Game of Life

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Chapter 1

Game of Life by David Zoller

1.1 Introduction

This is a Game of Life simulator implemented in C using the SDL2 library for graphics. It is made as a project for the Programming 1 course at the Budapest University of Technology and Economics.
The simulator allows users to create, save, and load different game states, and control the simulation with play, pause, step forward, and step back functions.

1.1.1 Conway's Game of Life

The Game of Life, also known simply as Life, is a cellular automaton devised by the British mathematician John Horton Conway in 1970. It is a zero-player game, meaning that its evolution is determined by its initial state, requiring no further input. One interacts with the Game of Life by creating an initial configuration and observing how it evolves. It is Turing complete and can simulate a universal constructor or any other Turing machine.

1.1.2 Rules

The universe of the Game of Life is an infinite (this simulator only works on finite grids), two-dimensional orthogonal grid of square cells, each of which is in one of two possible states, live or dead (or populated and unpopulated, respectively). Every cell interacts with its eight neighbours, which are the cells that are horizontally, vertically, or diagonally adjacent. At each step in time, the following transitions occur:

- Any live cell with fewer than two live neighbours dies, as if by underpopulation.
- Any live cell with two or three live neighbours lives on to the next generation.
- Any live cell with more than three live neighbours dies, as if by overpopulation.
- Any dead cell with exactly three live neighbours becomes a live cell, as if by reproduction.

The generations are created by applying the above rules simultaneously to every cell in the seed, live or dead; births and deaths occur simultaneously, and the discrete moment at which this happens is sometimes called a tick. Each generation is a pure function of the preceding one.

See also

Source: `https://en.wikipedia.org/wiki/Conway%27s_Game_of_Life`

1.2 Structure

The project is structured into several modules:

- Graphics.h: Handles all the graphical output using the SDL2 library.
- Menu.h: Handles the main menu where users can create, load, and save games.
- gameWindow.h: Handles the window where the simulation is displayed and controlled.
- gameArea.h: Represents the game area where the cells live.
- File.h: Handles file operations for saving and loading game states.
- Color.h: Defines the color theme used in the graphics.
- Dither.h: Provides functions for dithering colors.
- Error.h: Provides functions for error handling.

The state of the cells are stored in a 2D array of 8bit unsigned integers, where the LSB represents the current state of the cell, and the other 7 bits represent the history of the cell. This allows for the simulation to be run in reverse for 7 ticks and to show the decay of the cells.
For example:
`00000000` - Dead cell
`00000010` - Dead cell, was alive 1 tick ago
`01010001` - Alive cell, was alive 4 and 6 ticks ago

1.3 File Format (.con)

The first line of the file specifies the dimensions of the game board, separated by spaces (width first, then height). Additional data can be stored within the same line. The game board follows next. Here, empty cells are represented by a dot, while living cells are represented by a capital 'O'. These are stored in a grid layout. The file type is ".con".
For example: elso.con

```
7 3
.....O.
OOO..O.
.....O.
```

1.4 Installation

The project uses the `SDL2` and `gcc` libraries, which need to be installed before building the project. The project can be built using the build.sh script. The project can be run by running the main GameOfLife executable. They should be run from directory where the they are located.

Chapter 2

Data Structure Index

2.1 Data Structures

Here are the data structures with brief descriptions:

Chapter 3

File Index

3.1 File List

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

Chapter 4

Data Structure Documentation

4.1 Color_theme Struct Reference

A structure representing a color theme with five colors.

```
#include <Color.h>
```

Data Fields

- SDL_Color prim
- SDL_Color primacc
- SDL_Color sec
- SDL_Color secacc
- SDL_Color bg

4.1.1 Detailed Description

A structure representing a color theme with five colors.

4.1.2 Field Documentation

4.1.2.1 bg

```
SDL_Color Color_theme::bg
```

Background color of the theme

4.1.2.2 prim

```
SDL_Color Color_theme::prim
```

Primary color of the theme

4.1.2.3 primacc

```
SDL_Color Color_theme::primacc
```

Primary accent color of the theme

4.1.2.4 sec

```
SDL_Color Color_theme::sec
```

Secondary color of the theme

4.1.2.5 secacc

```
SDL_Color Color_theme::secacc
```

Secondary accent color of the theme

4.2 Fgame_file Struct Reference

Structure representing a game file.

```
#include <File.h>
```

Data Fields

- char ∗ **path**
  Path to the game file.
- SDL_Rect **location**
  Location of the opening button on screen.

4.2.1 Detailed Description

Structure representing a game file.

4.3 gameArea Struct Reference

Represents the game area and its properties.

```
#include <gameArea.h>
```

Data Fields

- size_t **w**

  Width of the game area.
- size_t **h**

  Height of the game area.
- uint8_t ** **area**

  Array representing the game area, least significant bit is the current state, from that the next 7 bits are the history of the cell.
- uint8_t **history_lenght**

  History length of the game area, maximum 7.

4.3.1 Detailed Description

Represents the game area and its properties.

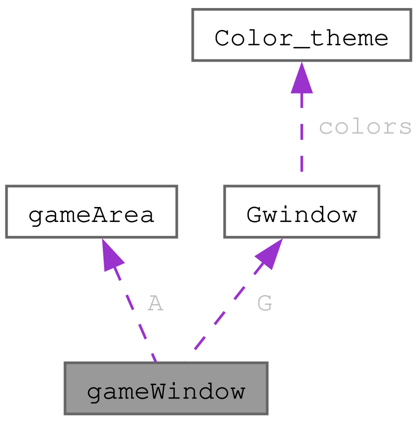
This structure should only be created with a function, and must be deleted with the Afree function.

4.4 gameWindow Struct Reference

Represents the game window and its properties.

`#include <gameWindow.h>`

Collaboration diagram for gameWindow:



Data Fields

- gameArea **A**

  The game area.
- Gwindow **G**

  The graphics window.
- char ∗ **name**

  The name of the game window.
- SDL_Texture ∗ **pre_rendered_cells**

  The pre-rendered cells.
- double **zoom**

  The zoom level.
- ssize_t **x_screen_offset**

  The x-coordinate screen offset.
- ssize_t **y_screen_offset**

  The y-coordinate screen offset.
- SDL_TimerID **autoplay_id**

  The autoplay timer ID.
- Uint32 **autoplay_delay**

  The autoplay delay.

4.4.1 Detailed Description

Represents the game window and its properties.

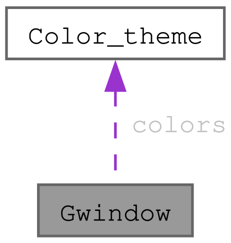
This structure should only be created with a function, and must be deleted with the Wclose function.

4.5 Gwindow Struct Reference

Represents the graphics window and its properties.

```
#include <Graphics.h>
```

Collaboration diagram for Gwindow:



Data Fields

- SDL_Window ∗ **win**

  The SDL window.
- SDL_Renderer ∗ **ren**

  The SDL renderer.
- size_t **w**

  The width of the window.
- size_t **h**

  The height of the window.
- TTF_Font ∗ **font_big**

  The font used for the title.
- TTF_Font ∗ **font_reg**

  The font used for regular text.
- Color_theme **colors**

  The color theme.

4.5.1 Detailed Description

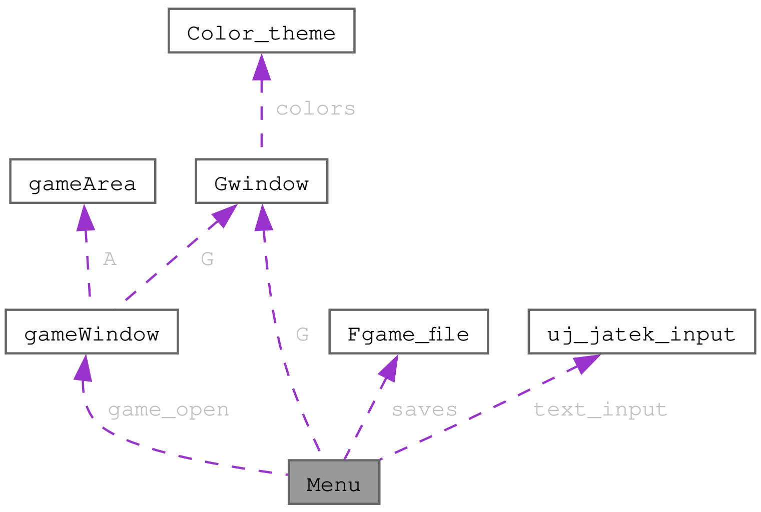
Represents the graphics window and its properties.

4.6 Menu Struct Reference

Represents the menu and its properties.

```
#include <Menu.h>
```

Collaboration diagram for Menu:



Data Fields

- Gwindow **G**

  The graphics window.
- Fgame_file ∗ **saves**

  The saved games.
- size_t **save_cnt**

  The count of saved games.
- gameWindow **game_open**

  The open game window.
- uj_jatek_input **text_input**

  The input for a new game.

4.6.1 Detailed Description

Represents the menu and its properties.

This structure should only be created with Minit, and must be deleted with the Mclose function.

4.7 uj_jatek_input Struct Reference

Represents the input for a new game.

```
#include <Menu.h>
```

Data Fields

- char **name** [INPUT_MAX_LENGHT+4]

  The name of the new game.
- SDL_Rect **name_rct**

  The text box for the name input.
- char **width** [INPUT_MAX_LENGHT]

  The width of the new game.
- SDL_Rect **width_rct**

  The text box for the width input.
- char **height** [INPUT_MAX_LENGHT]

  The height of the new game.
- SDL_Rect **height_rct**

  The text box for the height input.
- SDL_Rect **button**

  The bounding box for the new game button.

4.7.1 Detailed Description

Represents the input for a new game.

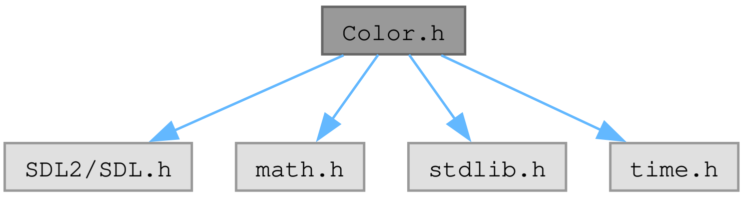
Chapter 5

File Documentation

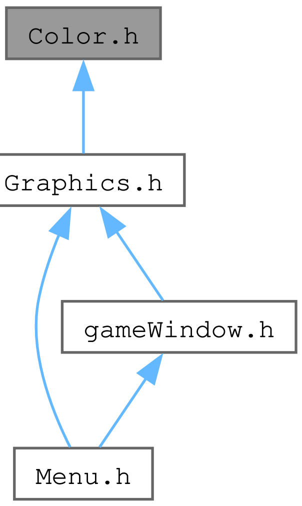
5.1 Color.h File Reference

This file contains color-related structures and functions.

```
#include <SDL2/SDL.h>
#include <math.h>
#include <stdlib.h>
#include <time.h>
```
Include dependency graph for Color.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct Color_theme

  A structure representing a color theme with five colors.

Enumerations

- enum Colortype { primary , secondary , primary_accent , secondary_accent }

  An enumeration representing different color types for rendering.

Functions

- Color_theme Cinit ()

  Initializes a Color_theme with a dynamically generated color scheme.

5.1.1 Detailed Description

This file contains color-related structures and functions.

5.1.2 Enumeration Type Documentation

5.1.2.1 Colortype

```
enum Colortype
```

An enumeration representing different color types for rendering.

Enumerator

primary	Primary color type
secondary	Secondary color type
primary_accent	Primary accent color type
secondary_accent	Secondary accent color type

5.1.3 Function Documentation

5.1.3.1 Cinit()

```
Color_theme Cinit ( )
```

Initializes a Color_theme with a dynamically generated color scheme.

Remarks

This function initializes a Color_theme structure with dynamically generated colors based on a random hue value that has a higher probability to be a warm color. From this hue, a complement color is generated for the secondary. The function ensures that if called multiple times, it returns the same theme.

Returns

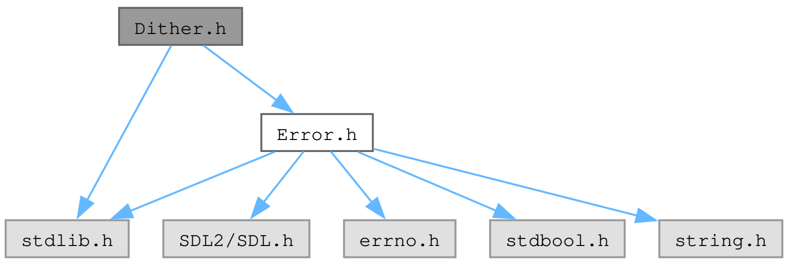
A Color_theme structure representing the generated color scheme.

5.2 Dither.h File Reference

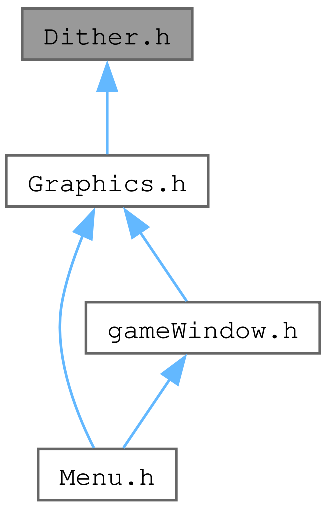
This file contains functions for generating and deallocating a Bayer matrix for ordered dithering.

```
#include <stdlib.h>
#include "Error.h"
```

Include dependency graph for Dither.h:



This graph shows which files directly or indirectly include this file:



Functions

- size_t ∗∗ Dgenerate_bayer_matrix (size_t n)

    Generates a Bayer matrix for ordered dithering.
- void Dfree_bayer_matrix (size_t ∗∗matrix)

    Deallocates memory used by a Bayer matrix.

5.2.1 Detailed Description

This file contains functions for generating and deallocating a Bayer matrix for ordered dithering.

5.2.2 Function Documentation

5.2.2.1 Dfree_bayer_matrix()

```
void Dfree_bayer_matrix (
             size_t ** matrix )
```

Deallocates memory used by a Bayer matrix.

Remarks

This function deallocates the memory used by a Bayer matrix that was generated by Dgenerate_bayer_matrix.

Parameters

matrix	The Bayer matrix to be freed. It should be a valid pointer to a Bayer matrix generated by Dgenerate_bayer_matrix.

5.2.2.2 Dgenerate_bayer_matrix()

```
size_t ** Dgenerate_bayer_matrix (
            size_t n )
```

Generates a Bayer matrix for ordered dithering.

Remarks

This function generates a Bayer matrix of size n x n. The generated matrix is used for ordered dithering.

Parameters

n	The side length of the matrix. It should be a power of 2.

Returns

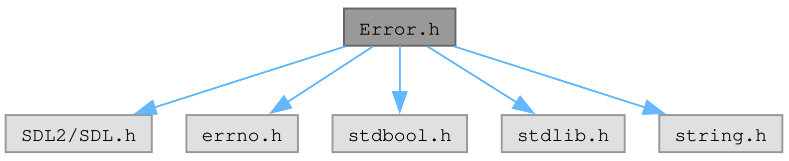
A new Bayer matrix of size n x n. Memory deallocation with Dfree_bayer_matrix is the caller's responsibility.

5.3 Error.h File Reference

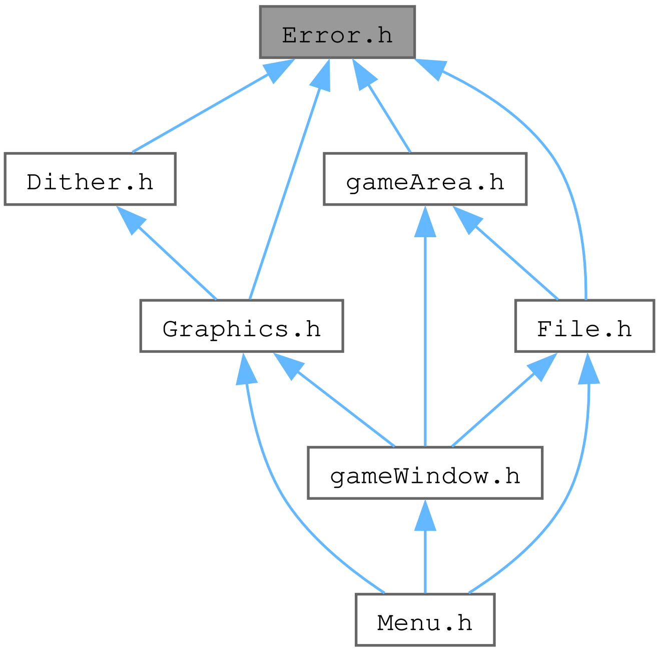
This file contains error handling macros and functions.

```
#include <SDL2/SDL.h>
#include <errno.h>
#include <stdbool.h>
#include <stdlib.h>
#include <string.h>
```

Include dependency graph for Error.h:



This graph shows which files directly or indirectly include this file:



Macros

- #define ErrorIFtrue(test, error_msg) ErrorIFtrue_with_params(test, error_msg, __FILE__, __LINE__);

  Checks if the test is true and if so, triggers an error with the provided message.
- #define ErrorIFnull(ptr, error_msg) ErrorIFtrue_with_params(ptr == NULL, error_msg, __FILE__, __LINE__);

  Checks if the pointer is null and if so, triggers an error with the provided message.
- #define ErrorIFsdl(func_with_negative_error) ErrorIFtrue_with_params(func_with_negative_error $<$ 0, "SDL hiba!", __FILE__, __LINE__);

  Checks if the SDL function returned a negative error code and if so, triggers an SDL error.
- #define ErrorIFnoMemory(ptr) ErrorIFtrue_with_params(ptr == NULL, "Nincs eleg memoria!", __FILE__, _↩ _LINE__);

  Checks if the pointer is null due to insufficient memory and if so, triggers an error.

Functions

- void ErrorIFtrue_with_params (bool test, char ∗error_msg, char ∗FILE, int LINE)

  Checks if the test is true and if so, triggers an error with the provided message, file name, and line number.
- void ErrorWarning (char ∗error_msg)

  Displays a warning message box and logs an error message.

5.3.1 Detailed Description

This file contains error handling macros and functions.

5.3.2 Macro Definition Documentation

5.3.2.1 ErrorIFnoMemory

```
#define ErrorIFnoMemory(
              ptr ) ErrorIFtrue_with_params(ptr == NULL, "Nincs eleg memoria!", __FILE__, __↩
LINE__);
```

Checks if the pointer is null due to insufficient memory and if so, triggers an error.

Parameters

ptr	The pointer to check.

5.3.2.2 ErrorIFnull

```
#define ErrorIFnull(
              ptr,
              error_msg ) ErrorIFtrue_with_params(ptr == NULL, error_msg, __FILE__, __LINE__);
```

Checks if the pointer is null and if so, triggers an error with the provided message.

Parameters

ptr	The pointer to check.
error_msg	The error message to display if the pointer is null.

5.3.2.3 ErrorIFsdl

```
#define ErrorIFsdl(
              func_with_negative_error ) ErrorIFtrue_with_params(func_with_negative_error < 0,
"SDL hiba!", __FILE__, __LINE__);
```

Checks if the SDL function returned a negative error code and if so, triggers an SDL error.

Parameters

func_with_negative_error	The SDL function to check.

5.3.2.4 ErrorIFtrue

```
#define ErrorIFtrue(
              test,
              error_msg ) ErrorIFtrue_with_params(test, error_msg, __FILE__, __LINE__);
```

Checks if the test is true and if so, triggers an error with the provided message.

Parameters

test	The condition to check.
error_msg	The error message to display if the test is true.

5.3.3 Function Documentation

5.3.3.1 ErrorIFtrue_with_params()

```
void ErrorIFtrue_with_params (
            bool test,
            char * error_msg,
            char * FILE,
            int LINE )
```

Checks if the test is true and if so, triggers an error with the provided message, file name, and line number.

Parameters

test	The condition to check.
error_msg	The error message to display if the test is true.
FILE	The file name where the error occurred.
LINE	The line number where the error occurred.

5.3.3.2 ErrorWarning()

```
void ErrorWarning (
            char * error_msg )
```

Displays a warning message box and logs an error message.

Parameters

error_msg	The error message to be displayed.

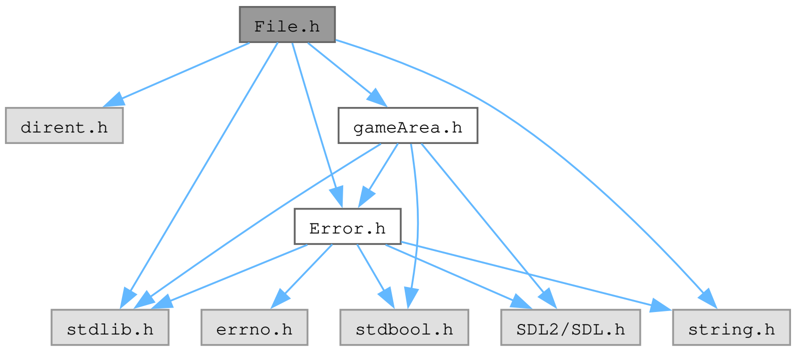
5.4 File.h File Reference

File operations for the game.

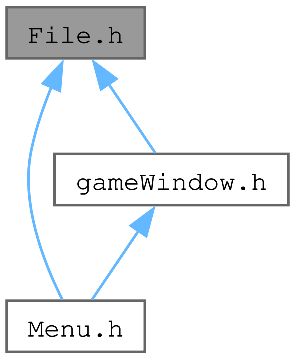
```
#include <dirent.h>
#include <stdlib.h>
#include <string.h>
#include "Error.h"
```

`#include "gameArea.h"`

Include dependency graph for File.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct Fgame_file

  Structure representing a game file.

Macros

- #define **SAVES_FOLDER** "saved/"

  Directory for saved games.

Functions

- gameArea Fopen (char ∗path)

  Opens a game file.
- void Fsave (char ∗path, gameArea ∗gamearea)

  Saves a game area to a file.
- size_t Flist (Fgame_file games[ ], size_t max_count)

  Lists game files.

5.4.1 Detailed Description

File operations for the game.

5.4.2 Function Documentation

5.4.2.1 Flist()

```
size_t Flist (
            Fgame_file games[],
            size_t max_count )
```

Lists game files.

Parameters

games	Array of game files. Must not be NULL.
max_count	Maximum number of game files to list.

Returns

The number of game files listed.

5.4.2.2 Fopen()

```
gameArea Fopen (
            char * path )
```

Opens a game file.

Parameters

path	Path to the game file. Must be a valid path.

Returns

The game area.

5.4.2.3 Fsave()

```
void Fsave (
            char * path,
            gameArea * gamearea )
```

Saves a game area to a file.

Parameters

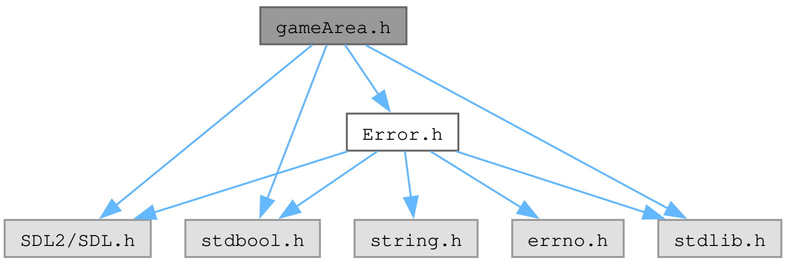
path	Path to the game file. Should be a valid path.
gamearea	Pointer to the game area to save.

5.5 gameArea.h File Reference

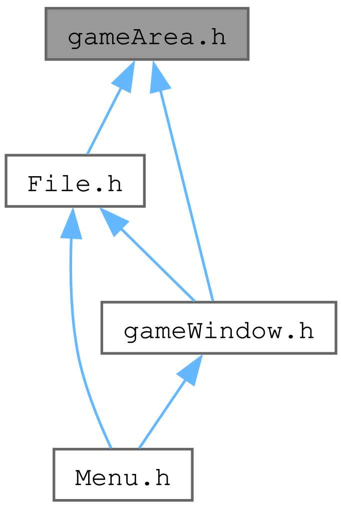
This file contains the structures and functions for the gameArea, where the simulation takes place and the cells live.

```
#include <SDL2/SDL.h>
#include <stdbool.h>
#include <stdlib.h>
#include "Error.h"
```

Include dependency graph for gameArea.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct gameArea

    Represents the game area and its properties.

Functions

- gameArea Anew (size_t width, size_t height)

    Creates a new game area.
- void Aclear (gameArea ∗gamearea)

    Clears the game area.
- void Afree (gameArea ∗gamearea)

    Frees the memory allocated for the game area.
- ssize_t Agetage (uint8_t cell)

    Gets the age of a cell.
- void Astep (gameArea ∗A)

    Advances the simulation by one step.
- bool Aback (gameArea ∗A)

    Steps back the simulation by one step.
- void Aflipcell (gameArea ∗A, double x, double y)

    Flips a cell in the game area.

5.5.1 Detailed Description

This file contains the structures and functions for the gameArea, where the simulation takes place and the cells live.

5.5.2 Function Documentation

5.5.2.1 Aback()

```
bool Aback (
            gameArea * A )
```

Steps back the simulation by one step.

Parameters

A	Pointer to the game area to step back. Must not be NULL.

Returns

True if successful, false otherwise.

5.5.2.2 Aclear()

```
void Aclear (
            gameArea * gamearea )
```

Clears the game area.

Parameters

gamearea	Pointer to the game area to clear. Must not be NULL.

5.5.2.3 Aflipcell()

```
void Aflipcell (
            gameArea * A,
            double x,
            double y )
```

Flips a cell in the game area.

Parameters

A	Pointer to the game area. Must not be NULL.
x	The x-coordinate of the cell to flip.
y	The y-coordinate of the cell to flip.

Remarks

If the coordinates are out of bounds, the function does nothing.

5.5.2.4 Afree()

```
void Afree (
            gameArea * gamearea )
```

Frees the memory allocated for the game area.

Parameters

gamearea	Pointer to the game area to free. Must not be NULL.

5.5.2.5 Agetage()

```
ssize_t Agetage (
            uint8_t cell )
```

Gets the age of a cell.

Parameters

cell	The cell to get the age of.

Returns

The age of the cell.

5.5.2.6 Anew()

```
gameArea Anew (
            size_t width,
            size_t height )
```

Creates a new game area.

Parameters

width	Width of the game area.
height	Height of the game area.

Returns

A new game area.

5.5.2.7 Astep()

```
void Astep (
            gameArea * A )
```

Advances the simulation by one step.

Parameters

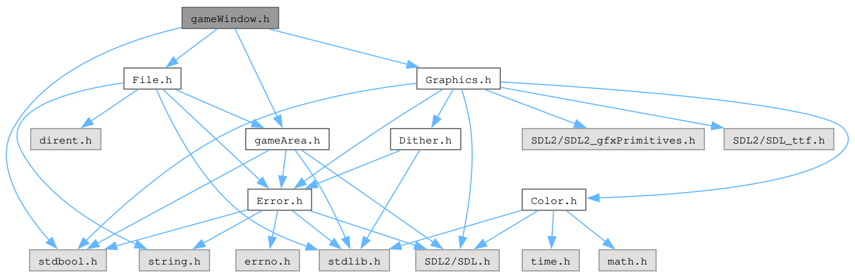
A	Pointer to the game area to step. Must not be NULL.

5.6 gameWindow.h File Reference

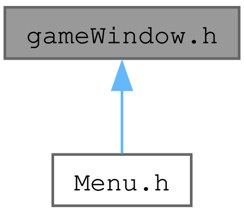
This file contains the structures and functions for the game window.

```
#include <stdbool.h>
#include "File.h"
#include "Graphics.h"
#include "gameArea.h"
```

Include dependency graph for gameWindow.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct gameWindow

    Represents the game window and its properties.

Functions

- gameWindow Winit (gameArea A, char ∗name)

  Initializes a new game window.
- void Wclose (gameWindow ∗game)

  Closes the game window.
- void Wclick (gameWindow ∗game, int x, int y)

  Handles a click event in the game window.
- void Wdraw (gameWindow ∗game, bool all_cells)

  Draws the game window.
- void Wzoom (gameWindow ∗game, double wheel, int x, int y)

  Zooms the game window.
- void Wresetzoom (gameWindow ∗game)

  Resets the zoom level of the game window.
- void Wevent (gameWindow ∗game, SDL_Event ∗e)

  Handles an event in the game window.

5.6.1 Detailed Description

This file contains the structures and functions for the game window.

5.6.2 Function Documentation

5.6.2.1 Wclick()

```
void Wclick (
             gameWindow ∗ game,
             int x,
             int y )
```

Handles a click event in the game window.

Parameters

game	Pointer to the game window. Must not be NULL.
x	The x-coordinate of the click.
y	The y-coordinate of the click.

5.6.2.2 Wclose()

```
void Wclose (
             gameWindow ∗ game )
```

Closes the game window.

Parameters

game	Pointer to the game window to close. Must not be NULL.

5.6.2.3 Wdraw()

```
void Wdraw (
            gameWindow * game,
            bool all_cells )
```

Draws the game window.

Parameters

game	Pointer to the game window to draw. Must not be NULL.
all_cells	Whether to draw all cells or just the ones that changed.

5.6.2.4 Wevent()

```
void Wevent (
            gameWindow * game,
            SDL_Event * e )
```

Handles an event in the game window.

Parameters

game	Pointer to the game window to handle event. Must not be NULL.
e	The event to handle.

5.6.2.5 Winit()

```
gameWindow Winit (
            gameArea A,
            char * name )
```

Initializes a new game window.

Parameters

A	The game area. Takes ownership of the game area and frees it when the game window is closed. Must not be NULL.
name	The name of the game window. Must not be NULL.

Returns

A new game window.

5.6.2.6 Wresetzoom()

```
void Wresetzoom (
            gameWindow * game )
```

Resets the zoom level of the game window.

Parameters

game	Pointer to the game window to reset zoom. Must not be NULL.

5.6.2.7 Wzoom()

```
void Wzoom (
            gameWindow * game,
            double wheel,
            int x,
            int y )
```

Zooms the game window.

Parameters

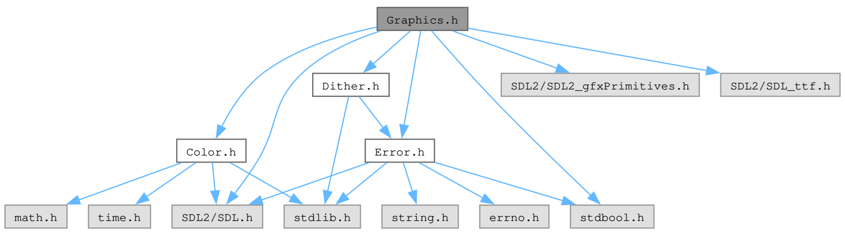
game	Pointer to the game window to zoom. Must not be NULL.
wheel	The amount to zoom.
x	The x-coordinate of the zoom center.
y	The y-coordinate of the zoom center.

5.7 Graphics.h File Reference

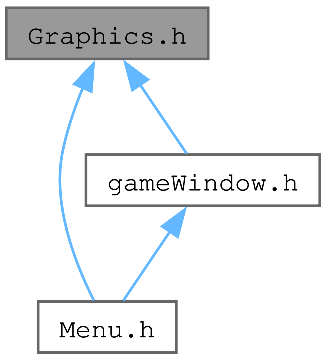
This file contains code used for graphics.

```
#include <SDL2/SDL.h>
#include <SDL2/SDL2_gfxPrimitives.h>
#include <SDL2/SDL_ttf.h>
#include <stdbool.h>
#include "Color.h"
#include "Dither.h"
#include "Error.h"
```

Include dependency graph for Graphics.h:



This graph shows which files directly or indirectly include this file:



Data Structures

- struct Gwindow

    Represents the graphics window and its properties.

Macros

- #define CELL_SIZE 8

    The size of a rendered cell in pixels.

Functions

- void Ginit ()

    Initializes SDL2.
- Gwindow Gnew (char title[ ], int width, int height, bool resizable)

    Creates a new window.
- void Gclose (Gwindow ∗window)

    Closes the graphics window.
- void Gquit ()

    Quits the SDL2 application.
- void Gset_color (Gwindow ∗window, SDL_Color col)

    Sets the color of the renderer.
- void Gfill_background (Gwindow ∗window)

    Fills the background of the Menu.
- void Gprint_title (Gwindow ∗window)

    Prints the title of the game.
- SDL_Rect Gprint (Gwindow ∗window, char ∗text, SDL_Rect ∗location, Colortype col)

    Prints text in the graphics window.
- void Gtextbox (Gwindow ∗window, char ∗text, SDL_Rect ∗location, Colortype col, size_t border_width)

    Creates a textbox in the graphics window.
- SDL_Texture ∗ Gpre_render_cells (Gwindow ∗window)

    Pre-renders cells in the graphics window.
- void Ginput_text (Gwindow ∗window, char ∗dest, size_t lenght, SDL_Rect bounding_box, bool is_file_name)

    Handles text input in the graphics window.

5.7.1 Detailed Description

This file contains code used for graphics.

5.7.2 Macro Definition Documentation

5.7.2.1 CELL_SIZE

```
#define CELL_SIZE 8
```

The size of a rendered cell in pixels.

It should be a power of 2. Smaller values will result in better performance, but worse quality.

5.7.3 Function Documentation

5.7.3.1 Gclose()

```
void Gclose (
             Gwindow * window )
```

Closes the graphics window.

Parameters

window	Pointer to the graphics window to close. Must not be NULL.

5.7.3.2 Gfill_background()

```
void Gfill_background (
             Gwindow * window )
```

Fills the background of the Menu.

Parameters

window	Pointer to the window to fill background. Must not be NULL.

5.7.3.3 Ginit()

```
void Ginit ( )
```

Initializes SDL2.

Warning

This function must be called before any other function.

5.7.3.4 Ginput_text()

```
void Ginput_text (
            Gwindow * window,
            char * dest,
            size_t lenght,
            SDL_Rect bounding_box,
            bool is_file_name )
```

Handles text input in the graphics window.

Parameters

window	Pointer to the window to handle text input. Must not be NULL.
dest	The destination for the input text.
lenght	The length of the input text.
bounding_box	The bounding box for the input text.
is_file_name	Whether the input text is a file name or not. If it is, it will append ".con" to the end, and the destination must be 4 bytes longer than lenght.

5.7.3.5 Gnew()

```
Gwindow Gnew (
            char title[],
            int width,
            int height,
            bool resizable )
```

Creates a new window.

Parameters

title	The title of the window. Must not be NULL.
width	The width of the window.
height	The height of the window.
resizable	Whether the window is resizable or not.

Returns

A new window.

5.7.3.6 Gpre_render_cells()

```
SDL_Texture * Gpre_render_cells (
            Gwindow * window )
```

Pre-renders cells in the graphics window.

Parameters

window	Pointer to the game window. Must not be NULL.

Returns

The texture of the pre-rendered cells.

Remarks

It uses the ordered dithering algorithm (Dither.h) to render the fading effect.

5.7.3.7 Gprint()

```
SDL_Rect Gprint (
            Gwindow * window,
            char * text,
            SDL_Rect * location,
            Colortype col )
```

Prints text in the graphics window.

Parameters

window	Pointer to the window to print text. Must not be NULL.
text	The text to print. Empty string for no text. Must not be NULL.
location	The location to print the text.
col	The color of the text.

Returns

The rectangle where the text was printed.

5.7.3.8 Gprint_title()

```
void Gprint_title (
            Gwindow * window )
```

Prints the title of the game.

Parameters

window	Pointer to the window to print title. Must not be NULL.

5.7.3.9 Gquit()

```
void Gquit ( )
```

Quits the SDL2 application.

Remarks

exit() should be called after this function.

5.7.3.10 Gset_color()

```
void Gset_color (
            Gwindow * window,
            SDL_Color col )
```

Sets the color of the renderer.

Parameters

window	Pointer to the window to set color. Must not be NULL.
col	The color to set.

5.7.3.11 Gtextbox()

```
void Gtextbox (
            Gwindow * window,
            char * text,
            SDL_Rect * location,
            Colortype col,
            size_t border_width )
```

Creates a textbox in the graphics window.

Parameters

window	Pointer to the window to create textbox. Must not be NULL.
text	The text for the textbox. Empty string for no text. Must not be NULL.
location	The location for the textbox.
col	The color of the textbox, only accepts primary or secondary.
border_width	The width of the border of the textbox.

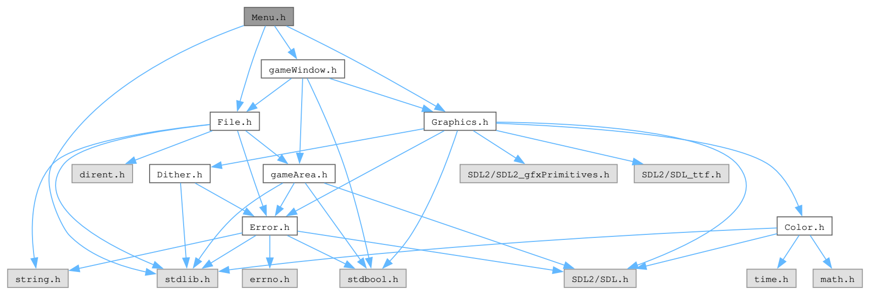
5.8 Menu.h File Reference

This file contains the structures and functions for the menu window.

```
#include <stdlib.h>
#include "File.h"
```

```
#include "Graphics.h"
#include "gameWindow.h"
```

Include dependency graph for Menu.h:



Data Structures

- struct uj_jatek_input

    Represents the input for a new game.
- struct Menu

    Represents the menu and its properties.

Macros

- #define **MAX_SAVES** 13

    Number of saves listed in the menu.
- #define **INPUT_MAX_LENGHT** 20

    Maximum length for the text inputs.

Functions

- Menu Minit ()

    Initializes the menu.
- void Mclose (Menu ∗menu)

    Closes the menu.
- void Mclick (Menu ∗menu, int x, int y)

    Handles a click event in the menu.
- void Mevent (Menu ∗menu, SDL_Event ∗e)

    Handles an event in the menu.

5.8.1 Detailed Description

This file contains the structures and functions for the menu window.

5.8.2 Function Documentation

5.8.2.1 Mclick()

```
void Mclick (
            Menu ∗ menu,
            int x,
            int y )
```

Handles a click event in the menu.

Parameters

menu	Pointer to the menu. Must not be NULL.
x	The x-coordinate of the click.
y	The y-coordinate of the click.

5.8.2.2 Mclose()

```
void Mclose (
            Menu * menu )
```

Closes the menu.

Parameters

menu	Pointer to the menu to close. Must not be NULL.

5.8.2.3 Mevent()

```
void Mevent (
            Menu * menu,
            SDL_Event * e )
```

Handles an event in the menu.

Parameters

menu	Pointer to the menu to handle event. Must not be NULL.
e	The event to handle. Must not be NULL.

5.8.2.4 Minit()

```
Menu Minit ( )
```

Initializes the menu.

Returns

The menu.

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