# Pre-session Tasks
# Reinforcement Learning

In these short exercises, you'll explore some key ideas behind **Reinforcement Learning**. By observing how decisions are made in games, you'll gain insights into how machines can learn strategies through trial and error.

We'll start by analyzing games and reflecting on our own experiences as p layers. Then, we'll consider a research question to learn from others' experiences. Finally, we'll tackle an open-ended question about building better game-playing strategies.

## 1 Learning from Experience

1. **Analyze a 3x3 Tic-Tac-Toe board.** Consider the following board:

   **X to move:**

   | | | |
   |---|---|---|
   | O | | |
   | X | | |

   Is this a winning position for X? Why or why not? Write your explanation.

2. **Analyze a 5x5 Tic-Tac-Toe board.** In this version, a win requires placing **four** X's or O's in a row, column, or diagonal.

   **O to move:**

   | | | | | |
   |---|---|---|---|---|
   | | | | | |
   | | | O | X | |
   | | | X | | |
   | | | | | |
   | | | | | |

   Is this a winning position for X? Explain your reasoning.

3. **Analyze a 7x7 Tic-Tac-Toe board.** In this version, a win requires placing **five** X's or O's in a row, column, or diagonal.

**X to move:**

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | O | X | | |
| | | O | X | | | |
| | O | | | X | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Is this a winning position for X? Explain your reasoning.

4. Why do the tasks become harder as the board size increases? Write a brief reflection.
5. Estimate how many unique positions are possible on an $n \times n$ Tic-Tac-Toe board.
6. Research: How many unique positions are possible in chess? Write a short summary of your findings.

# 2 Research

1. Watch the following videos and take notes:
   - **How to always win at Dots and Boxes** by Numberphile
   - **Algorithms Explained: Minimax and Alpha-Beta Pruning** by Sebastian Lague
2. Compare the two videos. How are they similar? How do they differ? Could any ideas from the second video improve your strategy for Dots and Boxes?
3. Read about the following terms on Wikipedia: **Heuristic Function, Minimax, Alpha-Beta Pruning.** Write short observations for each concept.
4. Reflect on your personal experiences. Can you think of a situation in your life where you unconsciously used a strategy similar to Minimax or Alpha-Beta pruning? Describe the situation and explain the parallels.

# 3 Open-Ended Question

Given an $n \times n$ Tic-Tac-Toe board, where the winner needs to place **five** X's or O's in a row, column, or diagonal to win, propose strategies for winning such a game.

# 4 Conclusion

See you in the live session in which we will discuss the history of Reinforcement Learning and implement some of the concepts discussed today in Python!