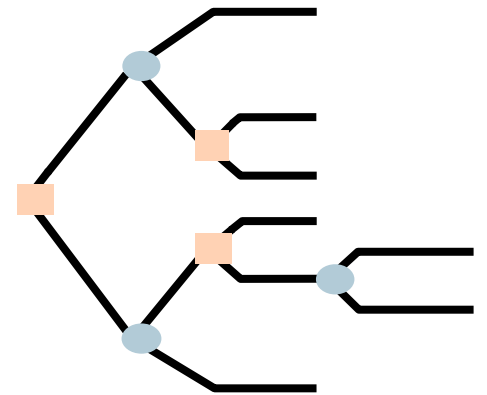
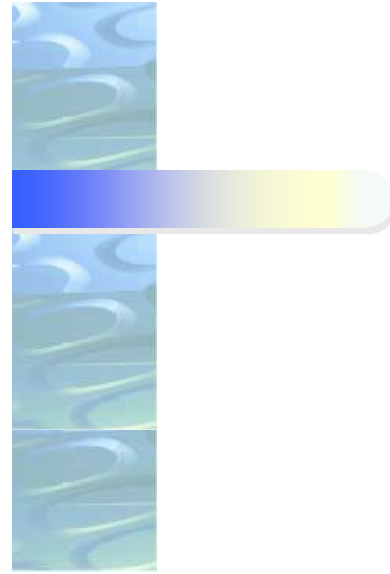


CHAPTER II

Decision making

Tools & Decisions in
Supply Chain



1-Break-even analysis

- Evaluating services or products
 - Volume sufficient to break even
 - The portion of the total cost that varies directly
 - The variable cost per unit

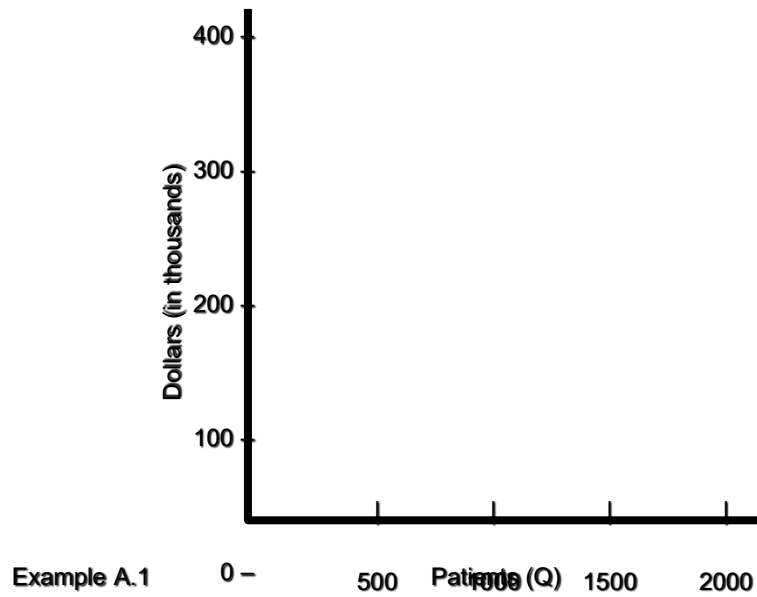


Example

- FINDING THE BREAK-EVEN QUANTITY

- A hospital is considering a new procedure to be offered at \$200 per patient. The fixed cost per year would be \$100,000, with total variable costs of \$100 per patient.
- What is the break-even quantity for this service? Use both algebraic and graphic approaches to get the answer.

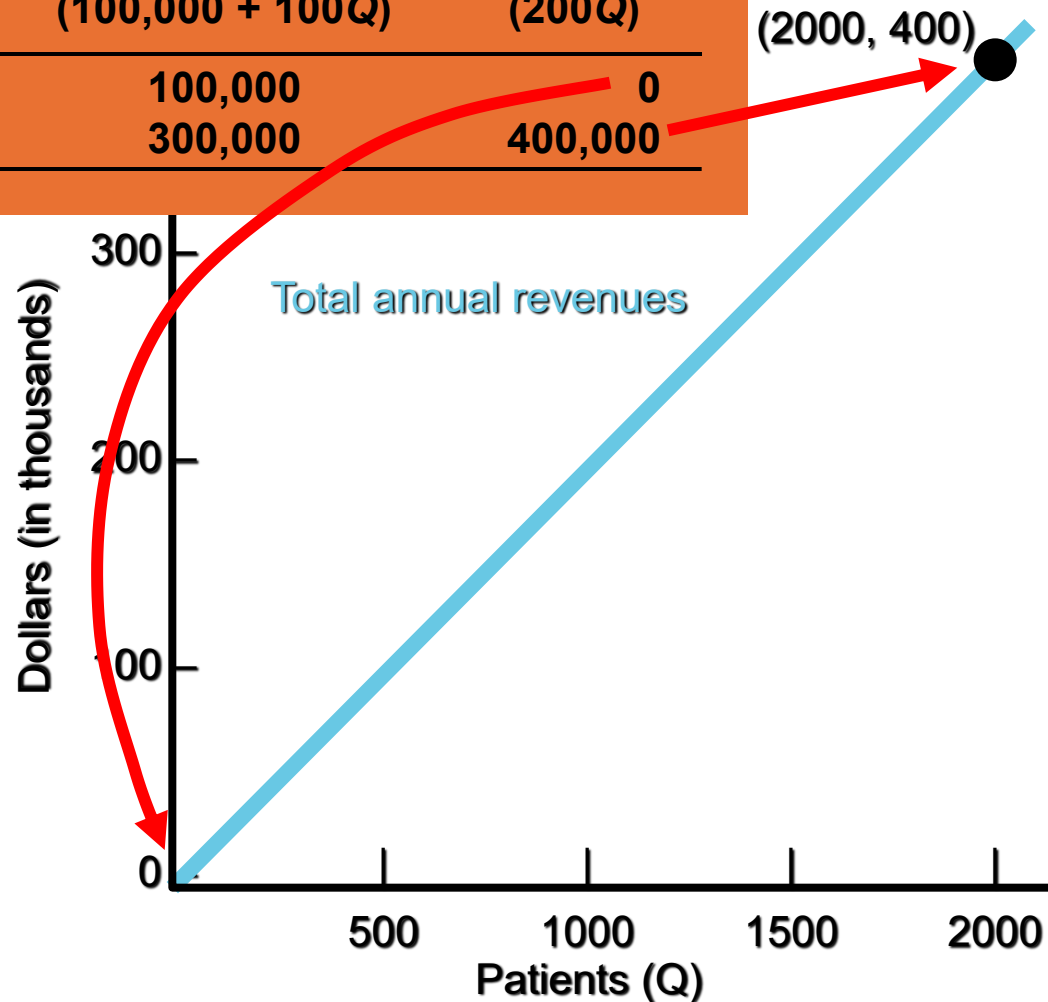
Break-Even Analysis



Break-Even Analysis



Quantity (patients) (Q)	Total Annual Cost (\$) (100,000 + 100Q)	Total Annual Revenue (\$) (200Q)
0	100,000	0
2000	300,000	400,000

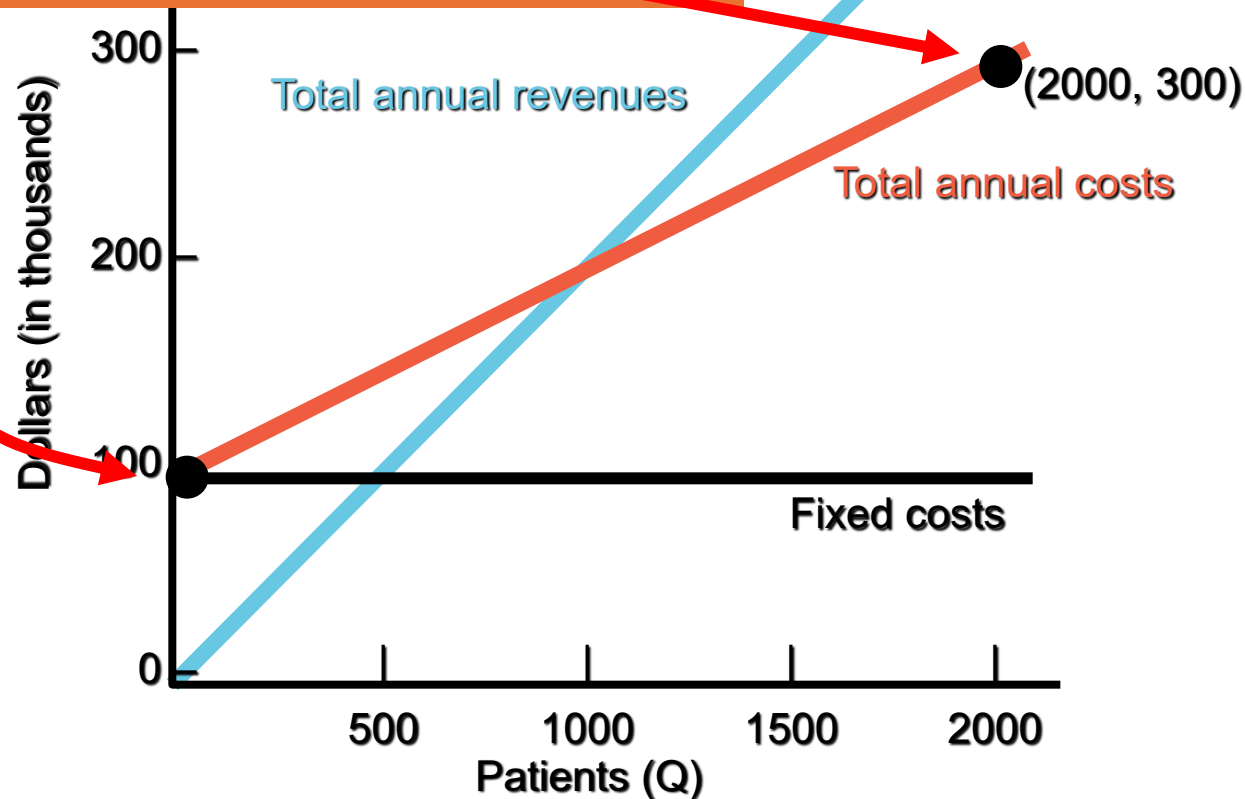


Example A.1

Break-Even Analysis



Quantity (patients) (Q)	Total Annual Cost (\$) (100,000 + 100Q)	Total Annual Revenue (\$) (200Q)
0	100,000	0
2000	300,000	400,000

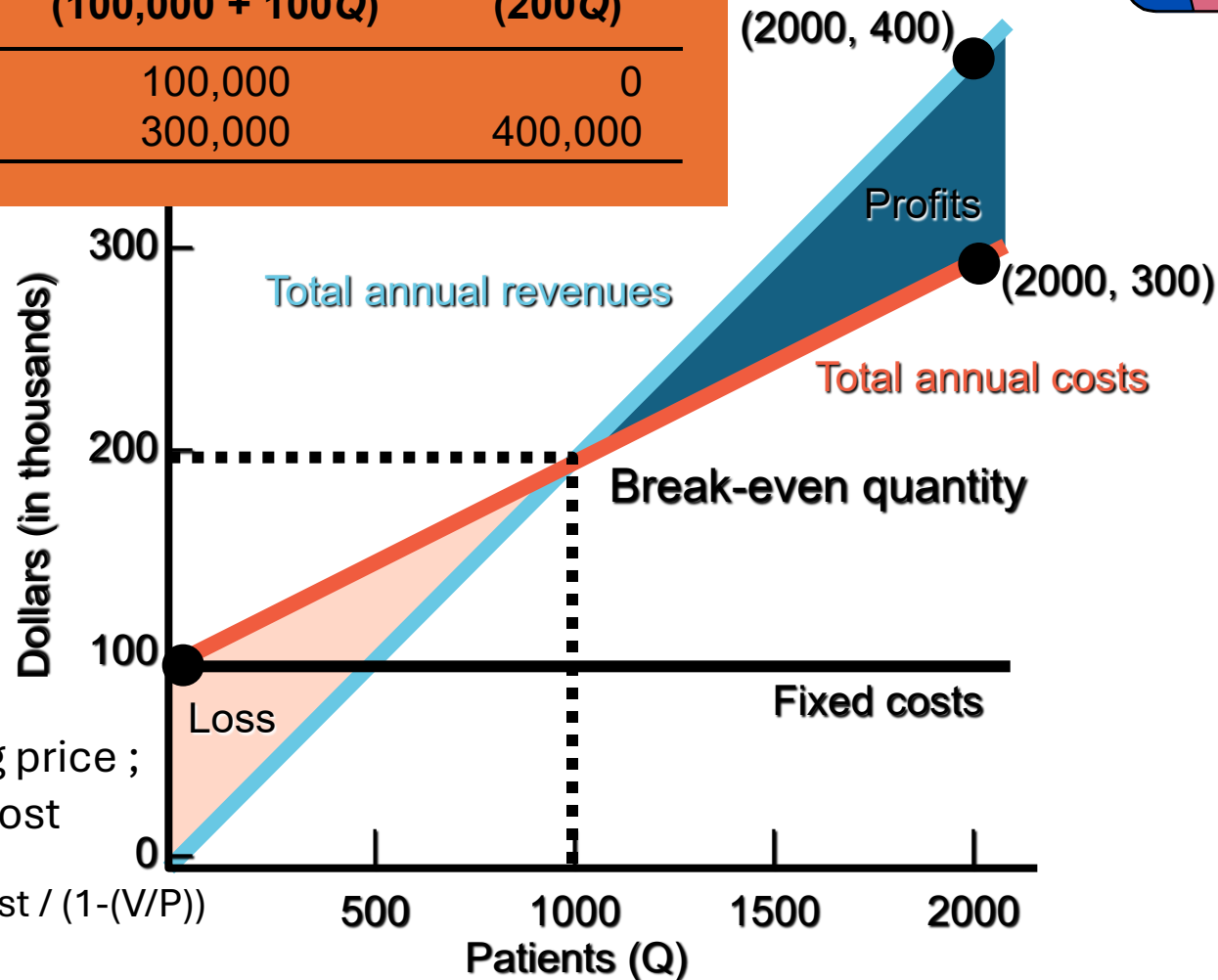


Example A.1

Break-Even Analysis



Quantity (patients) (Q)	Total Annual Cost (\$) (100,000 + 100Q)	Total Annual Revenue (\$) (200Q)
0	100,000	0
2000	300,000	400,000



$$Q = F / (p - v)$$

F Fixed cost

P = unit selling price ;

v = unit variable cost

Or Value = Fixed cost / (1 - (V/P))

i.e.

$$(F / (P - V)) \times P$$

Break-Even Analysis

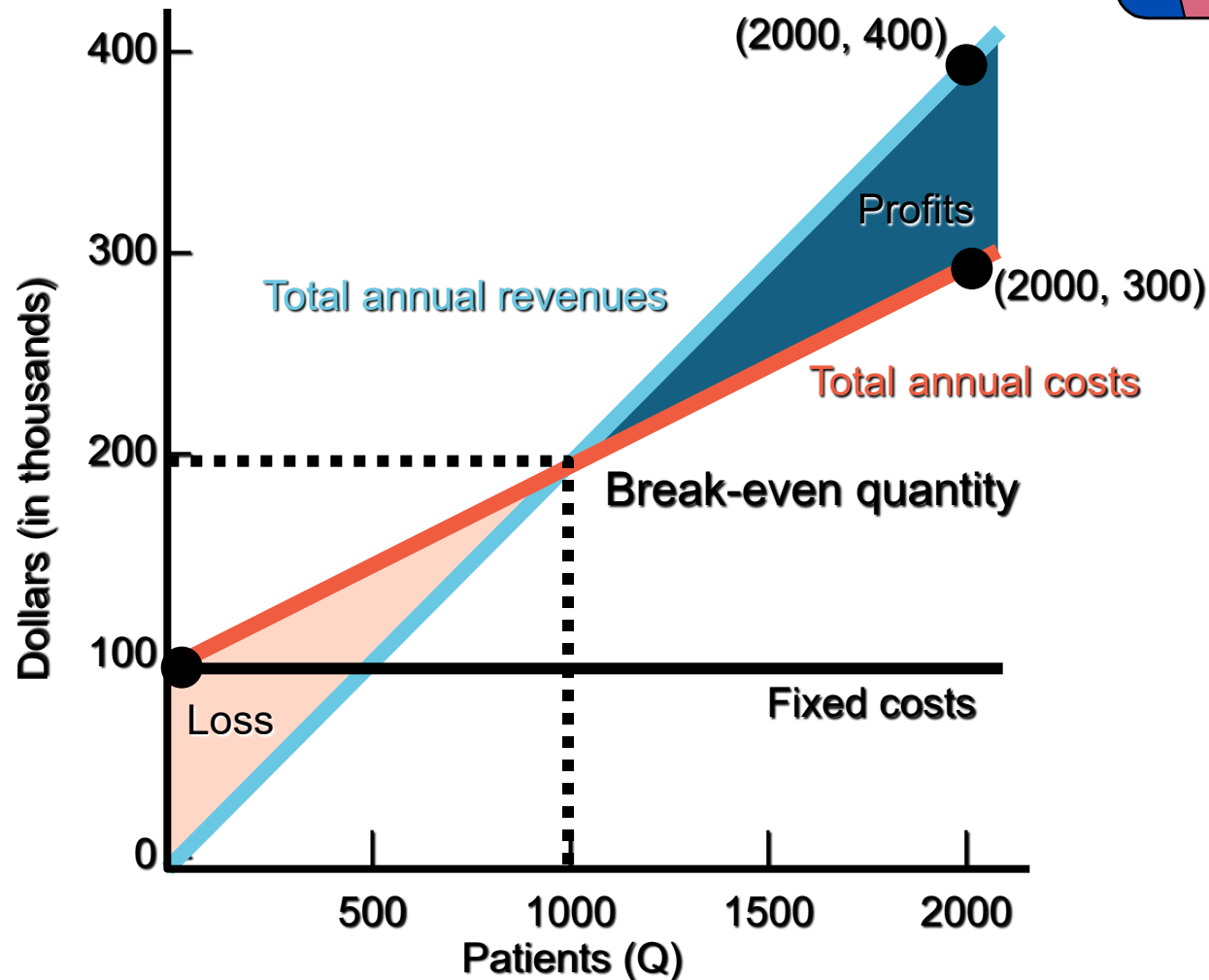
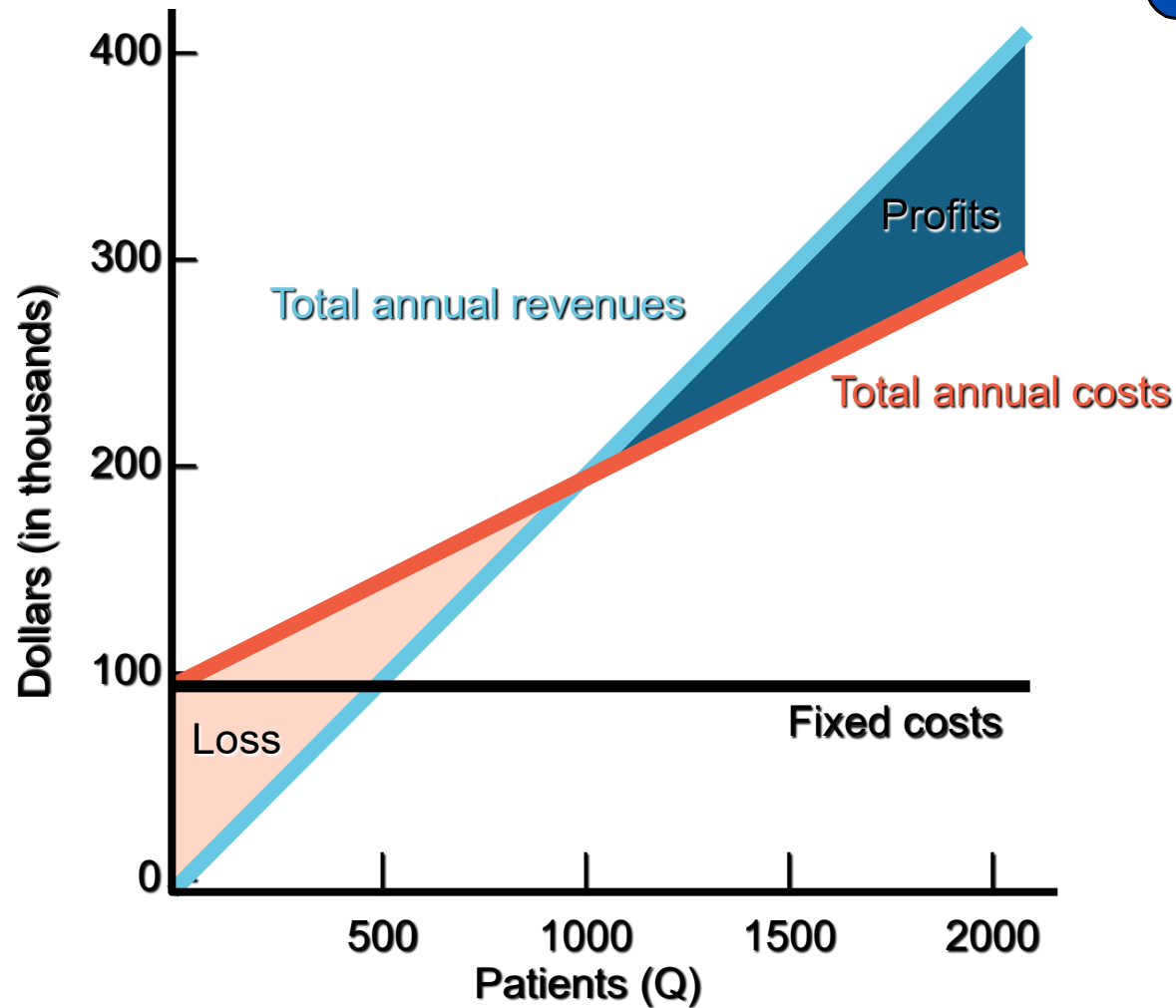


Figure A.1

Sensitivity analysis of sales forecasts

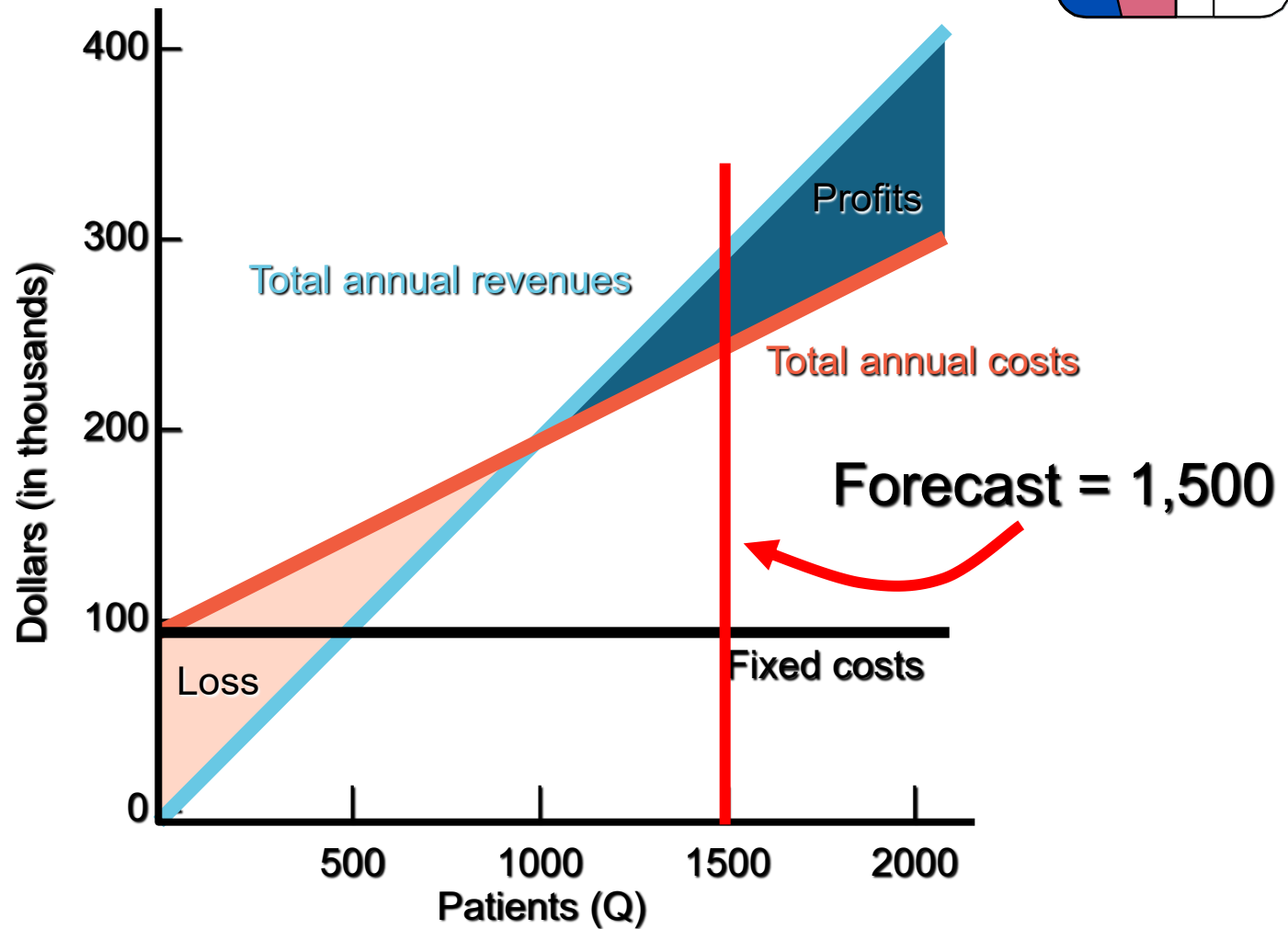
- If the most pessimistic sales forecast for the proposed service in Figure A.I were 1,500 patients, what would be the procedure's total contribution to profit and overhead per year?

Sensitivity Analysis



Example A.2

Sensitivity Analysis

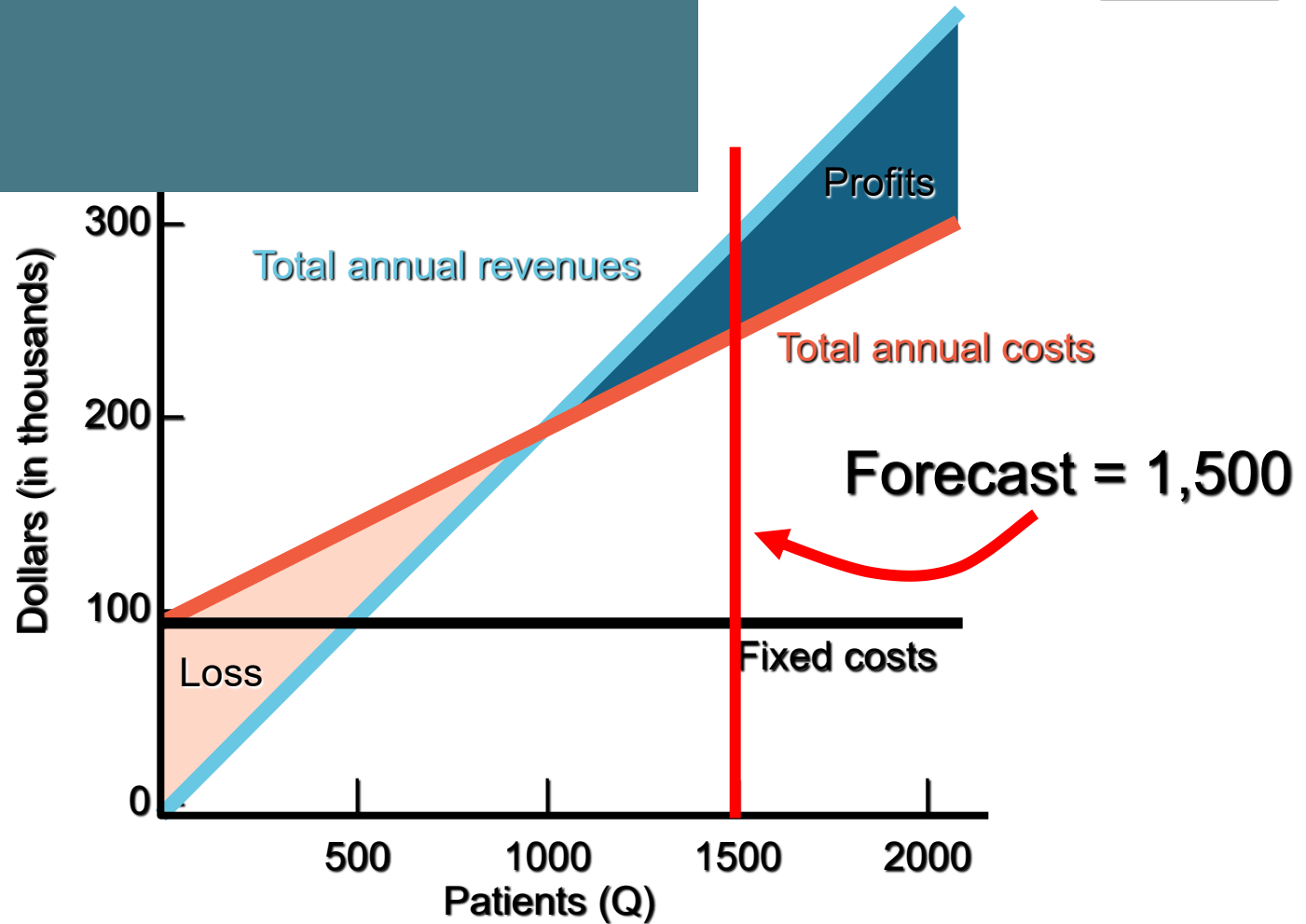


Example A.2

Sensitivity Analysis



$$pQ - (F + cQ)$$



Example A.2

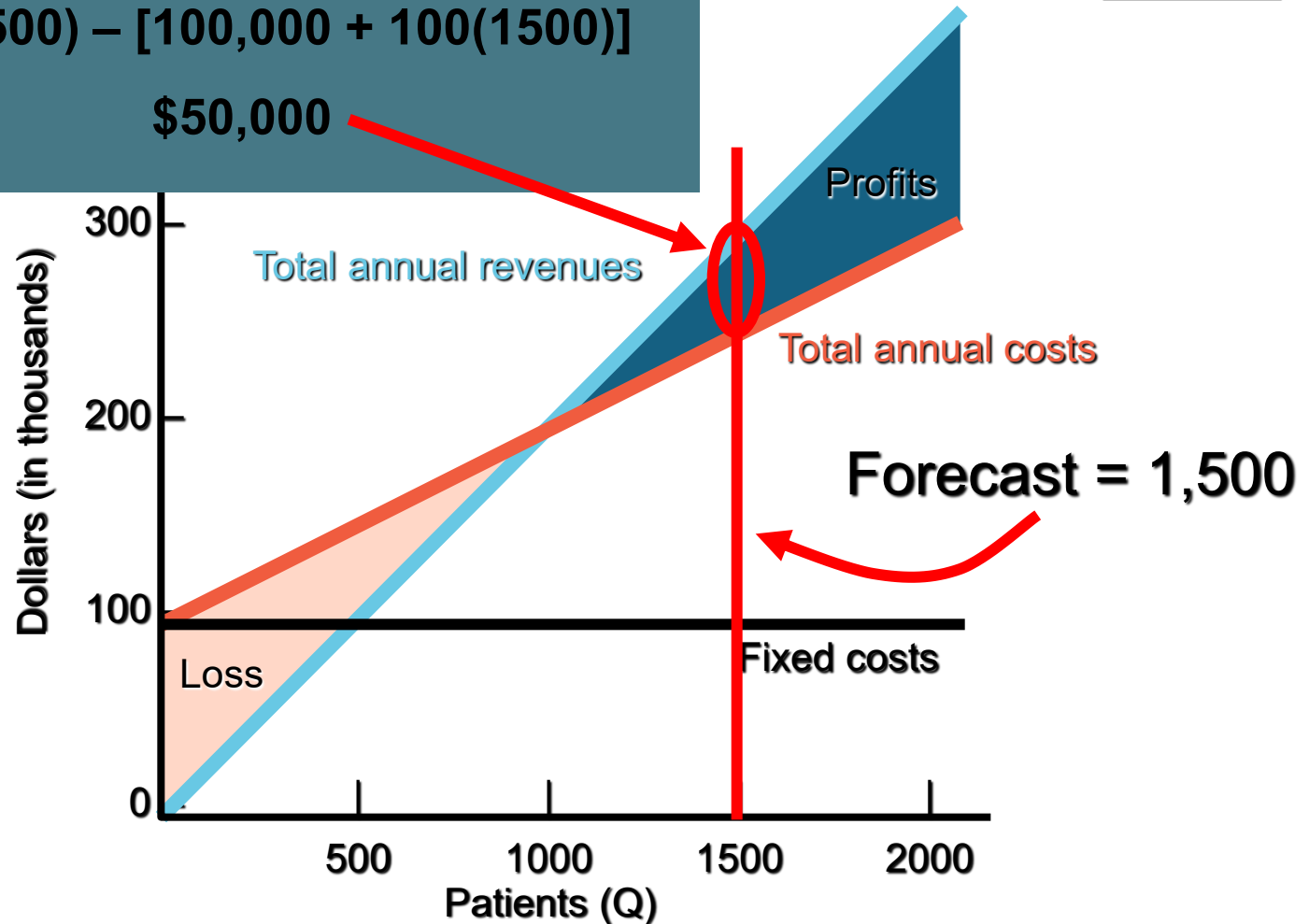
Sensitivity Analysis



$$pQ - (F + cQ)$$

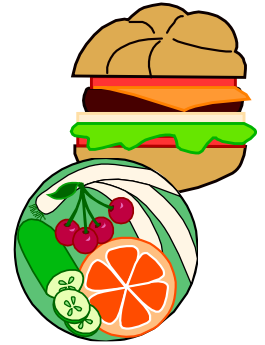
$$200(1500) - [100,000 + 100(1500)]$$

\$50,000



Example A.2

Make-or-Buy Decisions

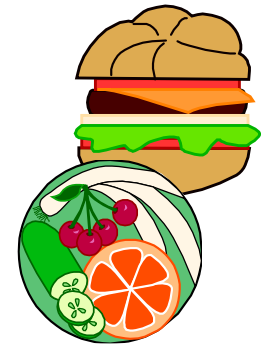


Evaluating processes

What is the break-even quantity?

- The manager of a fast-food restaurant featuring hamburgers is adding salads to the menu.
- There are **two options**, and the price to the customer will be the same for each. The make option is to install a salad bar stocked with vegetables, fruits, and toppings and let the customer assemble the salad. The salad bar would have to be leased and a part-time employee hired. The manager estimates the **fixed costs at \$12,000** and **variable costs totaling \$1.50 per salad**. The buy option is to have preassembled salads available for sale. They would be purchased from a **local supplier at \$2.00 per salad**. Offering preassembled salads would require installation and operation of additional refrigeration, with an **annual fixed cost of \$2,400**.
- The manager expects to sell 25,000 salads per year.

Make-or-Buy Decisions



Type

☐ Product/Service

☒ Two Processes

Solver - Break-Even Analysis

Enter data in yellow- shaded areas.

	Process 1	Process 2
Fixed costs (F)	\$12,000	\$2,400
Variable costs (c)	\$1.50	\$2.00

Expected demand 25,000

Break-even quantity 19,200.0

Decision: Process 1

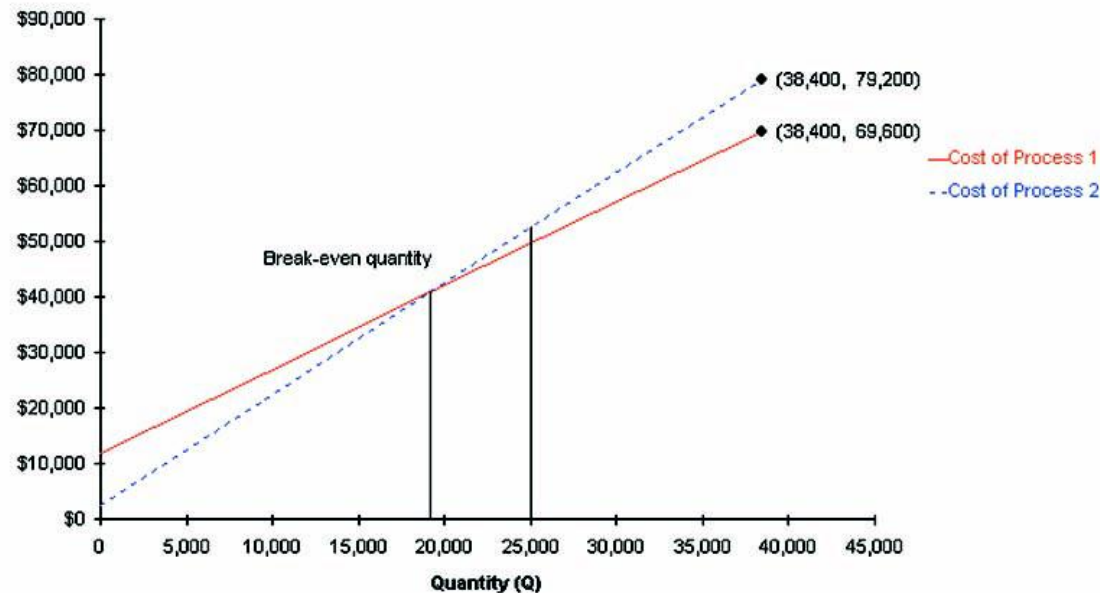
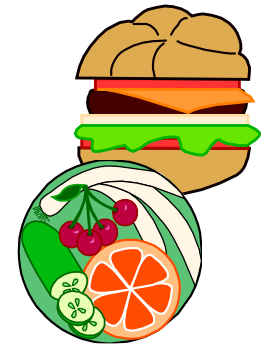


Figure A.2

Make-or-Buy Decisions



Type

☐ Product/Service

☒ Two Processes

Solver - Break-Even Analysis

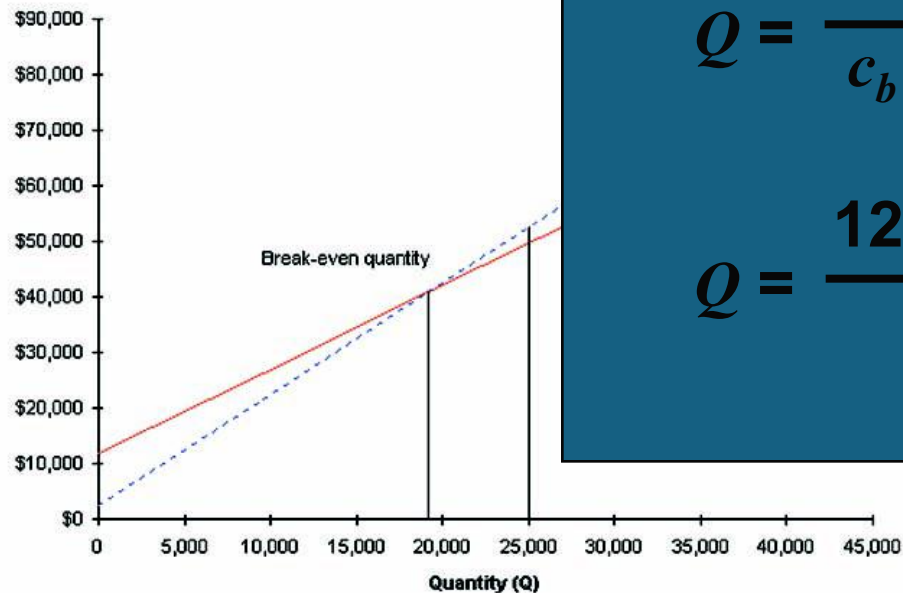
Enter data in yellow- shaded areas.

	Process 1	Process 2
Fixed costs (F)	\$12,000	\$2,400
Variable costs (c)	\$1.50	\$2.00

Expected demand 25,000

Break-even quantity 19,200.0

Decision: Process 1

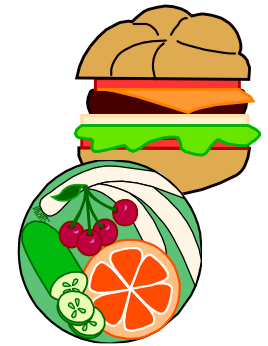


$$Q = \frac{F_m - F_b}{c_b - c_m}$$

$$Q = \frac{12,000 - 2,400}{2.0 - 1.5}$$

Example A.3

Make-or-Buy Decisions



Type

☐ Product/Service

☒ Two Processes

Solver - Break-Even Analysis

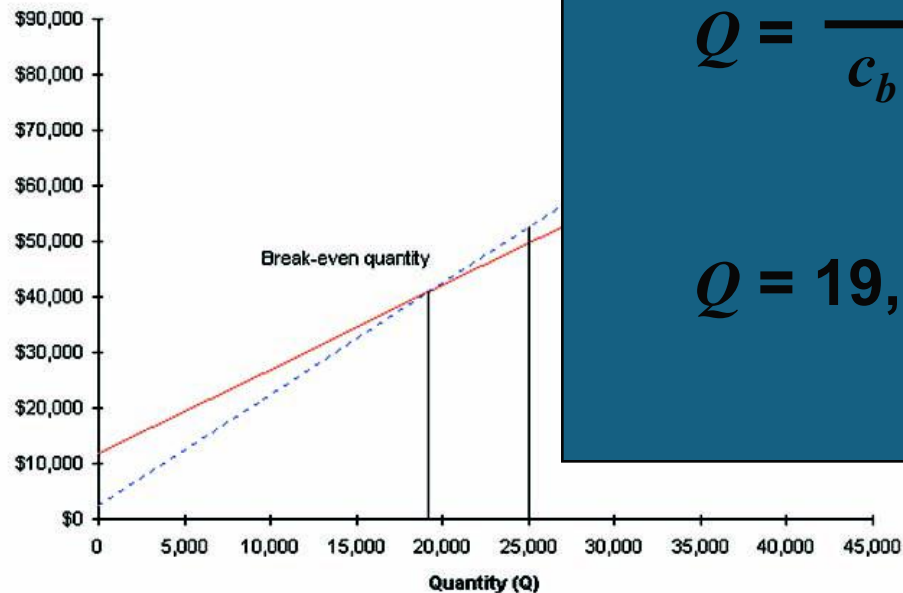
Enter data in yellow-shaded areas.

	Process 1	Process 2
Fixed costs (F)	\$12,000	\$2,400
Variable costs (c)	\$1.50	\$2.00

Expected demand 25,000

Break-even quantity 19,200.0

Decision: Process 1

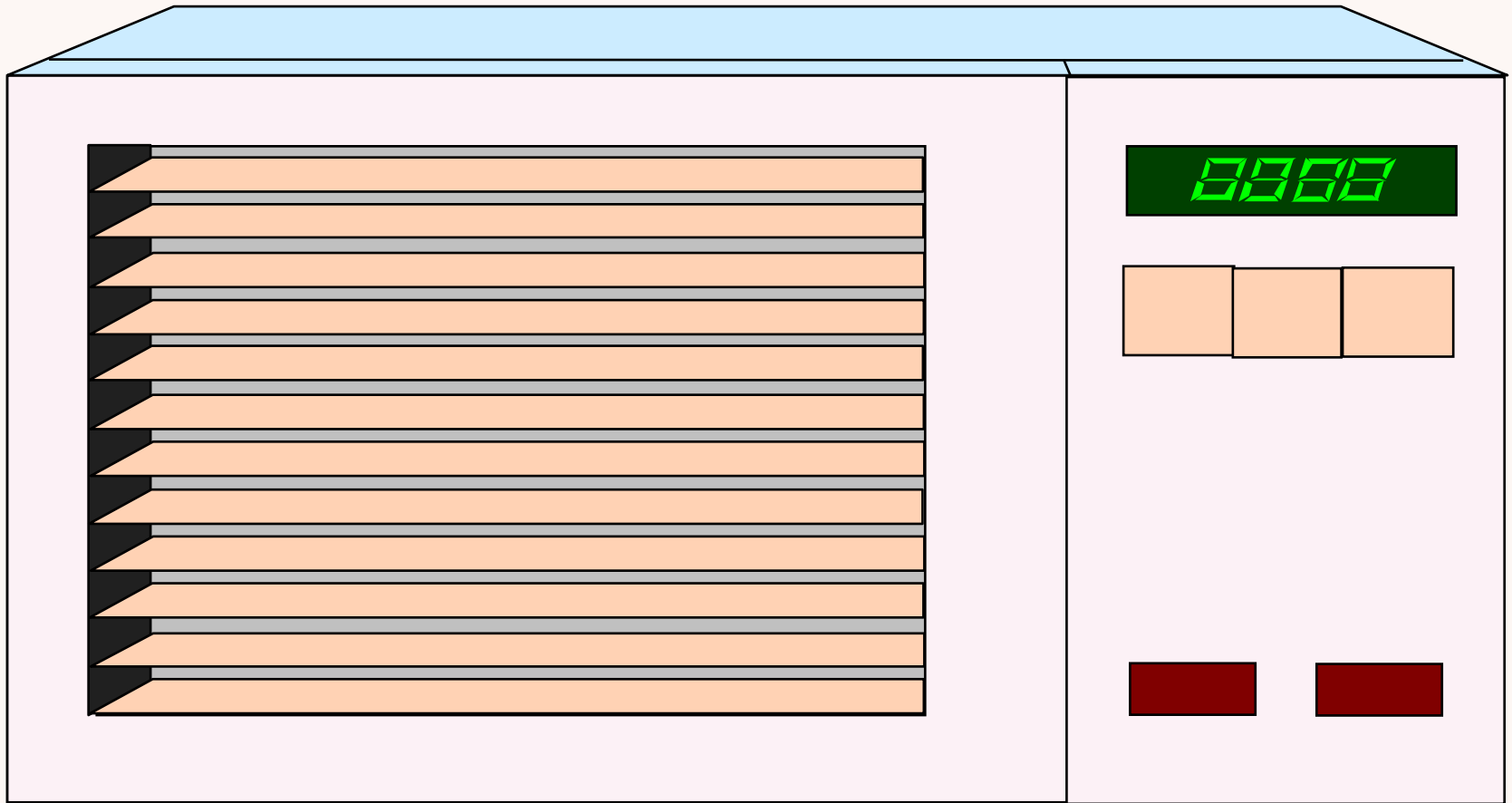


$$Q = \frac{F_m - F_b}{c_b - c_m}$$

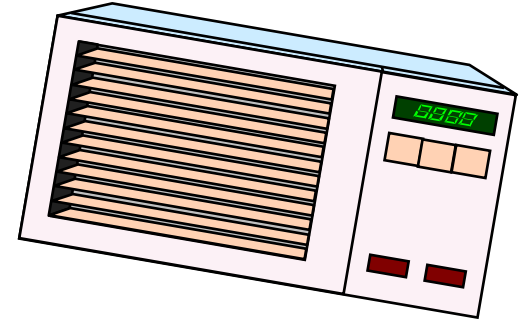
$$Q = 19,200 \text{ salads}$$

Example A.3

Preference Matrix



Preference Matrix

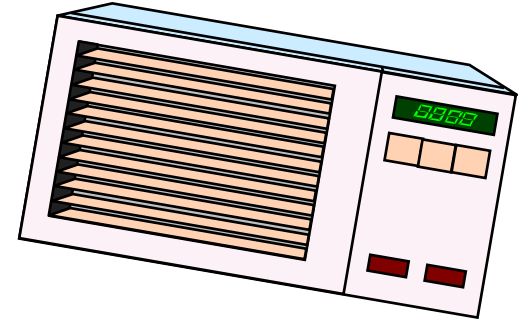


Threshold score = 800

Performance Criterion	Weight (A)	Score (B)	Weighted Score (A x B)
Market potential			
Unit profit margin			
Operations compatibility			
Competitive advantage			
Investment requirement			
Project risk			

Example A.4

Preference Matrix

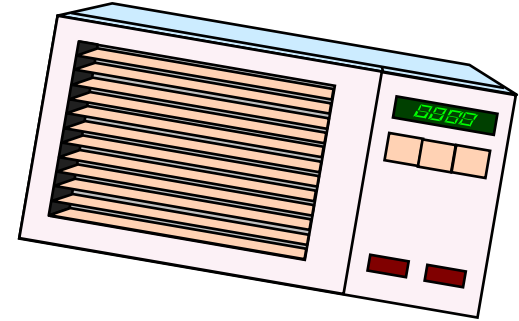


Threshold score = 800

Performance Criterion	Weight (A)	Score (B)	Weighted Score (A x B)
Market potential	30		
Unit profit margin	20		
Operations compatibility	20		
Competitive advantage	15		
Investment requirement	10		
Project risk	5		

Example A.4

Preference Matrix

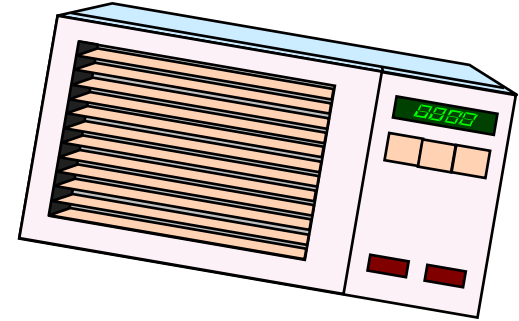


Threshold score = 800

Performance Criterion	Weight (A)	Score (B)	Weighted Score (A x B)
Market potential	30	8	
Unit profit margin	20	10	
Operations compatibility	20	6	
Competitive advantage	15	10	
Investment requirement	10	2	
Project risk	5	4	

Example A.4

Preference Matrix

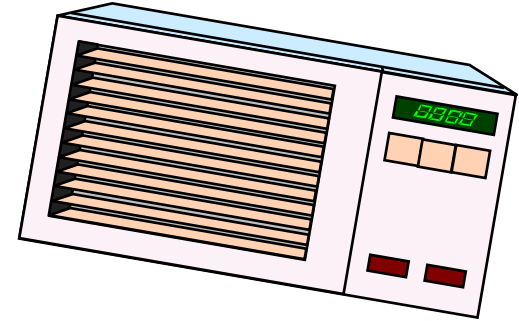


Threshold score = 800

Performance Criterion	Weight (A)	Score (B)	Weighted Score (A x B)
Market potential	30	8	240
Unit profit margin	20	10	200
Operations compatibility	20	6	120
Competitive advantage	15	10	150
Investment requirement	10	2	20
Project risk	5	4	20

Example A.4

Preference Matrix

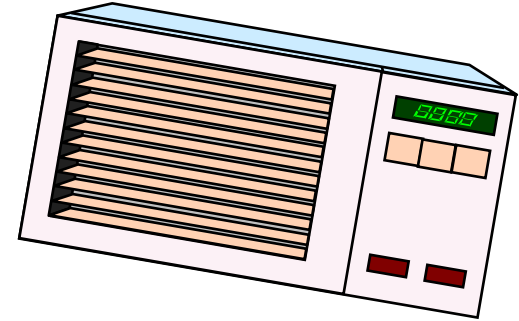


Threshold score = 800

Performance Criterion	Weight (A)	Score (B)	Weighted Score (A x B)
Market potential	30	8	240
Unit profit margin	20	10	200
Operations compatibility	20	6	120
Competitive advantage	15	10	150
Investment requirement	10	2	20
Project risk	5	4	20
			<u>750</u>
Weighted score =			<u><u>750</u></u>

Example A.4

Preference Matrix

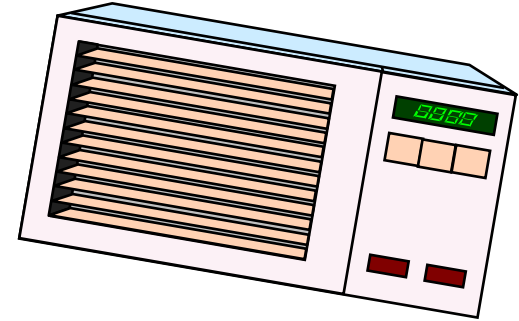


Threshold score = 800

Performance Criterion	Weight (A)	Score (B)	Weighted Score (A x B)
Market potential	30	8	240
Unit profit margin	20	10	200
Operations compatibility	20	6	120
Competitive advantage	15	10	150
Investment requirement	10	2	20
Project risk	5	4	20
			Weighted score = <u><u>750</u></u>

Example A.4

Preference Matrix



Threshold score = 800

Performance Criterion	Weight (A)	Score (B)	Weighted Score (A x B)
Market potential	30	8	240
Unit profit margin	20	10	200
Operations compatibility	20	6	120
Competitive advantage	15	10	150
Investment requirement	10	2	20
Project risk	5	4	20
			<u>750</u>
Weighted score =			<u><u>750</u></u>

Example A.4



Together

Supplier Selection

Your company is considering new suppliers in three different countries to provide critical raw materials. Each supplier has its strengths and weaknesses in terms of cost, reliability, and geopolitical stability.

Questions:

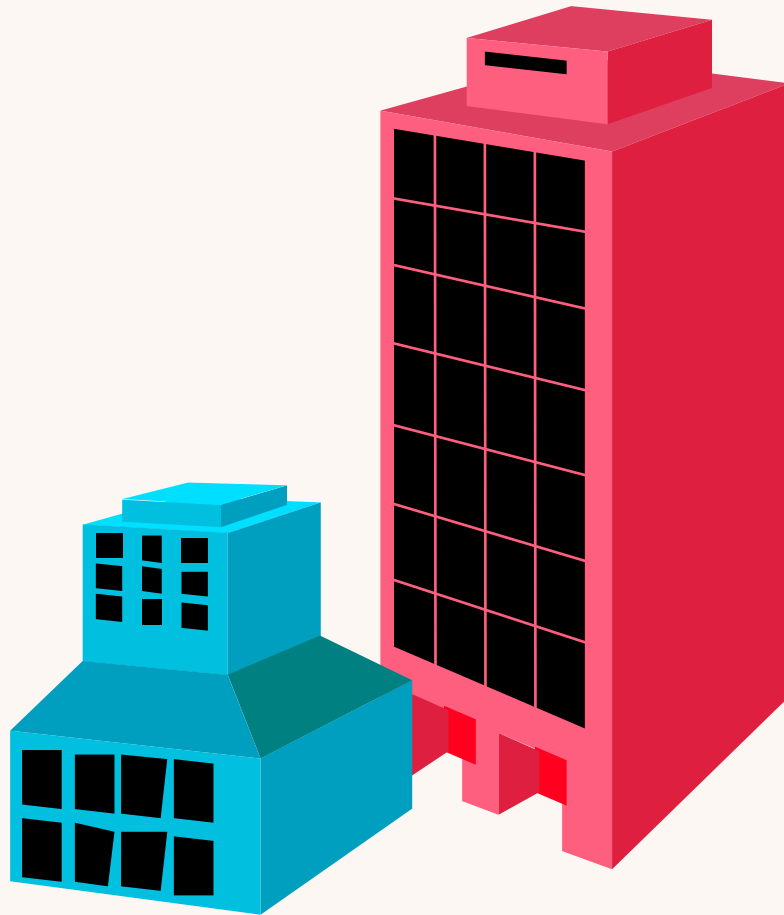
- What decision-making framework will you use to evaluate these suppliers?
 - How will you assess the risks associated with each supplier?
 - How will you ensure a balanced and diversified supply chain?
- 

3- decision theory

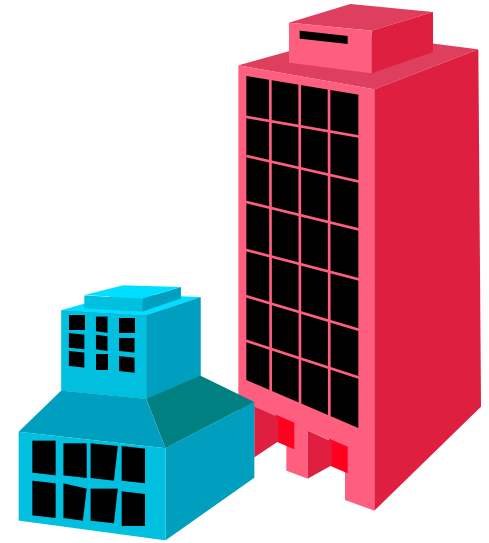
- List the feasible alternatives
- List the events
- Calculate the payoff
- Estimate the likelihood of each events
- Select a decision rule



Under Certainty



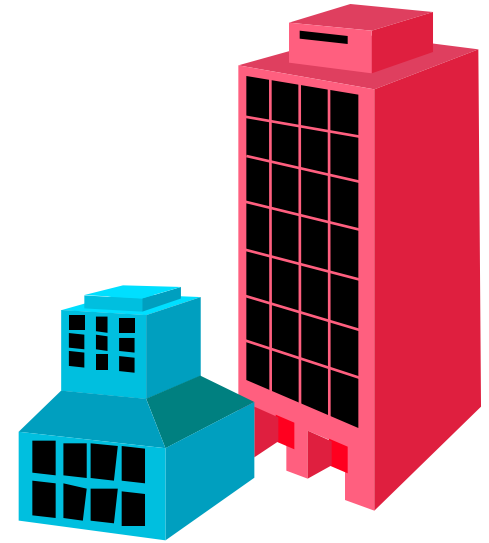
Under Certainty



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Example A.5

Under Certainty

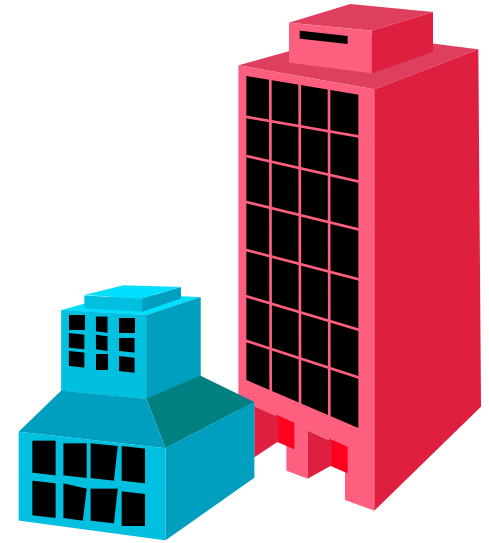


Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

If future demand will be low –

Example A.5

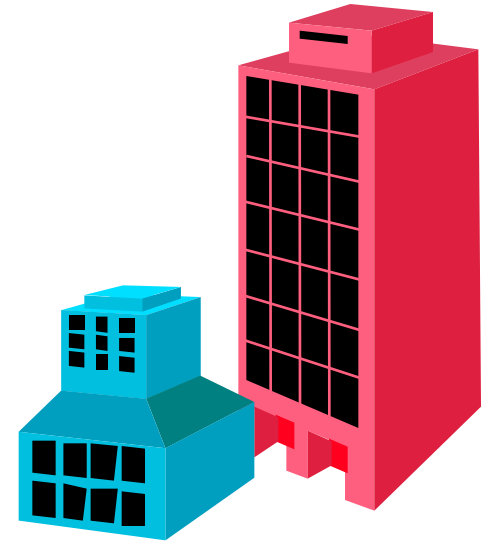
Under Certainty



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

If future demand will be low – Choose the small facility.

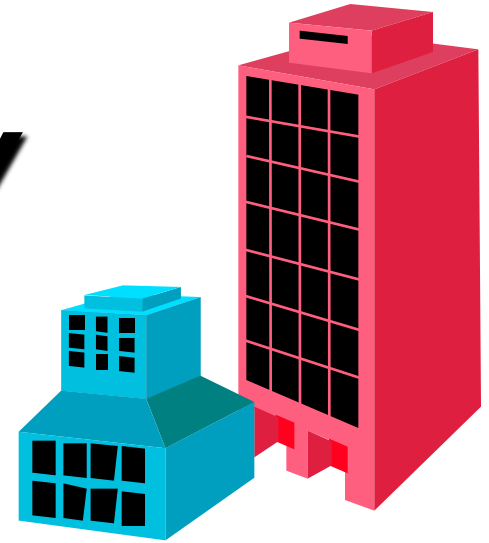
Under Certainty



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

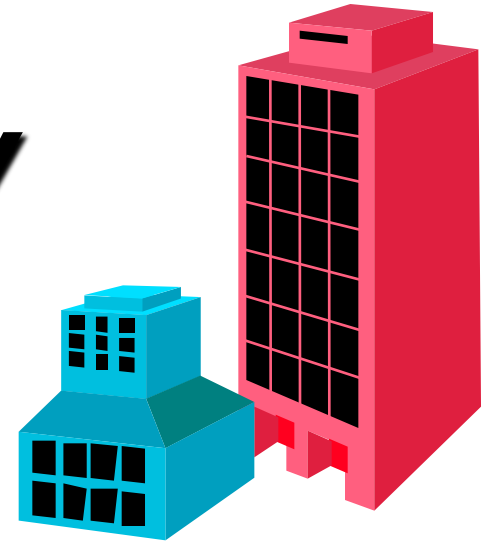
If future demand will be low – Choose the small facility.

Under Uncertainty



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

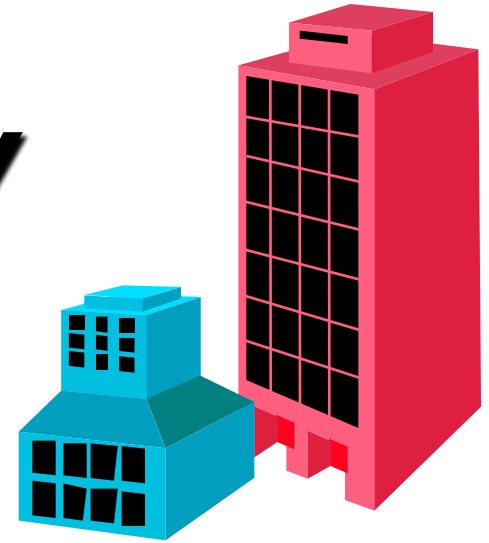
Under Uncertainty



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Maximin –

Under Uncertainty

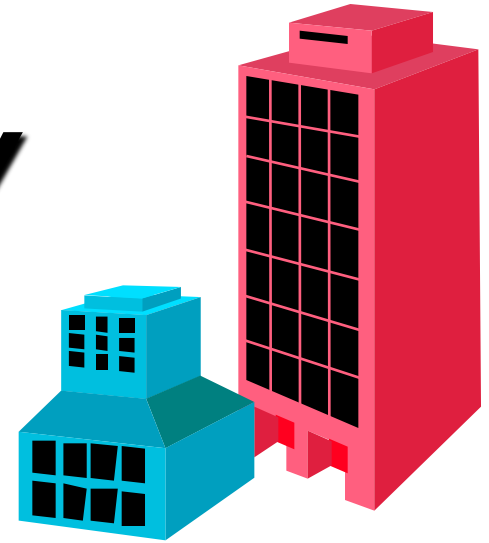


Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Maximin –

Best of the worst

Under Uncertainty

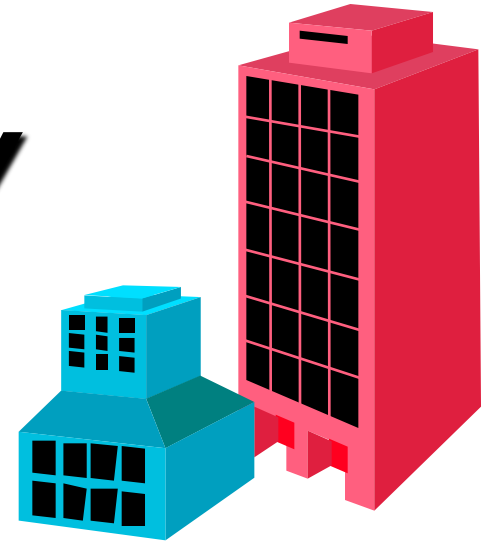


Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Maximin – Small

Best of the worst

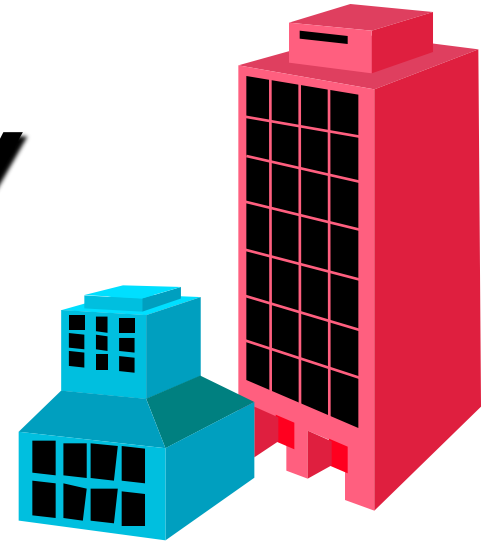
Under Uncertainty



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Maximin – Small
Maximax –

Under Uncertainty

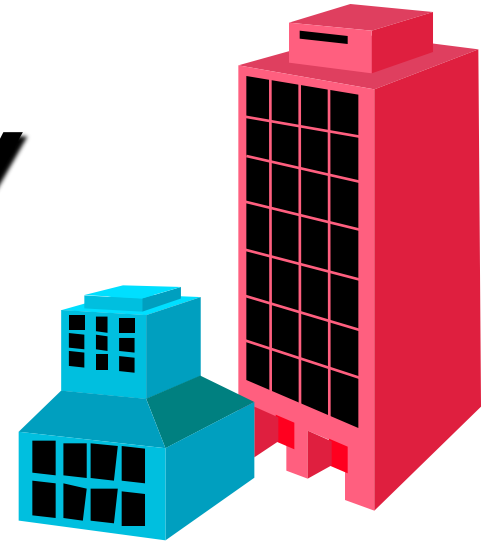


Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Maximin – Small
Maximax –

Best of the best

Under Uncertainty

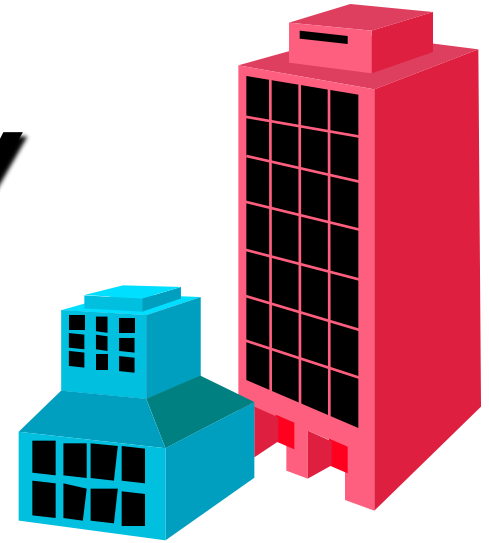


Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Maximin – Small
Maximax – Large

Best of the best

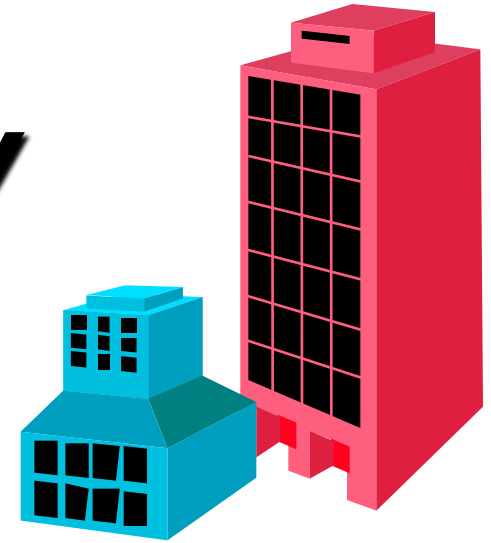
Under Uncertainty



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Maximin – Small
Maximax – Large
Laplace –

Under Uncertainty



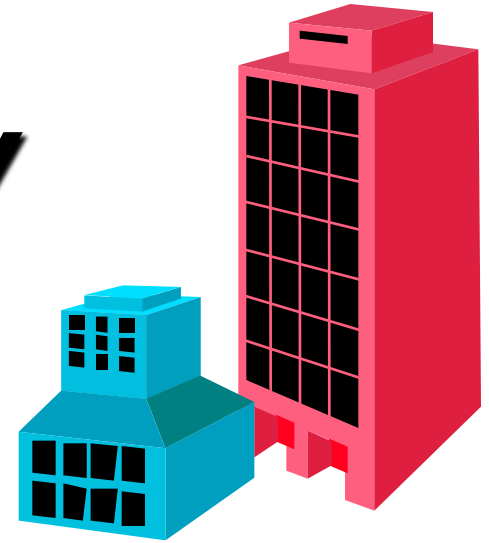
Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Maximin – Small
Maximax – Large
Laplace –

Small facility $0.5(200) + 0.5(270) = 235$

**Best
weighted
payoff**

Under Uncertainty



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

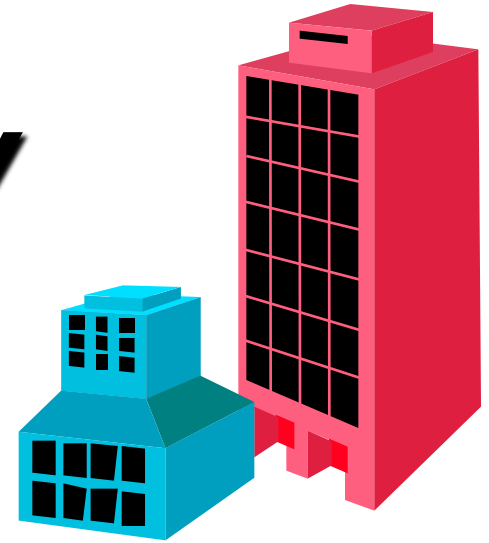
Maximin – Small
Maximax – Large
Laplace –

Small facility $0.5(200) + 0.5(270) = 235$

Large facility $0.5(160) + 0.5(800) = 480$

**Best
weighted
payoff**

Under Uncertainty



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

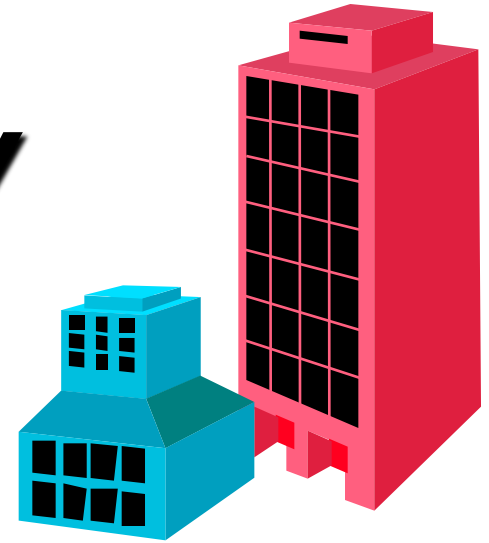
Maximin – Small
Maximax – Large
Laplace – Large

Small facility $0.5(200) + 0.5(270) = 235$

Large facility $0.5(160) + 0.5(800) = 480$

**Best
weighted
payoff**

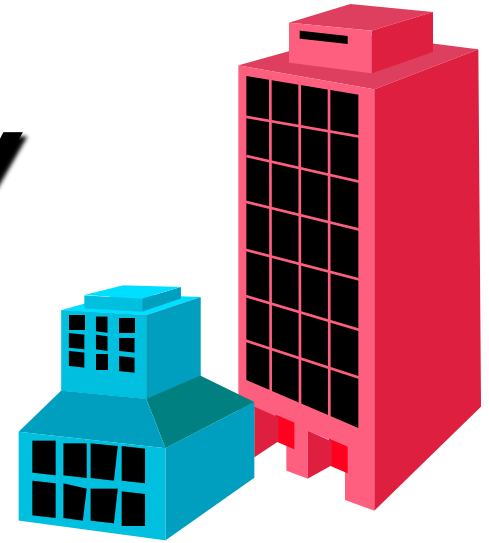
Under Uncertainty



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Maximin – Small
Maximax – Large
Laplace – Large
Minimax Regret –

Under Uncertainty



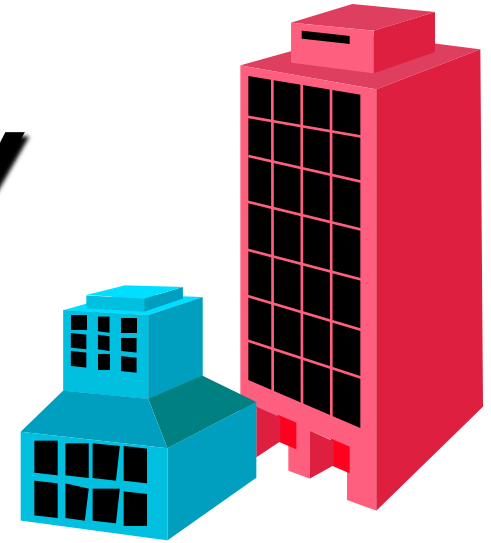
Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Maximin – Small
 Maximax – Large
 Laplace – Large
 Minimax Regret –

	Regret	
	Low Demand	High Demand
Small facility	$200 - 200 = 0$	$800 - 270 = 530$

Best
worst
regret

Under Uncertainty



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

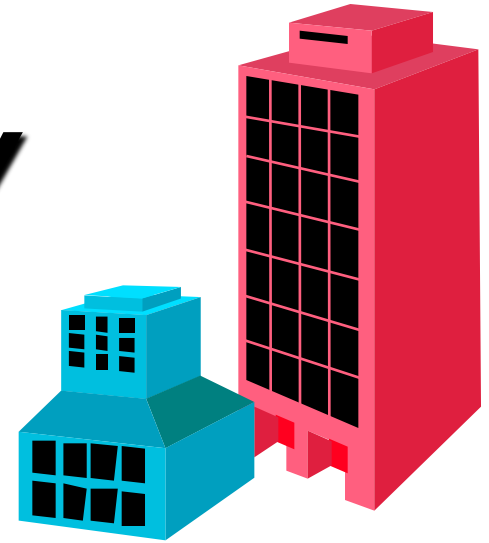
Maximin – Small
 Maximax – Large
 Laplace – Large
 Minimax Regret –

	Regret	
	Low Demand	High Demand
Small facility	$200 - 200 = 0$	$800 - 270 = 530$
Large facility	$200 - 160 = 40$	$800 - 800 = 0$

Best
worst
regret

Example A.6

Under Uncertainty



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

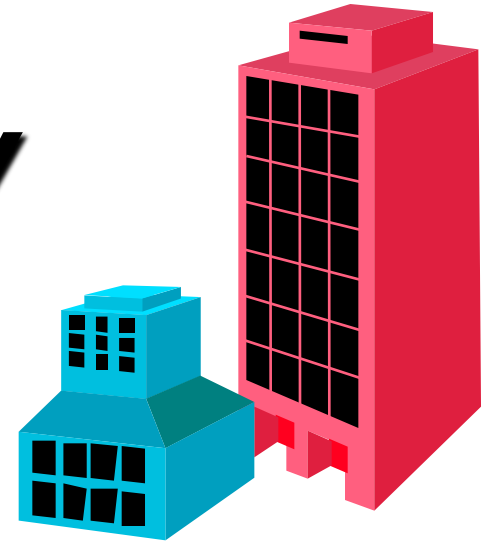
Maximin – Small
 Maximax – Large
 Laplace – Large
 Minimax Regret – Large

	Regret	
	Low Demand	High Demand
Small facility	$200 - 200 = 0$	$800 - 270 = 530$
Large facility	$200 - 160 = 40$	$800 - 800 = 0$

Best
 worst
 regret

Example A.6

Under Uncertainty



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Maximin – Small

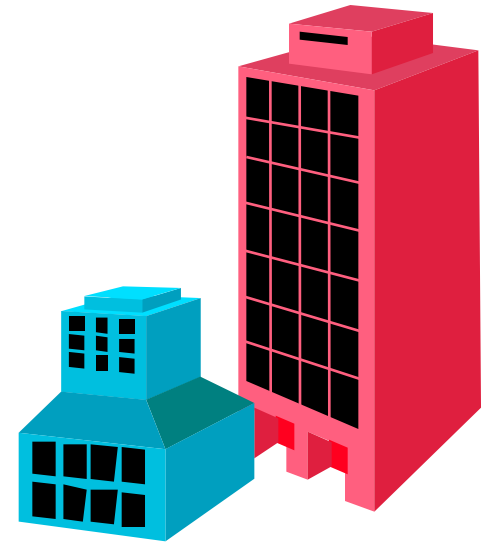
Maximax – Large

Laplace – Large

Minimax Regret – Large

Under Risk

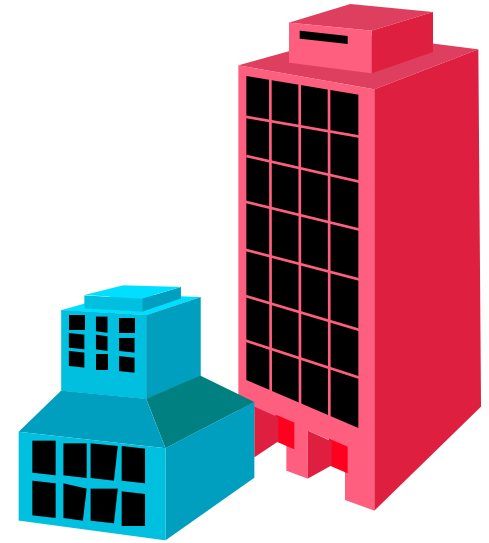
Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0



$$P_{\text{small}} = 0.4$$

$$P_{\text{large}} = 0.6$$

Under Risk



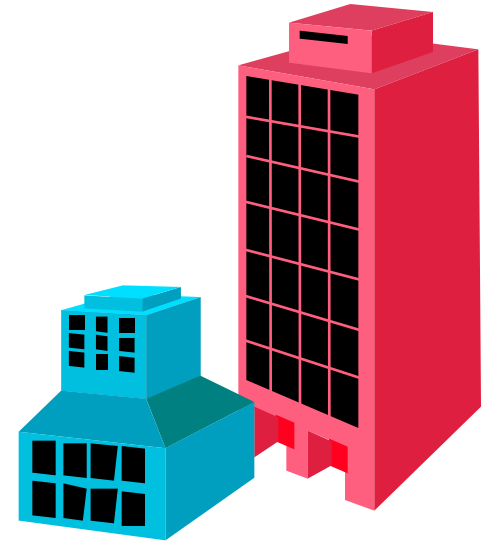
Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Alternative	Expected Value
Small facility	$0.4(200) + 0.6(270) = 242$

$$P_{\text{small}} = 0.4$$

$$P_{\text{large}} = 0.6$$

Under Risk



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

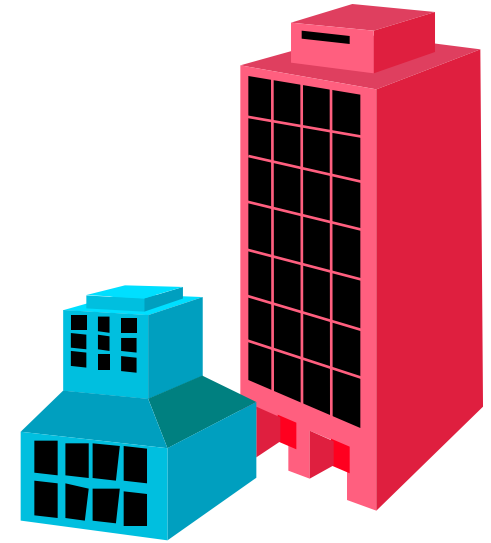
$$P_{\text{small}} = 0.4$$

$$P_{\text{large}} = 0.6$$

Alternative	Expected Value
Small facility	$0.4(200) + 0.6(270) = 242$
Large facility	$0.4(160) + 0.6(800) = 544$

Example A.7

Under Risk



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

$$P_{\text{small}} = 0.4$$

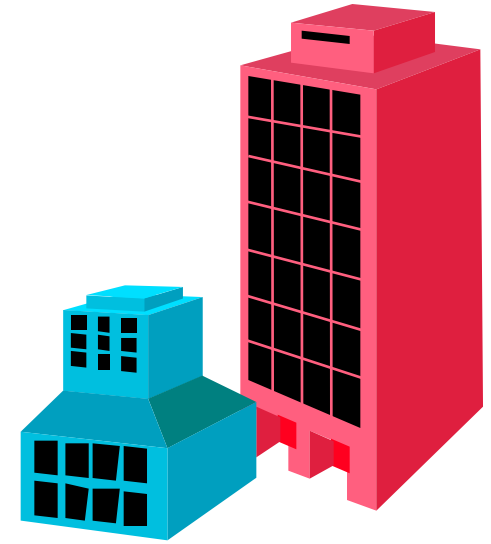
$$P_{\text{large}} = 0.6$$

Alternative	Expected Value
Small facility	$0.4(200) + 0.6(270) = 242$
Large facility	$0.4(160) + 0.6(800) = 544$

**Highest
Expected
Value**

Example A.7

Perfect Information

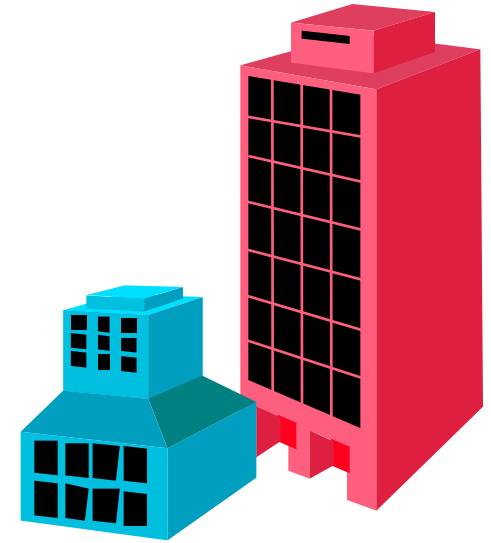


Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

$$P_{\text{small}} = 0.4$$

$$P_{\text{large}} = 0.6$$

Perfect Information



Alternative	Possible Future Demand	
	Low	High
Small facility	200	270
Large facility	160	800
Do nothing	0	0

Event	Best Payoff
Low demand	200
High demand	800

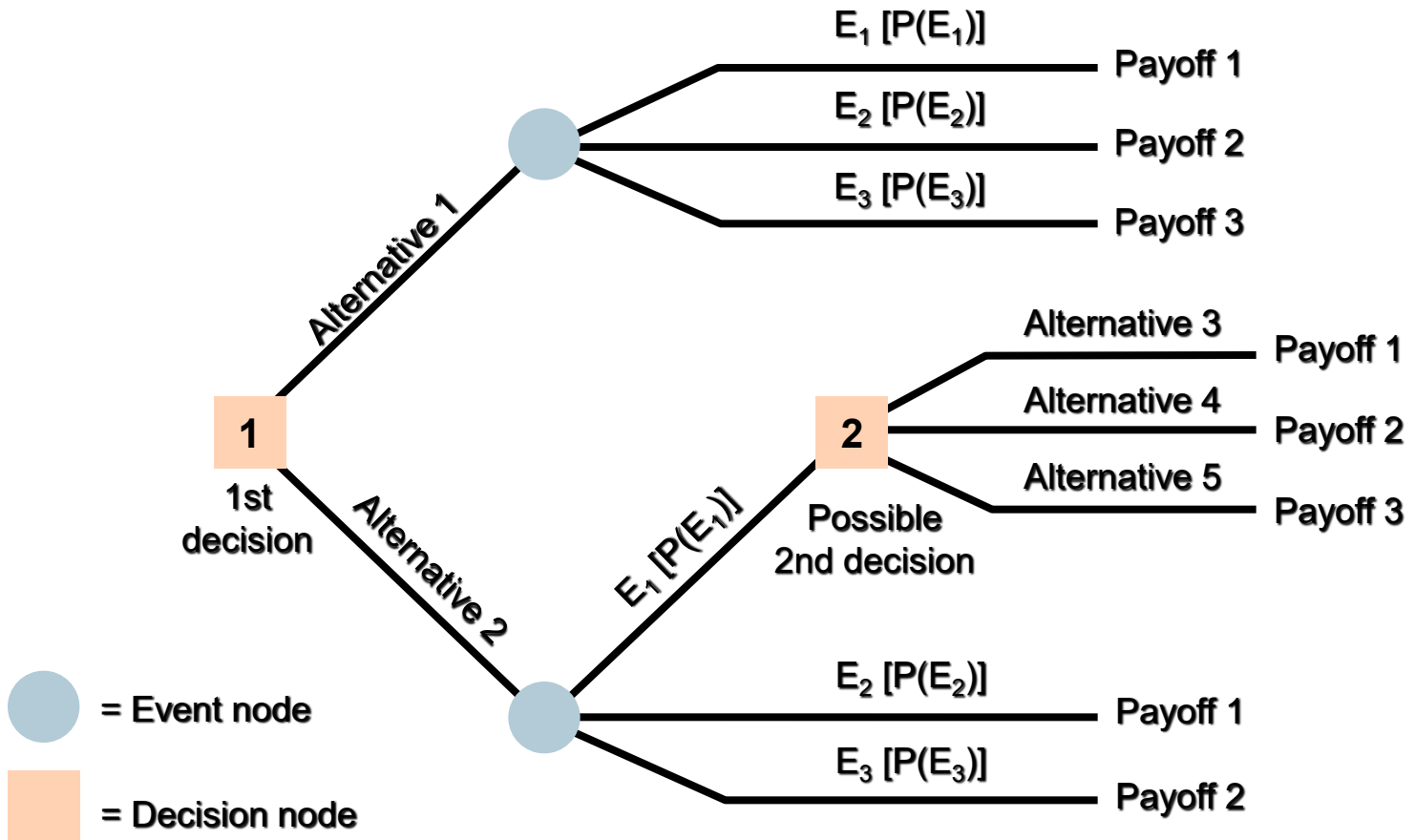
$$P_{\text{small}} = 0.4$$

$$P_{\text{large}} = 0.6$$

Example A.8

Decision Trees

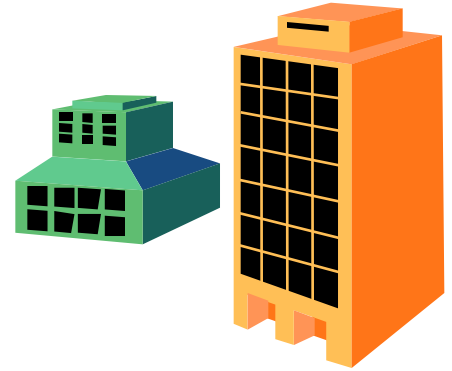
Decision Trees



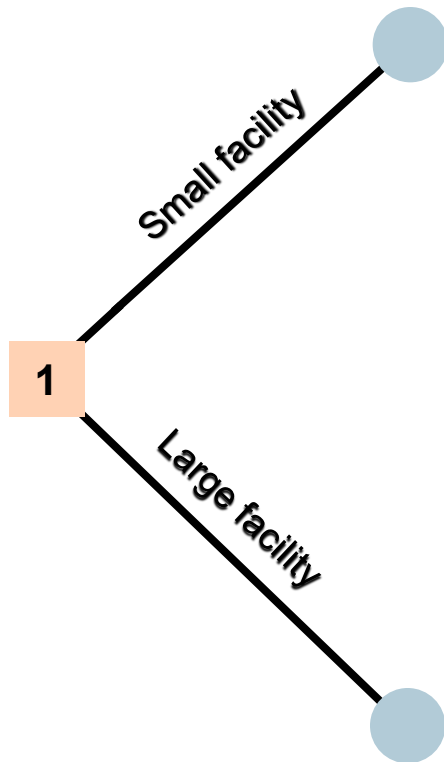
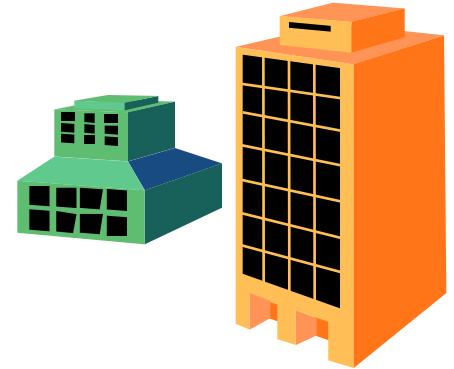
E_i = Event i
 $P(E_i)$ = Probability of event i

Figure A.5

Decision Trees

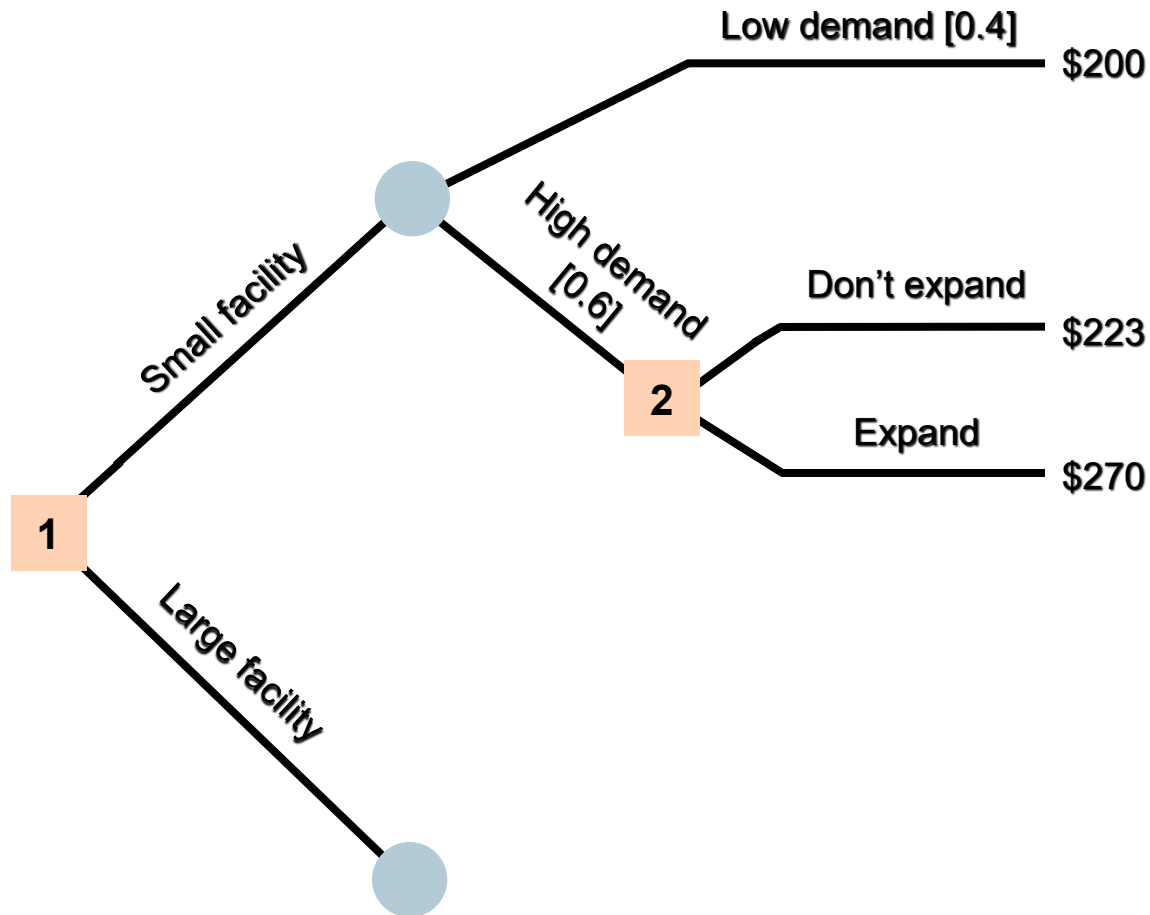
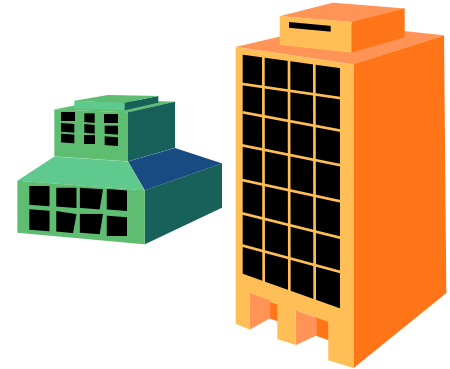


Decision Trees



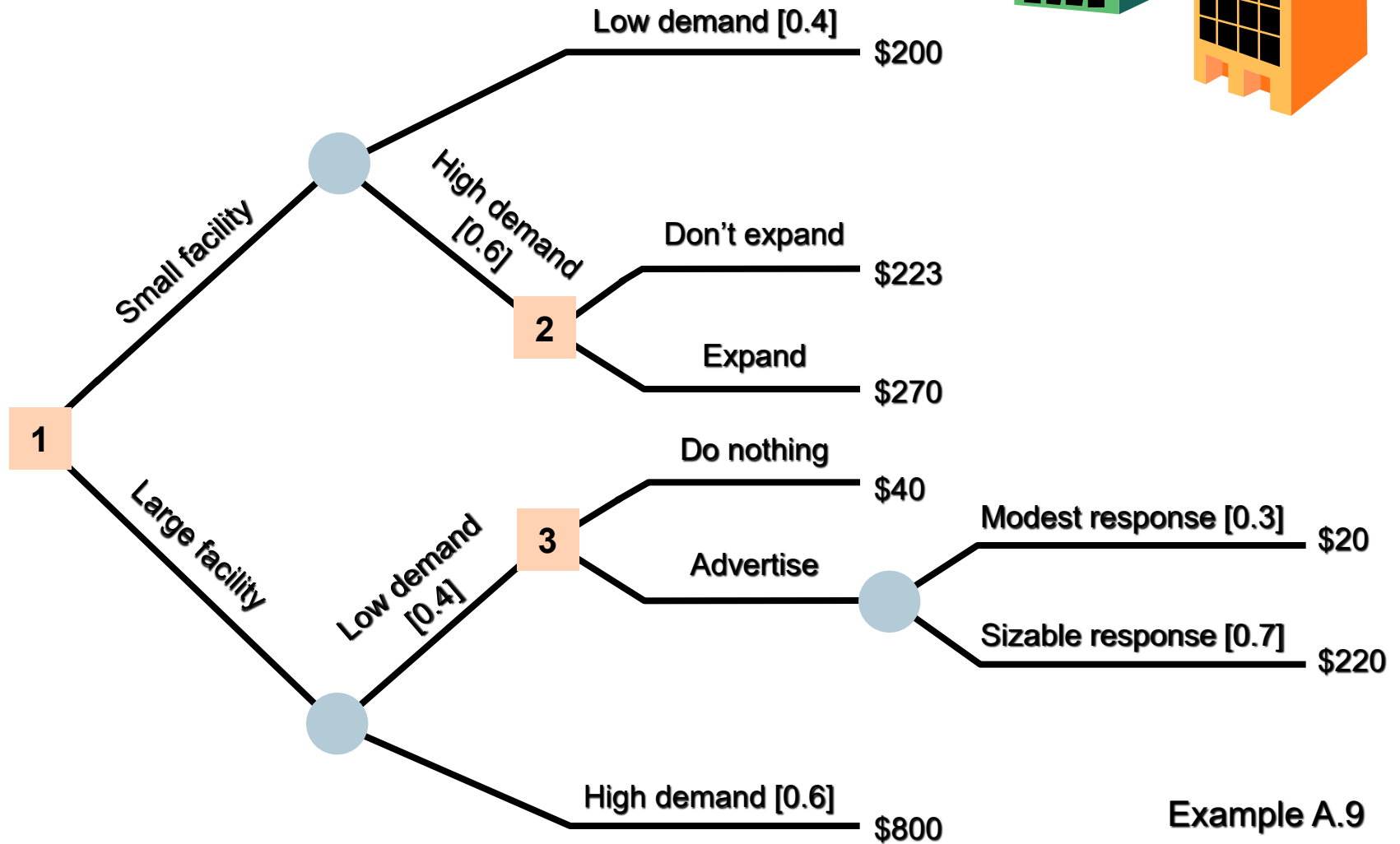
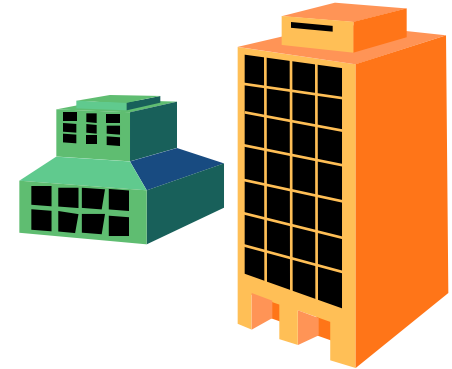
Example A.9

Decision Trees



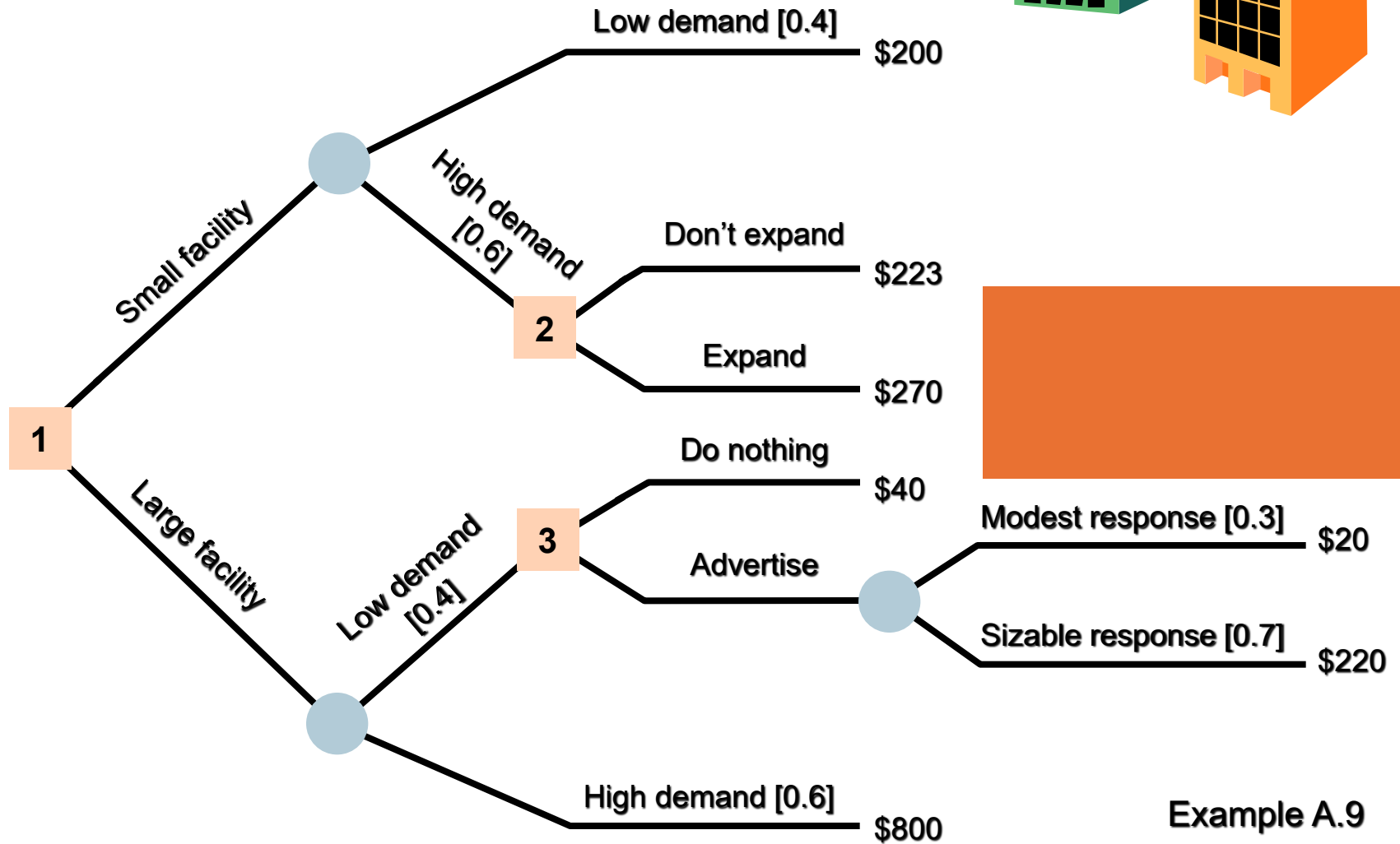
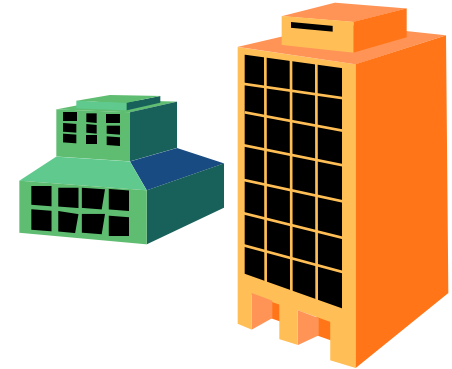
Example A.9

Decision Trees



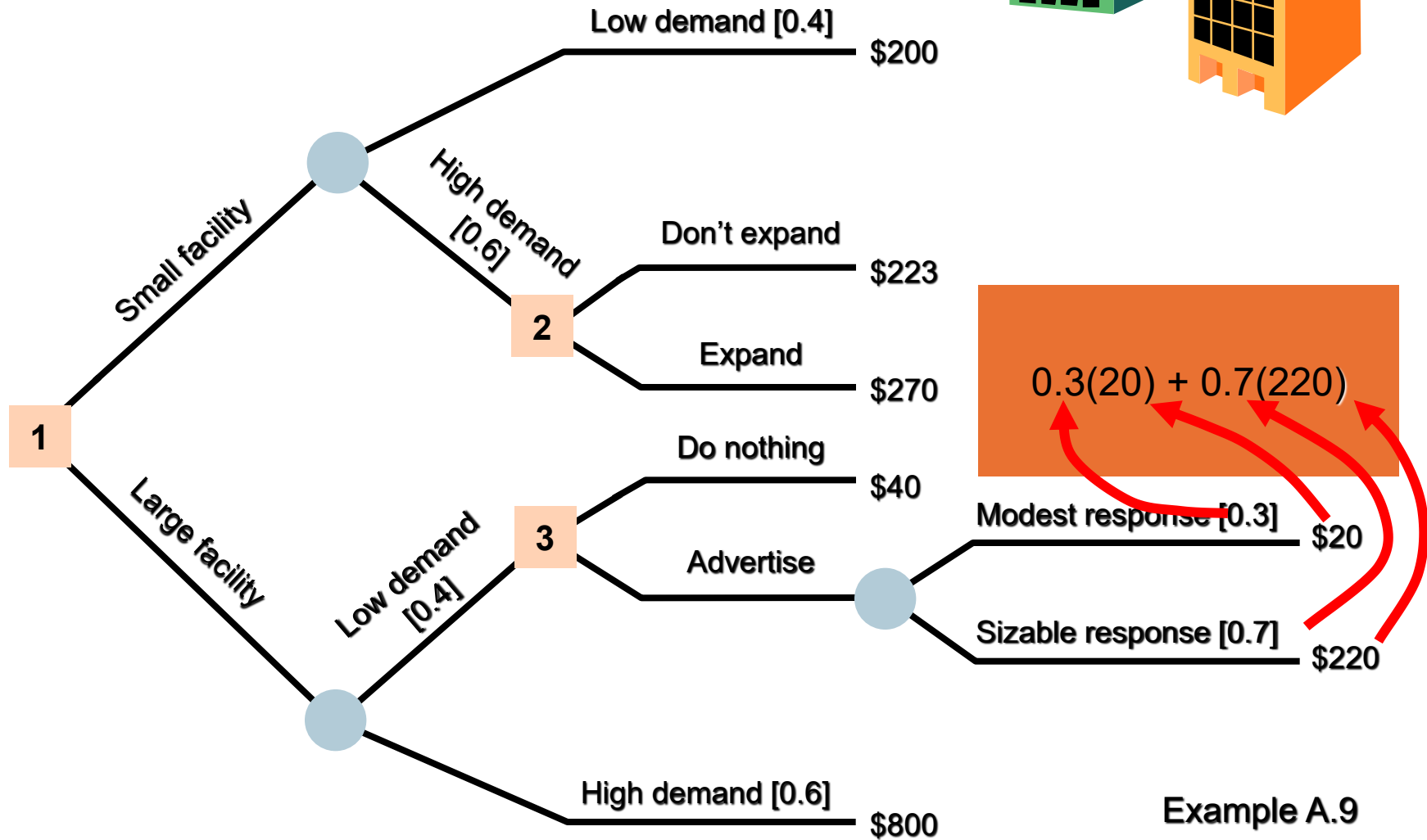
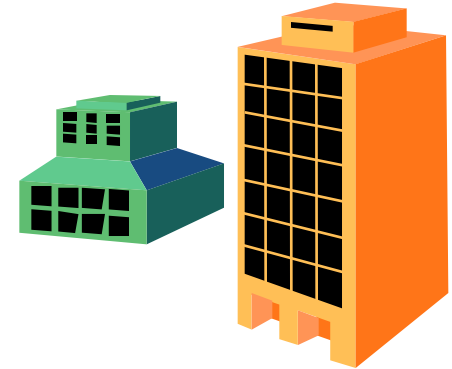
Example A.9

Decision Trees

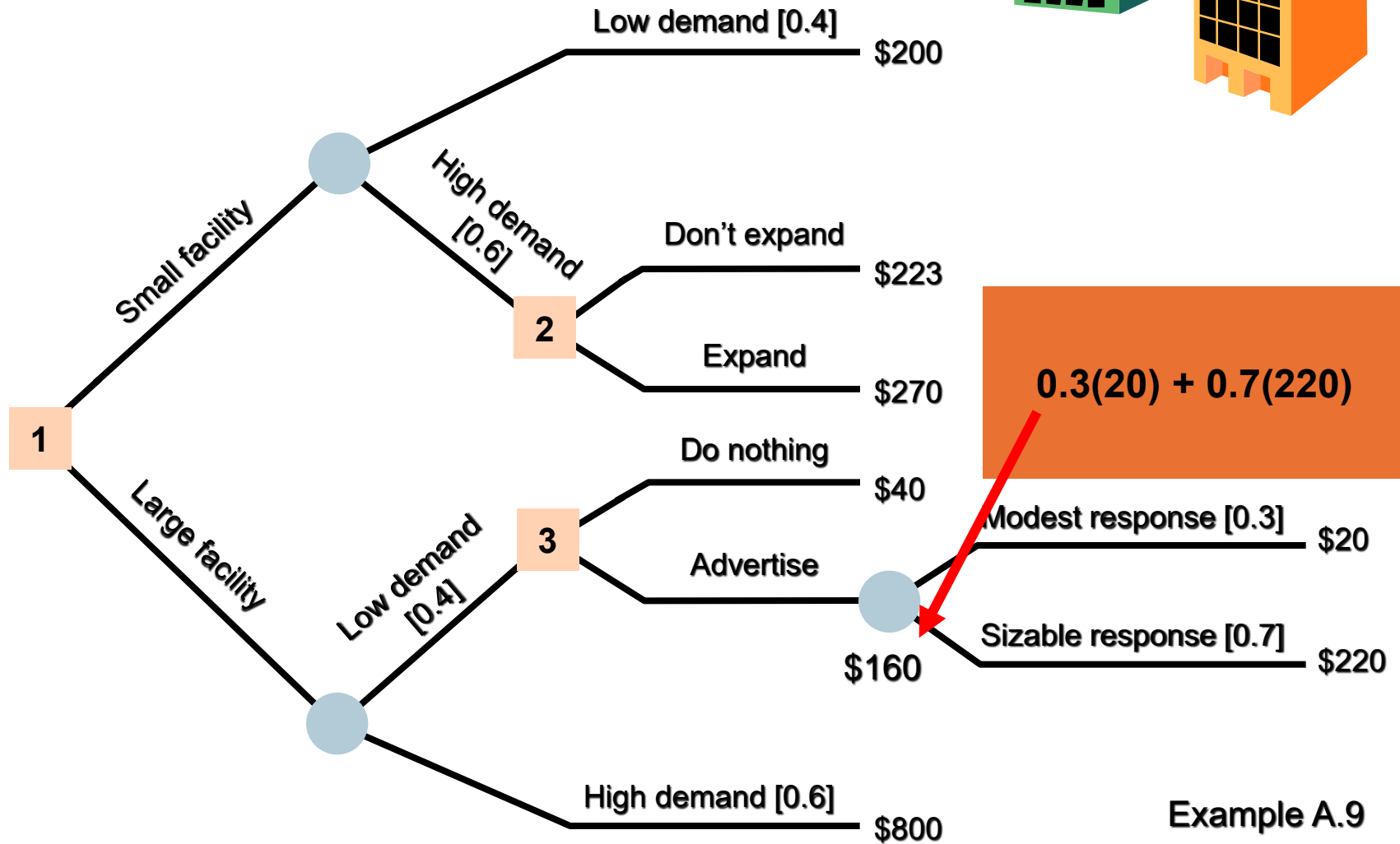
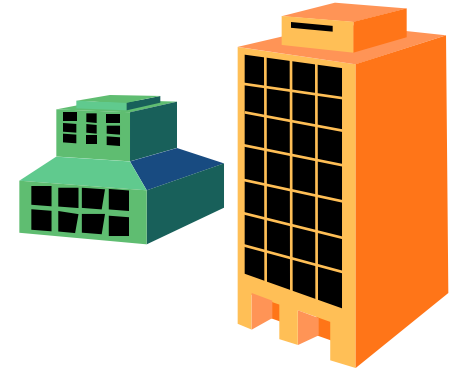


Example A.9

Decision Trees

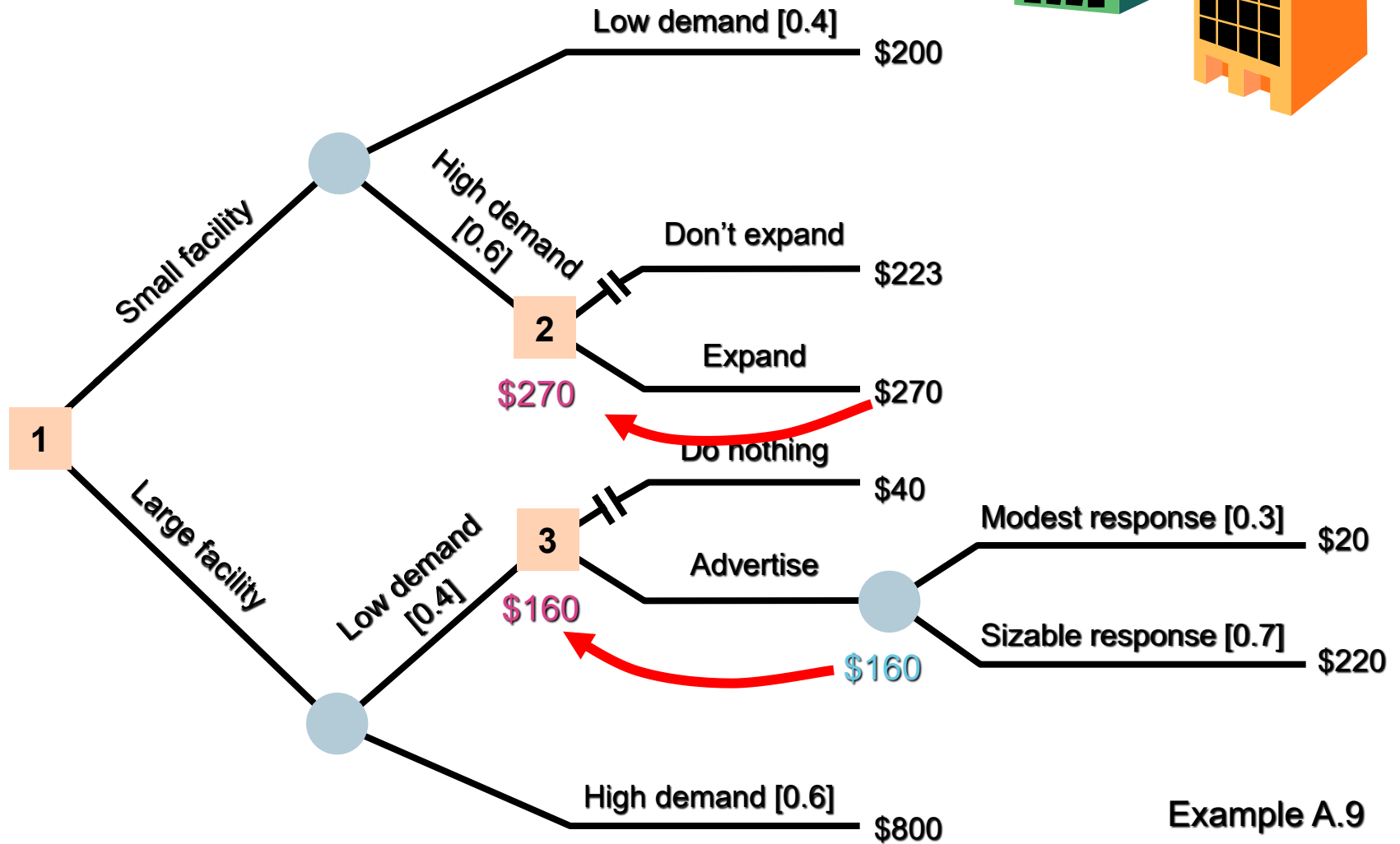
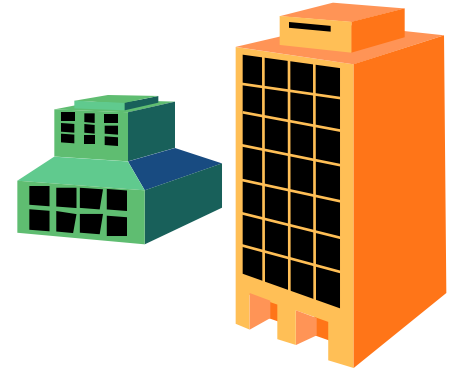


Decision Trees



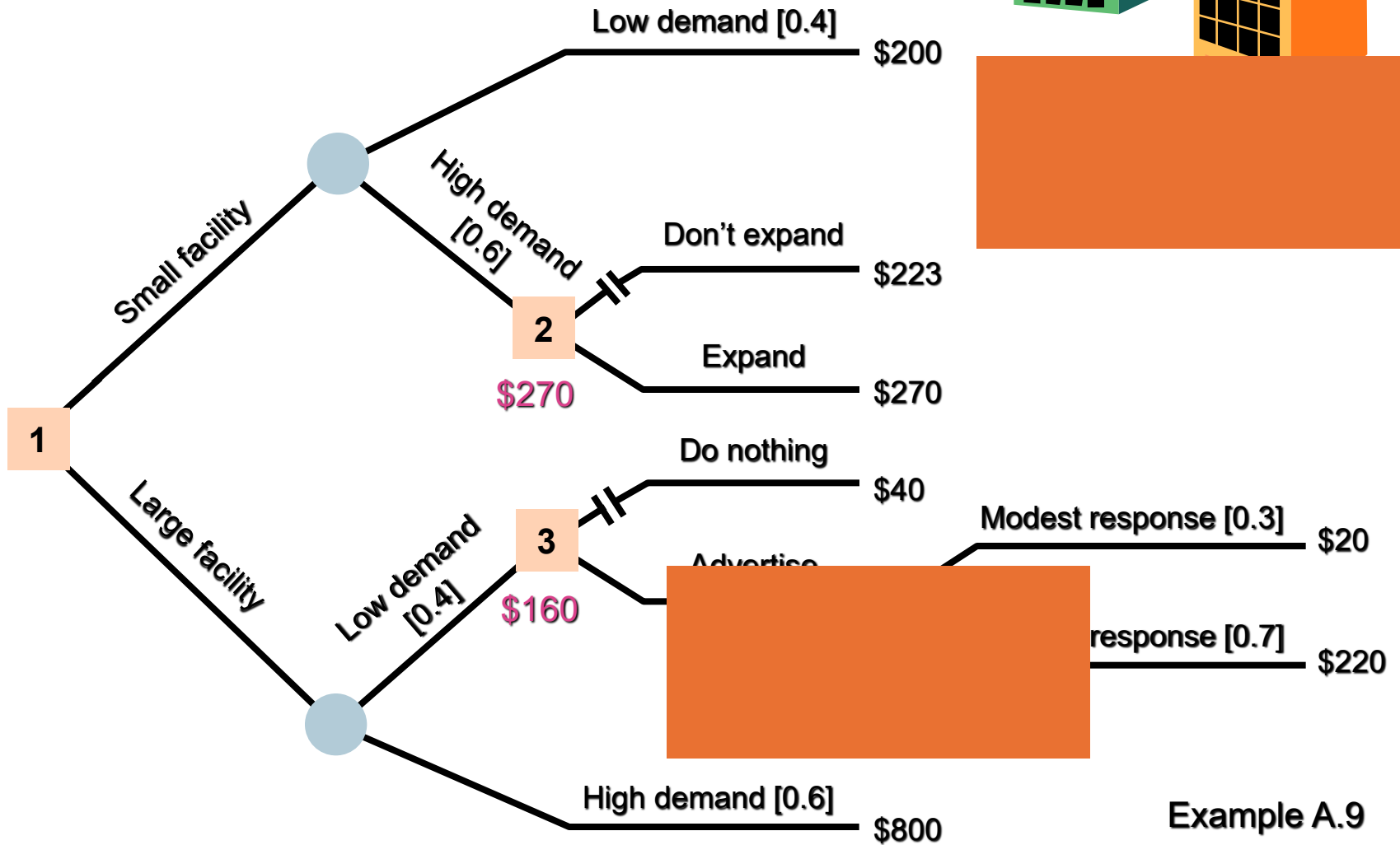
Example A.9

Decision Trees



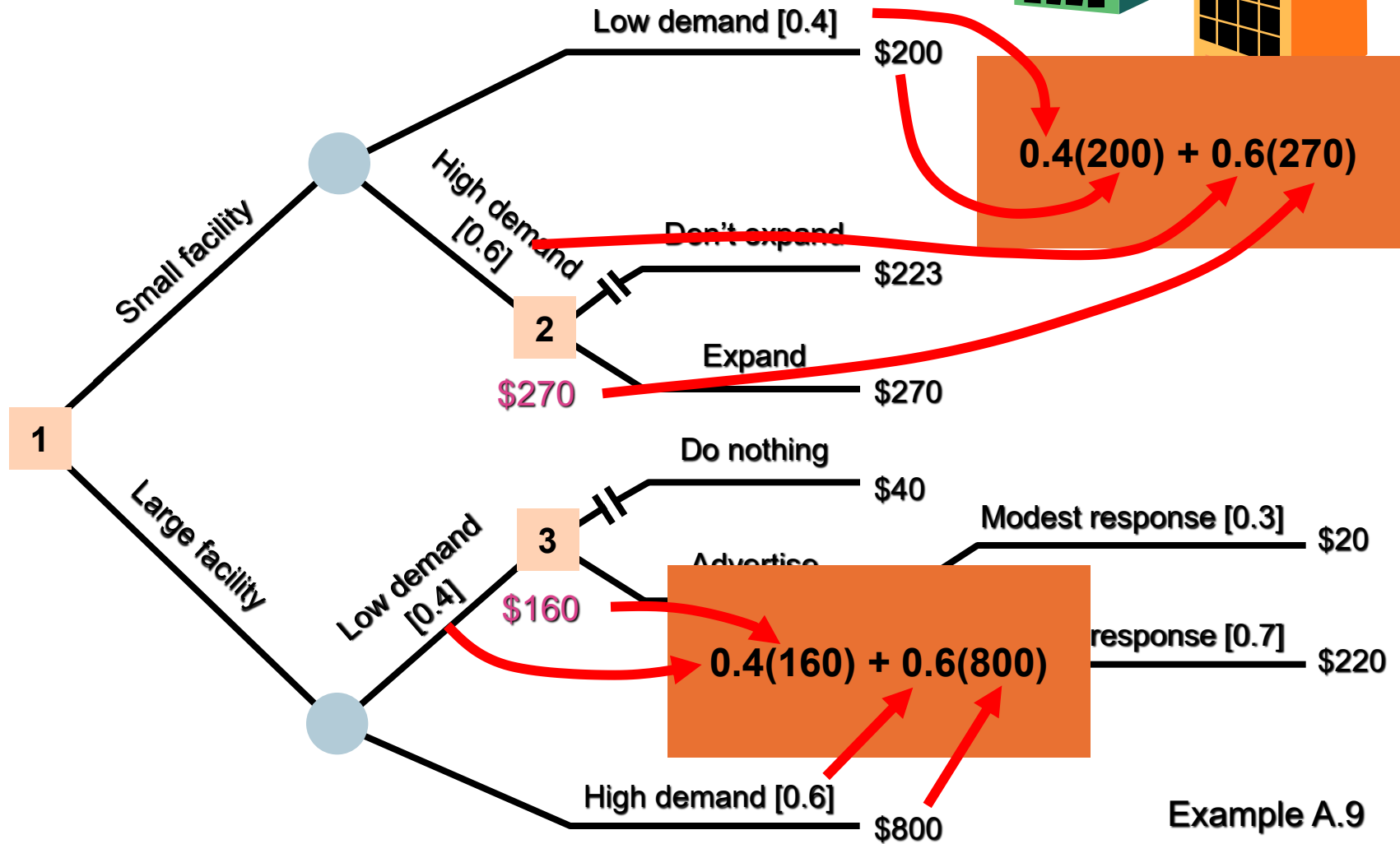
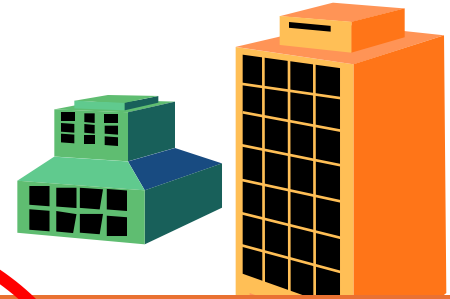
Example A.9

Decision Trees

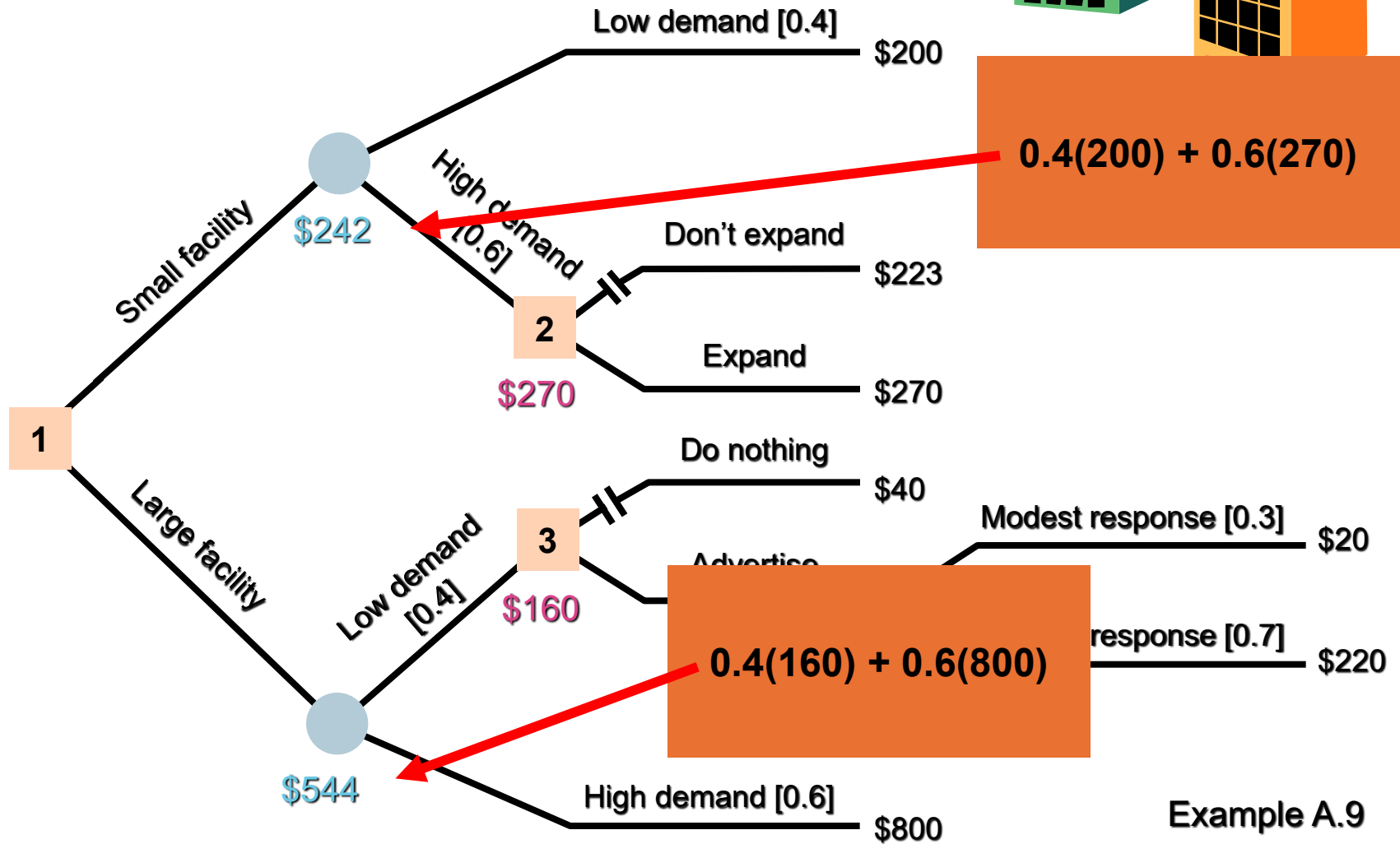
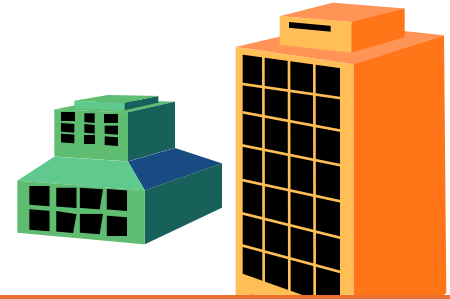


Example A.9

Decision Trees

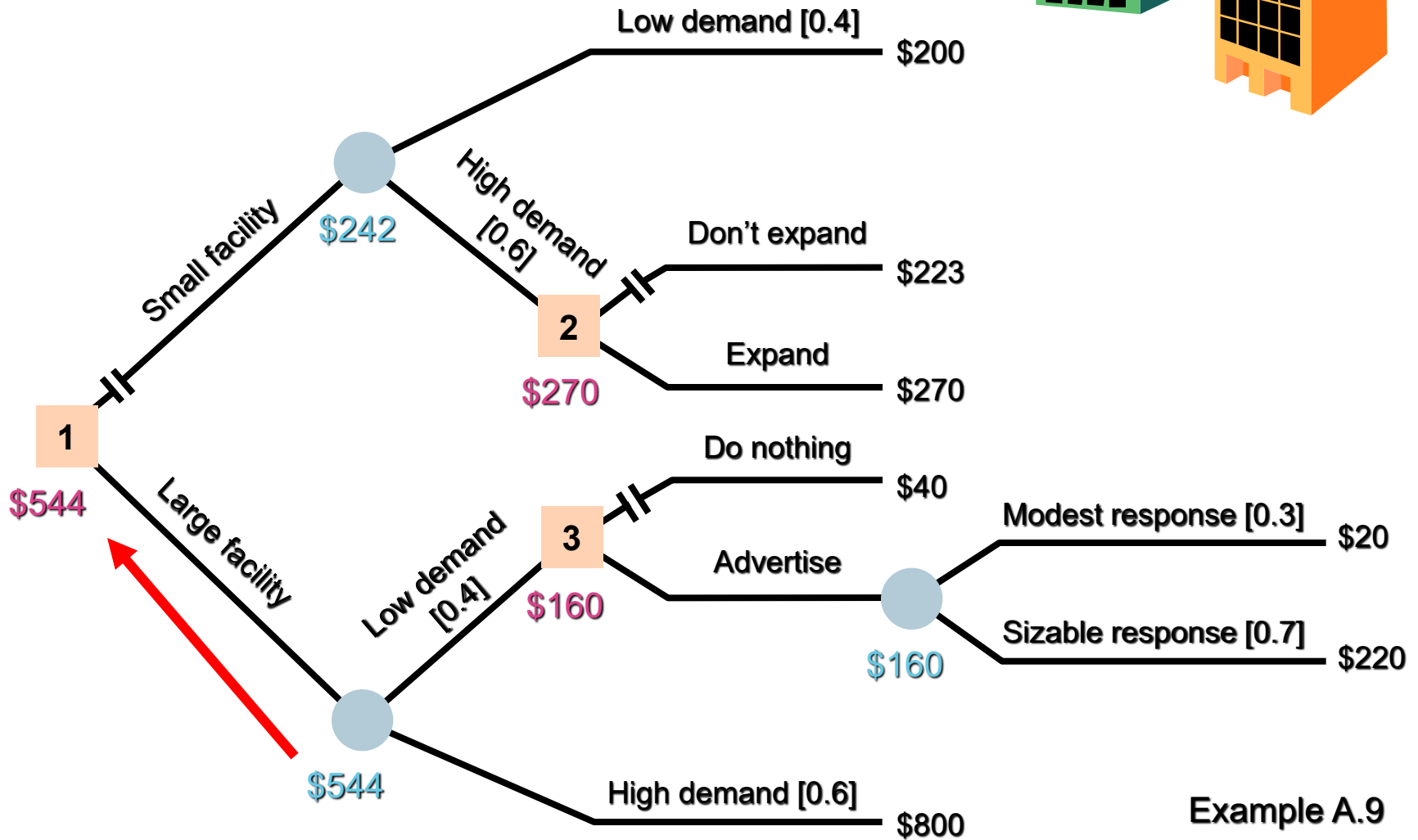
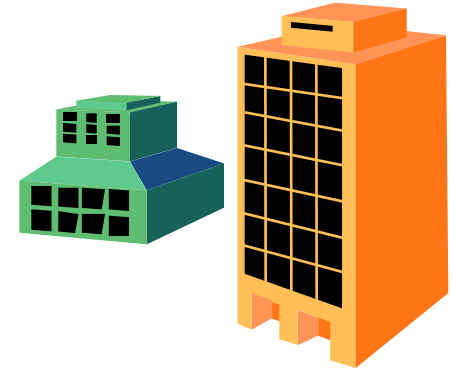


Decision Trees



Example A.9

Decision Trees



Decision Trees

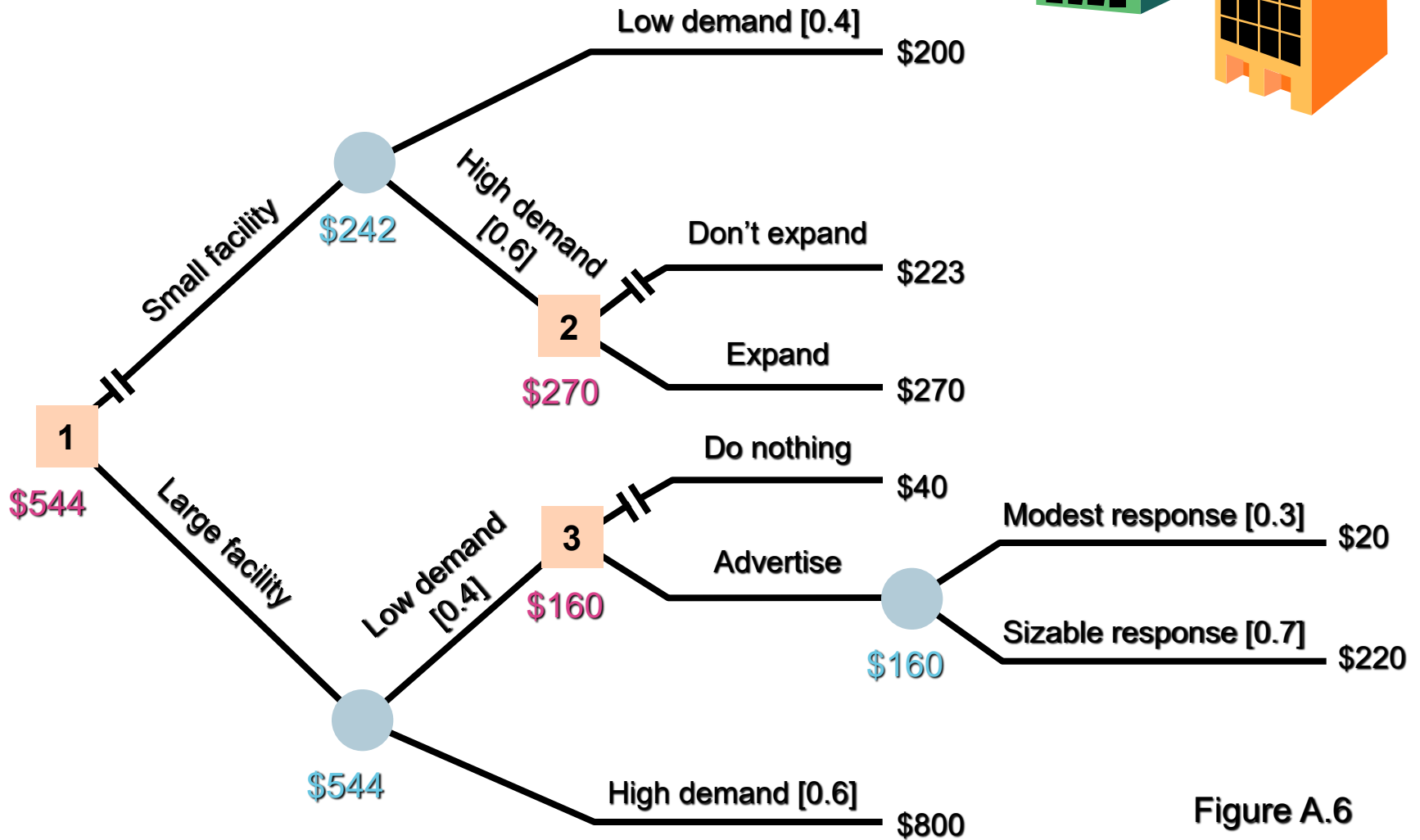
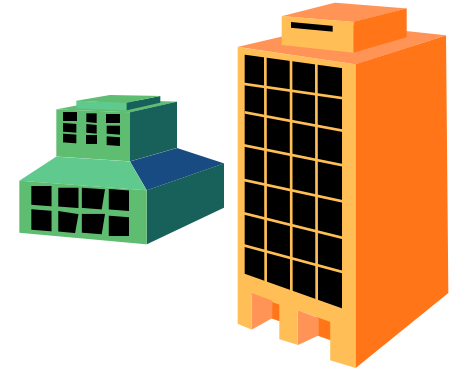


Figure A.6

NETWORK DESIGN DECISIONS

- Introducing method
 - Fixed and variable cost
 - Identified forecasts
 - One product
 - Total cost is fixed cost + unit variable cost x Quantity
 - Example and identification of equivalence levels
 - Best choice is



Fixed and variable cost

Site	Fixed cost	Variable cost
A	250 000 \$	11 \$ per unit
B	100 000 \$	30 \$ per unit
C	150 000 \$	20 \$ per unit
D	200 000 \$	35 \$ per unit

Site	Fixed cost	Variable cost ...	Total cost
A	250 000 \$	11x10 000 u	360 000 \$
B	100 000 \$	30x 10 000 u	400 000 \$
C	150 000 \$	20 x 10 000 u	350 000 \$
D	200 000 \$	35 x 10 000 u	550 000 \$

Let's come back to break even

$$100\,000 \$ + 30 \$ \times Q = 150\,000 \$ + 20 \$ \times Q \quad Q = 5000 \text{ u}$$

$$150\,000 \$ + 20 \$ \times Q = 250\,000 \$ + 11 \$ \times Q \quad Q = 11\,111 \text{ u}$$

$$100\,000 \$ + 30 \$ \times Q = 250\,000 \$ + 11 \$ \times Q \quad Q = 7\,895 \text{ u}$$

NETWORK DESIGN DECISIONS

Transport cost

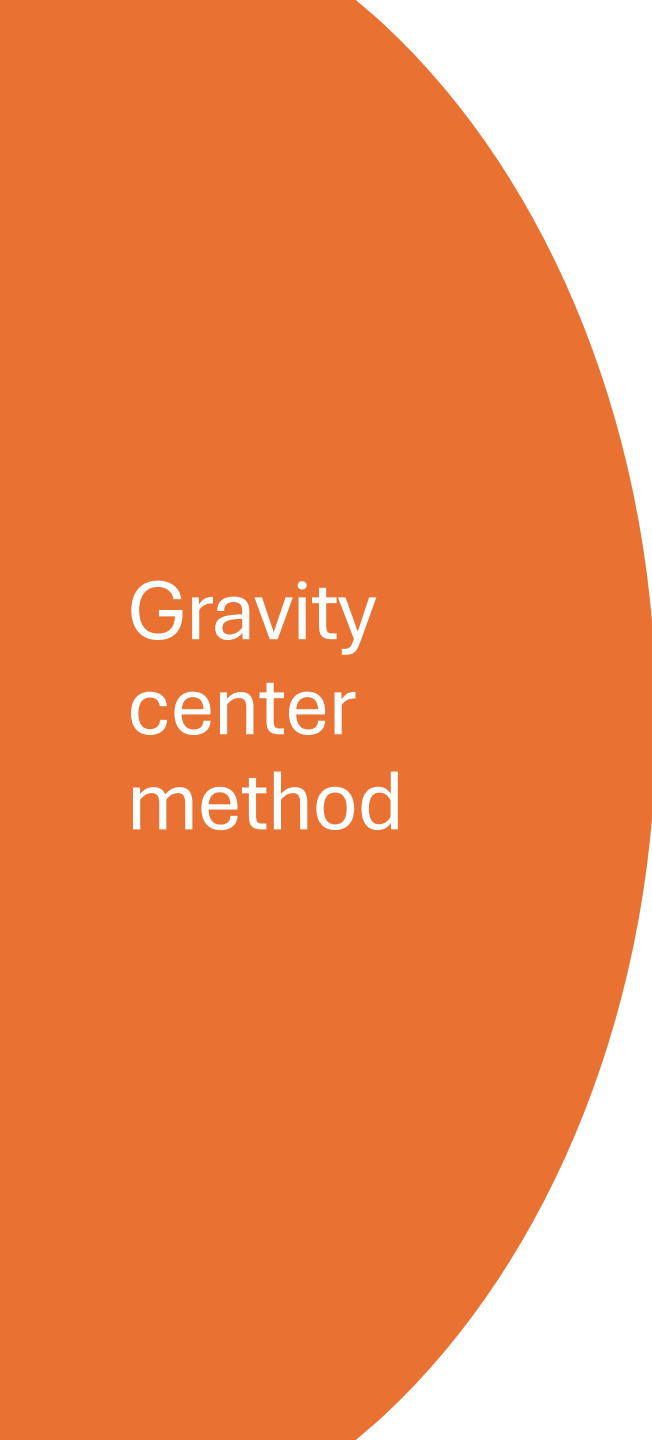
- Impact
- Finished goods flows
- Raw materials
- Multi choice to be solved through transport model

Weighing method

- Relevant factors
- Weighing

Gravity center method

- Geographical coordinates



Gravity center method

Coordinates of x,y

Average of x = Sum of x_i / n destinations

Average of y = sum of y_i / n destinations

Average of x,y will be optimum location

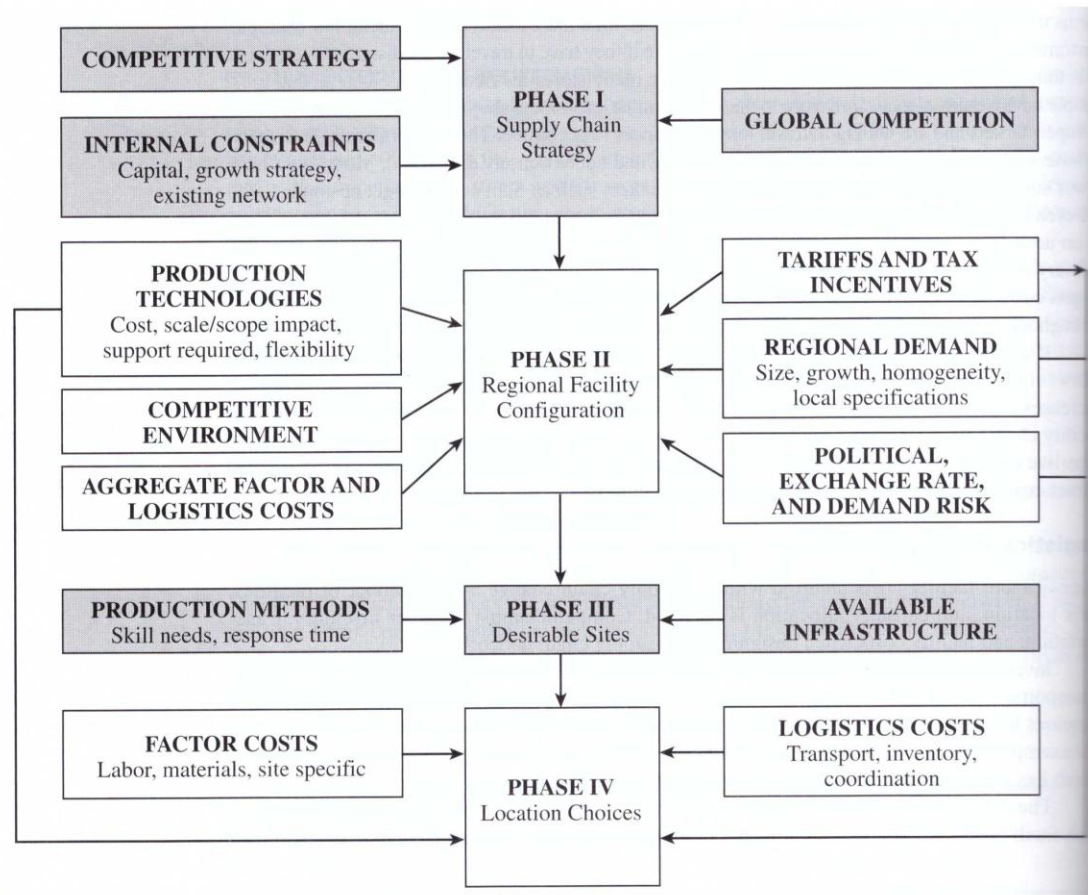


BUT
we have to
take into
account
quantities
carried

- Average of x becomes
 $\text{sum of } x_i \cdot Q_i / \text{sum } Q_i$
- Average of y becomes
 $\text{sum of } y_i \cdot Q_i / \text{sum } Q_i$



NETWORK DESIGN DECISIONS





Together

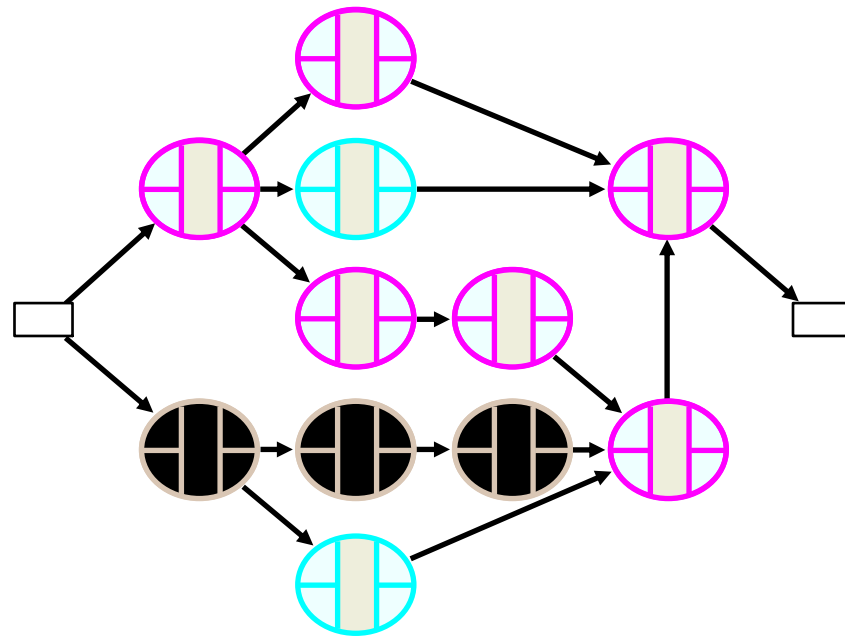
Route Optimization

Your company needs to transport goods from a manufacturing plant in Vietnam to distribution centers in Europe. Due to rising fuel prices and environmental regulations, optimizing transportation routes is crucial.

Questions:

- 
- 
- 
- 
- Which criteria will you prioritize in your route optimization (cost, time, environmental impact)?
 - What alternative transportation methods could you consider (e.g., sea, air, rail)?
 - How will you balance the trade-offs between cost, speed, and sustainability?

Planning and Managing Projects



Activity Relationships

Activity Relationship

AOA	AON

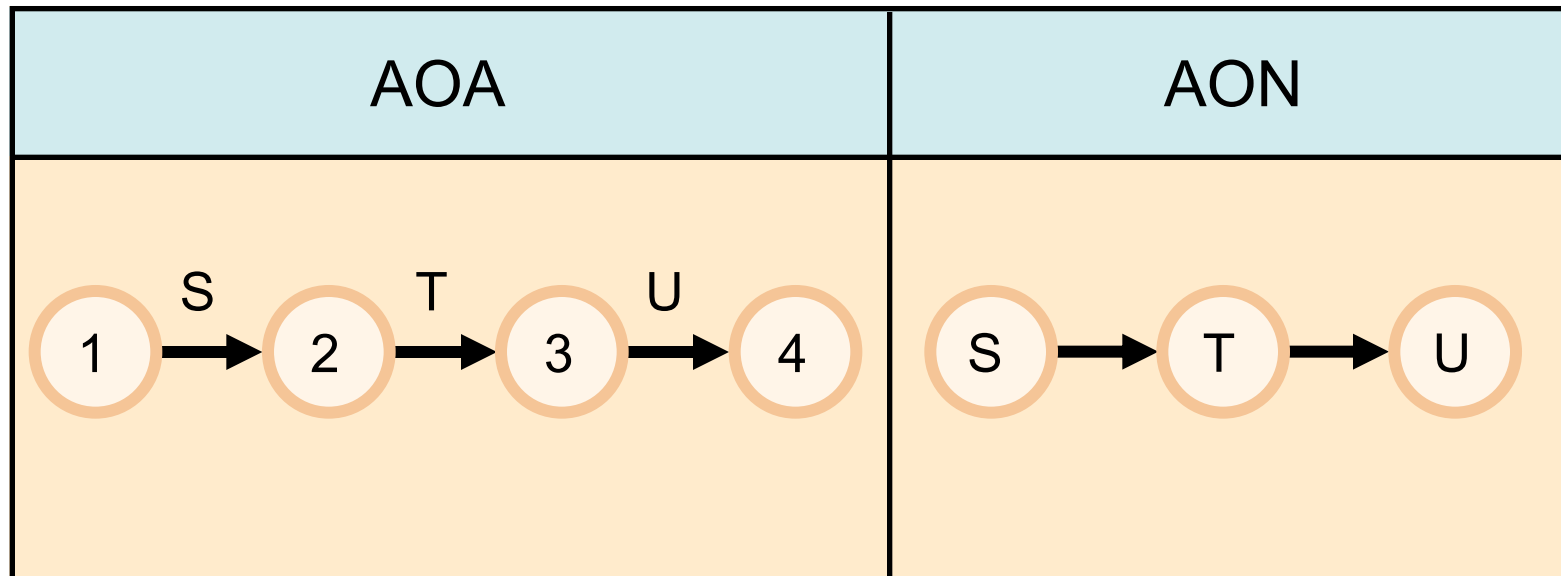
Activity on Arc

Activity on Network

Activity Relationships

Activity Relationship

S precedes T, which precedes U.



Activity on Arc

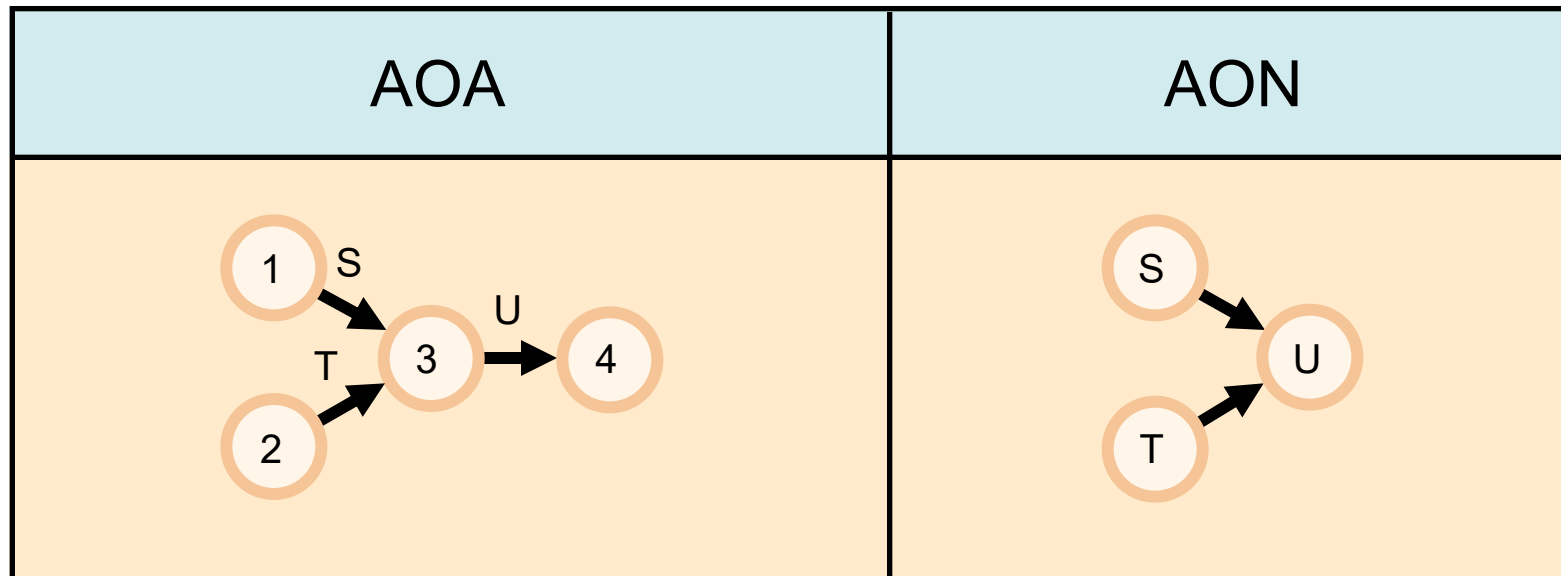
To Accompany Krajewski & Ritzman, *Operations Management: Strategy and Analysis*, 10th Edition
2004 Prentice Hall, Inc. All rights reserved.

Activity on Network

Activity Relationships

Activity Relationship

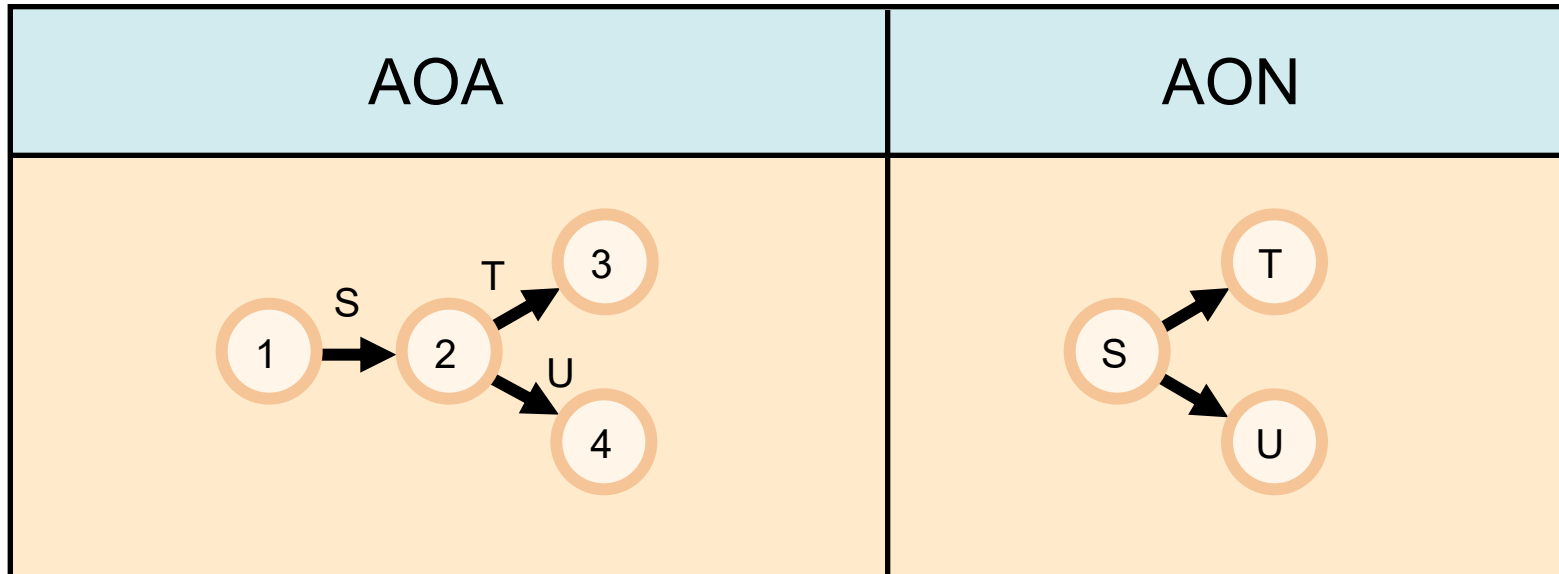
S and T must be completed before U can be started.



Activity Relationships

Activity Relationship

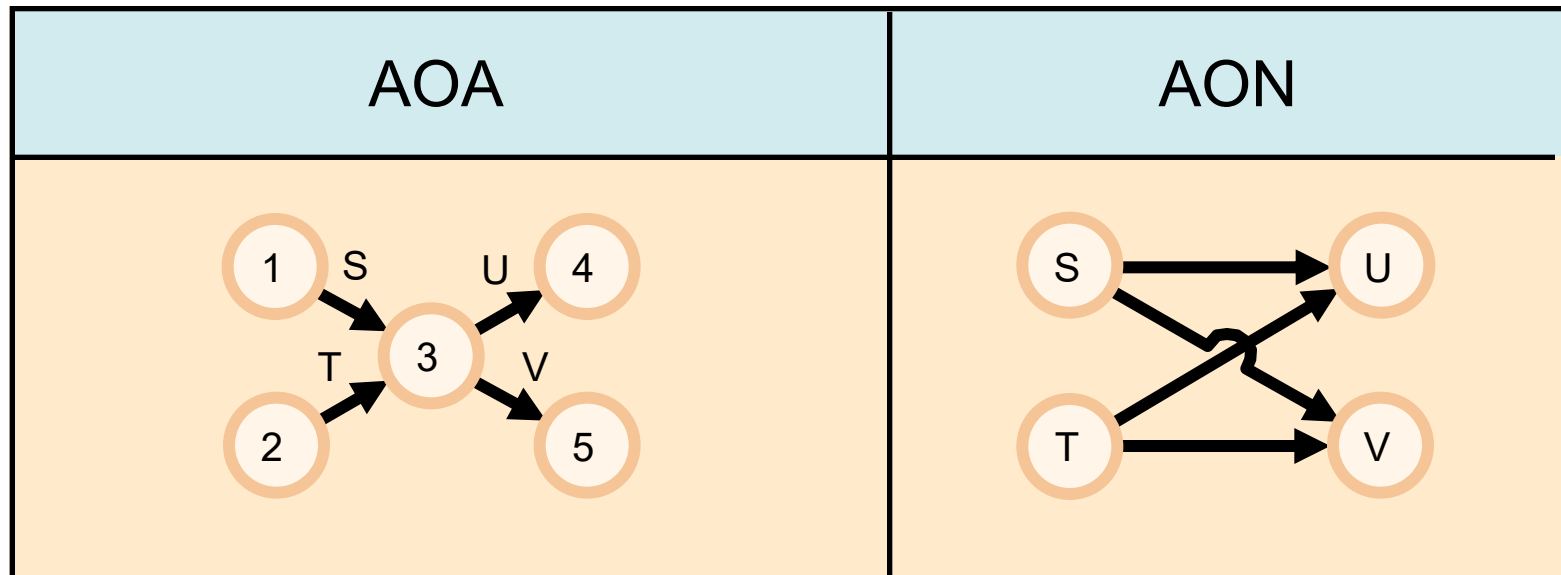
T and U cannot begin until S has been completed.



Activity Relationships

Activity Relationship

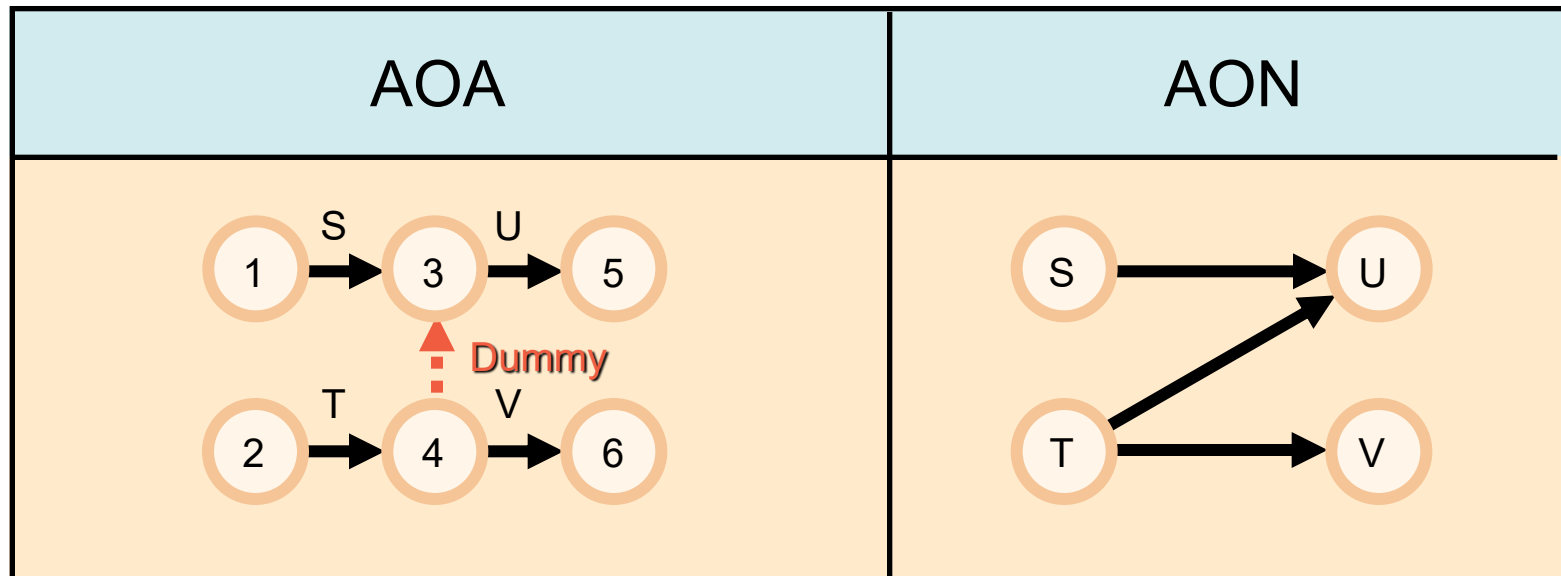
U and V cannot begin until both S and T have been completed.



Activity Relationships

Activity Relationship

U cannot begin until both S and T have been completed; V cannot begin until T has been completed.



Activity Relationships

Activity Relationship

T and U cannot begin until S has been completed; V cannot begin until both T and U have been completed.

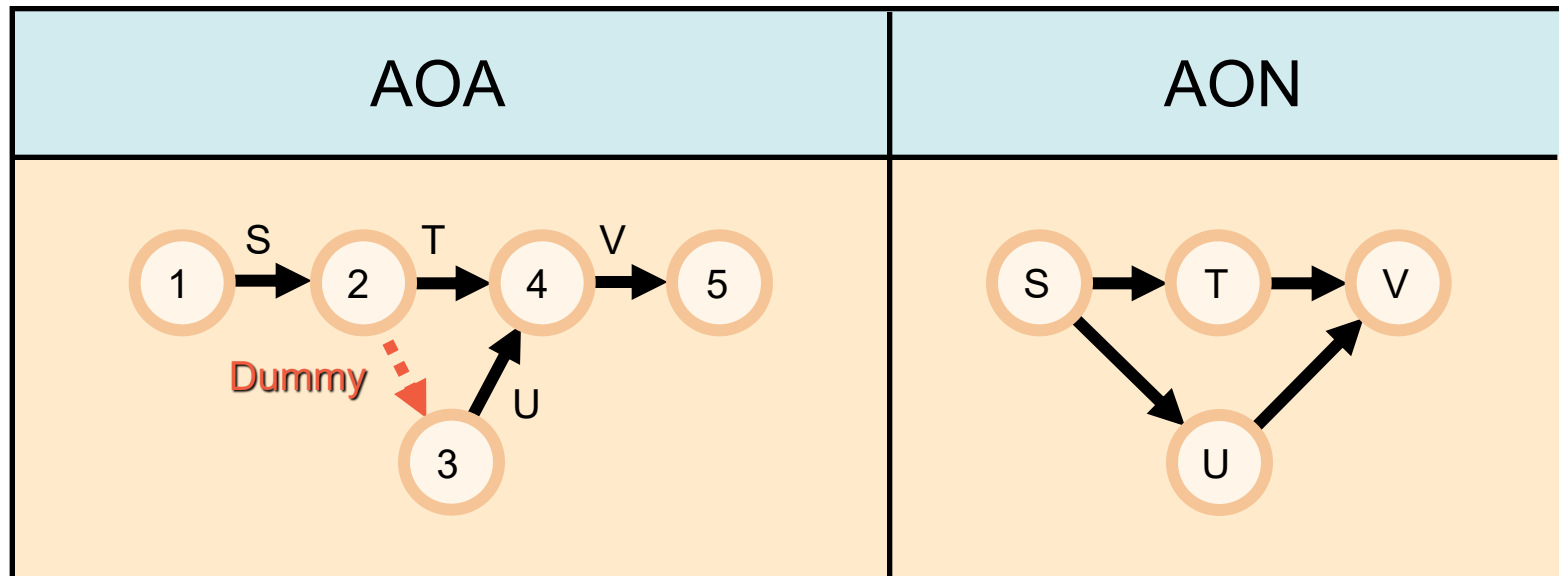


Figure 8.3

St. Adolf's Hospital



St. Adolf's Hospital



Activity	Description	Immediate Predecessor(s)	Responsibility
A	Select administrative and medical staff.		
B	Select site and do site survey.		
C	Select equipment.		
D	Prepare final construction plans and layout.		
E	Bring utilities to the site.		
F	Interview applicants and fill positions in nursing, support staff, maintenance, and security.		
G	Purchase and take delivery of equipment.		
H	Construct the hospital.		
I	Develop an information system.		
J	Install the equipment.		
K	Train nurses and support staff.		

St. Adolf's Hospital



Activity	Description	Immediate Predecessor(s)	Responsibility
A	Select administrative and medical staff.	—	Johnson
B	Select site and do site survey.	—	Taylor
C	Select equipment.	A	Adams
D	Prepare final construction plans and layout.	B	Taylor
E	Bring utilities to the site.	B	Burton
F	Interview applicants and fill positions in nursing, support staff, maintenance, and security.	A	Johnson
G	Purchase and take delivery of equipment.	C	Adams
H	Construct the hospital.	D	Taylor
I	Develop an information system.	A	Simmons
J	Install the equipment.	E,G,H	Adams
K	Train nurses and support staff.	F,I,J	Johnson

St. Adolf's Hospital



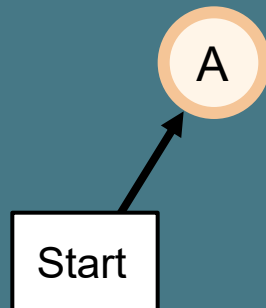
AON Network

Activity	Description	Immediate Predecessor(s)	Responsibility
A	Select administrative and medical staff.	—	Johnson
B	Select site and do site survey.	—	Taylor
C	Select equipment.	A	Adams
D	Prepare final construction plans and layout.	B	Taylor
E	Bring utilities to the site.	B	Burton
F	Interview applicants and fill positions in nursing, support staff, maintenance, and security.	A	Johnson
G	Purchase and take delivery of equipment.	C	Adams
H	Construct the hospital.	D	Taylor
I	Develop an information system.	A	Simmons
J	Install the equipment.	E,G,H	Adams
K	Train nurses and support staff.	F,I,J	Johnson

St. Adolf's Hospital



AON Network



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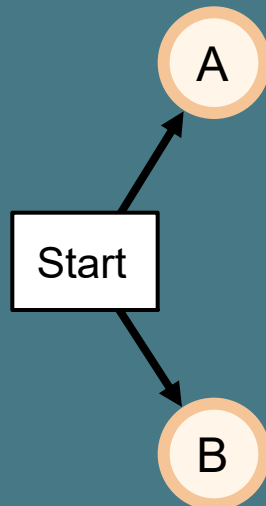
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St. Adolf's Hospital



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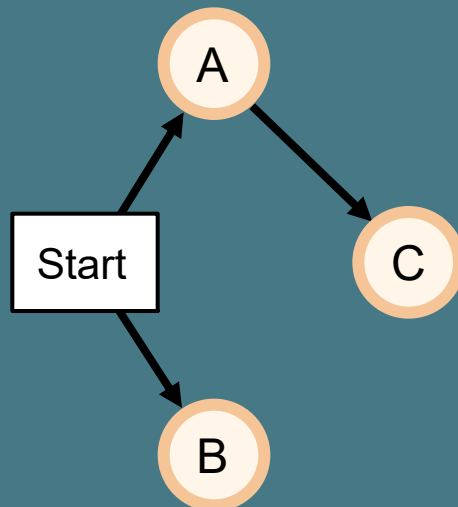
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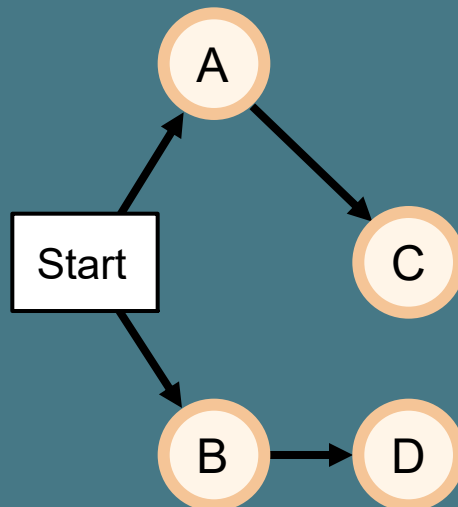
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St. Adolf's Hospital



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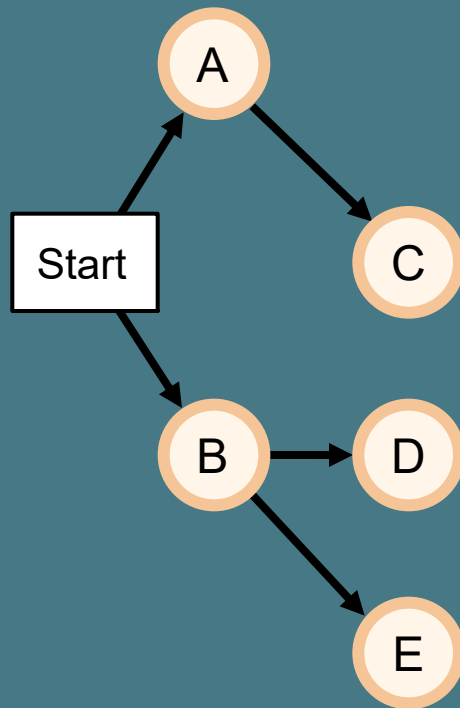
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St. Adolf's Hospital



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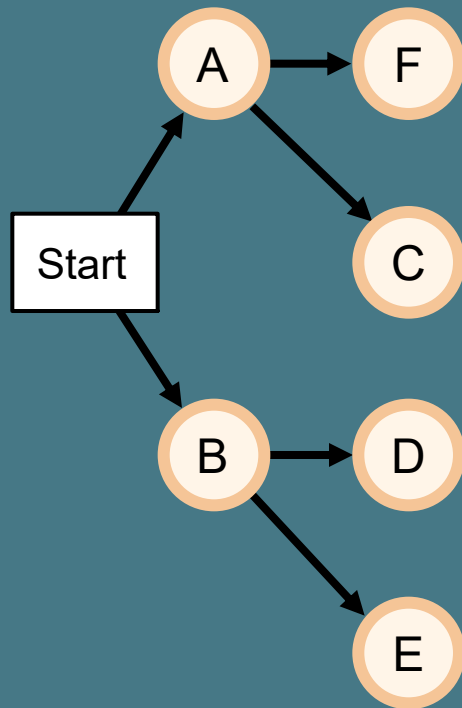
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St. Adolf's Hospital



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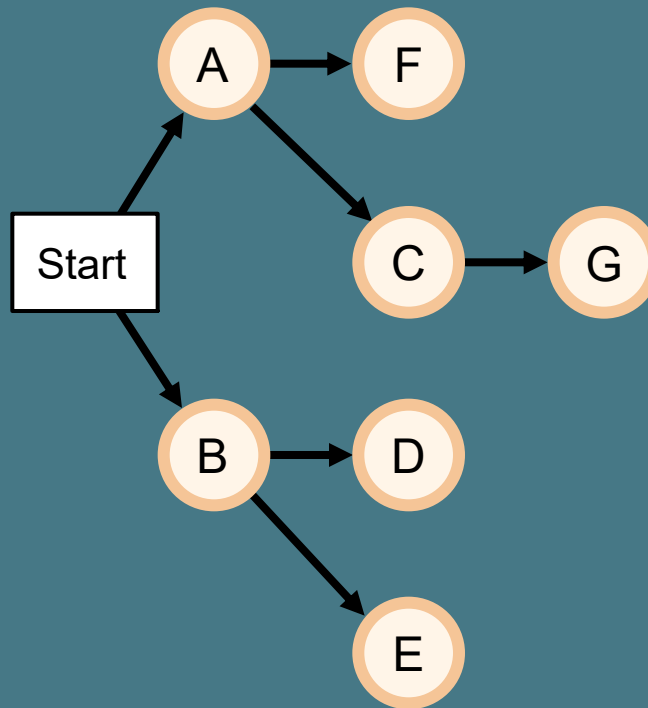
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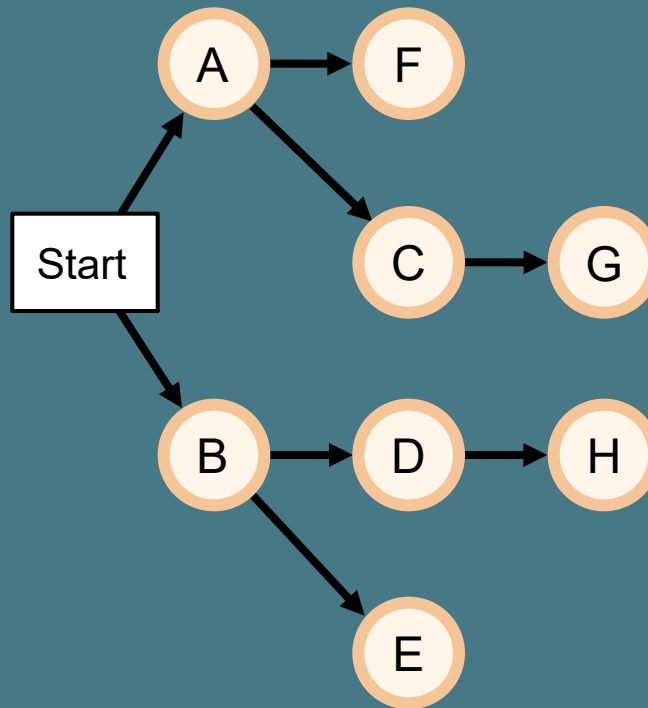
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St. Adolf's Hospital



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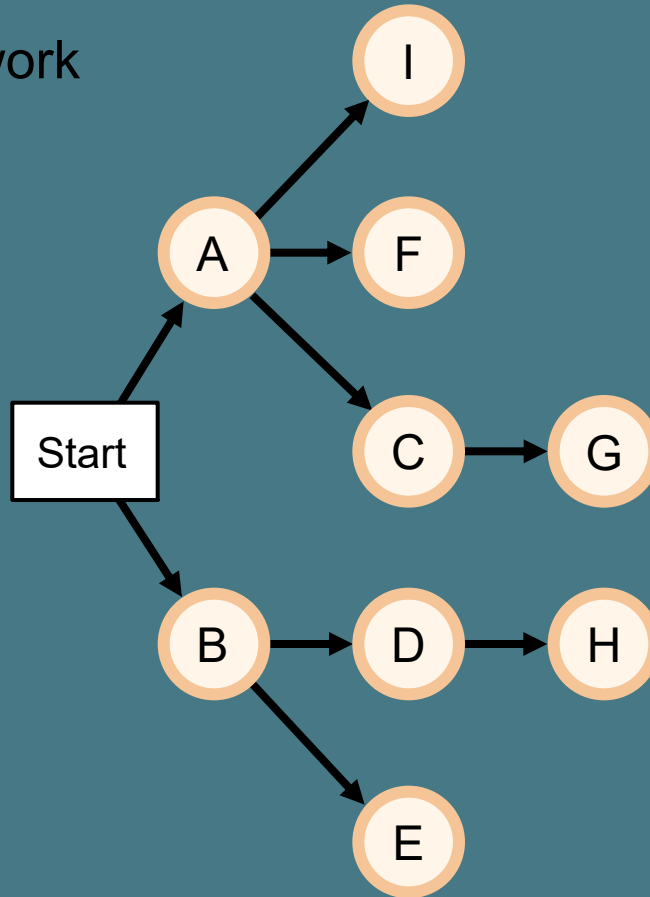
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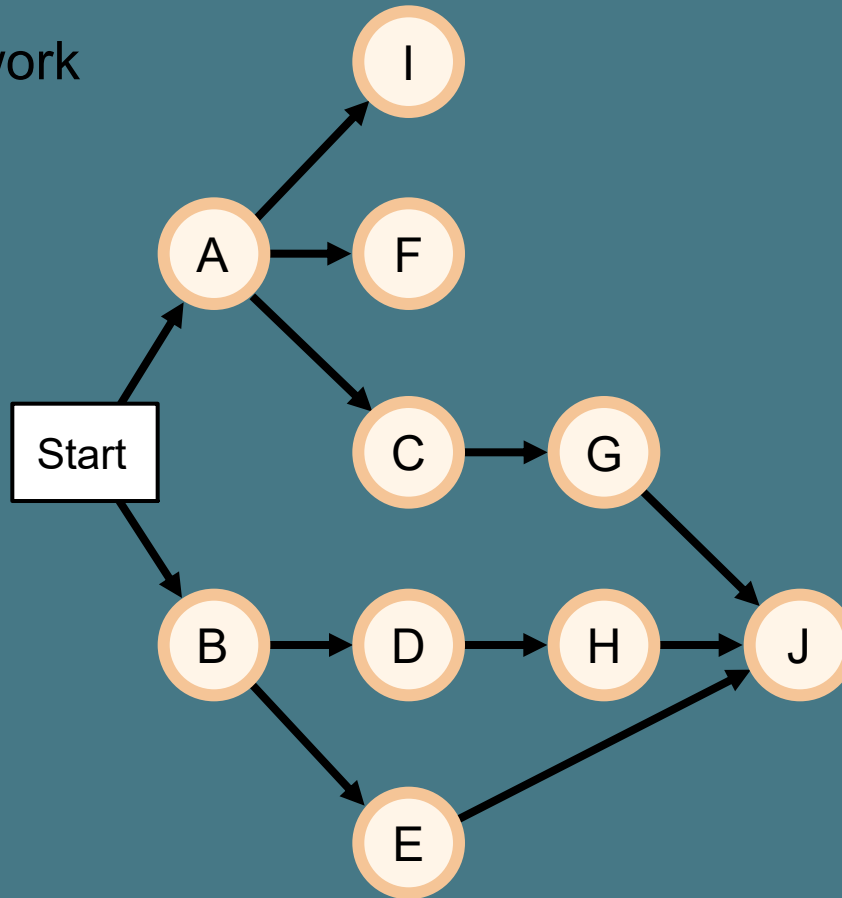
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St. Adolf's Hospital



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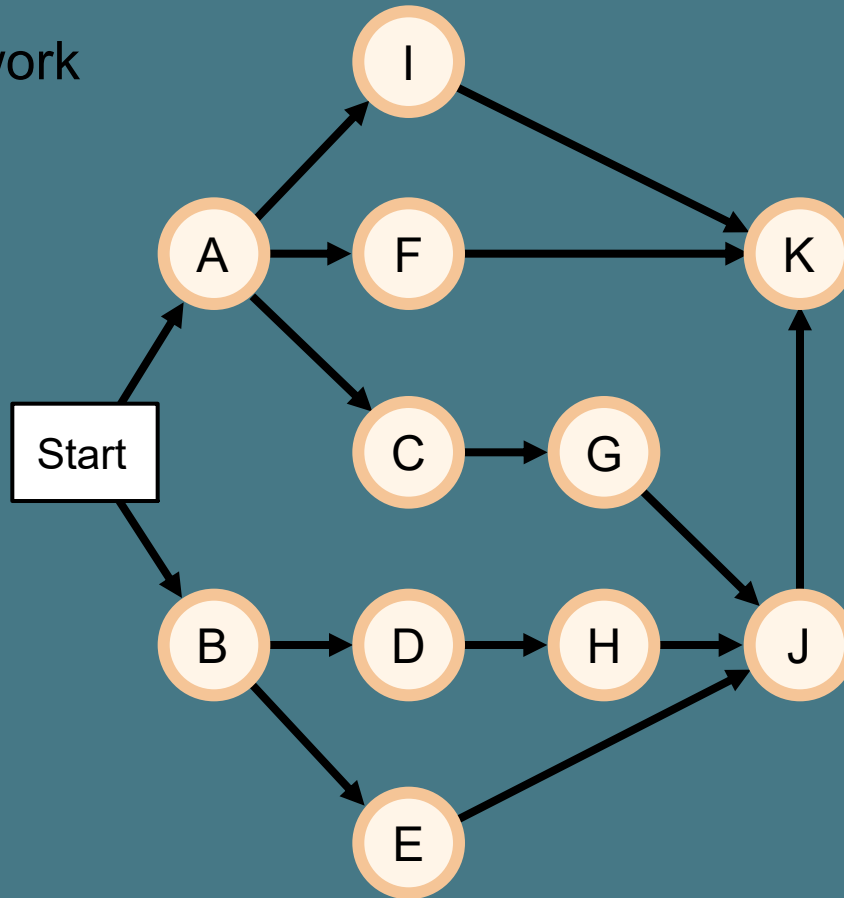
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St. Adolf's Hospital



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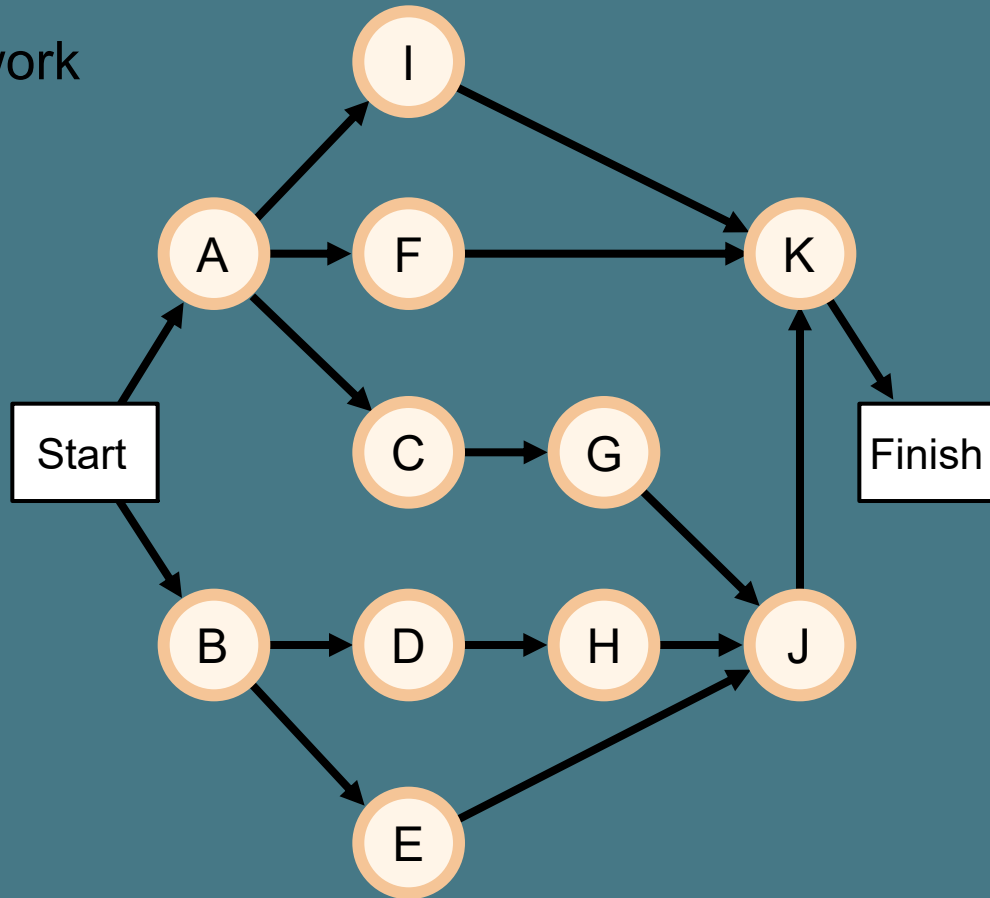
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St. Adolf's Hospital



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St. Adolf's Hospital



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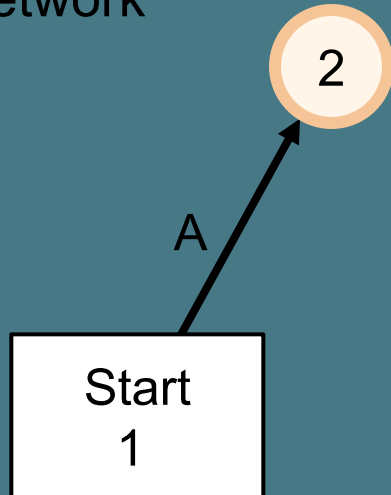
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St. Adolf's Hospital



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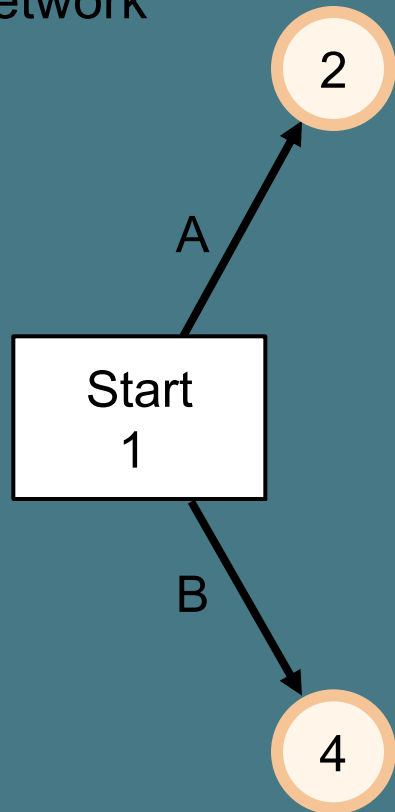
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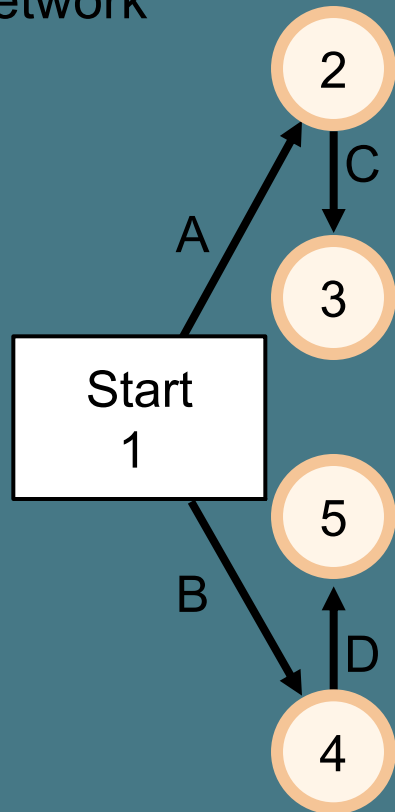
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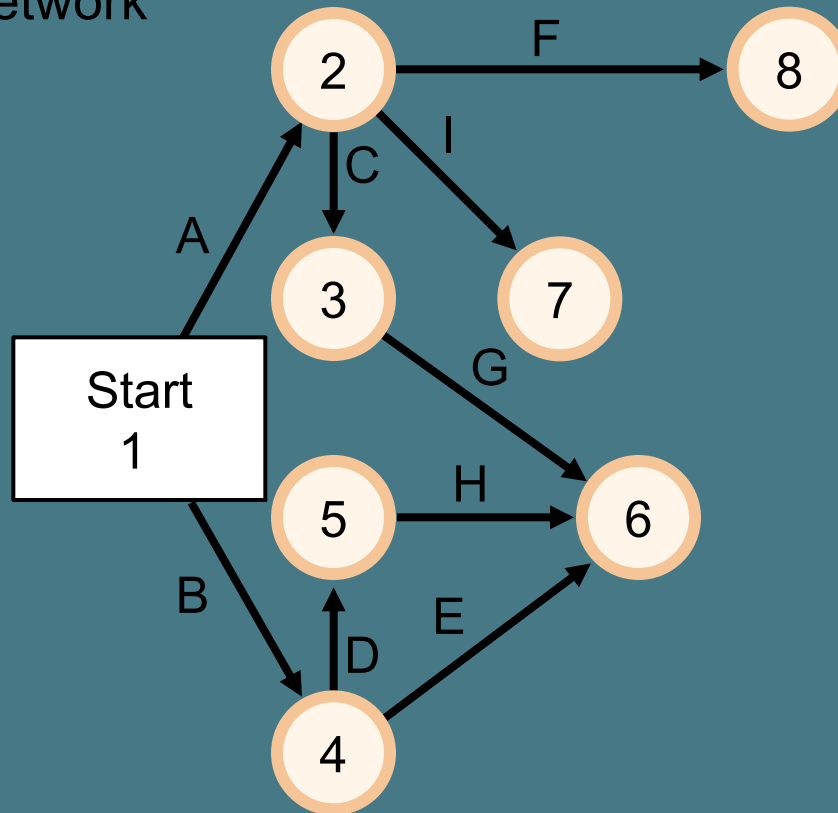
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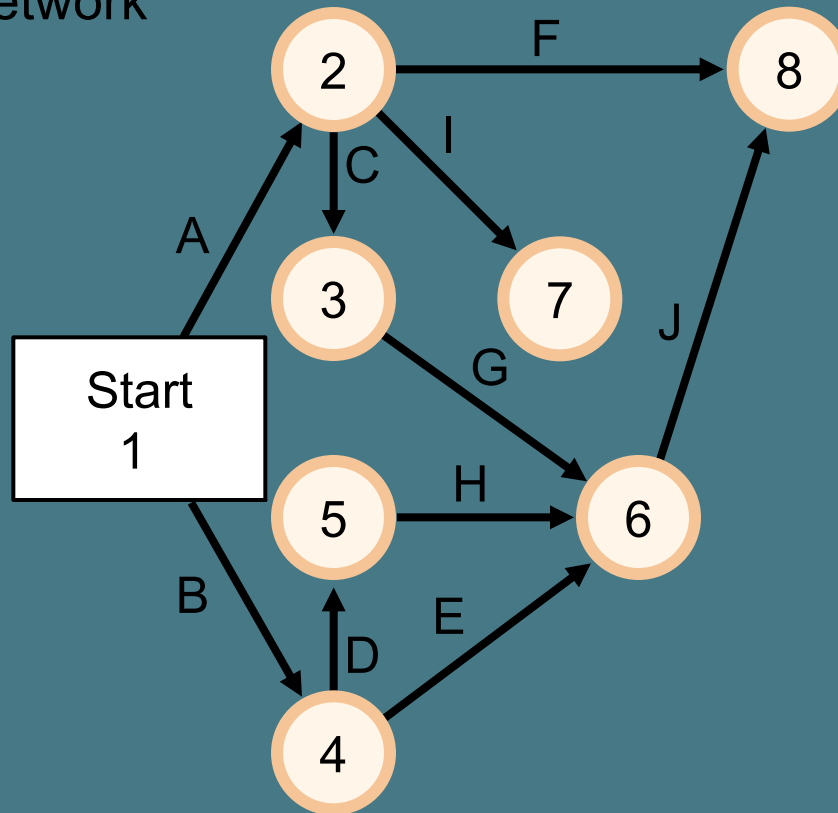
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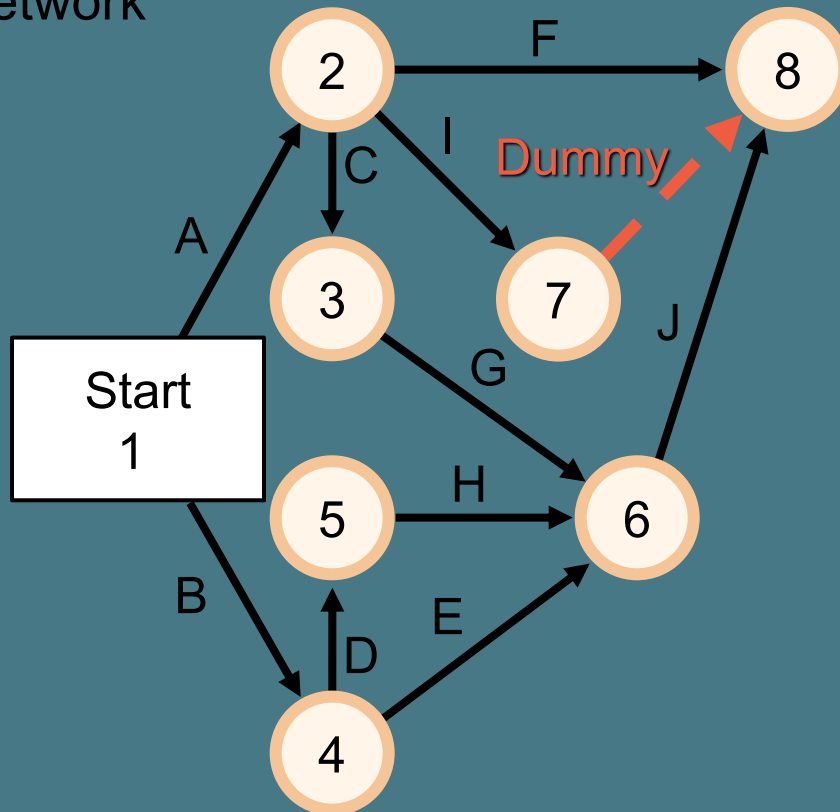
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AOA Network



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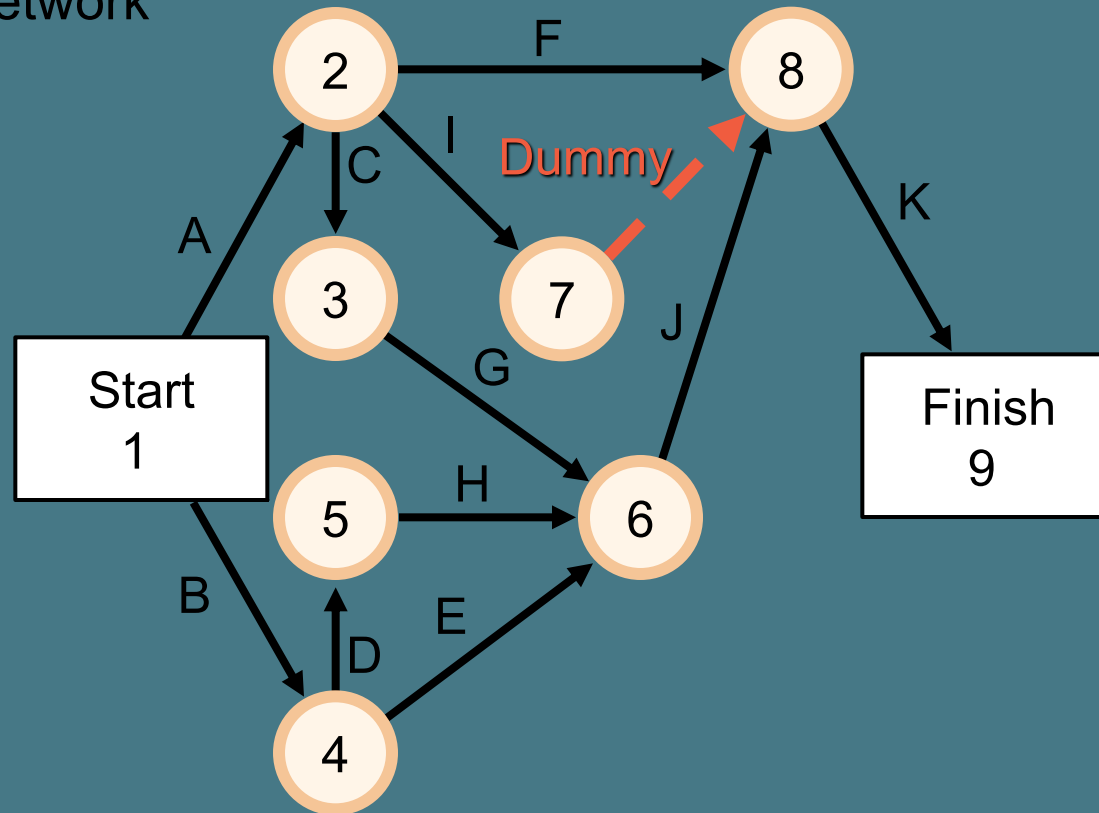
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St. Adolf's Hospital



AOA Network

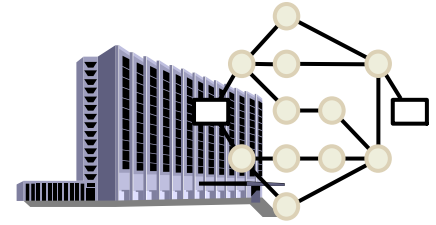


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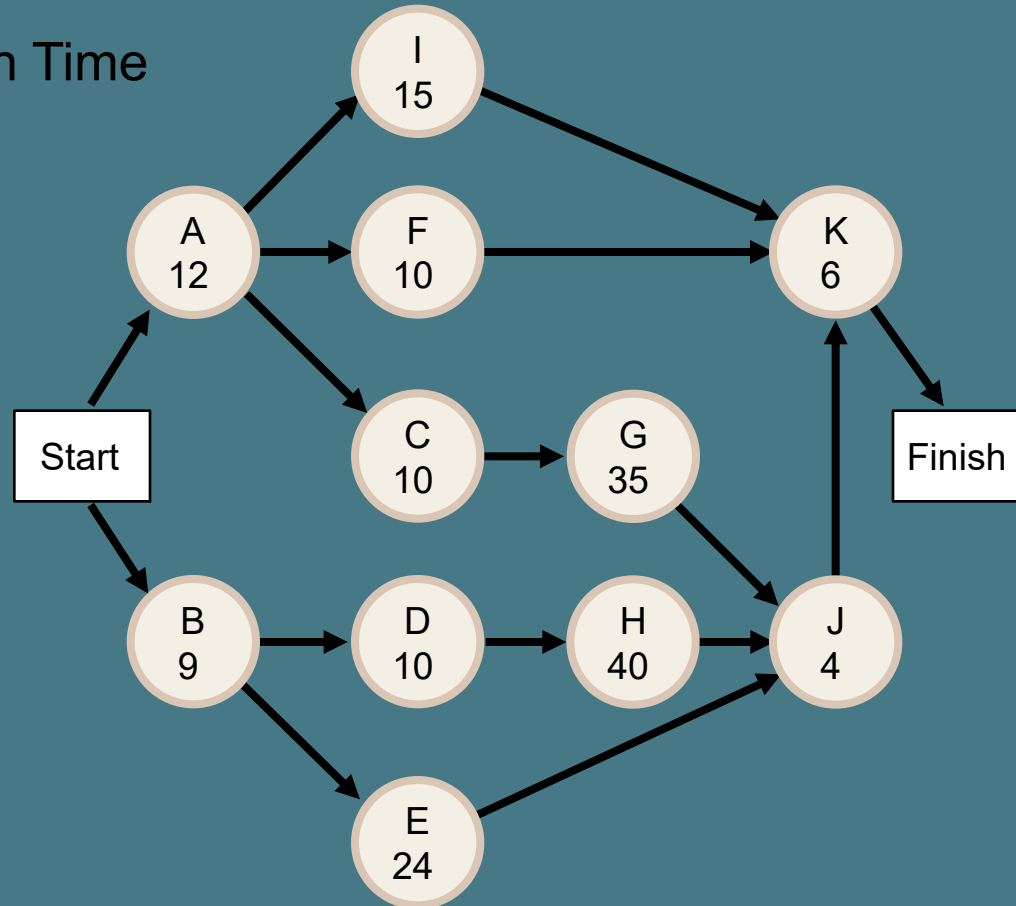
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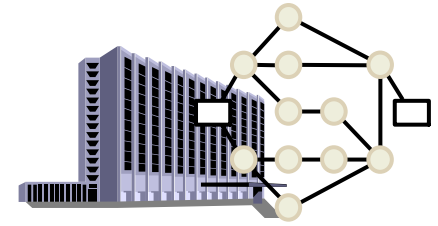
St. Adolf's Hospital



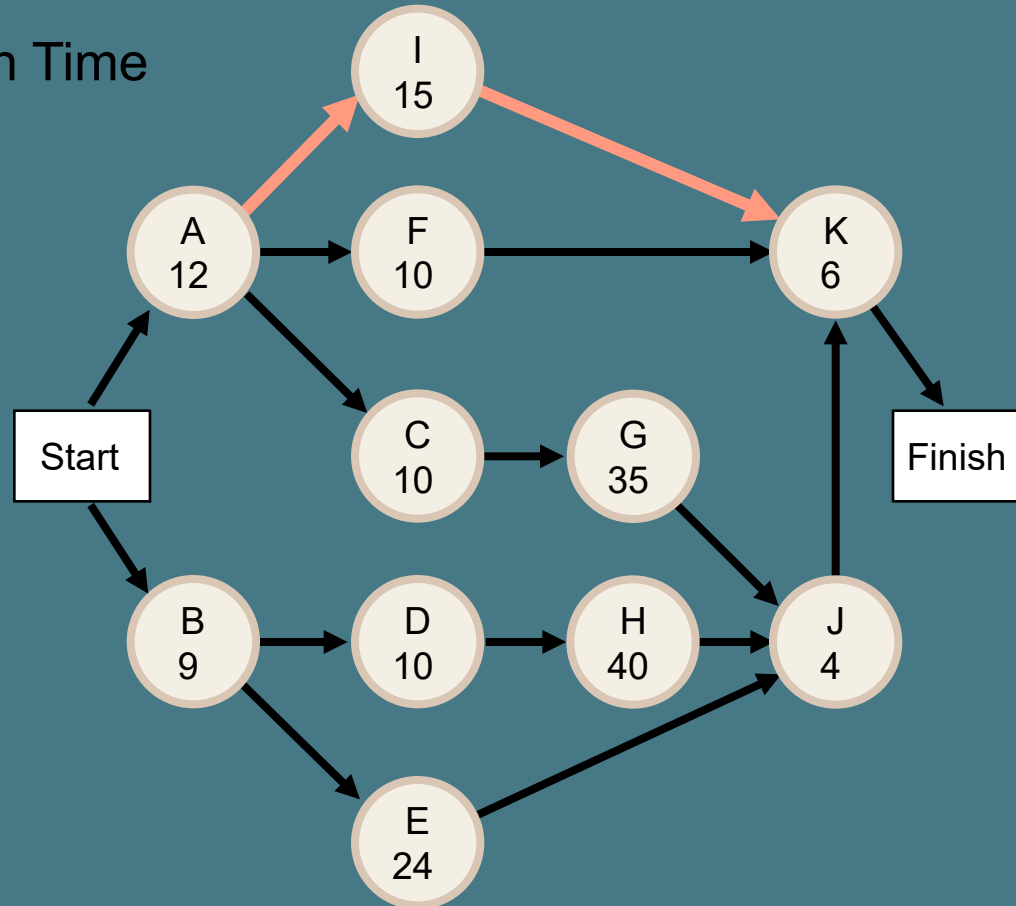
Completion Time



St. Adolf's Hospital



Completion Time

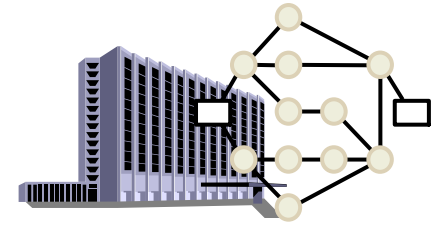


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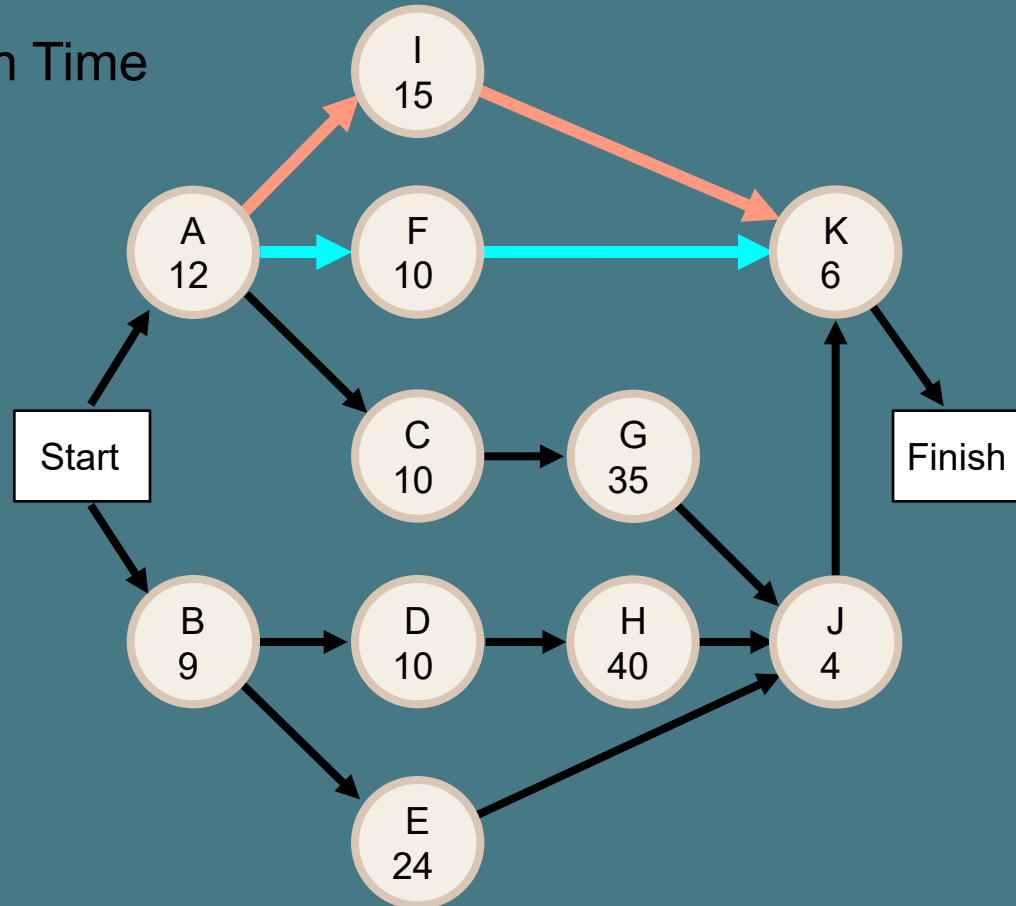
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St. Adolf's Hospital



Completion Time

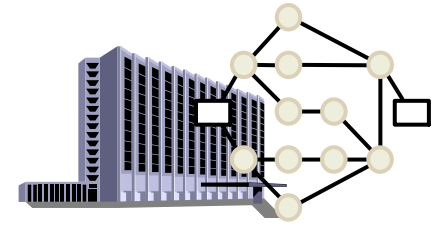


Responsibility

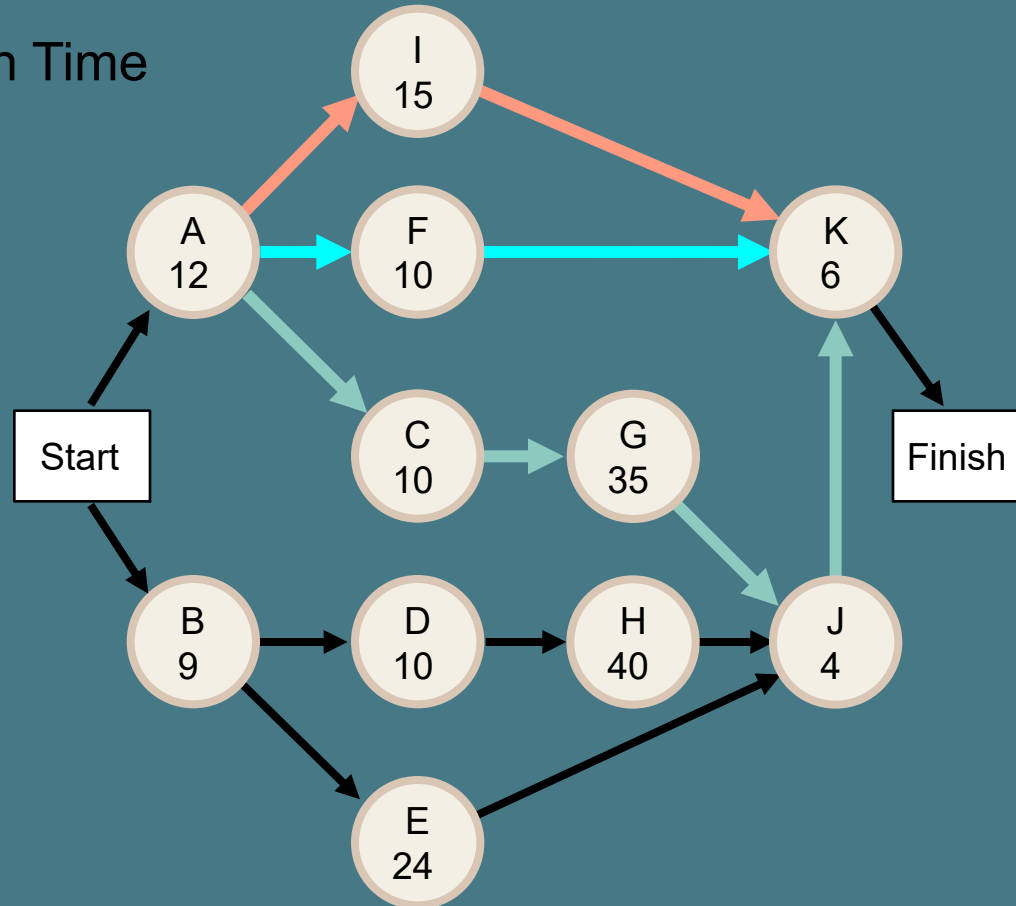
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St. Adolf's Hospital



Completion Time

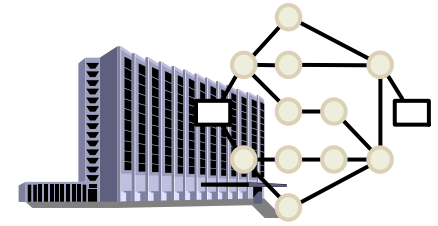


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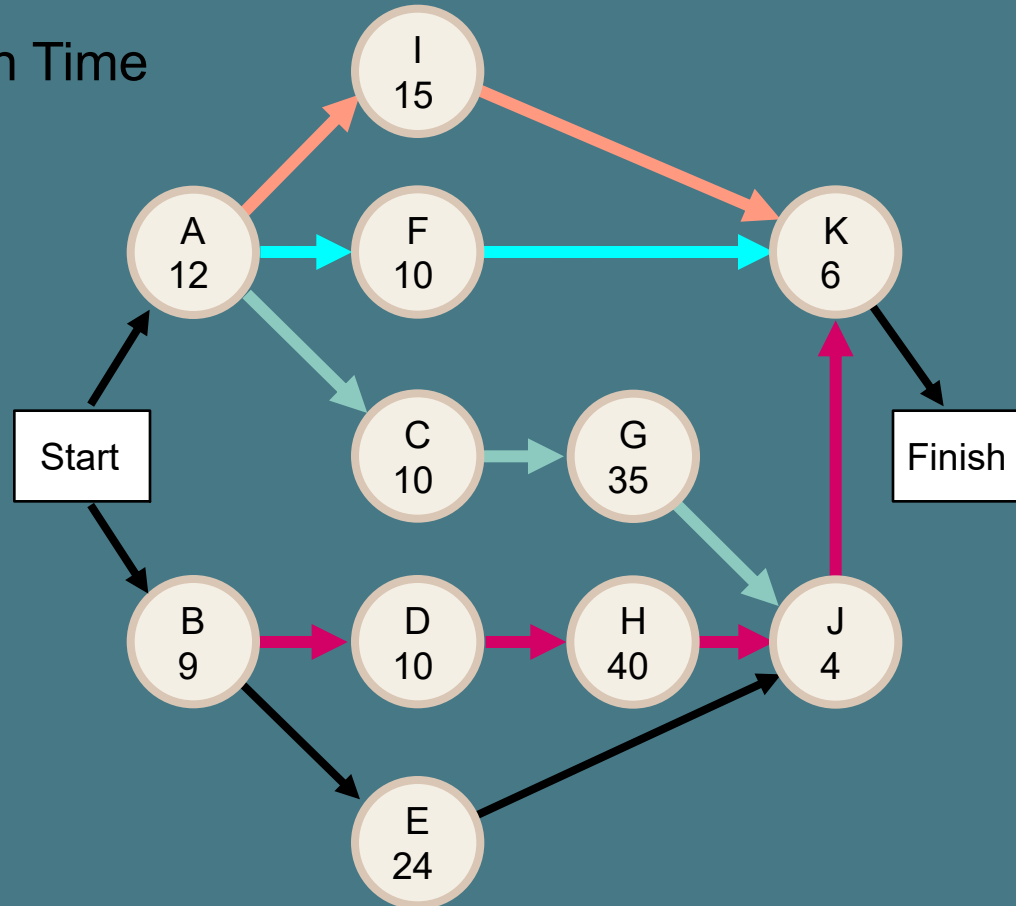
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St. Adolf's Hospital



Completion Time

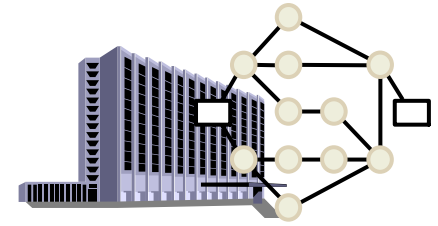


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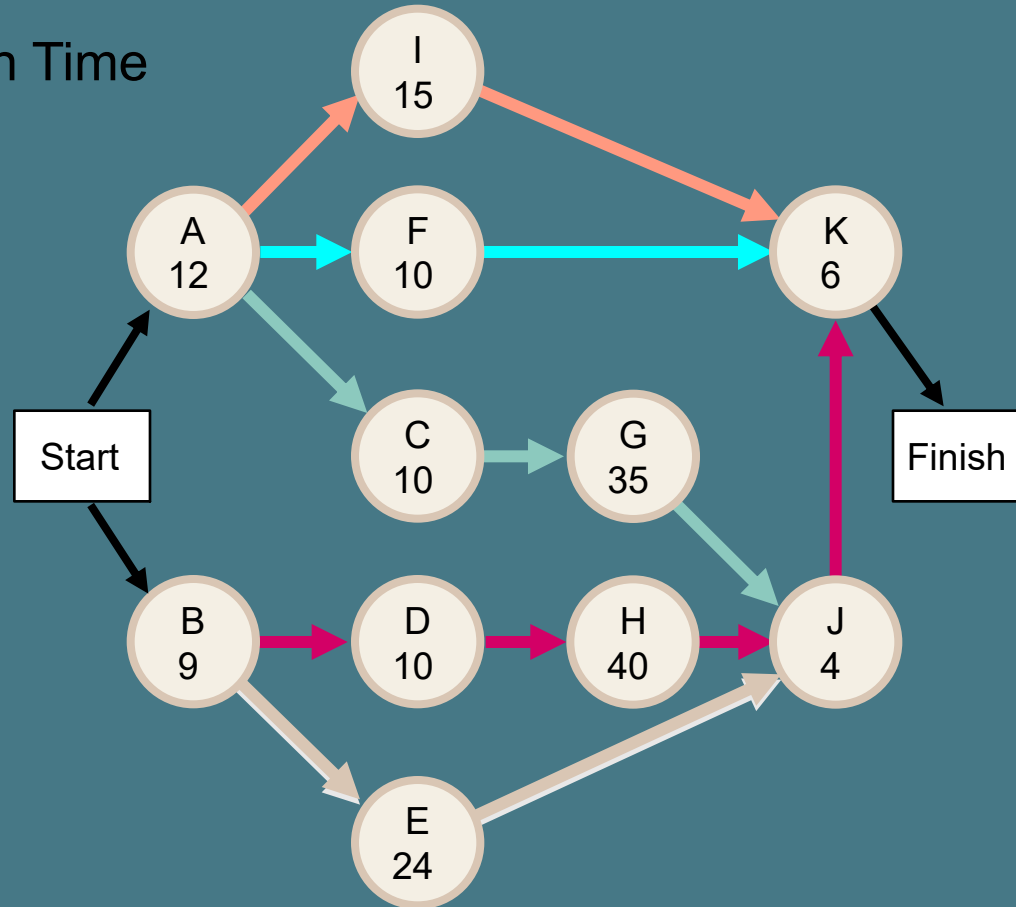
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St. Adolf's Hospital



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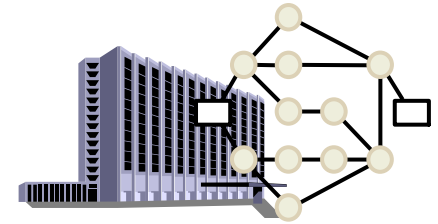


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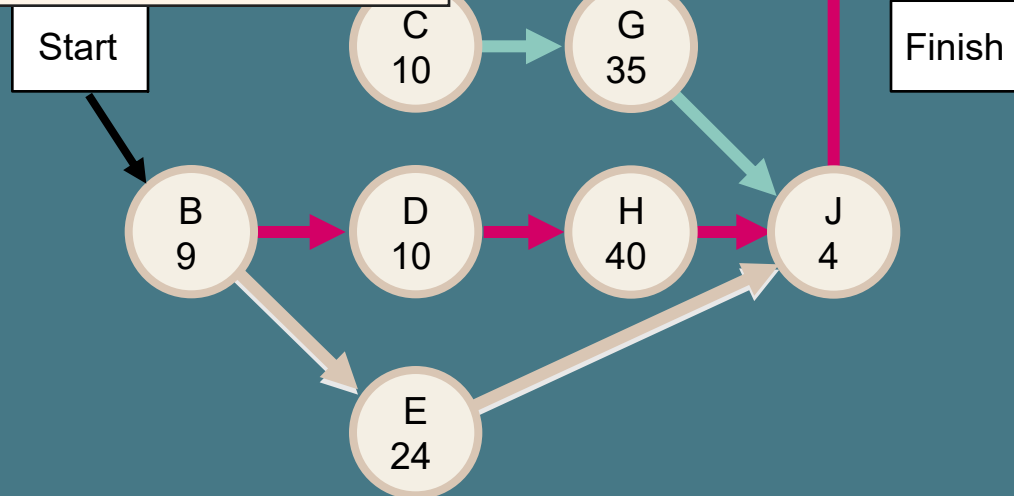
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St. Adolf's Hospital



Path	Expected Time (wks)
A-F-K	28
A-I-K	33
A-C-G-J-K	67
B-D-H-J-K	69
B-E-J-K	43



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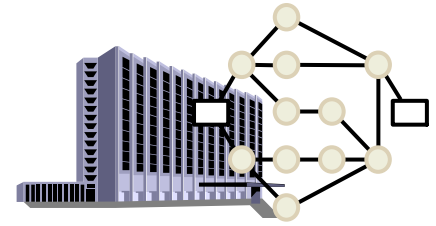
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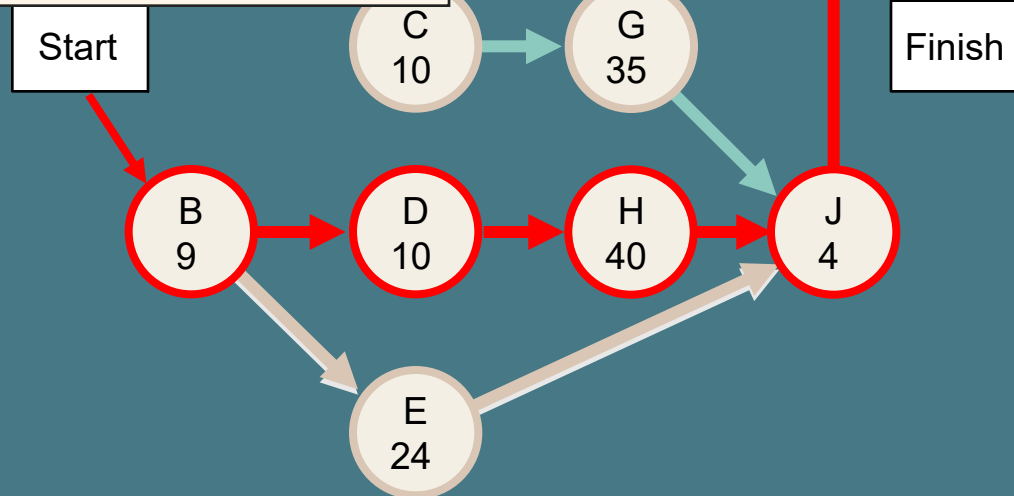
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St. Adolf's Hospital



Path	Expected Time (wks)
A-F-K	28
A-I-K	33
A-C-G-I-K	67
B-D-H-J-K	69
B-E-J-K	43



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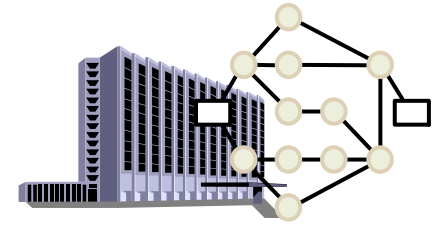
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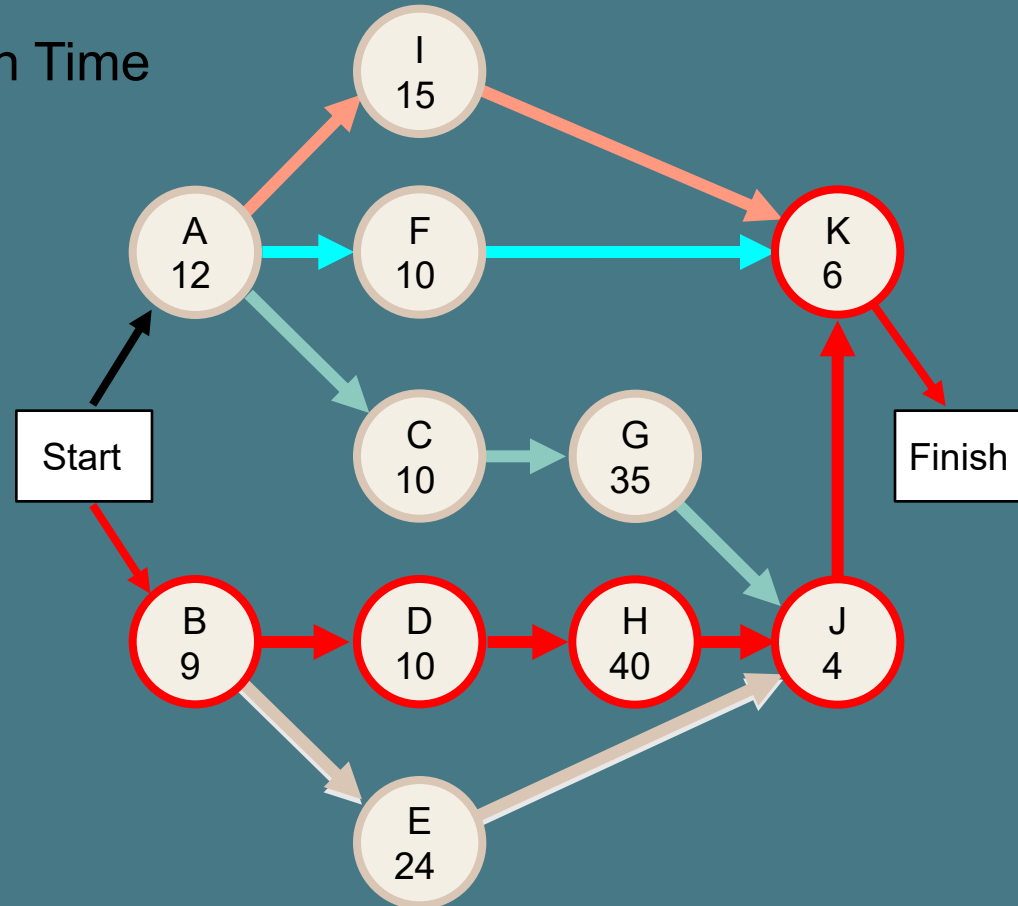
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St. Adolf's Hospital



Completion Time

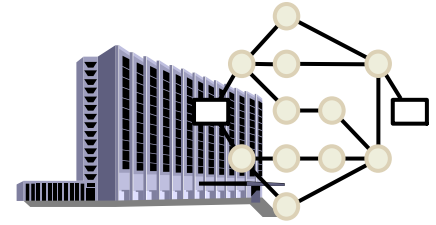


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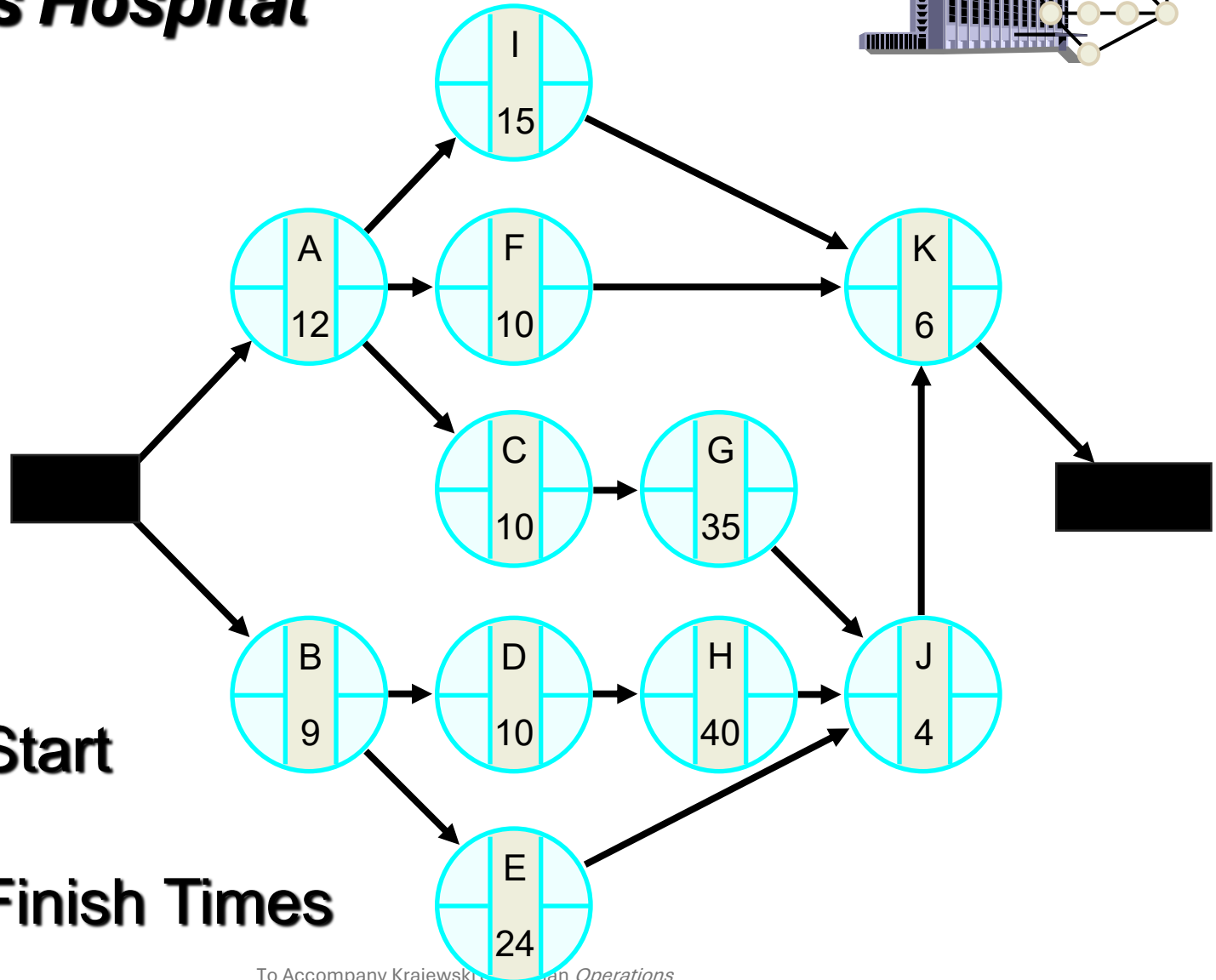
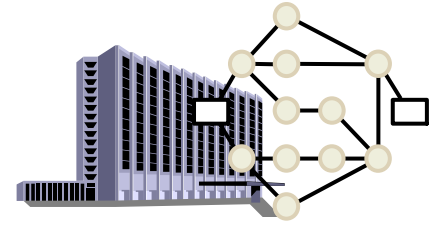
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St. Adolf's Hospital

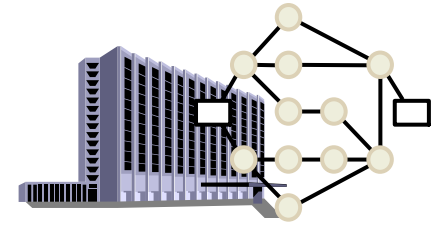


St. Adolf's Hospital

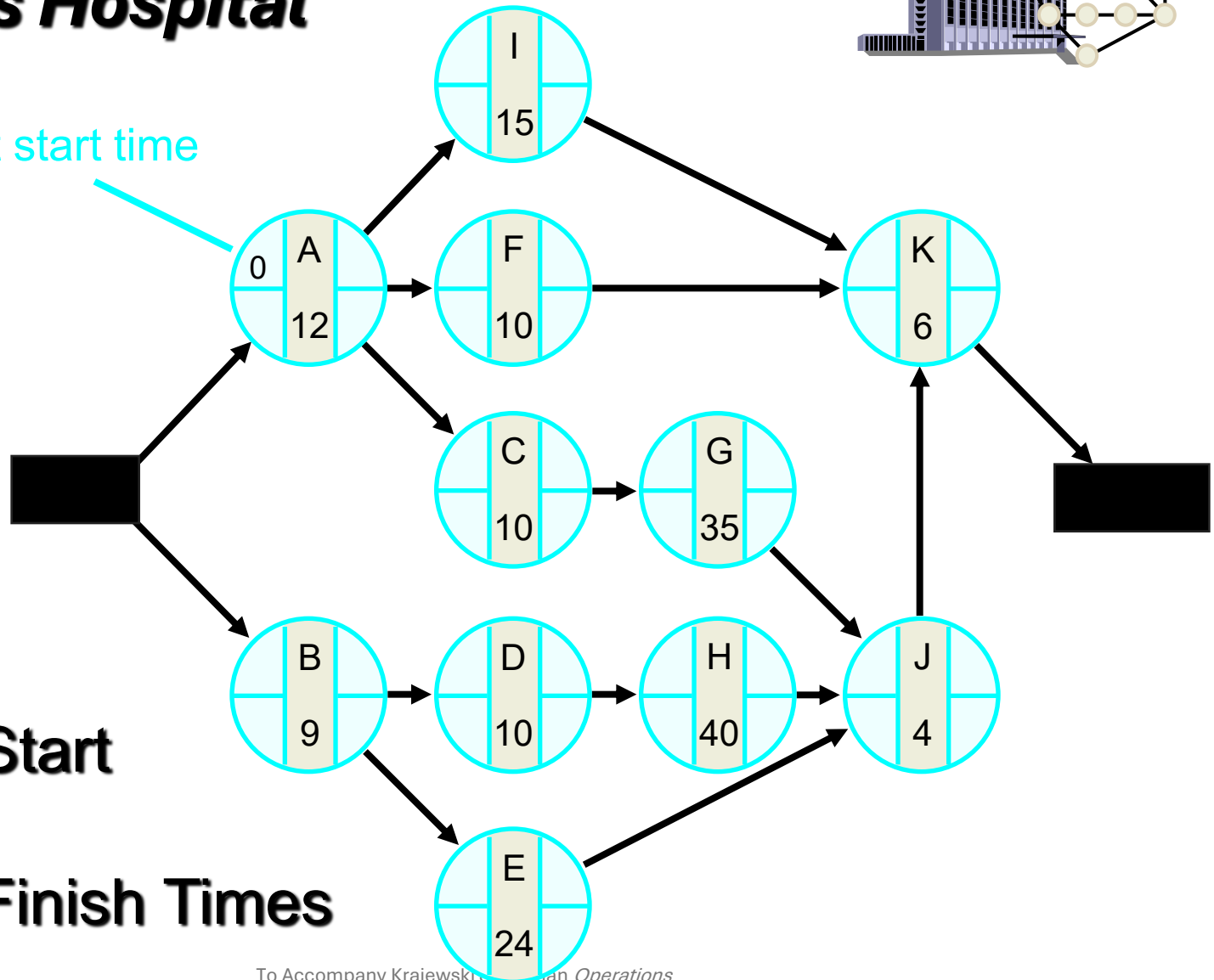


Earliest Start
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Earliest Finish Times

St. Adolf's Hospital

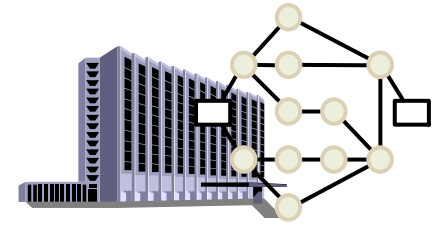


Earliest start time



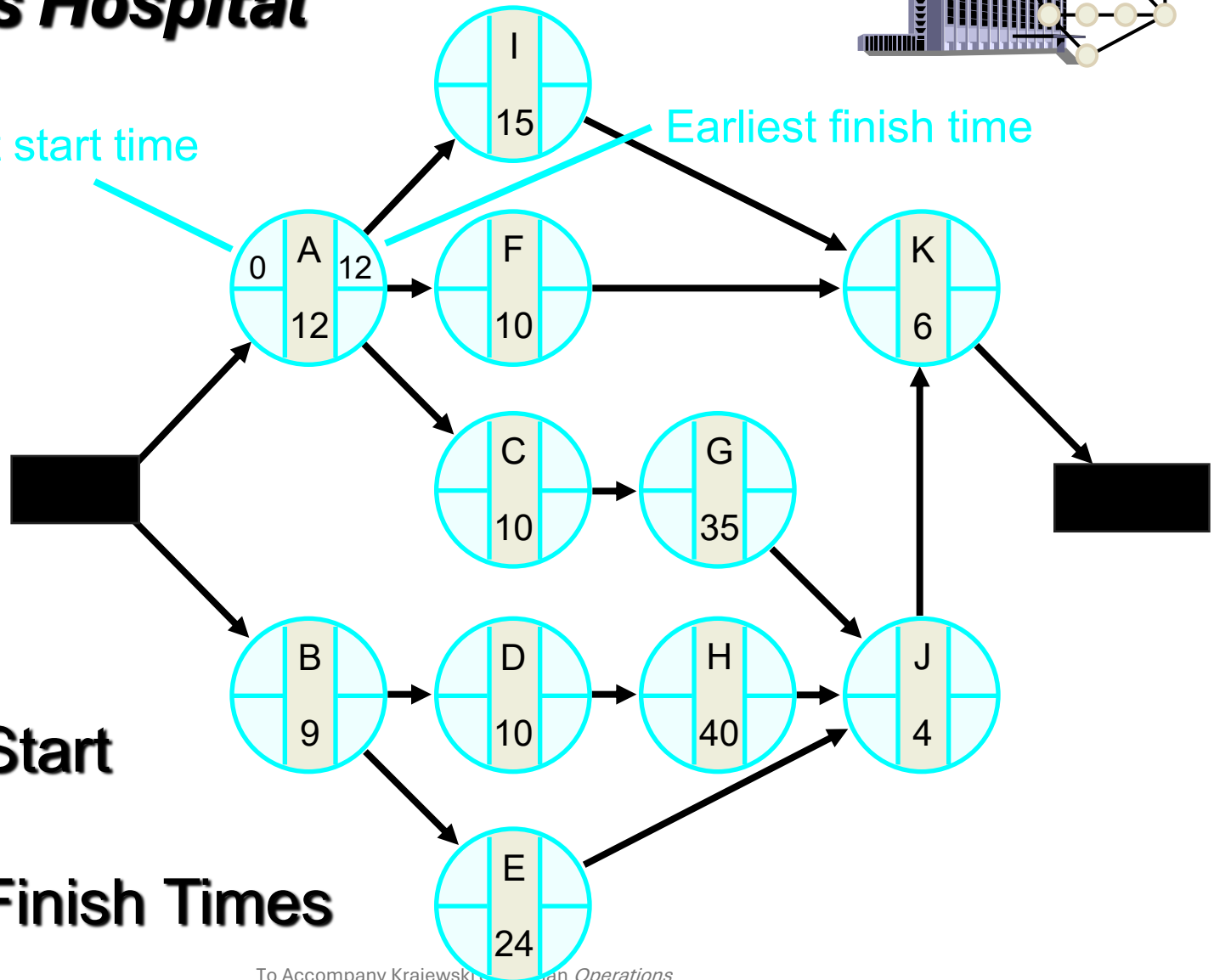
**Earliest Start
and
Earliest Finish Times**

St. Adolf's Hospital



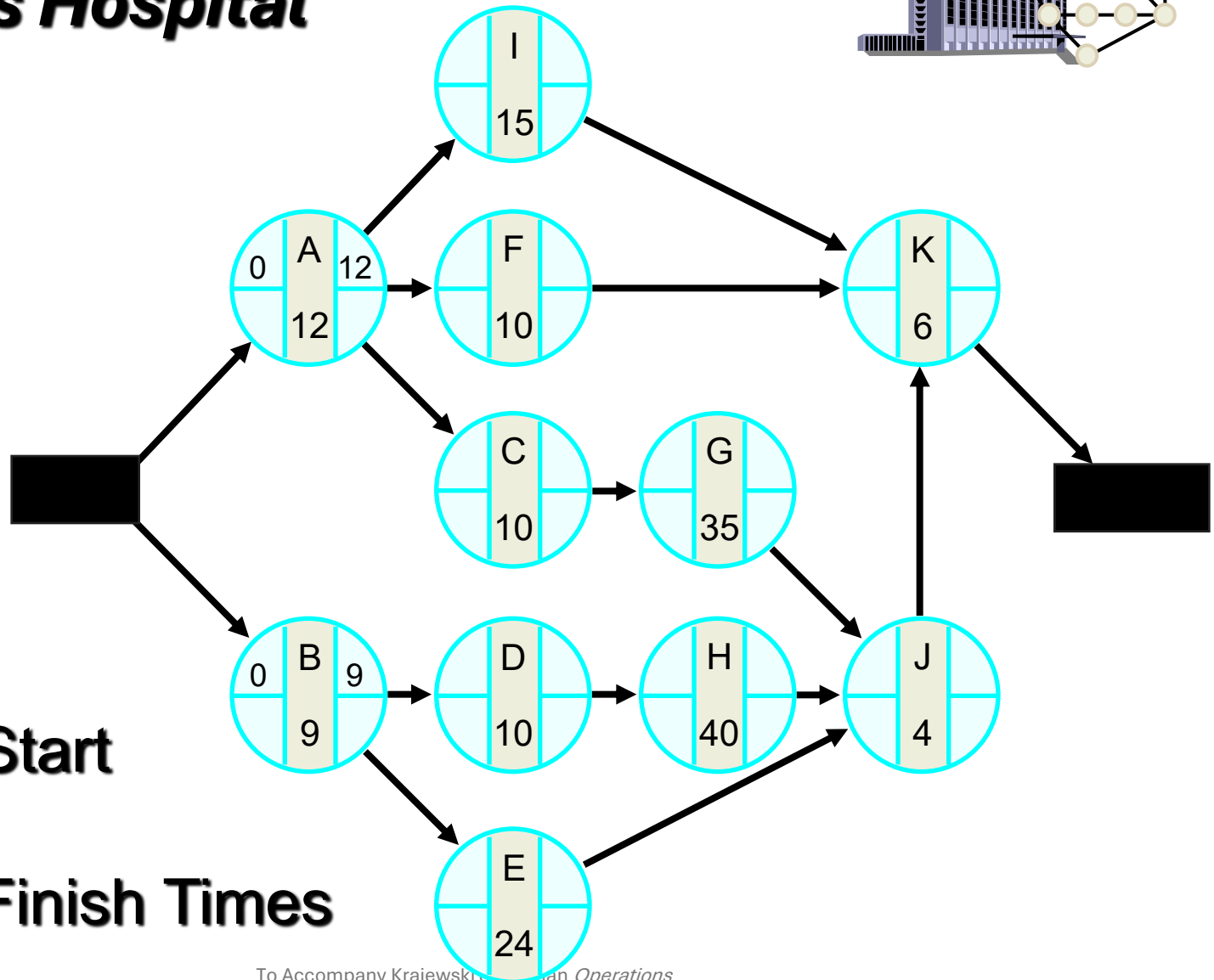
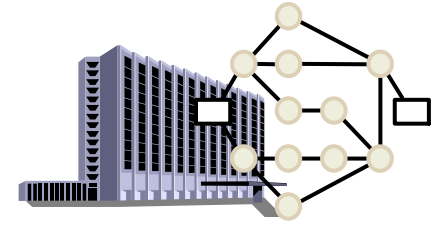
Earliest start time

Earliest finish time



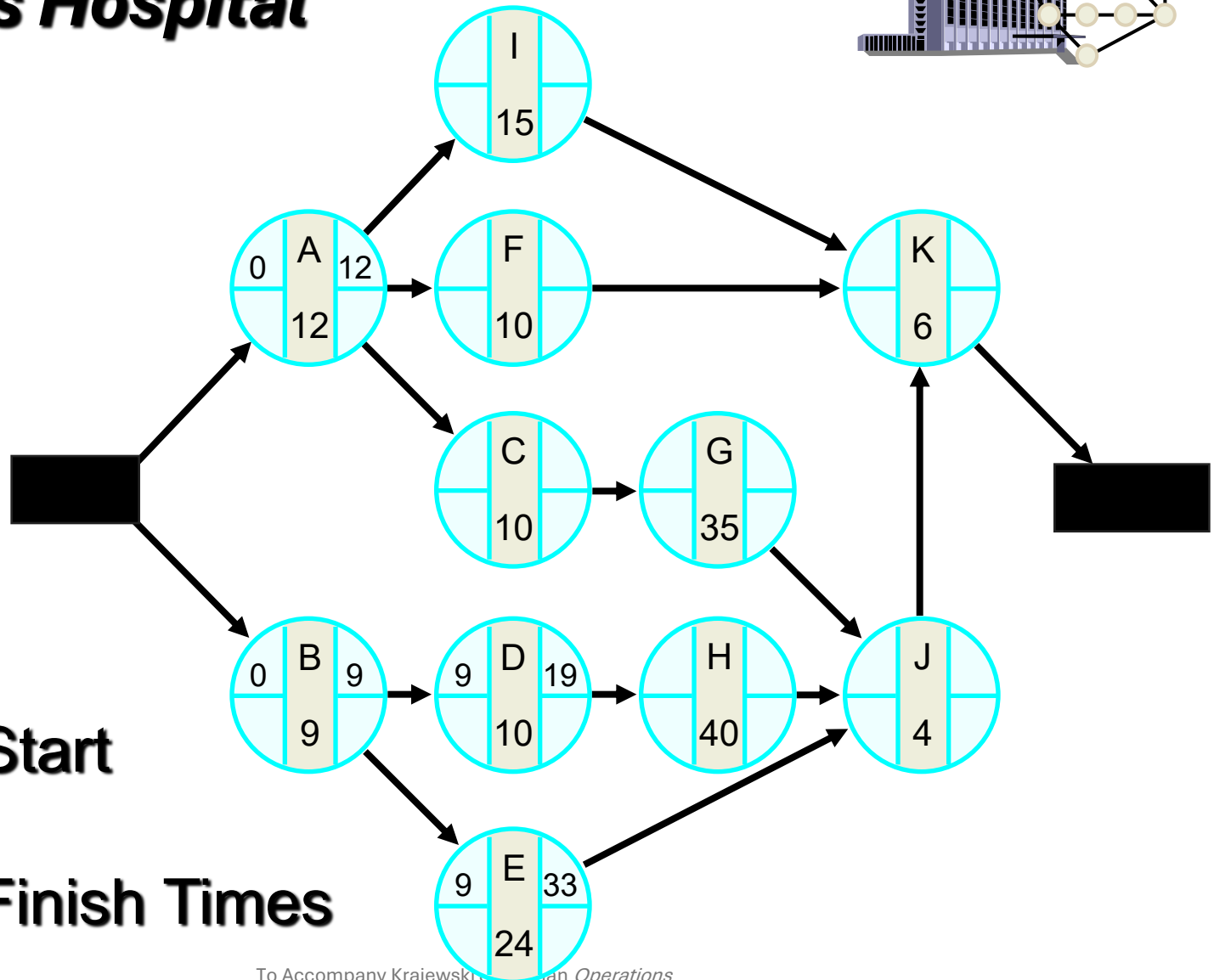
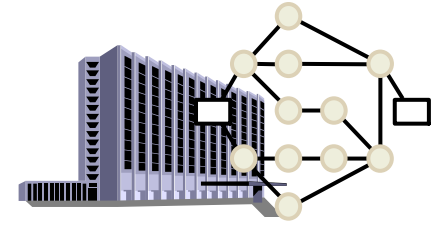
**Earliest Start
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Earliest Finish Times**

St. Adolf's Hospital



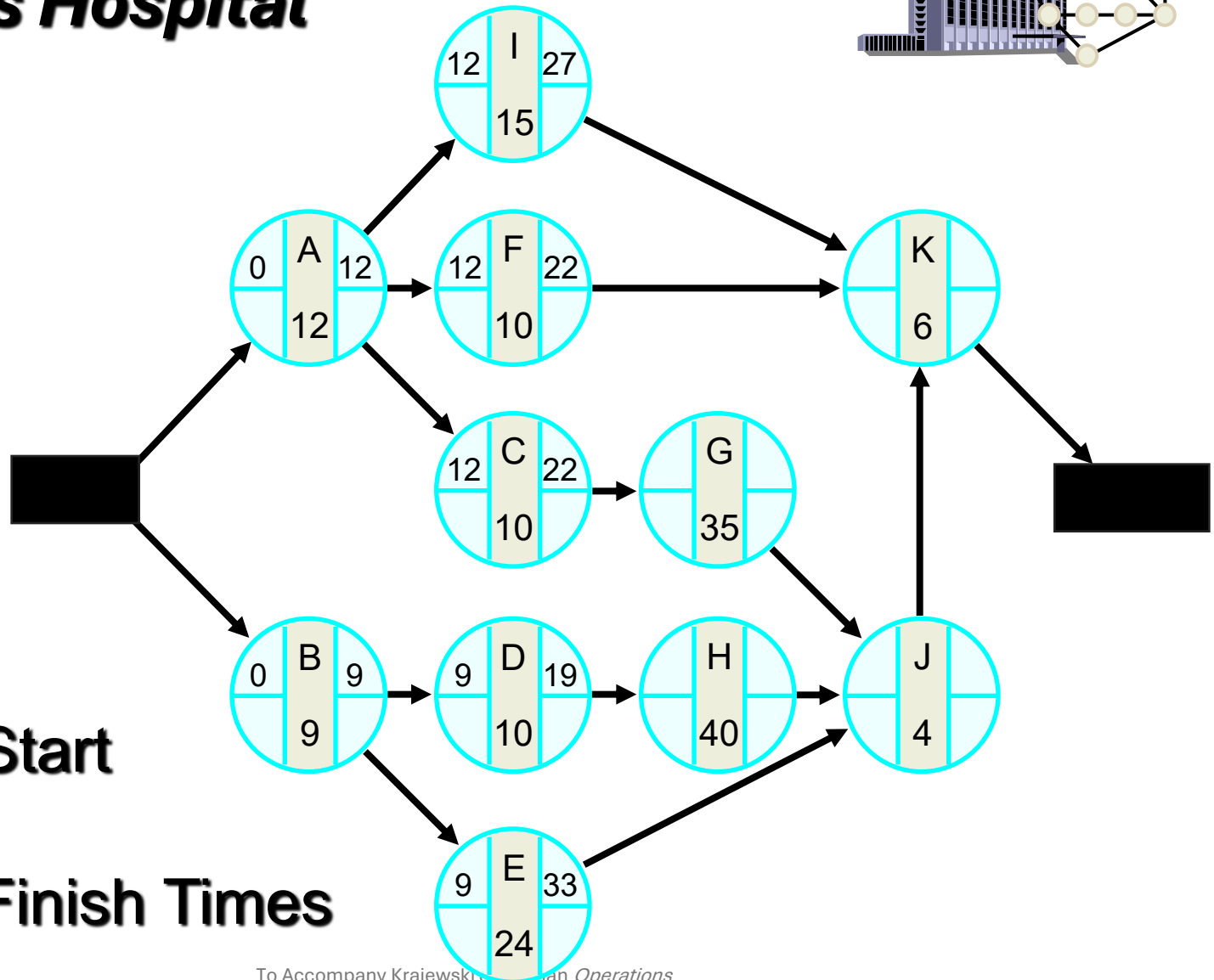
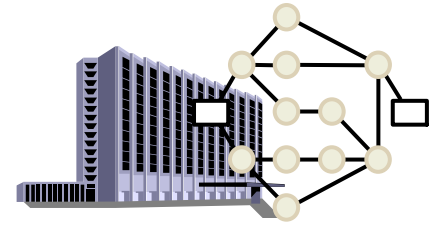
Earliest Start
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St. Adolf's Hospital



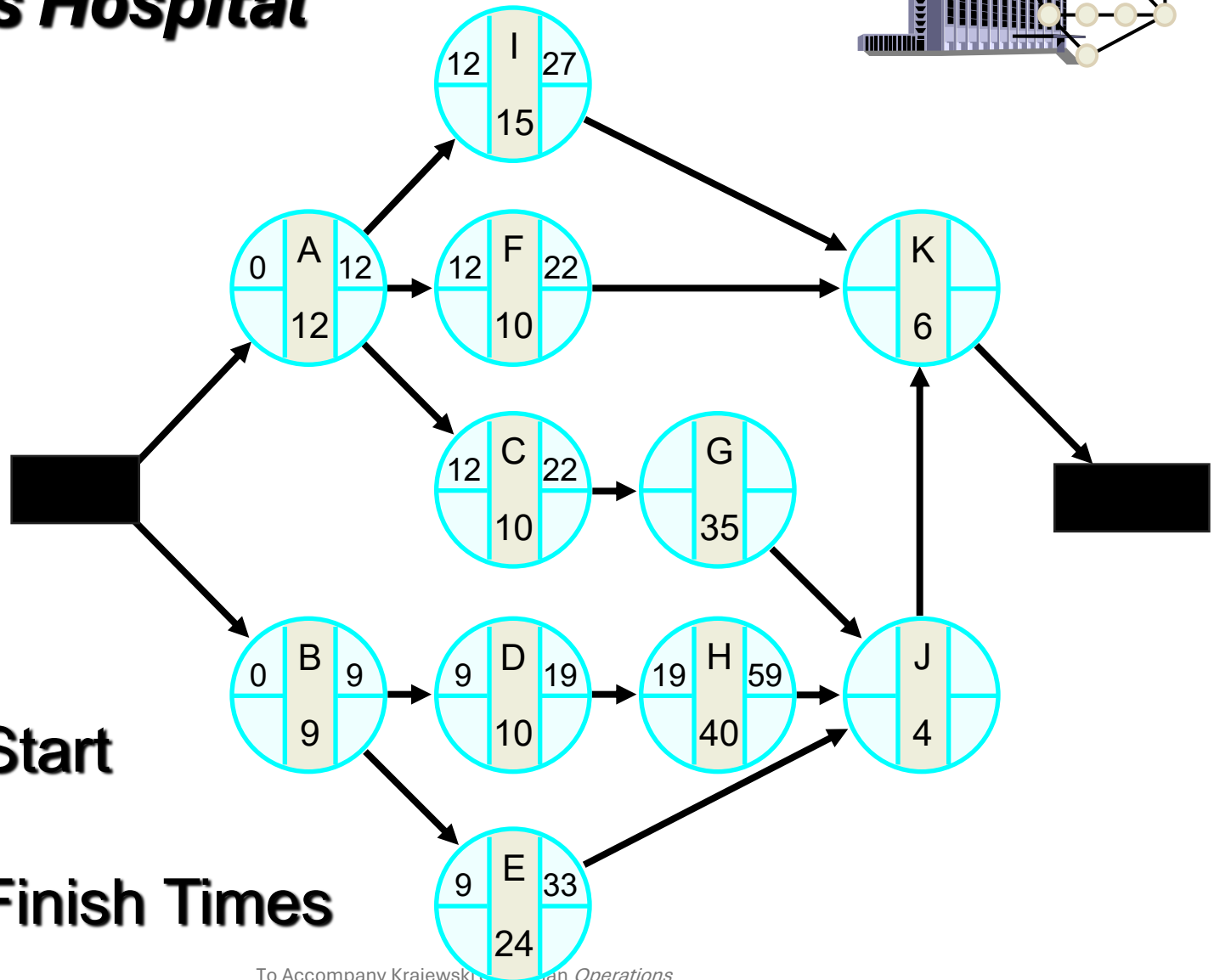
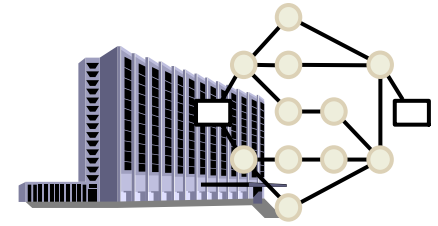
**Earliest Start
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St. Adolf's Hospital



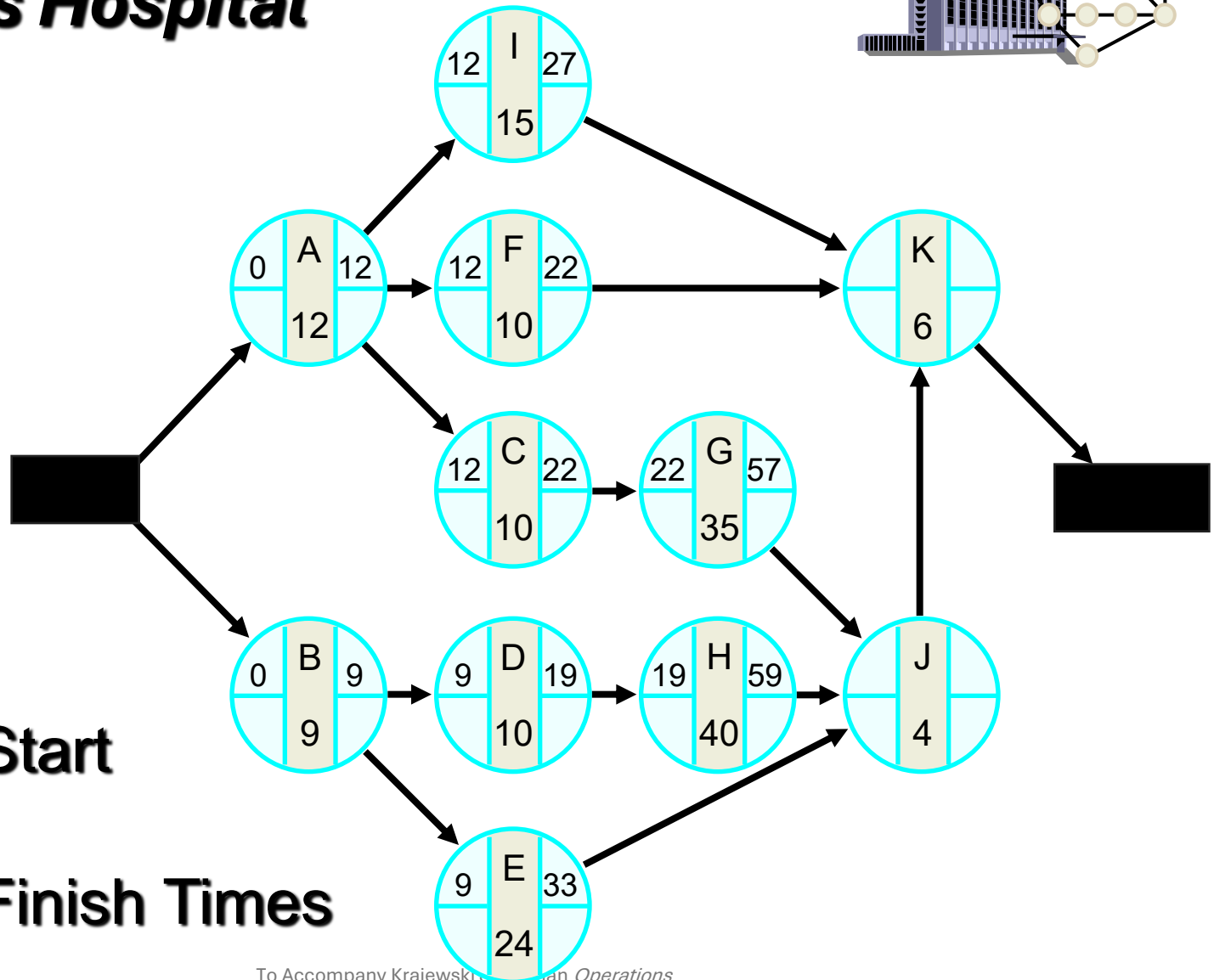
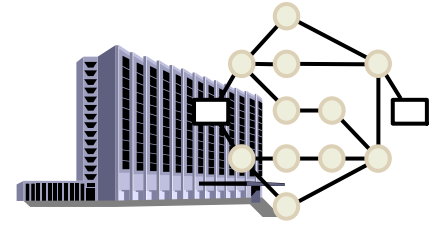
**Earliest Start
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St. Adolf's Hospital



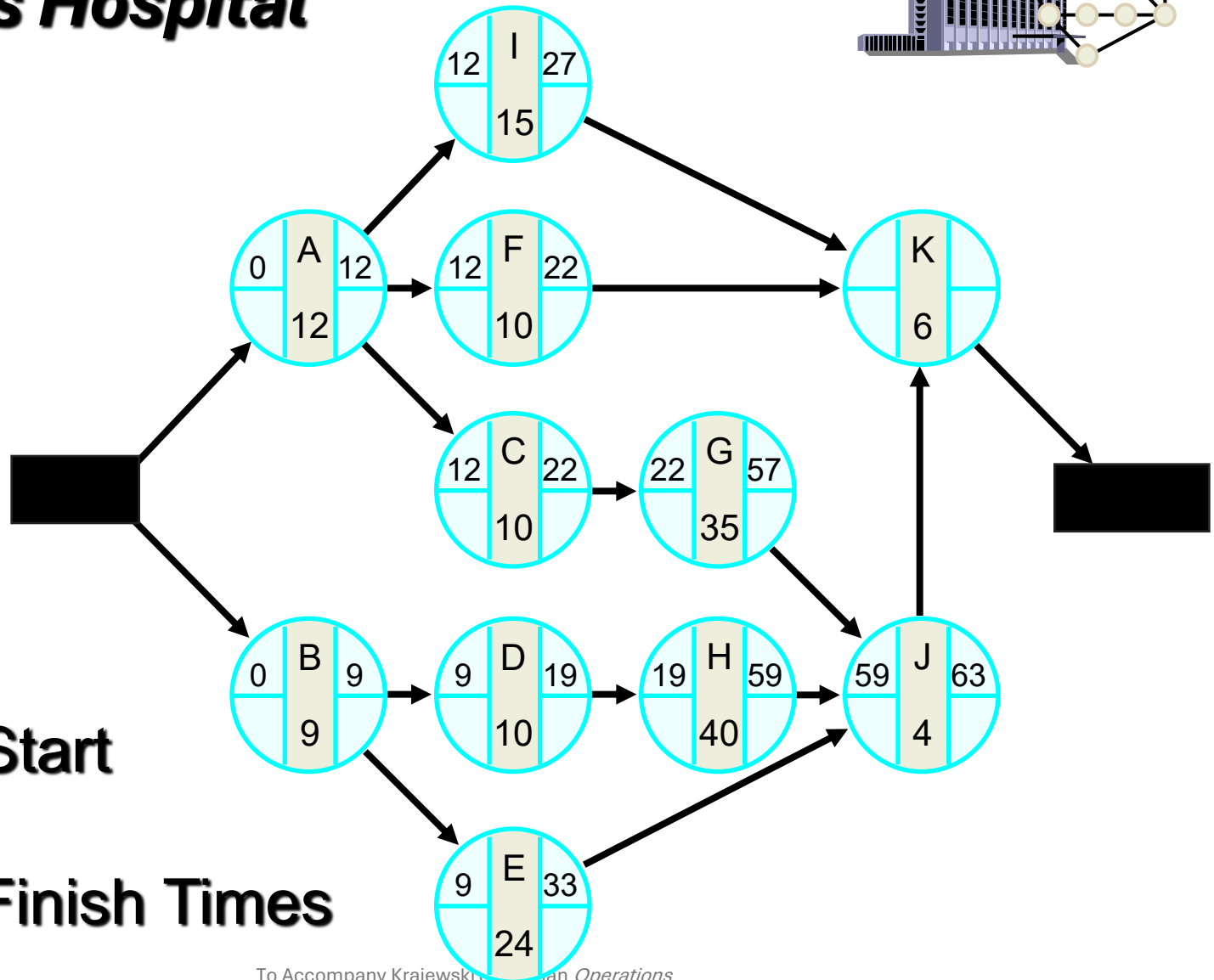
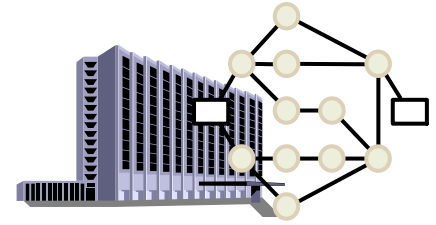
**Earliest Start
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St. Adolf's Hospital



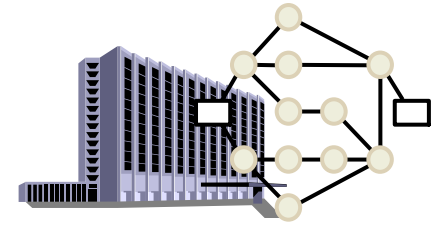
**Earliest Start
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Earliest Finish Times**

St. Adolf's Hospital



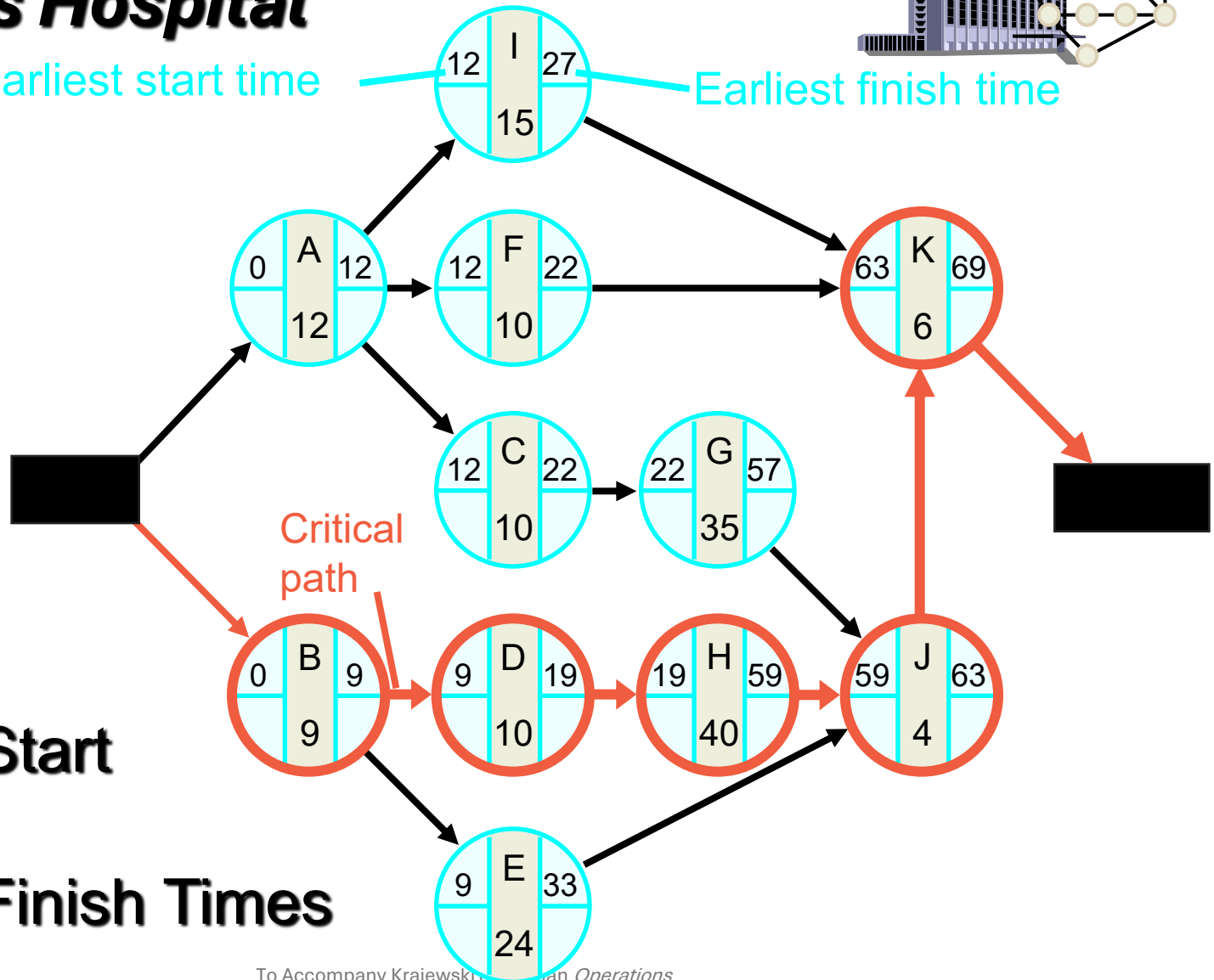
**Earliest Start
and
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St. Adolf's Hospital



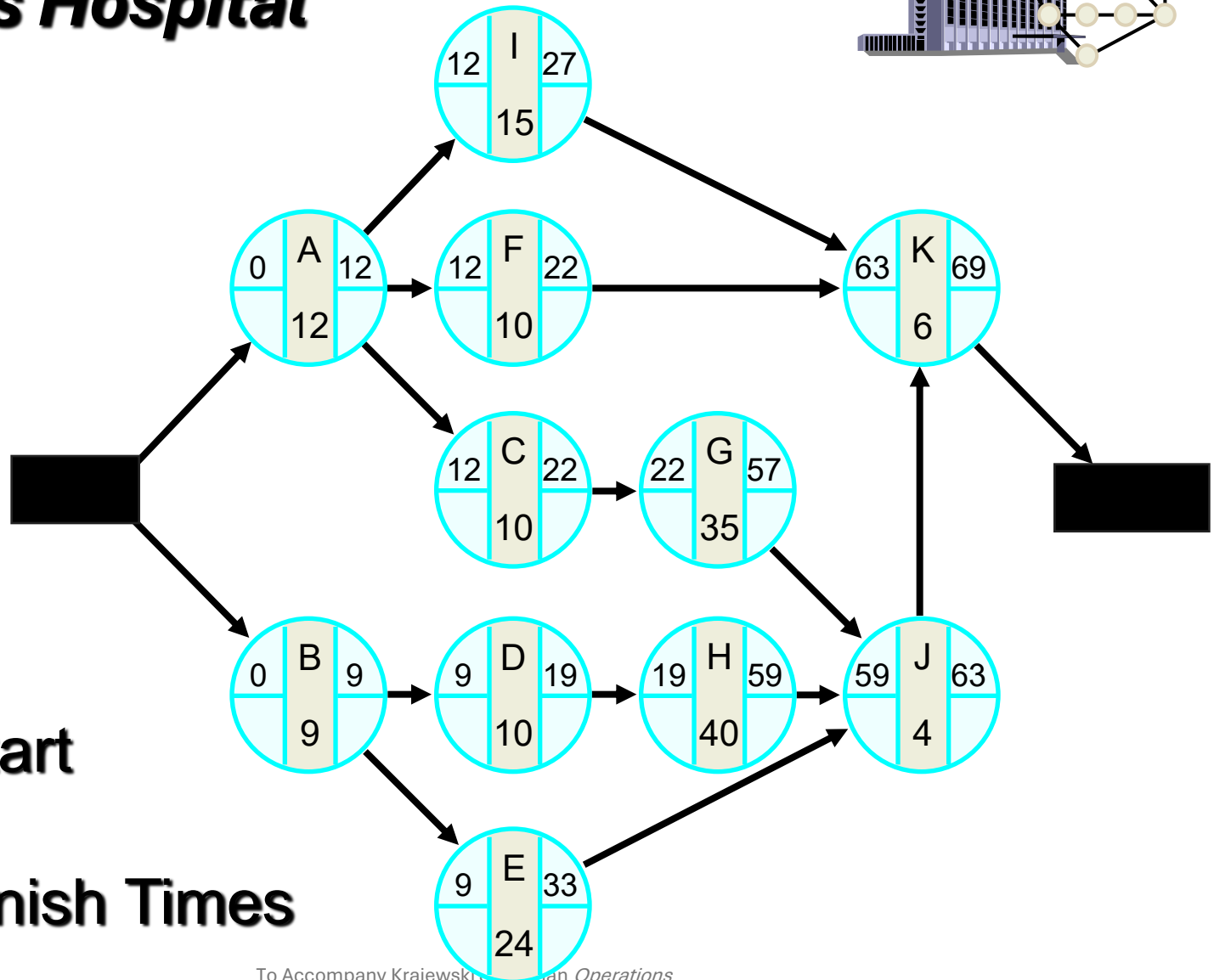
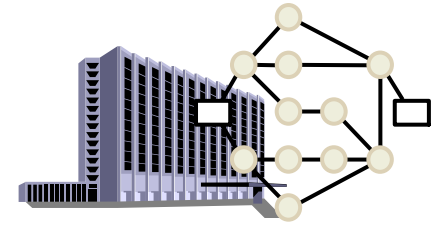
Earliest start time

Earliest finish time



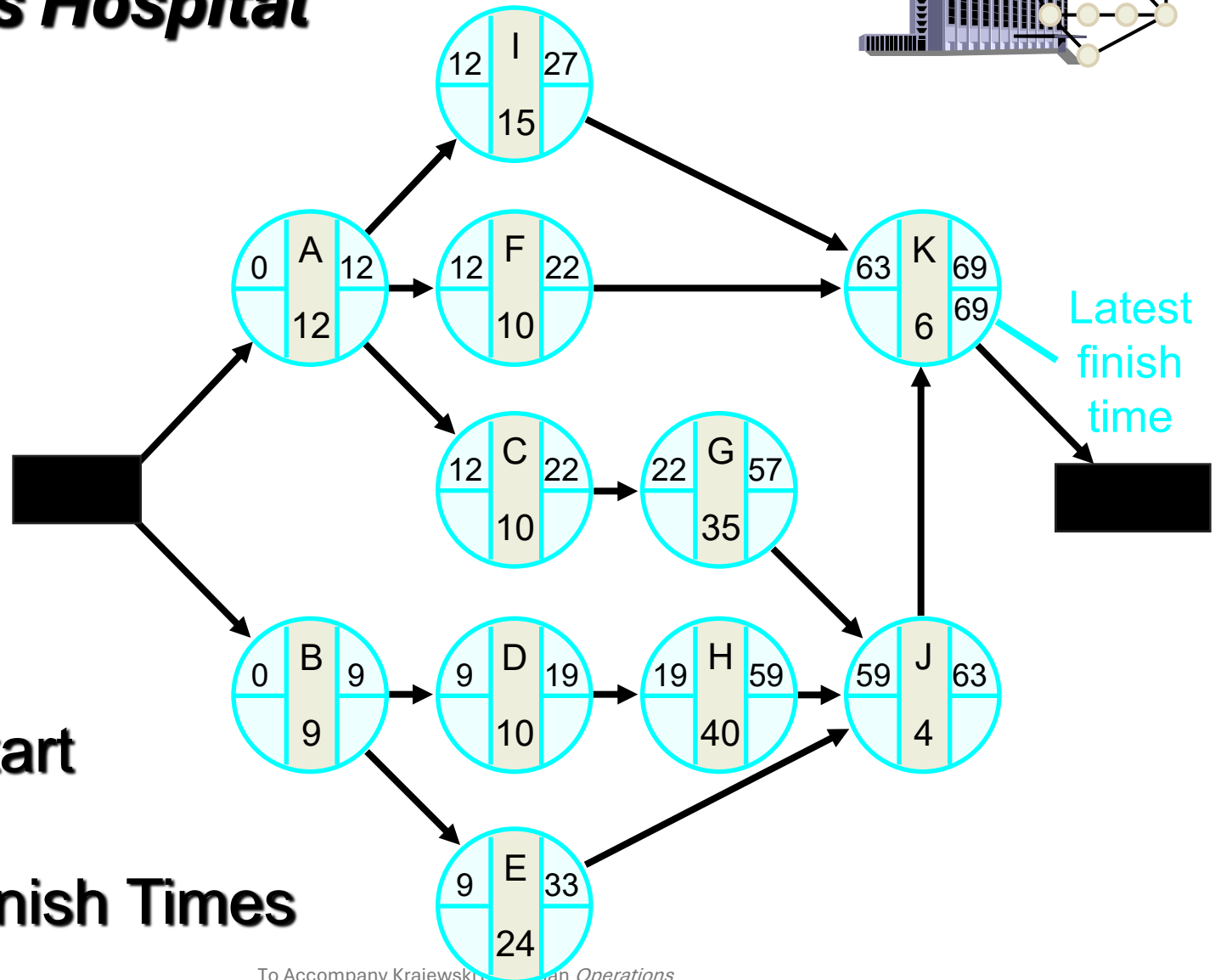
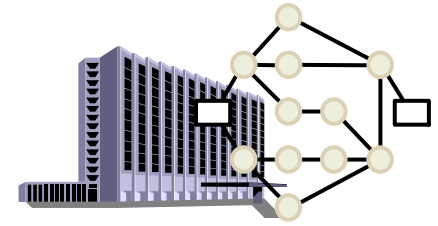
Earliest Start
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St. Adolf's Hospital



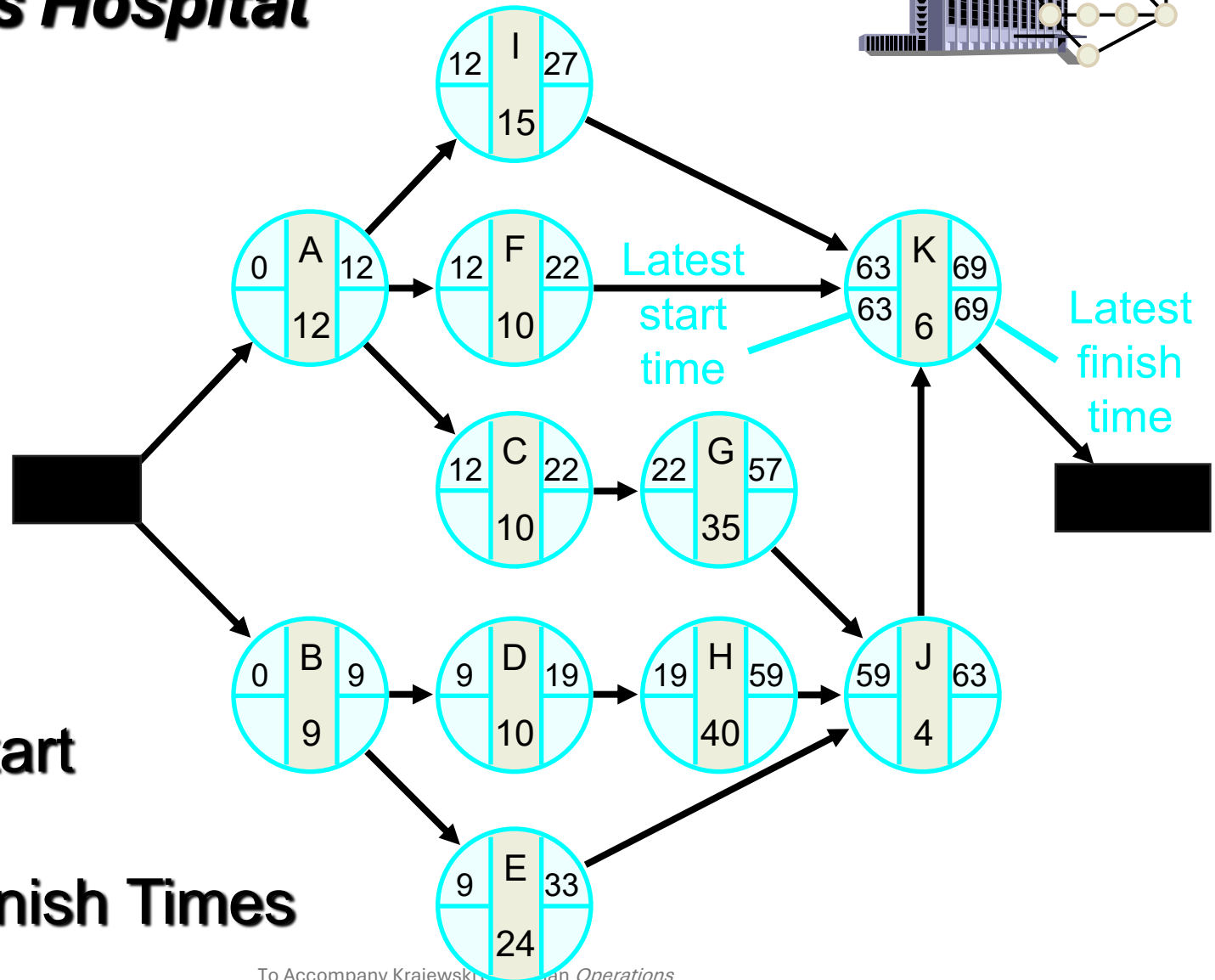
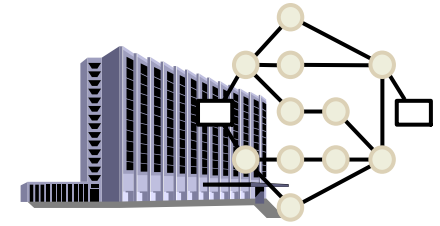
Latest Start
and
Latest Finish Times

St. Adolf's Hospital



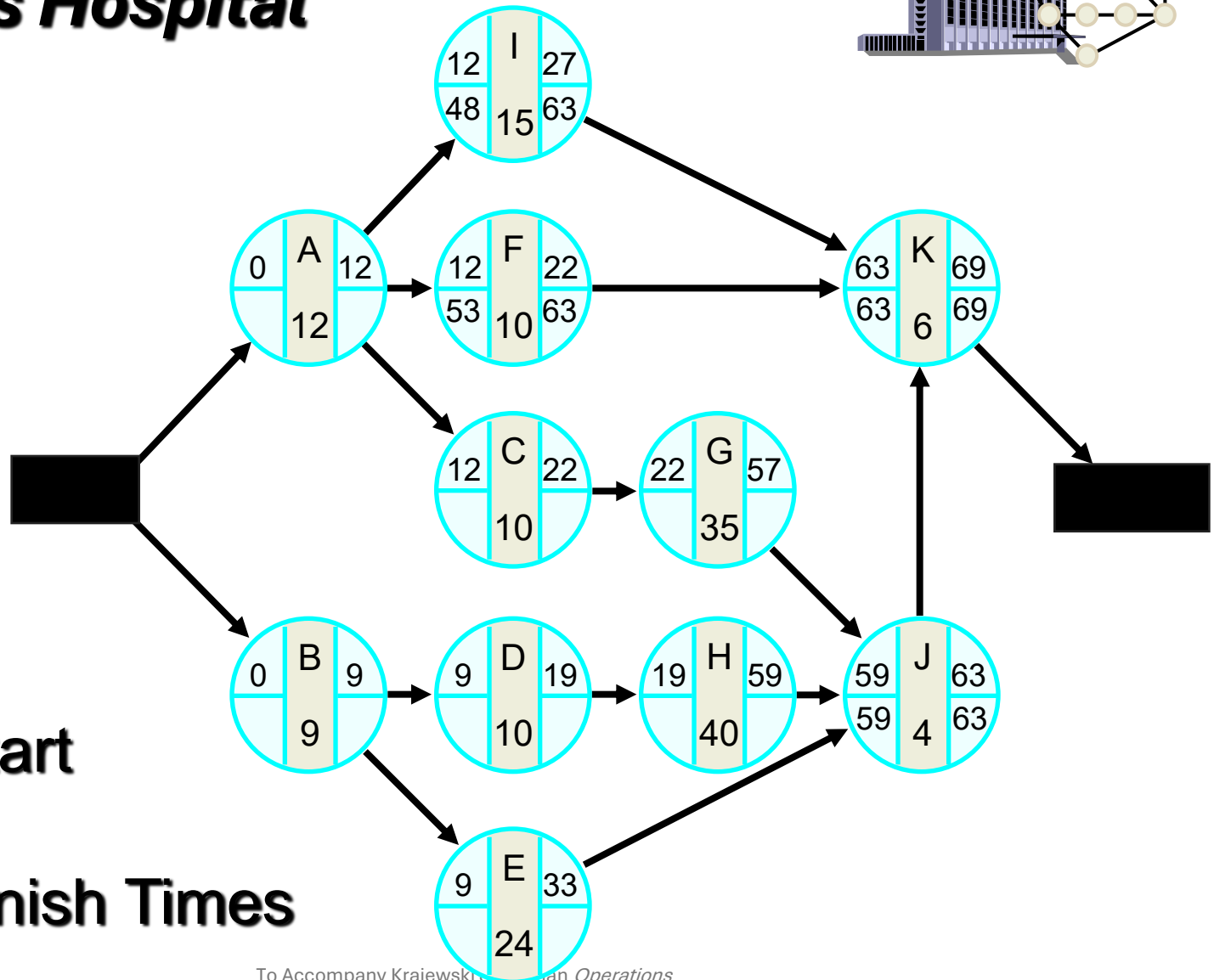
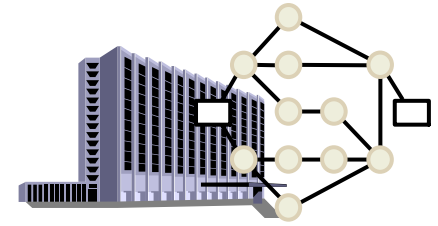
**Latest Start
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St. Adolf's Hospital



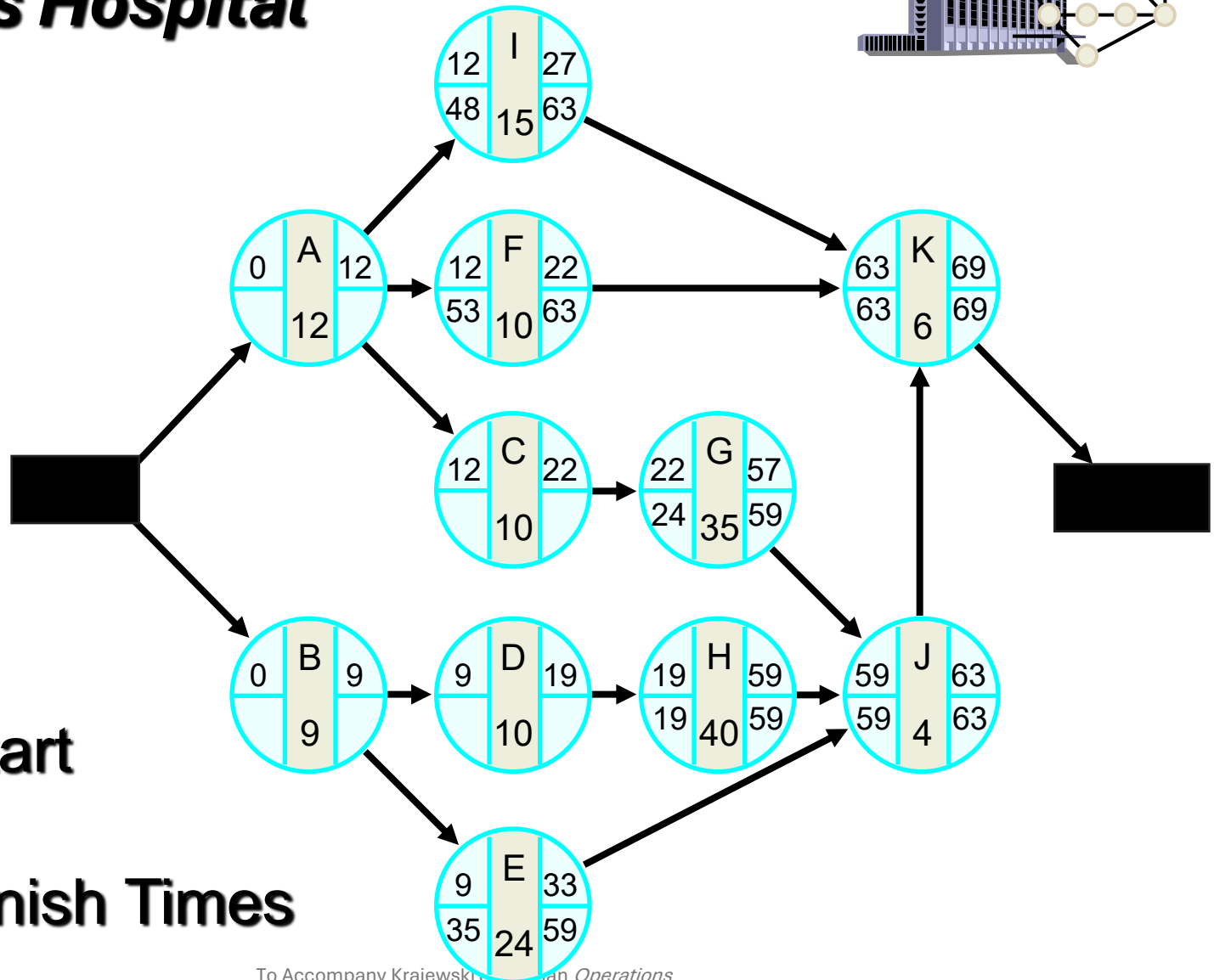
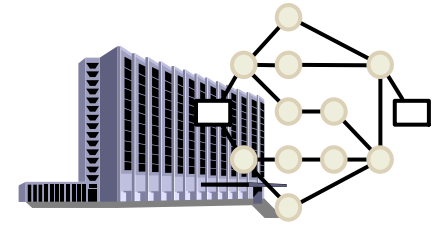
**Latest Start
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St. Adolf's Hospital



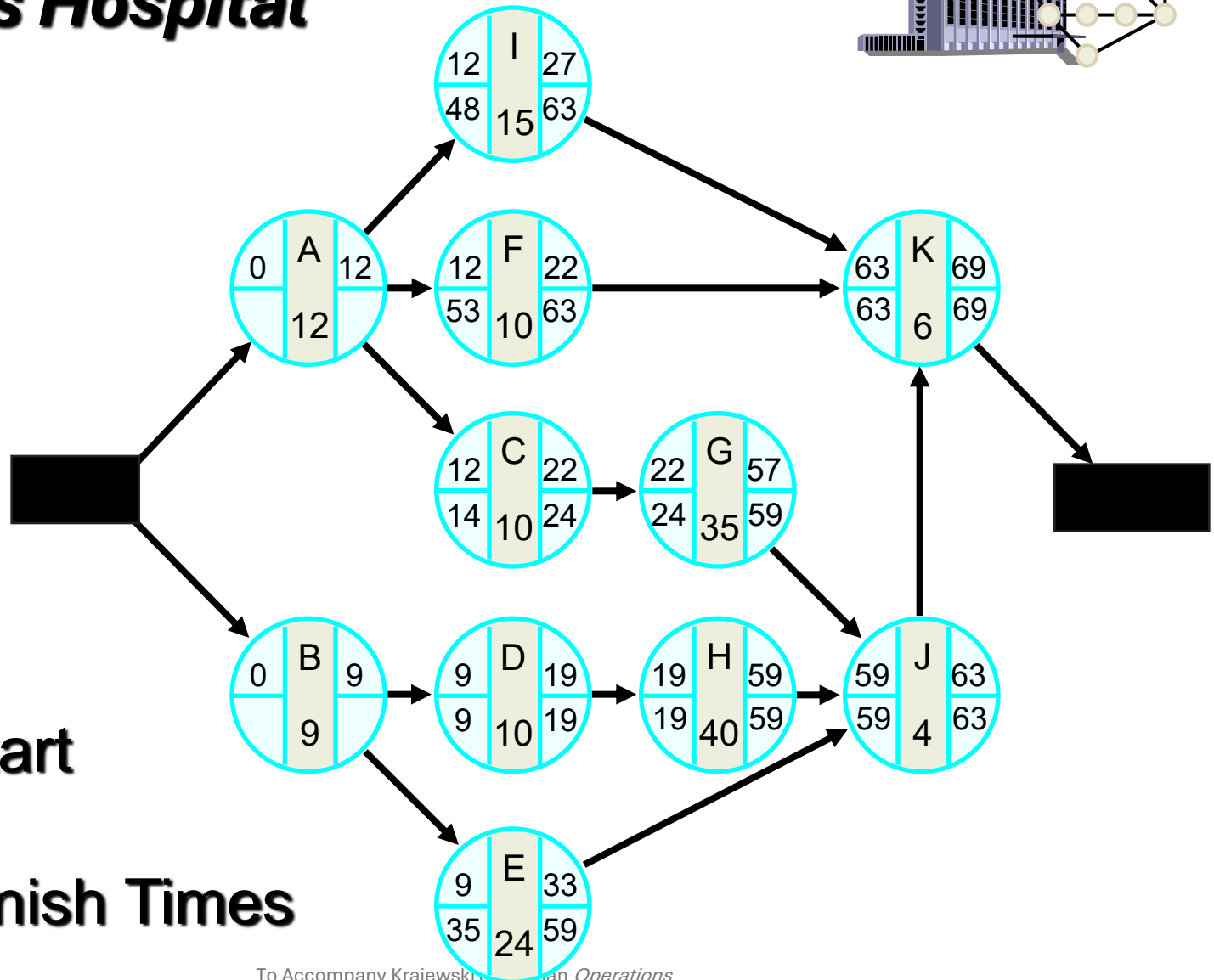
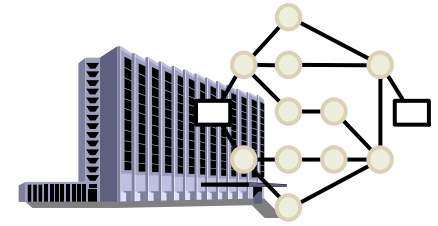
Latest Start
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St. Adolf's Hospital



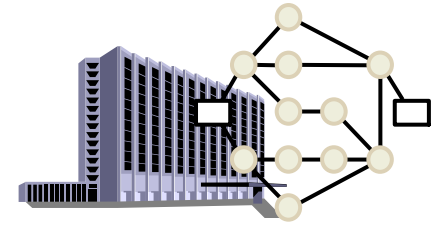
**Latest Start
and
Latest Finish Times**

St. Adolf's Hospital



Latest Start
and
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St. Adolf's Hospital

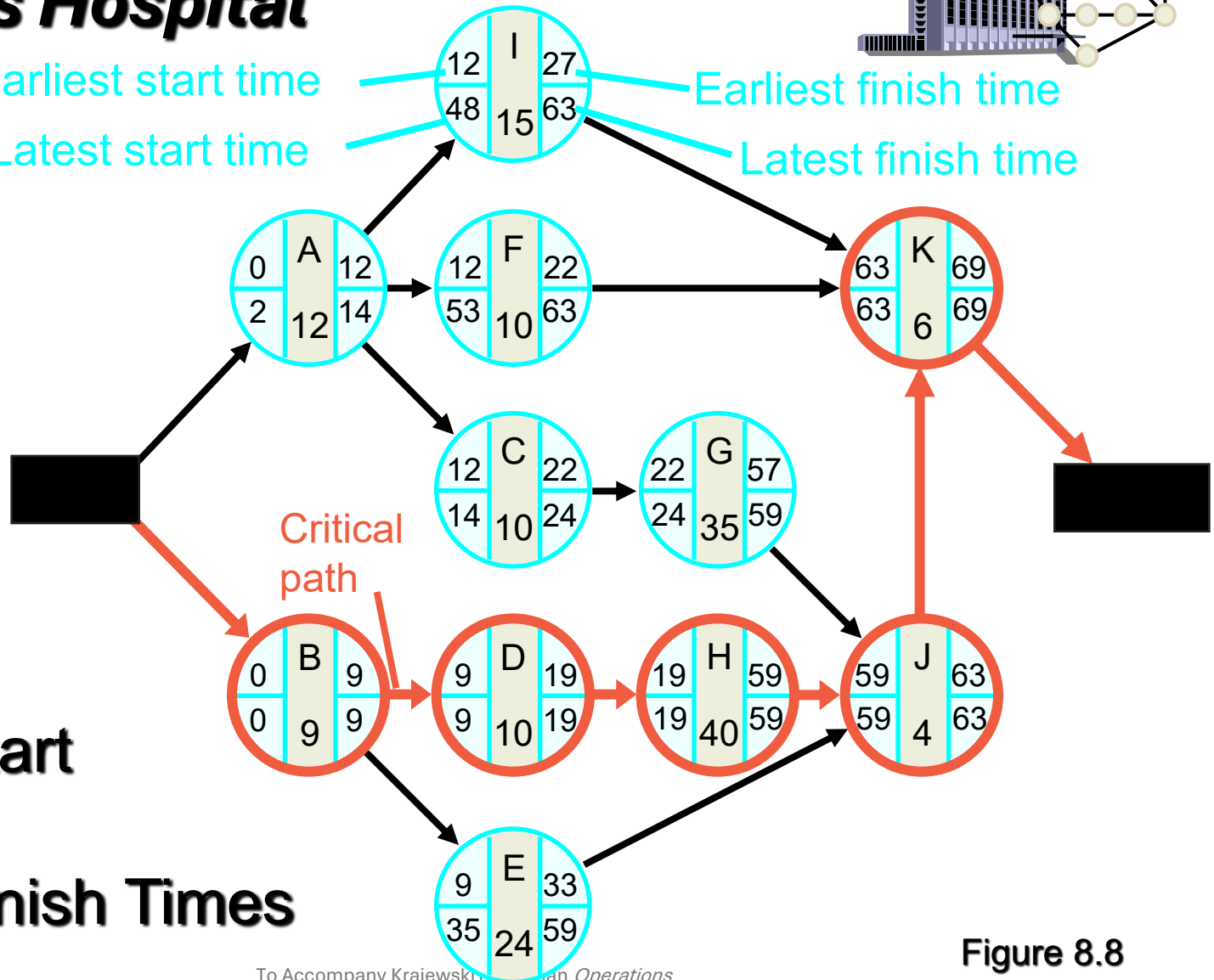


Earliest start time

Latest start time

Earliest finish time

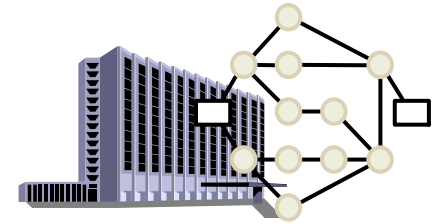
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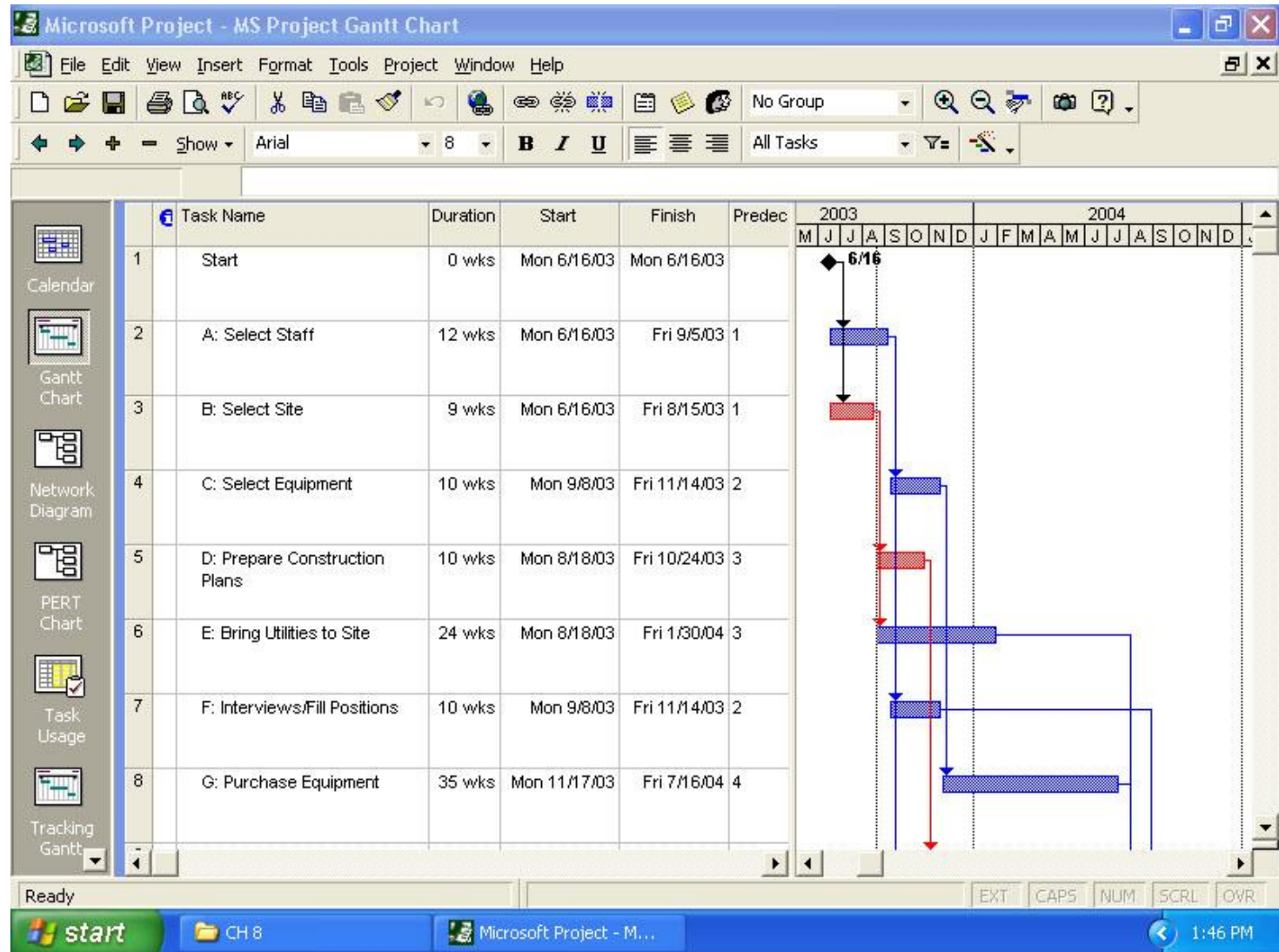
Latest Start
and
Latest Finish Times

Figure 8.8

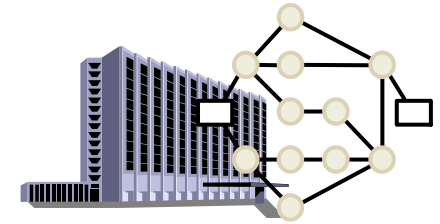
St. Adolf's Hospital



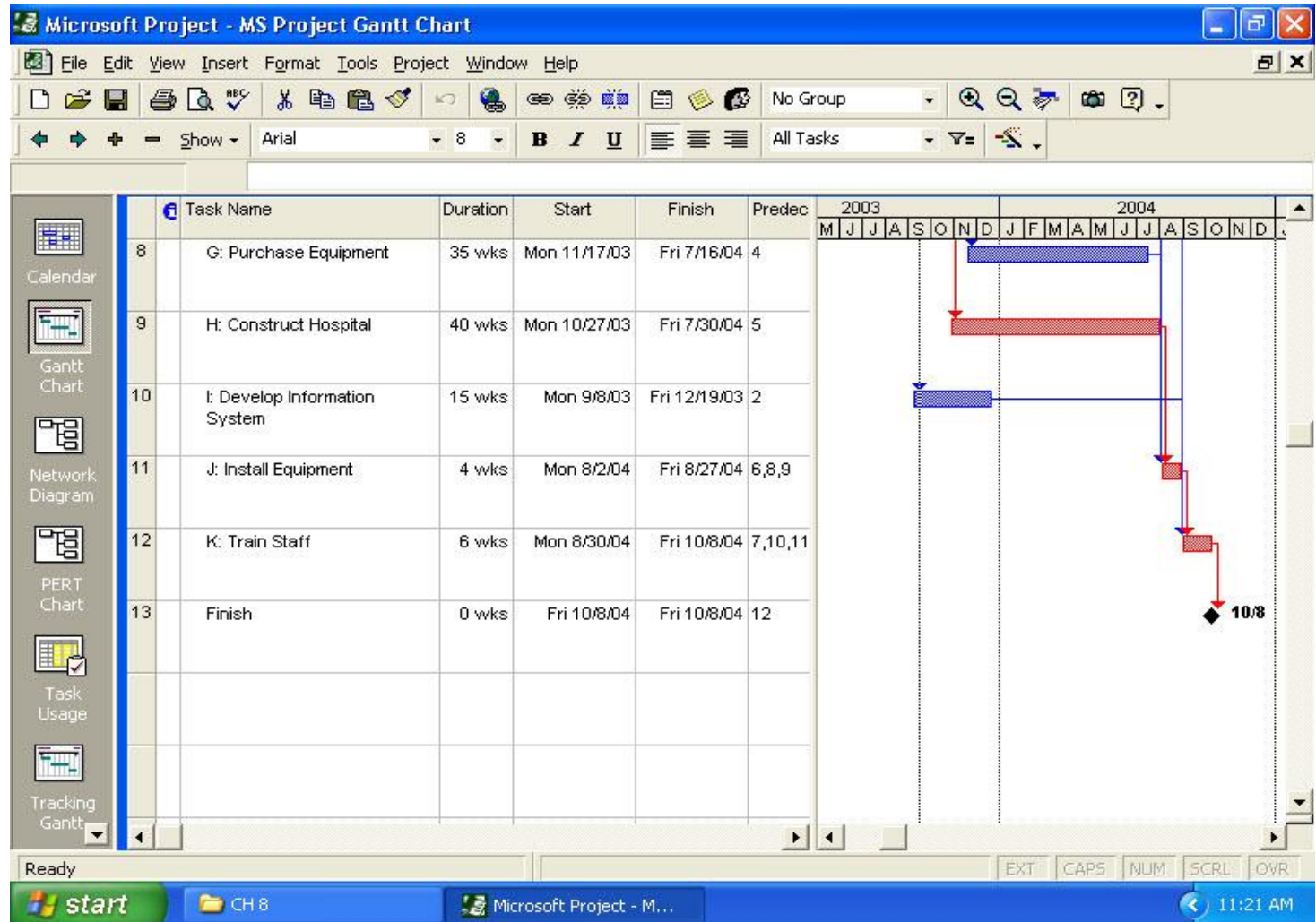
Gantt Charts



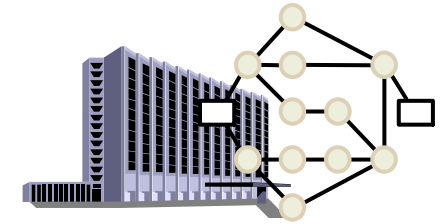
St. Adolf's Hospital



Gantt Charts



St. Adolf's Hospital



Activity Slack

Microsoft Project - MS Project Schedule Table

File Edit View Insert Format Tools Project Window Help

No Group

Arial 8 B I U All Tasks

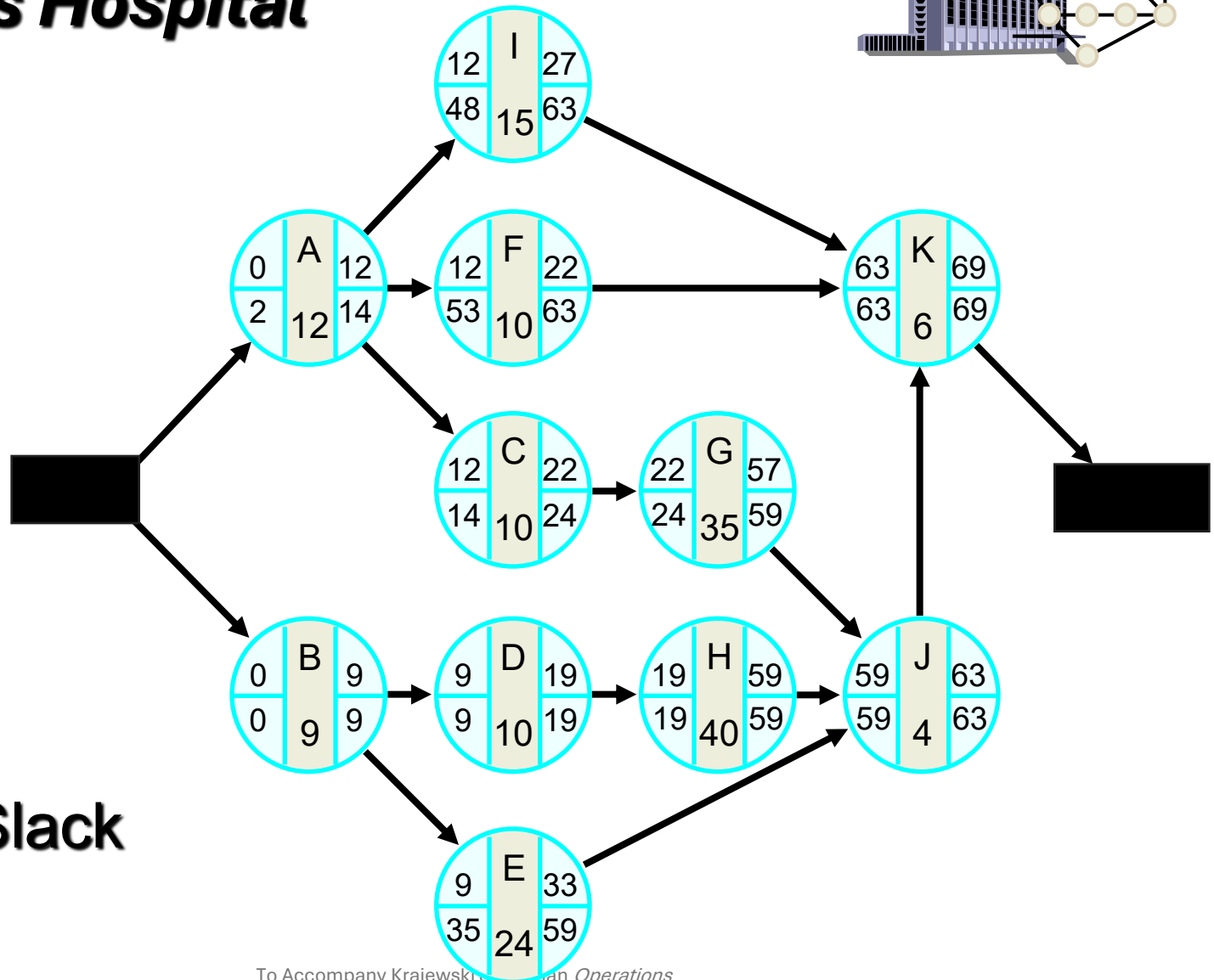
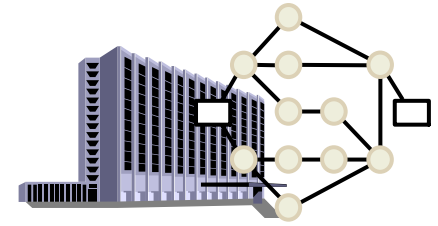
Task Name	Start	Finish	Late Start	Late Finish	Free Slack	Total Slack
1 Start	Mon 6/16/03	Mon 6/16/03	Mon 6/16/03	Mon 6/16/03	0 wks	0 wks
2 A: Select Staff	Mon 6/16/03	Fri 9/5/03	Mon 6/30/03	Fri 9/19/03	0 wks	2 wks
3 B: Select Site	Mon 6/16/03	Fri 8/15/03	Mon 6/16/03	Fri 8/15/03	0 wks	0 wks
4 C: Select Equipment	Mon 9/8/03	Fri 11/14/03	Mon 9/22/03	Fri 11/28/03	0 wks	2 wks
5 D: Prepare Construction Plans	Mon 8/18/03	Fri 10/24/03	Mon 8/18/03	Fri 10/24/03	0 wks	0 wks
6 E: Bring Utilities to Site	Mon 8/18/03	Fri 1/30/04	Mon 2/16/04	Fri 7/30/04	26 wks	26 wks
7 F: Interviews/Fill Positions	Mon 9/8/03	Fri 11/14/03	Mon 6/21/04	Fri 8/27/04	41 wks	41 wks
8 G: Purchase Equipment	Mon 11/17/03	Fri 7/16/04	Mon 12/1/03	Fri 7/30/04	2 wks	2 wks
9 H: Construct Hospital	Mon 10/27/03	Fri 7/30/04	Mon 10/27/03	Fri 7/30/04	0 wks	0 wks
10 I: Develop Information System	Mon 9/8/03	Fri 12/19/03	Mon 5/17/04	Fri 8/27/04	36 wks	36 wks
11 J: Install Equipment	Mon 8/2/04	Fri 8/27/04	Mon 8/2/04	Fri 8/27/04	0 wks	0 wks
12 K: Train Staff	Mon 8/30/04	Fri 10/8/04	Mon 8/30/04	Fri 10/8/04	0 wks	0 wks
13 Finish	Fri 10/8/04	Fri 10/8/04	Fri 10/8/04	Fri 10/8/04	0 wks	0 wks

Ready

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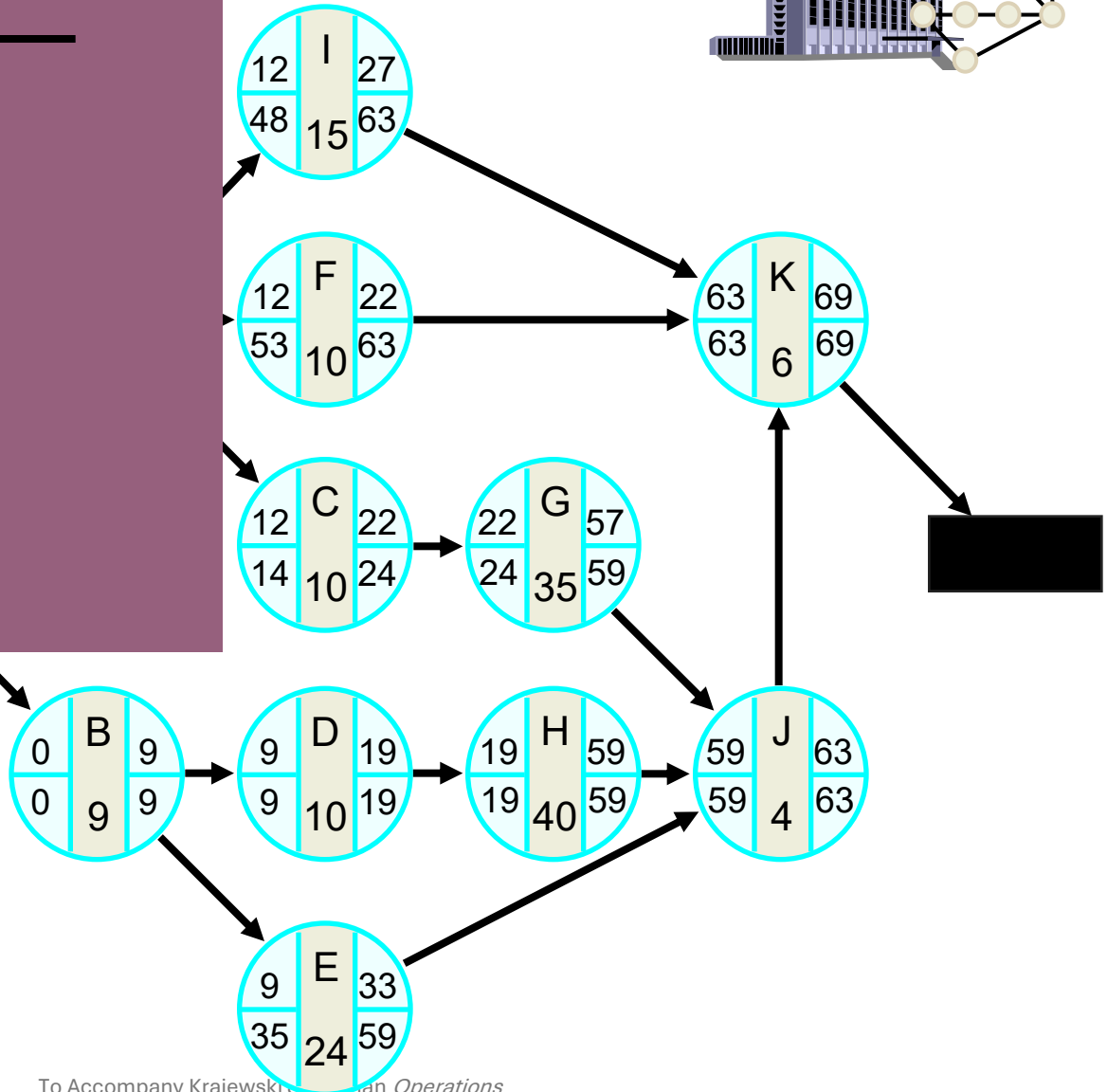
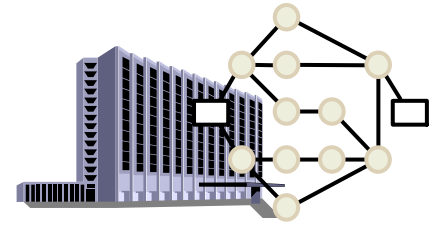
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St. Adolf's Hospital



Activity Slack Analysis

Activity Slack



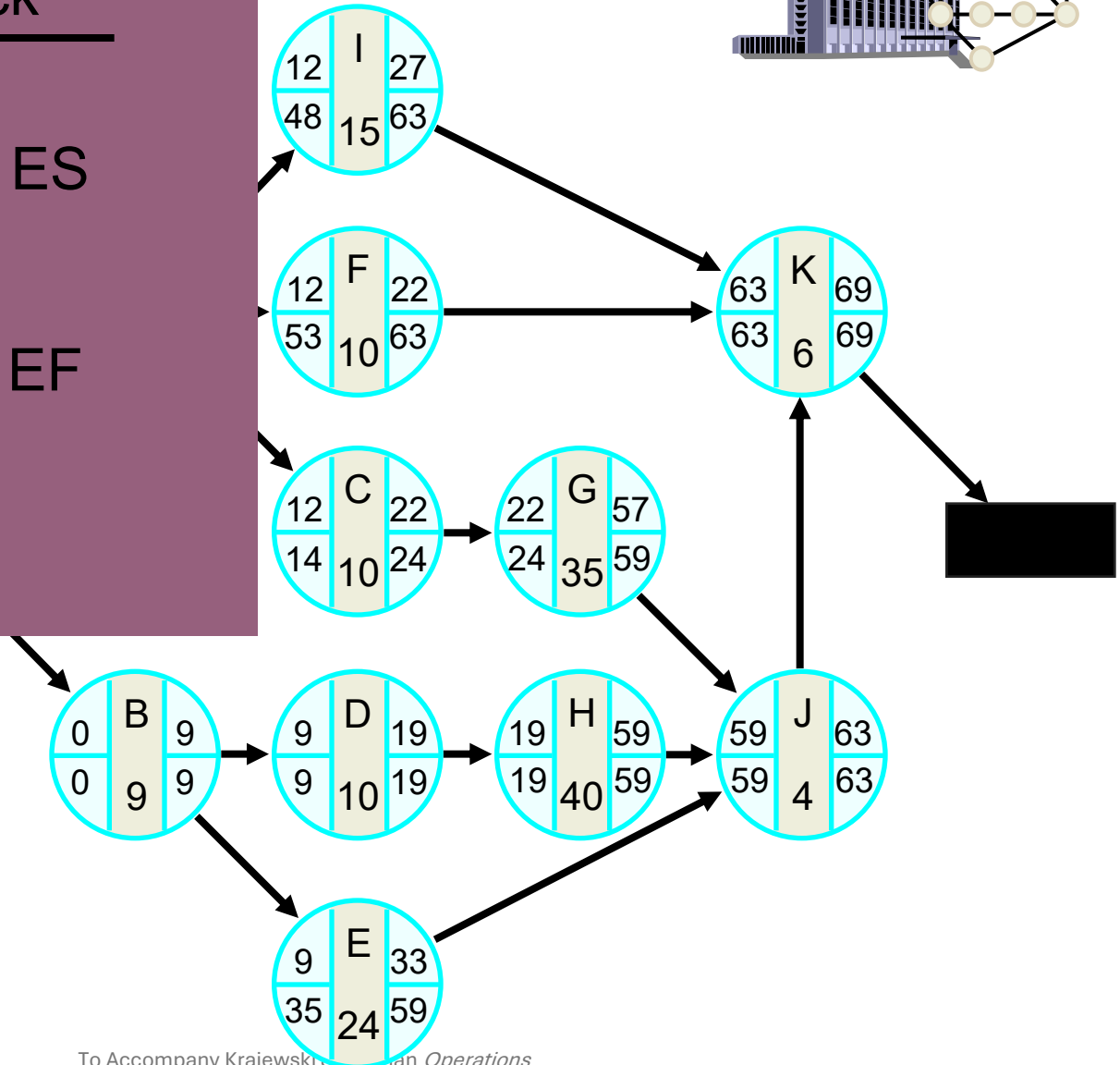
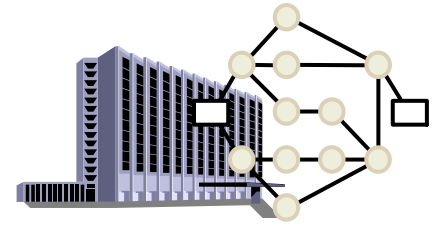
Activity Slack Analysis

Activity Slack

$$\text{Slack} = \text{LS} - \text{ES}$$

or

$$\text{Slack} = \text{LF} - \text{EF}$$



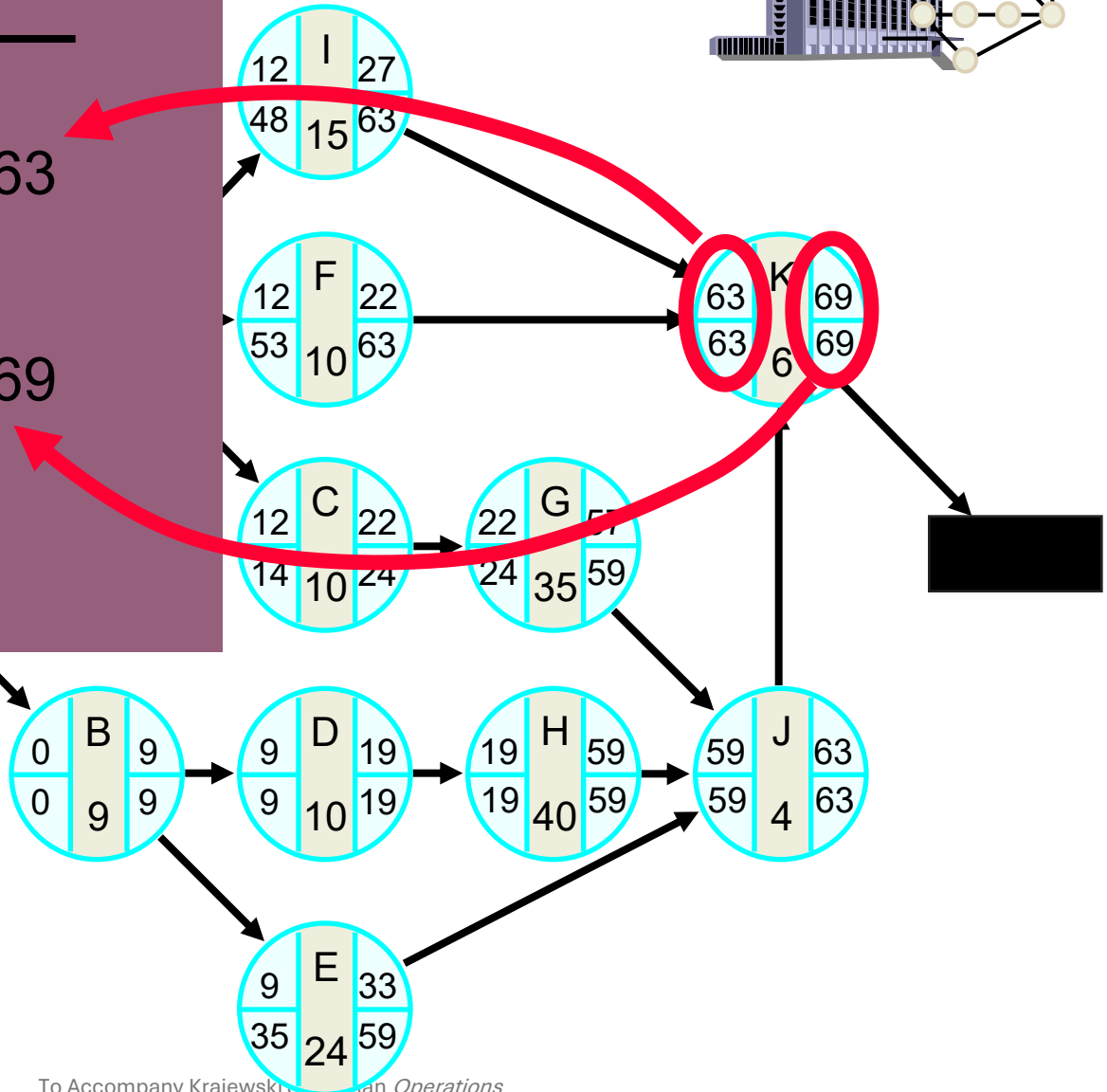
Activity Slack Analysis

Activity Slack

$$\text{Slack}_K = 63 - 63$$

or

$$\text{Slack}_K = 69 - 69$$



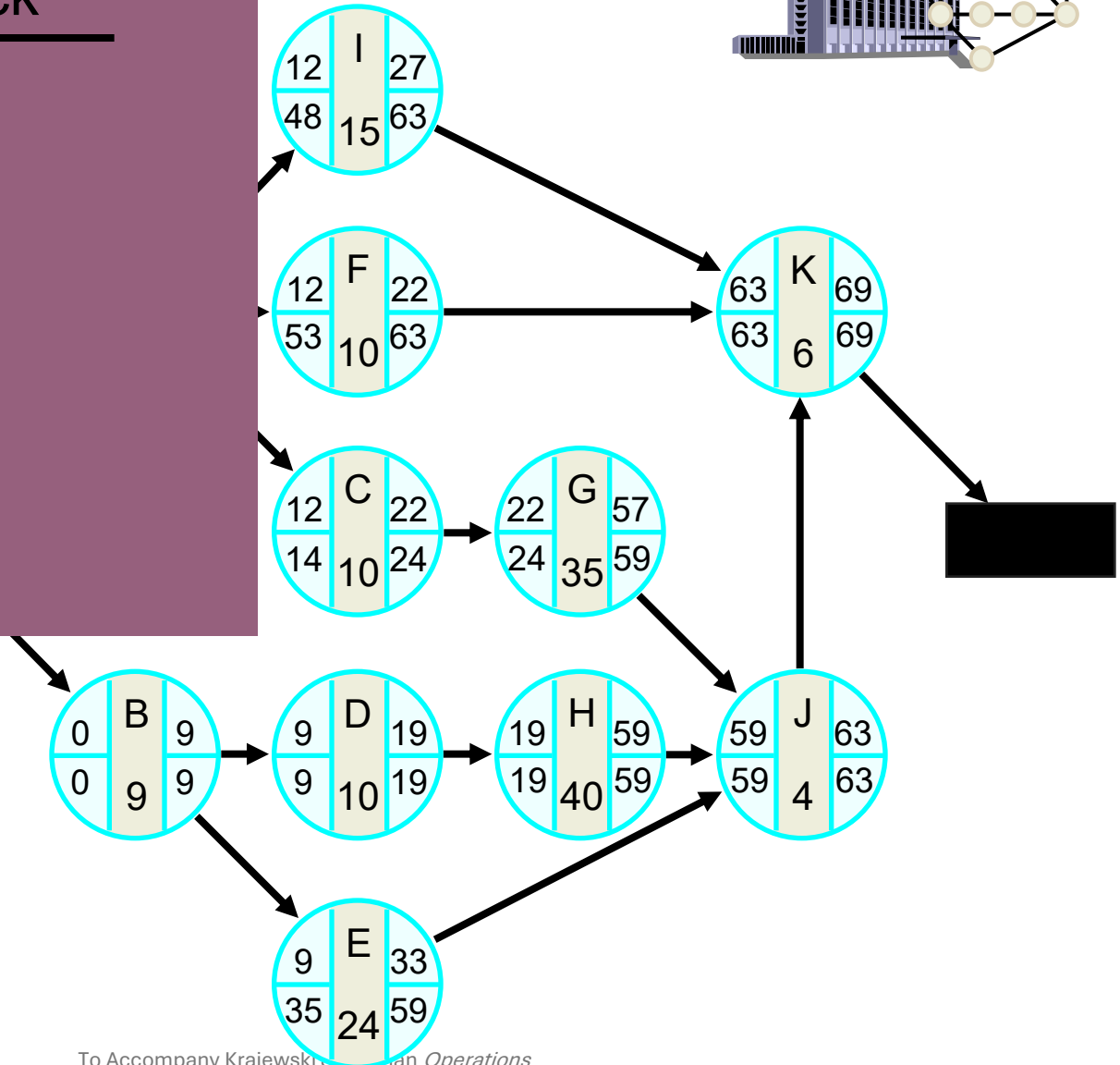
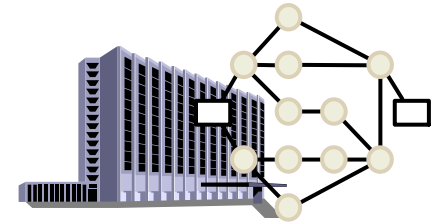
Activity Slack Analysis

Activity Slack

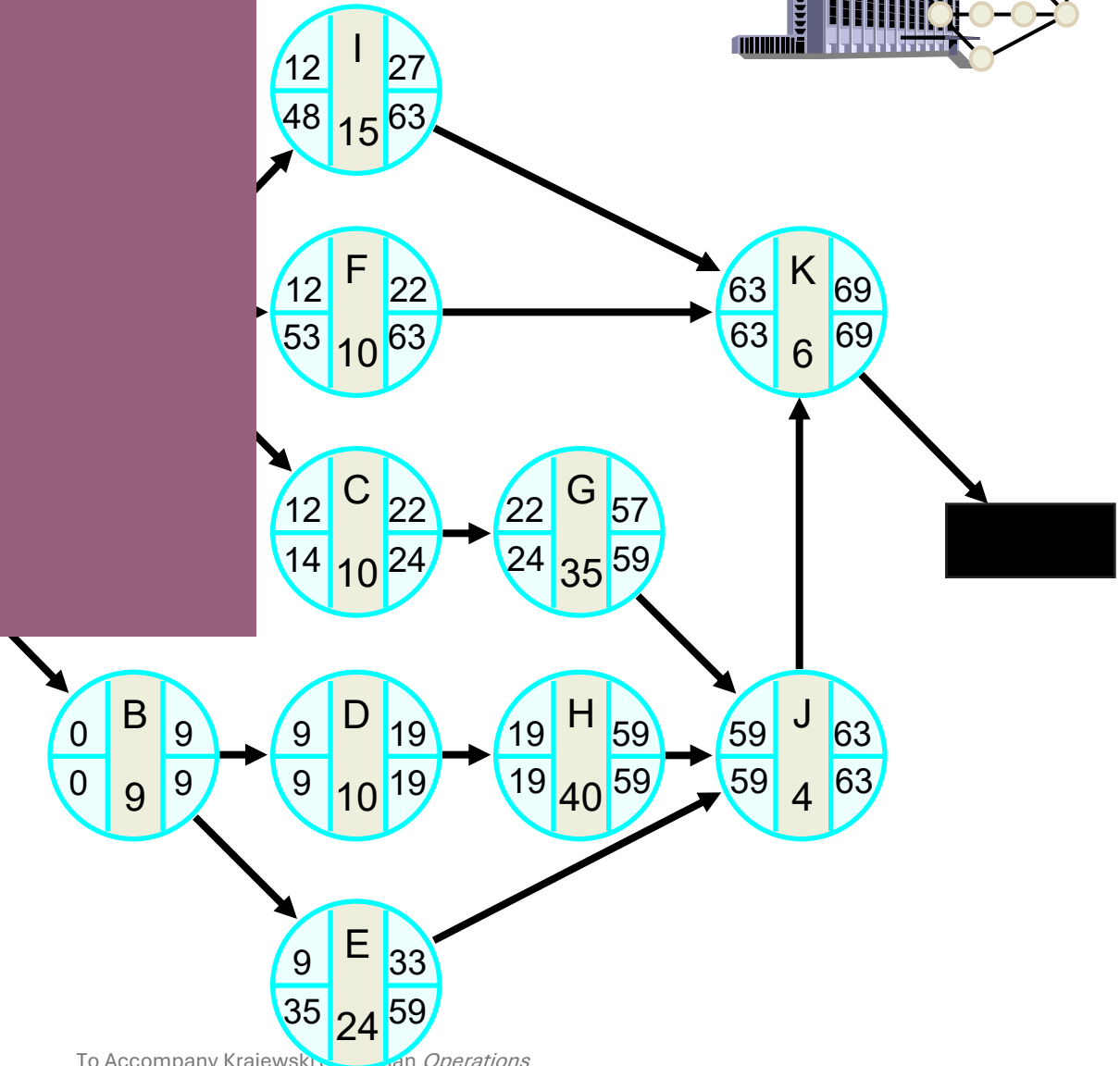
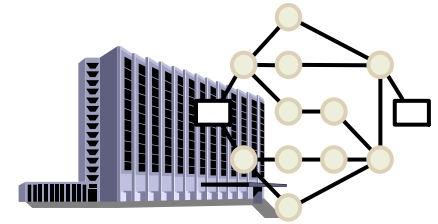
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or

$$\text{Slack}_K = 0$$

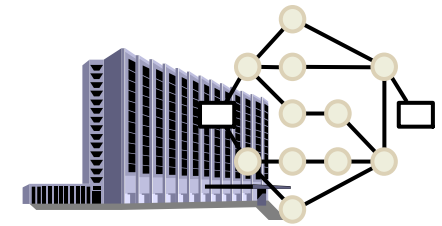
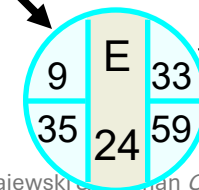
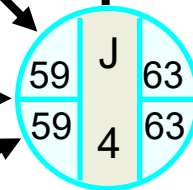
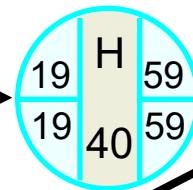
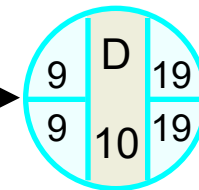
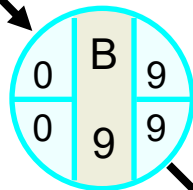
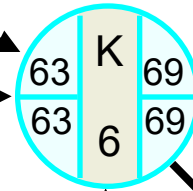
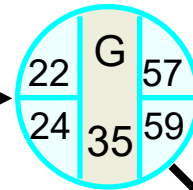
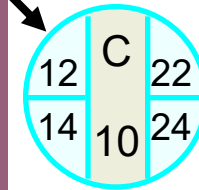
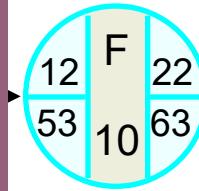
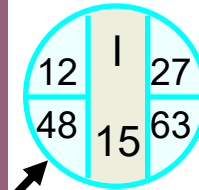


Activity Slack Analysis



Node	Duration	ES	LS	Slack
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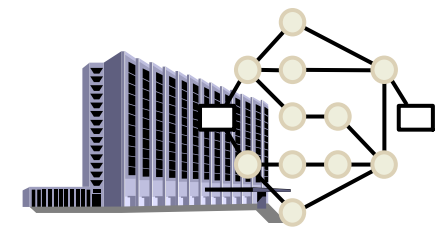
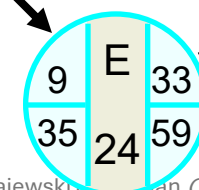
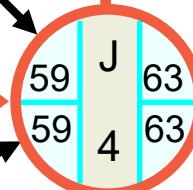
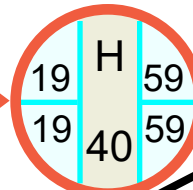
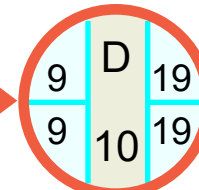
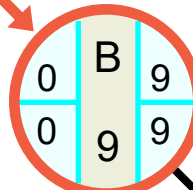
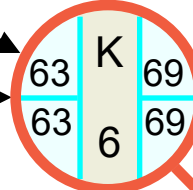
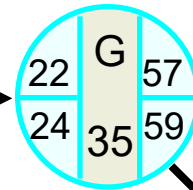
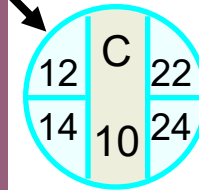
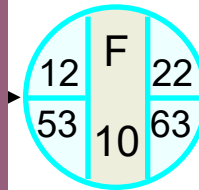
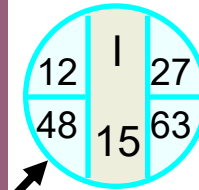
A	12	0	2	2
B	9	0	0	0
C	10	12	14	2
D	10	9	9	0
E	24	9	35	26
F	10	12	53	41
G	35	22	24	2
H	40	19	19	0
I	15	12	48	36
J	4	59	59	0
K	6	63	63	0



Activity Slack Analysis

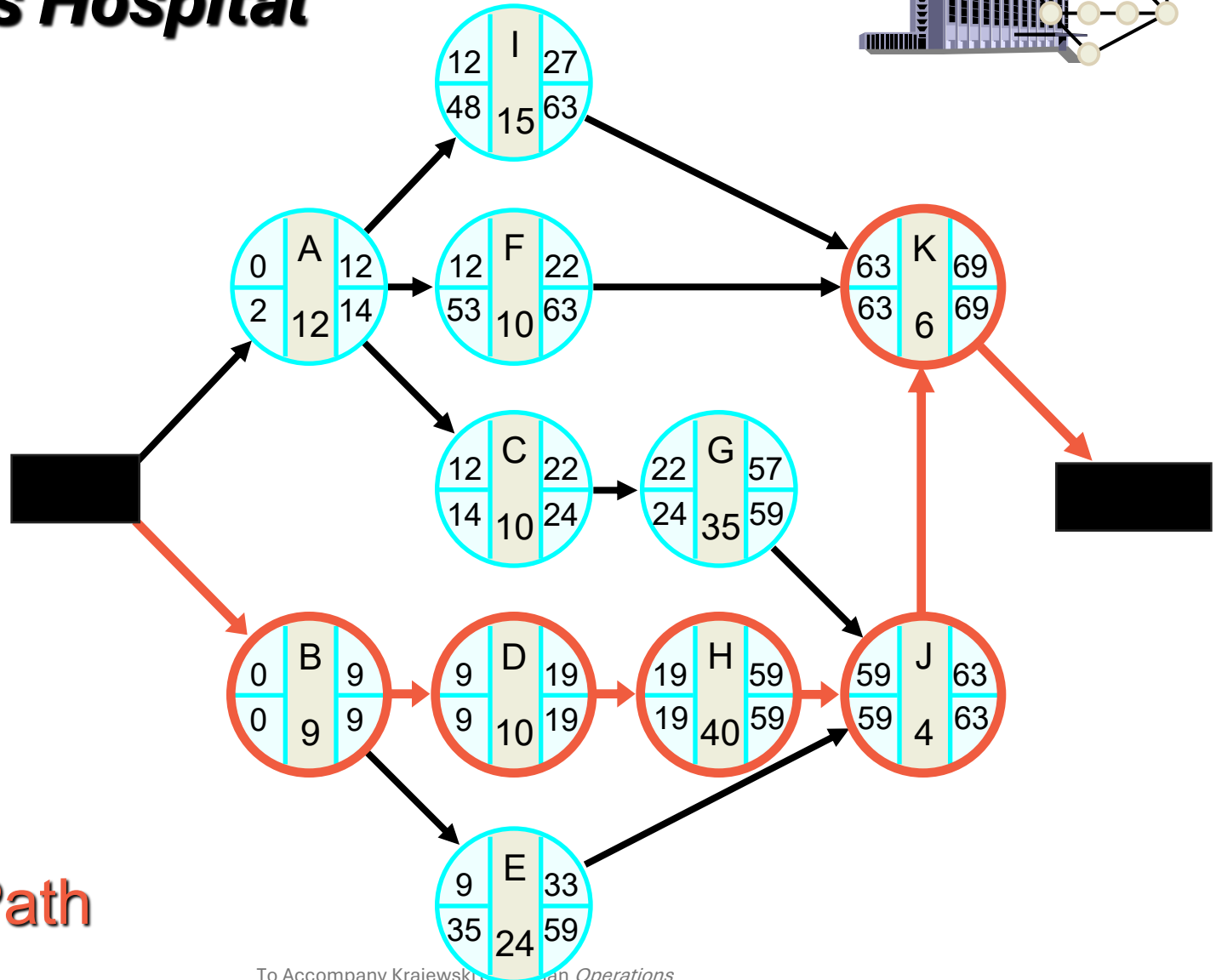
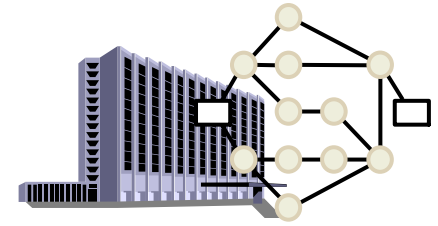
Node	Duration	ES	LS	Slack
------	----------	----	----	-------

A	12	0	2	2
B	9	0	0	0
C	10	12	14	2
D	10	9	9	0
E	24	9	35	26
F	10	12	53	41
G	35	22	24	2
H	40	19	19	0
I	15	12	48	36
J	4	59	59	0
K	6	63	63	0



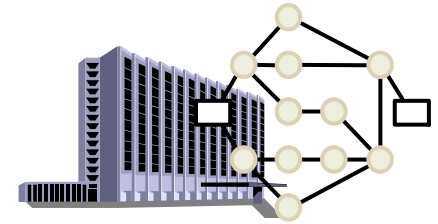
Critical Path

St. Adolf's Hospital

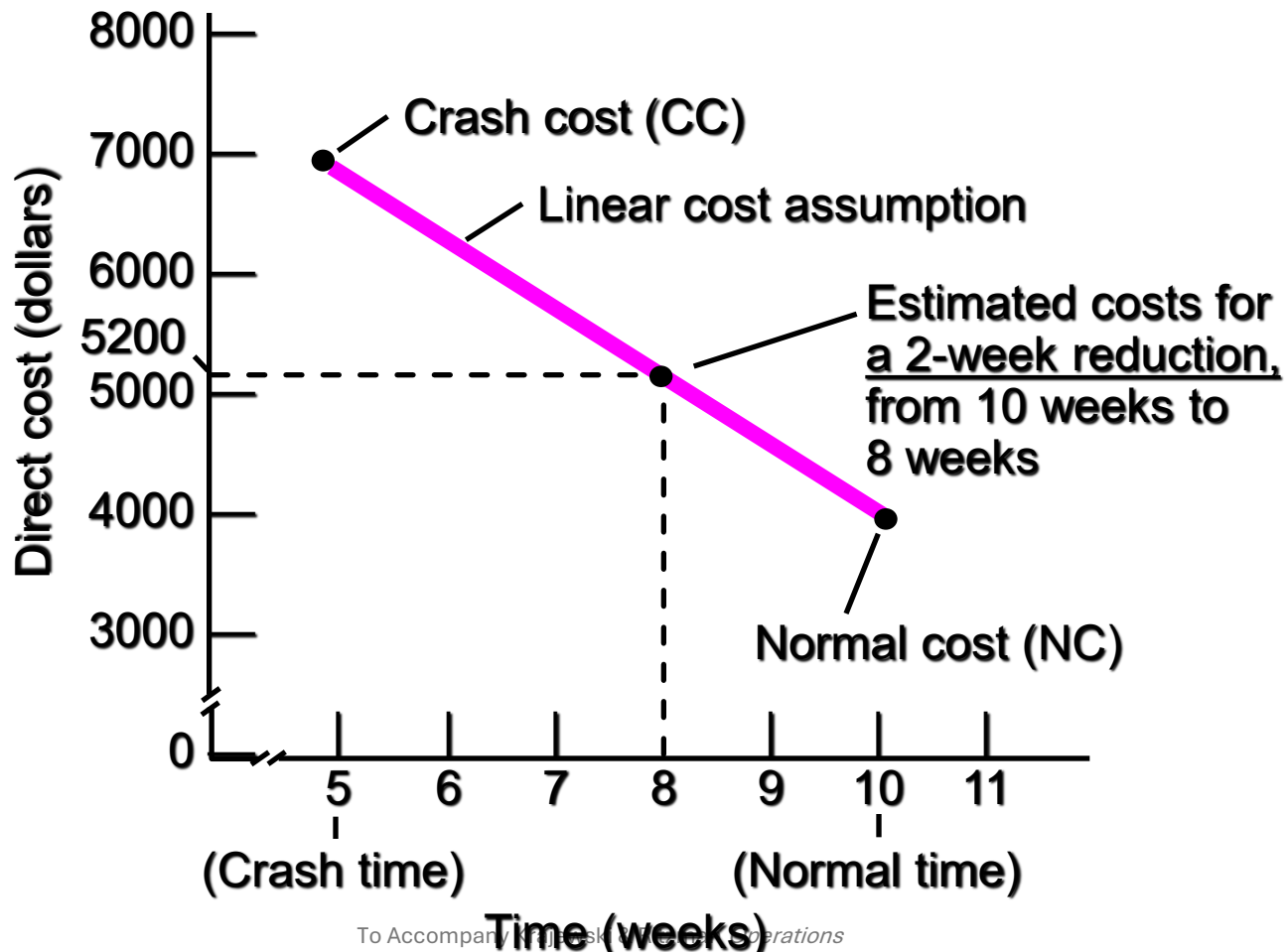


Critical Path

St. Adolf's Hospital



Cost-Time Relationships in Cost Analysis



St. Adolf's Hospital

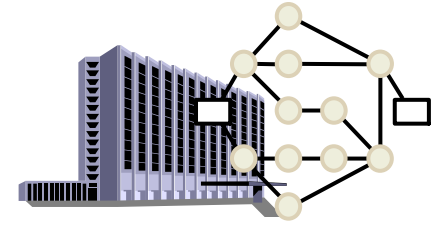


TABLE 8.1 DIRECT COST AND TIME DATA FOR
THE ST. ADOLF'S HOSPITAL PROJECT

Activity	Normal Time (NT)	Normal Cost (NC)	Crash Time (CT)	Crash Cost (CC)	Maximum Time Reduction (wk)	Cost of Crashing per Week
A	12	\$ 12,000	11	\$ 13,000	1	\$ 1,000
B	9	50,000	7	64,000	2	7,000
C	10	4,000	5	7,000	5	600
D	10	16,000	8	20,000	2	2,000
E	24	120,000	14	200,000	10	8,000
F	10	10,000	6	16,000	4	1,500
G	35	500,000	25	530,000	10	3,000
H	40	1,200,000	35	1,260,000	5	12,000
I	15	40,000	10	52,500	5	2,500
J	4	10,000	1	13,000	2	1,000
K	6	30,000	5	34,000	1	4,000
Totals		\$1,992,000		\$2,209,000		

Probabilistic Time Estimates

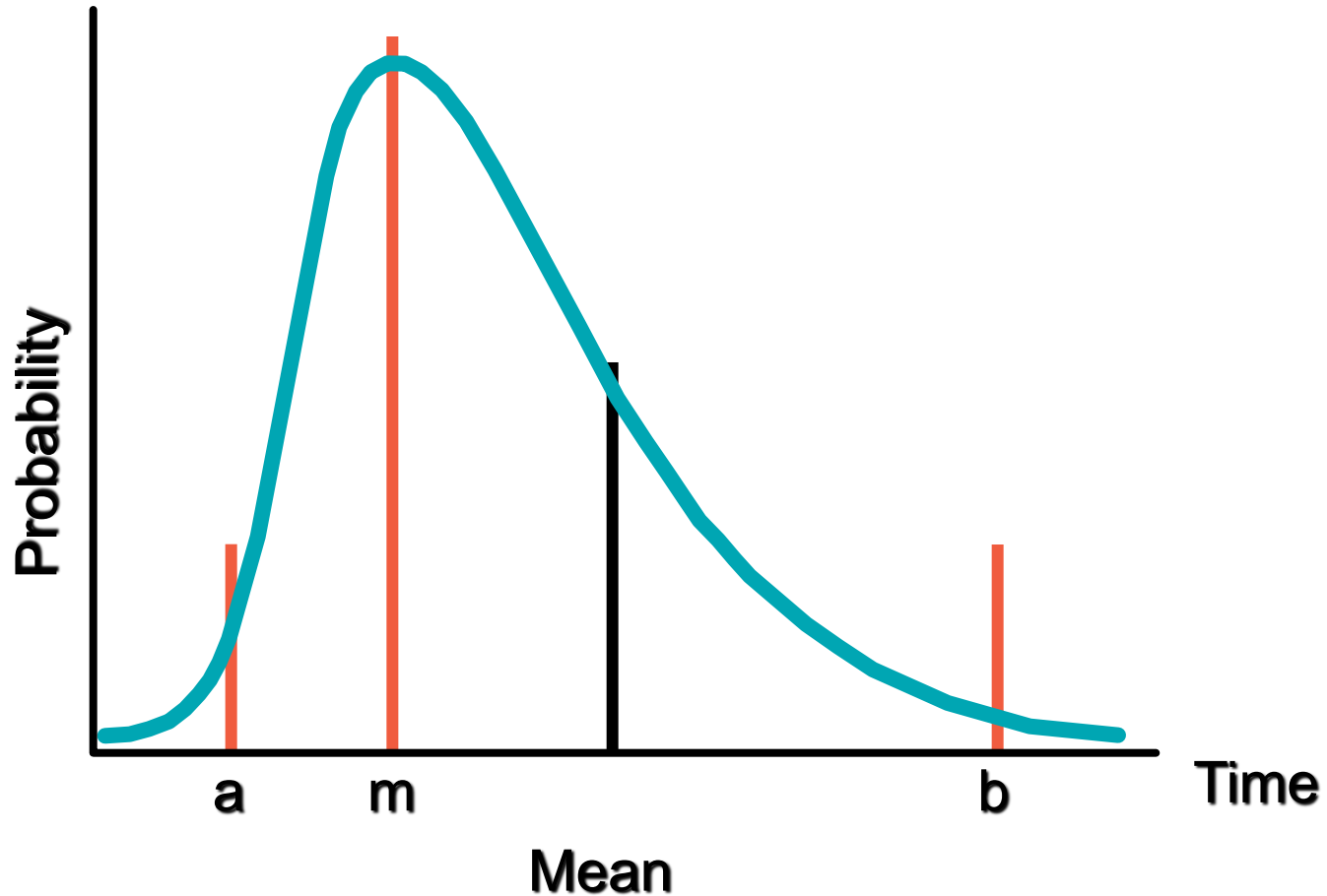
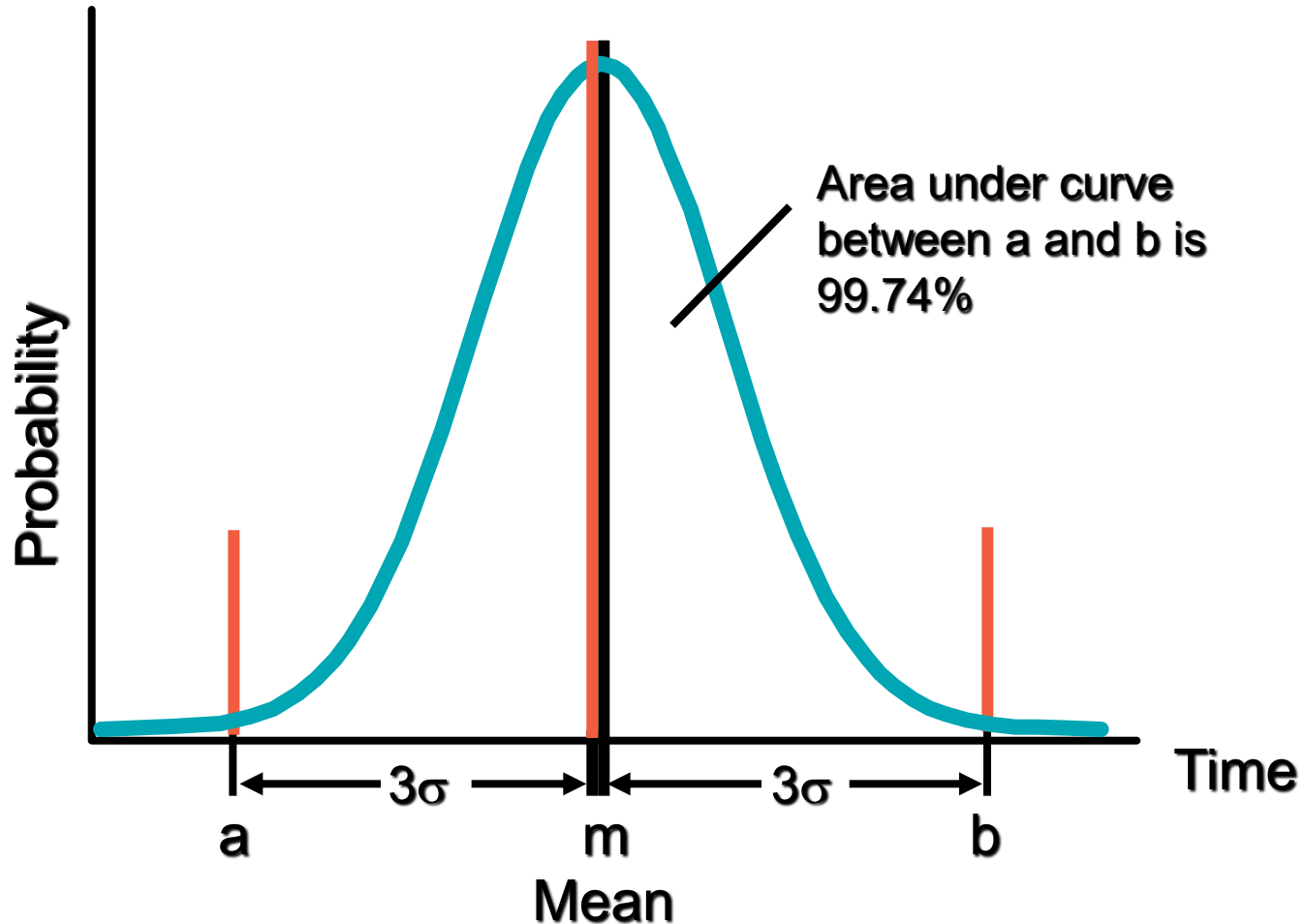


Figure 8.12 (a) Beta Distribution

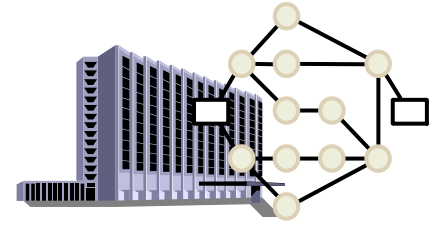
To Accompany Krajewski & Ritzman *Operations Management: Strategy and Analysis, Seventh Edition* ©
2004 Prentice Hall, Inc. All rights reserved.

Probabilistic Time Estimates



Normal Distribution

St. Adolf's Hospital



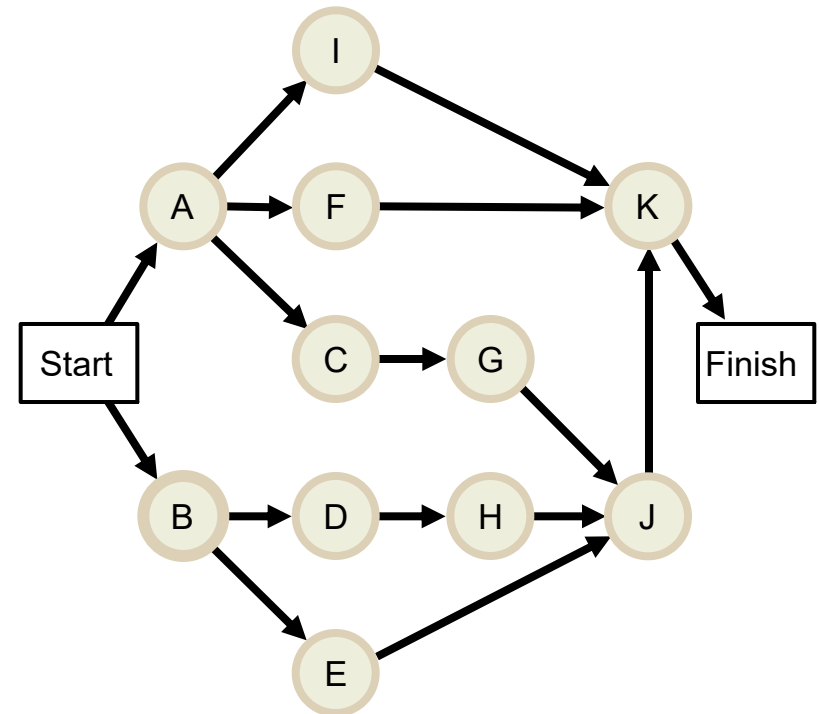
Probabilistic Time Estimates

Mean

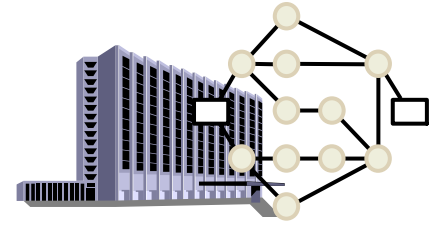
$$t_e = \frac{a + 4m + b}{6}$$

Variance

$$\sigma^2 = \left(\frac{b - a}{6} \right)^2$$

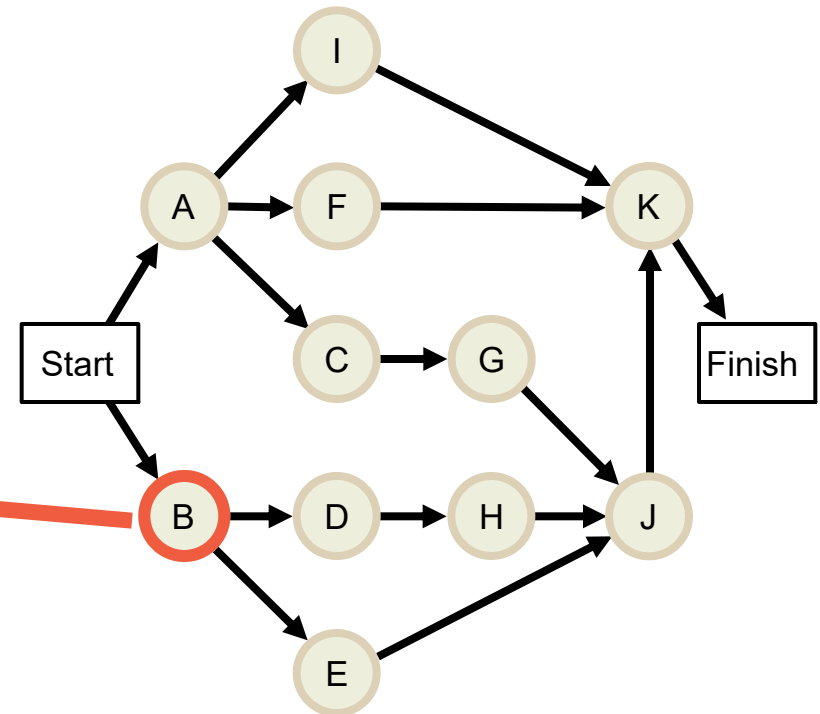


St. Adolf's Hospital

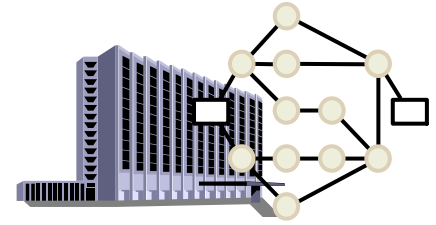


Probabilistic Time Estimates

Activity B		
Optimistic	Most Likely	Pessimistic
(a)	(m)	(b)
7	8	15



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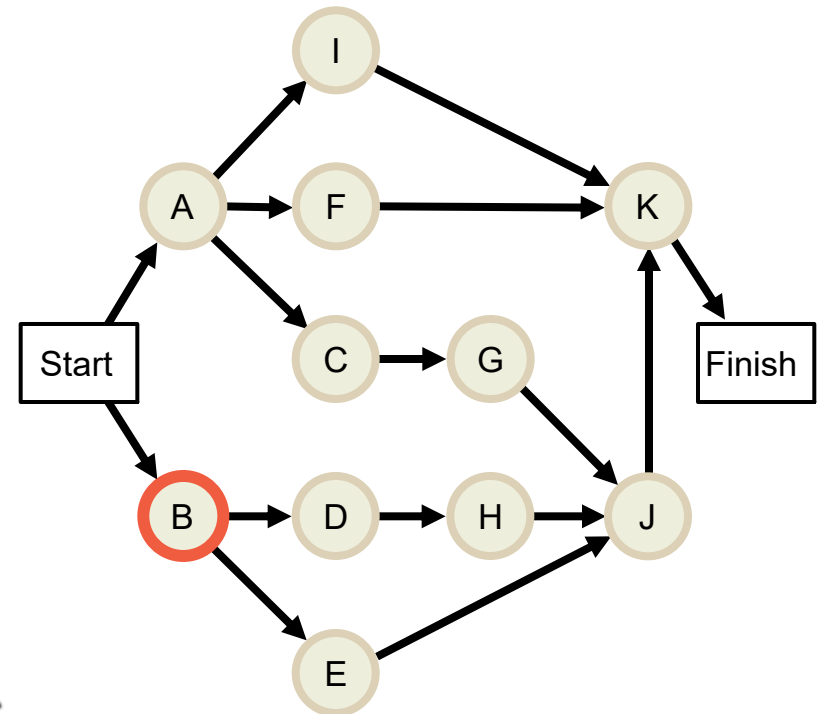


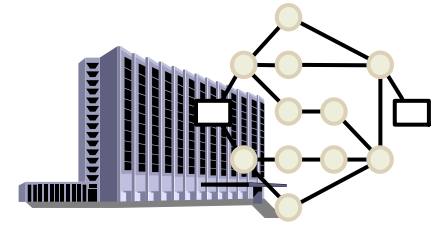
Probabilistic Time Estimates

<u>Activity B</u>		
Optimistic	Most Likely	Pessimistic
(a)	(m)	(b)
7	8	15

$$t_e = \frac{7 + 4(8) + 15}{6} = 9 \text{ weeks}$$

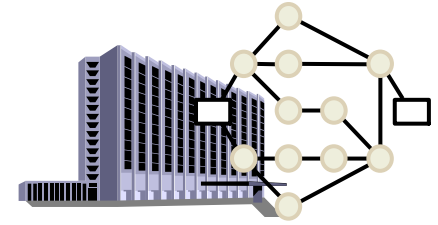
$$\sigma^2 = \left(\frac{15 - 7}{6} \right)^2 = 1.78$$





St. Adolf's Hospital

Activity	Time Estimates (wk)			Activity Statistics	
	Optimistic (a)	Likely (m)	Pessimistic (b)	Expected Time (t_e)	Variance (σ^2)
A	11	12	13	12	0.11
B	7	8	15	9	1.78
C	5	10	15	10	2.78
D	8	9	16	10	1.78
E	14	25	30	24	7.11
F	6	9	18	10	4.00
G	25	36	41	35	7.11
H	35	40	45	40	2.78
I	10	13	28	15	9.00
J	1	2	15	4	5.44
K	5	6	7	6	0.11



St. Adolf's Hospital

Probabilities

Critical Path = B - D - H - J - K

$T = 72$ days

$T_E = 69$ days

$\sigma^2 = \sum (\text{variances of activities})$

$$z = \frac{T - T_E}{\sqrt{\sigma^2}}$$

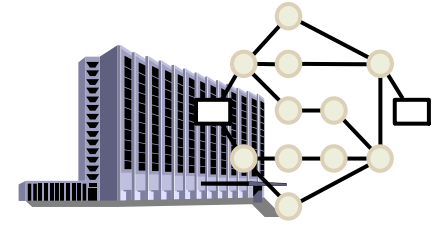
$$\sigma^2 = 1.78 + 1.78 + 2.78 + 5.44 + 0.11 = 11.89$$

$$z = \frac{72 - 69}{\sqrt{11.89}}$$

[illegible]

81% of probability to be late

St. Adolf's Hospital



Probabilities

Critical Path = B - D - H - J - K

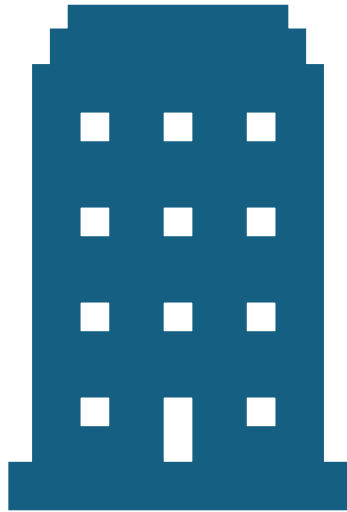
$T = 72$ days $T_E = 69$ days

$$\sigma^2 = \sum (\text{variances of activities}) \quad z = \frac{T - T_E}{\sqrt{\sigma^2}}$$

$$\sigma^2 = 1.78 + 1.78 + 2.78 + 5.44 + 0.11 = 11.89$$

$$z = \frac{72 - 69}{\sqrt{11.89}} = 0.87$$

From Appendix 2
 $P_z = .8078 \approx .81$



Design network decisions

- Complete method
 - Location of supply sources and markets
 - Location of potential facility sites
 - Demand forecast by market
 - Facility, labor and material costs by site
 - Transportation costs between each pair of sites
 - Inventory costs by site and as a function of quantity
 - Sale price of product in different regions
 - Taxes and tariffs
 - Desired response time and other service factors

Cost & Demand Data related to U.S. Petroleum

<u>Inputs-Costs,Capacities, Demands</u>									
<u>Demand Region :</u>	Production and transportation cost per 1,000,000 units					Fixed	Low	Fixed	High
<u>Supply region</u>	N America	S America	Europe	Asia	Africa	cost \$	capacity	cost \$	capacity
N.America	81	92	101	130	115	6000	10	9000	20
S. America	117	77	108	98	100	4500	10	6750	20
Europe	102	105	95	119	111	6500	10	9750	20
Asia	115	125	90	59	74	4100	10	6150	20
Africa	142	100	103	105	71	4000	10	6000	20
<i>Demand</i>	12	8	14	16	7				

U.S. Petroleum

with

n = number of potential plant locations/capacity (each level of capacity will count as a separate location)

m = number of markets or demand points

D_j = annual demand from market j

K_i = potential capacity of plant i

f_i = annualized fixed cost of keeping factory i open

c_{ij} = cost of producing and shipping one unit from factory i to market j (cost includes production, inventory, transportation and tariffs)

$y_i = 1$ if plant is open, 0 otherwise

x_{ij} = quantity shipped from plant i to market j

U.S. Petroleum

$$\text{Min } \sum_{i=1}^n f_i y_i + \sum_{i=1}^n \sum_{j=1}^m c_{ij} x_{ij}$$

Under conditions to minimize the total cost

$$\sum_{i=1}^n x_{ij} = D_j \text{ for } j = 1, \dots, m$$

Demand at each regional market is satisfied

$$\sum_{j=1}^m x_{ij} \leq K_i y_i \text{ for } i = 1, \dots, n$$

No plant can supply more than its capacity (K_i or 1)

$$y_i \in \{0, 1\} \text{ for } i = 1, \dots, n, x_{ij} \geq 0$$

so each plant is either open ($y_i = 1$) or closed ($y_i = 0$)

The solution identifies the plants that are to be kept open, their capacity, and the regional allocation of the demand for these plants.