

CMPS 270 Project—Battleship *Phoenix*

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High-level explanation of *Battleship*



Objective

Deliver an immersive, strategically challenging experience with adaptive bot AI, advanced special moves, and seamless handling of gameplay mechanics

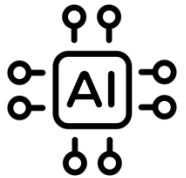


Project Highlights

Rigorous focus on **non-randomization** with the bot's strategy

Handling of all edge cases through **the class's specifications and test cases**

Implementation of the project bonus with a **clear difficulty system**



AI Features

Checkerboard system that aims to find and target ships in the least costly way possible (hunt mode)

Adjacent targeting mode that aims to sink a ship after one coordinate has been located (targeting mode)

Artillery, torpedo, and smoke screen are rationally implemented after checking hits and ships



Difficulty Modes

Easy mode is the only mode with randomization and limits the use of special moves

Medium uses all **AI hunting and targeting** features, with probabilistic special moves

Hard is aggressive, uses all special moves ASAP

Bot Implementation

Hunt Mode

- Target Cells Where $(X + Y) \% 2 == 0$
(checkerboard pattern where only alternating cells are considered)
- This method optimizes the search by avoiding unnecessary shots at cells less likely to contain ships.

Visual Representation:

- Checkerboard Pattern Grid:

	A	B	C	D	E	F	G	H	I	J
1	✓		✓		✓		✓		✓	
2		✓		✓		✓		✓		✓
3	✓		✓		✓		✓		✓	
4		✓		✓		✓		✓		✓
5	✓		✓		✓		✓		✓	
6		✓		✓		✓		✓		✓
7	✓		✓		✓		✓		✓	
8		✓		✓		✓		✓		✓
9	✓		✓		✓		✓		✓	
10		✓		✓		✓		✓		✓

- ✓ Represents Cells Targeted in Checkerboard Mode

Bot *Implementation* *Fire*

- We ensured that there are no redundant hits by recording the hits that the bot has made.
- The bot prioritizes adjacent cells for subsequent moves, mimicking **human intuition**.

DIFFICULTY LEVELS

EASY

Fires randomly at untargeted cells, but targets adjacent cells after hit to non-randomized

First HIT!

	A	B	C
1	*	~	~
2	~	~	~

Easy mode, NWSE system

MEDIUM

Targeting mode becomes linear and does not waste time targeting all adjacent targets

Goes horizontally, MISS!

	A	B	C
1	*	~	~
2	~	~	~

HARD

Probability density function to calculate what's the most likely target

Goes vertically, HIT AGAIN!

	A	B
1	*	~
2	*	~

Medium mode, HV mode

Bot *Implementation*

Example—Assume D5 is hit

- **Hard** difficulty
- **Hunt** mode found a hit in D5
- Targeting mode is entered with a probability density function model
- Start getting probability scores

- **Horizontal**
 - C5, D5, E5, F5
 - B5, C5, D5, E5
 - D5, E5, F5, G5
- **Vertical Placements**
 - D3, D4, D5, D6
 - D4, D5, D6, D7
 - D5, D6, D7, D8

- Add 1 for cells that are in the possibilities mentioned
- Find the coordinate with the highest probability score and target it
- Probabilistic targeting increases odds of a hit

Bot Implementation

Targeting Mode

	A	B	C	D	E	F	G	H	I	J
1	~	~	~	~	~	~	~	~	~	~
2	~	~	~	~	~	~	~	~	~	~
3	~	~	~	1	~	~	~	~	~	~
4	~	~	~	2	~	~	~	~	~	~
5	~	1	2	60	2	2	1	~	~	~
6	~	~	~	3	~	~	~	~	~	~
7	~	~	~	2	~	~	~	~	~	~
8	~	~	~	1	~	~	~	~	~	~
9	~	~	~	~	~	~	~	~	~	~
10	~	~	~	~	~	~	~	~	~	~

For hard mode only

Cell	ΔP from Placements	Total $P(x, y)$
B5	1	1
C5	1 (Placement 1) + 1 (Placement 2) = 2	2
D3	1	1
D4	1 (Placement 4) + 1 (Placement 5) = 2	2
D5	10 (all placements overlapping D5) * 6	60
D6	1 (Placement 4) + 1 (Placement 5) + 1 (Placement 6) = 3	3
D7	1 (Placement 5) + 1 (Placement 6) = 2	2
D8	1	1
E5	1 (Placement 1) + 1 (Placement 3) = 2	2
F5	1 (Placement 1) + 1 (Placement 3) = 2	2
G5	1	1

Bot Implementation

Artillery

- The bot ensures that it does not target already hit targets with a 3x3 artilleryHitTargets method
- We modified the frequency of artillery hits depending on difficulty levels

DIFFICULTY LEVELS

EASY

Fires randomly at unmarked cells with no specific focus after a hit. Rare chance of activation

MEDIUM

Medium chance of activation. Targeting mode is set to medium and can thus do more damage

HARD

Artillery is used ASAP and uses the probability density function of target mode to fire

KEY TAKEAWAY

As in the case with fire and radar, artillery coordinates are chosen according to a probabilistic model, simulating intelligent decision making

Bot *Implementation* Radar

- The radar system is used to locate enemy ships within a designated area. It also uses targeting mode to decide which coordinate is best to target

DIFFICULTY LEVELS

EASY

Every 10 turns,
Randomized

MEDIUM

Radar is still more
frequently usable
at 5 turns, still
randomized

HARD

50% chance of
usage, depends on
the hard targeting
mode to prioritize
relevant areas

KEY TAKEAWAY

Radar is smart and can use probability to identify relevant targets. It also updates the probability grid to ensure better firing.

Bot *Implementation* *Smoke*

- **Smoke** targets areas with ships by depending on the recorded grid mentioned before
- It is deemed a priority since the bot's goal is to delay the opponent's finding of ships ASAP

DIFFICULTY LEVELS

EASY

Very rarely used, every 20 turns based on availability, **RANDOMIZED**

MEDIUM

More frequently used, with a focus on areas with ships there

HARD

Used ASAP with same functionality as MEDIUM mode

KEY TAKEAWAY

The smoke screen is an effective defensive tool that obscures vulnerable areas, protecting ships and disrupting the opponent's targeting strategy.

Bot *Implementation* Torpedo

- The bot uses torpedoes when a high concentration of ships is detected or when there is a high probability of hitting an enemy ship.
- Targets an entire row or column, increasing the chances of hitting a ship.

DIFFICULTY LEVELS

EASY

Not allowed in easy mode

MEDIUM

Used once every 10 turns

Randomized torpedo function

HARD




Used ASAP

Probability based targeting


KEY TAKEAWAY

Torpedo is not allowed in easy mode to not overwhelm the player and used aggressively to do as much damage to the player in hard mode

Issues and Resolutions

 Limitations	 Severity	 Resolutions
Handling Edge Cases in Special Moves	High	Introduced boundary checks and a function (handleEdgeCoordinates) to adjust indices, ensuring all special moves operate within grid limits without errors
Bot's Intelligent Behavior	High	Developed adaptive algorithms for targeting, including probability-based strategies and random elements, to balance between predictability and challenge
Bot's Smoke Screen Deployment	Moderate	Improved strategy for deploying smoke screens by monitoring ship status and adding randomness to avoid predictability
Interdependent Function Conflicts	Low	Modularized code, defined interfaces, and implemented comprehensive unit tests, minimizing conflicts between functions like smoke screen and radar sweep.
Late-Game Pacing and Engagement	Low	Introduced additional mechanics, including hunting mode, to maintain player interest and accelerate bot hits

Limitations

 <i>Limitations</i>	<i>Description</i>
Predictability at Lower Difficulties	Players seeking a more challenging experience are encouraged to opt for Medium or Hard difficulties, which feature more strategic bot behavior
Late-Game Pacing	Introducing additional late-game mechanics, such as hints or strategic options, could keep players engaged after all special moves are exhausted
Balance of Special Moves	Providing adjustable settings for the frequency and impact of special moves would help balance gameplay and make it more enjoyable for inexperienced players
Inconsistent Challenge Between Rounds	Develop a system to scale bot difficulty dynamically based on player performance in previous rounds, ensuring a consistent level of challenge and reducing frustration or boredom

Assumptions

<i>Assumption</i>	<i>Description</i>
Smoke Screen Duration	Smoke screens remain active until they block a radar sweep, after which they deactivate, ensuring a balance between tactical use and game progression
Turn Loss on Invalid Input	Players lose a turn for invalid inputs, emphasizing careful command entry, enhancing skill-based gameplay
Special Moves at Edge	Special moves can be used on edge coordinates, with proper handling for out-of-bounds cases, maintaining strategic flexibility across the entire game map
Bot's Priority System	The bot adjusts special move priorities based on difficulty levels, creating variability in gameplay and accommodating different player skills
Map Visibility	Players see their grid and the opponent's tracking grid, with visibility affected by the "hardMode" setting for added challenge

Conclusion!