**.125Casey Levy – CS 325 – HW 6**

**Software used for each problem indicated below**

**Problem 1 – LINGO Used**

1. **Objective Function:**

max d7

**Constraints Given:**

da = 0

dv – du ≤ w(u,v) for all (u,v) ∈ E

**Code:**

max d7

ST

d0=0

d1 - d0 <=10

d3 - d0 <= 5

d0 - d4 <= 1

d1 - d4 <= 1

d4 - d3 <= 2

d2 - d1 <= 2

d2 - d4 <= 4

d7 - d2 <= 8

d7 - d6 <= 3

d2 - d6 <= 2

d6 - d2 <= 2

d4 - d6 <= 4

d6 - d5 <= 7

d5 - d3 <= 10

d4 - d5 <= 2

END

**Output**

Global optimal solution found.

Objective value: 15.00000

Infeasibilities: 0.000000

Total solver iterations: 4

Elapsed runtime seconds: 0.09

Model Class: LP

Total variables: 7

Nonlinear variables: 0

Integer variables: 0

Total constraints: 16

Nonlinear constraints: 0

Total nonzeros: 28

Nonlinear nonzeros: 0

Variable Value Reduced Cost

D7 15.00000 0.000000

D0 0.000000 0.000000

D1 8.000000 0.000000

D3 5.000000 0.000000

D4 7.000000 0.000000

D2 10.00000 0.000000

D6 12.00000 0.000000

D5 15.00000 0.000000

Row Slack or Surplus Dual Price

1 15.00000 1.000000

2 0.000000 1.000000

3 2.000000 0.000000

4 0.000000 1.000000

5 8.000000 0.000000

6 0.000000 1.000000

7 0.000000 1.000000

8 0.000000 1.000000

9 1.000000 0.000000

10 3.000000 0.000000

11 0.000000 1.000000

12 4.000000 0.000000

13 0.000000 1.000000

14 9.000000 0.000000

15 10.00000 0.000000

16 0.000000 0.000000

17 10.00000 0.000000

**According to the data above, the shortest path would be 15 giving us a path of 0 – 3 – 4 – 1 – 2 – 6 - 7**

1. **Objective Function:**max d7 + d1 + d2 + d3 + d4 + d5 + d6

**Constraints Given:**

da = 0

dv – du ≤ w(u,v) for all (u,v) ∈ E

**Code:**

max d7 + d1 + d2 + d3 + d4 + d5 + d6

ST

d0=0

d1 - d0 <=10

d3 - d0 <= 5

d0 - d4 <= 1

d1 - d4 <= 1

d4 - d3 <= 2

d2 - d1 <= 2

d2 - d4 <= 4

d7 - d2 <= 8

d7 - d6 <= 3

d2 - d6 <= 2

d6 - d2 <= 2

d4 - d6 <= 4

d6 - d5 <= 7

d5 - d3 <= 10

d4 - d5 <= 2

END

**Output**

Global optimal solution found.

Objective value: 72.00000

Infeasibilities: 0.000000

Total solver iterations: 5

Elapsed runtime seconds: 0.12

Model Class: LP

Total variables: 7

Nonlinear variables: 0

Integer variables: 0

Total constraints: 16

Nonlinear constraints: 0

Total nonzeros: 34

Nonlinear nonzeros: 0

Variable Value Reduced Cost

D7 15.00000 0.000000

D1 8.000000 0.000000

D2 10.00000 0.000000

D3 5.000000 0.000000

D4 7.000000 0.000000

D5 15.00000 0.000000

D6 12.00000 0.000000

D0 0.000000 0.000000

Row Slack or Surplus Dual Price

1 72.00000 1.000000

2 0.000000 7.000000

3 2.000000 0.000000

4 0.000000 7.000000

5 8.000000 0.000000

6 0.000000 4.000000

7 0.000000 5.000000

8 0.000000 3.000000

9 1.000000 0.000000

10 3.000000 0.000000

11 0.000000 1.000000

12 4.000000 0.000000

13 0.000000 2.000000

14 9.000000 0.000000

15 10.00000 0.000000

16 0.000000 1.000000

17 10.00000 0.000000

**According to the data above, the shortest distances from 0 to all other vertices is:**

**V1 = 8**

**V2 = 10**

**V3 = 5**

**V4 = 7**

**V5 = 15**

**V6 = 12**

**V7 = 15**

**Problem 2 – LINGO Used**

s = selling price

m = material cost

l = labor cost

st = number of silk ties

p = number of polyester ties

b = number of Blend1 tie

c = number of Blend2 tie

**Objective Function:**

max s – l – m

**Constraints:**

s = 6.7st + 3.55p + 4.31b + 4.81c

l = 0.75st + 0.75p + 0.75b + 0.75c

m = (0.125 \* 20)st + (0.08 \* 6)p + (0.05 \* 6 + 0.05 \* 9)b + (0.03 \* 6 + 0.07 \* 9)

6000 <= st <= 7000

10000 <= p <= 14000

13000 <= b <= 16000

6000 <= c <= 8500

.125st <= 1000

.08p + .05b + .03c <= 2000

.05b + .07c <= 1250

**Code:**

max s - l - m

ST

s - 6.7s - 3.55p - 4.31b - 4.81c = 0

l - 0.75s - 0.75p - 0.75b - 0.75c = 0

m - 2.5s - 0.48p - 0.75b - 0.81c = 0

s >= 6000

s <= 7000

p >= 10000

p <= 14000

b >= 13000

b <= 16000

c >= 6000

c <= 8500

0.125s <= 1000

0.08p + 0.05b + 0.03c <= 2000

0.05b + 0.07c <= 1250

END

**Output:**

Global optimal solution found.

**Objective value:** 120196.0

**Infeasibilities:** 0.000000

**Total solver iterations:** 2

**Elapsed runtime seconds:** 0.04

**Model Class:** LP

**Total variables:** 7

**Nonlinear variables:** 0

**Integer variables:** 0

**Total constraints:** 15

**Nonlinear constraints:** 0

**Total nonzeros:** 32

**Nonlinear nonzeros:** 0

**Variable Value Reduced Cost**

SP 192614.8 0.000000

LC 31668.75 0.000000

MC 40750.00 0.000000

S 7000.000 0.000000

P 13625.00 0.000000

B 13100.00 0.000000

C 8500.000 0.000000

**Row Slack or Surplus Dual Price**

1 120196.0 1.000000

2 0.000000 1.000000

3 0.000000 -1.000000

4 0.000000 -1.000000

5 1000.000 0.000000

6 0.000000 3.450000

7 3625.000 0.000000

8 375.0000 0.000000

9 100.0000 0.000000

10 2900.000 0.000000

11 2500.000 0.000000

12 0.000000 0.4760000

13 125.0000 0.000000

14 0.000000 29.00000

15 0.000000 27.20000

**Optimal Number of Each Tie Type:**

Silk Ties = 7,000

Polyester = 13,625 Blend2 = 8,500

Blend1 = 13,100

**Problem 3 – LINGO Used**

x1 = Tomato x2 = Lettuce x3 = Spinach x4 = Carrot

x5 = Sunflower Seeds x6 = Smoked Tofu x7 = Chickpeas x8 = Oil

**Part A**

1. min 21x1 + 16x2 + 40x3 + 41x4 + 585x5 + 120x6 + 164x7 + 884x8
2. min 21x1 + 16x2 + 40x3 + 41x4 + 585x5 + 120x6 + 164x7 + 884x8

ST

.85x1 + 1.62x2 + 2.86x3 + .93x4 + 23.4x5 + 16x6 + 9x7 + 0x8 >= 15

.33x1 + .20x2 + .39x3 + .24x4 + 48.7x5 + 5x6 + 2.6x7 + 100x8 >= 2

.33x1 + .20x2 + .39x3 + .24x4 + 48.7x5 + 5x6 + 2.6x7 + 100x8 <= 8

4.64x1 + 2.37x2 + 3.63x3 + 9.58x4 + 15x5 + 3x6 + 27x7 + 0x8 >= 4

.009x1 + .028x2 + .065x3 + .069x4 + .0038x5 + .12x6 + .078x7 + 0x8 <= 2

-.4x1 + .6x2 + .6x3 - .4x4 - .4x5 - .4x6 - .4x7 - .4x8 >= .4

x1 >= 0

x2 >= 0

x3 >= 0

x4 >= 0

x5 >= 0

x6 >= 0

x7 >= 0

x8 >= 0

END

**Output**

Global optimal solution found.

Objective value: 114.7541

Infeasibilities: 0.000000

Total solver iterations: 3

Elapsed runtime seconds: 1.65

Model Class: LP

Total variables: 8

Nonlinear variables: 0

Integer variables: 0

Total constraints: 15

Nonlinear constraints: 0

Total nonzeros: 62

Nonlinear nonzeros: 0

Variable Value Reduced Cost

TOM 0.000000 0.1690164

LETT 58.54801 0.000000

SPIN 0.000000 0.1451366

CAR 0.000000 0.3628962

SUN 0.000000 4.083880

TOFU 87.82201 0.000000

CHIC 0.000000 0.9755191

OIL 0.000000 8.864044

Row Slack or Surplus Dual Price

1 114.7541 -1.000000

2 0.000000 -7.650273

3 2.508197 0.000000

4 3.491803 0.000000

5 0.2224824E-01 0.000000

6 78.22014 0.000000

7 0.000000 -0.6010929E-01

8 0.000000 0.000000

9 58.54801 0.000000

10 0.000000 0.000000

11 0.000000 0.000000

12 0.000000 0.000000

13 87.82201 0.000000

14 0.000000 0.000000

15 0.000000 0.000000

**Cost = 2.33**

**Part B**

1. min 1x1 + .75x2 + .50x3 + .50x4 + .45x5 + 2.15x6 + .95x7 + 2x8
2. min 1x1 + .75x2 + .50x3 + .50x4 + .45x5 + 2.15x6 + .95x7 + 2x8

ST

.85x1 + 1.62x2 + 2.86x3 + .93x4 + 23.4x5 + 16x6 + 9x7 + 0x8 >= 15

.33x1 + .20x2 + .39x3 + .24x4 + 48.7x5 + 5x6 + 2.6x7 + 100x8 >= 2

.33x1 + .20x2 + .39x3 + .24x4 + 48.7x5 + 5x6 + 2.6x7 + 100x8 <= 8

4.64x1 + 2.37x2 + 3.63x3 + 9.58x4 + 15x5 + 3x6 + 27x7 + 0x8 >= 4

.009x1 + .028x2 + .065x3 + .069x4 + .0038x5 + .12x6 + .078x7 + 0x8 <= 2

-.4x1 + .6x2 + .6x3 - .4x4 - .4x5 - .4x6 - .4x7 - .4x8 >= .4

x1 >= 0, x2 >= 0, x3 >= 0, x4 >= 0, x5 >= 0, x6 >= 0, x7 >= 0, x8 >= 0

END

**Output**

LINGO/WIN64 19.0.32 (3 Dec 2020 ), LINDO API 13.0.4099.242

Licensee info: Eval Use Only

License expires: 21 AUG 2021

Global optimal solution found.

Objective value: 1.554133

Infeasibilities: 0.000000

Total solver iterations: 3

Elapsed runtime seconds: 0.08

Model Class: LP

Total variables: 8

Nonlinear variables: 0

Integer variables: 0

Total constraints: 15

Nonlinear constraints: 0

Total nonzeros: 61

Nonlinear nonzeros: 0

Variable Value Reduced Cost

X1 0.000000 0.1020813

X2 0.000000 0.4029122

X3 0.8322983 0.000000

X4 0.000000 0.4869142

X5 0.9608330E-01 0.000000

X6 0.000000 0.4056086

X7 1.152364 0.000000

X8 0.000000 7.281258

Row Slack or Surplus Dual Price

1 1.554133 -1.000000

2 0.000000 -0.1312607

3 6.000000 0.000000

4 0.000000 0.5184714E-01

5 31.57633 0.000000

6 1.855651 0.000000

7 0.000000 -0.2413582

8 0.000000 0.000000

9 0.000000 0.000000

10 0.8322983 0.000000

11 0.000000 0.000000

12 0.9608330E-01 0.000000

13 0.000000 0.000000

14 1.152364 0.000000

15 0.000000 0.000000

**Total Calories = 278.1**

**Problem 4 – Excel Solver used for this problem. Photo of output below**

 Aij = amount sent from Plant pi to Warehouse wj

Ajk = amount sent from Warehouse wj to Retailer rk

**Objective Function:**

Min ∑ ∑ Aij \* cp(I,j) + ∑ ∑ Ajk \* cw(j,k)

**Code:**

Min ∑ ∑ Aij \* cp(I,j) + ∑ ∑ Ajk \* cw(j,k)

ST

R1 demand ∑Aj1 = 100

R2 demand ∑Aj2 = 150

R3 demand ∑Aj3 = 100

R4 demand ∑Aj4 = 200

R5 demand ∑Aj5 = 200

R6 demand ∑Aj6 = 150

R7 demand ∑Aj7 = 100

W1 ∑Ai1 - ∑A1k = 0

W2 ∑Ai2 - ∑A2k = 0

W3 ∑Ai3 – A3k = 0

P1 supply ∑A1j = 150

P2 supply ∑A2j = 450

P3 supply ∑A3j = 250

P4 supply ∑A4j = 150

Aij ≥ 0

Ajk ≥ 0

**Screenshot of Excel below…**

![Graphical user interface

Description automatically generated]()