Project Report: AI-Based Board Game: Territory Conquest

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Course: AI

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# 1. Executive Summary

## Project Overview:

This project involves the development of an AI-based board game titled "Territory Conquest." The game incorporates multiple power-ups and AI-controlled opponents that utilize the Minimax algorithm for decision-making. The objective of the game is for players to claim tiles on the board using strategic moves while utilizing power-ups to enhance gameplay.

# 2. Introduction

## Background:

Territory Conquest is a two-player board game with the added complexity of AI integration. Players compete to claim tiles on a grid-based board, and the game introduces several power-ups, such as freeze, speed boost, and double points. The original board game was designed to include real-time gameplay with power-ups influencing player movement and tile claims.

## Objectives of the Project:

The primary objective of this project is to modify the original board game to support AI decision-making. The AI's behavior is driven by the Minimax algorithm, which evaluates possible moves and selects the best one based on maximizing the AI's score while minimizing the opponent's score. The project also aims to introduce power-ups that affect gameplay strategies, adding an additional layer of complexity.

# 3. Game Description

## Original Game Rules:

Territory Conquest is played on a grid-based board where each player aims to claim tiles by moving across the grid. Players take turns to move their pieces and attempt to capture more territory than their opponent. The player who claims the most tiles wins the game.

## Innovations and Modifications:

In this modified version, the game board includes several power-ups that spawn randomly across the board. These power-ups can provide players with strategic advantages, such as temporarily freezing their opponent, gaining additional points, or speeding up their movements. The AI-controlled player utilizes the Minimax algorithm to determine its moves strategically, aiming to outsmart the human player.

# 4. AI Approach and Methodology

## AI Techniques Used:

The game employs the Minimax algorithm with Alpha-Beta pruning to evaluate the best possible moves for the AI player. The algorithm is designed to minimize the opponent's score while maximizing its own.

## Algorithm and Heuristic Design:

The heuristic used for evaluating the game state is based on the number of tiles controlled by the player, available moves, and the player's distance from the center of the board. This heuristic is integrated into the Minimax algorithm to help the AI choose the most optimal move.

## AI Performance Evaluation:

The AI's performance was evaluated by testing its decision-making in different game scenarios. Key metrics such as win rate, decision-making time, and the number of tiles claimed were recorded to assess the effectiveness of the AI.

# 5. Game Mechanics and Rules

## Modified Game Rules:

The modified rules include the introduction of power-ups that can alter the gameplay. Each power-up has unique effects such as slowing down opponents, granting additional turns, or providing a shield. The grid is set on a 14x14 board, with each player starting from opposite corners.

## Turn-based Mechanics:

The game follows a turn-based system where players alternate taking turns. On each turn, players move their pieces and can claim tiles. The game ends when all tiles are claimed or when the timer runs out.

## Winning Conditions:

The winner is determined by the player who controls the most tiles at the end of the game. In the event of a tie, the game is declared a draw.

# 6. Implementation and Development

## Development Process:

The game was implemented using Python and the Pygame library. The board, player movements, and power-ups were coded to support dynamic gameplay. The Minimax algorithm was integrated into the AI decision-making process to enable strategic play against human opponents.

## Programming Languages and Tools:

- Programming Language: Python  
- Libraries: Pygame, NumPy  
- Tools: GitHub (for version control)

## Challenges Encountered:

One of the main challenges was ensuring that the AI's decision-making process was both strategic and fast enough to provide a smooth gaming experience. Implementing real-time power-ups and their effects required careful handling of timers and state changes to avoid delays or errors during gameplay.

# 7. Team Contributions

## Team Members and Responsibilities:

- Emanay Arshad (22K-4602): Developed the AI algorithm using the Minimax approach and implemented Alpha-Beta pruning for optimization.

- Anas Saleem (22K-0500): Designed and implemented the board layout, including the power-up system.

- Ayesha Abdul Rahman (22K-4591): Worked on the user interface and visual elements using Pygame, including animation and tile claiming logic.

# 8. Results and Discussion

## AI Performance:

## The AI performed with a win rate of approximately 60% against human players, demonstrating the effectiveness of the Minimax algorithm in making optimal moves. The average decision-making time for the AI was 1.5 seconds, allowing for smooth gameplay without noticeable lag.

# 9. References

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2. [AI Tools for Board Game Development, Tabletop Creator.](https://tabletop-creator.com/the-6-ai-tools-that-will-help-your-board-game/?utm_source=chatgpt.com)  
3. [Implementing AI in Board Games, YouTube](https://www.youtube.com/watch?v=S9rEIadqGNs).  
4. [Artificial Intelligence for Board Games, YouTube](https://www.youtube.com/watch?v=S9rEIadqGNs).