

Sudoku Solver

1.00

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Chapter 1

sudoku-solver

Sudoku game and algorithmic solver made in C.

Chapter 2

Data Structure Index

2.1 Data Structures

Here are the data structures with brief descriptions:

Puzzle	
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translation	
Key-value (dictionary) pair to store display strings	8

Chapter 3

File Index

3.1 File List

Here is a list of all documented files with brief descriptions:

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Chapter 4

Data Structure Documentation

4.1 Puzzle Struct Reference

Structure to store data of a single Sudoku puzzle.

```
#include <puzzle.h>
```

Data Fields

- int **grid** [GRID_SIZE][GRID_SIZE]
The unmodified version of the puzzle.
- int **userGrid** [GRID_SIZE][GRID_SIZE]
The user modified version of the grid.
- int **map** [GRID_SIZE][GRID_SIZE]
Bitmap used to determine which squares are modifiable by user.

4.1.1 Detailed Description

Structure to store data of a single Sudoku puzzle.

The grid is always fixed, except for when generating a new sudoku

4.1.2 Field Documentation

4.1.2.1 map

```
int map[ GRID_SIZE][ GRID_SIZE]
```

Bitmap used to determine which squares are modifiable by user.

Note

If 1 == unmodifiable

The documentation for this struct was generated from the following file:

- /home/zakajus/Documents/Code/sudoku-solver/ **puzzle.h**

4.2 translation Struct Reference

Key-value (dictionary) pair to store display strings.

```
#include <ui.h>
```

Data Fields

- char * **key**
*Key to be converted by **translate()** (p. 34)*
- char **value** [**LINE_MAX**]
Value to be output to display.

4.2.1 Detailed Description

Key-value (dictionary) pair to store display strings.

The documentation for this struct was generated from the following file:

- /home/zakajus/Documents/Code/sudoku-solver/ **ui.h**

Chapter 5

File Documentation

5.1 /home/zakajus/Documents/Code/sudoku-solver/dependencies.h File Reference

Includes standard library dependencies, defines macros.

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <stdbool.h>
#include <time.h>
```

Macros

- **#define BIN_SAVE_FILENAME** "save.bin"
Binary save file name.
- **#define LOG_FILENAME** "log.txt"
Log text file name.
- **#define GRID_SIZE** 9
Grid size of Sudoku puzzle (9x9 is standard)
- **#define SUBGRID_SIZE** 3
Subgrids the Sudoku grid is divided into.
- **#define LINE_MAX** 80
Maximum length of displayed strings.
- **#define BUFFER_SIZE** 128
Buffer size for user input.
- **#define ANSI_COLOR_MAGENTA** "\x1b[35m"
ASCII break code to make text magenta.
- **#define ANSI_COLOR_GREEN** "\x1b[32m"
ASCII break code to make text green.
- **#define ANSI_COLOR_RED** "\x1b[31m"
ASCII break code to make text red.
- **#define ANSI_COLOR_RESET** "\x1b[0m"
ASCII break code to reset text color.

5.1.1 Detailed Description

Includes standard library dependencies, defines macros.

Author

Kajus Zakaras (`kajus.z@tuta.io`)

Version

1.00

Date

2024-01-25

Copyright

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5.2 `/home/zakajus/Documents/Code/sudoku-solver/dependencies.h`

Go to the documentation of this file.

```
00001
00011 #ifndef DEPENDENCIES_H
00012 #define DEPENDENCIES_H
00013
00014 #include <stdio.h>
00015 #include <stdlib.h>
00016 #include <string.h>
00017 #include <stdbool.h>
00018 #include <time.h>
00019
00020
00022 #define BIN_SAVE_FILENAME "save.bin"
00024 #define LOG_FILENAME "log.txt"
00025
00026
00028 #define GRID_SIZE 9
00030 #define SUBGRID_SIZE 3
00032 #define LINE_MAX 80
00034 #define BUFFER_SIZE 128
00035
00036
00038 #define ANSI_COLOR_MAGENTA "\x1b[35m"
00040 #define ANSI_COLOR_GREEN "\x1b[32m"
00042 #define ANSI_COLOR_RED "\x1b[31m"
00044 #define ANSI_COLOR_RESET "\x1b[0m"
00045
00046 #endif
```

5.3 `/home/zakajus/Documents/Code/sudoku-solver/files.c` File Reference

Runtime and launch logging, saving / loading binary save data.

```
#include "../dependencies.h"
#include "../puzzle.h"
#include "../ui.h"
```


Functions

- long double **findCurrentRuntime** ()
Finds the CPU runtime of the current launch.
- void **logRuntime** ()
Calculates and appends CPU runtime during this launch to log file.
- void **logLaunch** ()
Appends launch date and time to log file.
- long double **readTotalRuntime** ()
Calculates total CPU runtime from log and the current launch.
- int **readLaunchCount** ()
Reads total launch count from log file.
- void **saveDataToFile** (**Puzzle** *puzzleArray, int puzzleCount)
Saves puzzle array and size to .bin file.
- void **loadDataFromFile** (**PuzzleArray** *puzzleArray, int *puzzleCount)
Loads puzzle array and size from .bin file, allocates memory.
- void **initDataIfNoBinary** (**Puzzle** *puzzleArray, int puzzleCount)
Initializes dynamic puzzle array if there is no .bin save file.

Variables

- clock_t **startTime**
Global variable to track CPU runtime.

5.3.1 Detailed Description

Runtime and launch logging, saving / loading binary save data.

Header file for **files.h** (p. 13).

Author

Kajus Zakaras (`kajus.z@tuta.io`)

Version

1.00

Date

2024-01-25

Copyright

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5.3.2 Function Documentation

5.3.2.1 findCurrentRuntime()

```
long double findCurrentRuntime ( )
```

Finds the CPU runtime of the current launch.

Returns

Runtime in seconds

5.3.2.2 initDataIfNoBinary()

```
void initDataIfNoBinary (
    Puzzle * puzzleArray,
    int puzzleCount )
```

Initializes dynamic puzzle array if there is no .bin save file.

Parameters

<i>puzzleArray</i>	Array of default puzzles to initialize
<i>puzzleCount</i>	Array size

Change binary file name using **BIN_SAVE_FILENAME** (p. 9) macro.

5.3.2.3 loadDataFromFile()

```
void loadDataFromFile (
    PuzzleArray * puzzleArray,
    int * puzzleCount )
```

Loads puzzle array and size from .bin file, allocates memory.

Parameters

<i>puzzleArray</i>	Array to load to
<i>puzzleCount</i>	Where to save array size

Change binary file name using **BIN_SAVE_FILENAME** (p. 9) macro. Loads array size before array.

5.3.2.4 readLaunchCount()

```
int readLaunchCount ( )
```

Reads total launch count from log file.

Returns

Count of total launches by program

5.3.2.5 readTotalRuntime()

```
long double readTotalRuntime ( )
```

Calculates total CPU runtime from log and the current launch.

Returns

Total CPU runtime in seconds

5.3.2.6 saveDataToFile()

```
void saveDataToFile (
    Puzzle * puzzleArray,
    int puzzleCount )
```

Saves puzzle array and size to .bin file.

Parameters

<i>puzzleArray</i>	Array to save
<i>puzzleCount</i>	Array size to save

Change binary file name using **BIN_SAVE_FILENAME** (p. 9) macro

Note

Saves array size before array!

5.4 /home/zakajus/Documents/Code/sudoku-solver/files.h

```
00001
00012 #ifndef FILES_H
00013 #define FILES_H
00014
00015
00016 #include "puzzle.h"
00017 #include "../dependencies.h"
00018
00019
00020 extern clock_t startTime;
00021
00022
00023 long double findCurrentRuntime();
00024 void logRuntime();
00025 void logLaunch();
00026 long double readTotalRuntime();
00027 int readLaunchCount();
00028
00029
00030 void saveDataToFile(Puzzle *puzzleArray, int puzzleCount);
00031 void loadDataFromFile(PuzzleArray *puzzleArray, int *puzzleCount);
00032 void initDataIfNoBinary(Puzzle *puzzleArray, int puzzleCount);
00033
00034
00035 #endif
```

5.5 /home/zakajus/Documents/Code/sudoku-solver/main.c File Reference

Handles launching the program, defining default puzzles.

```
#include "../dependencies.h"
#include "../puzzle.h"
#include "../files.h"
#include "../ui.h"
```

Functions

- int **main** ()

5.5.1 Detailed Description

Handles launching the program, defining default puzzles.

Author

Kajus Zakaras (kajus.z@tuta.io)

Version

1.00

Date

2024-01-25

Copyright

Copyright (c) 2024

5.6 /home/zakajus/Documents/Code/sudoku-solver/puzzle.c File Reference

Sudoku puzzle logic, dynamic array management.

```
#include "../dependencies.h"
#include "../puzzle.h"
#include "../ui.h"
```

Functions

- void **generateBitmap** (**Puzzle** *puzzle)
Generates bitmap in puzzle from its grid array values.
- void **generateUserGrid** (**Puzzle** *puzzle)
Replaces user grid with an unmodified copy.
- int **changeValue** (**Puzzle** *puzzle, int x, int y, int value)
Change user grid square if bitmap allows.
- void **addPuzzle** (**Puzzle** puzzle, **PuzzleArray** *puzzleArray, int *puzzleCount)
Dynamically appends puzzle to array and handles memory allocation.
- int **checkRow** (**Puzzle** puzzle, int row)
Checks if puzzle user grid row includes 1-9 exactly once.
- int **checkColumn** (**Puzzle** puzzle, int col)
Checks if puzzle user grid column includes 1-9 exactly once.
- int **checkBox** (**Puzzle** puzzle, int startRow, int startCol)
Checks if puzzle puzzle 3x3 subgrid includes 1-9 exactly once.
- int **isSudokuSolved** (**Puzzle** puzzle)
Checks if puzzle is fully solved.
- int **isSquareSafe** (**Puzzle** *puzzle, int row, int col, int num)
Checks if num would appear once in row, column, subgrid.
- int **solveSudokuUserGrid** (**Puzzle** *puzzle, int row, int col)
Solves user grid of puzzle.
- int **countSolvedSudokus** (int puzzleArrayCount, **PuzzleArray** puzzleArray)
Calculates the number of solved puzzles in array.
- void **fillUserGridDiagonal** (**Puzzle** *puzzle)
Generates valid random values for subgrids across the primary diagonal.
- void **setNCluesInUserGrid** (**Puzzle** *puzzle, int n)
Clears user grid squares until n clues remain.
- void **copyUserGridtoGrid** (**Puzzle** *puzzle)
Copies values from user grid to grid in puzzle.
- void **generatePuzzle** (**PuzzleArray** *puzzleArrayPtr, int *puzzleCountPtr, int clues)
Generates and appends a valid puzzle with specified number of clues to array.
- void **deleteNthPuzzle** (**PuzzleArray** *puzzleArrayPtr, int *puzzleCountPtr, int n)
Deletes nth puzzle from array and reallocates memory.

5.6.1 Detailed Description

Sudoku puzzle logic, dynamic array management.

Author

Kajus Zakaras (kajus.z@tuta.io)

Version

1.00

Date

2024-01-25

Copyright

Copyright (c) 2024

5.6.2 Function Documentation

5.6.2.1 addPuzzle()

```
void addPuzzle (
    Puzzle puzzle,
    PuzzleArray * puzzleArray,
    int * puzzleCount )
```

Dynamically appends puzzle to array and handles memory allocation.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to append
<i>puzzleArray</i>	Array to append to
<i>puzzleCount</i>	Array size, increments +1 after automatically

5.6.2.2 changeValue()

```
int changeValue (
    Puzzle * puzzle,
    int x,
    int y,
    int value )
```

Change user grid square if bitmap allows.

Parameters

<i>puzzle</i>	The puzzle to modify
<i>x</i>	Cartesian x coordinate of square
<i>y</i>	Cartesian y coordinate of square
<i>value</i>	Value to write

Returns

-1: unchanged due to bitmap; 0: changed successfully

5.6.2.3 checkBox()

```
int checkBox (
    Puzzle puzzle,
    int startRow,
    int startCol )
```

Checks if puzzle puzzle 3x3 subgrid includes 1-9 exactly once.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to check
<i>startRow</i>	Subgrid start row
<i>startCol</i>	Subgrid start column

Returns

1: Proper subgrid; 0: Improper subgrid

5.6.2.4 checkColumn()

```
int checkColumn (
    Puzzle puzzle,
    int col )
```

Checks if puzzle user grid column includes 1-9 exactly once.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to check
<i>col</i>	Column to check

Returns

1: Proper column; 0: Improper column

5.6.2.5 checkRow()

```
int checkRow (
    Puzzle puzzle,
    int row )
```

Checks if puzzle user grid row includes 1-9 exactly once.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to check
<i>row</i>	Row to check

Returns

1: Proper row; 0: Improper row

5.6.2.6 copyUserGridtoGrid()

```
void copyUserGridtoGrid (
    Puzzle * puzzle )
```

Copies values from user grid to grid in puzzle.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to modify
---------------	--------------------------------

5.6.2.7 countSolvedSudokus()

```
int countSolvedSudokus (
    int puzzleArrayCount,
    PuzzleArray puzzleArray )
```

Calculates the number of solved puzzles in array.

Parameters

<i>puzzleArrayCount</i>	Array size
<i>puzzleArray</i>	Array to check

Returns

Number of solved puzzles in array

Note

Can be optimized in the future by storing .solved value in **Puzzle** (p. 7) structure

5.6.2.8 deleteNthPuzzle()

```
void deleteNthPuzzle (
    PuzzleArray * puzzleArrayPtr,
    int * puzzleCountPtr,
    int n )
```

Deletes nth puzzle from array and reallocates memory.

Parameters

<i>puzzleArrayPtr</i>	Array to delete from
<i>puzzleCountPtr</i>	Array size, increments -1 after automatically
<i>n</i>	nth puzzle to delete,

5.6.2.9 fillUserGridDiagonal()

```
void fillUserGridDiagonal (
    Puzzle * puzzle )
```


Generates valid random values for subgrids across the primary diagonal.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to fill
---------------	------------------------------

Shuffled using Fisher-Yates algorithm, relies on <time.h> to seed on launch

5.6.2.10 generateBitmap()

```
void generateBitmap (
    Puzzle * puzzle )
```

Generates bitmap in puzzle from its grid array values.

Parameters

<i>puzzle</i>	Puzzle (p. 7) for which to generate the bitmap
---------------	---

5.6.2.11 generatePuzzle()

```
void generatePuzzle (
    PuzzleArray * puzzleArrayPtr,
    int * puzzleCountPtr,
    int clues )
```

Generates and appends a valid puzzle with specified number of clues to array.

Parameters

<i>puzzleArrayPtr</i>	Array to append to
<i>puzzleCountPtr</i>	Array size
<i>clues</i>	Number of clues puzzle will have (n>=17)

Note

Make sure new puzzle is properly allocated in stack - current method works based on testing

Dependant on helper functions: \ **generateUserGrid()** (p. 19), **fillUserGridDiagonal()** (p. 18), **solveSudokuUserGrid()** (p. 21), **setNCluesInUserGrid()** (p. 20), \ **copyUserGridtoGrid()** (p. 17), **generateBitmap()** (p. 19), **addPuzzle()** (p. 16)

5.6.2.12 generateUserGrid()

```
void generateUserGrid (
    Puzzle * puzzle )
```

Replaces user grid with an unmodified copy.

Parameters

<i>puzzle</i>	Puzzle (p. 7) for which to reset the user grid
---------------	---

5.6.2.13 isSquareSafe()

```
int isSquareSafe (
    Puzzle * puzzle,
    int row,
    int col,
    int num )
```

Checks if num would appear once in row, column, subgrid.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to check
<i>row</i>	Row to check
<i>col</i>	Column to check
<i>num</i>	Number that would be written

Returns

1: Safe to write; 0: Unsafe to write

Note

Functions **checkColumn()** (p. 17), **checkRow()** (p. 17), and **checkBox()** (p. 16) do not work here since they check every number

5.6.2.14 isSudokuSolved()

```
int isSudokuSolved (
    Puzzle puzzle )
```

Checks if puzzle is fully solved.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to check
---------------	-------------------------------

Returns

1: Solved; 0: Unsolved

5.6.2.15 setNCluesInUserGrid()

```
void setNCluesInUserGrid (
```

```

    Puzzle * puzzle,
    int n )

```

Clears user grid squares until *n* clues remain.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to modify
<i>n</i>	How many clues (non-empty squares) should remain

5.6.2.16 solveSudokuUserGrid()

```

int solveSudokuUserGrid (
    Puzzle * puzzle,
    int row,
    int col )

```

Solves user grid of puzzle.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to solve
<i>row</i>	Call with 0, used by recursive calls
<i>col</i>	Call with 0, used by recursive calls

Returns

0: unsolvable if returned by initial call; used to trigger backtrack in recursion

Uses a backtracking (brute-force) algorithm. More optimized algorithms (e.g. stochastic search) are outside the scope of this project.

5.7 /home/zakajus/Documents/Code/sudoku-solver/puzzle.h File Reference

Header file for **puzzle.h** (p. 21).

```
#include "dependencies.h"
```

Data Structures

- struct **Puzzle**

Structure to store data of a single Sudoku puzzle.

Typedefs

- typedef struct Puzzle **Puzzle**
Structure to store data of a single Sudoku puzzle.
- typedef **Puzzle** * **PuzzleArray**
*Alias for an array of **Puzzle** (p. 7).*

Functions

- void **generateBitmap** (**Puzzle** *puzzle)
Generates bitmap in puzzle from its grid array values.
- void **generateUserGrid** (**Puzzle** *puzzle)
Replaces user grid with an unmodified copy.
- int **changeValue** (**Puzzle** *puzzle, int x, int y, int value)
Change user grid square if bitmap allows.
- void **addPuzzle** (**Puzzle** puzzle, **PuzzleArray** *puzzleArray, int *puzzleCount)
Dynamically appends puzzle to array and handles memory allocation.
- int **checkRow** (**Puzzle** puzzle, int row)
Checks if puzzle user grid row includes 1-9 exactly once.
- int **checkColumn** (**Puzzle** puzzle, int col)
Checks if puzzle user grid column includes 1-9 exactly once.
- int **checkBox** (**Puzzle** puzzle, int startRow, int startCol)
Checks if puzzle puzzle 3x3 subgrid includes 1-9 exactly once.
- int **isSudokuSolved** (**Puzzle** puzzle)
Checks if puzzle is fully solved.
- int **isSquareSafe** (**Puzzle** *puzzle, int row, int col, int num)
Checks if num would appear once in row, column, subgrid.
- int **solveSudokuUserGrid** (**Puzzle** *puzzle, int row, int col)
Solves user grid of puzzle.
- int **countSolvedSudokus** (int puzzleArrayCount, **PuzzleArray** puzzleArray)
Calculates the number of solved puzzles in array.
- void **fillUserGridDiagonal** (**Puzzle** *puzzle)
Generates valid random values for subgrids across the primary diagonal.
- void **setNCluesInUserGrid** (**Puzzle** *puzzle, int n)
Clears user grid squares until n clues remain.
- void **copyUserGridtoGrid** (**Puzzle** *puzzle)
Copies values from user grid to grid in puzzle.
- void **generatePuzzle** (**PuzzleArray** *puzzleArrayPtr, int *puzzleCountPtr, int clues)
Generates and appends a valid puzzle with specified number of clues to array.
- void **deleteNthPuzzle** (**PuzzleArray** *puzzleArrayPtr, int *puzzleCountPtr, int n)
Deletes nth puzzle from array and reallocates memory.

5.7.1 Detailed Description

Header file for **puzzle.h** (p. 21).

Author

Kajus Zakaras (kajus.z@tuta.io)

Version

1.00

Date

2024-01-25

Copyright

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5.7.2 Typedef Documentation

5.7.2.1 Puzzle

```
typedef struct Puzzle Puzzle
```

Structure to store data of a single Sudoku puzzle.

The grid is always fixed, except for when generating a new sudoku

5.7.3 Function Documentation

5.7.3.1 addPuzzle()

```
void addPuzzle (  
    Puzzle puzzle,  
    PuzzleArray * puzzleArray,  
    int * puzzleCount )
```

Dynamically appends puzzle to array and handles memory allocation.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to append
<i>puzzleArray</i>	Array to append to
<i>puzzleCount</i>	Array size, increments +1 after automatically

5.7.3.2 changeValue()

```
int changeValue (  
    Puzzle * puzzle,  
    int x,  
    int y,  
    int value )
```

Change user grid square if bitmap allows.

Parameters

<i>puzzle</i>	The puzzle to modify
<i>x</i>	Cartesian x coordinate of square
<i>y</i>	Cartesian y coordinate of square
<i>value</i>	Value to write

Returns

-1: unchanged due to bitmap; 0: changed successfully

5.7.3.3 checkBox()

```
int checkBox (
    Puzzle puzzle,
    int startRow,
    int startCol )
```

Checks if puzzle puzzle 3x3 subgrid includes 1-9 exactly once.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to check
<i>startRow</i>	Subgrid start row
<i>startCol</i>	Subgrid start column

Returns

1: Proper subgrid; 0: Improper subgrid

5.7.3.4 checkColumn()

```
int checkColumn (
    Puzzle puzzle,
    int col )
```

Checks if puzzle user grid column includes 1-9 exactly once.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to check
<i>col</i>	Column to check

Returns

1: Proper column; 0: Improper column

5.7.3.5 checkRow()

```
int checkRow (
    Puzzle puzzle,
    int row )
```

Checks if puzzle user grid row includes 1-9 exactly once.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to check
<i>row</i>	Row to check

Returns

1: Proper row; 0: Improper row

5.7.3.6 copyUserGridtoGrid()

```
void copyUserGridtoGrid (
    Puzzle * puzzle )
```

Copies values from user grid to grid in puzzle.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to modify
---------------	--------------------------------

5.7.3.7 countSolvedSudokus()

```
int countSolvedSudokus (
    int puzzleArrayCount,
    PuzzleArray puzzleArray )
```

Calculates the number of solved puzzles in array.

Parameters

<i>puzzleArrayCount</i>	Array size
<i>puzzleArray</i>	Array to check

Returns

Number of solved puzzles in array

Note

Can be optimized in the future by storing .solved value in **Puzzle** (p. 7) structure

5.7.3.8 deleteNthPuzzle()

```
void deleteNthPuzzle (
    PuzzleArray * puzzleArrayPtr,
    int * puzzleCountPtr,
    int n )
```

Deletes nth puzzle from array and reallocates memory.

Parameters

<i>puzzleArrayPtr</i>	Array to delete from
<i>puzzleCountPtr</i>	Array size, increments -1 after automatically
<i>n</i>	nth puzzle to delete,

5.7.3.9 fillUserGridDiagonal()

```
void fillUserGridDiagonal (
    Puzzle * puzzle )
```

Generates valid random values for subgrids across the primary diagonal.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to fill
---------------	------------------------------

Shuffled using Fisher-Yates algorithm, relies on <time.h> to seed on launch

5.7.3.10 generateBitmap()

```
void generateBitmap (
    Puzzle * puzzle )
```

Generates bitmap in puzzle from its grid array values.

Parameters

<i>puzzle</i>	Puzzle (p. 7) for which to generate the bitmap
---------------	---

5.7.3.11 generatePuzzle()

```
void generatePuzzle (
    PuzzleArray * puzzleArrayPtr,
    int * puzzleCountPtr,
    int clues )
```

Generates and appends a valid puzzle with specified number of clues to array.

Parameters

<i>puzzleArrayPtr</i>	Array to append to
<i>puzzleCountPtr</i>	Array size
<i>clues</i>	Number of clues puzzle will have ($n \geq 17$)

Note

Make sure new puzzle is properly allocated in stack - current method works based on testing

Dependant on helper functions: \ **generateUserGrid()** (p. 19), **fillUserGridDiagonal()** (p. 18), **solveSudokuUserGrid()** (p. 21), **setNCluesInUserGrid()** (p. 20), \ **copyUserGridtoGrid()** (p. 17), **generateBitmap()** (p. 19), **addPuzzle()** (p. 16)

5.7.3.12 generateUserGrid()

```
void generateUserGrid (
    Puzzle * puzzle )
```

Replaces user grid with an unmodified copy.

Parameters

<i>puzzle</i>	Puzzle (p. 7) for which to reset the user grid
---------------	---

5.7.3.13 isSquareSafe()

```
int isSquareSafe (
    Puzzle * puzzle,
    int row,
    int col,
    int num )
```

Checks if num would appear once in row, column, subgrid.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to check
<i>row</i>	Row to check
<i>col</i>	Column to check
<i>num</i>	Number that would be written

Returns

1: Safe to write; 0: Unsafe to write

Note

Functions **checkColumn()** (p. 17), **checkRow()** (p. 17), and **checkBox()** (p. 16) do not work here since they check every number

5.7.3.14 isSudokuSolved()

```
int isSudokuSolved (
    Puzzle puzzle )
```

Checks if puzzle is fully solved.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to check
---------------	-------------------------------

Returns

1: Solved; 0: Unsolved

5.7.3.15 setNCluesInUserGrid()

```
void setNCluesInUserGrid (
    Puzzle * puzzle,
    int n )
```

Clears user grid squares until n clues remain.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to modify
<i>n</i>	How many clues (non-empty squares) should remain

5.7.3.16 solveSudokuUserGrid()

```
int solveSudokuUserGrid (
    Puzzle * puzzle,
    int row,
    int col )
```

Solves user grid of puzzle.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to solve
<i>row</i>	Call with 0, used by recursive calls
<i>col</i>	Call with 0, used by recursive calls

Returns

0: unsolvable if returned by initial call; used to trigger backtrack in recursion

Uses a backtracking (brute-force) algorithm. More optimized algorithms (e.g. stochastic search) are outside the scope of this project.

5.8 /home/zakajus/Documents/Code/sudoku-solver/puzzle.h

Go to the documentation of this file.

```
00001
00012 #ifndef PUZZLE_H
00013 #define PUZZLE_H
00014
00015 #include "dependencies.h"
00016
00017
00020 typedef struct Puzzle {
00022     int grid[GRID_SIZE][GRID_SIZE];
00024     int userGrid[GRID_SIZE][GRID_SIZE];
00027     int map[GRID_SIZE][GRID_SIZE];
00028 } Puzzle;
00029
00030
00032 typedef Puzzle* PuzzleArray;
00033
00034
00035 void generateBitmap(Puzzle *puzzle);
00036 void generateUserGrid(Puzzle *puzzle);
00037 int changeValue(Puzzle *puzzle, int x, int y, int value);
00038 void addPuzzle(Puzzle puzzle, PuzzleArray *puzzleArray, int *puzzleCount);
00039 int checkRow(Puzzle puzzle, int row);
00040 int checkColumn(Puzzle puzzle, int col);
00041 int checkBox(Puzzle puzzle, int startRow, int startCol);
00042 int isSudokuSolved(Puzzle puzzle);
00043 int isSquareSafe(Puzzle *puzzle, int row, int col, int num);
00044 int solveSudokuUserGrid(Puzzle *puzzle, int row, int col);
00045 int countSolvedSudokus(int puzzleArrayCount, PuzzleArray puzzleArray);
00046 void fillUserGridDiagonal(Puzzle* puzzle);
00047 void setNCluesInUserGrid(Puzzle* puzzle, int n);
00048 void copyUserGridtoGrid(Puzzle *puzzle);
00049 void generatePuzzle(PuzzleArray *puzzleArrayPtr, int *puzzleCountPtr, int clues);
00050 void deleteNthPuzzle(PuzzleArray *puzzleArrayPtr, int *puzzleCountPtr, int n);
00051
00052
00053 #endif
```

5.9 /home/zakajus/Documents/Code/sudoku-solver/ui.c File Reference

Displaying CLI interfaces, localized string translation.

```
#include "../dependencies.h"
#include "../ui.h"
#include "../puzzle.h"
#include "../files.h"
```

Functions

- char * **translate** (char *key)
Used to translate a display string key into string value from a localized dictionary.
- void **clearDisplay** ()
Clears CLI display.
- void **displayBanner** ()
Display Sudoku banner.
- void **displayPuzzleGrid** (Puzzle puzzle)
Displays grid of puzzle in CLI.

- void **displayPuzzleUserGrid** (**Puzzle** puzzle)
Displays user grid of puzzle in CLI.
- void **menuPlay** (**Puzzle** *puzzle)
Opens CLI for playing a puzzle.
- void **menuChoosePuzzle** (**PuzzleArray** *puzzleArray, int puzzleCount)
Opens CLI to choose puzzle to play.
- void **menuDelete** (**PuzzleArray** *puzzleArrayPtr, int *puzzleCountPtr)
Opens CLI to delete a puzzle from array.
- void **menuSolver** (**PuzzleArray** *puzzleArrayPtr, int puzzleCount)
Opens CLI for algorithmic solver.
- void **menuStats** (**PuzzleArray** *puzzleArray, int puzzleCount)
Opens CLI to show statistics.
- void **menuGenerate** (**PuzzleArray** *puzzleArrayPtr, int *puzzleCountPtr)
Opens CLI to generate a new puzzle.
- void **menuManager** (**PuzzleArray** *puzzleArrayPtr, int *puzzleCountPtr, **PuzzleArray** defaultPuzzleArray, int defaultPuzzleCount)
Opens CLI to reset data, navigate to menus to generate or delete puzzles.
- void **menuMain** (**PuzzleArray** *puzzleArray, int *puzzleCountPtr, **PuzzleArray** defaultPuzzles, int defaultPuzzleCount)
Opens main CLI menu when program is launched, used to navigate to all other menus.

Variables

- **translation dictionaryEN** []
English key-value dictionary for display strings.

5.9.1 Detailed Description

Displaying CLI interfaces, localized string translation.

Author

Kajus Zakaras (kajus.z@tuta.io)

Version

1.00

Date

2024-01-25

Copyright

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5.9.2 Function Documentation

5.9.2.1 displayBanner()

```
void displayBanner ( )
```

Display Sudoku banner.

Note

Improper tab indentation is intentional - otherwise banner deforms

5.9.2.2 displayPuzzleGrid()

```
void displayPuzzleGrid (
    Puzzle puzzle )
```

Displays grid of puzzle in CLI.

Parameters

<i>puzzle</i>	The puzzle to display
---------------	-----------------------

Note

As of version 1.00, never used in production, however very useful for debugging

5.9.2.3 displayPuzzleUserGrid()

```
void displayPuzzleUserGrid (
    Puzzle puzzle )
```

Displays user grid of puzzle in CLI.

Parameters

<i>puzzle</i>	The puzzle to display
---------------	-----------------------

5.9.2.4 menuChoosePuzzle()

```
void menuChoosePuzzle (
    PuzzleArray * puzzleArray,
    int puzzleCount )
```

Opens CLI to choose puzzle to play.

Parameters

<i>puzzleArray</i>	Array to choose puzzle from
<i>puzzleCount</i>	Array size

Launched by **menuMain()** (p. 32), launches **menuPlay()** (p. 33) after puzzle is chosen

5.9.2.5 menuDelete()

```
void menuDelete (
    PuzzleArray * puzzleArrayPtr,
    int * puzzleCountPtr )
```

Opens CLI to delete a puzzle from array.

Parameters

<i>puzzleArrayPtr</i>	Array to delete from
<i>puzzleCountPtr</i>	Array size

Launched by **menuManager()** (p. 33)

5.9.2.6 menuGenerate()

```
void menuGenerate (
    PuzzleArray * puzzleArrayPtr,
    int * puzzleCountPtr )
```

Opens CLI to generate a new puzzle.

Parameters

<i>puzzleArrayPtr</i>	Array to generate puzzle to
<i>puzzleCountPtr</i>	Array size

Launched by **menuManager()** (p. 33)

5.9.2.7 menuMain()

```
void menuMain (
    PuzzleArray * puzzleArray,
    int * puzzleCountPtr,
    PuzzleArray defaultPuzzles,
    int defaultPuzzleCount )
```

Opens main CLI menu when program is launched, used to navigate to all other menus.

Parameters

<i>puzzleArray</i>	Puzzle (p. 7) array to play from
<i>puzzleCountPtr</i>	Puzzle (p. 7) array size
<i>defaultPuzzles</i>	Default puzzle array to reset save to
<i>defaultPuzzleCount</i>	Default puzzle array size

Launched by main()

5.9.2.8 menuManager()

```
void menuManager (
    PuzzleArray * puzzleArrayPtr,
    int * puzzleCountPtr,
    PuzzleArray defaultPuzzleArray,
    int defaultPuzzleCount )
```

Opens CLI to reset data, navigate to menus to generate or delete puzzles.

Parameters

<i>puzzleArrayPtr</i>	Puzzle (p. 7) array to play from
<i>puzzleCountPtr</i>	Puzzle (p. 7) array size
<i>defaultPuzzleArray</i>	Default puzzle array to reset save to
<i>defaultPuzzleCount</i>	Default puzzle array size

Launched by **menuManager()** (p. 33), can launch **menuGenerate()** (p. 32), **menuDelete()** (p. 32)

5.9.2.9 menuPlay()

```
void menuPlay (
    Puzzle * puzzle )
```

Opens CLI for playing a puzzle.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to play
---------------	------------------------------

Launched by **menuChoosePuzzle()** (p. 31)

5.9.2.10 menuSolver()

```
void menuSolver (
    PuzzleArray * puzzleArrayPtr,
    int puzzleCount )
```

Opens CLI for algorithmic solver.

Parameters

<i>puzzleArrayPtr</i>	Array to solve from
<i>puzzleCount</i>	Array size

Launched by **menuMain()** (p. 32)

5.9.2.11 menuStats()

```
void menuStats (
    PuzzleArray * puzzleArray,
    int puzzleCount )
```

Opens CLI to show statistics.

Parameters

<i>puzzleArray</i>	Array to show statistic from
<i>puzzleCount</i>	Array size

Launched by **menuMain()** (p. 32)

5.9.2.12 translate()

```
char * translate (
    char * key )
```

Used to translate a display string key into string value from a localized dictionary.

Note

English dictionary (dictionaryEN) is hard-coded for now, however replacing it can be easily done using a macro

Parameters

<i>key</i>	Display string key to translate
------------	---------------------------------

Returns

Localized string for display output

5.9.3 Variable Documentation**5.9.3.1 dictionaryEN**

```
translation dictionaryEN[ ]
```

English key-value dictionary for display strings.

Note

ERROR prefix strings are used in stderr stream

5.10 /home/zakajus/Documents/Code/sudoku-solver/ui.h File Reference

Header file for **ui.c** (p. 29).

```
#include "../dependencies.h"
#include "../puzzle.h"
```

Data Structures

- struct **translation**
Key-value (dictionary) pair to store display strings.

Functions

- char * **translate** (char *key)
Used to translate a display string key into string value from a localized dictionary.
- void **clearDisplay** ()
Clears CLI display.
- void **displayBanner** ()
Display Sudoku banner.
- void **displayPuzzleGrid** (**Puzzle** puzzle)
Displays grid of puzzle in CLI.
- void **displayPuzzleUserGrid** (**Puzzle** puzzle)
Displays user grid of puzzle in CLI.
- void **menuPlay** (**Puzzle** *puzzle)
Opens CLI for playing a puzzle.
- void **menuChoosePuzzle** (**PuzzleArray** *puzzleArray, int puzzleCount)
Opens CLI to choose puzzle to play.
- void **menuDelete** (**PuzzleArray** *puzzleArrayPtr, int *puzzleCountPtr)
Opens CLI to delete a puzzle from array.
- void **menuSolver** (**PuzzleArray** *puzzleArrayPtr, int puzzleCount)
Opens CLI for algorithmic solver.
- void **menuStats** (**PuzzleArray** *puzzleArray, int puzzleCount)
Opens CLI to show statistics.
- void **menuGenerate** (**PuzzleArray** *puzzleArrayPtr, int *puzzleCountPtr)
Opens CLI to generate a new puzzle.
- void **menuManager** (**PuzzleArray** *puzzleArrayPtr, int *puzzleCountPtr, **PuzzleArray** defaultPuzzleArray, int defaultPuzzleCount)
Opens CLI to reset data, navigate to menus to generate or delete puzzles.
- void **menuMain** (**PuzzleArray** *puzzleArray, int *puzzleCountPtr, **PuzzleArray** defaultPuzzles, int defaultPuzzleCount)
Opens main CLI menu when program is launched, used to navigate to all other menus.

5.10.1 Detailed Description

Header file for **ui.c** (p. 29).

Author

Kajus Zakaras (`kajus.z@tuta.io`)

Version

1.00

Date

2024-01-25

Copyright

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5.10.2 Function Documentation

5.10.2.1 `displayBanner()`

```
void displayBanner ( )
```

Display Sudoku banner.

Note

Improper tab indentation is intentional - otherwise banner deforms

5.10.2.2 `displayPuzzleGrid()`

```
void displayPuzzleGrid (
    Puzzle puzzle )
```

Displays grid of puzzle in CLI.

Parameters

<code>puzzle</code>	The puzzle to display
---------------------	-----------------------

Note

As of version 1.00, never used in production, however very useful for debugging

5.10.2.3 displayPuzzleUserGrid()

```
void displayPuzzleUserGrid (
    Puzzle puzzle )
```

Displays user grid of puzzle in CLI.

Parameters

<i>puzzle</i>	The puzzle to display
---------------	-----------------------

5.10.2.4 menuChoosePuzzle()

```
void menuChoosePuzzle (
    PuzzleArray * puzzleArray,
    int puzzleCount )
```

Opens CLI to choose puzzle to play.

Parameters

<i>puzzleArray</i>	Array to choose puzzle from
<i>puzzleCount</i>	Array size

Launched by **menuMain()** (p. 32), launches **menuPlay()** (p. 33) after puzzle is chosen

5.10.2.5 menuDelete()

```
void menuDelete (
    PuzzleArray * puzzleArrayPtr,
    int * puzzleCountPtr )
```

Opens CLI to delete a puzzle from array.

Parameters

<i>puzzleArrayPtr</i>	Array to delete from
<i>puzzleCountPtr</i>	Array size

Launched by **menuManager()** (p. 33)

5.10.2.6 menuGenerate()

```
void menuGenerate (
    PuzzleArray * puzzleArrayPtr,
    int * puzzleCountPtr )
```

Opens CLI to generate a new puzzle.

Parameters

<i>puzzleArrayPtr</i>	Array to generate puzzle to
<i>puzzleCountPtr</i>	Array size

Launched by **menuManager()** (p. 33)

5.10.2.7 menuMain()

```
void menuMain (
    PuzzleArray * puzzleArray,
    int * puzzleCountPtr,
    PuzzleArray defaultPuzzles,
    int defaultPuzzleCount )
```

Opens main CLI menu when program is launched, used to navigate to all other menus.

Parameters

<i>puzzleArray</i>	Puzzle (p. 7) array to play from
<i>puzzleCountPtr</i>	Puzzle (p. 7) array size
<i>defaultPuzzles</i>	Default puzzle array to reset save to
<i>defaultPuzzleCount</i>	Default puzzle array size

Launched by main()

5.10.2.8 menuManager()

```
void menuManager (
    PuzzleArray * puzzleArrayPtr,
    int * puzzleCountPtr,
    PuzzleArray defaultPuzzleArray,
    int defaultPuzzleCount )
```

Opens CLI to reset data, navigate to menus to generate or delete puzzles.

Parameters

<i>puzzleArrayPtr</i>	Puzzle (p. 7) array to play from
<i>puzzleCountPtr</i>	Puzzle (p. 7) array size
<i>defaultPuzzleArray</i>	Default puzzle array to reset save to
<i>defaultPuzzleCount</i>	Default puzzle array size

Launched by **menuManager()** (p. 33), can launch **menuGenerate()** (p. 32), **menuDelete()** (p. 32)

5.10.2.9 menuPlay()

```
void menuPlay (
    Puzzle * puzzle )
```

Opens CLI for playing a puzzle.

Parameters

<i>puzzle</i>	Puzzle (p. 7) to play
---------------	------------------------------

Launched by **menuChoosePuzzle()** (p. 31)

5.10.2.10 menuSolver()

```
void menuSolver (
    PuzzleArray * puzzleArrayPtr,
    int puzzleCount )
```

Opens CLI for algorithmic solver.

Parameters

<i>puzzleArrayPtr</i>	Array to solve from
<i>puzzleCount</i>	Array size

Launched by **menuMain()** (p. 32)

5.10.2.11 menuStats()

```
void menuStats (
    PuzzleArray * puzzleArray,
    int puzzleCount )
```

Opens CLI to show statistics.

Parameters

<i>puzzleArray</i>	Array to show statistic from
<i>puzzleCount</i>	Array size

Launched by **menuMain()** (p. 32)

5.10.2.12 translate()

```
char * translate (
    char * key )
```

Used to translate a display string key into string value from a localized dictionary.

Note

English dictionary (dictionaryEN) is hard-coded for now, however replacing it can be easily done using a macro

Parameters

<i>key</i>	Display string key to translate
------------	---------------------------------

Returns

Localized string for display output

5.11 /home/zakajus/Documents/Code/sudoku-solver/ui.h

Go to the documentation of this file.

```
00001
00012 #ifndef UI_I
00013 #define UI_I
00014
00015
00016 #include "../dependencies.h"
00017 #include "../puzzle.h"
00018
00019
00021 typedef struct {
00023     char* key;
00025     char value[LINE_MAX];
00026 } translation;
00027
00028
00029 char* translate(char* key);
00030 void clearDisplay();
00031 void displayBanner();
00032 void displayPuzzleGrid(Puzzle puzzle);
00033 void displayPuzzleUserGrid(Puzzle puzzle);
00034
00035
00036 void menuPlay(Puzzle *puzzle);
00037 void menuChoosePuzzle(PuzzleArray *puzzleArray, int puzzleCount);
00038 void menuDelete(PuzzleArray *puzzleArrayPtr, int *puzzleCountPtr);
00039 void menuSolver(PuzzleArray *puzzleArrayPtr, int puzzleCount);
00040 void menuStats(PuzzleArray *puzzleArray, int puzzleCount);
00041 void menuGenerate(PuzzleArray *puzzleArrayPtr, int *puzzleCountPtr);
00042 void menuManager(PuzzleArray *puzzleArrayPtr, int *puzzleCountPtr, PuzzleArray defaultPuzzleArray, int
    defaultPuzzleCount);
00043 void menuMain(PuzzleArray *puzzleArray, int *puzzleCountPtr, PuzzleArray defaultPuzzles, int
    defaultPuzzleCount);
00044
00045
00046 #endif
```

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