

IE 400: Principles of Engineering Management

Study Set 5

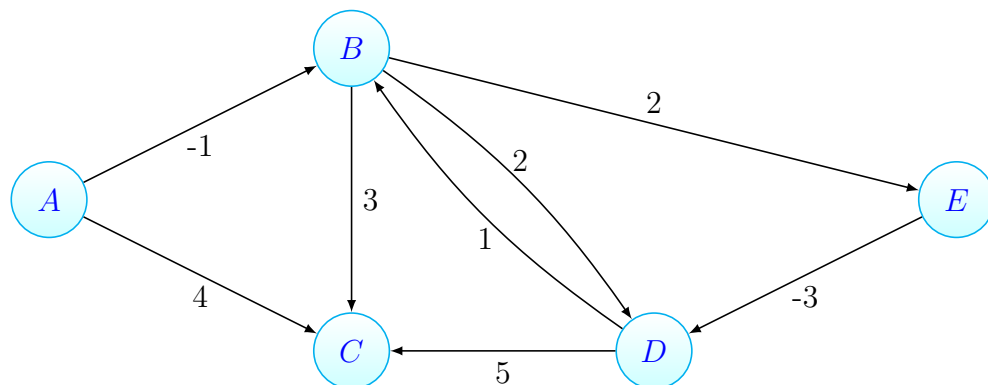
Spring 2021

Question 1. 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.

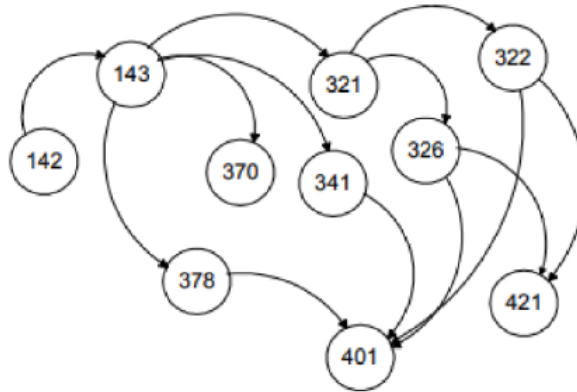
Age of Car (Years)	Resale Value (\$)	Operating Cost (\$)
1	7000	300 (year 1)
2	6000	500 (year 2)
3	4000	800 (year 3)
4	3000	1200 (year 4)
5	2000	1600 (year 5)
6	1000	2200 (year 6)

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



Question 3. Find an order in which all these courses can be taken using topological ordering.



Question 4. 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 .

Question 5. You and several friends are about to prepare a lasagna dinner. The tasks to be performed, their immediate predecessors and their estimated durations are as follows:

Task	Description	Predecessor	Time (minutes)
A	Buy the mozzarella cheese	-	30
B	Slice the mozzarella	A	5
C	Beat two eggs	-	2
D	Mix eggs and ricotta cheese	C	3
E	Cut up onions and mushrooms	-	7
F	Cook the tomato sauce	E	25
G	Boil water	-	15
H	Boil the lasagna noodles	G	10
I	Drain the lasagna noodles	H	2
J	Assemble all ingredients	B,D,F,I	10
K	Preheat the oven	-	15
L	Bake the lasagna	J,K	30

- Construct the project network and find the critical path for preparing this dinner.
- Find the earliest start time, earliest finish time, latest start time, latest finish time and the slack for each activity.
- Because of a phone call, you were interrupted for 6 minutes when you should have been cutting the onions and mushrooms. By how much will the dinner be delayed? If you use your food processor, which reduces the cutting time from 7 to 2 minutes, will the dinner still be delayed?
- Formulate an LP model that would give the latest start time of activities without delaying the dinner.

Question 6. Consider the list of activities for an agricultural field:

Activity			Completion Time (Hours)		
	Description	Predecessor	Optimistic	Most Likely	Pessimistic
A	Excavation	-	5	6	7
B	Sprinkler installation	-	4	5	18
C	Planting	A	4	15	20
D	Irrigation	B,C	3	4	5
E	Fertilizer Utilization	A	5	16	18

- (a) Determine the expected value and the variance of the completion time for each activity and find the critical path.
- (b) Assuming that the normal distribution applies, determine the probability that the critical path will take between 18 and 26 days to complete.