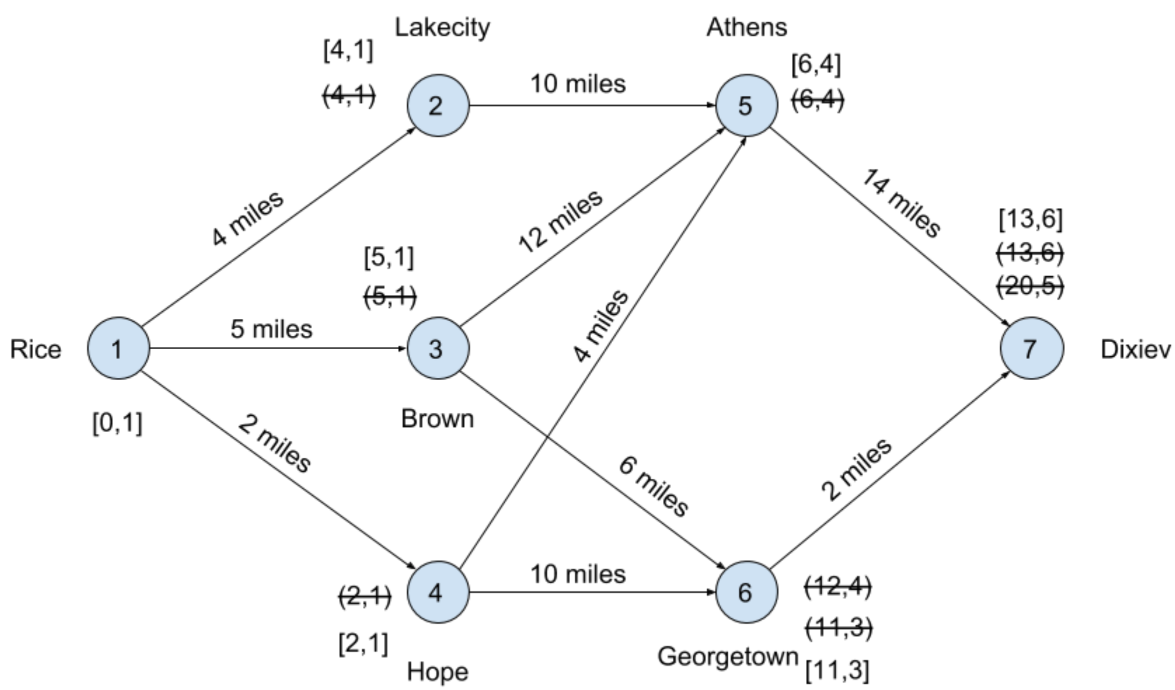
Prescriptive Analytics - HW 4

Saundarya Badhrinathan, Nabeel Ahmed, Divya Chandramohan,
Uttara Thiagarajan, Megan Mugavero

1. Readings completed

2. Dijkstra's algorithm:



Node	Distance	Route
1-2	4	1-2
1-3	5	1-3
1-4	2	1-4
1-5	6	1-4-5
1-6	11	1-3-6
1-7	13	1-3-6-7

3. Initial Feasible Solution:

	X	Y	Z	Supply
A	40,000 11	5	8	40,000
B	50,000 8	50,000 9	12	100,000
C	13	10,000 10	70,000 7	80,000
Demand	90,000	60,000	70,000	220,000 220,000

Total Transportation Cost:

(11*40,000)+(8*50,000)+(9*50,000)+(10*10,000)+(7*70,000) = $1,880,000

Evaluation:

R1 + K1 = 11	R1 = 0	K1 = 11
R2 + K1 = 8		R2 = -3
R2 + K2 = 9		K2 = 12
R3 + K2 = 10		R3 = -2
R3 + K3 = 7		K3 = 9

A-Y = 5 - (0 + 12) = -7

A-Z = 8 - (0 + 9) = -1

B-Z = 12 - (-3 + 9) = 6

C-X = 13 - (-2 + 11) = 4

Improvement in Optimality:

	X		Y		Z		Supply
A		11	40,000	5		8	40,000
B	90,000	8	10,000	9		12	100,000
C		13	10,000	10	70,000	7	80,000
Demand	90,000		60,000		70,000		220,000 \ 220,000

Evaluation:

R1 + K2 = 5	R1 = 0	K2 = 5
R2 + K1 = 8		K1 = 4
R2 + K2 = 9		R2 = 4
R3 + K2 = 10		R3 = 5
R3 + K3 = 7		K3 = 2

A-X = 11 - (0 + 4) = 7
A-Z = 8 - (0 + 2) = 6
B-Z = 12 - (4 + 2) = 6
C-X = 13 - (5 + 4) = 4

Optimal solution achieved since all evaluations are zero or positive.

The optimal shipping schedule is given below.

From	To	Shipment
A	Y	40,000
B	X	90,000
B	Y	10,000
C	Y	10,000
C	Z	70,000

Minimum Total Transportation Cost:

$$(5*40{,}000)+(8*90{,}000)+(9*10{,}000)+(10*10{,}000)+(7*70{,}000) = \$1{,}600{,}000$$

4. Decision variables:

    Let x be the number of drums produced.

    Let y be the number of gallons produced for bulk-orders.

MILP:

Maximize $Z = 50x + 1.25y$

Subject to:

$$\begin{aligned}
16.67x + 0.44y &\le 1000 \\
13.33x + 0.25y &\le 750 \\
0.53x + 0.04y &\le 80 \\
x &\ge 0 \text{ and integer} \\
y &\ge 0
\end{aligned}$$

Solver Solution:

Objective Cell (Max)

Cell	Name	Original Value	Final Value
$E$6	Max Z	0	2965.085227

Variable Cells

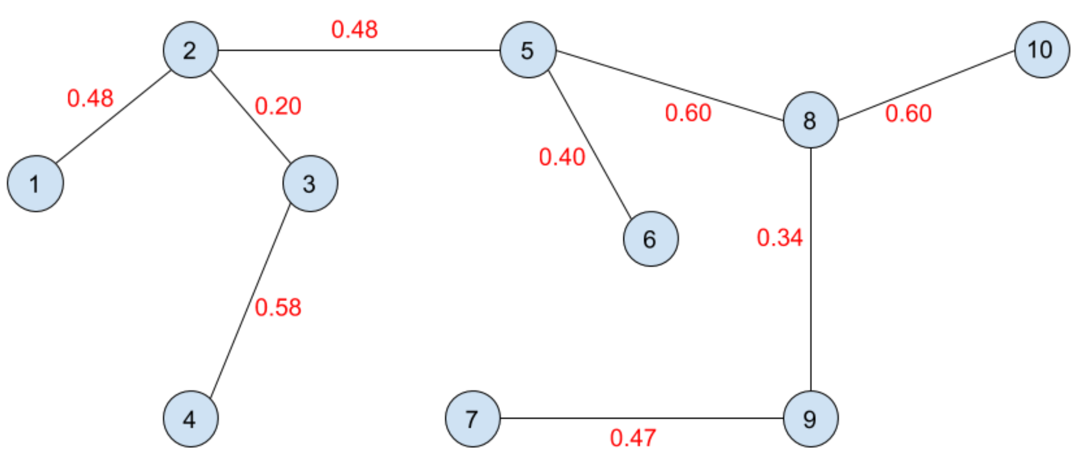
Cell	Name	Original Value	Final Value	Integer
$C$5	A	0	47	Integer
$D$5	B	0	492.0681818	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$E$8		1000	$E$8<=$G$8	Binding	0
$E$9		749.5270455	$E$9<=$G$9	Not Binding	0.472954545
$E$10		44.59272727	$E$10<=$G$10	Not Binding	35.40727273
$C$5=Integer					

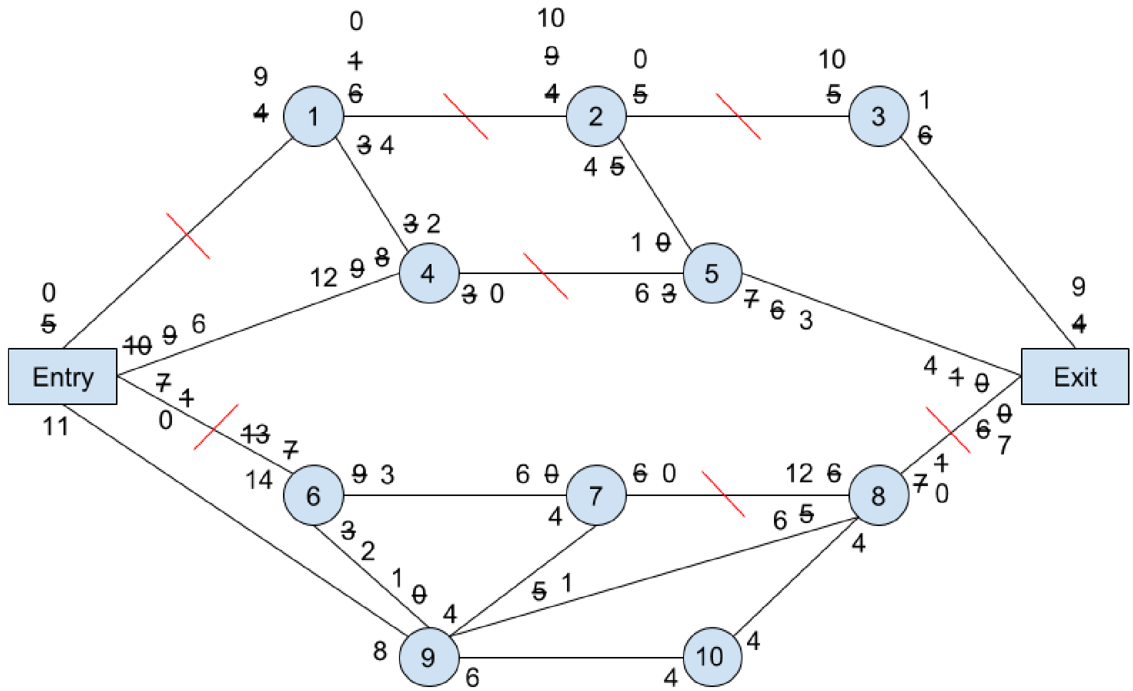
The optimal solution is producing 47 drums and 492.0681 gallons of the termite spray. This will maximize revenue at $2965.08.

5. Greedy Algorithm:



Minimum Distance = 4.15

6. Ford-Fulkerson Algorithm:



Path	Capacities	Minimum Capacity
Entry - 1 - 2 - 3 - Exit	5, 6, 5, 6	5
Entry - 4 - 1 - 2 - 5 - Exit	10, 3, 1, 5, 7	1
Entry - 4 - 5 - Exit	9, 3, 6	3
Entry - 6 - 7 - 8 - Exit	7, 9, 6, 7	6
Entry - 6 - 9 - 8 - Exit	1, 3, 5, 1	1

Maximum Flow:
(5+10+7+11) - (0+6+0+11) = (9+4+7) - (4+0+0)

Gas capacity of **16,000** cubic feet per minute.