Exercise 9, Discrete Mathematics for Bioinformatics

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9.1 PORTA — Polyhedron Representation Transformation Algorithm

a)
```
$ lp_solve example1.lp

Value of objective function: 2.5

Actual values of the variables:
x1                            1.5
x2                              0
x3                            0.5
x4                            0.5
```

b) Input file:

```
DIM = 4

LOWER_BOUNDS
0 0 0 0
UPPER_BOUNDS
??? hier komm ich nicht weiter

END
```

Output file:

```
DIM =  4

CONV_SECTION
???

END
```

c)

9.2 Branch and Bound

a)
```
$ lp_solve -S3 example2.lp

Value of objective function: 22.4

Actual values of the variables:
x1                            2.8
```

```
x2                              0
x3                              0
x4                              0

Actual values of the constraints:
c1                             14
```

b) Let us call the original problem P_0. We branch the problem into two problems: $P_{11} = P_0 \wedge x_1 \leq 2$ and $P_{12} = P_0 \wedge x_1 \geq 3$.

Result of solving P_{11}:

```
$ lp_solve -S3 example21.lp

Value of objective function: 22.2857

Actual values of the variables:
x1                              2
x2                       0.571429
x3                              0
x4                              0

Actual values of the constraints:
c1                             14
c2                              2
```

Result of solving P_{12}:

```
$ lp_solve -S3 example22.lp
This problem is infeasible
```

Hence, we branch further into $P_{21} = P_{11} \wedge x_2 \leq 0$ and $P_{22} = P_{11} \wedge x_2 \geq 1$.

Result of solving P_{21}:

```
$ lp_solve -S3 example221.lp

Value of objective function: 22

Actual values of the variables:
x1                              2
x2                              0
x3                              1
x4                              0

Actual values of the constraints:
c1                             14
c2                              2
c3                              0
```

Result of solving P_{22}:

```
$ lp_solve -S3 example222.lp

Value of objective function: 22.2

Actual values of the variables:
x1                            1.4
```

```
x2                              1
x3                              0
x4                              0

Actual values of the constraints:
c1                             14
c2                            1.4
c3                              1
```

Since $22 = \lfloor 22.4 \rfloor$, and the solutions of P_{21} are integers, this is the solution of the branch and bound ILP algorithm.