

# Project\_2 – A Sudoku\_Solver\_Game and Algorithm

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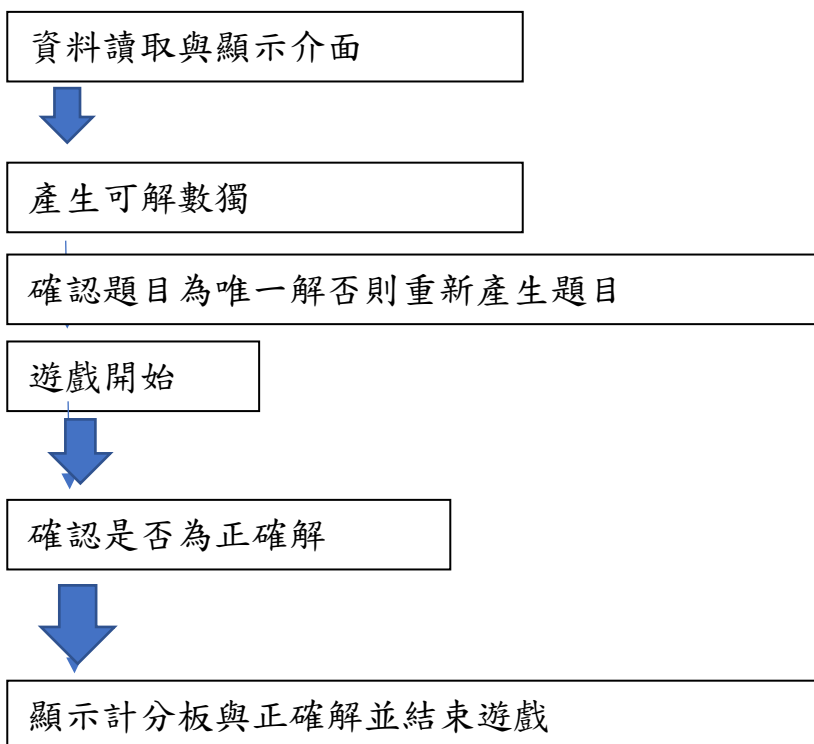
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## 1. Brief introduction:

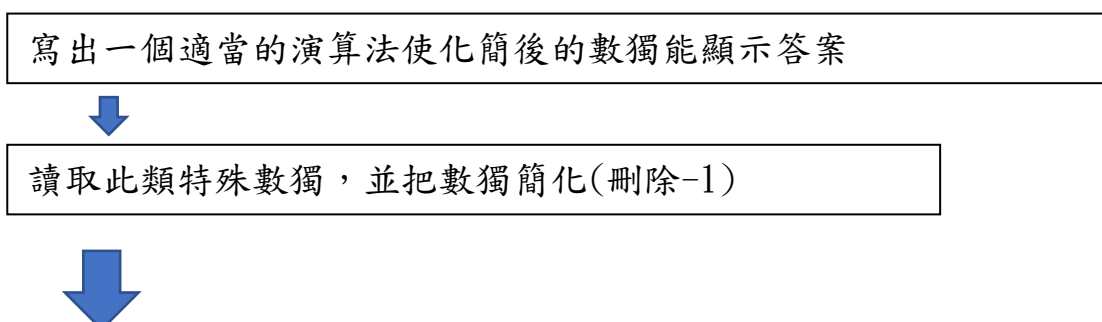
數獨是一個人人知曉的遊戲，填入適當的數字，使得數獨滿足每一行、每一列、及每一塊9宮格，都只出現1~9數字分別各一次，這是傳統的數獨，以所用時間長短，讓遊戲者彼此間競技，這就是數獨的遊戲。

## 2. 遊戲設計&程式執行流程圖

### (1)遊戲部分



### (2)解題與判斷題目類型



演算法解此題並回傳一組解



再次解該題，若該題無法回傳不同於前一次解的解，  
則為單一解，否則為多解



顯示解的類型與答案

### 3. UML Digram for the project code

<b>Sol_su</b>
-cells[12][12]:Cell*
-rows[12]:Ros*
-grids[12]:Grid*
-column[12]:Column*
<<constructor>> +Sudoku(borad[12][12]:int)
+fliterCandidate():void const
+showSu():void const
+duplicate():Sudoku* const
+isCorrect():bool const
+check_validity(Group* group):bool const

Note : Grid\* Column\* are type defined struct from struct Group.

As shown below

```
typedef struct Group
{
    Cell* cells[9];
}Grid, Row, Column;
```

And Cell\* is also a defined data type as shown below:

```
struct Cell{
    int number;
    bitset<10> candidates; // regard it as bool candidates[10]
    Cell(int _number)
    {
        if(_number != 0) // 0 if for empty cell
        {
            number = _number;
        }
    }
}
```

```

        for(int i=1;i<=9;++i)
            candidates[i] = false;
    }
    else
    {
        number = 0;
        for(int i=1;i<=9;++i)
            candidates[i] = true;
    }
}
};

```

GenSudoku
-sudoku_temp[12][12]:int
-board[12][12]:int
<<constructor>> +Gensudoku()
<<constructor>> +Gensudoku(int board_temp[12][12]:int)
+add_zero():void
+Single_Sol():bool
+bruteForceSolve(sudoku_ref:Sudoku* const ,answer[2]:Sudoku* )
+add():void
+Change_symbol():void
+Change_Column_Row():void
+do_total():void
+GenSingleSol_su():Sudoku


P.S Gensudoku is the friend of the Sudoku

#### 4. 基本功能與規則 (reference:上課 ppt)

(1) 特殊的 sudoku，如下圖

We have DARK place

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



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

說明：該數獨不讀-1之值，使每一行、每一列、每一個單元都滿足傳統

數獨，即為該數讀的解，如上右圖。

## (2) 遊戲要求

- a. 創造一個可解且唯一解的數獨，空白部分以0表示，且空白部分要求為40~50格之間。如下圖。

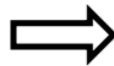
4	2	6	8	7	3	9	5	1			
		3	9	5		6		4			
9		1	6	2	4	8					
			1	3	2		8	7	9	5	6
			8		1	9		4	2		
			4	9	6	2	3		8	7	1
1				4					6	9	5
			4		6				1	3	7
6	9	5		1	7				2	8	4
3	1	2				7	4		5		9
7	4	8					6	9	3		2
	6					3	1		7		8



1	4	2	6	8	7	3	9	5	1	-1	-1	-1
2	0	0	3	9	5	0	6	0	4	-1	-1	-1
3	9	0	1	6	2	4	8	0	0	-1	-1	-1
4	-1	-1	-1	1	3	2	0	8	7	9	5	6
5	-1	-1	-1	0	8	0	1	9	0	4	2	0
6	-1	-1	-1	4	9	6	2	3	0	8	7	1
7	1	0	0	0	4	0	-1	-1	-1	6	9	5
8	0	0	4	0	6	0	-1	-1	-1	1	3	7
9	6	9	5	0	1	7	-1	-1	-1	2	8	4
10	3	1	2	-1	-1	-1	7	4	0	5	0	9
11	7	4	8	-1	-1	-1	0	6	9	3	0	2
12	0	6	0	-1	-1	-1	3	1	0	7	0	8

- b. 使用者能選擇填入的位置與數字，並顯示其結果，如下圖。

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



1	1											
2	4	2	6	8	7	3	9	5	1	-1	-1	-1
3	8	7	3	9	5	1	6	2	4	-1	-1	-1
4	9	5	1	6	2	4	8	7	3	-1	-1	-1
5	-1	-1	-1	1	3	2	4	8	7	9	5	6
6	-1	-1	-1	7	8	5	1	9	6	4	2	3
7	-1	-1	-1	4	9	6	2	3	5	8	7	1
8	1	3	7	2	4	8	-1	-1	-1	6	9	5
9	2	8	4	5	6	9	-1	-1	-1	1	3	7
10	6	9	5	3	1	7	-1	-1	-1	2	8	4
11	3	1	2	-1	-1	-1	7	4	8	5	6	9
12	7	4	8	-1	-1	-1	5	6	9	3	1	2
13	5	6	9	-1	-1	-1	3	1	2	7	4	8

## (3) 測資檢定與讀檔要求

- a. 讀檔類型為文件檔，如下圖所示。

```
新文字文件 (2) - 記事本
檔案(F) 編輯(E) 格式(O) 檢視(V) 說明(H)
4,2,6,8,7,3,9,5,1,-1,-1,-1,
0,0,3,9,5,0,6,0,4,-1,-1,-1,
9,0,1,6,2,4,8,0,0,-1,-1,-1,
-1,-1,-1,1,3,2,0,8,7,9,5,6,
-1,-1,-1,0,8,0,1,9,0,4,2,0,
-1,-1,-1,4,9,6,2,3,0,8,7,1,
1,0,0,0,4,0,-1,-1,-1,6,9,5,
0,0,4,0,6,0,-1,-1,-1,1,3,7,
6,9,5,0,1,7,-1,-1,-1,2,8,4,
3,1,2,-1,-1,-1,7,4,0,5,0,9,
7,4,8,-1,-1,-1,0,6,9,3,0,2,
0,6,0,-1,-1,-1,3,1,0,7,0,8
```

- b. 解題並判斷此題有無解，若有解則是否為多解類型之數獨。  
c. 若是唯一解，則解此題並顯示其結果。

## 5. 如何開始遊戲與功能說明

### (1) 如何編譯

>>在指令窗使用 make 指令，即可生成 main.exe。

Note:確保 main.cpp、Gensudoku.cpp、GenSudoku.h、Sol\_su.cpp  
Sol\_su.h 以及 makefile.txt 在同一個資料夾位置。

## (2) 如何執行

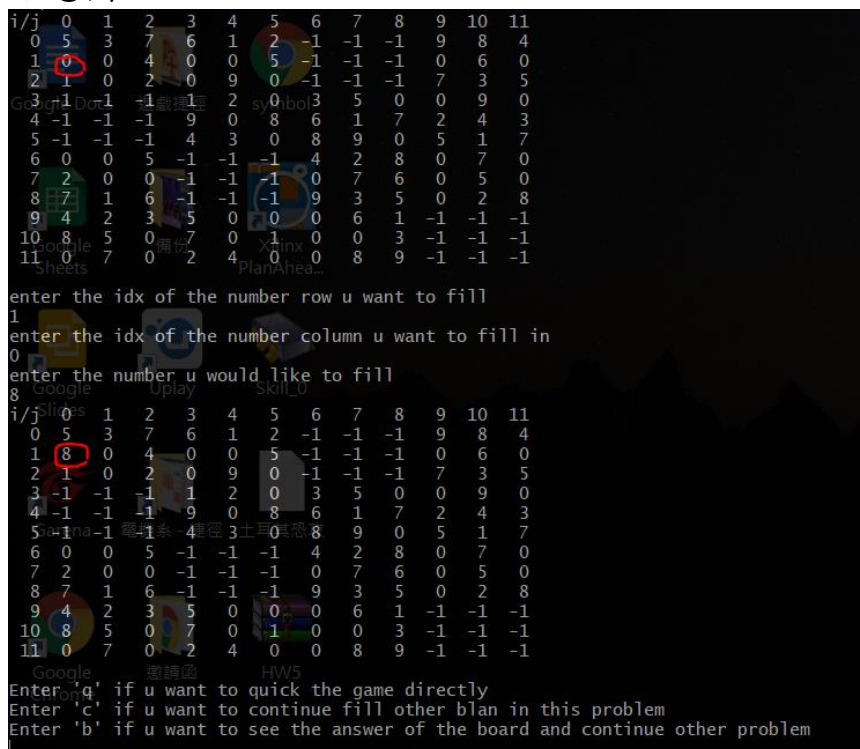
>>執行完(1)後，在指令窗內執行 ./main 即可執行遊戲程式與解題、讀題功能。

## (3) 特殊功能 - 記分板

>>

- 在每次遊戲結束後(即達到 gameover 條件或自行選擇離開)，使用者可自行輸入姓名，即可顯示記分板。
- 多解的數獨不僅可以判斷，而且還可以解出所有的解(程式碼部分僅解出第二個解即停止)

示意圖：



```
i/j 0 1 2 3 4 5 6 7 8 9 10 11
0 5 3 7 6 1 2 -1 -1 -1 9 8 4
1 0 4 0 0 5 -1 -1 -1 0 6 0
2 1 0 2 0 9 0 -1 -1 7 3 5
3 1 0 -1 2 0 3 5 0 0 9 0
4 -1 -1 -1 9 0 8 6 1 7 2 4 3
5 -1 -1 -1 4 3 0 8 9 0 5 1 7
6 0 0 5 -1 -1 -1 4 2 8 0 7 0
7 2 0 0 -1 -1 -1 0 7 6 0 5 0
8 7 1 6 -1 -1 -1 9 3 5 0 2 8
9 4 2 3 5 0 0 0 6 1 -1 -1 -1
10 8 5 0 7 0 1 0 0 3 -1 -1 -1
11 0 7 0 2 4 0 0 8 9 -1 -1 -1

enter the idx of the number row u want to fill
1
enter the idx of the number column u want to fill in
0
enter the number u would like to fill
8
i/j 0 1 2 3 4 5 6 7 8 9 10 11
0 5 3 7 6 1 2 -1 -1 -1 9 8 4
1 8 0 4 0 0 5 -1 -1 -1 0 6 0
2 1 0 2 0 9 0 -1 -1 -1 7 3 5
3 -1 -1 -1 1 2 0 3 5 0 0 9 0
4 -1 -1 -1 9 0 8 6 1 7 2 4 3
5 -1 -1 -1 4 3 0 8 9 0 5 1 7
6 0 0 5 -1 -1 -1 4 2 8 0 7 0
7 2 0 0 -1 -1 -1 0 7 6 0 5 0
8 7 1 6 -1 -1 -1 9 3 5 0 2 8
9 4 2 3 5 0 0 0 6 1 -1 -1 -1
10 8 5 0 7 0 1 0 0 3 -1 -1 -1
11 0 7 0 2 4 0 0 8 9 -1 -1 -1

Enter 'q' if u want to quick the game directly
Enter 'c' if u want to continue fill other blan in this problem
Enter 'b' if u want to see the answer of the board and continue other problem
```

圖1.1 數獨填答遊戲 -- 介面圖

```

here comes the answer and time u solve this sudoku
i/j 0 1 2 3 4 5 6 7 8 9 10 11
0 5 3 7 6 1 2 -1 -1 -1 9 8 4
1 9 8 4 3 7 5 -1 -1 -1 1 6 2
2 1 6 2 8 9 4 -1 -1 -1 7 3 5
3 -1 -1 1 2 7 3 5 4 8 9 6
4 -1 -1 9 5 8 6 1 7 2 4 3
5 -1 -1 4 3 6 8 9 2 5 1 7
6 3 9 5 -1 -1 4 -1 8 6 0 7 1
7 2 4 8 -1 -1 -1 1 7 6 3 5 9
8 7 1 6 -1 -1 -1 9 3 5 4 2 8
9 4 2 3 5 8 9 7 6 1 -1 -1 -1
10 8 5 9 7 6 1 2 4 3 -1 -1 -1
11 6 7 1 2 4 3 5 8 9 -1 -1 -1

time u use = 6seconds
please enter ur name to see the scoreboard
love
the scoreboard
order Name passing_time
1 love 6
2 meow 83

```

圖1.2 數獨填答遊戲 -- 記分板

說明：遊戲結束後輸入姓名即可顯示該題解答並顯示遊戲排名，圖中使用者遊戲2次，第一次姓名輸入 meow 第二次為 love，如上圖顯示。

```

the problem is as below
i/j 0 1 2 3 4 5 6 7 8 9 10 11
0 4 2 6 8 7 3 9 5 1 -1 -1 -1
1 0 0 3 9 5 0 6 0 4 -1 -1 -1
2 9 0 1 6 2 4 8 0 0 -1 -1 -1
3 -1 -1 -1 1 3 2 0 8 7 9 5 6
4 -1 -1 -1 0 8 0 1 9 0 4 2 0
5 -1 -1 -1 4 9 6 2 3 0 8 7 1
6 0 0 0 4 0 -1 -1 -1 6 9 5
7 0 0 4 0 6 0 -1 -1 1 3 7
8 6 9 5 0 1 7 -1 -1 2 8 4
9 3 1 2 -1 -1 -1 7 4 0 5 0 9
10 7 4 8 -1 -1 -1 0 6 9 3 0 2
11 0 6 0 -1 -1 -1 3 1 0 7 0 8

meow meow
it's a single solution case.
the answer is....
i/j 0 1 2 3 4 5 6 7 8 9 10 11
0 4 2 6 8 7 3 9 5 1 -1 -1 -1
1 8 7 3 9 5 1 6 2 4 -1 -1 -1
2 9 5 1 6 2 4 8 7 3 -1 -1 -1
3 -1 -1 -1 1 3 2 4 8 7 9 5 6
4 -1 -1 -1 7 8 5 1 9 6 4 2 3
5 -1 -1 -1 4 9 6 2 3 0 8 7 1
6 1 3 7 2 4 8 -1 -1 -1 6 9 5
7 2 8 4 5 6 9 -1 -1 -1 1 3 7
8 6 9 5 3 1 7 -1 -1 -1 2 8 4
9 3 1 2 -1 -1 -1 7 4 8 5 6 9
10 7 4 8 -1 -1 -1 5 6 9 3 1 2
11 5 6 9 -1 -1 -1 3 1 2 7 4 8

it's really a solution of the sudoku
Elapsed time for solving the sudoku is 0 seconds

```

圖2. 單一解解題示意圖



```

the problem is as below
i/j 0 1 2 3 4 5 6 7 8 9 10 11
0 0 0 0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0 0 0 0
2 9 0 0 1 6 2 4 8 0 0 0
3 -1 -1 -1 1 3 2 0 8 7 9 5
4 -1 -1 -1 0 8 0 1 9 0 4 2
5 -1 1 -1 4 9 6 2 3 0 8 7
6 1 0 0 0 4 0 -1 -1 -1 6 9
7 0 0 4 0 6 0 -1 -1 -1 1 0
8 6 9 5 0 1 7 -1 -1 -1 2 0
9 0 1 2 0 -1 -1 7 4 0 5 0
10 0 0 0 8 -1 2 -1 -1 0 6 7
11 0 0 0 -1 -1 -1 3 1 0 7 0

meow meow
it's multiple solution case
the first answer is...
i/j 0 1 2 3 4 5 6 7 8 9 10 11
0 4 5 16 0 3 0 7 0 8 9 -2
1 8 2 0 3 9 4 5 0 1 6 -7
2 9 7 0 1 6 2 2 4 8 5 4
3 -1 -1 -1 4 1 8 3 2 -4 0 8
4 -1 -1 4 1 6 7 0 8 1 5 -1
5 -1 -1 1 1 4 9 6 2 3 5 8
6 1 8 7 2 4 3 1 -1 -1 6 9
7 2 3 0 4 1 5 2 6 3 9 -1
8 6 9 4 5 2 8 6 1 8 7 -1
9 3 1 8 2 -1 3 -1 9 -1 7
10 7 4 8 9 -1 -1 -1 5 6 9
11 5 6 9 -1 -1 -1 3 1 2 7

and the second solution is
i/j 0 1 2 3 4 5 6 7 8 9 10 11
0 4 2 6 6 9 3 2 7 3 8 9
1 8 7 0 3 1 9 8 5 1 6 2
2 9 5 1 1 6 6 9 2 4 8 7
3 -1 -1 1 1 1 1 1 1 1 1 1
4 -1 -1 -1 1 1 1 1 1 1 1 1
5 -1 -1 -1 4 9 6 2 3 5 8 7
6 1 8 7 2 4 3 1 -1 -1 6 9
7 2 3 0 4 1 5 2 6 3 9 -1
8 6 9 4 5 2 8 6 1 8 7 -1
9 3 1 8 2 -1 3 -1 9 -1 7
10 7 4 8 9 -1 -1 -1 5 6 9
11 5 6 9 -1 -1 -1 3 1 2 7

it's really a solution of the sudoku
Elapsed time for solving the sudoku is 0.016 seconds

```

圖3. 多解判斷與求其解

## 6 感想與心得

這個 proj\_2 比起 proj\_1 做來煞費苦心，尤其是在解 sudoku 與產生唯一解題目這部分，因為 sudoku 的型態不同，不僅演算法的部分需要自己思考，在實現方面又需要用到許多 programing skill，算是這學期程式課集大成了（除了多型跟 exception handling 大概上課教的 c++ 語法都使用過了）。一學期就這樣不小心結束了，從完全不會打 code 花三個月能學到這樣，我自己都覺得自己很猛了，總之，謝謝助教跟教授上課的教導，end。