Shipmatrix

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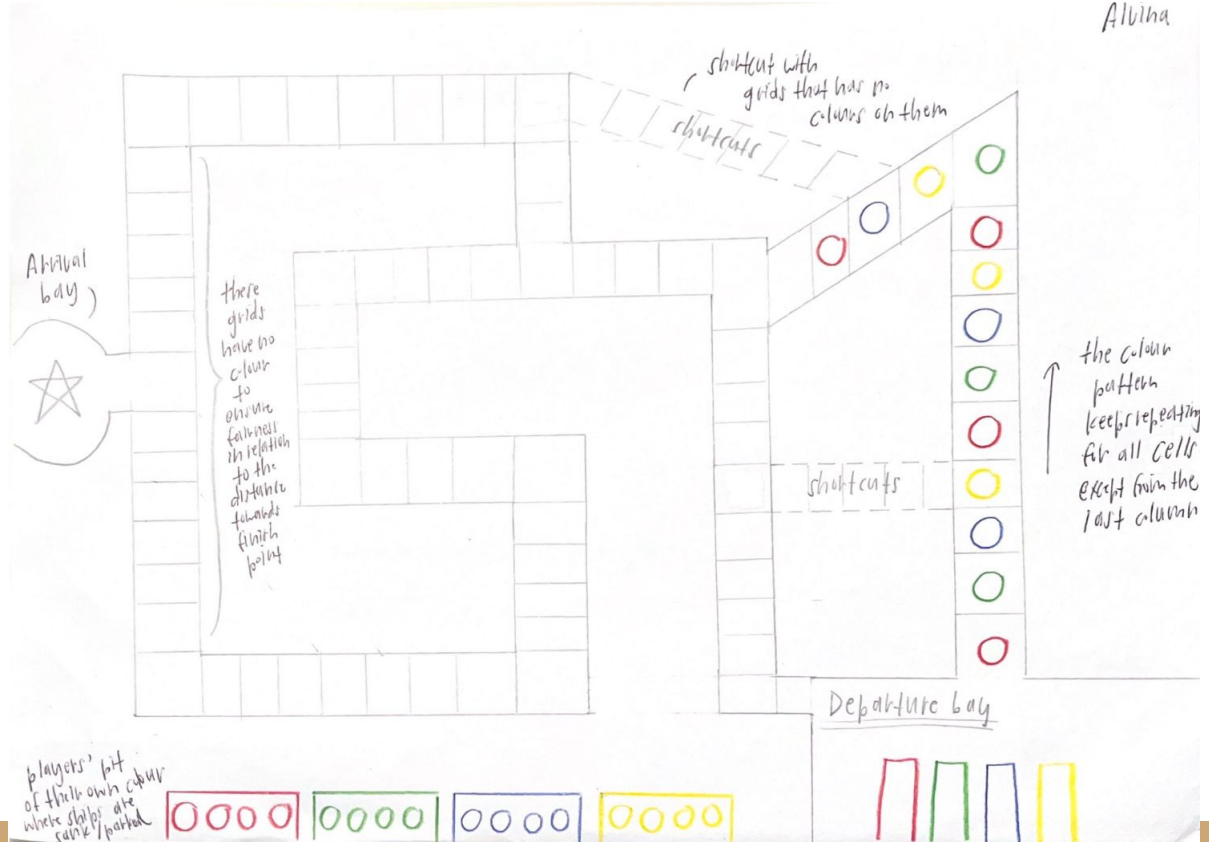
Introduction

From Battleships to Rummikub, Connect4 to Monopoly, I always have a keen interest in finding the most effective way to win but didn't really think much about the possible Maths that can help me to do so. I am always fascinated by the way Maths surrounds us everyday and that I could actually apply my knowledge into the world of games – a strategic mindset training and problem solving wrapped in one board!

The games I mentioned above may seem straightforward, but it actually involves a lot of skills, combining coordinate geometry, combinatorics and optimisation skills on the board! For example, many may think Battleships is just a game of guessing random positions with pure luck, but who would have thought we actually have a better chance of winning by dividing the plane and each coordinate into 2 colours and target only one colour to sank your opponent's ships quicker?

I designed Mathematrix with the aim of surprising players by the 'shortcut' underground ways to win. The game draws players into thinking 'there must be a better way to do this' or 'would this route be the fastest to get to the finish point?'. Not only would this be a great entertainment with your friends and family, it is also a trap to force players into training their problem solving and Mathematical skills. How? Let's start!

A Visual Overview - Rough Idea of ShipMatrix



Components and Set Up

- A grid board, all cells are divided into 4 groups, each allocated a specific colour – Red, Green, Blue, Yellow, arranged in a network interconnected with each other in a square shape, with finishing points at the centre of the square
- Each player picks a colour and are given 4 ships of their own colour, where the ships are parked at their own pit at the starting point before the tokens are ready to ‘depart’
- 2 spinners, where each face on each spinner is labelled 1,2,3 - representing the number of moves your token can head forward
- Arrival bay – first player to get all his 4 ships to the arrival bay will win

How to Play?

1. Players take turn to spin the spinner, players are only allowed to ‘depart’ their ship (one at a time) if they the sum of their scores on the spinners is an odd number
2. Once a ship is departed, the players can then start moving their ship on the grid, where the score on the spinner representing the number of grids their ship are allowed to move forward
3. Players can choose to depart their boats anytime during the game i.e. you don’t have to wait for your first ship to arrive before you depart the next ship
4. The first player who parks all their 4 ships to the arrival bay

Special Rules

- If the player's ship landed on a cell that is of their own colour after the ship has departed, they are allowed to jump across cells and move to the next closest cell of their own colour
- If the player's ship landed on a cell that's already occupied by another other colour ships, they can sink their opponents' ship back to their pit and that player will have to restart by departing their ship again – i.e. repeat step 1
- Players are allowed to choose whether to spin both spinners or only one of them whenever it's their turn
- There're no fixed direction as to which way the ships are moving, players can choose any route of their preferences, and can choose whether to use any shortcuts as well

Winning Strategies – The Maths behind Mathematrix

Probability calculation:

- Since players are allowed to choose how many spinners (only one or both) they want to use each move, they can actually calculate the probability of them getting an odd score in order to depart their ship – in this case, since the spinners are 3-sided and contain 2/3 odd numbers in each spinner, we could then work out the probability of getting an odd number from 2 spinners and compare the likelihood of the player getting an odd number to make their move
- By observing opponents' moves, players can also work out the probability of their own ship getting sank. If they don't want to restart the departure of that ship, they will have to prioritise whatever ship was at risk to move away from the attacker
- Similarly, they can also work out the probability of them sinking other opponents' ships, hence able to deduce whether or not to use 2 spinners to develop the likelihood to do so

Winning Strategies - The Maths behind Mathematrix

Graph theory (The Chinese Postman Algorithm):

- The network on the board may seem simple, but we could use graph theory to deduce the fastest possible route to reach from pit to arrival bay
- This could be done using the route inspection algorithm (also known as the Chinese Postman algorithm), part of decision maths to work out the length of the shortest route possible by counting the number of odd vertices i.e. corners within the shape
- The network on the board actually forms a semi-Eulerian graph, where players can use graph theory and draw out the board as a diagram, hence working out the shortest route possible to minimise the time needed for each ship to arrive

Winning Strategies – The Maths behind Mathematrix

Problem solving and Decision making - a bit of Game Theory:

- As mentioned, the cells around the square has repetitive colours with a rough periodicity of 4, players will have to weigh up the possibilities of them able to jump over 3 cells or decide they should just use the shortcuts to shorten their route
- They would also need to be observant and pay attention to other players' and predicts their potential movement as they would be able to avoid being sank by going the opposite direction as their opponent or vice versa, heading towards their opponent to attack instead
- Players would also need to decide whether they want to get their ship to the arrival bay one by one to minimise the risk of being sank, or do they want to depart several ships i.e. having more than 1 ships of your colour on the board at once to minimise the time needed for all 4 ships to arrive as soon as possible
- Players can also compromise amongst peers to reach nash equilibrium where their strategy stabilise and stick with the same strategy e.g. all players agree to depart their ships one by one and not sink each other's ship to avoid conflict – but that would be no fun!

Winning Strategies – The Maths behind Mathematrix

More advanced level of Maths:

- As mentioned, the game board can be modelled as a graph. To develop this further, players who are keen Mathematicians can model the corners as coordinates and edges as possible move, put it as a adjacency matrix of this graph to find the shortest path possible to optimise their ships movement
- The Markov chain can also be used - a process where the probability of transitioning to any particular state depends only on the current state and not on the sequence of events that preceded it, known as the memoryless property
- Each coordinate on the board can be considered as a state and the moving from one coordinate to another represents a transition between the states
- We can then use a transition matrix which is a square matrix used to describe the probabilities of moving from one state to another in the Markov chain, hence allow players to predict their future positions such as which colour they're likely to land on in order to plan ahead their strategy, which helps minimising risks and maximise successful moves

Thank you so much for reading! Hope you are intrigued into this new board game!

References:

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