Optimization tutorial

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1 Sudoku

In this tutorial we shall use `Python`. The objective is to solve the puzzle Sudoku for any size (order), using integer programming.

1.1 Formulation

To formulate the problem, propose answers to the following questions :

— Using only binary variables, how can we specify that a given number k is located in position (i, j) in the grid ?

— What variables should we use ?

— How do we express the line, column and square constraints ?

— How do we express the fact that only a single number can be located at any location (i, j) ?

— How do we express the known numbers as constraints ?

1.2 Resolution using `Python`

We use the "optimization toolbox" of `Matlab`.

Optimisation toolbox

— One of the best toolbox for optimisation in Python is `cvxopt`

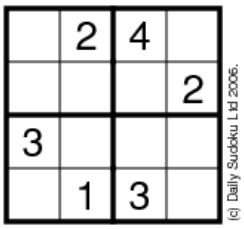
— In particular, `cvxopt.glpk` has an integer programming solver :

```
import numpy as np
import cvxopt
import cvxopt.glpk

cvxopt.glpk.ilp?
```

— you have to use the cvxopt "matrix" object

```
from cvxopt import matrix
b = matrix(np.ones(...))
```



1.3 Test

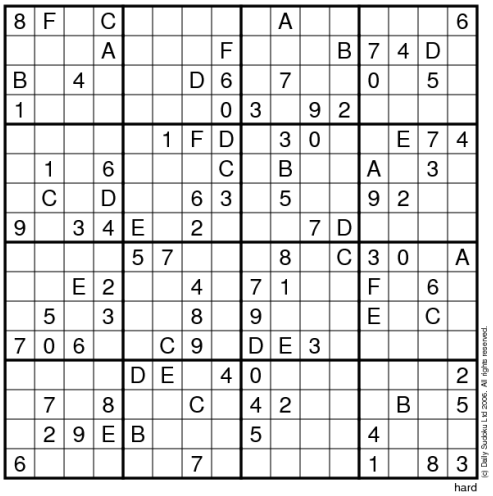
Solve the following sudokus.

	8		9		1		5	
		2	6	8	7	3		
		3				6		
3	9						6	5
6			4	7	5			3
5	7						8	4
		9				8		
		5	1	2	4	9		
	4		8		3		2	

(simple)

7						4		
	2			7			8	
		3			8			9
			5			3		
	6			2			9	
		1			7			6
			3			9		
	3			4			6	
		9			1			5

(Very hard)



Special version for computer scientists