ The Prototype Example (Hillier and Lieberman, 2015, Chap.12)

The CALIFORNIA MANUFACTURING COMPANY is considering expansion by building a new factory in either Los Angeles or San Francisco, or perhaps even in both cities. It also is considering building at most one new warehouse, but the choice of location is restricted to a city where a new factory is being built. The *net present value* (total profitability considering the time value of money) of each of these alternatives is shown in the fourth column of Table 12.1. The rightmost column gives the capital required (already included in the net present value) for the respective investments, where the total capital available is $10 million. The objective is to find the feasible combination of alternatives that maximizes the total net present value.

TABLE 12.1 Data for the California Manufacturing Co. example

Decision Number	Yes-or-No Question	Decision Variable	Net Present Value	Capital Required
1	Build factory in Los Angeles?	x_1	$9 million	$6 million
2	Build factory in San Francisco?	x_2	$5 million	$3 million
3	Build warehouse in Los Angeles?	x_3	$6 million	$5 million
4	Build warehouse in San Francisco?	x_4	$4 million	$2 million
			Capital available:	$10 million

$$\text{Maximize} \quad Z = 9x_1 + 5x_2 + 6x_3 + 4x_4,$$

subject to

$$\begin{aligned} 6x_1 + 3x_2 + 5x_3 + 2x_4 &\le 10 \\ x_3 + x_4 &\le 1 \\ -x_1 + x_3 &\le 0 \\ -x_2 + x_4 &\le 0 \\ x_j &\le 1 \\ x_j &\ge 0 \end{aligned}$$

  - □ Solution Techniques for Integer Programming
    - ⇨ Relaxed Linear Programming and Integer Friendly Formulation => The mining problem
    - ⇨ The Cutting Plane Method and Branch-and-Bound Method

- NETWORK MODEL
  - □ Introduction => *c.f.*: Continuous Mathematical Programming
  - □ Terminology: Node (Vertex), Arc (Link), Path, and Graph (Tree); Flow and Direction
  - □ Network Models with Linear Programming Formulation (Hillier and Lieberman, 2015, Chap.9)
    - ⇨ The Transportation and Assignment Problems
  - □ Classical Network Programming Models (Hillier and Lieberman, 2015, Chap.10)

⇨ Shortest-Path Problem (Has been covered! => Integer Friendly)

⇨ Minimum Spanning Tree Problem

⇨ Maximum Flow Problem

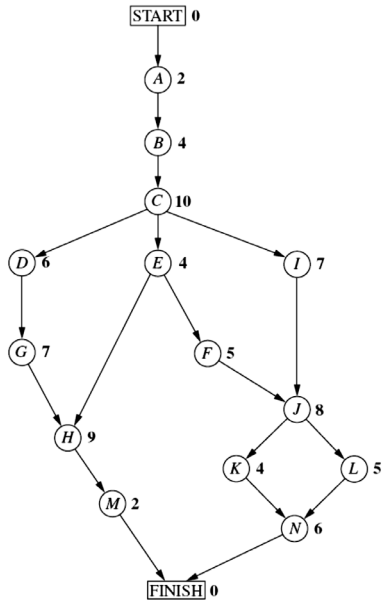
⇨ Minimum Cost Flow Problem

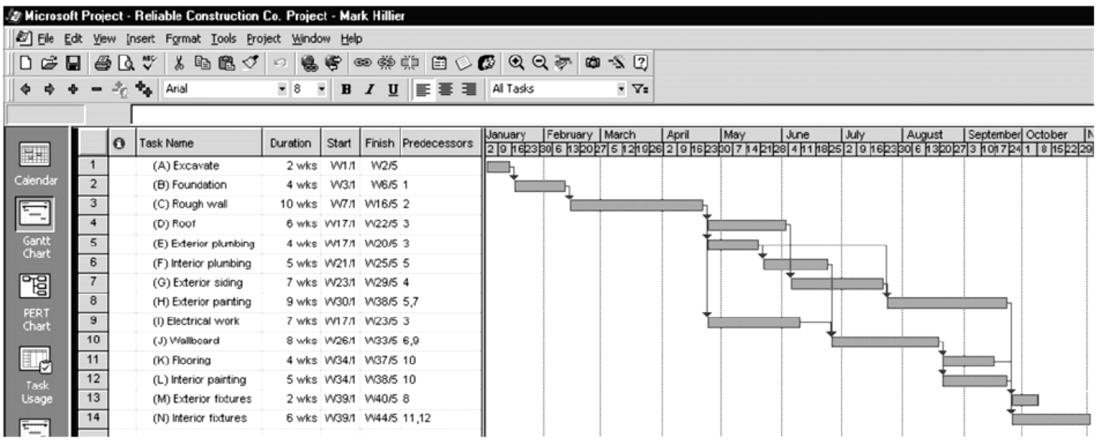
□ Other Models: Traveling Salesman Problem

- PROJECT MANAGEMENT AND PERT/CPM
  - □ Introduction to Project Management
    - ⇨ *A project is a collection of tasks that must be completed in minimum* **time** *or at minimal* **cost**.
    - ⇨ Other Resources: Human resource, materials…, etc.
    - ⇨ Presentations: Gantt Chart, Arrow Diagram (Network)
  - □ The phases of project management (Ravindran, 2009, Chap.1):
    - ⇨ Planning; Organizing; Scheduling; Controlling.
  - □ Constraints for Project Management (Ravindran, 2009, Chap.1):
    - ⇨ Schedule constraints (time limitation)
    - ⇨ Cost constraints (budget limitation)
    - ⇨ Performance constraints (quality limitation)
  - □ Solution Techniques for Project Management:
    - ⇨ Critical Path Method (CPM)
    - ⇨ Program Evaluation Review Technique (PERT)
  - □ Prototype Example: Hillier - Reliable Construction Co.

TABLE 10.1 Activity list for the Reliable Construction Co. project

Activity	Activity Description	Immediate Predecessors	Estimated Duration
A	Excavate	—	2 weeks
B	Lay the foundation	*A*	4 weeks
C	Put up the rough wall	*B*	10 weeks
D	Put up the roof	*C*	6 weeks
E	Install the exterior plumbing	*C*	4 weeks
F	Install the interior plumbing	*E*	5 weeks
G	Put up the exterior siding	*D*	7 weeks
H	Do the exterior painting	*E, G*	9 weeks
I	Do the electrical work	*C*	7 weeks
J	Put up the wallboard	*F, I*	8 weeks
K	Install the flooring	*J*	4 weeks
L	Do the interior painting	*J*	5 weeks
M	Install the exterior fixtures	*H*	2 weeks
N	Install the interior fixtures	*K, L*	6 weeks





- HOMEWORK #5 (Integrate into the Midterm Exam.): Please use Microsoft Project or other similar software to construct a *project* for completing your own thesis research.