

IE 400: Principles of Engineering Management

Study Set 4

Fall 2020

Question 1. Use the branch-and-bound method to find the optimal solution to the following IP:

$$\begin{aligned} \min \quad & 9x_1 + 13x_2 + 10x_3 + 8x_4 + 8x_5 \\ \text{s.t.} \quad & 6x_1 + 3x_2 + 2x_3 + 4x_4 + 7x_5 \geq 40 \\ & x_1 \leq 1, x_2 \geq 1, x_3 \geq 2, x_4 \geq 1, x_5 \leq 3 \\ & x_1, x_2, x_3, x_4, x_5 \geq 0 \\ & x_1, x_2, x_3, x_4, x_5 \text{ integer} \end{aligned}$$

Question 2. Use the branch-and-bound method to find the optimal solution to the following IP:

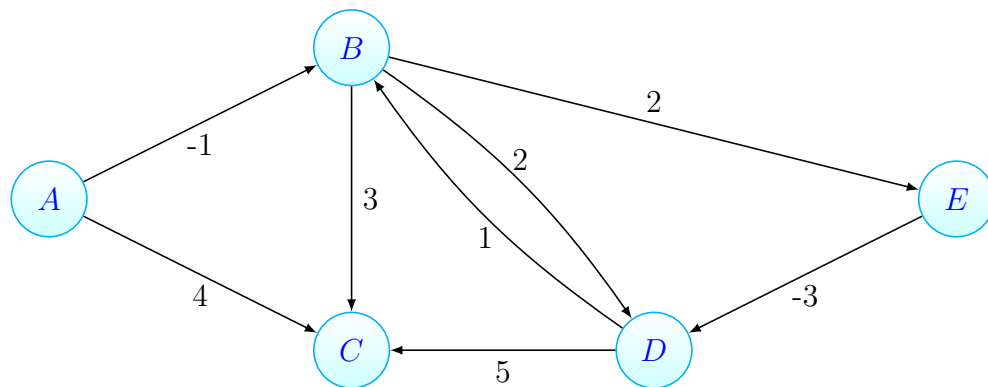
$$\begin{aligned} \max \quad & 4x_1 + 5x_2 \\ \text{s.t.} \quad & 3x_1 + 2x_2 \leq 10 \\ & x_1 + 4x_2 \leq 11 \\ & 3x_1 + 3x_2 \leq 13 \\ & x_1, x_2 \geq 0 \\ & x_1, x_2 \text{ integer} \end{aligned}$$

Question 3. Suppose it costs \$12,000 to purchase a new car. The annual operating cost and resale value of a used car are shown in the table below.

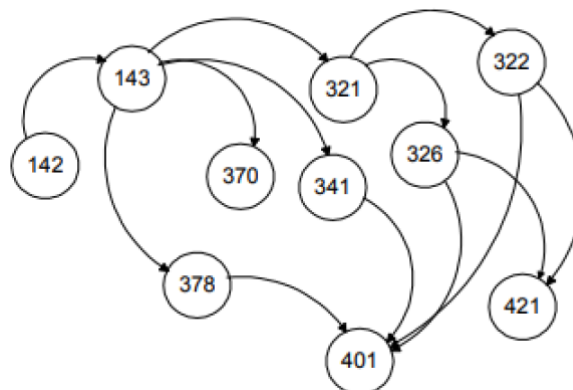
Age of Car (Years)	Resale Value (\$)	Operating Cost (\$)
1	7000	300 (year 1)
2	6000	500 (year 2)
3	4000	800 (year 3)
4	3000	1200 (year 4)
5	2000	1600 (year 5)
6	1000	2200 (year 6)

Assuming that one now has a new car, model and solve replacement problem that minimizes the net costs of owning and operating a car for the next six years using shortest path.

Question 4. Use Bellman Ford algorithm to find the shortest path of the following graph where A is the source node.



Question 5. Find an order in which all these courses can be taken using topological ordering.



Question 6. For the following statements, indicate whether they are True or False. Either provide a counter example or explain your answer.

- (a) If all arcs in a network have different costs, the network has a unique shortest path tree.
- (b) Given a graph with positive edge weights, Dijkstra's algorithm and the Bellman-Ford algorithm can produce different shortest-path trees despite always producing the same shortest-path weights.
- (c) In a shortest path problem, if each arc length increases by k units, shortest path distances increases by a multiple of k .