

# Domineering: A Web-Based AI-Driven Game

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## Course Details

This project is submitted as part of the course **Foundation of AI** under the guidance of **Prof. Neeldhara Misra** and **Prof. Manisha Padala**.

## Abstract

This report presents the development of a web-based implementation of the strategy game "Domineering," where a human player competes against an AI opponent. The project highlights game rule enforcement, strategic decision-making by the AI, and a user-friendly interface. The AI employs the Minimax algorithm with Alpha-Beta pruning to deliver a challenging and dynamic gaming experience. Additional features include dynamic board size selection, showcasing the practical application of game theory and artificial intelligence in creating an interactive and engaging game.

## Project Goals

The project aims to:

- Create a functional and interactive web application for "Domineering."
- Implement an AI opponent using the Minimax algorithm with alpha-beta pruning for strategic gameplay.
- Provide an engaging, user-friendly interface with dynamic board size selection and real-time feedback.
- Demonstrate the application of artificial intelligence and game theory concepts in strategic game design.

## Development Framework

- **Frontend Technologies:** HTML, CSS, JavaScript for designing the user interface.
- **Game Interface:** Designed using CSS for styling and JavaScript for interactivity.
- **AI Logic:** Implemented in JavaScript, employing the Minimax algorithm with alpha-beta pruning to optimize decision-making.

# AI Algorithm: Minimax with Alpha-Beta Pruning

The AI in this project utilizes the **Minimax algorithm** with **Alpha-Beta pruning** to enhance decision-making efficiency. Alpha-Beta pruning is an optimization technique for the Minimax algorithm that reduces the number of nodes evaluated in the game tree. By maintaining two values, alpha and beta, the algorithm prunes branches that cannot affect the final decision, improving its performance. The AI opponent evaluates the best move by simulating all possible game states, pruning unpromising paths, and making strategic decisions accordingly.

## Final Product

The final product is a web-based Domineering game that:

- Allows the user to place dominoes on a grid-based game board via mouse clicks.
- Incorporates AI decision-making to generate immediate and strategic moves after the player's turn.
- Implements game rule enforcement to ensure valid moves for both players.
- Detects win/loss conditions and displays results.
- Allows users to restart the game or select different board sizes for variety in gameplay.

## Challenges and Solutions

- **Challenges:**
  - Ensuring moves were valid and did not overlap existing pieces.
  - The computer's depth setting affected its performance and difficulty level.
- **Solutions:**
  - The 'placeItem' function checks adjacency rules before placing a piece on the board.
  - Depth was set to 5 for a balance between challenging gameplay and reasonable response time.

## Future Work

Potential improvements include:

- Expanding AI difficulty levels to cater to a broader range of players.
- Integrate machine learning to allow the AI to adapt and improve based on past games.
- Can include more efficient AI algorithms for more competitive play.

## Project Links

- **GitHub Repository:** <https://github.com/ruchikasonagote/Domineering>
- **Demo Video:** <https://www.youtube.com/watch?v=rLQjQgIwTHk>