Problem 3

PART A

1.0/1.0 point (graded)

Sudoku is a popular number puzzle. The goal is to place the digits in [1,9] on a nine-by-nine grid, with some of the digits already filled in, where [1,9] denotes the set of integers from 1 to 9. Your solution must satisfy the following four rules:

- Rule 1. Each cell contains an integer in [1,9].
- Rule 2. Each row must contain each of the integers in [1,9].
- Rule 3. Each column must contain each of the integers in [1,9].
- Rule 4. Each of the nine 3x3 squares with bold outlines must contain each of the integers in [1,9].

Figure 1 below presents a Sudoku puzzle. Figure 2 presents the solved Sudoku puzzle in which all four of the rules are satisfied.

- Exit Survey

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

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

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

Sudoku isn't an optimization problem, it's actually a feasibility problem: we wish to find a feasible solution that satisfies these rules. You can think of it as an optimization problem in which the objective is always equal to 0. This problem firsts asks you to use integer programming formulation techniques to model the rules of Sudoku. It then asks you to solve it using Julia and JuMP.

Model this problem using integer programming. Define binary variable $x_{ijk} \in \{0,1\}, \forall i = 1,\ldots,9, j = 1,\ldots,9, k = 1,\ldots,9$, which equals to 1 if we put number k in the i^{th} row and j^{th} column and 0 otherwise.

Let $a_{ijk} = 1$ if the initial puzzle has a k in row i and column j. Otherwise, $a_{ijk} = 0$.

The following constraints model the Sudoku problem.

C1. $x_{ijk} \geq a_{ijk}$,
$\forall i = 1,\ldots,9, j = 1,\ldots,9, k = 1,\ldots,9$

C2. $\sum_{i=1}^{9} x_{ijk} = 1$,
$\forall j = 1,\ldots,9, k = 1,\ldots,9$

C3. $\sum_{j=1}^{9} x_{ijk} = 1$,
$\forall i = 1,\ldots,9, k = 1,\ldots,9$

C4. $\sum_{k=1}^{9} x_{ijk} = 1$,
$\forall i = 1,\ldots,9, j = 1,\ldots,9$

C5. $\sum_{a\in\{1,2,3\},b\in\{1,2,3\}} X_{(3i+a),(3j+b),k} = 1,$
$\forall i \in \{0,1,2\}, j \in \{0,1,2\}, k = 1,\ldots,9$

C2 models which rule?

- Rule 1 (rule for cells)
- Rule 2 (rule for rows) ✔
- Rule 3 (rule for columns)
- Rule 4. (rule for 3 x 3 squares)

Submit You have used 1 of 2 attempts

PART B

1.0/1.0 point (graded)

C3 models which rule?

- Rule 1 (rule for cells)
- Rule 2 (rule for rows)

- (•) Rule 3 (rule for columns) ✔
- ( ) Rule 4. (rule for 3 x 3 squares)

Submit You have used 1 of 2 attempts

PART C

1.0/1.0 point (graded)

C4 models which rule?

- (•) Rule 1 (rule for cells) ✔
- ( ) Rule 2 (rule for rows)
- ( ) Rule 3 (rule for columns)
- ( ) Rule 4. (rule for 3 x 3 squares)

Submit You have used 1 of 2 attempts

PART D

1.0/1.0 point (graded)

C5 models which rule?

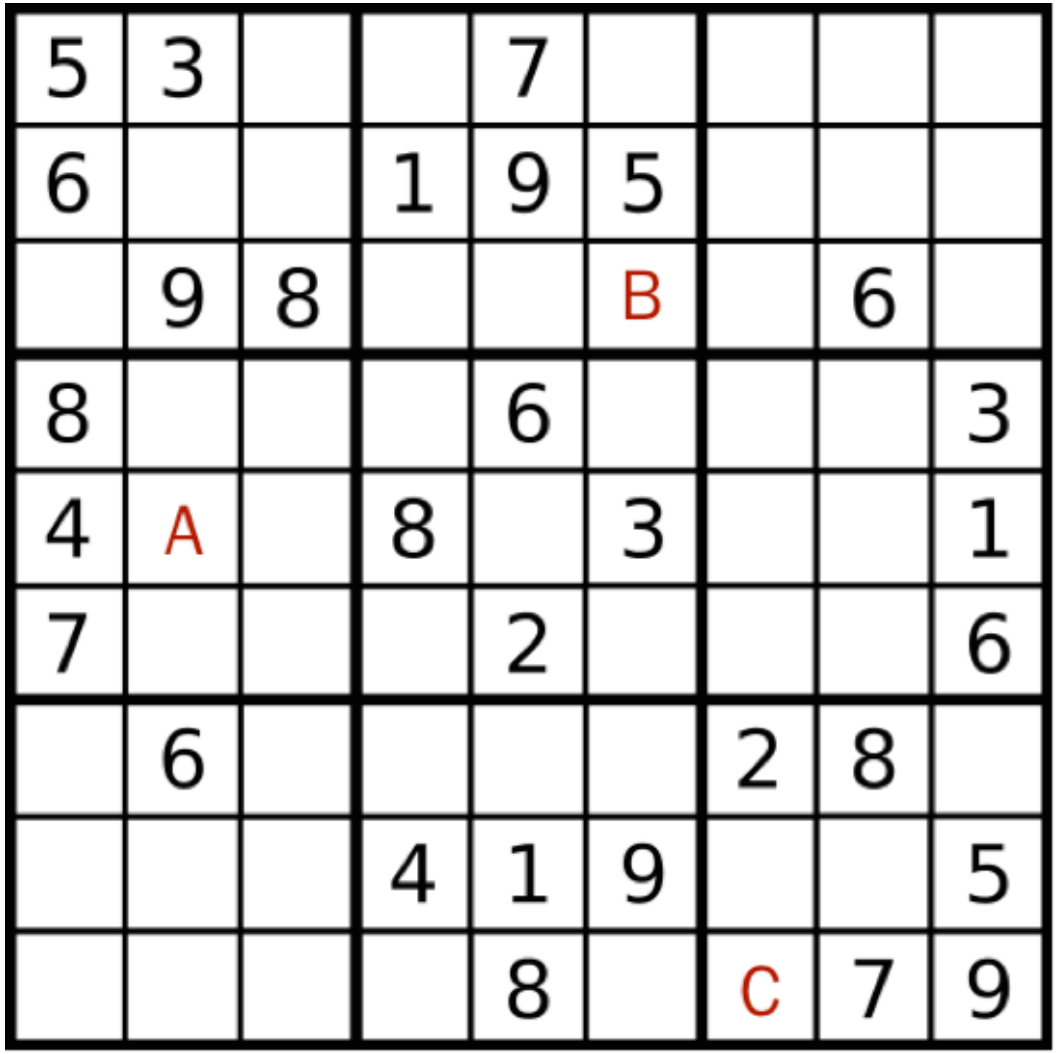
- ○ Rule 1 (rule for cells)
- ○ Rule 2 (rule for rows)
- ○ Rule 3 (rule for columns)
- ◉ Rule 4. (rule for 3 x 3 squares) ✔

Submit You have used 1 of 2 attempts

PART E

2.0/2.0 points (graded)

Solve the feasibility problem you formulated using Julia and JuMP and what is the value of $A + B + C$ in your solution?



5 ✔

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PS4. Problem 3
Topic: Week 4 / PS4. Problem 2

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