

CSC 320 Project Report
MingyuDu --V00815833
TianyiZhao --V00839072

Readme.txt indicates how to run a Python file.

1. Recommended environment:

Ubuntu 16.04 LTS, Python2

Note: we have not test on Windows and macOS.

1. Get the default test puzzle from

projecteuler.net/project/resources/p096_sudoku.txt

which has 50 grids.

The program Project.py would solve those 50 grids individually.

2. What we do

In the Python file Project.py, we implement multiple functions to achieve different purposes.

They are commented in the Python file.

3. Evaluation:

Our Project.py can only read a single unsolved puzzle and output a single solved puzzle.

Therefore, we have to split the provided test file into 50 test files, named from test1.txt to test50.txt. Then we run Project.py on test files.

The result is printed to the terminal and we paste the results to the report.

4. 50 test results are as following.

1-5

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

Time used : 0.011526 seconds

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

Time used : 0.011479 seconds

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

Time used : 0.011218 seconds

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

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

Time used : 0.011353 seconds

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

Time used : 0.01138 seconds

6-10

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

Time used : 0.011284 seconds

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

Time used : 0.011343 seconds

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

Time used : 0.011272 seconds

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

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

Time used : 0.011384 seconds

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

Time used : 0.011185 seconds

11-15

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

Time used : 0.011127 seconds

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

Time used : 0.011179 seconds

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

Time used : 0.01143 seconds

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

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

Time used : 0.011542 seconds

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

Time used : 0.01194 seconds

16-20

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

Time used : 0.011192 seconds

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

Time used : 0.01152 seconds

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

Time used : 0.011888 seconds

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

┌──────────┴──────────┴──────────┐

Time used : 0.011201 seconds

┌──────────┴──────────┴──────────┐
7 8 2	6 1 4	3 5 9
4 3 9	8 2 5	1 7 6
6 5 1	9 3 7	4 2 8
┌──────────┴──────────┴──────────┐		
2 9 3	4 7 1	8 6 5
5 6 8	3 9 2	7 1 4
1 4 7	5 6 8	2 9 3
┌──────────┴──────────┴──────────┐		
3 2 6	7 4 9	5 8 1
9 7 5	1 8 3	6 4 2
8 1 4	2 5 6	9 3 7
┌──────────┴──────────┴──────────┐

Time used : 0.011287 seconds

21-25

┌──────────┴──────────┴──────────┐
4 2 8	5 3 1	7 9 6
3 6 5	9 4 7	1 8 2
9 7 1	2 6 8	4 3 5
┌──────────┴──────────┴──────────┐		
2 1 4	8 9 6	5 7 3
6 9 7	4 5 3	2 1 8
5 8 3	1 7 2	9 6 4
┌──────────┴──────────┴──────────┐		
8 4 9	6 1 5	3 2 7
7 5 2	3 8 9	6 4 1
1 3 6	7 2 4	8 5 9
┌──────────┴──────────┴──────────┐

Time used : 0.01109 seconds

┌──────────┴──────────┴──────────┐
4 2 5	7 8 1	9 3 6
1 7 8	3 6 9	5 2 4
3 6 9	5 2 4	1 8 7
┌──────────┴──────────┴──────────┐

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

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

Time used : 0.011412 seconds

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

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

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

Time used : 0.013378 seconds

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

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

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

Time used : 0.011283 seconds

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

Time used : 0.011131 seconds

26-30

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

Time used : 0.011687 seconds

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

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

Time used : 0.011511 seconds

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

Time used : 0.011547 seconds

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

Time used : 0.012171 seconds

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

Time used : 0.011322 seconds

31-35

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

Time used : 0.0152 seconds

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

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

Time used : 0.011308 seconds

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

Time used : 0.011054 seconds

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

Time used : 0.011524 seconds

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

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

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

Time used : 0.011377 seconds

36-40

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

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

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

Time used : 0.011254 seconds

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

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

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

Time used : 0.011048 seconds

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

Time used : 0.011483 seconds

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

Time used : 0.011207 seconds

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

Time used : 0.011209 seconds

41-45

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

Time used : 0.01107 seconds

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

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

Time used : 0.011073 seconds

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

Time used : 0.011253 seconds

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

Time used : 0.011203 seconds

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

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

Time used : 0.011662 seconds

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

Time used : 0.011125 seconds

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

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

Time used : 0.011161 seconds

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

Time used : 0.01121 seconds

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

Time used : 0.011378 seconds

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

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

Time used : 0.01142 seconds

Average time of 50 tests: 0.01146962 seconds

5.Findings

The running time for the same test is actually varies, but not dramatically. We notice it when we look at the totalTime value in the terminal. We assume that it may be due to the CPU is dealing with different tasks at different time, which means that the CPU has different amount of available resources such as memory, threads and cores.

6.Extended Tasks

We have done the extend task 1, 3 and 4, which is specifically and detailed explained in the Readme file in the folders ExtenedTask 1&3 and ExtendedTask 4.