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Q20)

First step is defining our decision variables:

FC30 = final cash flow at 3.0years after now
Pi = investment amount in i'th project and i = 1,2,3
Bt = amount borrowed ($millions) at time t=00, 05, 10, 15, 20, 25, 30
Lt = amount loaned ($millions) at time t=00, 05, 10, 15, 20, 25, 30

TABLE 44

Time (Years)	Cash Flow		
	Project 1	Project 2	Project 3
0	−3	−2	−2
0.5	−1	−.5	−2
1	+1.8	1.5	−1.8
1.5	1.4	1.5	1
2	1.8	1.5	1
2.5	1.8	.2	1
3	5.5	−1	6

Notice in this kind of problems we must first figure out our restriction then we can find out what is objective function. :/

max -1.035B25 + 5.5P1 -1P2 + 6P3 + 1.03L25

s.t.

B00 -3P1 -2P2 -2P3 - L00 = -2

-1.035B00 - 3P1 - 5P2 - 2P3 +1.03L00 +B05 -L05 =0

-1.035B05 +1.8P1 +1.5P2 -1.8P3 +1.03L05 +B10 -L10 =0

-1.035B10 +1.4P1 +1.5P2 + 1P3 +1.03L10 +B15 -L15 =0

-1.035B15 +1.8P1 +1.5P2 + 1P3 +1.03L15 +B20 -L20 =0

-1.035B20 +1.8P1 +1.5P2 + 1P3 +1.03L20 +B25 -L25 =0

B00, B05, B10, B15, B20, B25 <=2

P1, P2, P3 <= 1

B00, B05, B10, B15, B20, B25, P1, P2, P3, L00, L05, L10 ,L15,L20, L25 >=0

END

```
max -1.035B25 + 5.5P1 -1P2 + 6P3 + 1.03L25
s.t.
B00 -3P1 -2P2 -2P3 - L00 = -2
-1.035B00 -  3P1 -  5P2 -  2P3 +1.03L00 +B05 -L05 =0
-1.035B05 +1.8P1 +1.5P2 -1.8P3 +1.03L05 +B10 -L10 =0
-1.035B10 +1.4P1 +1.5P2 +  1P3 +1.03L10 +B15 -L15 =0
-1.035B15 +1.8P1 +1.5P2 +  1P3 +1.03L15 +B20 -L20 =0
-1.035B20 +1.8P1 +1.5P2 +  1P3 +1.03L20 +B25 -L25 =0
B00<=2
B05<=2
B10<=2
B15<=2
B20<=2
B25<=2
P1<=1
P2<=1
P3<=1
B00>=0
B05>=0
B10>=0
B15>=0
B20>=0
B25>=0
P1>=0
P2>=0
P3>=0
L00>=0
L05>=0
L10>=0
L15>=0
L20>=0
L25>=0

END
```

```
Global optimal solution found.
Objective value:                      6.211679
Infeasibilities:                      0.000000
Total solver iterations:                     8
Elapsed runtime seconds:                  0.10

Model Class:                               LP

Total variables:              15
Nonlinear variables:           0
Integer variables:             0

Total constraints:            31
Nonlinear constraints:         0

Total nonzeros:               69
Nonlinear nonzeros:            0


                 Variable           Value        Reduced Cost
                      B25        0.000000       0.5000000E-02
                       P1        0.6666667       0.000000
                       P2        0.000000       9.400690
                       P3        0.000000       1.404916
                      L25        2.470886       0.000000
                      B00        0.000000       0.1053300E-01
                      L00        0.000000       0.000000
                      B05        2.000000       0.000000
                      L05        0.000000       0.9416974
                      B10        0.8700000       0.000000
                      L10        0.000000       0.5463635E-02
                      B15        0.000000       0.5304500E-02
                      L15        0.3288333E-01   0.000000
                      B20        0.000000       0.5150000E-02
                      L20        1.233870       0.000000
```

Q2)

	1	2	3	4
	F1	F1	F2	S2
	F2	S1	S1	T1
	T2	S2	T1	Fr1
	Fr1	Fr2	T2	Fr2

F : first period , S: second T:third FR: fourth
F1 means : number of nurse that start their work at first period and their next period of work is
after the time they had started (in this case means second period)
and same way for other variables

```
 MIN 2F1 + 2S1 + 2T1 + 2FR1 +3F2 + 3S2 + 3T2 + 3FR2

s.t.
F1+F2+T2+FR1>=6
F1+S1+S2>=15
F2+S1+T1+T2>=8
S2+T1+FR1+FR2>=12

END
gin F1
gin F2
gin S1
gin S2
gin T1
gin T2
gin FR1
gin FR2
```

```
Total constraints:            5
Nonlinear constraints:        0

Total nonzeros:              23
Nonlinear nonzeros:           0
```

Variable	Value	Reduced Cost
F1	6.000000	2.000000
S1	3.000000	2.000000
T1	6.000000	2.000000
FR1	0.000000	2.000000
F2	0.000000	3.000000
S2	6.000000	3.000000
T2	0.000000	3.000000
FR2	0.000000	3.000000

Row	Slack or Surplus	Dual Price
1	48.00000	-1.000000
2	0.000000	0.000000
3	0.000000	0.000000
4	1.000000	0.000000
5	0.000000	0.000000

Q10)

P means "Portugal " ☺
P9S means : used Portugal from 9 degree quality for Sell
P9J means : used Portugal from 9 degree quality for producing juice
and same definition for 6

```
MAX 2P9S + 2P6S + 3P9J + 3P6J

s.t.
P9S + P9J <=100000
P6S + P6J <=120000
2P9S -1P6S >=0
1P9J -2P6J >=0

END
gin P9S
gin P6S
gin P9J
gin P6J
```

```
Global optimal solution found.
Objective value:                    519999.0
Objective bound:                    519999.0
Infeasibilities:                    0.000000
Extended solver steps:                     0
Total solver iterations:                   5
Elapsed runtime seconds:                0.09

Model Class:                            PILP

Total variables:              4
Nonlinear variables:          0
Integer variables:            4

Total constraints:            5
Nonlinear constraints:        0

Total nonzeros:              12
Nonlinear nonzeros:           0


                  Variable           Value        Reduced Cost
                       P9S        46666.00           -2.000000
                       P6S        93332.00           -2.000000
                       P9J        53334.00           -3.000000
                       P6J        26667.00           -3.000000
```

Q7)

fij:
how much we produce in i'th month for jth month in first workshop
Sij:
how much we produce in ith month jth month in second workshop

i1 = total unit of initial goods that we use for first month demand
i2 = total unit of initial goods that we use for S month demand
i3 = total unit of initial goods that we use for T month demand

```
MIN 400F11 + 350S11 +500F12 + 600F13 + 450S12 + 550S13 +400F22 + 350S22 +
500F23 + 150S23 + 400F33 + 350S33 + 0i1 +100i2 + 200i3

s.t.
i1 + i2 + i3 =200
F11 + S11 +i1 =300
F22 + S22 +F12 + S12 +i2 = 400
F13 + S13 + F23 + S23 +F33 + S33 +i3 = 500

1.5F11 + 1.5F12 + 1.5F13 <=420
3S11   + 3S12   + 3S13  <=420
1.5F22 +  1.5F23  <=420
3S22   +  3S23     <=420
1.5F33 <=420
3S33   <=420

END
gin i1
gin i2
gin i3
Gin F11
gin S11
gin F12
gin F13
gin S12
gin S13
gin F22
gin S22
gin F23
gin S23
gin F33
gin S33
```