

# Optimization Methods in Finance

Fall 2009

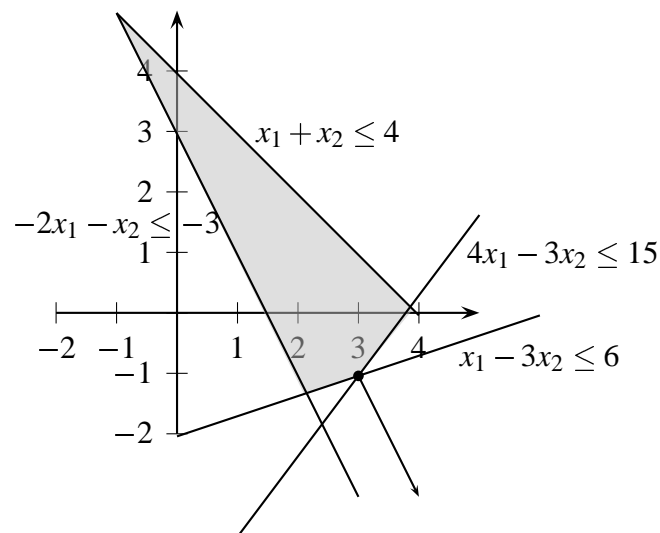
## Guide how to use ZIMPL on terminal PCs

### 1 Intro

For this guide I assume that you use the Linux-PCs in the terminal room. We consider the following example linear program

$$\begin{aligned} \max \quad & x_1 - 2x_2 \\ & x_1 + x_2 \leq 4 \\ & x_1 - 3x_2 \leq 6 \\ & -2x_1 - x_2 \leq -3 \\ & 4x_1 - 3x_2 \leq 15 \end{aligned}$$

The optimum solution is  $(x_1, x_2) = (3, -1)$  with an objective function value of 5.



We create a ZIMPL file `exercise2_2.zpl` in the base directory and fill it with

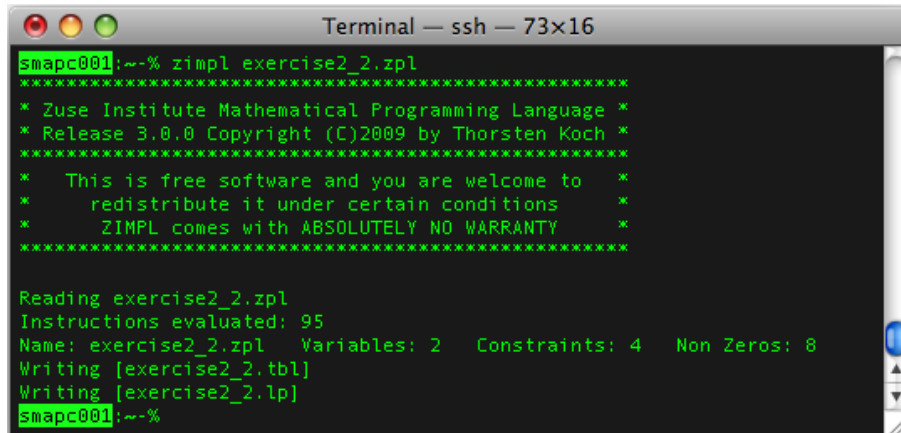
```
# Example from exercise 2.2
# Optimum solution should be x = (3,-1) with value 5

var x1 real >= -infinity;
var x2 real >= -infinity;

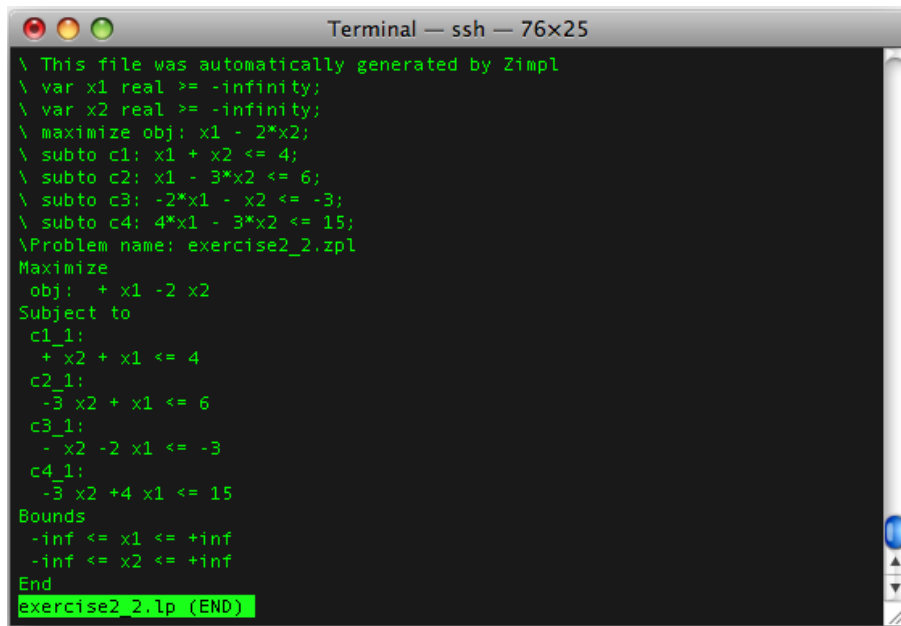
maximize obj: x1 - 2*x2;
```

```
subto c1: x1 + x2 <= 4;
subto c2: x1 - 3*x2 <= 6;
subto c3: -2*x1 - x2 <= -3;
subto c4: 4*x1 - 3*x2 <= 15;
```

Then we open a terminal and type `zimpl exercise2_2.zpl` to translate it into a lp file.



The lp file looks as follows



## 2 Soplex

SOPLEX is a free linear programming solver that can solve files in the lp format. The command

```
soplex -x exercise2_2.lp
```

solves the above example. SOPLEX outputs

```

Terminal — ssh — 96x50
smapc001:~-% soplex -x exercise2_2.lp
*****
* SoPlex --- the Sequential object-oriented simPlex. Release 1.4.2 *
* Copyright (C) 1997-2009 Zuse Institute Berlin *
*****

SoPlex parameters:
Delta          = 1.000000e-06
Epsilon Zero   = 1.000000e-16
Epsilon Factor = 1.000000e-20
Epsilon Update = 1.000000e-16

algorithm      = Leaving
representation = Column
update         = Forest-Tomlin
pricing        = Steep
starter        = no
simplifier     = MainSM
ratioTest     = Fast
scaling        = bi-Equilibrium / no

Loading LP file exercise2_2.lp
LP has 4 rows 2 columns 8 nonzeros
LP reading time: 0.00

Solving LP ...
IEQUSC01 Equilibrium scaling LP
IMAISM69 Main simplifier removed 0 rows, 0 columns, 0 nonzeros, 0 col bounds, 0 row bounds
IMAISM74 Reduced LP has 4 rows 2 columns 8 nonzeros
ISOLVE01 iteration = 0 lastUpdate = 0 value = 0.000000e+00
ISOLVE01 iteration = 0 lastUpdate = 0 value = 0.000000e+00
ISOLVE01 iteration = 2 lastUpdate = 2 value = 0.000000e+00
ISOLVE01 iteration = 2 lastUpdate = 0 value = 1.060000e+01
ISOLVE01 iteration = 2 lastUpdate = 0 value = 1.060000e+01
ISOLVE02 Finished solving (status=OPTIMAL, iters=2, leave=0, enter=2, objValue=1.060000e+01)

SoPlex statistics:
Factorizations : 5
Time spent : 0.00
Solves : 18
Time spent : 0.00
solution time : 0.00
iterations : 2

Solution value is: 6.0000000e+00
x1 0 2.4000000e+00
x2 1 -1.0000000e+00
All other variables are zero.
smapc001:~-%

```

But the returned solution  $(x_1, x_2) = (2.4, -1.8)$  is not even feasible<sup>1</sup>. Thus we want to explain in the following, how lp files can be solved with the help of other (seemingly more reliable) tools. We suggest 2 possible options: SCIP and QSOpt.

### 3 SCIP

SCIP is a free linear *and* integer program solver that can solve programs in the lp format (and in the ZIMPL format). Hence it is a more powerful tool than for example QSOpt. It is already installed on the terminal machines and can be used for example via:

```
scip -c "read exercise2_2.lp" -c "optimize" -c "display solution" -c "quit"
```

---

<sup>1</sup>Remark: Also on other examples I did not get any correct answer

```

Terminal — ssh — 135x34
smapc001:~-% scip -c "read exercise2_2.lp" -c "optimize" -c "display solution" -c "quit"
SCIP version 1.2.0 [precision: 8 byte] [memory: block] [mode: optimized] [LP solver: SoPlex 1.4.2]
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user parameter file <scip.set> not found - using default parameters

original problem has 2 variables (0 bin, 0 int, 0 impl, 2 cont) and 4 constraints

presolving:
presolving (1 rounds):
 0 deleted vars, 0 deleted constraints, 0 tightened bounds, 0 added holes, 0 changed sides, 0 changed coefficients
 0 implications, 0 cliques
presolved problem has 2 variables (0 bin, 0 int, 0 impl, 2 cont) and 4 constraints
   4 constraints of type <linear>
Presolving Time: 0.00

   time | node | left | LP iter | mem | mdpt | frac | vars | cons | ccons | cols | rows | cuts | confs | strbr | dualbound | primalbound | gap
   0.0s | 1 | 0 | 3 | 68k | 0 | 0 | 2 | 4 | 4 | 2 | 4 | 0 | 0 | 0 | 5.000000e+00 | -- | Inf
* 0.0s | 1 | 0 | 3 | 68k | 0 | - | 2 | 4 | 4 | 2 | 4 | 0 | 0 | 0 | 5.000000e+00 | 5.000000e+00 | 0.00%

SCIP Status      : problem is solved [optimal solution found]
Solving Time (sec) : 0.00
Solving Nodes    : 1
Primal Bound     : +5.000000000000000e+00 (1 solutions)
Dual Bound      : +5.000000000000000e+00
Gap              : 0.00 %

objective value:          5
x1                        3 (obj:1)
x2                       -1 (obj:-2)

smapc001:~-%

```

## 4 QSOpt

QSOpt is a free linear program solver that solves files in the lp format. It is not yet installed on the terminal machines, but this can be easily done as follows

1. Download the file  
<http://www2.isye.gatech.edu/~wcook/qsopt/downloads/codes/linux24/qsopt.gz>
2. Open a terminal
3. Enter `gunzip qsopt.gz`
4. Enter `chmod 777 qsopt` to make QSOpt executable
5. Enter `./qsopt -O exercise2_2.lp`

```

Terminal — ssh — 78x21
smapc001:~-% ./qsopt -O exercise2_2.lp
Data Warning: Setting problem name to "unnamed".
ILLlp_add_logicals ...
Time for SOLVER_READ: 0.00 seconds.
starting ILLsimplex on scaled_lp...
Problem has 4 rows and 6 cols
starting primal phase I
(0): primal infeas = 6.000000
starting primal phase II
completed ILLsimplex
scaled_lp: time = -0.000, pI = 2, pII = 3, dI = 0, dII = 0, opt = -5.000000
starting ILLsimplex on unnamed...
Problem has 4 rows and 6 cols
completed ILLsimplex
unnamed: time = -0.000, pI = 0, pII = 0, dI = 0, dII = 0, opt = -5.000000
LP Value: 5.000000
Time for SOLVER: 0.00 seconds.
Solution Values
x1 = 3.000000
x2 = -1.000000
smapc001:~-%

```

## 5 General remarks

- The command `var x;` in ZIMPL creates a variable with a default lower bound of 0. Better use `var x real >= -infinity;` if you want  $x$  to be unbounded, i.e.  $x \in \mathbb{R}$ .