



Wentworth Institute of Technology

COMP4960 – Software Engineering

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Software Design Document

for

Arcane Chess

Version 1.2

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11/5/25

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Revision History

Date	Version	Description	Author(s)
09/18/2025	1.0	SRS Document Created; Collaborators added	David Costa
10/20/2025	1.1	Version 1 Revised	Nathaly Phrasavath, David Costa, Bryce Parkinson, Ibukunoluwa Folajimi
10/23/2025	1.2	First draft of SDD	Nathaly Phrasavath, David Costa, Bryce Parkinson, Ibukunoluwa Folajimi
11/3/2025	1.3	Final revision of SDD with edits	Nathaly Phrasavath, David Costa, Bryce Parkinson, Ibukunoluwa Folajimi

1. Introduction

1.1. Document purpose

The purpose of this Software Design Document (SDD) is to outline the technical architecture and design framework for Arcane Chess, a modern version of the classic chess game enhanced with trading card mechanics inspired by Magic: The Gathering. This document translates the functional requirements from the Software Requirements Specification (SRS) into detailed design specifications, describing system structure, component interactions, and data flow to guide developers during implementation.

Arcane Chess aims to blend the strategic depth of traditional chess with the dynamic, customizable gameplay of a trading card system. Players will be able to build decks before matches and decide each turn whether to move a chess piece or play a card, introducing new possibilities for tactical decision-making. This SDD ensures that the design supports these objectives through a scalable, maintainable, and well-structured software architecture.

1.2. Product overview

1.2.1. Problem statements

Traditional online chess platforms provide consistent gameplay experiences but offer limited variability or strategic diversity beyond standard moves. This can make matches feel repetitive and predictable, especially for experienced players seeking new layers of depth. Additionally, most platforms focus solely on classic chess mechanics and lack features that blend other genres or dynamic gameplay systems to enhance engagement.

1.2.2. Proposed solution

Arcane Chess introduces an innovative twist to traditional chess by integrating trading card game mechanics into standard chess rules. Players will build custom decks of 16 cards, each containing unique effects that can alter the state of the board, enhance pieces, or manipulate gameplay conditions. Every turn, a player can choose to either move a chess piece or play a card, creating a dual-layered strategy system that balances tactical positioning with card-based decision-making.

The system will be implemented as a web-based application featuring real-time matchmaking, interactive tutorials, and an intuitive user interface that provides visual feedback for all player actions.

1.2.3. Novelty

Arcane Chess stands out by merging two established gaming genres—classical chess and strategic trading card games—into a single, balanced competitive experience. Unlike other chess variants, this system introduces resource management and deck customization, allowing for personalized strategies and evolving gameplay. The combination of real-time web interactivity, visual effects, and deck-building mechanics provides a fresh, engaging approach that revitalizes the timeless appeal of chess while maintaining its intellectual challenge.

1.3. Product functionality

The Arcane Chess system integrates traditional chess gameplay with collectible card mechanics through an interactive, web-based platform. The system's functional requirements outline how players interact with the interface, build decks, enter matchmaking, and engage in matches.

Players will connect through a visual web interface where they can construct a 16-card deck from a catalog of 32 available cards. Once both players confirm their decks, the system automatically pairs them using the matchmaking service. Gameplay follows a turn-based structure, allowing players to move chess pieces or activate card effects that alter the board state.

The interface dynamically reflects game updates in real-time, including animations, piece movements, and visual indicators of captured pieces. Each match is governed by synchronized 15-minute timers per player, ensuring fairness and pacing. When a game concludes, players are prompted to rematch or re-enter the matchmaking queue. Together, these functions ensure a seamless, interactive, and competitive experience that combines the strategic depth of chess with the variability of a trading card game.

1.4. Definitions

Arcane Chess: a digital game that combines traditional chess mechanics with trading card elements, where players can choose to move a chess piece or play a card on their turn.

Card Effect: A special ability or modification applied to the board, pieces, or game state when a card is played. Examples include enhancing a piece, altering movement, or creating environmental effects.

Deck: A collection of cards selected by a player before the match, influencing strategy and gameplay style.

Turn: A single opportunity for a player to either move a piece or play a card.

Piece: A standard chess unit (e.g., pawn, rook, bishop, or any unit new to Arcane Chess) that can move according to traditional chess rules unless modified by card effects.

Board State: The current configuration of all chess pieces, cards in play, and ongoing effects.

1.5. Acronyms and abbreviations

SDD: Software Design Document.

FR: Functional Requirement.

NFR: Non-Functional Requirement.

JS: JavaScript.

HTML: Hypertext Markup Language.

CSS: Cascading Style Sheets.

WS: Web Socket.

ASGI: Asynchronous Server Gateway Interface.

UI: User Interface(s).

2. System requirements

2.1. Functional requirements

1. FR1: The system shall provide a visual web interface for players to interact with using their cursor.

Design Implementation:

- 1.1. Implemented using JavaScript for a responsive, browser-based interface.
- 1.2. The chessboard and cards shall be rendered dynamically using JS.
- 1.3. Event listeners in JavaScript shall capture player actions (clicks, hovers, drags) for piece movement and card play.
- 1.4. The interface communicates with the backend through a WebSocket connection for real-time updates and synchronization between players.
- 1.5. Visual feedback such as animations or color changes will be achieved using JS.

2. FR2: Once connected, players shall build their deck of 16 cards from the available 32 and click a button to enter matchmaking.

Design Implementation:

- 2.1. A deck-building page created with JavaScript will display all available cards as selected elements.
 - 2.2. When a player selects or deselects cards, JavaScript shall update the deck configuration dynamically.
 - 2.3. The selected deck (16 cards) will be validated client-side, then sent to the server.
 - 2.4. The server validates deck size and uniqueness before storing it for matchmaking.
3. FR3: Once two players have joined the queue, players shall be placed into a match together.

Design Implementation:

- 3.1. The client sends a match request to the server using a WebSocket message.
 - 3.2. The back-end Game Manager module manages an in-memory queue that pairs available players.
 - 3.3. When two players are matched, the server creates a new Game State instance and notifies both clients through WebSocket messages to start the game.
4. FR4: Players shall be able to view an enlarged view of each of their cards by hovering their cursor on the card.

Design Implementation:

- 4.1. JavaScript shall be used to give updates and show animations that will visually represent state change.
 - 4.2. The visual state of the game will always reflect the latest synchronized data from the server.
5. FR5: All player actions shall be performed by selecting a piece or card using the cursor, then selecting either where the piece shall move, or which piece/location the card shall affect.

Design Implementation:

- 5.1. JavaScript shall handle all interaction logic for player inputs (selecting a piece, card, or target square).
- 5.2. Each input event triggers a WebSocket message sent to the server containing the move or card details.
- 5.3. The backend validates each action and updates the Game State accordingly.
- 5.4. The updated state is broadcast back to both clients to refresh their views in real time.
6. FR6: After performing an action, the player's screen shall be updated according to the action they performed.

Design Implementation:

- 6.1. JavaScript shall be used to give updates and show animations that will visually represent state change.
- 6.2. Visual effects such as a color change or sprite alteration shall indicate the effect of a card.
- 6.3. A piece being moved shall appear in its new location.
7. FR7: All Pieces taken shall appear between the board and card playing sections. Opponents taken pieces shall appear near the top while players taken pieces shall appear near the bottom.

Design Implementation:

- 7.1. A visual bar will be displayed along the top of the game interface, showing all pieces that the opponent has captured from the player.
- 7.2. The bottom of the game interface will display the pieces that the player has captured from the opponent for visual balance.
- 7.3. When a piece is captured, the backend sends a WebSocket message to both clients, identifying the captured piece type, its color, and the capturing player.
- 7.4. Upon receiving the event, the frontend JavaScript code updates the captured pieces bar by adding the appropriate piece icon or increasing the count if the same piece type has already been captured.
- 7.5. The captured pieces are non-interactive, serving only as a visual indicator of captured material throughout the match.
8. FR8: Cards held in hand shall appear along the right of the view.

Design Implementation:

- 8.1. A card display panel shall be positioned along the right side of the game interface, showing all cards currently held by the player.
- 8.2. Each card will be represented by a rectangular placeholder asset containing the card's name and a short description of its effect.
- 8.3. The front-end JavaScript manages the player's hand state locally, updating the right-side panel in real time as cards are drawn, played, or discarded.
- 8.4. The backend server sends updates to each player through WebSocket messages whenever a card is added to or removed from their hand.
9. FR9: The game state shall include a timer for each player which begins at 15 minutes and counts down for each player while it is their turn. If a player's timer reaches 0, they lose the game automatically.

Design Implementation:

- 9.1. A JavaScript timer displays each player's remaining time in the game interface.
- 9.2. The backend manages the official countdown
- 9.3. WebSocket updates keep both clients synchronized with the server clock.
- 9.4. When a timer reaches zero, the server ends the match and declares the opponent as the winner.
- 10. FR10: When a game concludes, both players shall be prompted to either rematch, or rejoin the queue to find a new opponent.

Design Implementation:

- 10.1. The backend will send a game-end message via WebSocket containing the result and player options.
- 10.2. JavaScript displays a dialog box with "Rematch" and "Return to Queue" options.
- 10.3. Selecting "Rematch" sends a signal to the server to restart the game with the same players.
- 10.4. Selecting "Return to Queue" re-enqueues the player through the matchmaking system.

2.2. Non-functional requirements

1. NFR1: The system shall update the opponent's screen no more than 5 seconds after a player's move has been registered.

Design Implementation:

- 1.1. The backend transmits move updates via WebSocket immediately after processing a turn.
 - 1.2. The front-end listens for these messages and updates the board state in real time.
 - 1.3. If a delay exceeds 5 seconds, the client triggers a resync request to fetch the current state.
 - 1.4. This ensures both players' views remain synchronized throughout the game.
2. NFR2: The server which manages the game state shall have a maximum capacity of 20 concurrent games.

Design Implementation:

- 2.1. Each active game session is managed by a separate Game State instance in memory.
 - 2.2. The server enforces a connection limit of 40 players (20 matches).
 - 2.3. Attempts beyond this limit return a "server full" message to connecting clients.
 - 2.4. Resource usage is monitored to ensure stable performance under maximum load.
3. NFR3: The server shall validate each player's turn, through confirmation of movements and/or played cards based on the previous state of the gameboard and players' hands.

Design Implementation:

- 3.1. Each move or card play is checked against the Game State before being accepted.
- 3.2. Invalid or duplicate actions are ignored, and an error message is returned to the client.

- 3.3. Validation includes piece legality, card rules, and turn ownership.
- 3.4. All confirmed actions are logged for debugging purposes.
4. NFR4: The system shall have a dedicated URL for players to access the game.

Design Implementation:

- 4.1. The web app is hosted at a fixed URL.
- 4.2. A landing page provides a “Play Game” button linking to the main game client.
- 4.3. Routing ensures secure and direct access to the multiplayer environment.
5. NFR5: The server shall be hosted on a team member’s machine during the duration of the project.

Design Implementation:

- 5.1. The game server runs locally using Unicorn or a similar lightweight Python web server.
- 5.2. External players connect via local network port forwarding.
- 5.3. Regular backups and logs are maintained by the hosting team members.
- 5.4. Hosting configuration is documented for easy handoff if needed.
6. NFR6: The game shall be accessible from any web browser regardless of the user’s machine or operating system.

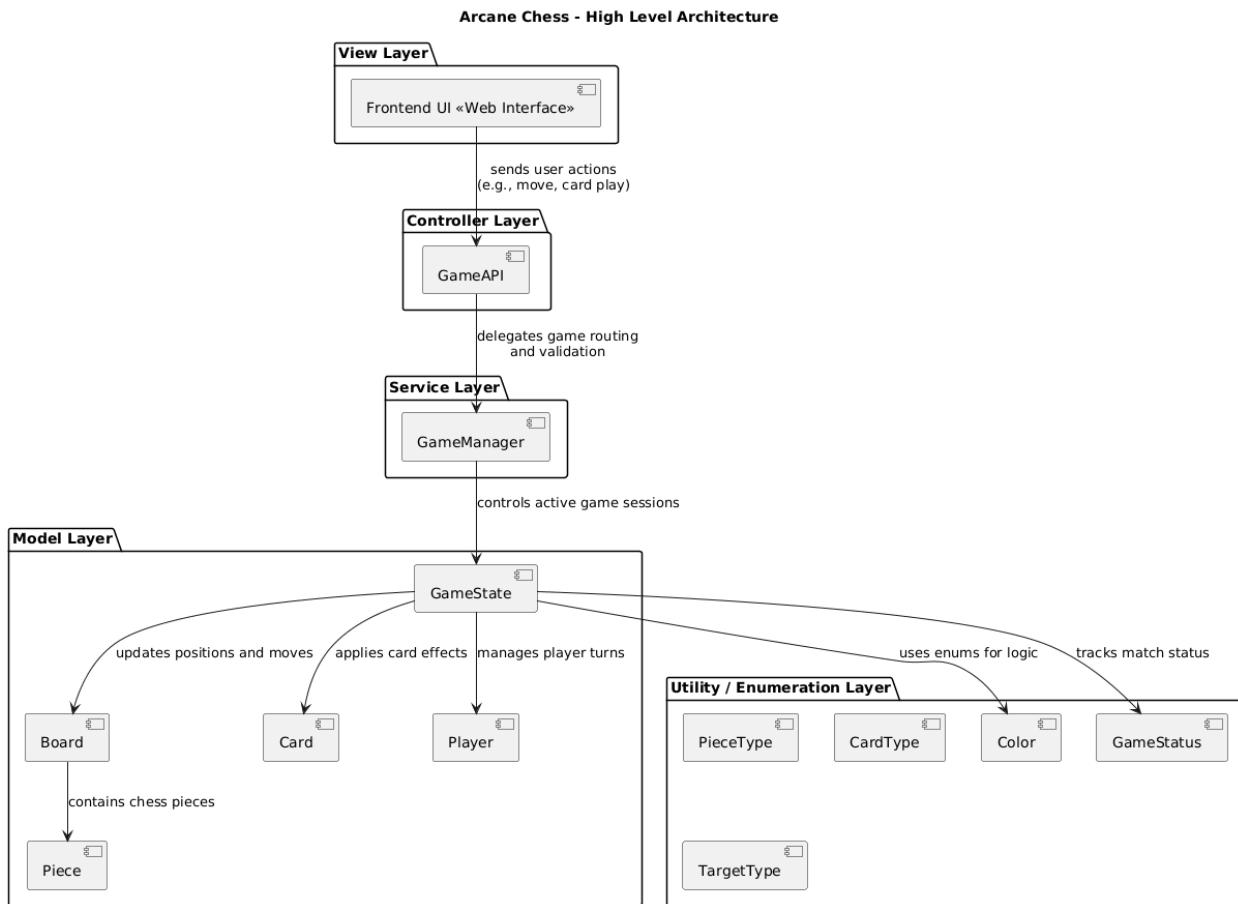
Design Implementation:

- 6.1. The front-end is built using JavaScript for universal compatibility.
- 6.2. Tested browsers include Chrome, Edge, Firefox, and Safari.
- 6.3. The UI automatically scales for different screen resolutions.
- 6.4. No installation or plugins are required — the game runs entirely in the browser.

3. System architecture

3.1. Overall architecture

The Arcane Chess system follows a hybrid Model–View–Controller (MVC) architecture, extended with a Game Management (Service) layer. The MVC structure promotes modularity and maintainability by separating domain logic, presentation, and user interaction. The additional Service layer provides centralized orchestration for managing multiple concurrent games and encapsulating server responsibilities. This combination ensures that the system remains scalable, testable, and adaptable.



3.2. Components mapping

3.2.1. Functional requirements

Requirement	Component Classes	System Architecture Component(s)	Technologies
<u>FR1</u>	N/A	View	React, CSS, Javascript
<u>FR2</u>	Deck, Player, GameManager	Model, Controller	Python, WebSocket, JavaScript

FR3	GameManager, Player, GameState,	Controller, Service	Python, WebSocket
FR4	Card	View	JavaScript
FR5	Piece, Card, Board, GameState	Controller, Model	Python, WebSocket, JavaScript
FR6	Board, GameState, Move	Controller, View	JavaScript, WebSocket
FR7	Board, Piece, GameState	View, Model	JavaScript, WebSocket
FR8	Card, Player, GameState	View	JavaScript, WebSocket
FR9	GameState	Controller	Python, WebSocket, JavaScript
FR10	GameManager, Player, GameState	Controller	Python, WebSocket, JavaScript

3.2.2. Non-functional requirements

Requirement	Component Classes	System Architecture Component(s)	Technologies
NFR1	GameState, Board	Controller, Communication	Python (WebSocket), JavaScript
NFR2	GameManager, GameState, GameAPI	Controller	Uvicorn, Python
NFR3	GameState,	Model, Service	Python, Websocket

	Board, GameManager, GameAPI		
<u>NFR4</u>	GameAPI	View, Controller	Uvicorn, Websocket, Javascript
<u>NFR5</u>	GameAPI, GameManager	Service	Websocket, Uvicorn
<u>NFR6</u>	N/A	View, Service	Javascript

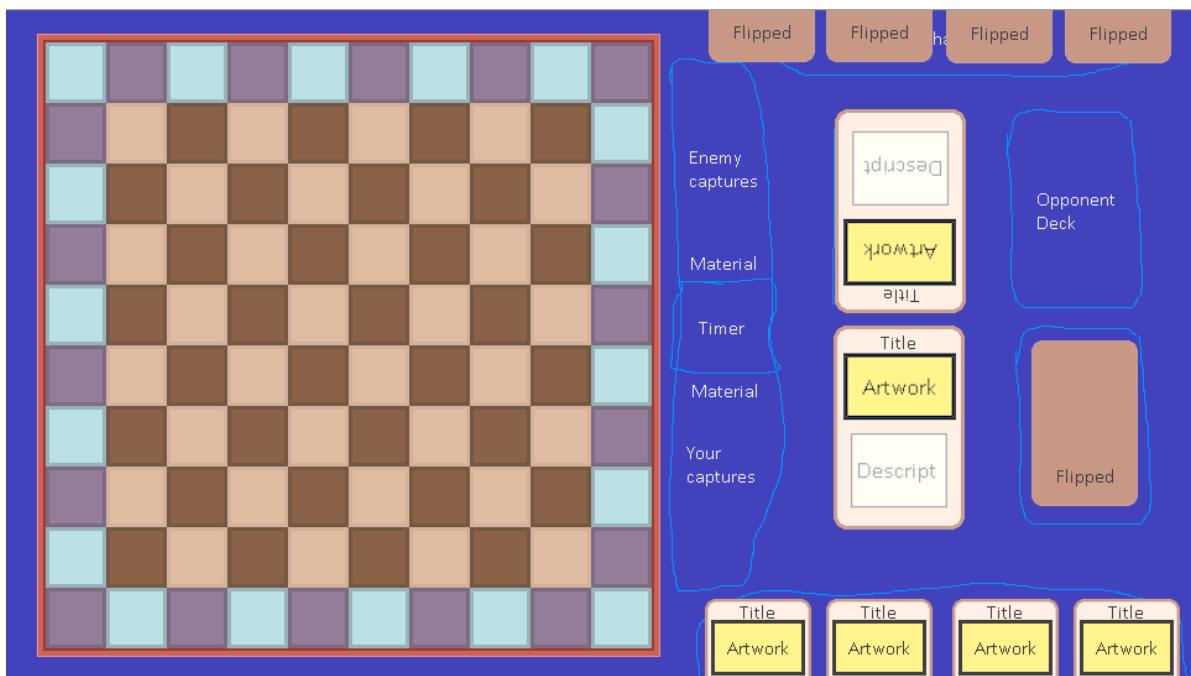
3.3. Technology stack selection

- 3.3.1. **Python 3.8+:** A versatile language which supports OOP paradigms that are useful for design of chess pieces/objects. 3.8+ because only those versions support FastAPI
- 3.3.2. **FastAPI:** A modern framework for building web API's with python to act as the controller. Will handle interactions between the model (game logic) and the view (web page).
- 3.3.3. **Uvicorn:** An ASGI web server implementation for Python. Which supports WS connections. This will facilitate communication between clients and our server/application.
- 3.3.4. **React.js:** A JS library for building UI using declarative, component-based views, and can be rendered on the server and mobile. In our case it will lend itself to building the front end quickly and with a modern appearance.
- 3.3.5. **CSS:** The language used to style HTML documents and, in this case, React components. It is absolutely necessary for the webpage to appear professionally built.

4. System Design

4.1. UI

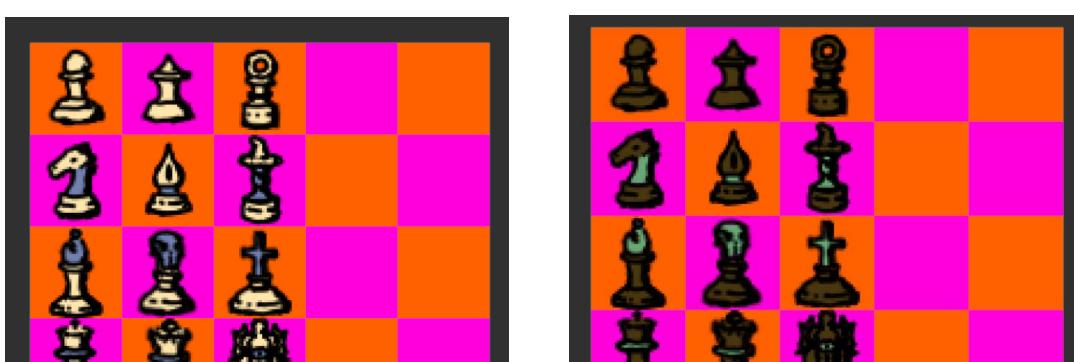
- 4.1.1. Game Board:



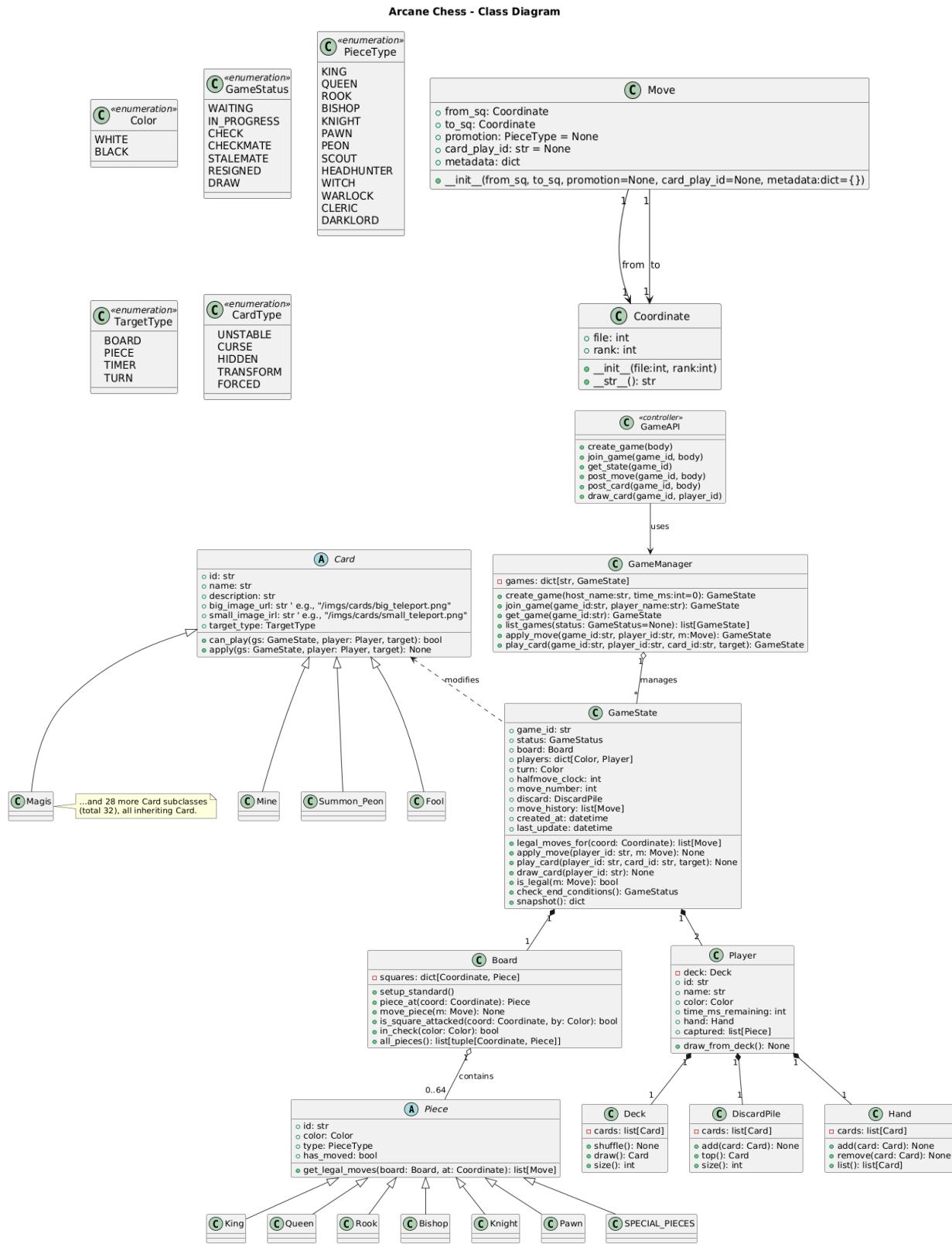
4.1.2. Web Landing Page:



4.1.3. Pieces:

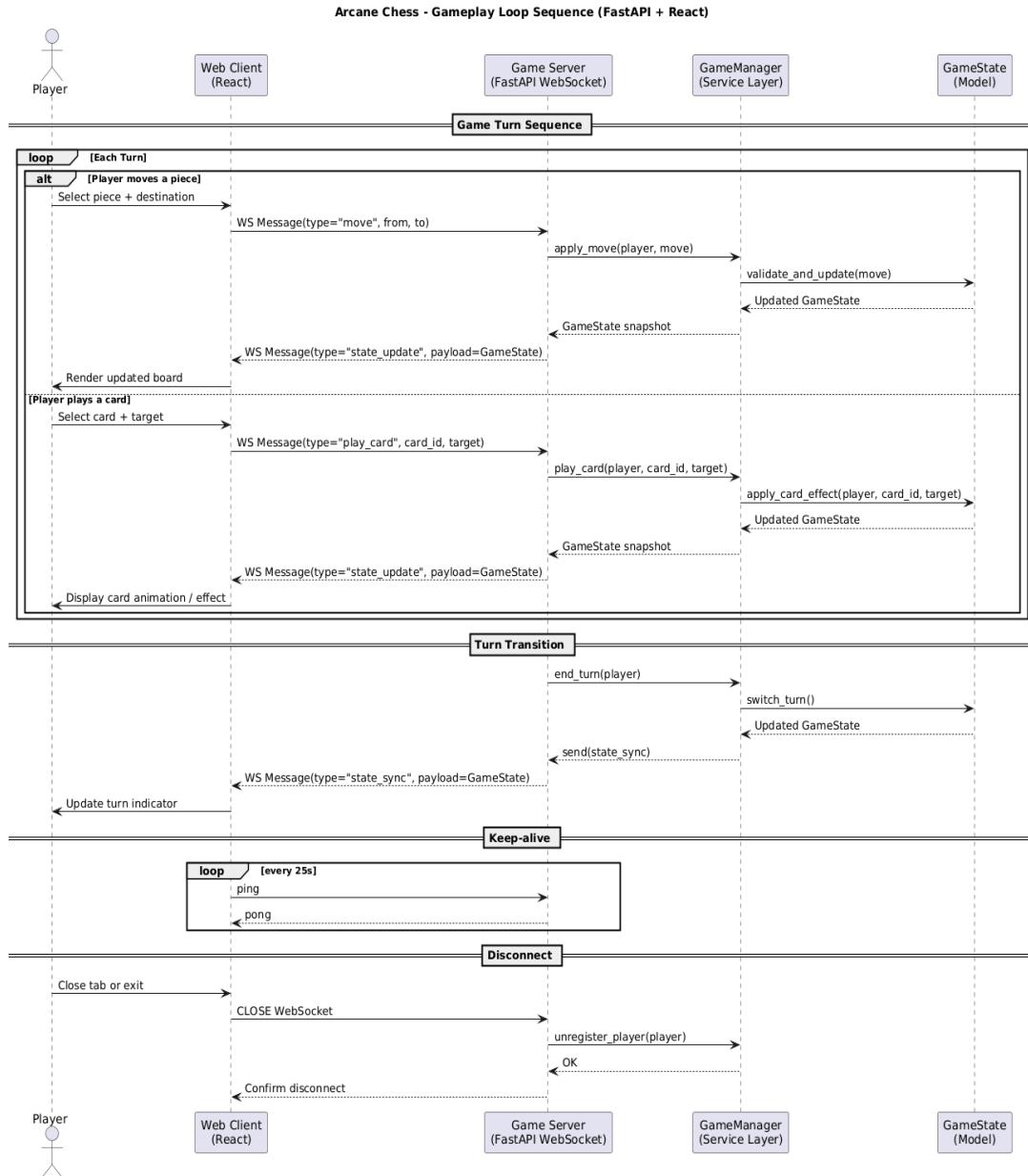


4.2. Class diagram



4.3. Sequence/activity diagram

4.3.1. Gameplay Loop



4.4. Database

N/A.

5. Others

5.1 Algorithms

- **Matchmaking Algorithm:**
The matchmaking system pairs players based on their availability in the queue. It ensures that two players are matched in the order they entered the queue to maintain fairness and reduce waiting time.
- **Card Effect Resolution Algorithm:**
Each card has unique effects defined. When a card is played, the system resolves its effect using a priority-based stack.
- **Move Validation Algorithm:**
Movement logic is implemented using coordinate-based validation, verifying that each piece move complies with its rules.

5.2 Third-Party Libraries and APIs

- **Backend:**
 - *Python*.
- **Frontend:**
 - *React.js*.
- **Version Control:**
 - *GitHub* for repository hosting.

6. Test plan

6.1. Game Interface and Player Interaction

6.1.1. Launching the Game UI

Table 1

No.	Test case	User input	Pass criteria
1	Launch the game	Open the game URL in browser	The interface loads successfully with Web landing page visible

6.1.2. Piece and Card Interaction

Table 2

No.	Test case	User input	Pass criteria
1	Correct squares are marked as available moves	Click a piece	Marked squares appear on user's screen in accordance with expected available moves depending on piece type
2	Select and move a piece	Click a piece -> click invalid target	Piece should not move to the select target and should display invalid move message

3	Select and move a piece	Click a piece -> click valid target	Piece moves correctly and board updates
4	Play a card	Click a card -> click again to see the option to activate card -> select yes	Card animation plays and state updates
5	Play a card	Click a card -> click again to see the option to activate card -> select no	No card animation plays, state is maintained, and the player is able to reperform the action
6	Hover over card	Hover cursor over card	Enlarged card view appears with effect description
7	Play valid card	Player plays card from hand on their turn	Card removed from hand, added to discard, new card drawn
8	Play card not in hand	Attempt to play card_id not in player's hand	Returns error "Card not in hand"
9	Play card on opponent's turn	Attempt to play card when not current player	Returns error "Not your turn"
10	Hand size limit	Start with Max_hand_size cards, play 1	Hand size returns to Max_hand_size after drawing
11	Legal rook move	Move rook vertically on empty file	Move succeeds, piece position updates
12	Rook blocked by own piece	Attempt rook move through friendly piece	Move rejected, returns "Illegal move"
13	Rook capture	Move rook to square with enemy piece	Piece captured, added to captured list, rook moves
14	Bishop diagonal move	Move bishop diagonally 3 squares	Move succeeds
15	Knight L-shape move	Move knight in L-pattern over pieces	Move succeeds regardless of blocking pieces
16	Pawn initial double move	Move pawn 2 squares on first move	Move succeeds
17	Pawn single move only	Attempt 2-square pawn move after first move	Move rejected
18	Pawn diagonal capture	Move pawn diagonally to capture	Capture succeeds
19	Pawn forward capture attempt	Attempt pawn forward move onto enemy piece	Move rejected

6.2. Matchmaking and Deck Building

6.2.1. Deck Creation

Table 3

No.	Test case	User input	Pass criteria
1	Select cards for deck	Choose cards from available 32	Selected cards highlight and count updates
2	Validate deck size	Attempt to select >16 cards	System prevents selecting more than 16 cards
3	Validate deck size	Attempt to select <16 cards	System prevents selecting less than 16 cards
4	Confirm deck submission	Click "Confirm Deck"	Deck submits successfully and server validates it
5	Reject invalid deck	Call add_to_queue() with 15 cards	Returns error "Deck must contain exactly 16 cards"
6	Reject invalid deck	Call add_to_queue() with 17 cards	Returns error "Deck must contain exactly 16 cards"

6.2.2. Matchmaking

Table 4

No.	Test case	User input	Pass criteria
1	Enter matchmaking queue	Click "Find Match"	Player enters queue and waits for opponent
2	Match creation	Two players in queue	Players are paired, removed from queue, and game starts
3	Add player to queue	Call add_to_queue() with valid deck (16 cards)	Player added successfully, returns success message
4	Prevent duplicate queue entry	Add same player to queue twice	Second attempt returns "Already in matchmaking queue"

6.3. Game State and Turn Logic

6.3.1. Timer

Table 5

No.	Test case	User input	Pass criteria
1	Timer countdown	Begin player's turn	Timer starts counting down from 15 minutes
2	Timeout condition	Let timer reach 0	Game ends and opponent declared winner
3	Timer countdown	Wait 5 seconds during turn	Current player's time decreases by 5 seconds
4	Turn switching	Complete valid move	Turn switches to opponent, timer resets for new turn
5	Timer task starts	Server startup with start_timer_updates()	Background task running, updates every second
6	Multiple game timers	5 active games running	All 5 games' timers update correctly
7	Timer stops on game end	Game ends in checkmate	Timer for that game stops updating

8	Timeout callback	Player runs out of time	Callback function called with game object
9	Timer task cleanup	Server shutdown with stop_timer_updates()	Background task cancelled cleanly

6.3.2. Move Validation

Table 6

No.	Test case	User input	Pass criteria
1	Valid move execution	Select legal move	Move executes correctly and syncs with opponent
2	Invalid move rejection	Attempt illegal move	System rejects move and displays warning
3	Capture event	Capture opponent piece	Captured piece appears in capture bar Captured opponent piece is replaced by player piece

6.4. Game End and Replay Options

6.4.1. Game Conclusion

Table 7

No.	Test case	User input	Pass criteria
1	End by checkmate	Perform final move to checkmate	Game ends and displays winner/loser message
2	End by timeout	Allow timer to hit 0	Match ends and opponent declared winner

6.4.2. Post-Game Options

Table 8

No.	Test case	User input	Pass criteria
1	Request rematch	Click "Rematch"	New match starts with the same players if the opponent also clicked "Rematch" Otherwise, player re-enters matchmaking system
2	Return to matchmaking	Click "Return to Queue"	Player re-enters matchmaking system

6.5. UI Display Elements

6.5.1. Captured Pieces Display

Table 9

No.	<i>Test case</i>	<i>User input</i>	<i>Pass criteria</i>
1	Display captured pieces	Capture opponent's piece	Piece appears in correct capture bar (top/bottom)
2	Multiple captures	Capture multiple pieces	Each piece icon updates with count
3	Opponent capture	Opponent captures a piece	Captured piece appears on opponent's bar
4	Refresh synchronization	Reload browser	Board state reload accurately

6.5.2. Card Hand Panel

Table 10

No.	<i>Test case</i>	<i>User input</i>	<i>Pass criteria</i>
1	Display hand	Start game	4 drawn cards appear on right panel
2	Draw new card	Play turn that triggers draw	New card appears immediately in hand
3	Play card	Select and play valid card	Card removed from hand and action processed
4	Hover preview	Hover over card	Enlarged card preview appears

6.6. System Performance

6.6.1. Screen Update Delay

Table 11

No.	<i>Test case</i>	<i>User input</i>	<i>Pass criteria</i>
1	Move synchronization	Player makes move	Opponent board updates within 5 seconds
2	Network lag recovery	Temporarily disconnect	Board resyncs automatically on reconnect

6.6.2. Server Load Capacity

Table 12

No.	<i>Test case</i>	<i>User input</i>	<i>Pass criteria</i>
1	Multiple active games	Start 20 concurrent matches	Server runs all matches without failure
2	Over-capacity test	Attempt 21st game connection	System denies connection with "server full" message

6.7. Accessibility and Compatibility

6.7.1. Cross-Browser Access

Table 13

No.	Test case	User input	Pass criteria
1	Access from Chrome	Open URL in Chrome	Game loads successfully
2	Access from Firefox	Open URL in Firefox	Game loads successfully
3	Access from Safari	Open URL in Safari	Game loads successfully

6.7.2. Hosting and URL

Table 14

No.	Test case	User input	Pass criteria
1	Access via dedicated URL	Enter official game URL	Player reaches Arcane Chess homepage
2	Server availability	Access when server offline	System displays "server unavailable" message

6.8. Board Class

Table 15

No.	Test case	User input	Pass criteria
1	Initialize Board and verify it starts empty	Call Board()	Board is created with squares = {} and dmzActive = False
2	Setup standard board layout	Call setup_standard()	32 pieces are placed correctly in starting positions
3	Retrieve a piece at a given coordinate	piece_at_coord(Coordinate(5,1))	Returns the White King (id='wK')
4	Check if coordinate is inside bounds	is_in_bounds(Coordinate(5,5))	Returns True if DMZ is inactive; otherwise checks full 10x10 grid
5	Verify empty and occupied squares	is_empty(Coordinate(5,5)), is_empty(Coordinate(5,1))	Returns True for empty and False for occupied square
6	Move a piece to a valid coordinate	Move from Coordinate(5,1) → Coordinate(5,2)	Piece is moved, origin cleared, and destination filled
7	Attempt invalid move (no piece)	Move from empty coordinate	Raises ValueError("No piece at...")
8	Test capture functionality	Move to a coordinate occupied by an opponent	Returns captured piece object
9	Test cloning of board	clone()	Returns deep copy; original and clone do not affect each other
10	Serialize board state	to_dict()	Returns JSON dictionary with "dmzActive" and "pieces" list

6.9. Piece Class

Table 16

No.	Test case	User input	Pass criteria

1	Initialize a specific piece	Rook("wR01", Color.WHITE)	Piece is created with correct ID, color, and type
2	Generate legal moves	get_legal_moves(board, Coordinate(1,1))	Returns all valid moves within boundaries
3	Generate capture moves	get_legal_captures(board, Coordinate(1,1))	Returns only enemy-occupied coordinates
4	Test serialization	to_dict(at=Coordinate(1,1))	Returns dictionary with id, type, color, and position
5	Test serialization with moves	to_dict(at=Coordinate(1,1), include_moves=True, board=board)	Includes "moves" list in output

6.10 Deck Class

Table 17

No.	Test case	User input	Pass criteria
1	Add a valid card	deck.add_card(card)	Card is added; deck size increases by 1
2	Add invalid object	deck.add_card("NotACard")	Raises TypeError
3	Enforce deck size limit	Add 17th card	Raises ValueError("Deck cannot hold more than 16 cards.")
4	Draw a card	deck.draw()	Returns and removes the top card
5	Draw from empty deck	Empty deck then call draw()	Raises ValueError("Deck is empty.")
6	Shuffle deck	deck.shuffle()	Randomly reorders cards (order differs from before)
7	Check top card	deck.top()	Returns last card in list without removing it
8	Verify size method	deck.size()	Returns number of cards currently in deck

6.10. Hand Class

Table 18

No.	Test case	User input	Pass criteria
1	Add a valid card to hand	hand.add(card)	Card is added successfully
2	Add invalid type	hand.add("NotACard")	Raises TypeError
3	Remove card in hand	hand.remove(card)	Card is removed from hand
4	Remove non-existent card	hand.remove(fake_card)	Does nothing, no error raised
5	Get list of cards	hand.list()	Returns list of current cards

6	Check hand length	<code>len(hand)</code>	Returns number of cards currently in hand
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6.11. Move Class

Table 19

No.	Test case	User input	Pass criteria
1	Create coordinate	Coordinate(3,4)	Initializes correctly with file=3, rank=4
2	Check hashing	Use Coordinate as dictionary key	No TypeError; key works correctly
3	Offset coordinate	offset(1,1) from (3,4)	Returns new coordinate (4,5) if in bounds
4	Algebraic conversion	<code>to_algebraic()</code> for (4,5)	Returns "e5"

6.12. All Piece Classes

Table 20

No.	Test case	User input	Pass criteria
1	Initialize a piece	Create any subclass, e.g. <code>Rook("wR01", Color.WHITE)</code>	Object is created with correct ID, color, and type from PieceType
2	Verify string representation	<code>__str__(piece)</code>	Returns formatted string like "W R (wR01)"
3	Generate legal moves	Call <code>get_legal_moves(board, coordinate)</code>	Returns a list of valid Move objects according to movement rules and board bounds
4	Generate capture moves	Call <code>get_legal_captures(board, coordinate)</code>	Returns only moves that capture enemy pieces
5	Prevent out-of-bounds movement	Place piece near board edge and call <code>get_legal_moves()</code>	Returned moves stay within valid coordinate range
6	Obey blocking rules	Place allied piece along a valid move path	Legal move list stops before allied piece (cannot move through or capture it).
7	Allow capturing enemies	Place enemy piece along valid move path	Returned move list includes that coordinate once, then stops beyond it.
8	Verify move exclusivity	Piece in open area (no blockers)	Legal moves do not duplicate coordinates and follow movement pattern correctly.
9	Validate color awareness	Place two pieces of same color nearby	No moves include friendly piece coordinates.
10	Validate algebraic notation	Call <code>algebraic_notation()</code>	Returns correct single-character notation (e.g., K, Q, R, B, N, P).

11	Check serialization	Call <code>to_dict(at=Coordinate(...))</code>	Returns dictionary with "id", "type", "color", and "position".
12	Include moves in serialization	Call <code>to_dict(at=..., include_moves=True, board=board)</code>	Dictionary includes "moves" key with correct from and to coordinates.

6.13. Game Manager

Table 21

No.	Test case	User input	Pass criteria
1	Create sample game	<i>Call</i> <code>create_sample_game()</code>	Game created with valid game_id, two players, and initialized board
2	Retrieve game by ID	<i>Call</i> <code>get_game(game_id)</code>	Returns correct GameState object
3	Find player's game	<i>Call</i> <code>get_player_game(player_id)</code>	Returns game the player is in, or None
4	Get game statistics	<i>Call</i> <code>get_stats()</code>	Returns correct counts for active games, queue size, finished games
5	Cleanup finished games	<i>Call</i> <code>cleanup_finished_games()</code>	Removes all non-IN_PROGRESS games from memory

6.14. Game State

Table 22

No.	Test case	User input	Pass criteria
1	Initialize game state	Create new GameState	Board initialized, White's turn, both players have 900s on clock
2	Get player perspective	<i>Call</i> <code>to_dict(player_id)</code>	Returns state with player's hand visible, opponent's hand size only
3	Halfmove clock increment	Make non-capture, non-pawn move	Halfmove clock increments by 1
4	Halfmove clock reset	Capture piece or move pawn	Halfmove clock resets to 0
5	Fullmove increment	Black completes turn	Fullmove number increments by 1
6	Fifty-move rule	Reach 100 halfmoves	Game status becomes DRAW with reason "Fifty-move rule"

6.15. Websocket Communications

Table 23

No.	Test case	User input	Pass criteria
1	Client connection	Connect to <code>/ws/{client_id}</code>	WebSocket accepted, client added to active connections

2	<i>Game start notification</i>	<i>Two players matched</i>	<i>Both receive {"type": "game_started"} with game_state</i>
3	<i>Error message</i>	<i>Send invalid move</i>	<i>Receive {"type": "error", "message": "..."}</i>
4	<i>Ping/pong</i>	<i>Send {"type": "ping"}</i>	<i>Receive {"type": "pong"}</i>
5	<i>Client disconnect</i>	<i>Close WebSocket connection</i>	<i>Client removed from active connections and queue</i>
6	<i>Opponent disconnect handling</i>	<i>One player disconnects mid-game</i>	<i>Other player notified, game marked as forfeit</i>
7	<i>Broadcast to game</i>	<i>One player makes move</i>	<i>Both players receive identical game state update</i>

6.16. Coordinate System

Table 24

No.	Test case	User input	Pass criteria
1	<i>Parse algebraic notation</i>	<i>Coordinate.from_algebraic("e4")</i>	<i>Returns Coordinate with file=4, rank=3 (0-indexed)</i>
2	<i>Invalid notation</i>	<i>Coordinate.from_algebraic("z9")</i>	<i>Raises exception or returns None</i>
3	<i>Coordinate offset</i>	<i>Call offset(1, 1) on "e4"</i>	<i>Returns "f5" coordinate</i>
4	<i>Offset out of bounds</i>	<i>Call offset(5, 0) on "h4"</i>	<i>Returns None (off board)</i>
5	<i>Coordinate equality</i>	<i>Compare two Coordinate("e4") objects</i>	<i>Returns True</i>
6	<i>Convert to string</i>	<i>Call str() on Coordinate</i>	<i>Returns algebraic notation "e4"</i>

6.17. Player Management

Table 25

No.	Test case	User input	Pass criteria
1	<i>Player initialization</i>	<i>Create Player with deck</i>	<i>Player has correct color, 4 cards in hand, 12 in deck</i>
2	<i>Draw card</i>	<i>Call draw_card()</i>	<i>Card moved from deck to hand, returns card object</i>
3	<i>Draw from empty deck</i>	<i>Call draw_card() when deck empty</i>	<i>Returns None, hand unchanged</i>
4	<i>Play card</i>	<i>Call play_card(card_id)</i>	<i>Card moved from hand to discard, returns card object</i>
5	<i>Has card check</i>	<i>Call has_card(card_id) for card in hand</i>	<i>Returns True</i>
6	<i>Capture piece</i>	<i>Call capture_piece(piece)</i>	<i>Piece added to captured list</i>
7	<i>Get hand size</i>	<i>Call hand_size()</i>	<i>Returns correct integer</i>
8	<i>Get deck size</i>	<i>Call deck_size()</i>	<i>Returns correct integer</i>

9	<i>Serialize player</i>	<i>Call to_dict()</i>	<i>Returns dict with id, name, color, hand, captures</i>
10	<i>Player representation</i>	<i>Call str(player)</i>	<i>Returns formatted string with name and color</i>

7. References

- 7.1. UML diagrams made using PlantUML online editor: <https://plantuml.com/>.
- 7.2. Drawn created with Paint.net: <https://www.getpaint.net/index.html>.
- 7.3. FastAPI documentation: <https://fastapi.tiangolo.com/>.
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