Prof. Friedrich Eisenbrand
Location: MA A3 31

Due date: 26.01.09

Practical exercises

Optimization Methods in Finance

Fall 2009

Practical exercise (Bonus project - 4 points)
Implement the branch and bound algorithm. More precisely implement a method

```
void branchAndBound(Vector<double> c, Matrix<double> A, Vector<double> b)
```

in C++ (or in Matlab) that solves

$$\begin{aligned} \max\, & c^T x \\ Ax &\leq b \\ x &\in \mathbb{Z}^n \end{aligned}$$

using the branch and bound algorithm (and outputs the found solution).
Hints:

1. You can use any LP library to solve the relaxations (as you did for the Frank-Wolfe algorithm).
2. We recommend to test your instance with a small example, say from exercise 6.1.
3. If for a fractional solution x^* one has several variables $x_i^* \notin \mathbb{Z}$ you can branch on an arbitrary such i.

The details for the submission are as follows:

1. Send your (compilable) C++/Matlab code till **26.01.09** to yanick.raja@epfl.ch.
2. The submission has to contain the solutions for the following 2 integer programs:

$$\begin{array}{lrrrrrrrrrrlll} \max & (5, & 6, & 10, & 10, & 8, & 10, & 10, & 10, & 9, & 10)^T x & & (IP1) & \\ & (4788, & 3703, & 8104, & 8357, & 5089, & 6832, & 9723, & 7054, & 3680, & 6088) x & \leq & 10000 & \\ & & & & & & & & & & -x_i & \leq & 0 & \forall i = 1, \ldots, 10 \\ & & & & & & & & & & x_i & \in & \mathbb{Z} & \forall i = 1, \ldots, 10 \end{array}$$

$$\max(1.1, 1.2, 1.3, 1.4, 1.5, 1.6)^T x \qquad (IP2)$$

$$\begin{pmatrix} 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix} x \leq \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

$$x_1, \ldots, x_6 \in \mathbb{Z}$$

Good luck and merry Christmas.