CMPS 270 Project—Battleship
Phoenix

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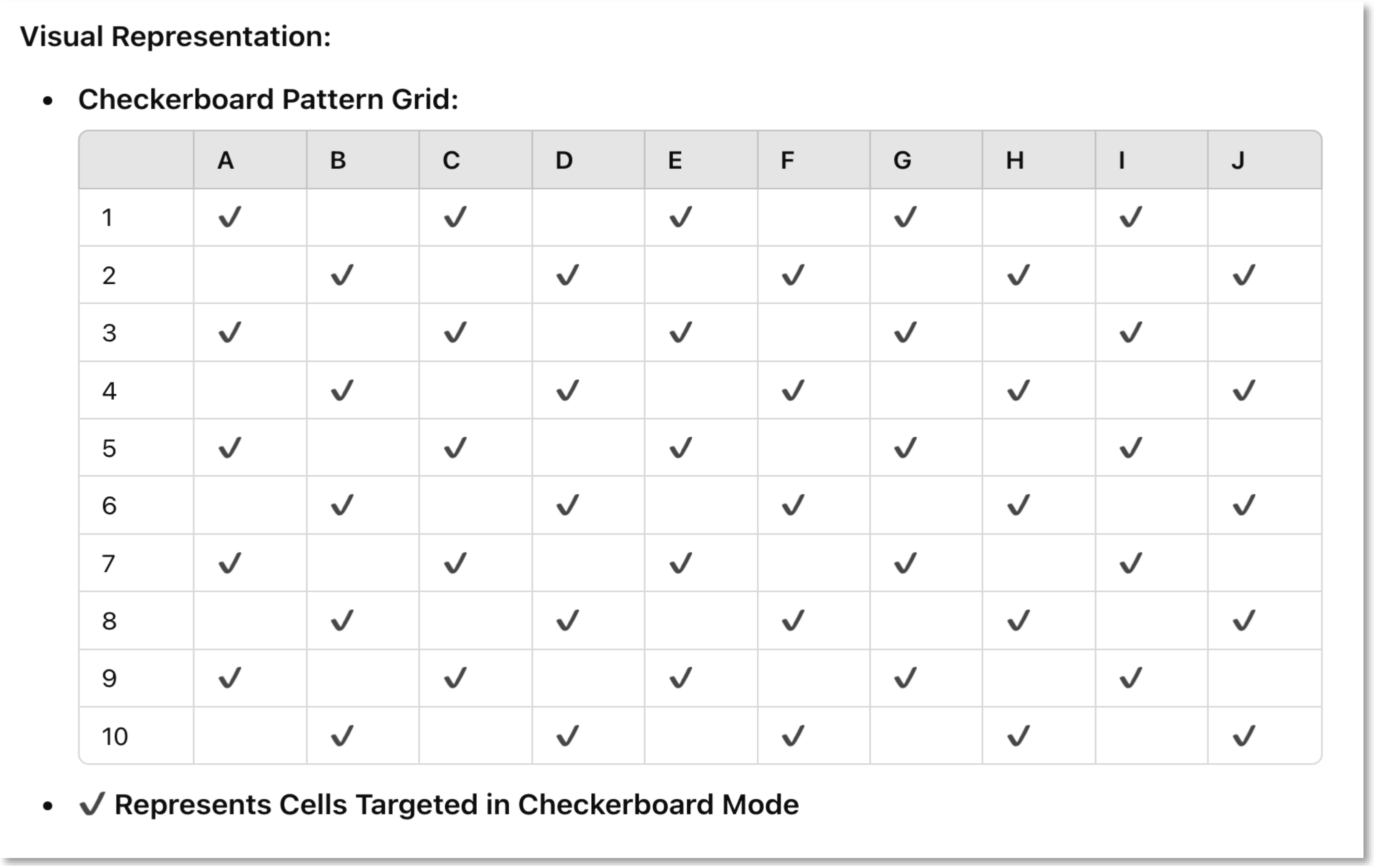
*High-level explanation of **Battleship***

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

Targeting and 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:

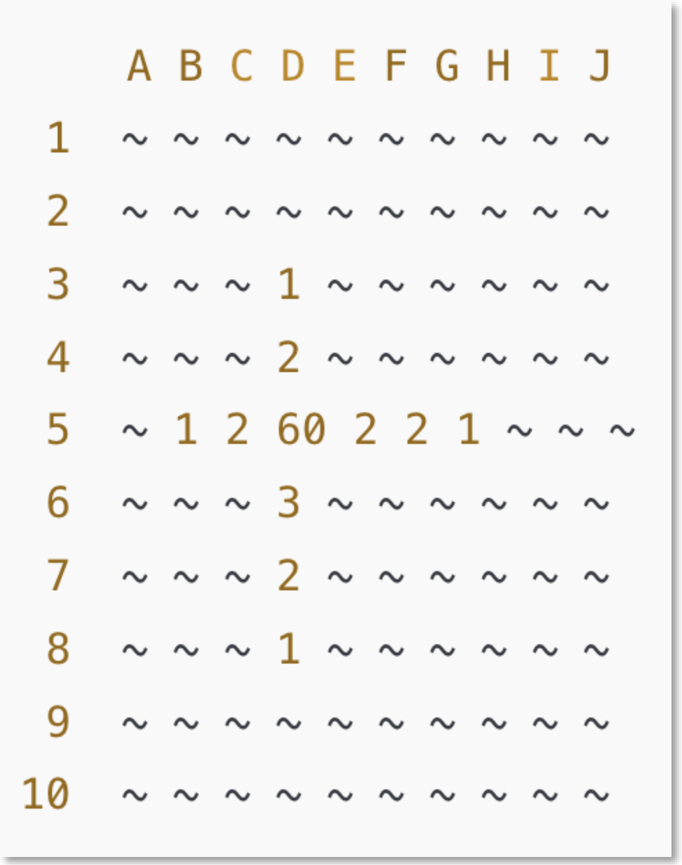
- **Checkerboard Pattern Grid:**

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

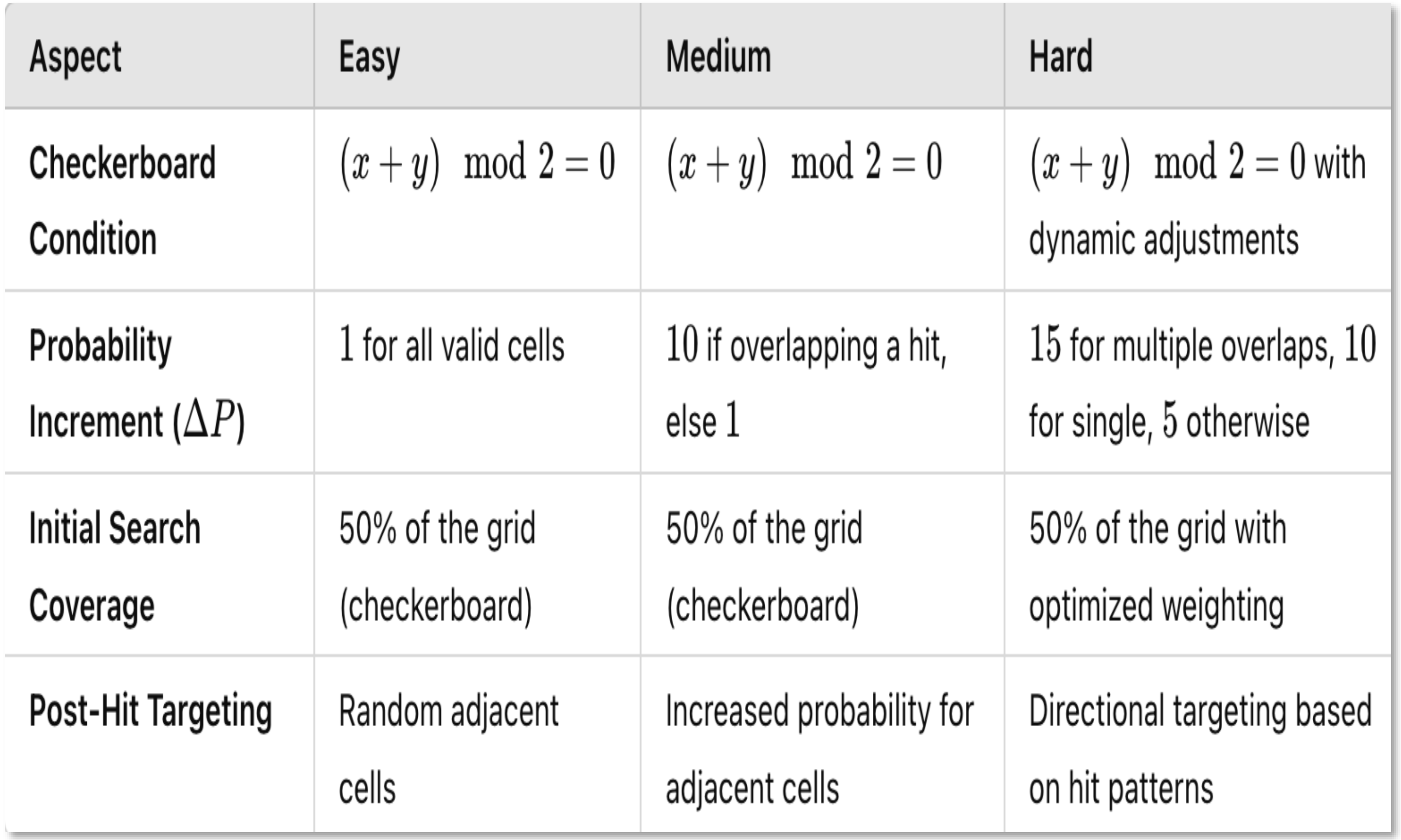
- **✓ Represents Cells Targeted in Checkerboard Mode**

Bot *Implementation*

Probabilistic Explanation



```
   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 ~ ~ ~ ~ ~ ~ ~ ~ ~ ~
```



Aspect	Easy	Medium	Hard
Checkerboard Condition	$(x+y) \mod 2 = 0$	$(x+y) \mod 2 = 0$	$(x+y) \mod 2 = 0$ with dynamic adjustments
Probability Increment (ΔP)	1 for all valid cells	10 if overlapping a hit, else 1	15 for multiple overlaps, 10 for single, 5 otherwise
Initial Search Coverage	50% of the grid (checkerboard)	50% of the grid (checkerboard)	50% of the grid with optimized weighting
Post-Hit Targeting	Random adjacent cells	Increased probability for adjacent cells	Directional targeting based on hit patterns

Bot Implementation

Fire

- When the bot successfully hits a ship, it enters **"Targeting Mode,"** focusing on adjacent tiles to locate and sink the ship.
- The bot prioritizes adjacent cells for subsequent moves, mimicking **human intuition.**

DIFFICULTY LEVELS

EASY

Fires randomly at untargeted cells with no focus after a hit.

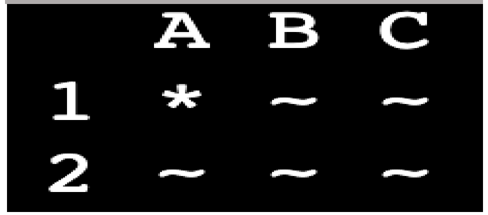
MEDIUM

Switches to Targeting Mode after a hit and targets adjacent cells. *See explanation below*

HARD

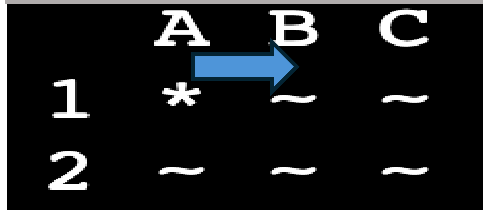
Aforementioned probability density function to calculate what's the most likely target

First HIT!



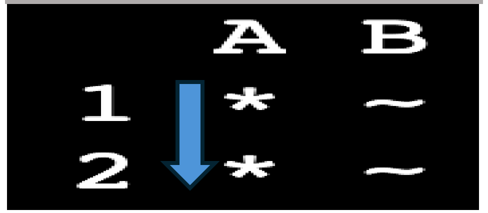
```
    A  B  C
1   *  ~  ~
2   ~  ~  ~
```

Goes horizontally, MISS!



```
    A  B  C
1   *  ~  ~
2   ~  ~  ~
```

Goes vertically, HIT AGAIN!



```
    A  B
1   *  ~
2   *  ~
```

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	*MEDIUM*	*HARD*
Every 10 turns, Randomized	Radar is still more frequently usable at 5 turns, still randomized	Radar is used every 3 turns, uses targeting mode to target near already hit coordinates

KEY TAKEAWAY

The radar system is crucial for identifying enemy ships, enabling targeted follow-up attacks and adapting strategy based on difficulty level to optimize gameplay effectiveness.

Bot Implementation

Artillery

- The bot also targets near already hit coordinates
- Targeting mode is also activated when a hit is confirmed

DIFFICULTY LEVELS

EASY	MEDIUM	HARD
Fires randomly at unmarked cells with no specific focus after a hit, NO targeting mode	Activates Targeting Mode after a hit and targets adjacent cells systematically.	Probability density function to calculate what's the most likely target (targeting mode)

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

Smoke

- **Defensive Maneuver**: The smoke screen is a defensive ability used to obscure a specific area on the board, making it difficult for the opponent to accurately target ships.
- Frequency varies depending on difficulty

DIFFICULTY LEVELS

EASY	*MEDIUM*	*HARD*
Very rarely used, every 20 turns based on availability, RANDOMIZED	More frequently used, with a focus on areas with ships there	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	MEDIUM	HARD
Not allowed in easy mode	Used once every 10 turns Randomized torpedo function	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, incluindg hunting mode, to maintain player interest and accelerate bot hits

Limitations

Limitations	Description
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

Assumption	*Description*
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!