homework 2

use `mosek` to solve a `QP` convex problem

consider the problem:

minimize

$$x_1^2 + 0.15x_2^2 + x_3^2 - x_1x_3 - x_2$$

subject to

$$1 \leq x_1 + x_2 + x_3 - x_1^2 - x_2^2 - 0.1x_3^2 + 0.2x_1x_3, \quad x \geq 0$$

this is equivalent to

minimize

$$\frac{1}{2}x^TQ^ox + c^Tx$$

subject to

$$\frac{1}{2}x^TQ^0x + Ax \geq b, \quad x \geq 0$$

where

$$Q^o = \begin{bmatrix} 2 & 0 & -1 \\ 0 & 0.15 & 0 \\ -1 & 0 & 2 \end{bmatrix}, \quad c = \begin{bmatrix} 0 \\ -1 \\ 0 \end{bmatrix}$$

and

$$Q^0 = \begin{bmatrix} -2 & 0 & 0.2 \\ 0 & -2 & 0 \\ 0.2 & 0 & -0.2 \end{bmatrix}, \quad A = [1 \quad 1 \quad 1], \quad b = 1$$

use revised example `cpp` executable

```
Problem
  Name                   :
  Objective sense        : minimize
  Type                   : QCQO (quadratically constrained optimization
problem)
  Constraints            : 1
  Affine conic cons.     : 0
  Disjunctive cons.      : 0
  Cones                  : 0
  Scalar variables       : 3
  Matrix variables       : 0
  Integer variables      : 0

Optimizer started.
Quadratic to conic reformulation started.
Quadratic to conic reformulation terminated. Time: 0.00
```

```
Presolve started.
Eliminator started.
Freed constraints in eliminator : 0
Eliminator terminated.
Linear dependency checker started.
Linear dependency checker terminated.
Eliminator started.
Freed constraints in eliminator : 0
Eliminator terminated.
Eliminator - tries                  : 2                 time
: 0.00
Lin. dep.  - tries                  : 1                 time
: 0.00
Lin. dep.  - number                 : 0
Presolve terminated. Time: 0.00
Problem
  Name                   :
  Objective sense        : minimize
  Type                   : QCQO (quadratically constrained optimization
problem)
  Constraints            : 1
  Affine conic cons.     : 0
  Disjunctive cons.      : 0
  Cones                  : 0
  Scalar variables       : 3
  Matrix variables       : 0
  Integer variables      : 0

Optimizer  - threads                : 4
Optimizer  - solved problem         : the primal
Optimizer  - Constraints            : 5
Optimizer  - Cones                  : 2
Optimizer  - Scalar variables       : 11                conic
: 10
Optimizer  - Semi-definite variables: 0                 scalarized
: 0
Factor     - setup time             : 0.00              dense det. time
: 0.00
Factor     - ML order time          : 0.00              GP order time
: 0.00
Factor     - nonzeros before factor : 15                after factor
: 15
Factor     - dense dim.             : 0                 flops
: 1.76e+02
ITE PFEAS    DFEAS    GFEAS    PRSTATUS   POBJ              DOBJ
MU       TIME
0   1.0e+00  1.8e+00  3.1e+00  0.00e+00   1.414213562e+00   -2.828427125e+00
1.0e+00  0.01
1   2.4e-01  4.4e-01  3.6e-01  4.35e-01   1.770292557e-02   -1.230280685e+00
2.4e-01  0.01
2   5.0e-02  9.1e-02  3.0e-02  1.02e+00   -4.895105575e-01  -7.501174562e-01
5.0e-02  0.01
3   1.3e-03  2.3e-03  1.1e-04  1.07e+00   -5.131624792e-01  -5.199449081e-01
1.3e-03  0.01
```

```
4   2.7e-05  5.0e-05  3.4e-07  1.01e+00   -5.137829543e-01  -5.139291461e-01
2.7e-05  0.01
5   2.7e-06  5.0e-06  1.1e-08  1.00e+00   -5.138012848e-01  -5.138159186e-01
2.7e-06  0.01
6   3.3e-07  6.1e-07  4.5e-10  1.00e+00   -5.138032183e-01  -5.138049909e-01
3.3e-07  0.01
7   5.1e-08  9.3e-08  2.7e-11  1.00e+00   -5.138034523e-01  -5.138037227e-01
5.1e-08  0.01
8   8.3e-09  1.5e-08  1.8e-12  1.00e+00   -5.138034878e-01  -5.138035317e-01
8.3e-09  0.01
9   1.2e-10  2.1e-10  4.1e-15  1.00e+00   -5.138034946e-01  -5.138034951e-01
1.2e-10  0.01
Optimizer terminated. Time: 0.01


Interior-point solution summary
  Problem status  : PRIMAL_AND_DUAL_FEASIBLE
  Solution status : OPTIMAL
  Primal.  obj: -5.1380349464e-01   nrm: 1e+00    Viol.  con: 2e-10    var:
0e+00
  Dual.    obj: -5.1381896040e-01   nrm: 1e+00    Viol.  con: 0e+00    var: 1e-
05
Optimal primal solution
x[0]: 4.535553e-01
x[1]: 9.457797e-01
x[2]: 6.856943e-01
```

which needs to be reminded

```
qcsubi (MSKint32t*) - Row subscripts for quadratic constraint matrix. (input)
qcsubj (MSKint32t*) - Column subscripts for quadratic constraint matrix.
(input)
qcval (MSKrealt*) - Quadratic constraint coefficient values. (input)
```