

**Instructions:**

Solve the given problems and submit the code and report by today 11.55 PM.

**AMPL Review Exercise:** [15 Marks]

	2				
		3	5		
1			3	6	
	3	6			4
		1	4		
				3	

Figure 1: Sample Problem 1

We consider a version of sudoku puzzle grid which is of size  $6 \times 6$  (see Figure 1). Thus the grid contains 36 cells. The grid contains 6 rectangular sub-grids, each of which is of size  $2 \times 3$ . The aim is to fill the grids with numbers from the set  $S_6 = \{1, 2, 3, 4, 5, 6\}$  such that the following conditions are satisfied:

- Each row of the grid contains every number of  $S_6$ .
- Each column of the grid contains every number of  $S_6$ .
- Each rectangular sub-grid contains every number of  $S_6$ .

Usually, the grid is seeded or initialized with some fixed values in particular cells which cannot be changed (as shown in Figure 1). The aim is then to fill the remaining cells such that the conditions mentioned above are satisfied.

The following questions deal with solving the sudoku problem mentioned above. Include all answers in your report:

1. Construct a suitable AMPL optimization model for the example mentioned in Figure 1. Explain the construction and justify why it solves the problem.
2. Execute the model for the example in Figure 1 (design a suitable data file) and check if the solution obtained is correct. Report also the CPU time required to solve the problem.
3. Does the optimization problem have multiple solutions? Explain.
4. Construct suitable models for solving examples in Figure 2 and 3.

5. Solve them and report the solutions and time taken.
6. Based on the CPU time taken to solve the problems, can you categorize the problems to be easy or hard? (As a pastime activity, check if the categorization is indeed true.)

		<b>5</b>		<b>3</b>	
					<b>6</b>
<b>6</b>			<b>5</b>		
		<b>4</b>			<b>1</b>
<b>4</b>					
	<b>2</b>		<b>6</b>		

Figure 2: Sample Problem 2

<b>3</b>		<b>4</b>	<b>1</b>	<b>2</b>	
	<b>5</b>		<b>4</b>		
<b>6</b>					
					<b>1</b>
		<b>6</b>		<b>1</b>	
	<b>4</b>	<b>1</b>	<b>5</b>		<b>3</b>

Figure 3: Sample Problem 3