Gomoku AI

Generated by Doxygen 1.9.1

Chapter 1

Class Index

1.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

Chapter 2

File Index

2.1 File List

Here is a list of all files with brief descriptions:

Chapter 3

Class Documentation

3.1 AIStats Struct Reference

AI statistics.

`#include <types.h>`

Public Attributes

- int nodes_searched
- int cache_hits
- int pruned
- double time_taken

3.1.1 Detailed Description

AI statistics.

3.1.2 Member Data Documentation

3.1.2.1 cache_hits

`int AIStats::cache_hits`

3.1.2.2 nodes_searched

`int AIStats::nodes_searched`

3.1.2.3 pruned

```
int AIStats::pruned
```

3.1.2.4 time_taken

```
double AIStats::time_taken
```

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

- includes/types.h

3.2 Direction Struct Reference

Direction structure for pattern detection.

```
#include <types.h>
```

Public Attributes

- int dx
- int dy

3.2.1 Detailed Description

Direction structure for pattern detection.

3.2.2 Member Data Documentation

3.2.2.1 dx

```
int Direction::dx
```

3.2.2.2 dy

```
int Direction::dy
```

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

- includes/types.h

3.3 GomokuGame Struct Reference

Game state structure.

`#include <types.h>`

Public Attributes

- int board [BOARD_SIZE][BOARD_SIZE]
- int current_player
- int taken_stones [2]
- bool rule_center_opening
- bool rule_no_double_threes
- bool rule_captures
- bool mode_ai

3.3.1 Detailed Description

Game state structure.

3.3.2 Member Data Documentation

3.3.2.1 board

```
int GomokuGame::board[BOARD_SIZE][BOARD_SIZE]
```

3.3.2.2 current_player

```
int GomokuGame::current_player
```

3.3.2.3 mode_ai

```
bool GomokuGame::mode_ai
```

3.3.2.4 rule_captures

```
bool GomokuGame::rule_captures
```

3.3.2.5 rule_center_opening

```
bool GomokuGame::rule_center_opening
```

3.3.2.6 rule_no_double_threes

```
bool GomokuGame::rule_no_double_threes
```

3.3.2.7 taken_stones

```
int GomokuGame::taken_stones[2]
```

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

- includes/types.h

3.4 Move Struct Reference

Move structure.

```
#include <types.h>
```

Public Attributes

- int row
- int col
- int score

3.4.1 Detailed Description

Move structure.

3.4.2 Member Data Documentation

3.4.2.1 col

```
int Move::col
```

3.4.2.2 row

```
int Move::row
```

3.4.2.3 score

```
int Move::score
```

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

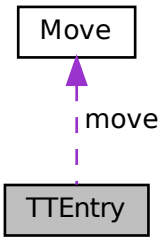
- includes/types.h

3.5 TTEntry Struct Reference

Transposition table entry.

```
#include <types.h>
```

Collaboration diagram for TTEntry:



Public Attributes

- uint64_t key
- int depth
- int score
- Move move

3.5.1 Detailed Description

Transposition table entry.

3.5.2 Member Data Documentation

3.5.2.1 depth

```
int TTEntry::depth
```

3.5.2.2 key

```
uint64_t TTEntry::key
```

3.5.2.3 move

```
Move TTEntry::move
```

3.5.2.4 score

```
int TTEntry::score
```

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

- includes/types.h

3.6 VisualMarker Struct Reference

Visual marker for AI visualization.

```
#include <types.h>
```

Public Attributes

- int row
- int col
- SDL_Color color

3.6.1 Detailed Description

Visual marker for AI visualization.

3.6.2 Member Data Documentation

3.6.2.1 col

```
int VisualMarker::col
```

3.6.2.2 color

```
SDL_Color VisualMarker::color
```

3.6.2.3 row

```
int VisualMarker::row
```

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

- includes/types.h

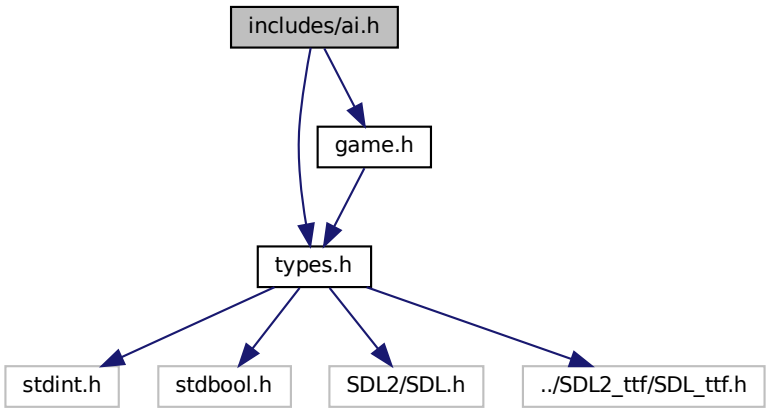
Chapter 4

File Documentation

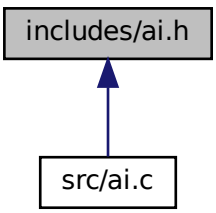
4.1 includes/ai.h File Reference

```
#include "types.h"
#include "game.h"
```

Include dependency graph for ai.h:



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



Functions

- void ai_init (void)

  Initialize AI engine.
- void ai_cleanup (void)

  Cleanup AI resources.
- Move ai_get_best_move (const GomokuGame *game, int depth, AIStats *stats)

  Get best move for current player.
- int ai_evaluate_position_for_player (GomokuGame *game, int row, int col, int player)

  Evaluate position for a specific player.
- void ai_generate_moves (const GomokuGame *game, Move *moves, int *move_count, int max_moves)

  Generate candidate moves.
- int ai_evaluate_position (const GomokuGame *game)

  Evaluate game position.
- AIStats ai_get_last_stats (void)

  Get AI statistics from last search.

4.1.1 Function Documentation

4.1.1.1 ai_cleanup()

```
void ai_cleanup (
            void  )
```

Cleanup AI resources.

4.1.1.2 ai_evaluate_position()

```
int ai_evaluate_position (
            const GomokuGame * game )
```

Evaluate game position.

Parameters

game	Game state

Returns

Position evaluation score

4.1.1.3 ai_evaluate_position_for_player()

```
int ai_evaluate_position_for_player (
            GomokuGame * game,
            int row,
            int col,
            int player )
```

Evaluate position for a specific player.

Parameters

game	Game state
row	Row position
col	Column position
player	Player to evaluate for

Returns

Position score

4.1.1.4 ai_generate_moves()

```
void ai_generate_moves (
            const GomokuGame * game,
            Move * moves,
            int * move_count,
            int max_moves )
```

Generate candidate moves.

Parameters

game	Game state
moves	Array to store generated moves
move_count	Pointer to store number of moves generated
max_moves	Maximum number of moves to generate

4.1.1.5 ai_get_best_move()

```
Move ai_get_best_move (
            const GomokuGame * game,
            int depth,
            AIStats * stats )
```

Get best move for current player.

Parameters

game	Game state
depth	Search depth
stats	Pointer to store AI statistics (can be NULL)

Returns

Best move found

4.1.1.6 ai_get_last_stats()

```
AIStats ai_get_last_stats (
            void  )
```

Get AI statistics from last search.

Returns

AI statistics

4.1.1.7 ai_init()

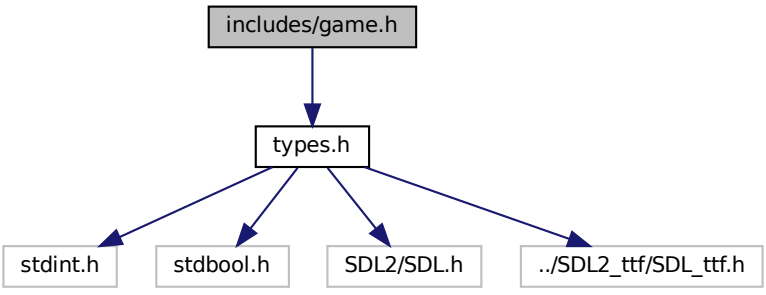
```
void ai_init (
            void  )
```

Initialize AI engine.

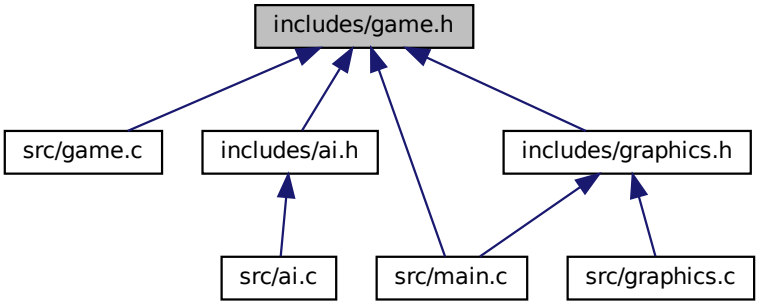
4.2 includes/game.h File Reference

```
#include "types.h"
```

Include dependency graph for game.h:



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



Functions

- void game_init (GomokuGame *game)
  Initialize game state.
- void game_copy (GomokuGame *dest, const GomokuGame *src)
  Copy game state.
- bool game_place_stone (GomokuGame *game, int row, int col)
  Place a stone on the board.
- bool game_check_winner (const GomokuGame *game, int *winner)
  Check if the game has a winner.
- bool game_is_valid_position (const GomokuGame *game, int row, int col)
  Check if position is valid for placement.
- bool game_is_double_free_three (GomokuGame *game, int row, int col, int player)
  Check if move creates double free three.
- int game_capture_stones (GomokuGame *game, int row, int col)
  Capture stones around a placed stone.
- uint64_t game_hash (const GomokuGame *game)
  Get hash value for game state.
- void game_print_board (const GomokuGame *game)
  Print board state to console.

4.2.1 Function Documentation

4.2.1.1 game_capture_stones()

```
int game_capture_stones (
            GomokuGame * game,
            int row,
            int col )
```

Capture stones around a placed stone.

Parameters

game	Game state
row	Row of placed stone
col	Column of placed stone

Returns

Number of stones captured

4.2.1.2 game_check_winner()

```
bool game_check_winner (
            const GomokuGame * game,
            int * winner )
```

Check if the game has a winner.

Parameters

game	Game state
winner	Pointer to store winner (if any)

Returns

true if game is over, false otherwise

4.2.1.3 game_copy()

```
void game_copy (
            GomokuGame * dest,
            const GomokuGame * src )
```

Copy game state.

Parameters

dest	Destination game structure
src	Source game structure

4.2.1.4 game_hash()

```
uint64_t game_hash (
            const GomokuGame * game )
```

Get hash value for game state.

Parameters

game	Game state

Returns

Hash value

4.2.1.5 game_init()

```
void game_init (
            GomokuGame * game )
```

Initialize game state.

Parameters

game	Pointer to game structure

4.2.1.6 game_is_double_free_three()

```
bool game_is_double_free_three (
            GomokuGame * game,
            int row,
            int col,
            int player )
```

Check if move creates double free three.

Parameters

game	Game state
row	Row position
col	Column position
player	Player making the move

Returns

true if creates double free three, false otherwise

4.2.1.7 game_is_valid_position()

```
bool game_is_valid_position (
            const GomokuGame * game,
            int row,
            int col )
```

Check if position is valid for placement.

Parameters

game	Game state
row	Row position
col	Column position

Returns

true if position is valid, false otherwise

4.2.1.8 game_place_stone()

```
bool game_place_stone (
            GomokuGame * game,
            int row,
            int col )
```

Place a stone on the board.

Parameters

game	Game state
row	Row position
col	Column position

Returns

true if move was successful, false otherwise

4.2.1.9 game_print_board()

```
void game_print_board (
            const GomokuGame * game )
```

Print board state to console.

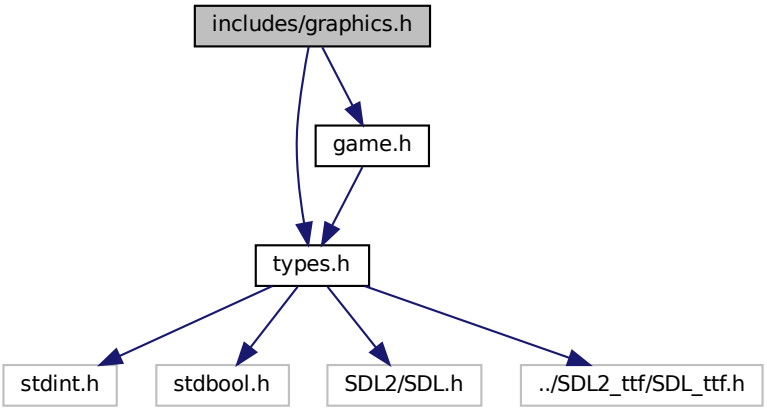
Parameters

game	Game state

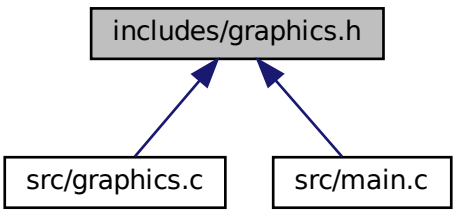
4.3 includes/graphics.h File Reference

```
#include "types.h"
#include "game.h"
```

Include dependency graph for graphics.h:



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



Functions

- bool graphics_init (void)

  Initialize graphics system.
- void graphics_cleanup (void)

  Cleanup graphics resources.
- void graphics_draw_game (const GomokuGame ∗game)

  Draw the complete game state.
- bool graphics_handle_click (int x, int y, int ∗row, int ∗col)

  Handle mouse click events.
- void graphics_add_visual_marker (int row, int col, SDL_Color color)

  Add visual marker for AI visualization.
- void graphics_clear_visual_markers (void)

  Clear all visual markers.
- void graphics_remove_visual_marker (int row, int col)

  Remove visual marker at specific position.
- void graphics_show_winner (int winner)

  Show winner message.
- SDL_Renderer ∗ graphics_get_renderer (void)

  Get SDL renderer (for custom drawing)
- SDL_Window ∗ graphics_get_window (void)

  Get SDL window (for event handling)

Variables

- SDL_Rect button_rects [4]

4.3.1 Function Documentation

4.3.1.1 graphics_add_visual_marker()

```
void graphics_add_visual_marker (
            int row,
            int col,
            SDL_Color color )
```

Add visual marker for AI visualization.

Parameters

row	Board row
col	Board column
color	Marker color

4.3.1.2 graphics_cleanup()

```
void graphics_cleanup (
            void  )
```

Cleanup graphics resources.

4.3.1.3 graphics_clear_visual_markers()

```
void graphics_clear_visual_markers (
            void  )
```

Clear all visual markers.

4.3.1.4 graphics_draw_game()

```
void graphics_draw_game (
            const GomokuGame * game )
```

Draw the complete game state.

Parameters

game	Game state to draw

4.3.1.5 graphics_get_renderer()

```
SDL_Renderer* graphics_get_renderer (
            void  )
```

Get SDL renderer (for custom drawing)

Returns

SDL renderer pointer

4.3.1.6 graphics_get_window()

```
SDL_Window* graphics_get_window (
            void  )
```

Get SDL window (for event handling)

Returns

SDL window pointer

4.3.1.7 graphics_handle_click()

```
bool graphics_handle_click (
            int x,
            int y,
            int * row,
            int * col )
```

Handle mouse click events.

Parameters

x	Mouse x coordinate
y	Mouse y coordinate
row	Pointer to store board row
col	Pointer to store board column

Returns

true if click is on valid board position

4.3.1.8 graphics_init()

```
bool graphics_init (
            void  )
```

Initialize graphics system.

Returns

true if successful, false otherwise

4.3.1.9 graphics_remove_visual_marker()

```
void graphics_remove_visual_marker (
            int row,
            int col )
```

Remove visual marker at specific position.

Parameters

row	Board row
col	Board column

4.3.1.10 graphics_show_winner()

```
void graphics_show_winner (
            int winner )
```

Show winner message.

Parameters

winner	Winner player (BLACK, WHITE, or EMPTY for draw)

4.3.2 Variable Documentation

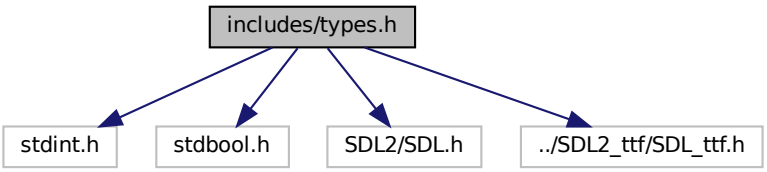
4.3.2.1 button_rects

```
SDL_Rect button_rects[4]  [extern]
```

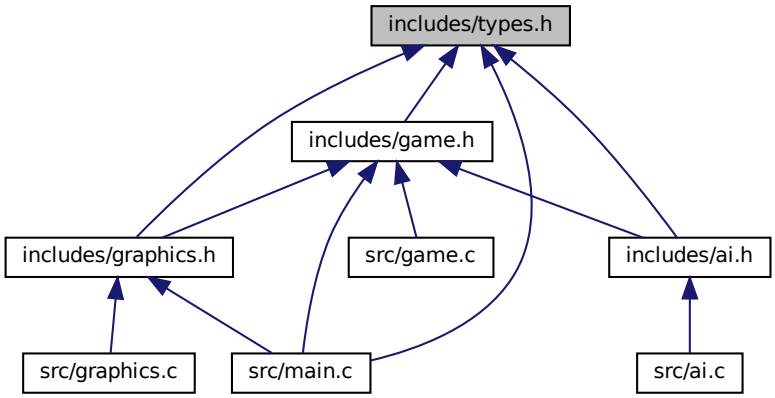
4.4 includes/types.h File Reference

```
#include <stdint.h>
#include <stdbool.h>
#include <SDL2/SDL.h>
#include "../SDL2_ttf/SDL_ttf.h"
```

Include dependency graph for types.h:



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



Classes

- struct Direction

  Direction structure for pattern detection.
- struct Move

  Move structure.
- struct GomokuGame

  Game state structure.
- struct TTEntry

  Transposition table entry.
- struct VisualMarker

  Visual marker for AI visualization.
- struct AIStats

  AI statistics.

Macros

- #define BOARD_SIZE 19
- #define CELL_SIZE 40
- #define WINDOW_WIDTH 1000
- #define WINDOW_HEIGHT 800
- #define AI_INFINITY 1000000000
- #define MAX_TT_SIZE 500000
- #define MAX_MOVES 15
- #define MAX_VISUAL_MARKERS 1000
- #define PATTERN_WIN 100000
- #define PATTERN_FOUR 50000
- #define PATTERN_THREE 8000
- #define PATTERN_TWO 800
- #define PATTERN_ONE 80
- #define EMPTY 0
- #define BLACK 1
- #define WHITE 2
- #define M_PI 3.14159265358979323846

Variables

- const SDL_Color COLOR_BLACK
- const SDL_Color COLOR_WHITE
- const SDL_Color COLOR_BLUE
- const SDL_Color COLOR_RED
- const SDL_Color COLOR_BACKGROUND

4.4.1 Macro Definition Documentation

4.4.1.1 AI_INFINITY

```
#define AI_INFINITY 1000000000
```

4.4.1.2 BLACK

```
#define BLACK 1
```

4.4.1.3 BOARD_SIZE

```
#define BOARD_SIZE 19
```

4.4.1.4 CELL_SIZE

```
#define CELL_SIZE 40
```

4.4.1.5 EMPTY

```
#define EMPTY 0
```

4.4.1.6 M_PI

```
#define M_PI 3.14159265358979323846
```

4.4.1.7 MAX_MOVES

```
#define MAX_MOVES 15
```

4.4.1.8 MAX_TT_SIZE

```
#define MAX_TT_SIZE 500000
```

4.4.1.9 MAX_VISUAL_MARKERS

```
#define MAX_VISUAL_MARKERS 1000
```

4.4.1.10 PATTERN_FOUR

```
#define PATTERN_FOUR 50000
```

4.4.1.11 PATTERN_ONE

```
#define PATTERN_ONE 80
```

4.4.1.12 PATTERN_THREE

```
#define PATTERN_THREE 8000
```

4.4.1.13 PATTERN_TWO

```
#define PATTERN_TWO 800
```

4.4.1.14 PATTERN_WIN

```
#define PATTERN_WIN 100000
```

4.4.1.15 WHITE

```
#define WHITE 2
```

4.4.1.16 WINDOW_HEIGHT

```
#define WINDOW_HEIGHT 800
```

4.4.1.17 WINDOW_WIDTH

```
#define WINDOW_WIDTH 1000
```

4.4.2 Variable Documentation

4.4.2.1 COLOR_BACKGROUND

```
const SDL_Color COLOR_BACKGROUND  [extern]
```

4.4.2.2 COLOR_BLACK

```
const SDL_Color COLOR_BLACK  [extern]
```

4.4.2.3 COLOR_BLUE

```
const SDL_Color COLOR_BLUE  [extern]
```

4.4.2.4 COLOR_RED

```
const SDL_Color COLOR_RED  [extern]
```

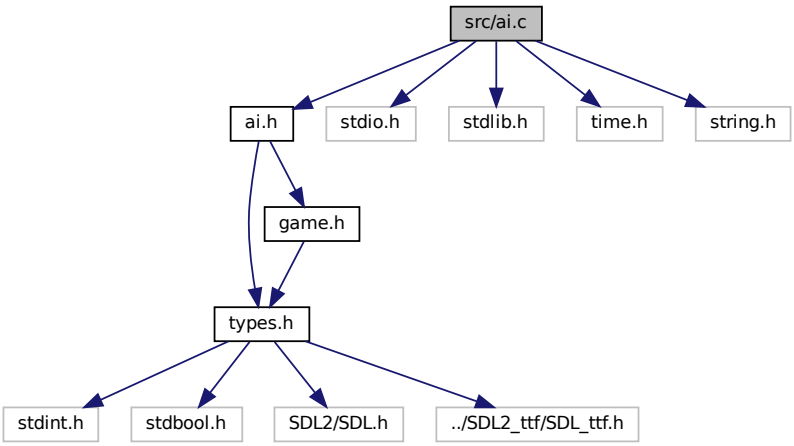
4.4.2.5 COLOR_WHITE

```
const SDL_Color COLOR_WHITE  [extern]
```

4.5 src/ai.c File Reference

```
#include "ai.h"
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <string.h>
```

Include dependency graph for ai.c:



Functions

- static int minimax_balanced (GomokuGame *game, int depth, int alpha, int beta, bool maximizing, Move *best_move)
- static int count_consecutive_optimized (const GomokuGame *game, int row, int col, int dx, int dy, int player)
- static int evaluate_line_optimized (const GomokuGame *game, int row, int col, int dx, int dy, int player)
- static void find_winning_moves_smart (const GomokuGame *game, Move *moves, int *count, int player)
- static void find_blocking_moves_smart (const GomokuGame *game, Move *moves, int *count, int player)
- static void find_neighbor_positions_smart (const GomokuGame *game, Move *moves, int *count, int max↩ _moves)
- static uint64_t game_hash_optimized (const GomokuGame *game)
- static bool is_immediate_threat (const GomokuGame *game, int row, int col, int player)
- void ai_init (void)

  Initialize AI engine.
- void ai_cleanup (void)

  Cleanup AI resources.
- int ai_evaluate_position_for_player (GomokuGame *game, int row, int col, int player)

  Evaluate position for a specific player.
- static bool is_winning_move_fast (const GomokuGame *game, int row, int col, int player)

- void ai_generate_moves (const GomokuGame *game, Move *moves, int *move_count, int max_moves)

  Generate candidate moves.
- int ai_evaluate_position (const GomokuGame *game)

  Evaluate game position.
- Move ai_get_best_move (const GomokuGame *game, int depth, AIStats *stats)

  Get best move for current player.
- AIStats ai_get_last_stats (void)

  Get AI statistics from last search.

Variables

- static TTEntry * transposition_table = NULL
- static AIStats last_stats = {0}
- static const Direction directions [4] = {{1, 0}, {0, 1}, {1, 1}, {1, -1}}

4.5.1 Function Documentation

4.5.1.1 ai_cleanup()

```
void ai_cleanup (
            void  )
```

Cleanup AI resources.

4.5.1.2 ai_evaluate_position()

```
int ai_evaluate_position (
            const GomokuGame * game )
```

Evaluate game position.

Parameters

game	Game state

Returns

Position evaluation score

4.5.1.3 ai_evaluate_position_for_player()

```
int ai_evaluate_position_for_player (
            GomokuGame * game,
            int row,
            int col,
            int player )
```

Evaluate position for a specific player.

Parameters

game	Game state
row	Row position
col	Column position
player	Player to evaluate for

Returns

Position score

4.5.1.4 ai_generate_moves()

```
void ai_generate_moves (
            const GomokuGame * game,
            Move * moves,
            int * move_count,
            int max_moves )
```

Generate candidate moves.

Parameters

game	Game state
moves	Array to store generated moves
move_count	Pointer to store number of moves generated
max_moves	Maximum number of moves to generate

4.5.1.5 ai_get_best_move()

```
Move ai_get_best_move (
            const GomokuGame * game,
            int depth,
            AIStats * stats )
```

Get best move for current player.

Parameters

game	Game state
depth	Search depth
stats	Pointer to store AI statistics (can be NULL)

Returns

Best move found

4.5.1.6 ai_get_last_stats()

```
AIStats ai_get_last_stats (
            void  )
```

Get AI statistics from last search.

Returns

AI statistics

4.5.1.7 ai_init()

```
void ai_init (
            void  )
```

Initialize AI engine.

4.5.1.8 count_consecutive_optimized()

```
static int count_consecutive_optimized (
            const GomokuGame * game,
            int row,
            int col,
            int dx,
            int dy,
            int player )  [inline], [static]
```

4.5.1.9 evaluate_line_optimized()

```
static int evaluate_line_optimized (
            const GomokuGame * game,
            int row,
            int col,
            int dx,
            int dy,
            int player )  [inline], [static]
```

4.5.1.10 find_blocking_moves_smart()

```
static void find_blocking_moves_smart (
            const GomokuGame * game,
            Move * moves,
            int * count,
            int player )  [static]
```

4.5.1.11 find_neighbor_positions_smart()

```
static void find_neighbor_positions_smart (
            const GomokuGame * game,
            Move * moves,
            int * count,
            int max_moves )  [static]
```

4.5.1.12 find_winning_moves_smart()

```
static void find_winning_moves_smart (
            const GomokuGame * game,
            Move * moves,
            int * count,
            int player )  [static]
```

4.5.1.13 game_hash_optimized()

```
static uint64_t game_hash_optimized (
            const GomokuGame * game )  [static]
```

4.5.1.14 is_immediate_threat()

```
static bool is_immediate_threat (
            const GomokuGame * game,
            int row,
            int col,
            int player )  [static]
```

4.5.1.15 is_winning_move_fast()

```
static bool is_winning_move_fast (
            const GomokuGame * game,
            int row,
            int col,
            int player )  [inline], [static]
```

4.5.1.16 minimax_balanced()

```
static int minimax_balanced (
            GomokuGame * game,
            int depth,
            int alpha,
            int beta,
            bool maximizing,
            Move * best_move )  [static]
```

4.5.2 Variable Documentation

4.5.2.1 directions

```
const Direction directions[4] = {{1, 0}, {0, 1}, {1, 1}, {1, -1}}  [static]
```

4.5.2.2 last_stats

```
AIStats last_stats = {0}  [static]
```

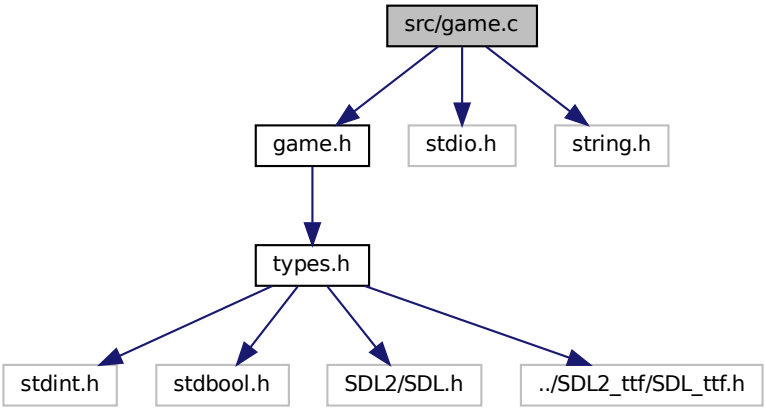
4.5.2.3 transposition_table

```
TTEntry* transposition_table = NULL  [static]
```

4.6 src/game.c File Reference

```
#include "game.h"
#include <stdio.h>
#include <string.h>
```

Include dependency graph for game.c:



Functions

- void game_init (GomokuGame *game)

  Initialize game state.
- void game_copy (GomokuGame *dest, const GomokuGame *src)

  Copy game state.
- bool game_is_valid_position (const GomokuGame *game, int row, int col)

  Check if position is valid for placement.
- bool game_is_double_free_three (GomokuGame *game, int row, int col, int player)

  Check if move creates double free three.
- int game_capture_stones (GomokuGame *game, int row, int col)

  Capture stones around a placed stone.
- bool game_place_stone (GomokuGame *game, int row, int col)

  Place a stone on the board.
- bool game_check_winner (const GomokuGame *game, int *winner)

  Check if the game has a winner.
- uint64_t game_hash (const GomokuGame *game)

  Get hash value for game state.
- void game_print_board (const GomokuGame *game)

  Print board state to console.

Variables

- static const Direction directions [4] = {{1, 0}, {0, 1}, {1, 1}, {1, -1}}

4.6.1 Function Documentation

4.6.1.1 game_capture_stones()

```
int game_capture_stones (
            GomokuGame * game,
            int row,
            int col )
```

Capture stones around a placed stone.

Parameters

game	Game state
row	Row of placed stone
col	Column of placed stone

Returns

Number of stones captured

4.6.1.2 game_check_winner()

```
bool game_check_winner (
            const GomokuGame * game,
            int * winner )
```

Check if the game has a winner.

Parameters

game	Game state
winner	Pointer to store winner (if any)

Returns

true if game is over, false otherwise

4.6.1.3 game_copy()

```
void game_copy (
            GomokuGame * dest,
            const GomokuGame * src )
```

Copy game state.

Parameters

dest	Destination game structure
src	Source game structure

4.6.1.4 game_hash()

```
uint64_t game_hash (
            const GomokuGame * game )
```

Get hash value for game state.

Parameters

game	Game state

Returns

Hash value

4.6.1.5 game_init()

```
void game_init (
            GomokuGame * game )
```

Initialize game state.

Parameters

game	Pointer to game structure

4.6.1.6 game_is_double_free_three()

```
bool game_is_double_free_three (
```

```
            GomokuGame * game,
            int row,
            int col,
            int player )
```

Check if move creates double free three.

Parameters

game	Game state
row	Row position
col	Column position
player	Player making the move

Returns

true if creates double free three, false otherwise

4.6.1.7 game_is_valid_position()

```
bool game_is_valid_position (
            const GomokuGame * game,
            int row,
            int col )
```

Check if position is valid for placement.

Parameters

game	Game state
row	Row position
col	Column position

Returns

true if position is valid, false otherwise

4.6.1.8 game_place_stone()

```
bool game_place_stone (
            GomokuGame * game,
            int row,
            int col )
```

Place a stone on the board.

Parameters

game	Game state
row	Row position
col	Column position

Returns

true if move was successful, false otherwise

4.6.1.9 game_print_board()

```
void game_print_board (
            const GomokuGame * game )
```

Print board state to console.

Parameters

game	Game state

4.6.2 Variable Documentation

4.6.2.1 directions

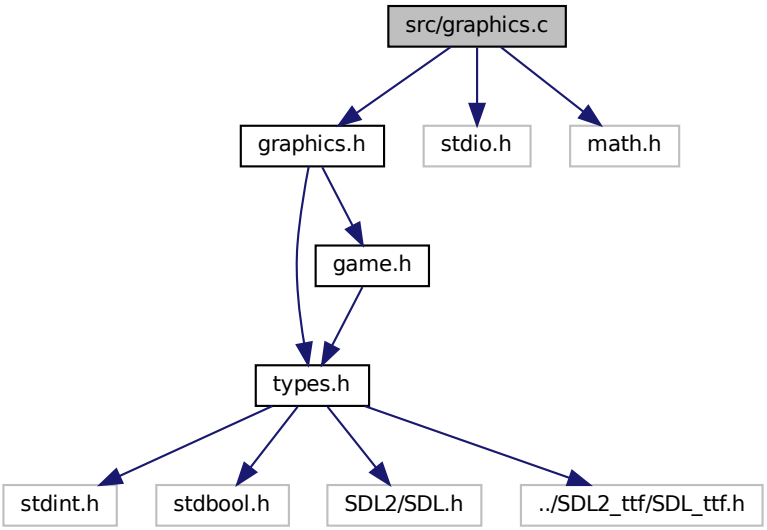
```
const Direction directions[4] = {{1, 0}, {0, 1}, {1, 1}, {1, -1}}  [static]
```

4.7 src/graphics.c File Reference

```
#include "graphics.h"
#include <stdio.h>
```

```
#include <math.h>
```

Include dependency graph for graphics.c:



Macros

- #define BUTTON_WIDTH 180
- #define BUTTON_HEIGHT 40
- #define BUTTON_MARGIN 10

Functions

- static void draw_board (void)
- static void draw_stone (int row, int col, SDL_Color color)
- static void draw_circle_filled (int x, int y, int radius, SDL_Color color)
- static void draw_visual_markers (void)
- static void draw_simple_number (int x, int y, int num)
- static void draw_simple_text (int x, int y, const char *text)
- static void draw_rule_buttons (const GomokuGame *game)
- bool graphics_init (void)

  Initialize graphics system.
- void graphics_cleanup (void)

  Cleanup graphics resources.
- void graphics_draw_game (const GomokuGame *game)

  Draw the complete game state.
- bool graphics_handle_click (int x, int y, int *row, int *col)

  Handle mouse click events.
- void graphics_add_visual_marker (int row, int col, SDL_Color color)

  Add visual marker for AI visualization.
- void graphics_clear_visual_markers (void)

Clear all visual markers.

- void graphics_remove_visual_marker (int row, int col)

  Remove visual marker at specific position.

- void graphics_show_winner (int winner)

  Show winner message.

- SDL_Renderer * graphics_get_renderer (void)

  Get SDL renderer (for custom drawing)

- SDL_Window * graphics_get_window (void)

  Get SDL window (for event handling)

Variables

- const SDL_Color COLOR_BLACK = {0, 0, 0, 255}
- const SDL_Color COLOR_WHITE = {255, 255, 255, 255}
- const SDL_Color COLOR_BLUE = {0, 0, 255, 255}
- const SDL_Color COLOR_RED = {255, 0, 0, 255}
- const SDL_Color COLOR_BACKGROUND = {255, 190, 90, 255}
- static SDL_Window * window = NULL
- static SDL_Renderer * renderer = NULL
- static VisualMarker visual_markers [MAX_VISUAL_MARKERS]
- static int visual_marker_count = 0
- static TTF_Font * font = NULL
- SDL_Rect button_rects [4]

4.7.1 Macro Definition Documentation

4.7.1.1 BUTTON_HEIGHT

```
#define BUTTON_HEIGHT 40
```

4.7.1.2 BUTTON_MARGIN

```
#define BUTTON_MARGIN 10
```

4.7.1.3 BUTTON_WIDTH

```
#define BUTTON_WIDTH 180
```

4.7.2 Function Documentation

4.7.2.1 draw_board()

```
static void draw_board (
            void  )  [static]
```

4.7.2.2 draw_circle_filled()

```
static void draw_circle_filled (
            int x,
            int y,
            int radius,
            SDL_Color color )  [static]
```

4.7.2.3 draw_rule_buttons()

```
void draw_rule_buttons (
            const GomokuGame * game )  [static]
```

4.7.2.4 draw_simple_number()

```
static void draw_simple_number (
            int x,
            int y,
            int num )  [static]
```

4.7.2.5 draw_simple_text()

```
static void draw_simple_text (
            int x,
            int y,
            const char * text )  [static]
```

4.7.2.6 draw_stone()

```
static void draw_stone (
            int row,
            int col,
            SDL_Color color )  [static]
```

4.7.2.7 draw_visual_markers()

```
static void draw_visual_markers (
            void  )  [static]
```

4.7.2.8 graphics_add_visual_marker()

```
void graphics_add_visual_marker (
            int row,
            int col,
            SDL_Color color )
```

Add visual marker for AI visualization.

Parameters

row	Board row
col	Board column
color	Marker color

4.7.2.9 graphics_cleanup()

```
void graphics_cleanup (
            void  )
```

Cleanup graphics resources.

4.7.2.10 graphics_clear_visual_markers()

```
void graphics_clear_visual_markers (
            void  )
```

Clear all visual markers.

4.7.2.11 graphics_draw_game()

```
void graphics_draw_game (
            const GomokuGame * game )
```

Draw the complete game state.

Parameters

game	Game state to draw

4.7.2.12 graphics_get_renderer()

```
SDL_Renderer* graphics_get_renderer (
            void  )
```

Get SDL renderer (for custom drawing)

Returns

SDL renderer pointer

4.7.2.13 graphics_get_window()

```
SDL_Window* graphics_get_window (
            void  )
```

Get SDL window (for event handling)

Returns

SDL window pointer

4.7.2.14 graphics_handle_click()

```
bool graphics_handle_click (
            int x,
            int y,
            int * row,
            int * col )
```

Handle mouse click events.

Parameters

x	Mouse x coordinate
y	Mouse y coordinate
row	Pointer to store board row
col	Pointer to store board column

Returns

true if click is on valid board position

4.7.2.15 graphics_init()

```
bool graphics_init (
            void  )
```

Initialize graphics system.

Returns

true if successful, false otherwise

4.7.2.16 graphics_remove_visual_marker()

```
void graphics_remove_visual_marker (
            int row,
            int col )
```

Remove visual marker at specific position.

Parameters

row	Board row
col	Board column

4.7.2.17 graphics_show_winner()

```
void graphics_show_winner (
            int winner )
```

Show winner message.

Parameters

winner	Winner player (BLACK, WHITE, or EMPTY for draw)

4.7.3 Variable Documentation

4.7.3.1 button_rects

```
SDL_Rect button_rects[4]
```

Initial value:

```
= {
    {CELL_SIZE * BOARD_SIZE + 20, 150, 180, 40},
    {CELL_SIZE * BOARD_SIZE + 20, 200, 180, 40},
    {CELL_SIZE * BOARD_SIZE + 20, 250, 180, 40},
    {CELL_SIZE * BOARD_SIZE + 20, 300, 180, 40}
}
```

4.7.3.2 COLOR_BACKGROUND

```
const SDL_Color COLOR_BACKGROUND = {255, 190, 90, 255}
```

4.7.3.3 COLOR_BLACK

```
const SDL_Color COLOR_BLACK = {0, 0, 0, 255}
```

4.7.3.4 COLOR_BLUE

```
const SDL_Color COLOR_BLUE = {0, 0, 255, 255}
```

4.7.3.5 COLOR_RED

```
const SDL_Color COLOR_RED = {255, 0, 0, 255}
```

4.7.3.6 COLOR_WHITE

```
const SDL_Color COLOR_WHITE = {255, 255, 255, 255}
```

4.7.3.7 font

```
TTF_Font* font = NULL  [static]
```

4.7.3.8 renderer

```
SDL_Renderer* renderer = NULL  [static]
```

4.7.3.9 visual_marker_count

```
int visual_marker_count = 0  [static]
```

4.7.3.10 visual_markers

```
VisualMarker visual_markers[MAX_VISUAL_MARKERS]  [static]
```

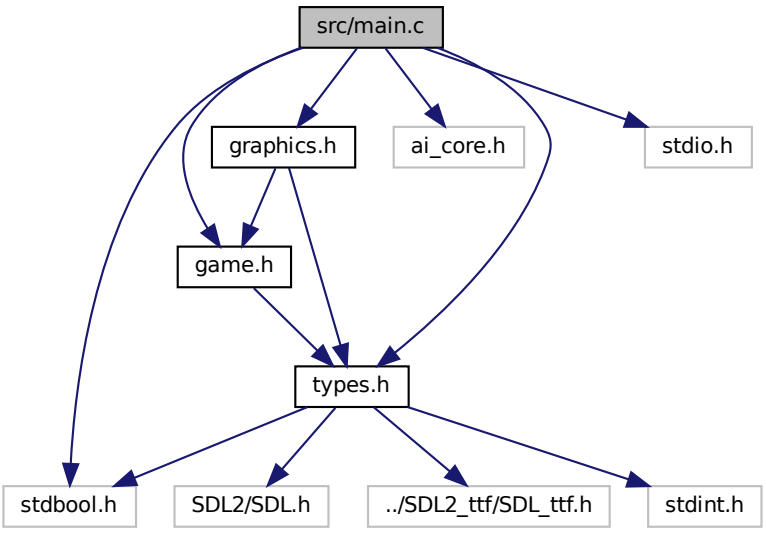
4.7.3.11 window

```
SDL_Window* window = NULL  [static]
```

4.8 src/main.c File Reference

```
#include "types.h"
#include "game.h"
#include "ai_core.h"
#include "graphics.h"
#include <stdio.h>
#include <stdbool.h>
```

Include dependency graph for main.c:



Macros

- #define AI_SEARCH_DEPTH 10
- #define AI_PLAYER WHITE

Functions

- static void handle_player_move (GomokuGame *game, int row, int col)
- static void handle_ai_move (GomokuGame *game)
- static void print_game_info (const GomokuGame *game)
- static int get_rule_button_clicked (int x, int y)
- int main (void)

4.8.1 Macro Definition Documentation

4.8.1.1 AI_PLAYER

```
#define AI_PLAYER WHITE
```

4.8.1.2 AI_SEARCH_DEPTH

```
#define AI_SEARCH_DEPTH 10
```

4.8.2 Function Documentation

4.8.2.1 get_rule_button_clicked()

```
static int get_rule_button_clicked (
            int x,
            int y )  [static]
```

4.8.2.2 handle_ai_move()

```
static void handle_ai_move (
            GomokuGame * game )  [static]
```

4.8.2.3 handle_player_move()

```
static void handle_player_move (
            GomokuGame * game,
            int row,
            int col )  [static]
```

4.8.2.4 main()

```
int main (
            void  )
```

4.8.2.5 print_game_info()

```
static void print_game_info (
            const GomokuGame * game )  [static]
```

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