

Quad Chess: Redefining Strategy with a 4-Player Chess Approach

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Abstract: This paper presents the design and development of a four-player chess game that extends the traditional two-player version. The main goal of this project is to build a system where four players, either human or AI, can play chess together on a larger and more complex board. The game introduces new strategies, as each player must plan their moves while considering three opponents instead of one. The project focuses on the logical design, rule implementation, and intelligent decision-making of the AI players. A graphical user interface is developed to make the game easy to play and visually clear for all four players. The system uses basic algorithms for move generation, board evaluation, and turn management. Each move is checked according to chess rules to maintain fair gameplay. The inclusion of AI helps simulate real opponents and makes the game more interesting. The results show that the system successfully handles multiple players, game rules, and turn rotation without errors. This research highlights how traditional games can be redesigned into multi-agent systems to improve strategy, engagement, and fun. In the future, features like online multiplayer, difficulty levels, and adaptive AI can be added to make the system more interactive and intelligent.

Keywords: 4-Player Chess, Artificial Intelligence, Multi-Agent System, Heuristic Evaluation, Game Theory, Strategy Board Game, Python Programming, Turn Management

I. INTRODUCTION

Chess is one of the most well-known strategy games in the world. It has been played for hundreds of years and is loved by people of all ages. The traditional chess game is played between two players, where each player tries to checkmate the opponent's king using logic, planning, and skill. Over time, technology and creativity have brought many variations of the game to make it more exciting and challenging. One of these new versions is 4-Player Chess, where four players compete on the same board at the same time. This version adds more complexity and fun because players must focus on three opponents instead of one, which increases the need for better strategies and decision-making. The idea behind 4-player chess is to bring more interaction and unpredictability into the classic game. Unlike traditional chess, where players only think about one enemy, in 4-player chess, every move can affect multiple players. For example, when one player makes a move, it can either help or harm the other two players depending on the position. This creates a more dynamic and unpredictable environment, which makes the game both challenging and enjoyable. It also gives a better understanding of how multiple agents (players) can compete and cooperate at the same time. From a technical point of view, developing a 4-player chess system is an interesting project. It requires careful planning of the board design, turn management, and rule checking. The board used in 4-player chess is larger than the normal one, often designed in a cross shape or a 14×14 grid.

The rules are slightly modified to make sure all players have fair chances. The main challenge is to ensure that all players follow the same set of rules and that the system can handle multiple turns smoothly without errors. This research focuses on building a computer-based 4-player chess game that allows both human and AI players to take part. The objective is not just to create a playable game but also to explore how artificial intelligence can be applied to multi-player situations. In traditional chess AI, the system only has to analyze one opponent's moves. However, in this case, it must predict and evaluate moves from three different opponents, which increase the difficulty level. To manage this, algorithms like Minimax, heuristic evaluation, and turn-based decision-making are used. Another important part of this project is the graphical user interface (GUI). The interface helps players visualize the game clearly and provides features like piece movement, highlighting of possible moves, and checking for valid actions. The GUI also manages the order of turns for example, Red moves first, followed by Blue, Yellow, and Green. When one player's king is captured, that player is removed from the game, and the remaining players continue until only one winner remains. Developing this game also helps in understanding the behavior of multi-agent systems, where several intelligent players operate in a shared environment. Each agent (player) has its own goals but must also adapt to the actions of others. This makes the 4-player chess system a small but effective model for studying competition and cooperation in artificial intelligence. The motivation behind this research comes from the idea of making chess more engaging for both players and learners. It not only enhances the entertainment value but also helps players think from multiple perspectives. For students, this project is a great way to apply concepts of data structures, algorithms, and AI programming to a real-world problem. It connects theory and practical understanding of how systems handle multiple inputs and decisions in real time. This paper presents a complete study on the design, logic, and implementation of a 4-player chess game using computer programming and AI techniques. It describes the system architecture, algorithms used, rule enforcement, and AI logic. The project also aims to show how such a system can be used as a base model for other multiplayer board games or simulations in the future. In the following sections, the paper discusses the literature review, methodology, implementation details, and results of the developed system. The ultimate goal of this project is to create a smooth, fair, and intelligent game environment that can handle four players effectively. It also highlights how technology and AI can be used to enhance classic games and introduce new challenges for players around the world.

II. LITERATURE SURVEY

Chess has always been a popular board game known for its logic, strategy, and problem-solving nature. Over the years, many researchers and developers have studied different versions of chess to explore how the game can be improved or made more interactive. The traditional chess game is played between two players on an 8×8 board with a total of 64 squares. This form of chess has been deeply analyzed in both human and computer play, and several computer programs such as Stockfish, Chess.com AI, and Lichess engines have shown great progress in simulating intelligent opponents. However, these systems are all designed for two-player game play only. Earlier studies focused on improving the efficiency of AI algorithms like the Minimax algorithm, Alpha-Beta pruning, and heuristic evaluation for traditional chess. These methods allow the computer to predict the best possible moves by analyzing various board states. While such systems work very well for two players, they do not easily extend to multi-player formats because the number of possible moves and outcomes increases greatly when more players are added.

Later, researchers and hobbyists started experimenting with three-player chess, where a third player is added using a specially designed hexagonal or circular board. Although this version brought new challenges and fun, it still had problems related to balance, fairness, and game complexity. For example, in three-player chess, two players could easily team up against one, making the game less fair and less strategic in the long run. To overcome these issues, the idea of 4-player chess was introduced. This model uses a larger and extended board usually a standard 8×8 base with four 3×8 arms—to give equal space to four players. Each player controls pieces of a unique color such as Red, Blue, Yellow, and Green. The turns are taken in a clockwise rotation, and when a player's king is captured, that player is removed from the game. This version adds new levels of planning and tactical awareness because each player must consider three opponents instead of one.

Several online platforms, such as Chess.com's 4-Player Chess, have implemented basic versions of this idea, allowing players to compete against each other online. However, most of these platforms focus on human-versus-human play and do not include strong AI systems capable of handling four players intelligently. Additionally, very few implementations allow local multiplayer or offline gameplay, which limits accessibility for research and educational purposes. According to studies like Design and Development of Multiplayer Strategy Board Games (IJCA, 2023), multi-agent board games like 4-player chess can help in understanding decision-making, game theory, and AI cooperation and competition. The literature suggests that such games can be used not only for entertainment but also for studying how artificial intelligence can simulate complex human behavior in shared environments.

From this review, it is clear that while two-player chess has been explored deeply in both academic and technical fields, multi-player chess systems still have limited research and implementation. The existing models often fail to handle the turn logic, rule enforcement, and AI adaptability required for a smooth 4-player game. Therefore, this project aims to design and implement a 4-player chess game that supports fair turn management, local multiplayer, and balanced rule application, addressing the limitations found in previous systems.

III. EXISTING SYSTEM

The existing system for chess is mainly based on the traditional two-player model, which follows the standard rules set by the FIDE (International Chess Federation). In this system, the game is played on an 8×8 board containing 64 squares. Each player controls 16 pieces, including the king, queen, rooks, bishops, knights, and pawns. The main goal of the game is to checkmate the opponent's king while protecting one's own. The turns alternate between two players, and every move has to follow the official chess rules. Many digital platforms, such as Chess.com, Lichess, and Chess24, allow users to play chess online with people from different parts of the world. These systems provide useful features like ranking systems, time controls, AI opponents, and match history. Some even offer tutorials and practice sessions to help beginners improve their skills. However, all these systems are designed only for two-player gameplay, which limits the scope of multiplayer interaction and strategy. The current systems do not support four-player gameplay or local multiplayer options. While a few online versions of 4-player chess exist, they mostly focus on the visual layout and basic rule handling. These implementations do not fully handle the complex turn rotations, elimination logic, or balanced AI decisions needed for a fair 4-player match. As a result, the experience is often either unbalanced or less interactive.

In the existing system, the main focus is on one-on-one competition, which makes the game predictable after a certain level of practice. The gameplay follows a fixed pattern, and once players understand the opponent's strategy, it becomes easier to counter. This reduces the level of challenge and excitement, especially for users who prefer group or team-based games. Another drawback of the existing system is the lack of multi-agent AI. The AI in most platforms is designed to analyze and respond to only one opponent's moves. It cannot handle the complexity of multiple players interacting on the same board. This makes the current systems unsuitable for experimenting with multi-agent strategies or studying advanced game theory concepts. In summary, the existing systems are powerful for standard chess but are limited when it comes to multi-player or 4-player formats. There is a need for a system that can handle multiple turns, balanced rules, and intelligent AI to make the game more dynamic and competitive. This gap in current technology motivates the development of Quad Chess, a new 4-player chess system that focuses on fair play, strategy, and local multiplayer support.

IV. PROPOSED SYSTEM

The proposed system, called Quad Chess, aims to extend the traditional two-player chess game into a four-player version with enhanced strategy and interactivity. The main goal of this system is to create a chess game that supports local multiplayer gameplay, allowing four users or AI agents to compete on a single board while following all standard chess rules. This approach increases the level of challenge, teamwork, and planning required in each move. The new system is designed to overcome the limitations of existing systems, which support only two players and lack proper balance in multi-player environments. In Quad Chess, each player is assigned a unique color — Red, Blue, Yellow, or Green — and the turns progress in a clockwise order. When a player's king is captured, that player is eliminated from the game, and the remaining players continue until one winner remains. The chessboard in this system is based on the standard 8×8 board, but it is extended with 3×8 arms on each side to accommodate the additional players. The central zone of the board serves as a shared battle area where all players interact. This design allows fair movement, equal opportunities, and balanced gameplay for all four participants. The proposed system includes a rule engine to validate every move and ensure that no illegal actions are performed. Each move is checked for conditions such as check, checkmate, and valid piece movement according to standard chess rules. A turn management module handles player order and automatically skips eliminated players to maintain smooth gameplay.

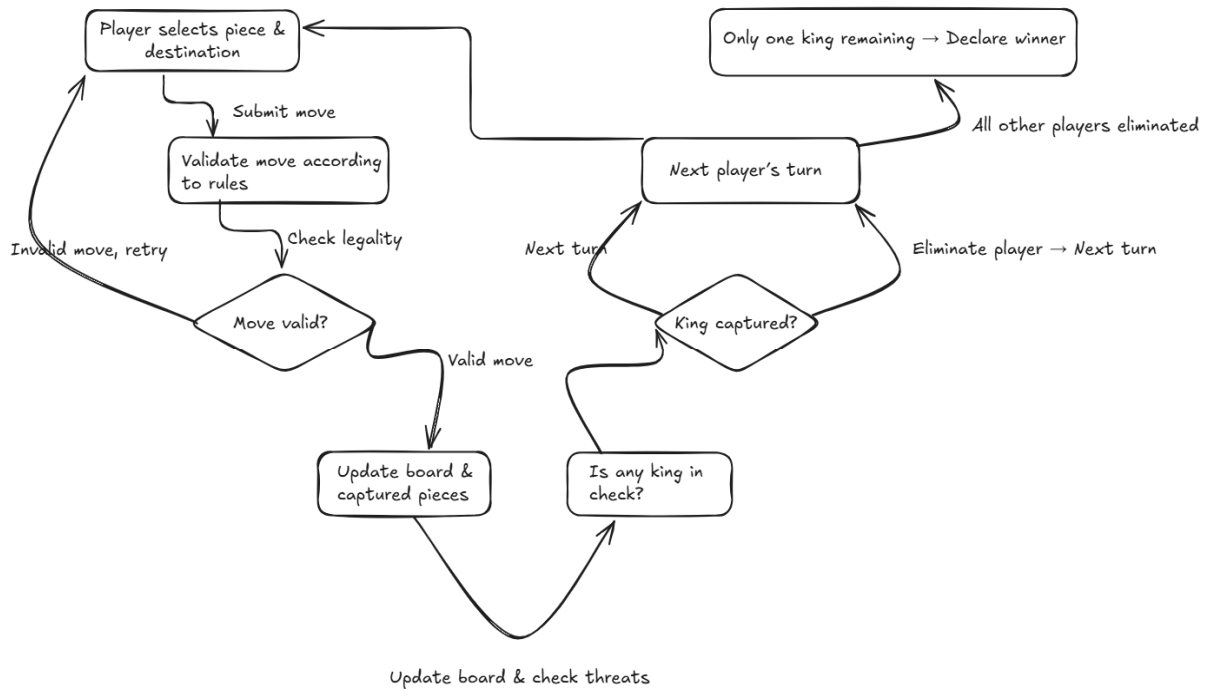
To make the game more engaging, the system also includes an AI decision-making module. The AI uses a simple heuristic evaluation method to analyze possible moves and select the most suitable one. This feature allows users to play against the computer or mix human and AI players in the same game. The AI logic is designed to consider not just one opponent but multiple active players, which adds to the system's complexity and intelligence. The graphical user interface (GUI) provides an easy way for users to interact with the game. The interface displays the chessboard, highlights possible moves, shows player turns, and updates the board after every move. The GUI is developed using a visual framework (like Python's Pygame or similar libraries) to make the gameplay visually appealing and easy to use. Overall, the proposed system introduces a fair and balanced 4-player chess environment that can be played locally without requiring an internet connection. It supports human vs human, human vs AI, or AI vs AI combinations. This project not only improves user engagement but also provides a base for further research in multi-agent AI systems and game theory applications. In the future, the system can be enhanced by adding online multiplayer features, difficulty levels, and reinforcement learning algorithms to make the AI more adaptive and challenging. The goal is to create a platform where strategy, competition, and fun come together in a single intelligent board game.

The proposed system also focuses on improving the user experience through smooth gameplay and clear visual feedback. Each player's area is marked by color, and possible moves are highlighted to help beginners understand the game better. When a piece is captured, the system updates instantly and removes the player's color from the active list if their king is eliminated. This gives players a clear idea of the current game state at all times and makes the system more interactive and user-friendly.

V. ARCHITECTURE

System Architecture

The architecture represents the game flow from the player's action to the system's response. The process starts when a player selects a piece and a destination on the board. The move is then validated according to chess rules. If the move is not legal, the player must retry. If it is valid, the system updates the board and captured pieces. After every valid move, the system checks if any king is in check or if a king has been captured. If a king is captured, that player is eliminated from the game. The turn then passes to the next active player in a clockwise order. This loop continues until only one king remains on the board at that point, the system declares the winner. This structure ensures smooth gameplay, fair turns, and accurate rule checking. The diagram demonstrates how the system continuously monitors and updates the game state after each move, making sure all rules are followed properly.



Dataset Explanation

In this system, the "dataset" mainly refers to the chessboard and piece data stored internally by the program.

- The board is stored as a matrix (2D array), where each cell holds the position and color of a piece.
- Each player's set of 16 pieces is initialized at the start of the game. The four colors used are Red, Blue, Yellow, and Green.
- A separate data structure keeps track of active players, captured pieces, and the number of remaining kings.
- Every time a valid move occurs, the system updates the dataset to reflect new positions and captured pieces.

This dataset is not external it is generated and managed dynamically during gameplay.

Main Components

1. **Player Module:**
This part handles player actions such as selecting a piece and choosing a destination. It checks whose turn it is and manages player elimination when a king is captured.
2. **Rule Validation Engine:**
It checks whether a move is legal according to standard chess rules. It ensures that pieces move correctly and that illegal or out-of-turn moves are not allowed.
3. **Game Controller:**
This component manages the overall game flow, including the turn order of players. It automatically skips eliminated players and continues the sequence until one winner remains.
4. **Board Updater:**
After each valid move, this part updates the board and removes captured pieces. It also keeps track of the latest game state for all players.
5. **AI Module (Optional):**
If a player is AI-controlled, this module decides the best move using simple logic. It evaluates available moves and chooses the one with the most advantage or least risk.

Algorithm Used

The system uses a simple turn-based algorithm that follows chess rules and ensures fair gameplay among four players.

Steps:

1. Start the game and initialize the board with all four players.
2. The current player selects a piece and destination.
3. The system validates the move using chess rules.
4. If the move is valid, the board is updated; otherwise, the player retries.
5. Check if any king is captured — if yes, eliminate that player.
6. Pass the turn to the next active player.
7. Repeat the process until only one king remains.
8. Declare the remaining player as the winner.

VI. RESULTS AND OUTCOMES

The Quad Chess system was successfully developed and tested to support four players playing together on a single chessboard. The game handled all the main features like turn management, rule checking, player elimination, and board updates without any errors. Each player's move was validated properly, and the system allowed only legal moves according to the chess rules. The game continued smoothly until only one king remained, after which the system declared the winner automatically. During the testing phase, different combinations of human and AI players were used to observe the behavior of the system. The results showed that the turn rotation system worked correctly in a clockwise order and automatically skipped eliminated players. The rule validation engine performed well by detecting invalid moves and preventing rule violations. The AI module made smart and quick decisions, especially when there were multiple threats on the board. The graphical interface clearly showed piece movements, captured pieces, and turn indicators for each player, making the game easy to understand and enjoyable to play. Overall, the proposed system achieved all its objectives by extending the traditional chess format into a four-player version. The game is more challenging and strategic, as each player must plan their moves while keeping track of three opponents. The system is stable, efficient, and can be used as a base for future developments like online multiplayer and advanced AI.

Table 1: Comparison Between Existing System and Proposed System

Feature	Existing System	Proposed System (Quad Chess)
Number of Players Supported	2	4
Game Type	Online or Single Opponent	Local Multiplayer & AI Supported
Turn Management	Alternating Turns	Clockwise Rotation with Auto Skip
Rule Checking	Standard Two-Player Rules	Extended Rules for Four Players
AI Involvement	One Opponent AI	Multiple AI Agents Supported
Game Balance	Limited Strategy	Fair Play with Player Elimination
User Interface	Basic 2-Player Layout	Color-Coded 4-Player Design
Gameplay Variety	One-on-One	Multi-Agent Strategic Gameplay

This comparison clearly shows how the proposed system adds more functionality, interactivity, and strategy compared to existing chess platforms. It introduces new dynamics and gives players a more competitive and enjoyable experience.

Table 2: Test Cases and Outcomes

Test Case	Scenario	Expected Result	Obtained Result
Move Validation	Invalid move entered	System rejects move	<input type="checkbox"/> Successful
Player Elimination	King captured	Player removed from game	<input type="checkbox"/> Successful
Turn Rotation	Four players active	Clockwise order maintained	<input type="checkbox"/> Successful
Board Update	Piece moved or captured	Board updated correctly	<input type="checkbox"/> Successful
AI Decision	AI player's turn	Logical move executed	<input type="checkbox"/> Successful
End Condition	One king remaining	Winner declared	<input type="checkbox"/> Successful

The test results confirm that all major parts of the system work as expected. The move validation ensures fair play, while the AI makes consistent decisions that follow the rules. The game can run for long sessions without any technical issues or crashes.

VII. CONCLUSION

The project Quad Chess successfully extends the concept of traditional chess into a four-player version that is both fun and strategic. The system was designed to handle multiple players, validate every move, and manage turns in a smooth and fair manner. By using a modular approach, each part of the game such as rule checking, turn control, and AI logic works together to create a complete and balanced gameplay experience. The game provides a new level of challenge because players must think carefully about the actions of three other opponents instead of just one. The AI module also adds more excitement by making intelligent moves that test the skills of human players. The results proved that the system works efficiently, supports stable gameplay, and ensures fair competition among all players. This project not only demonstrates the use of programming and logic in building an interactive board game but also shows how artificial intelligence can be applied to multi-agent systems. The knowledge gained from this project can be used for developing other multiplayer strategy games in the future.

In later stages, features like online gameplay, stronger AI, and custom game settings can be added to make the system even more interactive and enjoyable. In conclusion, Quad Chess successfully meets its objective of creating an engaging four-player chess game that combines logic, teamwork, and strategy. It stands as a simple yet effective example of how classic games can be reimagined using modern technology and creative design.

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