Puzzle Solver Assignment 1806ICT

Note to marker

When you test data you will need to be aware of how my solution reads in data and where it is done in my solution. The following code is used to read in test#.txt test data, fopen("../test26.txt", "r"), found in getSize() function on line 144 and also in fillArray() function on line 165 of my codesolution. Below is the code from within getSize() function as an example. Please adjust accordingly to read in your data.

In getSize() function:

```
FILE * pointer;
int size;

// file reads here. Change according to your data name and location.
pointer = fopen("../test1.txt", "r");
```

1. Data

Variables

Int size

Size is taken as the first data from the test.txt file. Size will be used as a parameter for size for all arrays and array operations.

Int solved

Solved is used in several functions but all for the same purpose. You will find it in main(), solveArray() function and specialCase() function. In each case solved is used a variable to the status of the puzzle. 1 means puzzle is solved program can print solution and finish, 2 means puzzle was not solved by simple solution and now puzzle will be sent to specialCase() and any other number means not solved.

Int myArray[size][size]

myArray will take initial puzzle data from test.txt file using fscanf() within a nested loops. Pointer to myArray is passed to solveArray() function to be solved. Again it will be passed to specialCase() if puzzle turns out to be more difficult. When and if myArray is passed to specialCase() it will be passed updated to the point the solveArray() could achieve. The rest of the work to solve will be done in specialCase().

Int copyArray[size][size]

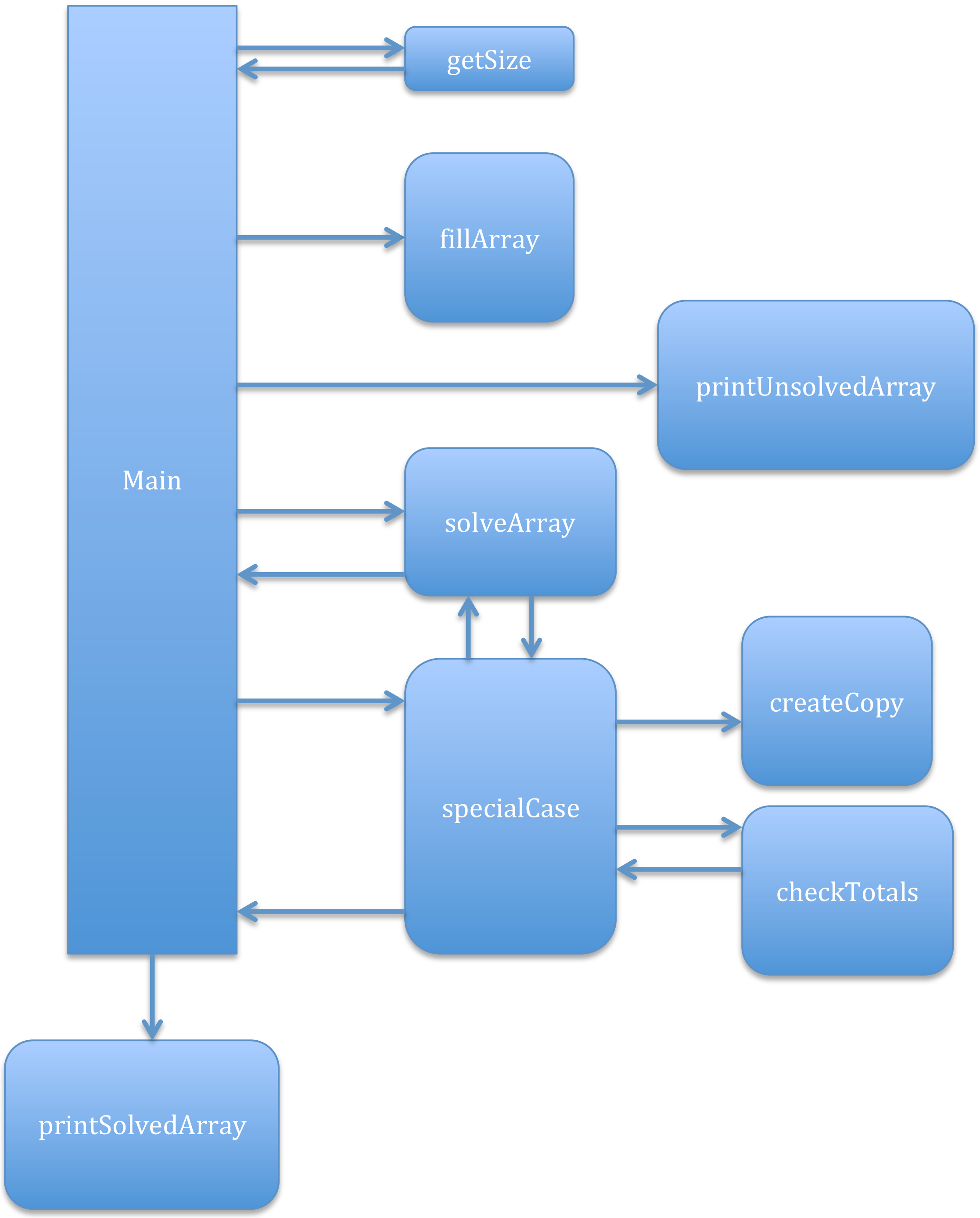
Initially memory is allocated for copyArray using malloc() along with myArray but it is only used if solveArray() cannot solve the puzzle. In specialCase() copyArray is sent to createCopy() function to copy myArray (in its current, partly solved state) into copyArray. Then copyArray is used to test values along with solveArray() function to solve the puzzle. If a solution is found it is then put into myArray and myArray is sent to solveArray() again to solved.

Int rowTotal[size]
A 1D array that stores row totals obtained from test.txt file from within fillArray() function.

Int colTotal[size]
A 1D array that store column totals obtained from test.txt file from within fillArray() function.

2. Functions

Flow Chart



Descriptions of functions

(1)
Int getSize()
Returns size, read as the first data from test.txt with **fscanf()**. Size will be used as a parameter for size for all arrays and array operations throughout the complete program.

(2)
void fillArray(int **array, int *rowTotal, int *colTotal, int count)
fillArray takes as parameters pointers to myArray, rowTotal and colTotal and also int size. The first data point in test.txt file is skipped by assigning it to the variable x. Then nested loops, with int size as limit, are use to fill myArray. Once size is reach, size+1 fills rowTotal and size+2 fills column totals. All data are obtained from test.txt using fopen() and fscanf().

(3)
void printUnsolvedArray(int **array, int *rowTotal, int *colTotal, int size)
Once myArray, rowTotal, colTotal are filled with data printUnsolvedArray() takes pointers to the 3 arrays mentioned ass parameters along with int size to print to console. The function uses nested loops and printf() to print unsolved array then row totals and then column totals.

(4)
int solveArray(int **myArray, int *rowTotal, int *colTotal, int size)
This function takes as parameters pointers to myArray, rowTotal and colTotal and also int size. This is where the simple algorithm is used to solve the puzzle. 13 out of the 15 examples given from blackboard and from our assignment specs are solved here. The algorithm is explained below. If myArray is solved function returns 1 and main() moves onto printSolvedArray(). If myArray is not solved in solveFunction() after 20 loops of trying my solveArray() will return 2 and my program will send myArray to specialCase() to attempt to solve from there.

(5)
int specialCase(int **myArray, int **copyArray, int *rowTotal, int *colTotal, int size); If puzzle is not solved in solveArray() mayArray will be sent here. This function takes as parameters pointers to myArray, copyArry, rowTotals and colTotal and also int size. Firstly important variables are created and set to 0, solved, check1 and check2. All of these variables need to equal 1 for the puzzle to be solved. myArray comes here partly solved from solveArray(). A copy of myArray's current state is put into copyArray through the function call of createCopy() described below. A loop tests a value between 0 and 9 in copyArray at the first location of a -1. With each guess check1 and check2 need to equal 1 for the puzzle to be solved. copyArray is sent with the guess value back to solveArray() to see if it solves. If it solved 1 is returned and stored in check1. Check2 will only be true if checkTotals() returns 1. CheckTotals() takes copyArray which has just been "solved" in solveArray() and uses nested loops to check if totals match up. If totals match up check2 receives a 1 and program moves onto next step. If totals don't match copyArray is refilled with myArray in

its unsolved state to test a new value until a solution is found. Once solution is found the correct value is put into myArray and sent to solveArray() to be solved with the simple algorithm described below in the algorithm section.

(6)
void createCopy(int **myArray, int **copyArray, int size)
Takes pointers to myArray and copyArray along with int size to generate copies of myArray when needed. This function is used in specialCase() function only in the case where myArray is not solved in solveArray() function. How it is used is described more in the description for specialCase() function above. Copying is done with nested loops.

(7)
int checkTotals(int **copyArray, int *rowTotal, int *colTotal, int size)
Checks row and column totals, returns 1 if true.
CheckTotals() takes copyArray which has just been solved in solveArray() and uses nested loops to check if totals match up. How it is used is described in specialCase() description above.

(8)
void printSolvedArray(int **array, int size)
This function takes myArray a soon as it is solved and size to prints to console using nested loops.

Algorithm

The simple algorithm is to look through a row and if only one -1 is found sum the values in the row and replace the -1 with the difference of the row sum and the row total and loops through all rows doing this then through all columns using column totals. Continue going from rows to columns like this until solved. In some cases the simple algorithm could not solve such as when a row and a column are left with two -1's in each. After 20 tries unsolved my special case algorithm will start. My special case solution algorithm is as follows. Use a copy array to test guess values in one of the -1's and test if arrays solves and also if row and column totals are correct. Repeat until correct guess value is found. Once correct guess value is found use it in the real array and solve using the simple algorithm.

Testing

I copied the 15 examples provided into test#.txt files and also all the examples in the assignment document plus a few more I created. In total I tested 28 sets of data. My data files are saved as test1.txt, test2.txt, test3.txt ………… test28.txt. I found 2 of the given example data not to be solved with the simple algorithm, test11.txt and test16.txt shown below. I also generated another like this myself, test25.txt. The three I just mentioned were solved in the special case algorithm. All test data I used are provided in the appendix. Luke said to me that the test data will be no more difficult than the examples given so I am confident all given data sets can be solved by my solution.

I spent a lot of time debugging my solution as it grew to include functions and solve for the special case. I tested for trying to read from a file that doesn't exist and also when data is not integers or the wrong integer (test26.txt and test27.txt). In Both cases a message is printed to console and the program is stopped. Also if test data puzzle is to difficult for my solution a massage will be displayed and program will stop running. Such is the case for test28.txt.

Where to find tests within solution

Line 65 in main() tests if array size is incorrect value.
Line 147 in getSize() tests if data was loaded.
Line 188 in fillArray() tests if array element read from the data is invalid.
Line 383 in solveArray() tests if myArray cannot be solved by simple algorithm.
Line 442 in specialCase() tests if array is unsolvable by my complete algorithm.

Appendix 1.

Test Data

```
Test1
3
3 9 5
8 1 -1
-1 -1 3
17 9 11
11 18 8

test2
3
3 -1 -1
1 2 2
6 -1 5
16 5 13
10 11 13

test3
3
5 -1 -1
-1 7 -1
8 -1 0
14 19 11
22 15 7

test4
```

4
1 1 -1 9
-1 7 2 2
3 -1 1 2
6 8 5 -1
19 12 6 27
11 16 16 21
test5
4
-1 -1 7 2
3 1 9 2
-1 2 4 -1
-1 7 6 7
21 15 16 22
13 15 26 20

test6
4
-1 7 3 5
-1 -1 -1 -1
6 0 9 5
3 -1 4 9
23 20 20 16
24 15 16 24

test7
5
5 9 2 -1 -1
-1 -1 2 9 0
8 3 3 -1 6
6 1 3 0 -1
3 4 0 -1 5
26 21 23 14 21
25 24 10 27 19

test8
5
1 3 5 -1 -1
5 3 -1 -1 9
5 2 1 7 -1
0 -1 0 0 8
-1 5 2 2 -1
21 27 19 10 23
17 15 9 25 34

test9
6
1 -1 1 -1 -1 5
-1 1 2 6 4 5
6 3 3 3 0 5

```
1 5 8 2 -1 -1
9 6 9 2 1 3
-1 4 0 1 4 9
24 25 20 26 30 25
31 23 23 21 23 29

test10
6
9 6 6 -1 1 8
1 4 8 -1 8 -1
-1 0 3 9 6 9
-1 -1 1 8 3 -1
6 8 -1 1 -1 9
8 9 7 2 -1 -1
35 32 27 19 41 35
27 27 33 31 32 39

test11
6
-1 0 0 6 0 -1
-1 7 6 -1 8 -1
5 9 6 -1 -1 2
1 -1 -1 -1 7 8
-1 6 1 9 3 3
2 7 3 1 3 -1
10 32 29 31 27 18
14 33 24 23 27 26

test12
3 7 3 5 4 0 2 -1
0 7 2 5 1 8 -1 4
5 -1 3 0 9 5 5 6
8 4 1 0 6 6 9 -1
9 5 -1 6 -1 -1 3 -1
8 -1 0 0 2 4 -1 8
-1 4 3 5 6 6 3 2
3 1 8 0 1 -1 -1 2
25 28 38 35 41 31 31 30
38 35 21 21 37 38 37 32

test13
8
1 -1 4 5 0 7 6 -1
1 8 2 4 -1 5 6 -1
0 6 2 4 6 1 6 -1
8 9 1 9 3 4 -1 0
1 -1 -1 -1 0 -1 -1 3
-1 8 2 2 6 8 1 4
4 0 5 4 8 7 6 -1
-1 4 0 2 6 6 4 -1
```

```
27 33 26 36 18 37 41 38
30 44 20 30 29 39 33 31
```

```
test14
8
8 5 6 3 4 6 -1 2
1 7 1 5 8 4 -1 6
6 1 -1 1 6 7 -1 9
-1 -1 4 4 5 -1 4 -1
6 -1 4 3 5 7 0 4
1 4 2 3 6 1 -1 -1
2 0 5 -1 -1 -1 0 7
8 4 0 2 9 -1 8 5
34 39 39 28 38 32 35 44
34 32 29 25 52 43 29 45
```

```
test15
10
9 -1 4 1 3 -1 0 0 9 7
8 3 6 8 7 -1 5 2 6 -1
4 7 6 7 0 1 6 9 8 -1
2 3 4 7 -1 5 0 4 9 2
-1 2 1 -1 8 2 1 1 -1 3
-1 6 4 9 -1 7 -1 0 6 8
2 3 -1 1 -1 -1 0 4 9 1
9 8 3 2 4 1 6 3 5 7
5 5 8 4 0 7 3 7 -1 9
1 3 6 5 2 3 5 -1 0 2
42 56 54 42 27 61 32 48 50 32
53 47 42 44 42 45 33 35 55 48
```

```
test16
4
-1 -1 -1 1
9 0 -1 -1
1 3 -1 -1
0 8 6 -1
7 10 14 19
10 12 18 10
```

```
test17
5
-1 7 -1 5 -1
7 -1 5 -1 2
2 2 4 -1 6
-1 -1 7 5 4
5 4 4 4 -1
20 20 20 19 18
17 15 25 25 15
```

```
test18
3
2 4 -1
1 -1 1
-1 8 -1
8 9 16
8 9 16

test19
4
0 0 -1 4
2 9 4 -1
-1 8 3 -1
0 -1 0 0
11 24 19 9
2 26 14 21

test20
4
-1 -1 -1 1
9 0 -1 -1
1 3 -1 -1
0 8 6 -1
7 10 14 19
10 12 18 10

test21
5
-1 -1 0 -1 7
0 4 5 -1 4
7 1 -1 9 8
0 5 0 -1 -1
3 -1 -1 1 8
15 15 29 22 23
15 14 17 22 36

test22
-1 6 9 -1 8
6 2 -1 -1 0
2 6 -1 9 0
4 -1 -1 2 -1
1 -1 9 4 7
27 16 26 15 26
15 21 38 19 17

test23
6
5 -1 -1 2 6 -1
-1 5 4 9 6 0
2 2 1 -1 2 4
```

```
-1 5 8 -1 2 9
-1 6 -1 3 6 6
6 2 6 -1 -1 4
31 24 11 35 30 27
28 23 28 18 30 31

test24
6
-1 5 -1 -1 -1 9
1 2 0 9 -1 1
-1 6 9 0 7 8
8 9 3 8 -1 2
7 -1 6 -1 1 -1
7 -1 2 5 5 4
41 18 30 34 30 25
28 29 29 33 28 31

test25
6
0 0 0 -1 0 -1
-1 7 6 -1 8 -1
5 9 6 -1 -1 2
1 -1 -1 -1 7 8
-1 6 1 9 3 3
2 7 3 1 3 -1
10 32 29 31 27 18
14 33 24 23 27 26

test26
3
hello
how
are
you
doing

test27
11
3 9 5
8 1 -1
-1 -1 3
17 9 11
11 18 8

test28
6
-1 0 0 -1 0 -1
-1 7 -1 -1 8 -1
5 -1 6 -1 -1 2
1 -1 -1 -1 7 8
```

```
-1 6 1 -1 3 3
2 7 -1 1 3 -1
10 32 29 31 27 18
14 33 24 23 27 26
```