**********Project 1**********

Title

Sudoku

Course

CSC-17A

Section

46097

Due Date

July 17, 2019

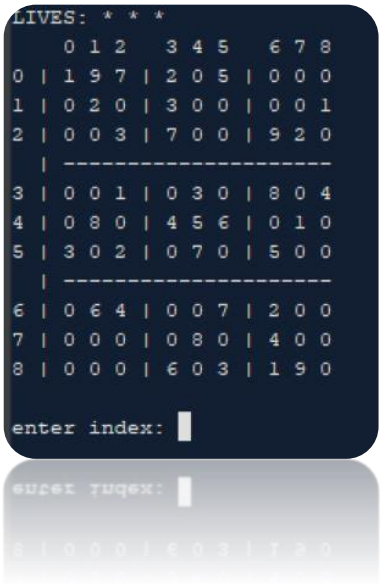
Author

**********Tyler Stevens**********

Table of Contents

Introduction

Project 1 Sudoku explores the classic game of Sudoku written entirely in C++. Imitating the whole Sudoku board with numbers 0 through 9 and symbols from the keyboard to draw the familiar table. Solving Sudoku puzzles can be a significant challenge, the rules for traditional solution finding are quite straight forward. Each row, column, and nonet can contain each number, 1 through 9 and zeros represent blank spaces, exactly once.



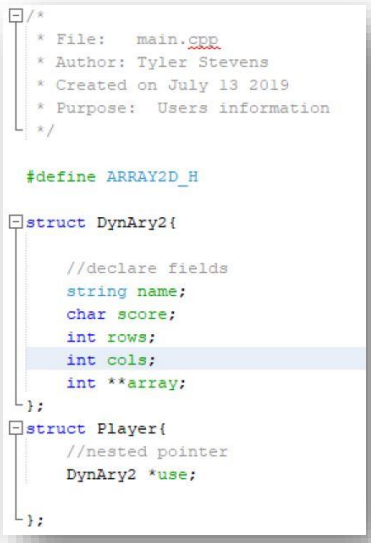
The sum of all numbers in any nonet, row, or column must match the small number printed in its corner. For traditional Sudoku puzzles featuring the numbers 1 to 9, this sum is equal to 45. This project is important because it demonstrates how useful and versatile the C++ language is. The tools and concepts required for building this game will stay with me a throughout my software engineering career.

Summary

This game was coded entirely in C++ and uses various techniques learned in class to simulate the game of Sudoku. From utilizing pointers, structures, and advanced file operations, they all come together to run the game. The meat of the program is found in the *main.cpp* file and contains 370 lines of code. There is one user library I created in a header file named *Array2D.h*

Which contains the two structures needed for the program and is comprised of 25 lines of code. Inside the file you will two structures named *DynAry2* and *player* which contains a nested

DynAry2 object. There are many text files used in the program that are written to and read from. These files include all three Sudoku tables of difficulty, the game rules and a list of past players with the score they received from playing.



```
/*
 * File:   main.cpp
 * Author: Tyler Stevens
 * Created on July 13 2019
 * Purpose:  Users information
 */

#define ARRAY2D_H

struct DynAry2{

    //declare fields
    string name;
    char score;
    int rows;
    int cols;
    int **array;
};
struct Player{
    //nested pointer
    DynAry2 *use;

};
```

There are roughly thirty-two variables used in the and eight functions used in the project. All in all, this project was not extremely challenging, but still hard and took many hours to complete. The idea itself is very simple, just create a 2d array puzzle and have the user enter an index and input value then validate that input. No that wasn't hard the hard part was implementing all ideas from the project check list. I am sure there are many instances of "you didn't have to do that", but it was done to demonstrate my understanding of the constructs we have learned in the course. For instance, I write the score to the file in binary for really no reason other than to show I can. Overall the hardest part of the project was demonstrating my pointer prowess and being able to make pointer to pointer to structure of pointer etc. Finally, I don't know exactly how many hours I spent on written the code, but every time I sat down and worked, I had a cup of coffee and 3 hours blocked out for solely programming. In fact, that is what I am doing as I finish this write up.

Description

The program opens to the rules of the game loaded from a text file named *instructions.txt*. The user is prompted to the choose difficulty (easy, medium, and hard) and to enter their name. From

there the board will be loaded based on input and the game begins inside a while loop. The user inputs row followed by a space, the column followed by a space, and what number they want to input. The input is sent to a function that determines whether it meets the rules of Sudoku. There are three lives in total and each time the player inputs an invalid number they lose a life. The program will exit the game play loop when either the player loses all three lives or successfully completes the board. After which the users name and score, based on life counter, will be sent to a text file named *scores.txt* and displayed on screen.

Pseudocode

Enter main function

Display rules

Declare Variables and Initialize

- chances for uses to try a value
- rows
- pointer to a pointer array for sudoku matrix
- fills structure from pointer array
- the score the user starts off with
- Two variable play state that determines loop execution
- users name

Input to variable name from user

print lives with cout statement

Print the board by calling function prnStrc(array2D);

Enter game loop meat

while(if game state one is true continue to execute) {

Pass array to test function and set it to game state one

- If game state one returns true, print out *true*
- If game state one returns *false*, print call and subtract user score by one

Pass array to win or lose function and set it to game state two

- If game state two is *false,* player wins the game and loop is terminated
- If game state two is *true*, player while loop continues

Use System clear screen to clear the screen and display updated lives and Sudoku Board.

}

End of while loop

Print out Game-over message

Determine Score

- If strikes are equal to two score is a *B*
- If strikes are equal to one score is a *C*
- If strikes are equal to zero score is a *F*

- Otherwise default initialization score of an *A* is recorded

Call function *add2File* and pass the name and score.

Call function *file* and pass *"Scores"* as a string to display past players name and score

Call function *destroy* to deallocated dynamically created memory from arrays

Exit main function

Enter **fill2D(row size, column size) function

//**

//Definition of function **fill2D. This function dynamically creates *

//a 2d pointer array and fill it with contents of a file. *

//It is filled with either a easy, medium, or hard Sudoku board. *

//**

Declare variables

- Dynamically allocated to pointer to pointer array with row size nine
- File object
- Choice if difficulty
- An enum object with values easy, medium, and hard

Determine difficulty from user input

- Display that 1 = easy, 2 = medium, and 3 = hard
- User inputs choice
- Use a switch statement with enum cases to open corresponding files
- Default case is enum hard and will load the hardest Sudoku board

Verify if file could be opened

- If file could not open display error message and exit function.

Create and fill the second dimension of the pointer to pointer dynamic array with column size 9

Fill array from file chosen by user

- Loop through index of 2D array and file is from file object
- If data cannot be put into index from file display error message and where it accorded in 2D array. Also, exit function because there is no need to continue

Return filled array to function call

Enter *filStrc(2D pointer array, row of 9, column of 9)

//**

//Definition of function *filStrc. This function creates a dynamically allocated *

//pointer objects to store Sudoku boards from a 2d pointer array. As well ` *

//as the size of the rows and columns or the board. *

//**

Dynamically allocate array

Point object to row variable in structure and set it equal to 9

Point object to column variable in structure and set it equal to 9

Fill Structures array variable with 2D array

Return structure array

***Enter* prnStrc(Dynaimic 2D structure array)**

//**

//Definition of function prnStrc. This function prints contents from a *

//structure and formats it to prints out board like sudoku game *

//**

Display column index

- Print out a zero
- Use for loop print out column index
- If index is equal to 2, 5 or 8 print a space

Display board

- Use for loop to loop three 2D array and print contents
- For the horizontal line if row index is equal to 3,6 or 9 print a line of characters
- For vertical line if column index is equal to 3, 6 or 9 print out vertical line with character "|"
- If column index is zero display row index

Exit void function

Enter function destroy(Dynamic 2Dpointer structure array)

//**

//Definition of function destroy. This function deallocates *

//memory created from dynamically allocated arrays. *

//**

Deallocate memory

- Use a for loop to loop through index and delete each
- If index reaches the size or the rows exit for loop
- Delete object array and just object

Exit void function

Enter bool test2(Dynamic 2Dpointer structure array)

//**

//Definition of function test2. This function verifies if the user *

//index input and number play by the rules of Sudoku. Which are *

//there can be no repeats of number through the row, column, or in the 3x3 *

//boxes. *

//**

Declare variables

- Rows
- Columns
- Users input for use on board
- Starts for loop at the beginning of 3x3 table for the row index
- Starts for loop at the beginning of 3x3 table for column index

Input variable row, column and choice

To find the right index for row beginning in 3x3 box, use row index minus row index modulus 3

To find the right index for column beginning in 3x3 box, use column index minus column index modulus 3

Check if cell is empty

- If array at row and column that does not equal to zero return *false*

Check for repeats in column

- Use for loop to loop through array only change the column index
- If match is found return false otherwise continue through loop until column index is equal to 9

Check for repeats in row

- Use for loop to loop through array only change the row index
- If match is found return false otherwise continue through loop until row index is equal to 9

Check for repeats inside 3x3 box

- Nested for loop starting at 0 for three increments for each
- If match is found from comparing the array with input return *false*

If rules are met set value at user input for row and column equal to users input

Return *true*

Enter function add2File(name, score)

//**

//Definition of *addFile. This function receives the name of the user and their *

//overall score. A nested dynamic structure pointer object is created to store *

//these values into a file. *

//**

Declare variables

- Dynamically allocated *Player* object
- File Object
- nested structure for enter username and score from dynamically allocated *Player* object

Input name and score to nested structure

- user->use->score=s;
- user->use->name=n;

O**pen file with in, append and binary modes and verify if it was a success**

- If file was not opened print error message and exit function

Write name to file

Write score in binary to file

Exit void function

Enter file(name of file)

//**

//Definition of function prnScore. This function copies data from file *

//into a char array. After that the contents of the array are displays *

//**

Declare Variables

- Array size set to one thousand
- Character array with size one thousand
- Size of file set to zero
- Index set to zero

Open file with string sent to function plus the .txt extension

- If file is successfully opened get data from file and put it inside array while it doesn't encounter an end of file marker
- Increment index and size every while loop success

Display output

- Set counter equal to zero and loop through as long as the counter is less than the size of the file
- Increment counter every success of outputting place in array

Enter winOrLose(Dynamic 2Dpointer structure array)

//**

//Definition of function winOrLose. Determine if player *

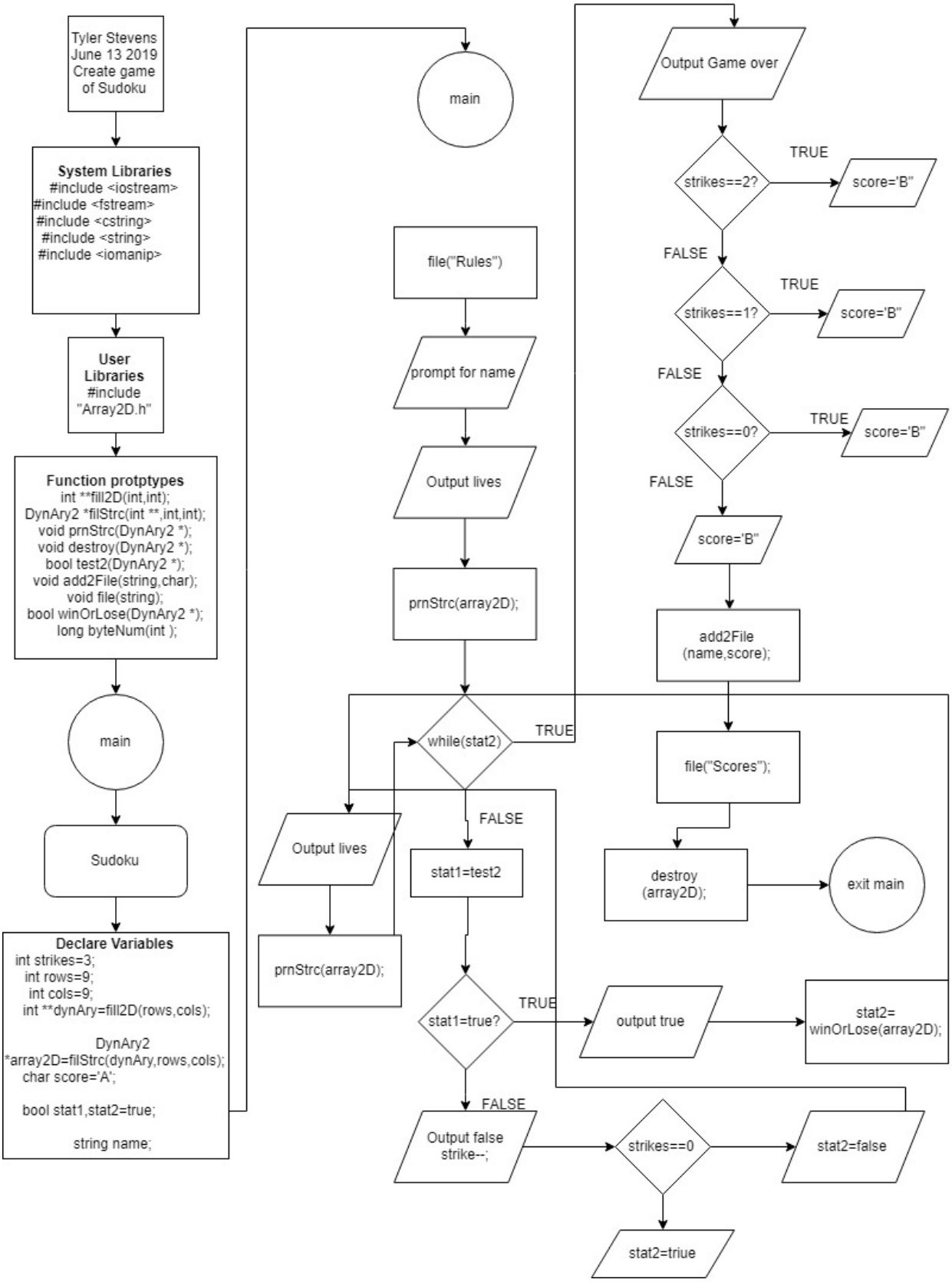
//has filled in board with at least one life *

//**

Scan for blank spaces

- Nested for loop that increment through rows and columns
- If array does not have any blank spaces return *true* meaning the player completed the board
- Otherwise return false

Flowchart


Tyler Stevens
June 13 2019
Create game
of Sudoku
System Libraries
#include <iostream>
#include <fstream>
#include <cstring>
#include <string>
#include <iomanip>
User
Libraries
#include
"Array2D.h"
Function protptypes
int **fill2D(int,int);
DynAry2 *filStrc(int **,int,int);
void prnStrc(DynAry2 *);
void destroy(DynAry2 *);
bool test2(DynAry2 *);
void add2File(string,char);
void file(string);
bool winOrLose(DynAry2 *);
long byteNum(int);
main
Sudoku
Declare Variables
int strikes=3;
int rows=9;
int cols=9;
int **dynAry=fill2D(rows,cols);
DynAry2
*array2D=filStrc(dynAry,rows,cols);
char score='A';
bool stat1,stat2=true;
string name;
main
file("Rules")
prompt for name
Output lives
prnStrc(array2D);
while(stat2)
TRUE
FALSE
Output lives
prnStrc(array2D);
stat1=test2
stat1=true?
TRUE
output true
stat2=
winOrLose(array2D);
FALSE
Output false
strike--;
strikes==0
stat2=false
stat2=triue
Output Game over
strikes==2?
TRUE
score='B"
FALSE
strikes==1?
TRUE
score='B"
FALSE
strikes==0?
TRUE
score='B"
FALSE
score='B"
add2File
(name,score);
file("Scores");
destroy
(array2D);
exit main

Variables

Main
int strikes=3; //chances for uses to try a value
int rows=9; //rows
int **dynAry=fill2D(rows,cols); //pointer to a pointer array for sudoku matrix
DynAry2 *array2D=filStrc(dynAry,rows,cols);//fills structure from pointer array array
char score='A'; //the score the user starts off with
bool stat1,stat2=true; //play state
string name; //users name

fill2D
int **a=new int*[row]; //sudoku array
ifstream dataFile; //file object
int choice; //for choosing difficulty
enum funTime {zero,easy,medium,hard}; //difficulties
a[i]=new int[col]; //dynamic array

fillStrc
DynAry2 *d2=new DynAry2; //dynamic memory allocation

Test2
int x, //rows
y, //columns
z, //users input for board
bx, //starts for loop at beginning of 3x3 matrix row

by;	//starts for loop at beginning of 3x3 matrix column

add2File	
Player *user=new Player;	//create object from struc
ofstream inFile;	//file object
user->use=new DynAry2; name and score	//nested struc for enter user

file	
int arraysize = 1000;	//array size
char myArray[arraysize];	//character array with size 1000
int size = 0;	//initial file size
int i = 0;	//initial index

Concepts

CSC/CIS 17A Project 1 Check-Off Sheet

Chapter	Section	Concept	Points for Inclusion	Location in Code	Comments
9		**Pointers/Memory Allocation**			
	1	Memory Addresses			
	2	Pointer Variables	5	44, 45, 125, 180, 302	also in struc 17 & 21
	3	Arrays/Pointers	5	44, 45, 125, 157	also in 17
	4	Pointer Arithmetic			
	5	Pointer Initialization			
	6	Comparing			
	7	Function Parameters	5	25 to 29 and 32	seen in prototypes
	8	Memory Allocation	5	125, 157, 180, 302, 304	all with new
	9	Return Parameters	5	170, 188	all returns with pointers
	10	Smart Pointers			
10		**Char Arrays and Strings**			
	1	Testing			
	2	Case Conversion			
	3	C-Strings	10	339	for file
	4	Library Functions			
	5	Conversion			
	6	Your own functions			
	7	Strings	10	48 and 14 in struc	used to store a name
11		**Structured Data**			
	1	Abstract Data Types			
	2	Data			
	3	Access			
	4	Initialize			
	5	Arrays	5	45	data type from struc
	6	Nested	5	305	
	7	Function Arguments	5	27 to 29 and 32	prototypes
	8	Function Return	5	170, 188	
	9	Pointers	5	struc 17 and 21	
	10	Unions ****			
	11	Enumeration	5	128	
12		**Binary Files**			
	1	File Operations			
	2	Formatting	2	320, 321	
	3	Function Parameters	2	106	
	4	Error Testing			
	5	Member Functions	2	311, 321,324,347,348	
	6	Multiple Files	2	32,109,137, 140,143,311	
	7	Binary Files	5	311, 321	
	8	Records with Structures	5	307,308	
	9	Random Access Files	5	306	
	10	Input/Output Simultaneous	2	299,335	
		Total	100		

References

Starting out with C++ from control structures through objects. 8th edition, Tony Gaddis

Dr. Mark Lehr
https://github.com/ml1150258/2019_Summer_CSC_CIS_17A/blob/master/Class/Array_of_Structure/main.cpp

Program

https://github.com/TS2535824/StevensTyler_CSC-17A_46097/tree/master/Projects/Sudoku