Optimization II Homework 1 Solution

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Problem 1

(a)

```
% Problem 1(a)
M1a = [8 0 0 0 0 0 0 0 0;
       0 0 3 6 0 0 0 0 0;
       0 7 0 0 9 0 2 0 0;
       0 5 0 0 0 7 0 0 0;
       0 0 0 0 4 5 7 0 0;
       9 0 0 1 0 0 0 3 0;
       0 0 1 0 0 0 0 6 8
       0 0 8 5 0 0 0 1 0;
       0 9 0 0 0 0 4 0 0];

result1a = solveSudoku(M1a,3);
```

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

(b)

```
% Problem 1(b)
M1b = [8 0 0 0 0 0 0 0 3;
       0 0 3 6 0 0 0 0 0;
       0 7 0 0 9 0 2 0 0;
       0 5 0 0 0 7 0 0 0;
       0 0 0 0 4 5 7 0 0;
       9 0 0 1 0 0 6 3 0;
       0 0 1 0 0 0 0 6 8
       0 0 8 5 0 0 0 1 0;
       5 9 0 0 8 0 4 0 0];

result1b =  solveSudoku(M1b,3);
```

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

Problem 2

```
%Problem 2
ratioList = [];
for i = 1:10
    M2 = ceil(9*rand(9,9));
    result2 = solveSudoku(M2,3);
    ratio = errorRatio(result2,M2);
    ratioList = [ratioList, ratio];
end

fprintf("mean = %f\nsd = %f", mean(ratioList), std(ratioList));
```

```
Elapsed time is 161.692168 seconds.
mean = 0.496728
sd = 0.020310
```

Problem 3

```
% Problem 3
M3 = zeros(16,16);
result3a = solveSudoku(M3,4);
M3(1,1) = 1;
result3b = solveSudoku(M3,4);
```

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(a) label 1

1	2	6	10	16	11	13	12	14	15	7	3	5	4	9	8
4	14	5	16	15	9	8	10	2	1	13	11	6	12	7	3
8	12	15	7	6	4	14	3	9	10	16	5	11	2	13	1
9	11	3	13	7	1	2	5	12	8	4	6	14	10	15	16
3	8	13	12	5	7	6	9	11	4	1	10	2	15	16	14
16	5	1	4	13	15	11	2	3	6	14	9	7	8	12	10
2	15	11	6	14	10	4	8	16	7	12	13	9	1	3	5
10	7	14	9	1	3	12	16	15	2	5	8	13	11	6	4
5	16	2	1	4	8	9	6	7	3	15	12	10	14	11	13
12	4	7	11	10	16	15	13	8	9	2	14	1	3	5	6
6	9	8	15	3	14	5	11	1	13	10	4	12	16	2	7
14	13	10	3	2	12	1	7	6	5	11	16	8	9	4	15
13	3	12	2	9	6	10	4	5	16	8	1	15	7	14	11
11	1	4	5	8	2	3	15	13	14	9	7	16	6	10	12
7	6	9	8	12	13	16	14	10	11	3	15	4	5	1	2
15	10	16	14	11	5	7	1	4	12	6	2	3	13	8	9

(b) label 2

Figure 1: 2 Figures side by side

1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	00	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(a) label 1

1	11	10	8	6	5	7	9	14	2	16	3	4	15	13	12
15	6	7	13	11	10	2	12	8	4	9	1	16	5	14	3
3	16	4	2	14	13	1	15	10	7	5	12	6	9	11	8
9	12	5	14	16	4	3	8	13	15	11	6	10	7	2	1
11	3	1	6	9	16	5	4	2	8	12	14	15	13	7	10
12	7	8	16	10	3	6	13	9	11	15	5	2	14	1	4
13	14	15	10	12	7	8	2	3	1	4	16	5	11	6	9
5	2	9	4	1	11	15	14	7	6	10	13	12	3	8	16
10	15	11	12	4	1	14	5	6	3	13	7	8	16	9	2
2	13	6	9	8	15	16	7	5	12	14	4	3	1	10	11
8	1	14	5	3	12	13	10	16	9	2	11	7	6	4	15
16	4	3	7	2	6	9	11	1	10	8	15	13	12	5	14
4	10	12	1	13	14	11	16	15	5	6	8	9	2	3	7
7	9	13	15	5	8	4	1	12	14	3	2	11	10	16	6
14	8	16	3	15	2	10	6	11	13	7	9	1	4	12	5
6	5	2	11	7	9	12	3	4	16	1	10	14	8	15	13

(b) label 2

Figure 2: 2 Figures side by side

Problem 4

```
% Problem 4
M4 = [1 2 3 6 4 5 0 0 0;
      4 5 6 0 0 0 0 0 0;
      7 8 9 0 0 0 0 0 0;
      5 0 0 0 0 0 0 0 0;
      8 0 0 0 0 0 0 0 0;
      2 0 0 0 0 0 0 0 0;
      0 0 0 0 0 0 0 0 0;
      0 0 0 0 0 0 0 0 0;
      0 0 0 0 0 0 0 0 0];

result4 = solveSudoku_more_constraints(M4,3);
```

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