國立臺北大學自然資源與環境管理研究所

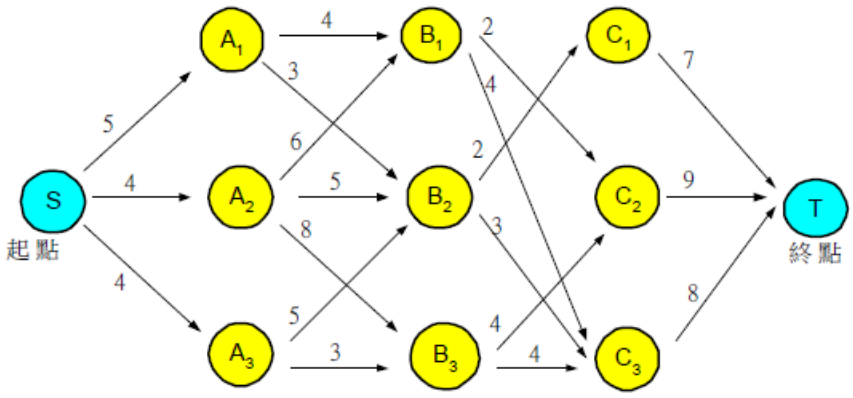
113 學年度第二學期『資源管理與環境系統分析』期中考試

（紙本答案卷繳交日期：2025 年 05 月 06 日；請嚴守學術倫理規範）

1.（15%）以下為詢問 Copilot 有關“Business Analytics”之對話內容，請就課堂舉例「股票投資」以外之領域，例如，醫療服務、企業減碳、環境影響評估作業等，挑選一應用領域，以闡述三項分析類別（analytics categories）之可能應用實例：

> Business analytics is the practice of using data to improve decision-making and performance in organizations. It encompasses various methods and tools to collect, analyze, and interpret data effectively. The key components are:
>
> 1. **Data Collection**:
>   - Gathering data from various sources, such as customer feedback, operational metrics, and financial records.
> 2. **Data Analysis**:
>   - Applying statistical methods, algorithms, and software tools to uncover insights, trends, and patterns.
> 3. **Decision Support**:
>   - Using the insights to make strategic decisions and solve business problems.
>
> Business analytics can be divided into three main categories:
>
> - **Descriptive Analytics** (examines past data),
> - **Predictive Analytics** (forecasts future trends),
> - **Prescriptive Analytics** (suggests optimal actions).
>
> It's widely used across industries like retail, healthcare, finance, and manufacturing to enhance efficiency, maximize profits, and improve customer experience.

2.（25%）給定一最短路徑問題圖示如下：



請嘗試比照 Hillier and Lieberman (2021)之“the Seervada Park Shortest-Path Problem”建構一 Excel 工作表，並應用『名稱定義』功能與『規劃求解』增益集，求解上述問題。線性規劃模型之目標函數為最小化通行路徑，決策變數則為每段連結是否在最短路徑上（二元決策變數），限制式則為各節點若有進入則必須也是下一階段之出發點。

3.（30%）給定 MaxDEA「《数据包络分析方法与 MaxDEA 软件》第 2 版书稿 X」中之表 2-3 案例，請嘗試應用 Excel 繪製如圖 2-1 之圖示，並應用 MaxDEA、DEAFrontier 或 pyDEA 求解該問題。

【加分題】：應用 Excel 建構 7 個線性規劃模型（投入導向之乘子模型）求解

DMU	x_1	x_2	y
A	10	40	10
B	15	25	10
C	32	24	16
D	48	16	16
E	24	48	16
F	54	27	18
G	50	60	20

4.（30%）「污染總量分配 Waste Allocation」為一典型之環境系統分析問題，近期有一學術論文 Zhou, Y, B. Yang, J.C. Han, and Y.F. Huang. 2019. "Robust Linear Programming and Its Application to Water and Environmental Decision-Making under Uncertainty", *Sustainability*, 11, No.1:33. https://doi.org/10.3390/su11010033. 探討"A semi-hypothetical regional water quality management problem"，其問題為分配污染源排入河川之污染總量，並以最小化處理成本為目標函數。請先檢視該線性規劃模型（EQ.14~EQ.17）何處有誤並加以修正，並以方程式編輯器（Equation Editor）重新編輯該線性規劃模型，之後再代入 Table 1 之模型參數並應用規劃求解軟體，以找出最適之污染總量分配方式。模型之係數請先行化簡計算，並請留意單位之轉換（例如 mg/L => ton/m^3）。

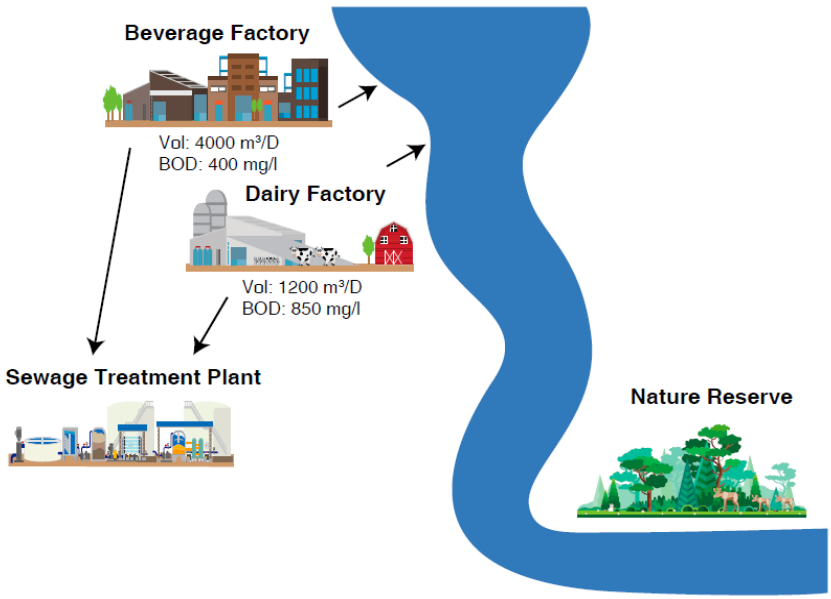


Figure 1. A schematic diagram of the regional water quality management problem.

This water quality management problem can be formulated as the following optimization model:

$$\min \sum_{i=1}^{n} C_i B_i x_i + \sum_{i=1}^{n} S_i y_i \tag{14}$$

Subject to:

(Water quality requirement)

$$\sum_{i=1}^{n} B_i(1 - E_i)x_i \leq L, \forall i \tag{15}$$

(Wastewater treatment capacity)

$$x_i \leq W_i, \forall i \tag{16}$$

(Wastewater discharge capacity)

$$y_i = W_i - x_i, \forall i \tag{17}$$

where:

C_i = the cost of BOD removal at factory i (\$/ton)
B_i = the BOD concentration of wastewater at factory i (10^{-6} ton/m^3)
S_i = the service fee of wastewater discharged into the municipal sewage system from factory i (\$/m^3)
E_i = the BOD removal efficiency of the wastewater treatment system at factory i (%)
L = the BOD mass limit (10^{-3} ton)
W_i = the daily volume of wastewater produced at factory i (m^3/day)
x_i = the volume of wastewater treated by the wastewater treatment system of factory i (m^3)
y_i = the volume of wastewater discharged into the municipal sewage system from factory i (m^3)

Table 1. Parameter values for the regional water quality management problem illustrated in Figure 1.

	Influent BOD (mg/L)	**Wastewater (m^3/d)**	**BOD Treatment Cost (\$/ton)**	**BOD Removal Efficiency**	**Sewage Fee (\$/m^3)**
Dairy factory	850	1200	400	0.9	0.56
Beverage factory	400	4000	500	0.95	0.25
BOD mass limit (kg)	170				
Penalty (\$/ton)	5000				