OR LAB

DATE: 4th March 2022

Assignment 7

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Branch and Bound

The output is shown without tableaus due to space constraint.

Question 1:

```
The Simplex tableau:
0 4 -2 3 1 0 6
0 5 6 1 0 1 30

Reached the termination state

The Optimisation function is optimised at the point : x2 = 4.8, x1 = 4.2, Rest all xis=0
The value of the objective function at this point is : 54.6


STARTING BRANCH AND BOUND...

Reached the termination state

The Optimisation function is optimised at the point : x2 = 4, x3 = 2.66667, x1 = 4.33333, Rest all xis=0
The value of the objective function at this point is : 49.6667


STARTING BRANCH AND BOUND...

Reached the termination state

The Optimisation function is optimised at the point : x2 = 4, x4 = 2, x1 = 4, x3 = 2, Rest all xis=0
The value of the objective function at this point is : 48


STARTING BRANCH AND BOUND...

Reached the termination state

The iterations have been completed and there are artificial variables in the base with values strictly greater than 0, s
o the problem has no solution (INFEASIBLE!!!!!).

Reached the termination state

The iterations have been completed and there are artificial variables in the base with values strictly greater than 0, s
o the problem has no solution (INFEASIBLE!!!!!).
```

Question 2:

```
The Simplex tableau:
0 4 6 5 1 0 25
0 5 1 3 0 1 10

Reached the termination state

The Optimisation function is optimised at the point : x1 = 1.92308, x2 = 2.69231, Rest all xis=0
The value of the objective function at this point is : 11.9231


STARTING BRANCH AND BOUND...

Reached the termination state

The Optimisation function is optimised at the point : x1 = 2.5, x4 = 1.5, x2 = 2, Rest all xis=0
The value of the objective function at this point is : 11


STARTING BRANCH AND BOUND...

Reached the termination state

The Optimisation function is optimised at the point : x3 = 3, x4 = 2, x2 = 2, x1 = 2, Rest all xis=0
The value of the objective function at this point is : 10
```

```
STARTING BRANCH AND BOUND...

Reached the termination state

The iterations have been completed and there are artificial variables in the base with values strictly greater than 0, s
o the problem has no solution (INFEASIBLE!!!!!).

Reached the termination state

The iterations have been completed and there are artificial variables in the base with values strictly greater than 0, s
o the problem has no solution (INFEASIBLE!!!!!).
```

Question 3:

```
The Simplex tableau:
0 5 -1 2 1 1 0 0 4
0 6 0 2 -1.5 0 1 0 1
0 7 1 -3 2 0 0 1 3

Reached the termination state

The Optimisation function is optimised at the point : x3 = 3.33333, x2 = 3, x1 = 5.33333, Rest all xis=0
The value of the objective function at this point is : 29


STARTING BRANCH AND BOUND...

Reached the termination state

The Optimisation function is optimised at the point : x4 = 0.75, x2 = 2.75, x1 = 5.25, x3 = 3, Rest all xis=0
The value of the objective function at this point is : 27.5


STARTING BRANCH AND BOUND...

Reached the termination state

The Optimisation function is optimised at the point : x4 = 3, x2 = 2, x1 = 5, x7 = 1, x3 = 2, Rest all xis=0
The value of the objective function at this point is : 23
```

```
STARTING BRANCH AND BOUND...

Reached the termination state

The iterations have been completed and there are artificial variables in the base with values strictly greater than 0, s
o the problem has no solution (INFEASIBLE!!!!!).

Reached the termination state

The iterations have been completed and there are artificial variables in the base with values strictly greater than 0, s
o the problem has no solution (INFEASIBLE!!!!!).
```

Question 4:

```
The bigM tableau:
0 5 2 20 4 1 0 15
-1e+06 6 6 20 4 0 1 20

Reached the termination state

The Optimisation function is optimised at the point : x2 = 0.625, x1 = 1.25, Rest all xis=0
The value of the objective function at this point is : 15


STARTING BRANCH AND BOUND...

Reached the termination state

The Optimisation function is optimised at the point : x4 = 8.33333, x1 = 3.33333, x2 = 0, Rest all xis=0
The value of the objective function at this point is : 6.66667


STARTING BRANCH AND BOUND...

Reached the termination state

The Optimisation function is optimised at the point : x4 = 7, x3 = 0.5, x2 = 0, x1 = 3, Rest all xis=0
The value of the objective function at this point is : 1
```

```
STARTING BRANCH AND BOUND...

Reached the termination state

The iterations have been completed and there are artificial variables in the base with values strictly greater than 0, s
o the problem has no solution (INFEASIBLE!!!!!).

Reached the termination state

The iterations have been completed and there are artificial variables in the base with values strictly greater than 0, s
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Reached the termination state

The iterations have been completed and there are artificial variables in the base with values strictly greater than 0, s
o the problem has no solution (INFEASIBLE!!!!!).
```

Cutting Plane Method

Question 1:

```
Iteration: 0
The Tableau:
0 4 -2 3 1 0 6
0 5 6 1 0 1 30
Deviations: 5 7 0 0
leaving_var_row_index: 0, entering_var_col_index: 3


Iteration: 1
The Tableau:
7 3 -0.666667 1 0.333333 0 2
0 5 6.66667 0 -0.333333 1 28
Deviations: 9.66667 0 -2.33333 0
leaving_var_row_index: 1, entering_var_col_index: 2


Iteration: 2
The Tableau:
7 3 0 1 0.3 0.1 4.8
5 2 1 0 -0.05 0.15 4.2
Deviations: 0 0 -1.85 -1.45
Reached the termination state

The Optimisation function is optimised at the point : x2 = 4.8, x1 = 4.2, Rest all xis=0
The value of the objective function at this point is : 54.6
```

```
BIG_M done, moving on to finding an integral solution



Iteration index: 0


Iteration: 0
The Tableau:
7 3 0 1 0.3 0.1 0 4.8
5 2 1 0 -0.05 0.15 0 4.2
0 6 0 0 -0.3 -0.1 1 -0.8
Deviations: 0 0 -1.85 -1.45 0
Leaving variable: x5
Entering variable: x3


Iteration: 1
The Tableau:
7 3 0 1 0 0 1 4
5 2 1 0 0 0.166667 -0.166667 4.33333
0 4 -0 -0 1 0.333333 -3.33333 2.66667
Reached the termination state since all RHS values are positive

The Optimisation function is optimised at the point : x2 = 4, x1 = 4.33333, x3 = 2.66667, Rest all xis=0
The value of the objective function at this point is : 49.6667
```

```
Iteration index: 1


Iteration: 0
The Tableau:
7 3 0 1 0 0 1 0 4
5 2 1 0 0 0.166667 -0.166667 0 4.33333
0 4 -0 -0 1 0.333333 -3.33333 0 2.66667
0 7 0 0 0 -0.333333 -0.666667 1 -0.666667
Deviations: 0 0 0 -0.833333 -6.16667 0
Leaving variable: x6
Entering variable: x4


Iteration: 1
The Tableau:
7 3 0 1 0 0 1 0 4
5 2 1 0 0 0 -0.5 0.5 4
0 4 0 0 1 0 -4 1 2
0 5 -0 -0 -0 1 2 -3 2
Reached the termination state since all RHS values are positive

The Optimisation function is optimised at the point : x2 = 4, x1 = 4, x3 = 2, x4 = 2, Rest all xis=0
The value of the objective function at this point is : 48
The solution found is a valid integral solution
```

Question 2:

```
Iteration: 0
The Tableau:
0 4 6 5 1 0 25
0 5 1 3 0 1 10
Deviations: 2 3 0 0
leaving_var_row_index: 1, entering_var_col_index: 3


Iteration: 1
The Tableau:
0 4 4.33333 0 1 -1.66667 8.33333
3 3 0.333333 1 0 0.333333 3.33333
Deviations: 1 0 0 -1
leaving_var_row_index: 0, entering_var_col_index: 2


Iteration: 2
The Tableau:
2 2 1 0 0.230769 -0.384615 1.92308
3 3 0 1 -0.0769231 0.461538 2.69231
Deviations: 0 0 -0.230769 -0.615385
Reached the termination state

The Optimisation function is optimised at the point : x1 = 1.92308, x2 = 2.69231, Rest all xis=0
The value of the objective function at this point is : 11.9231


BIG_M done, moving on to finding an integral solution



Iteration index: 0


Iteration: 0
The Tableau:
2 2 1 0 0.230769 -0.384615 0 1.92308
3 3 0 1 -0.0769231 0.461538 0 2.69231
0 6 0 0 -0.230769 -0.615385 1 -0.923077
Deviations: 0 0 -0.230769 -0.615385 0
Leaving variable: x5
Entering variable: x4


Iteration: 1
The Tableau:
2 2 1 0 0.375 0 -0.625 2.5
3 3 0 1 -0.25 0 0.75 2
0 5 -0 -0 0.375 1 -1.625 1.5
```

```
The Optimisation function is optimised at the point : x1 = 2.5, x2 = 2, x4 = 1.5, Rest all xis=0
The value of the objective function at this point is : 11


Iteration index: 1


Iteration: 0
The Tableau:
2 2 1 0 0.375 0 -0.625 0 2.5
3 3 0 1 -0.25 0 0.75 0 2
0 5 -0 -0 0.375 1 -1.625 0 1.5
0 7 0 0 -0.375 0 -0.375 1 -0.5
Deviations: 0 0 0 0 -1 0
Leaving variable: x6
Entering variable: x5


Iteration: 1
The Tableau:
2 2 1 0 1 0 0 -1.66667 3.33333
3 3 0 1 -1 0 0 2 1
0 5 -0 -0 2 1 0 -4.33333 3.66667
0 6 -0 -0 1 -0 1 -2.66667 1.33333
Reached the termination state since all RHS values are positive

The Optimisation function is optimised at the point : x1 = 3.33333, x2 = 1, x4 = 3.66667, x5 = 1.33333, Rest all xis=0
The value of the objective function at this point is : 9.66667


Iteration index: 2


Iteration: 0
The Tableau:
2 2 1 0 1 0 0 -1.66667 0 3.33333
3 3 0 1 -1 0 0 2 0 1
0 5 -0 -0 2 1 0 -4.33333 0 3.66667
0 6 -0 -0 1 -0 1 -2.66667 0 1.33333
0 8 0 0 0 0 0 -0.666667 1 -0.666667
Deviations: 0 0 1 0 0 -2.66667 0
Leaving variable: x7
Entering variable: x6


Iteration: 1
```

```
Iteration: 1
The Tableau:
2 2 1 0 1 0 0 -1.66667 3.33333
3 3 0 1 -1 0 0 2 1
0 5 -0 -0 2 1 0 -4.33333 3.66667
0 6 -0 -0 1 -0 1 -2.66667 1.33333
Reached the termination state since all RHS values are positive

The Optimisation function is optimised at the point : x1 = 3.33333, x2 = 1, x4 = 3.66667, x5 = 1.33333, Rest all xis=0
The value of the objective function at this point is : 9.66667


Iteration index: 2


Iteration: 0
The Tableau:
2 2 1 0 1 0 0 -1.66667 0 3.33333
3 3 0 1 -1 0 0 2 0 1
0 5 -0 -0 2 1 0 -4.33333 0 3.66667
0 6 -0 -0 1 -0 1 -2.66667 0 1.33333
0 8 0 0 0 0 0 -0.666667 1 -0.666667
Deviations: 0 0 1 0 0 -2.66667 0
Leaving variable: x7
Entering variable: x6


Iteration: 1
The Tableau:
2 2 1 0 1 0 0 0 -2.5 5
3 3 0 1 -1 0 0 0 3 -1
0 5 -0 -0 2 1 0 0 -6.5 8
0 6 -0 -0 1 -0 1 0 -4 4
0 7 -0 -0 -0 -0 -0 1 -1.5 1
Deviations: 0 0 1 0 0 0 -4
Leaving variable: x2
INFEASIBLE!! {Since we could not find valid entering variable}
```

Question 3:

```
Iteration: 0
The Tableau:
0 5 -1 2 1 1 0 0 4
0 6 0 2 -1.5 0 1 0 1
0 7 1 -3 2 0 0 1 3
Deviations: 3 1 3 0 0 0
leaving_var_row_index: 2, entering_var_col_index: 2


Iteration: 1
The Tableau:
0 5 0 -1 3 1 0 1 7
0 6 0 2 -1.5 0 1 0 1
3 2 1 -3 2 0 0 1 3
Deviations: 0 10 -3 0 0 -3
leaving_var_row_index: 1, entering_var_col_index: 3


Iteration: 2
The Tableau:
0 5 0 0 2.25 1 0.5 1 7.5
1 3 0 1 -0.75 0 0.5 0 0.5
3 2 1 0 -0.25 0 1.5 1 4.5
Deviations: 0 0 4.5 0 -5 -3
leaving_var_row_index: 0, entering_var_col_index: 4


Iteration: 3
The Tableau:
3 4 0 0 1 0.444444 0.222222 0.444444 3.33333
1 3 0 1 0 0.333333 0.666667 0.333333 3
3 2 1 0 0 0.111111 1.55556 1.11111 5.33333
Deviations: 0 0 0 -2 -6 -5
Reached the termination state

The Optimisation function is optimised at the point : x3 = 3.33333, x2 = 3, x1 = 5.33333, Rest all xis=0
The value of the objective function at this point is : 29


BIG_M done, moving on to finding an integral solution



Iteration index: 0
```

```
Iteration: 0
The Tableau:
3 4 0 0 1 0.444444 0.222222 0.444444 0 3.33333
1 3 0 1 0 0.333333 0.666667 0.333333 0 3
3 2 1 0 0 0.111111 1.55556 1.11111 0 5.33333
0 8 0 0 0 -0.111111 -0.555556 -0.111111 1 -0.333333
Deviations: 0 0 0 -2 -6 -5 0
Leaving variable: x7
Entering variable: x5


Iteration: 1
The Tableau:
3 4 0 0 1 0.4 0 0.4 0.4 3.2
1 3 0 1 0 0.2 0 0.2 1.2 2.6
3 2 1 0 0 -0.2 0 0.8 2.8 4.4
0 6 -0 -0 -0 0.2 1 0.2 -1.8 0.6
Reached the termination state since all RHS values are positive

The Optimisation function is optimised at the point : x3 = 3.2, x2 = 2.6, x1 = 4.4, x5 = 0.6, Rest all xis=0
The value of the objective function at this point is : 25.4


Iteration index: 1


Iteration: 0
The Tableau:
3 4 0 0 1 0.4 0 0.4 0.4 0 3.2
1 3 0 1 0 0.2 0 0.2 1.2 0 2.6
3 2 1 0 0 -0.2 0 0.8 2.8 0 4.4
0 6 -0 -0 -0 0.2 1 0.2 -1.8 0 0.6
0 9 0 0 0 -0.2 0 -0.2 -0.2 1 -0.6
Deviations: 0 0 0 -0.8 0 -3.8 -10.8 0
Leaving variable: x8
Entering variable: x4


Iteration: 1
The Tableau:
3 4 0 0 1 0 0 1.11022e-16 5.55112e-17 2 2
1 3 0 1 0 0 0 0 1 1 2
3 2 1 0 0 0 0 1 3 -1 5
0 6 0 0 0 0 0 1 1.38778e-16 -2 1 -1.11022e-15
```

```
The Optimisation function is optimised at the point : x3 = 2, x2 = 2, x1 = 5, x5 = -1.11022e-15, x4 = 3, Rest all xis=0
The value of the objective function at this point is : 23
```

Question 4:

```
Iteration: 0
The Tableau:
0 5 2 20 4 1 0 15
-1e+06 6 6 20 4 0 1 20
Deviations: 6e+06 2e+07 3.99999e+06 0 0
leaving_var_row_index: 0, entering_var_col_index: 3


Iteration: 1
The Tableau:
20 3 0.1 1 0.2 0.05 0 0.75
-1e+06 6 4 0 0 -1 1 5
Deviations: 4e+06 0 -14 -1e+06 0
leaving_var_row_index: 1, entering_var_col_index: 2


Iteration: 2
The Tableau:
20 3 0 1 0.2 0.075 -0.025 0.625
2 2 1 0 0 -0.25 0.25 1.25
Deviations: 0 0 -14 -1 -1e+06
Reached the termination state

The Optimisation function is optimised at the point : x2 = 0.625, x1 = 1.25, Rest all xis=0
The value of the objective function at this point is : 15


BIG_M done, moving on to finding an integral solution



Iteration index: 0


Iteration: 0
The Tableau:
20 3 0 1 0.2 0.075 -0.025 0 0.625
2 2 1 0 0 -0.25 0.25 0 1.25
0 7 0 0 -0.2 -0.075 -0.975 1 -0.625
Deviations: 0 0 -14 -1 -1e+06 0
Leaving variable: x6
Entering variable: x4


Iteration: 1
```

```
The Tableau:
20 3 0.1 1 0.2 0.05 0 0.75
-1e+06 6 4 0 0 -1 1 5
Deviations: 4e+06 0 -14 -1e+06 0
leaving_var_row_index: 1, entering_var_col_index: 2


Iteration: 2
The Tableau:
20 3 0 1 0.2 0.075 -0.025 0.625
2 2 1 0 0 -0.25 0.25 1.25
Deviations: 0 0 -14 -1 -1e+06
Reached the termination state

The Optimisation function is optimised at the point : x2 = 0.625, x1 = 1.25, Rest all xis=0
The value of the objective function at this point is : 15


BIG_M done, moving on to finding an integral solution



Iteration index: 0


Iteration: 0
The Tableau:
20 3 0 1 0.2 0.075 -0.025 0 0.625
2 2 1 0 0 -0.25 0.25 0 1.25
0 7 0 0 -0.2 -0.075 -0.975 1 -0.625
Deviations: 0 0 -14 -1 -1e+06 0
Leaving variable: x6
Entering variable: x4


Iteration: 1
The Tableau:
20 3 0 1 0 0 -1 1 0
2 2 1 0 0.666667 0 3.5 -3.33333 3.33333
0 5 -0 -0 2.66667 1 13 -13.3333 8.33333
Reached the termination state since all RHS values are positive

The Optimisation function is optimised at the point : x2 = 0, x1 = 3.33333, x4 = 8.33333, Rest all xis=0
The value of the objective function at this point is : 6.66667
```

```
Iteration index: 1


Iteration: 0
The Tableau:
20 3 0 1 0 0 -1 1 0 0
2 2 1 0 0.666667 0 3.5 -3.33333 0 3.33333
0 5 -0 -0 2.66667 1 13 -13.3333 0 8.33333
0 8 0 0 -0.666667 0 -0.5 -0.666667 1 -0.333333
Deviations: 0 0 -11.3333 0 -999987 -13.3333 0
Leaving variable: x7
Entering variable: x3


Iteration: 1
The Tableau:
20 3 0 1 0 0 -1 1 0 0
2 2 1 0 0 0 3 -4 1 3
0 5 0 0 0 1 11 -16 4 7
-10 4 -0 -0 1 -0 0.75 1 -1.5 0.5
Reached the termination state since all RHS values are positive

The Optimisation function is optimised at the point : x2 = 0, x1 = 3, x4 = 7, x3 = 0.5, Rest all xis=0
The value of the objective function at this point is : 1


Iteration index: 2


Iteration: 0
The Tableau:
20 3 0 1 0 0 -1 1 0 0 0
2 2 1 0 0 0 3 -4 1 0 3
0 5 0 0 0 1 11 -16 4 0 7
-10 4 -0 -0 1 -0 0.75 1 -1.5 0 0.5
0 9 0 0 0 0 -0.75 0 -0.5 1 -0.5
Deviations: 0 0 0 0 -999979 -2 -17 0
Leaving variable: x8
Entering variable: x7


Iteration: 1
The Tableau:
20 3 0 1 0 0 -1 1 0 0 0
2 2 1 0 0 0 1.5 -4 0 2 2
0 5 0 0 0 1 5 -16 0 8 3
```

```
Reached the termination state since all RHS values are positive

The Optimisation function is optimised at the point : x2 = 0, x1 = 2, x4 = 3, x3 = 2, x7 = 1, Rest all xis=0
The value of the objective function at this point is : -16
```