

# Specifications and Test Cases for Battleship Game Methods

Below are the detailed specifications and test cases for the methods defined in the Battleship game implementation.

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## **1. initializePlayer**

### **Specification**

**Purpose:** Initializes a Player structure with default values, including setting up empty grids and resetting all counters and flags.

### **Prototype:**

```
void initializePlayer(Player* player, bool isBot, DifficultyLevel difficulty);
```

### **Parameters:**

- player: Pointer to the Player structure to initialize.
- isBot: Boolean indicating whether the player is a bot (true) or a human player (false).
- difficulty: The difficulty level for the bot (ignored for human players).

### **Behavior:**

- Initializes the player's grid and tracking grid with empty water ('~').
- Resets all counters, including radar sweeps used, smoke screens used, ships sunk, and ships remaining.
- Sets the availability of special moves (artilleryAvailable, torpedoAvailable) to false.
- Initializes bot-specific fields like potential targets and last artillery coordinates.
- Resets the turn number for the bot.

### **Test Cases**

1. **Test Case 1:** Initialize a human player.

### **Input:**

```
Player player;
```

```
initializePlayer(&player, false, MEDIUM);
```

### **Expected Result:**

- player.isBot is false.
- Grids are initialized with '~'.
- All counters are set to zero.
- Special moves are unavailable.
- Difficulty level is set to MEDIUM.

2. **Test Case 2:** Initialize a bot player at HARD difficulty.

**Input:**

Player bot;

initializePlayer(&bot, true, HARD);

**Expected Result:**

- bot.isBot is true.
- Grids are initialized with '~'.
- All counters are set to zero.
- Special moves are unavailable.
- Difficulty level is set to HARD.
- Bot-specific fields are properly initialized.

---

## 2. initializeGrid

### Specification

**Purpose:** Initializes a game grid by filling it with water ('~').

### Prototype:

```
void initializeGrid(char grid[GRID_SIZE][GRID_SIZE]);
```

### Parameters:

- grid: A 2D array representing the game grid to initialize.

**Behavior:**

- Sets every cell in the grid to '~'.

**Test Cases**

1. **Test Case:** Initialize a grid.

**Input:**

```
char grid[GRID_SIZE][GRID_SIZE];
```

```
initializeGrid(grid);
```

**Expected Result:**

- All cells in grid contain '~'.
- 

### 3. displayGrid

**Specification**

**Purpose:** Displays the game grid to the console, optionally showing ships.

**Prototype:**

```
void displayGrid(char grid[GRID_SIZE][GRID_SIZE], bool showShips);
```

**Parameters:**

- grid: The grid to display.
- showShips: If true, displays ships; if false, hides ship symbols.

**Behavior:**

- Prints the grid with column headers (A-J) and row numbers (1-10).
- Replaces ship symbols with '~' if showShips is false.

**Test Cases**

1. **Test Case 1:** Display grid without ships.

**Input:**

```
char grid[GRID_SIZE][GRID_SIZE];  
  
initializeGrid(grid);  
  
grid[0][0] = 'C'; // Place a ship symbol  
  
displayGrid(grid, false);
```

**Expected Result:**

- The displayed grid shows '~' at position (0,0), hiding the ship.

2. **Test Case 2:** Display grid with ships.

**Input:**

```
displayGrid(grid, true);
```

**Expected Result:**

- The displayed grid shows 'C' at position (0,0), revealing the ship.
- 

## 4. **placeShips**

### **Specification**

**Purpose:** Allows a human player to place their ships on the grid.

**Prototype:**

```
void placeShips(Player* player, Fleet* fleet);
```

**Parameters:**

- player: Pointer to the player placing ships.
- fleet: Pointer to the player's fleet.

**Behavior:**

- Prompts the player to input coordinates and orientation for each ship.
- Validates placement and updates the player's grid accordingly.
- Clears the screen after successful placement.

**Note:**

- If player->isBot is true, calls placeShipsBot instead.

**Test Cases**

1. **Test Case:** Simulate ship placement (assuming valid inputs).

**Input:**

- Player inputs: "A1 h" for Carrier, "B2 v" for Battleship, etc.

**Expected Result:**

- Ships are placed at the specified coordinates with the correct orientation.
  - Grid is updated accordingly.
- 

## 5. placeShipsBot

**Specification**

**Purpose:** Automatically places ships for a bot player randomly on the grid.

**Prototype:**

```
void placeShipsBot(Player* bot, Fleet* fleet);
```

**Parameters:**

- bot: Pointer to the bot player.
- fleet: Pointer to the bot's fleet.

**Behavior:**

- Randomly selects starting coordinates and orientations for each ship.

- Ensures ships do not overlap and are within grid boundaries.
- Updates the bot's grid with ship placements.

### **Test Cases**

1. **Test Case:** Verify that ships are placed without overlapping.

#### **Input:**

Player bot;

Fleet fleet;

initializePlayer(&bot, true, MEDIUM);

placeShipsBot(&bot, &fleet);

#### **Expected Result:**

- All ships are placed on the bot's grid.
- No ships overlap.
- All ships are within the grid boundaries.

---

## **6. isValidPlacement**

### **Specification**

**Purpose:** Checks if a ship can be placed at the specified location without overlapping and within grid boundaries.

#### **Prototype:**

bool isValidPlacement(char grid[GRID\_SIZE][GRID\_SIZE], Coordinate coord, int size, char orientation);

#### **Parameters:**

- grid: The grid to check.



- coord: Starting coordinate for the ship.
- size: Size of the ship.
- orientation: 'h' for horizontal, 'v' for vertical.

**Returns:**

- true if the placement is valid.
- false otherwise.

**Behavior:**

- Verifies that the ship fits within the grid.
- Checks that the placement does not overlap with existing ships.

**Test Cases**

1. **Test Case 1:** Valid horizontal placement.

**Input:**

Coordinate coord = {0, 0};

int size = 5;

char orientation = 'h';

bool result = isValidPlacement(grid, coord, size, orientation);

**Expected Result:**

- result is true if positions (0,0) to (4,0) are empty.

2. **Test Case 2:** Invalid vertical placement (overlapping).

**Input:**

grid[1][0] = 'C'; // Existing ship

Coordinate coord = {0, 0};

int size = 4;

```
char orientation = 'v';
```

```
bool result = isValidPlacement(grid, coord, size, orientation);
```

**Expected Result:**

- result is false due to overlap at (0,1).

3. **Test Case 3:** Invalid placement (out of bounds).

**Input:**

```
Coordinate coord = {8, 0};
```

```
int size = 3;
```

```
char orientation = 'h';
```

```
bool result = isValidPlacement(grid, coord, size, orientation);
```

**Expected Result:**

- result is false because the ship would extend beyond column 9.
- 

## 7. placeShipOnGrid

### Specification

**Purpose:** Places a ship on the grid at the specified location and orientation.

**Prototype:**

```
void placeShipOnGrid(char grid[GRID_SIZE][GRID_SIZE], Coordinate coord, int size, char  
orientation, char symbol);
```

**Parameters:**

- grid: The grid to update.
- coord: Starting coordinate for the ship.
- size: Size of the ship.

- orientation: 'h' for horizontal, 'v' for vertical.
- symbol: Character symbol representing the ship.

**Behavior:**

- Updates the grid cells with the ship's symbol along the specified orientation and size.

**Test Cases**

1. **Test Case:** Place a ship on the grid.

**Input:**

Coordinate coord = {0, 0};

int size = 3;

char orientation = 'v'; char

symbol = 'D';

placeShipOnGrid(grid, coord, size, orientation, symbol);

**Expected Result:**

- Grid cells at positions (0,0), (0,1), (0,2) contain 'D'.

---

**8. parseCoordinate**

**Specification**

**Purpose:** Parses a coordinate string (e.g., "A5") into a Coordinate struct.

**Prototype:**

Coordinate parseCoordinate(const char\* input);

**Parameters:**

- input: String representing the coordinate.

**Returns:**

- Coordinate with valid x and y if parsing is successful.
- Coordinate with x = -1 and y = -1 if invalid.

**Behavior:**

- Converts column letter to x index (0-9).
- Converts row number to y index (0-9).

**Test Cases**

1. **Test Case 1:** Valid coordinate.

**Input:**

Coordinate coord = parseCoordinate("A1");

**Expected Result:**

- coord.x is 0, coord.y is 0.

2. **Test Case 2:** Invalid coordinate (out of bounds).

**Input:**

Coordinate coord = parseCoordinate("K11");

**Expected Result:**

- coord.x is -1, coord.y is -1.

3. **Test Case 3:** Invalid format.

**Input:**

Coordinate coord = parseCoordinate("1A");

**Expected Result:**

- coord.x is -1, coord.y is -1.

---

**9. clearScreen**

## Specification

**Purpose:** Clears the console screen.

**Prototype:**

```
void clearScreen();
```

**Behavior:**

- Executes the appropriate system command to clear the console screen based on the operating system.

## Test Cases

1. **Test Case:** Invoke clearScreen and verify that the console is cleared.

**Input:**

```
clearScreen();
```

**Expected Result:**

- Console screen is cleared.
- 

## 10. gameLoop

### Specification

**Purpose:** Main game loop handling turns and checking for win conditions.

**Prototype:**

```
void gameLoop(Player* currentPlayer, Player* opponent, Fleet* currentFleet, Fleet*  
opponentFleet, bool hardMode);
```

**Parameters:**

- currentPlayer: Pointer to the player whose turn it is.
- opponent: Pointer to the opponent player.

- `currentFleet`: Pointer to the current player's fleet.
- `opponentFleet`: Pointer to the opponent's fleet.
- `hardMode`: Boolean indicating if hard mode is enabled (affects tracking grid visibility).

**Behavior:**

- Alternates turns between players.
- Invokes `performMove` or `performBotMove` based on the player type.
- Checks for win conditions after each turn.
- Ends the loop when a player wins.

**Test Cases**

1. **Test Case:** Simulate a game loop where a player wins after sinking all opponent's ships.

**Input:**

- Initialize players and fleets.
- Set up conditions for a quick game (e.g., small grid or pre-determined moves).

**Expected Result:**

- Game loop runs until `checkWin` returns true.
- The winning player's name is printed.

---

## 11. `performMove`

**Specification**

**Purpose:** Handles a human player's move, processing commands and executing actions.

**Prototype:**

```
void performMove(Player* player, Player* opponent, Fleet* opponentFleet, bool hardMode);
```

**Parameters:**

- player: Pointer to the player making the move.
- opponent: Pointer to the opponent player.
- opponentFleet: Pointer to the opponent's fleet.
- hardMode: Boolean indicating if hard mode is enabled.

**Behavior:**

- Displays the player's tracking grid.
- Prompts the player for a move (fire, radar, smoke, artillery, torpedo).
- Validates the input command and arguments.
- Executes the move and updates the game state.
- Provides feedback to the player about the result.

**Test Cases**

1. **Test Case 1:** Player fires at a valid coordinate and hits a ship.

**Input:**

- Command: "fire A1"

**Expected Result:**

- If a ship is at (0,0), reports "Hit!".
- Updates tracking grid.

2. **Test Case 2:** Player enters an invalid command.

**Input:**

- Command: "fly A1"

**Expected Result:**

- Reports "Invalid command or command not available."
- Player loses their turn.

## 12. performBotMove

### Specification

**Purpose:** Handles the bot's move based on its difficulty level.

### Prototype:

```
void performBotMove(Player* bot, Player* opponent, Fleet* opponentFleet, bool hardMode);
```

### Parameters:

- bot: Pointer to the bot player.
- opponent: Pointer to the opponent player.
- opponentFleet: Pointer to the opponent's fleet.
- hardMode: Boolean indicating if hard mode is enabled.

### Behavior:

- Determines the bot's action based on its difficulty level.
- Uses strategies appropriate for EASY, MEDIUM, or HARD difficulties.
- Executes special moves or fires at the player's grid.
- Updates the game state and provides feedback.

### Test Cases

1. **Test Case:** Bot in EASY difficulty performs a random fire.

### Input:

- Bot's difficulty set to EASY.

### Expected Result:

- Bot selects a random untargeted coordinate.
- Updates tracking grid accordingly.



### **13. fire**

#### **Specification**

**Purpose:** Fires at a specified coordinate, updating grids and ship statuses.

#### **Prototype:**

```
int fire(Player* player, Player* opponent, Fleet* opponentFleet, Coordinate coord, bool  
hardMode, char* sunkShipName);
```

#### **Parameters:**

- player: Pointer to the player making the fire.
- opponent: Pointer to the opponent player.
- opponentFleet: Pointer to the opponent's fleet.
- coord: Coordinate to fire at.
- hardMode: Boolean indicating if hard mode is enabled.
- sunkShipName: Buffer to store the name of a sunk ship, if any.

#### **Returns:**

- 0: Miss.
- 1: Hit.
- 2: Hit and sunk a ship.
- 3: Already targeted.
- -1: Invalid or ineffective shot.

#### **Behavior:**

- Checks if the coordinate is under a smoke screen.
- Updates opponent's grid based on the result.

- Updates player's tracking grid if appropriate.
- Updates ship hit counts and sunk status.

### **Test Cases**

1. **Test Case 1:** Fire at an empty cell.

#### **Input:**

Coordinate coord = {0, 0};

int result = fire(player, opponent, opponentFleet, coord, false, sunkShipName);

#### **Expected Result:**

- result is 0 (Miss).
- Opponent's grid at (0,0) is updated to 'o'.

2. **Test Case 2:** Fire at a ship and sink it.

#### **Input:**

- Coordinate of the last remaining part of a ship.

#### **Expected Result:**

- result is 2 (Hit and sunk).
- sunkShipName contains the name of the sunk ship.
- Ship's sunk status is updated.

---

## **14. radarSweep**

### **Specification**

**Purpose:** Performs a radar sweep at the specified coordinate.

#### **Prototype:**

void radarSweep(Player\* player, Player\* opponent, Coordinate coord);

**Parameters:**

- player: Pointer to the player performing the radar sweep.
- opponent: Pointer to the opponent player.
- coord: Coordinate where the radar sweep is deployed.

**Behavior:**

- Checks a 2x2 area around the coordinate for enemy ships.
- Considers active smoke screens that may obscure the area.
- Reports to the player whether enemy ships were detected.
- If the area is obscured by smoke, the radar sweep is ineffective, and the smoke screen deactivates.

**Test Cases**

1. **Test Case:** Radar sweep detects enemy ships.

**Input:**

- Radar sweep at coordinate where opponent has ships within the area.

**Expected Result:**

- Reports "Radar detected enemy ships near the target area."
- If the player is a bot, potential targets are added.

2. **Test Case:** Radar sweep area is covered by a smoke screen.

**Input:**

- Radar sweep at coordinate covered by an active smoke screen.

**Expected Result:**

- Reports "Radar sweep found no enemy ships (area obscured by smoke)."
- Smoke screen deactivates.

## 15. smokeScreen

### Specification

**Purpose:** Deploys a smoke screen at the specified coordinate.

### Prototype:

```
bool smokeScreen(Player* player, Coordinate coord);
```

### Parameters:

- player: Pointer to the player deploying the smoke screen.
- coord: Coordinate where the smoke screen is deployed.

### Returns:

- true if successfully deployed.
- false otherwise.

### Behavior:

- Checks if the player has smoke screens available.
- Deploys the smoke screen, activating it over a 2x2 area.
- Updates the player's smoke screen data.

### Test Cases

1. **Test Case 1:** Deploy smoke screen successfully.

### Input:

```
player.shipsSunk = 1;
```

```
player.smokeScreensUsed = 0;
```

```
bool result = smokeScreen(&player, (Coordinate){0, 0});
```

### Expected Result:

- result is true.
- Smoke screen is active at the specified coordinate.

2. **Test Case 2:** Fail to deploy smoke screen (none available).

**Input:**

player.shipsSunk = 0;

player.smokeScreensUsed = 0;

bool result = smokeScreen(&player, (Coordinate){0, 0});

**Expected Result:**

- result is false.
  - Reports "No smoke screens available."
- 

## 16. artillery

### Specification

**Purpose:** Performs an artillery strike at the specified coordinate.

**Prototype:**

```
void artillery(Player* player, Player* opponent, Fleet* opponentFleet, Coordinate coord, bool  
hardMode);
```

**Parameters:**

- player: Pointer to the player performing the artillery strike.
- opponent: Pointer to the opponent player.
- opponentFleet: Pointer to the opponent's fleet.
- coord: Coordinate where the artillery strike is deployed.
- hardMode: Boolean indicating if hard mode is enabled.

**Behavior:**

- Attacks a 2x2 area centered around the coordinate.
- Updates grids and ship statuses based on hits.
- Reports total hits and misses.
- If ships are sunk, updates the game state accordingly.

**Test Cases**

1. **Test Case:** Perform artillery strike and sink a ship.

**Input:**

- Artillery strike at coordinate covering the last parts of a ship.

**Expected Result:**

- Reports hits and misses.
- Sunk ship is reported.
- Ship's sunk status is updated.

---

**17. torpedo**

**Specification**

**Purpose:** Performs a torpedo attack on a specified row or column.

**Prototype:**

```
void torpedo(Player* player, Player* opponent, Fleet* opponentFleet, const char* input, bool  
hardMode);
```

**Parameters:**

- player: Pointer to the player performing the torpedo attack.
- opponent: Pointer to the opponent player.

- `opponentFleet`: Pointer to the opponent's fleet.
- `input`: String indicating the row (number) or column (letter) to attack.
- `hardMode`: Boolean indicating if hard mode is enabled.

**Behavior:**

- Determines if the input is a row or column.
- Attacks all cells in the specified row or column.
- Updates grids and ship statuses based on hits.
- Reports total hits and misses.
- If ships are sunk, updates the game state accordingly.

**Test Cases**

1. **Test Case 1:** Torpedo attack on a row.

**Input:**

`torpedo(player, opponent, opponentFleet, "5", false);`

**Expected Result:**

- Attacks row 5.
- Reports hits and misses.
- Updates grids accordingly.

2. **Test Case 2:** Torpedo attack on an invalid column.

**Input:**

`torpedo(player, opponent, opponentFleet, "K", false);`

**Expected Result:**

- Reports "Invalid column."
- No action taken.

## 18. checkWin

### Specification

**Purpose:** Checks if all ships in the fleet are sunk.

**Prototype:**

```
bool checkWin(Fleet* fleet);
```

**Parameters:**

- fleet: Pointer to the fleet to check.

**Returns:**

- true if all ships are sunk.
- false otherwise.

**Behavior:**

- Iterates through all ships in the fleet.
- Returns false if any ship is not sunk.

### Test Cases

1. **Test Case:** Fleet with all ships sunk.

**Input:**

- All ships in fleet have sunk set to true.

**Expected Result:**

- checkWin(fleet) returns true.

2. **Test Case:** Fleet with at least one ship not sunk.

**Input:**

- At least one ship in fleet has sunk set to false.



**Expected Result:**

- checkWin(fleet) returns false.
- 

**19. updateShipStatus**

**Specification**

**Purpose:** Updates the sunk status of a ship based on hits.

**Prototype:**

```
void updateShipStatus(Ship* ship);
```

**Parameters:**

- ship: Pointer to the ship to update.

**Behavior:**

- Sets ship->sunk to true if ship->hits >= ship->size.

**Test Cases**

1. **Test Case:** Ship has hits equal to its size.

**Input:**

```
ship.size = 3;
```

```
ship.hits = 3;
```

```
updateShipStatus(&ship);
```

**Expected Result:**

- ship.sunk is true.

2. **Test Case:** Ship has fewer hits than its size.

**Input:** ship.size

```
= 4;
```

```
ship.hits = 2;
```

```
updateShipStatus(&ship);
```

**Expected Result:**

- ship.sunk is false.
- 

## **20. unlockSpecialMoves**

### **Specification**

**Purpose:** Unlocks special moves for the player based on game conditions.

### **Prototype:**

```
void unlockSpecialMoves(Player* player, Player* opponent);
```

### **Parameters:**

- player: Pointer to the player unlocking special moves.
- opponent: Pointer to the opponent player.

### **Behavior:**

- Unlocks artilleryAvailable after sinking a ship.
- Unlocks torpedoAvailable when the opponent has only one ship remaining.
- Allows additional smoke screens based on the number of ships sunk.

### **Test Cases**

1. **Test Case:** Player sinks a ship; artillery becomes available.

### **Input:**

```
player.artilleryAvailable = false;
```

```
opponent.shipsRemaining = 3;
```

```
unlockSpecialMoves(&player, &opponent);
```

**Expected Result:**

- player.artilleryAvailable is set to true.
- 2. **Test Case:** Opponent has one ship remaining; torpedo becomes available.

**Input:**

player.torpedoAvailable = false;

opponent.shipsRemaining = 1;

unlockSpecialMoves(&player, &opponent); **Expected**

**Result:**

- player.torpedoAvailable is set to true.
- 

## 21. displayTrackingGrid

**Specification**

**Purpose:** Displays the player's tracking grid, showing the results of their attacks on the opponent.

**Prototype:**

```
void displayTrackingGrid(Player* player, bool hardMode);
```

**Parameters:**

- player: Pointer to the player whose tracking grid is to be displayed.
- hardMode: Boolean indicating if hard mode is enabled (affects ship visibility).

**Behavior:**

- Calls displayGrid with the player's tracking grid.
- In hard mode, hides ship symbols; otherwise, shows them.

**Test Cases**

1. **Test Case 1:** Display tracking grid in normal mode.

**Input:**

```
displayTrackingGrid(&player, false);
```

**Expected Result:**

- The tracking grid is displayed with ships visible (if any have been detected).

2. **Test Case 2:** Display tracking grid in hard mode.

**Input:**

```
displayTrackingGrid(&player, true);
```

**Expected Result:**

- The tracking grid is displayed with ships hidden, showing '~' instead of ship symbols.

---

22. **isValidCommand**

**Specification**

**Purpose:** Validates if a command is valid and available for the player.

**Prototype:**

```
bool isValidCommand(const char* command, Player* player);
```

**Parameters:**

- command: String representing the command input by the player.
- player: Pointer to the player attempting to execute the command.

**Returns:**

- true if the command is valid and available.
- false otherwise.

**Behavior:**

- Checks if the command is among the allowed commands: "fire", "radar", "smoke", "artillery", "torpedo".
- Verifies if the player has the special move available (e.g., artillery is unlocked).

**Test Cases**

1. **Test Case 1:** Valid command "fire".

**Input:**

```
bool result = isValidCommand("fire", &player);
```

**Expected Result:**

- result is true.
2. **Test Case 2:** Command "torpedo" when torpedo is not available.

**Input:**

```
player.torpedoAvailable = false;
```

```
bool result = isValidCommand("torpedo", &player);
```

**Expected Result:**

- result is false.
3. **Test Case 3:** Invalid command "fly".

**Input:**

```
bool result = isValidCommand("fly", &player);
```

**Expected Result:**

- result is false.

---

**23. getInput**

## Specification

**Purpose:** Safely gets input from the user, handling buffer overflows and input termination.

### Prototype:

```
void getInput(char* input, int size);
```

### Parameters:

- input: Buffer to store the input.
- size: Size of the input buffer.

### Behavior:

- Reads a line from stdin into the input buffer.
- Removes the trailing newline character.
- Flushes the input buffer if the input exceeds the buffer size.

## Test Cases

1. **Test Case:** User inputs "fire A1".

### Input:

```
char input[50];
```

```
// Simulate user input "fire A1\n"
```

```
// (In actual unit testing, this may involve mocking stdin) getInput(input,
```

```
sizeof(input));
```

### Expected Result:

- input contains "fire A1".
- 

## 24. coordinateToString

### Specification

**Purpose:** Converts a Coordinate struct to a string representation (e.g., {0,4} -> "A5").

**Prototype:**

```
void coordinateToString(Coordinate coord, char* coordStr);
```

**Parameters:**

- coord: The coordinate to convert.
- coordStr: Buffer to store the string representation.

**Behavior:**

- Converts the x index to a column letter (A-J).
- Converts the y index to a row number (1-10).
- Stores the result in coordStr.

**Test Cases**

1. **Test Case:** Convert coordinate {2, 4}.

**Input:**

```
Coordinate coord = {2, 4};
```

```
char coordStr[5];
```

```
coordinateToString(coord, coordStr);
```

**Expected Result:**

- coordStr contains "C5".

2. **Test Case:** Convert coordinate {9, 9}.

**Input:**

```
Coordinate coord = {9, 9};
```

```
char coordStr[5];
```

```
coordinateToString(coord, coordStr);
```

**Expected Result:**

- coordStr contains "J10".
- 

## **25. toLowerCase**

### **Specification**

**Purpose:** Converts a string to lowercase.

### **Prototype:**

```
void toLowerCase(char* str);
```

### **Parameters:**

- str: The string to convert.

### **Behavior:**

- Converts all uppercase letters in str to lowercase.

### **Test Cases**

1. **Test Case:** Convert "Fire A1".

### **Input:**

```
char str[] = "Fire A1";
```

```
toLowerCase(str); Expected
```

### **Result:**

- str is "fire a1".
- 

## **26. flushInputBuffer**

### **Specification**

**Purpose:** Flushes the input buffer to remove any extraneous input.



**Prototype:**

```
void flushInputBuffer();
```

**Behavior:**

- Reads and discards characters from stdin until a newline or EOF is encountered.

**Test Cases**

1. **Test Case:** Simulate overflowing input and ensure buffer is flushed.

**Input:**

```
// User inputs a long string exceeding buffer size
```

```
flushInputBuffer();
```

**Expected Result:**

- Input buffer is cleared.
- 

## 27. getRandomNumber

**Specification**

**Purpose:** Generates a random number between min and max (inclusive).

**Prototype:**

```
int getRandomNumber(int min, int max);
```

**Parameters:**

- min: Minimum value.
- max: Maximum value.

**Returns:**

- A random integer between min and max.

**Test Cases**

1. **Test Case:** Generate random number between 1 and 10.

**Input:**

```
int num = getRandomNumber(1, 10);
```

**Expected Result:**

- num is an integer between 1 and 10.
- 

## 28. getRandomCoordinate

### Specification

**Purpose:** Generates a random coordinate within the grid.

**Prototype:**

```
Coordinate getRandomCoordinate();
```

**Returns:**

- A Coordinate with x and y between 0 and GRID\_SIZE - 1.

### Test Cases

1. **Test Case:** Generate random coordinate.

**Input:**

```
Coordinate coord = getRandomCoordinate();
```

**Expected Result:**

- coord.x and coord.y are integers between 0 and 9.
- 

## 29. getNextTarget

### Specification

**Purpose:** Selects the next target for the bot by choosing the coordinate with the highest probability based on the probability grid.

**Prototype:**

Coordinate getNextTarget(Player\* bot, Fleet\* opponentFleet);

**Parameters:**

- bot: Pointer to the bot player.
- opponentFleet: Pointer to the opponent's fleet.

**Returns:**

- A Coordinate representing the next target.

**Behavior:**

- Calculates a probability grid using calculateProbabilityGrid.
- Selects coordinates with the highest probability that haven't been targeted yet.
- If multiple coordinates have the same highest probability, selects one at random.

**Test Cases**

1. **Test Case:** Bot selects next target based on probability.

**Input:**

Coordinate target = getNextTarget(&bot, &opponentFleet);

**Expected Result:**

- target is a valid coordinate.
- The coordinate corresponds to a cell with the highest calculated probability.

---

### 30. calculateProbabilityGrid

**Specification**

**Purpose:** Calculates a probability grid representing the likelihood of each cell containing a ship.

**Prototype:**

```
void calculateProbabilityGrid(Player* bot, Fleet* opponentFleet, int  
probabilityGrid[GRID_SIZE][GRID_SIZE]);
```

**Parameters:**

- bot: Pointer to the bot player.
- opponentFleet: Pointer to the opponent's fleet.
- probabilityGrid: 2D array to store the calculated probabilities.

**Behavior:**

- Considers the bot's tracking grid and remaining ships in the opponent's fleet.
- Assigns higher probabilities to cells where ships are more likely to be based on remaining ship sizes and previous hits.
- Increases probability for cells adjacent to hits.

**Test Cases**

1. **Test Case:** Probability grid reflects higher likelihood near hits.

**Input:**

```
// Assume bot's tracking grid has a hit at (5,5)  
  
bot.trackingGrid[5][5] = '*';  
  
int probabilityGrid[GRID_SIZE][GRID_SIZE];  
  
calculateProbabilityGrid(&bot, &opponentFleet, probabilityGrid);
```

**Expected Result:**

- Cells adjacent to (5,5) have higher probability values.
- Cells with misses ('o') have zero probability.

### 31. addAdjacentTargets

#### Specification

**Purpose:** Adds adjacent tiles to the bot's potential target queue after a successful hit, considering ship orientation.

#### Prototype:

```
void addAdjacentTargets(Player* bot, Coordinate coord);
```

#### Parameters:

- bot: Pointer to the bot player.
- coord: Coordinate where the hit occurred.

#### Behavior:

- If aligned hits are found, continues targeting in that direction.
- Adds valid adjacent coordinates to bot->potentialTargets.

#### Test Cases

1. **Test Case:** Add adjacent targets after a hit.

#### Input:

```
// Assume bot hit at (5,5) Coordinate
```

```
hitCoord = {5, 5};
```

```
addAdjacentTargets(&bot, hitCoord);
```

#### Expected Result:

- Coordinates (5,6), (6,5), (5,4), (4,5) are added to bot->potentialTargets if not already targeted.
2. **Test Case:** Extend search in a specific direction.

**Input:**

```
// Bot has hits at (5,5) and (5,6)
```

```
bot.trackingGrid[5][5] = '*';
```

```
bot.trackingGrid[5][6] = '*';
```

```
Coordinate hitCoord = {5, 6};
```

```
addAdjacentTargets(&bot, hitCoord);
```

**Expected Result:**

- Only adds coordinates in the same column (vertical direction), e.g., (5,7), to bot->potentialTargets.
- 

## 32. addPotentialTarget

### Specification

**Purpose:** Adds a new potential target to the bot's target queue if it hasn't been added already.

**Prototype:**

```
void addPotentialTarget(Player* player, Coordinate coord);
```

**Parameters:**

- player: Pointer to the player (bot).
- coord: Coordinate to add to the potential target queue.

**Behavior:**

- Checks if the coordinate is already in player->potentialTargets.
- Adds it to the queue if it's not already present.

### Test Cases

1. **Test Case:** Add a new potential target.

**Input:**

Coordinate coord = {5, 5};

addPotentialTarget(&bot, coord);

**Expected Result:**

- coord is added to bot->potentialTargets.

2. **Test Case:** Attempt to add a duplicate potential target.

**Input:**

addPotentialTarget(&bot, coord); // coord already added

**Expected Result:**

- coord is not added again.
  - bot->potentialTargetCount remains the same.
- 

### 33. getBestArtilleryTarget

**Specification**

**Purpose:** Determines the optimal 2x2 area for deploying an artillery strike based on untargeted tiles.

**Prototype:**

Coordinate getBestArtilleryTarget(Player\* bot);

**Parameters:**

- bot: Pointer to the bot player.

**Returns:**

- A Coordinate representing the top-left corner of the best artillery target area.

**Behavior:**

- Scans the grid for 2x2 areas with the highest number of untargeted ('~') tiles.
- Returns the coordinate of the area with the maximum untargeted tiles.

### Test Cases

1. **Test Case:** Bot selects artillery target area with maximum untargeted tiles.

### Input:

Coordinate target = getBestArtilleryTarget(&bot);

### Expected Result:

- target is the coordinate of a 2x2 area with the most untargeted tiles.
- 

## 34. countUntargetedTilesInArtilleryArea

### Specification

**Purpose:** Counts the number of untargeted tiles within a 2x2 artillery strike area.

### Prototype:

```
int countUntargetedTilesInArtilleryArea(Player* bot, Coordinate coord);
```

### Parameters:

- bot: Pointer to the bot player.
- coord: Coordinate representing the top-left corner of the artillery area.

### Returns:

- Number of untargeted ('~') tiles in the specified area.

### Behavior:

- Adjusts for grid boundaries.
- Counts untargeted tiles within the 2x2 area.

### Test Cases



1. **Test Case:** Count untargeted tiles in a given area.

**Input:**

Coordinate coord = {5, 5};

int count = countUntargetedTilesInArtilleryArea(&bot, coord);

**Expected Result:**

- count reflects the number of untargeted tiles in the area starting at (5,5).
- 

### 35. chooseTorpedoTarget

**Specification**

**Purpose:** Selects the best row or column to deploy a torpedo based on untargeted tiles.

**Prototype:**

bool chooseTorpedoTarget(Player\* bot, Player\* opponent, Fleet\* opponentFleet, bool hardMode);

**Parameters:**

- bot: Pointer to the bot player.
- opponent: Pointer to the opponent player.
- opponentFleet: Pointer to the opponent's fleet.
- hardMode: Boolean indicating if hard mode is enabled.

**Returns:**

- true if a torpedo was successfully deployed.
- false otherwise.

**Behavior:**

- Evaluates all rows and columns to find the one with the most untargeted tiles.

- Deploys torpedo attack on the optimal row or column.

### Test Cases

1. **Test Case:** Bot selects a row with the most untargeted tiles.

#### Input:

```
bool success = chooseTorpedoTarget(&bot, &opponent, &opponentFleet, false);
```

#### Expected Result:

- Torpedo is deployed on the selected row or column.
  - success is true.
2. **Test Case:** No valid torpedo targets available.

#### Input:

```
// All rows and columns have been targeted
```

```
bool success = chooseTorpedoTarget(&bot, &opponent, &opponentFleet, false);
```

#### Expected Result:

- success is false.

---

## 36. isUnderSmoke

### Specification

**Purpose:** Checks if a coordinate is under an active smoke screen.

#### Prototype:

```
bool isUnderSmoke(Player* opponent, Coordinate coord);
```

#### Parameters:

- opponent: Pointer to the opponent player.
- coord: Coordinate to check.

**Returns:**

- true if the coordinate is under an active smoke screen.
- false otherwise.

**Behavior:**

- Iterates through the opponent's active smoke screens.
- Determines if coord falls within any smoke screen areas.

**Test Cases**

1. **Test Case:** Coordinate is under smoke.

**Input:**

// Opponent has an active smoke screen at (5,5)

opponent.smokeScreens[0].active = true;

opponent.smokeScreens[0].coord = {5, 5};

bool result = isUnderSmoke(&opponent, (Coordinate){5, 5});

**Expected Result:**

- result is true.

2. **Test Case:** Coordinate is not under smoke.

**Input:**

bool result = isUnderSmoke(&opponent, (Coordinate){0, 0});

**Expected Result:**

- result is false.

---

**37. getSmokeScreenCoordinateForBot**

**Specification**

**Purpose:** Determines the best coordinate for the bot to deploy a smoke screen.

**Prototype:**

Coordinate getSmokeScreenCoordinateForBot(Player\* bot);

**Parameters:**

- bot: Pointer to the bot player.

**Returns:**

- A Coordinate representing the best smoke screen location.
- { -1, -1 } if no suitable location is found.

**Behavior:**

- Scans the bot's grid for areas containing ships.
- Prefers areas where multiple ships are present.
- Returns the coordinate for deploying the smoke screen.

**Test Cases**

1. **Test Case:** Bot selects a coordinate over its ships.

**Input:**

Coordinate coord = getSmokeScreenCoordinateForBot(&bot);

**Expected Result:**

- coord corresponds to a location where the bot has ships.
2. **Test Case:** No ships remaining; bot cannot deploy smoke screen.

**Input:**

// All bot's ships are sunk

Coordinate coord = getSmokeScreenCoordinateForBot(&bot);

**Expected Result:**

- coord is { -1, -1 }.
- 

### **38. handleEdgeCoordinates**

#### **Specification**

**Purpose:** Adjusts coordinate start and end values to prevent out-of-bounds access.

#### **Prototype:**

```
void handleEdgeCoordinates(int* start, int* end);
```

#### **Parameters:**

- start: Pointer to the starting index.
- end: Pointer to the ending index.

#### **Behavior:**

- Ensures that start is not less than 0.
- Ensures that end does not exceed GRID\_SIZE - 1.

#### **Test Cases**

1. **Test Case:** Adjust coordinates at grid boundaries.

#### **Input:**

```
int xStart = -1;
```

```
int xEnd = 10;
```

```
handleEdgeCoordinates(&xStart, &xEnd);
```

#### **Expected Result:**

- xStart is adjusted to 0.
  - xEnd is adjusted to GRID\_SIZE - 1 (9).
-

### **39. addArtilleryHitTargets**

#### **Specification**

**Purpose:** Adds targets around successful artillery hits to the bot's potential target queue.

#### **Prototype:**

```
void addArtilleryHitTargets(Player* bot, Coordinate coord);
```

#### **Parameters:**

- bot: Pointer to the bot player.
- coord: Coordinate where the artillery hit occurred.

#### **Behavior:**

- Adds all untargeted tiles within a 3x3 area centered on coord to the bot's potential targets.
- Resets bot->lastArtilleryHits to zero.

#### **Test Cases**

1. **Test Case:** Bot adds potential targets after artillery hits.

#### **Input:**

```
// Assume artillery hit at (5,5)
```

```
addArtilleryHitTargets(&bot, (Coordinate){5, 5});
```

#### **Expected Result:**

- All untargeted coordinates within the area are added to bot->potentialTargets.
- bot->lastArtilleryHits is set to 0.