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Assignment: CS325 HW6

1. *Shortest Path using LP. Using linear programming to answer the questions below. Submit a copy of the LP code and output*
2. *Find the distance of the shortest path from G to C*

I originally was going to try and complete this function in Matlabs but in reading the documentation I found it a bit confusing and honestly a little difficult. As a result I entered the entered the values of the edges in LINDO as shown in video 3. Below is my input code:

max dc

ST

dg = 0

dd - dg <= 2

dh - dg <= 3

da - dh <= 4

dg - de <= 7

db - dh <= 9

de - db <= 10

db - da <= 8

dd - de <= 9

dd - dc <= 3

df - dd <= 18

dc - db <= 4

de - dd <= 25

dc - df <= 3

db - df <= 7

df - da <= 10

da - df <= 5

de - df <= 2

END

And below was my output code:

LP OPTIMUM FOUND AT STEP 5

OBJECTIVE FUNCTION VALUE

1) 16.00000

VARIABLE VALUE REDUCED COST

DC 16.000000 0.000000

DG 0.000000 0.000000

DD 0.000000 0.000000

DH 3.000000 0.000000

DA 4.000000 0.000000

DE 16.000000 0.000000

DB 12.000000 0.000000

DF 14.000000 0.000000

ROW SLACK OR SURPLUS DUAL PRICES

2) 0.000000 1.000000

3) 2.000000 0.000000

4) 0.000000 1.000000

5) 3.000000 0.000000

6) 23.000000 0.000000

7) 0.000000 1.000000

8) 6.000000 0.000000

9) 0.000000 0.000000

10) 25.000000 0.000000

11) 19.000000 0.000000

12) 4.000000 0.000000

13) 0.000000 1.000000

14) 9.000000 0.000000

15) 1.000000 0.000000

16) 9.000000 0.000000

17) 0.000000 0.000000

18) 15.000000 0.000000

19) 0.000000 0.000000

NO. ITERATIONS= 5

**Answer**: the shortest distance from G -> C is 16.

1. *Find the distances of the shortest paths from G to all other vertices*

As suggested in video 3 of the lectures, I used LINDO to enter the values to find the “max” distance from G to all the remaining vertices in the graph. Below is my input code:

(NOTE: the only value we do not insert in the “max” command is the value of dg because we are starting in vertex G.

Input Code:

max dc + da + db + dd + de + df

ST

dg = 0

dd - dg <= 2

dh - dg <= 3

da - dh <= 4

dg - de <= 7

db - dh <= 9

de - db <= 10

db - da <= 8

dd - de <= 9

dd - dc <= 3

df - dd <= 18

dc - db <= 4

de - dd <= 25

dc - df <= 3

db - df <= 7

df - da <= 10

da - df <= 5

de - df <= 2

END

Below is the output code that shows the shortest paths from G -> to other vertices :

LP OPTIMUM FOUND AT STEP 8

OBJECTIVE FUNCTION VALUE

1) 73.00000

VARIABLE VALUE REDUCED COST

DC 16.000000 0.000000

DA 7.000000 0.000000

DB 12.000000 0.000000

DD 2.000000 0.000000

DE 19.000000 0.000000

DF 17.000000 0.000000

DG 0.000000 0.000000

DH 3.000000 0.000000

ROW SLACK OR SURPLUS DUAL PRICES

2) 0.000000 6.000000

3) 0.000000 1.000000

4) 0.000000 5.000000

5) 0.000000 3.000000

6) 26.000000 0.000000

7) 0.000000 2.000000

8) 3.000000 0.000000

9) 3.000000 0.000000

10) 26.000000 0.000000

11) 17.000000 0.000000

12) 3.000000 0.000000

13) 0.000000 1.000000

14) 8.000000 0.000000

15) 4.000000 0.000000

16) 12.000000 0.000000

17) 0.000000 2.000000

18) 15.000000 0.000000

19) 0.000000 1.000000

NO. ITERATIONS= 8

**Answer**:

G -> C = 16 (as noted in answer for 1a.)

G-> A = 7

G-> B = 12

G-> D = 2

G-> E = 19

G-> F = 17

G-> G = 0

G -> H = 3

1. *Product Mix: Acme Industries produces four types of men’s ties using three types of material. Your job is to determine how many of each type of tie to make each month. The goal is maximize profit:*

*Profit per tie = selling price – labor cost – material cost*

*Labor cost = $0.75 per tie for all 4 types of ties*

1. *Formulate the problem as linear program w/ an objective function and all constraints*

Taking into account the 4th table in the question, the profit for each tie is arrived to by the following:

Profit per tie = selling price – labor – material cost

We arrive to the material costs by multiplying the volume of material needed times (\*) the cost per yard of that material (ex: Silk Material Cost = .125 \* 20 = $2.50). As a result, below are the functions for each of the four types of ties:

Silk tie, s, profit:

6.70 - .75 – 2.5 = $3.45

Polyester tie, pt, profit:

3.55 - .75 - .48 = $2.32

Blend 1, bt1, profit:

4.31 - .75 - .75 = $2.81

Blend 2, bt2, profit:

4.81 - .75 - .81 = $3.25

**As a result our objective is**:

MAX $3.45s + $2.32pt + $2.81bt1 + $3.25bt2

And the **constraints** to our problem are the following:

* The available yards per month for the materials used

Silk tie material limit:

0.125s <= 1000

Polyester tie material limit, keeping in mind it’s used in the ties p, bt1, and bt2:

.08pt + .05bt1 + .03bt2 <= 2000

Cotton tie material limit, keeping in mind it’s used in the ties bt1 and bt2:

.05bt1 + .07bt2 <= 1250

* Another constraint is the minimum and maximum number of tie we need to sell:

Silk tie production:

s >= 6000 & s <= 7000

Polyester tie production:

pt >= 10,000 & pt <= 14,000

Blend 1 tie production:

Bt1 >= 13,000 & bt1 <= 16,000

Blend 2 tie production:

Bt2 >= 6000 & bt2 <= 8,500

1. *The optimal solution for the linprog using any software.*

Again, used LINDO I felt it was easier when compared to MATHWORKS

Below was my **input** code:

MAX 3.45s + 2.32pt + 2.81bt1 + 3.25bt2

ST

0.125s <= 1000

.08pt + .05bt1 + .03bt2 <= 2000

.05bt1 + .07bt2 <= 1250

s >= 6000

s <= 7000

pt >= 10000

pt <= 14000

bt1 >= 13000

bt1 <= 16000

bt2 >= 6000

bt2 <= 8500

END

Below is my output code:

LP OPTIMUM FOUND AT STEP 4

OBJECTIVE FUNCTION VALUE

1) 120196.0

VARIABLE VALUE REDUCED COST

S 7000.000000 0.000000

PT 13625.000000 0.000000

BT1 13100.000000 0.000000

BT2 8500.000000 0.000000

ROW SLACK OR SURPLUS DUAL PRICES

2) 125.000000 0.000000

3) 0.000000 29.000000

4) 0.000000 27.200001

5) 1000.000000 0.000000

6) 0.000000 3.450000

7) 3625.000000 0.000000

8) 375.000000 0.000000

9) 100.000000 0.000000

10) 2900.000000 0.000000

11) 2500.000000 0.000000

12) 0.000000 0.476000

NO. ITERATIONS= 4

1. *What are the optimal numbers of ties of each type to maximize profit?*

So per the calculations, I need to sell:

|  |  |  |
| --- | --- | --- |
| ***Type of Tie*** | ***Optimal # of Units to Sell*** | ***Total Profit*** |
| Silk | 7000 | 7000 \* 3.45 = $24,150 |
| Polyester | 13625 | 13625 \* 2.32 = $31610 |
| Blend 1 | 13100 | 13100 \* 2.81 = $36811 |
| Blend 2 | 8500 | 1. 3.25 = $27625 |

**Total Profit: $120,196.00**

1. Transshipment Model
2. Formulate the objective function and the constraints

Objective is to minimize the cost of shipping. Per the tables provided below is the **objective function** when in relation to the plant -> warehouse -> retailer:

Min 10p1w1 + 15p1w2 + 11p2w1 + 8p2w2 + 13p3w1 + 8p3w2 + 9p3w3 + 14p4w2 + 8p4w3 + 5w1r1 + 6w1r2 + 7w1r3 + 10w1r4 + 12w2r3 + 8w2r4 + 10w2r5 + 14w2r6 + 14w3r4 + 12w3r5 + 12w3r6 +6w3r7

The **constraints** are as follows:

We know there is a constraint in relationship to the supply regarding capacity at each of the plants:

P1w1 + p1w2 <= 150

P2w1 + p2w2 <= 450

P3w1 + p3w2 + p3w3 <= 250

P4w2 + p4w3 <= 150

Constraint regarding demand at each of the retailers:

W1r1 >= 100

W1r2 >= 150

W1r3 + w2r3 >= 100

W1r4 + w2r4 + w3r4 >= 200

W2r5 + w3r5 >= 200

W2r6 + w3r6 >= 150

W3r7 >= 100

The final constraint is ensuring we deliver more than 0 refrigerators from our plants:

P1w1 + p2w1 + p3w1 – w1r1 – w1r2 – w1r3 – w1r4 >= 0

P1w2 + p2w2 + p3w2 + p4w2 – w2r3 – w2r4 – w2r5 – w2r6 >= 0

P3w3 + p4w3 – w3r4 – w3r5 – w3r6 – w3r7 >= 0

1. Determine the optimal solution for the linprog

Again I used LINDO to find the optimum solution.

Below is my **input** code:

MIN 10P1W1 + 15P1W2 + 11P2W1 + 8P2W2 + 13P3W1 + 8P3W2 + 9P3W3 + 14P4W2 + 8P4W3 + 5W1R1 + 6W1R2 + 7W1R3 + 10W1R4 + 12W2R3 + 8W2R4 + 10W2R5 + 14W2R6 + 14W3R4 + 12W3R5 + 12W3R6 + 6W3R7

ST

P1W1 + P1W2 <= 150

P2W1 + P2W2 <= 450

P3W1 + P3W2 + P3W3 <= 250

P4W2 + P4W3 <= 150

W1R1 >= 100

W1R2 >= 150

W1R3 + W2R3 >= 100

W1R4 + W2R4 + W3R4 >= 200

W2R5 + W3R5 >= 200

W2R6 + W3R6 >= 150

W3R7 >= 100

P1W1 + P2W1 + P3W1 - W1R1 - W1R2 - W1R3 - W1R4 >= 0

P1W2 + P2W2 + P3W2 + P4W2 - W2R3 - W2R4 - W2R5 - W2R6 >= 0

P3W3 + P4W3 - W3R4 - W3R5 - W3R6 - W3R7 >= 0

END

Below is my **output**:

LP OPTIMUM FOUND AT STEP 13

OBJECTIVE FUNCTION VALUE

1) 17100.00

VARIABLE VALUE REDUCED COST

P1W1 150.000000 0.000000

P1W2 0.000000 8.000000

P2W1 200.000000 0.000000

P2W2 250.000000 0.000000

P3W1 0.000000 2.000000

P3W2 150.000000 0.000000

P3W3 100.000000 0.000000

P4W2 0.000000 7.000000

P4W3 150.000000 0.000000

W1R1 100.000000 0.000000

W1R2 150.000000 0.000000

W1R3 100.000000 0.000000

W1R4 0.000000 5.000000

W2R3 0.000000 2.000000

W2R4 200.000000 0.000000

W2R5 200.000000 0.000000

W2R6 0.000000 1.000000

W3R4 0.000000 7.000000

W3R5 0.000000 3.000000

W3R6 150.000000 0.000000

W3R7 100.000000 0.000000

ROW SLACK OR SURPLUS DUAL PRICES

2) 0.000000 1.000000

3) 0.000000 0.000000

4) 0.000000 0.000000

5) 0.000000 1.000000

6) 0.000000 -16.000000

7) 0.000000 -17.000000

8) 0.000000 -18.000000

9) 0.000000 -16.000000

10) 0.000000 -18.000000

11) 0.000000 -21.000000

12) 0.000000 -15.000000

13) 0.000000 -11.000000

14) 0.000000 -8.000000

15) 0.000000 -9.000000

NO. ITERATIONS= 13

1. What are the optimal shipping routes and minimum costs:

|  |  |
| --- | --- |
| ***Route*** | ***Number of Fridges*** |
| P1 -> w1 | 150 |
| P2 -> w1 | 200 |
| P2 -> w2 | 250 |
| P3 -> w2 | 150 |
| P3 -> w3 | 100 |
| P4 -> w3 | 150 |
| W1 -> r1 | 100 |
| W1 -> r2 | 150 |
| W1 -> r3 | 100 |
| W2 -> r4 | 200 |
| W2 -> r5 | 200 |
| W3 -> r6 | 150 |
| W3 -> r7 | 100 |
|  |  |
|  |  |

The optimum solution to the minimum cost is: $17,100.