Final Report – PuzzLink

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https://github.com/Adivered/PuzzLink.git

1. Introduction

PuzzLink was created to offer a unique space for collaboration and creativity in the digital world. The platform blends puzzle-solving, real-time communication through chat, and creative expression, allowing users to work together seamlessly. It was designed to overcome the limitations of traditional virtual interaction by enabling users to collaborate in a shared, interactive space. PuzzLink focuses on fostering connection and communication, whether for couples, friends, or colleagues. The platform offers a dynamic way for people to create and engage together, regardless of physical distance.

2. Problem Statement

Even though there are many digital tools for communication and collaboration, most of them don't combine puzzle-solving, creativity, and real-time chat in one interactive space. People—like couples, friends, or coworkers—often struggle to find a single platform where they can connect, create, and work together in a fun and interactive way, without being limited by distance or complicated interfaces.

3. Regarding competitors & Literature Review

Regarding competitors –

our app offers new and unique features that don't currently exist in the market, so we don't have direct competitors to describe.

Literature Review –

Existing research on collaborative drawing and art highlights the potential of these platforms to foster deeper, more meaningful connections, moving beyond traditional methods of communication. Collaborative drawing, particularly in therapeutic contexts, has been identified as a valuable tool for couples to disengage from long, emotionally charged conversations characterized by pain, resentment, and blame. The focus in such therapy is not on the content of the imagery created by the partners, but on the dialogical exchange surrounding the drawings. This approach allows for the opening of new narratives and perspectives within the relationship, enabling space for reflection and understanding. In therapeutic settings, the therapist's role is to concentrate on the partners' interactions—particularly their hesitations and surprises—facilitating an environment where they can explore what is essential to their connection. This method, rooted in both extensive therapeutic experience and dialogical theory, has been central to previous studies on relational drawings [0].

The psychological benefits of collaborative drawing, and its potential to create shared, non-verbal spaces of communication, are well-documented. Previous studies, including those by Snir et al. (2023), explored how this form of creative expression can reduce emotional tension, enhance empathy, and foster communication between partners. In the therapeutic context, relational drawings allow couples to engage with one another in ways that traditional verbal communication may not facilitate, creating space for new emotional insights to emerge. When these principles are applied in virtual platforms, the potential for deep, meaningful interactions is significantly expanded, as the digital space removes the physical constraints of face-to-face communication, opening up opportunities for reflection, connection, and shared experiences beyond geographical boundaries [1].

One of the key psychological benefits of collaborative drawing in both therapeutic and digital contexts is the creation of a safe, non-verbal medium that encourages interaction rather than focusing on the content of the images themselves. This shifts the emphasis from product to process, allowing participants to reflect on their interactions with one another. Such an approach helps reduce stress and anxiety, promoting a sense of calm and trust within the collaboration. These findings are consistent with the therapeutic use of relational drawing, which serves as an alternative form of communication that enhances understanding and emotional intimacy between individuals. The collaborative nature of these activities not only fosters communication but also strengthens relationships, supporting the idea that creative collaboration can act as a tool for healing and personal growth in both personal and social contexts [0].

Technologically, platforms that adopt the principles of collaborative drawing often incorporate sophisticated communication tools, real-time interactivity, and dynamic user interfaces to facilitate collaboration. These technologies create a seamless user experience, making it possible for participants to interact in real time while working together on creative projects. The integration of chat features, interactive drawing boards, and shared puzzles allows for a rich and engaging collaborative experience, ensuring that the focus remains on the interaction rather than the specifics of the content itself. This technological implementation mirrors the goals of therapy, where the primary aim is not to focus on the content but to encourage reflection and interaction between participants. In this way, the technology used in such platforms helps recreate the reflective, dialogical space that is crucial in therapeutic settings, where communication is as much about the process as it is about the outcome [1].

Future research could further explore the psychological effects of collaborative digital art, especially in relation to stress reduction, emotional connection, and

conflict resolution. The integration of gaming elements into creative platforms could offer additional insights into how play and creativity intersect to foster deeper, more engaging experiences. Additionally, exploring the use of digital platforms like collaborative drawing tools in cross-cultural communication could yield valuable insights into the universality of creative collaboration and its potential for building understanding across cultural boundaries. Furthermore, investigating how these platforms could serve therapeutic purposes, similar to relational drawings in therapy, would provide an important area for further exploration, as digital platforms hold the potential to offer alternative spaces for reflection and communication [0].

In conclusion, the intersection of psychological insights from collaborative drawing and innovative technology presents a unique opportunity to enhance virtual interactions. By emphasizing creative collaboration and reflective interaction, these platforms hold the potential to reshape how people connect and communicate online. They provide users with a space to engage meaningfully, reflect deeply, and strengthen relationships—similar to the therapeutic outcomes achieved through relational drawings. This approach has the potential to offer a powerful model for future social technologies, where the focus is on fostering deeper connections through shared creative experiences rather than superficial exchanges [1].

References:

1. Friedlander, S. R., Escudero, V., & Heatherington, L. (2009). Relational drawings in couple therapy. *Family Process, 48*(1), 117–133 https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1545-5300.2009.01271.x

2. Löffler, S., Hoffmann, M., & Grau, I. (2023). Joint drawings as a tool for observing couple relationships: Development of the Couples' Closeness-Distance Scale (CCDS). The Arts in Psychotherapy, 85, 101942 https://www.sciencedirect.com/science/article/abs/pii/S0197455623000722

4. Functional Requirements & Non-Functional Requirements

Functional Requirements –

1. User Authentication:
    - Users can register an account using their email, user-name and password.
    - Users can log in to their account using their credentials.
    - Users would be tokenized and remembered with cookies.
2. Private Rooms:
    - Users can create / join rooms.

- Users can progress to shared web page.

3. Private Rooms Based Chat:
    - Users can enter the chat corresponding to their room.
    - Users can send text messages in the chat room.
    - Users can receive real-time updates for new messages.
4. Room Type:
    - Users can choose to upload an image or plain white board.
5. Image Uploading:
    - Users can upload an image.
    - Users can then begin drawing activities.
6. Room Options:
    - Users can draw / erase on the board.
    - Users can change pencil width / color.
7. Profile Tab:
    - Users can view and edit their profile information, including name, contact details and recent drawings.
    - Users can upload a profile picture.
    - Users can view their activity history within the app (e.g., past rooms, partners).
8. Notifications:
    - Users receive notifications for new chat messages.

Non- Functional Requirements –

Performance:

1. Real-Time Communication:
    - Chat messages, room white board updates should be delivered with minimal latency (< 1 second).
    - The system should be capable of handling concurrent private room sessions efficiently.
2. Response Time:
    - The application should respond to user interactions within 2 seconds on average.

- The maximum acceptable response time for any action is 5 seconds (excluding image uploading / downloading).

Security:

1. Authentication and Authorization:
    - User authentication should be secure, employing industry-standard encryption techniques.
    - Access to certain features (e.g.,creating room, join room ,dashboard) should require user authorization.
2. Data Protection:
    - User data should be stored securely, adhering to best practices for data protection.
    - Sensitive data transmission should be encrypted using HTTPS.

Reliability:

1. Availability:
    - The system should aim for at least 99% availability, allowing for scheduled maintenance downtime.
2. Backup and Recovery:
    - Regular backups of the database should be performed to prevent data loss.
    - Procedures for data recovery in case of system failures should be in place.

Usability:

1. User Interface:
    - The user interface should be intuitive and user-friendly, facilitating easy navigation.
    - Adequate feedback should be provided to users for their actions (e.g., successful session, error messages).
2. Compatibility:
    - Responsive design principles should be followed to ensure usability across different screen sizes.

5. System Architecture & Technologies

Server-Side Architecture:

- Application Server: Node.js
- Database: MongoDB

Client-Side Architecture:

- React
- State Management and Storage: Redux
- Styling: CSS3
- Animations: GSAP

Communication Between Server and Client:

- Security Mechanism: Middleware for traffic management
- Session Management System: Express
- Routing and Data Access System: API-like structure
- Web Sockets: For real-time updates (e.g., tracking puzzle progress).

Security:

- User authentication using JWT.
- Third-party authentication for added security (e.g., Google).

6. Results

Test Cases -

Test Case ID	Description	Preconditions	Test Steps	Expected Result	Actual Result
TC-001	Register new user	Backend and DB running	1. Go to signup page 2. Enter unique username,email,and password 3. Submit form	User account is created and redirected to homepage	Same as Expected Result
TC-002	Attempt to register with existing username	Username already registered	1. Open signup page 2. Enter existing username 3. Submit form	Error message: "Username already exists"	Same as Expected Result
TC-003	Login with valid credentials	Valid user account exists	1. Navigate to login page	User is logged in and	Same as

			2. Enter correct username and password 3. Submit	redirected to home	Expected Result
TC-004	Login with invalid password	Valid user account exists	1. Open login page 2. Enter valid username, incorrect password 3. Submit	Error message: "Invalid credentials"	Same as Expected Result
TC-005	Create room with puzzle upload	User logged in	1. Click "Create Room" 2. Upload a valid puzzle file 3. Click "Create"	New room is created and user is redirected to it	Same as Expected Result
TC-006	Attempt to create room without puzzle	User logged in	1. Click "Create Room" 2. Leave puzzle file empty 3. Click "Create"	Error: "Puzzle file required"	Same as Expected Result
TC-007	Join room via invite link	Valid room exists	1. Copy invite link 2. Open in browser 3. Authenticate if needed 4. Confirm join	User is added to the specified room	Same as Expected Result
TC-008	Rejoin same room after browser refresh	User is in a room	1. Join a room 2. Refresh the browser tab	User is automatically rejoined to the same room with current puzzle and chat state restored	Same as Expected Result
TC-009	Send chat message	User in a room	1. Type message in chat input 2. Press Enter or click Send	Message appears in chat for all users	Same as Expected Result
TC-010	Receive chat from another user	At least 2 users in room	1. User A sends a message 2. User B observes chat area	User B sees User A's message instantly	Same as Expected Result
TC-011	Move puzzle piece	Puzzle is loaded	1. Click and drag a puzzle piece	Piece moves and updates on	Same as

			2. Drop it on valid target area	all connected clients	Expected Result
TC-012	Try moving piece out of board	The game is running and a piece is selected	1. Select a piece on the board. 2. Attempt to drag the piece outside the board area.	The piece returns to its original position on the board	Same as Expected Result
TC-013	Use drawing tool on white board	Drawing mode is enabled	1. Select drawing tool 2. Draw on canvas using mouse	Drawing appears in real time for all users	Same as Expected Result
TC-014	Drawing state sync on join	Drawing exists before join	1. Existing user draws 2. New user joins the room	New user sees existing drawing correctly rendered	Same as Expected Result
TC-015	Puzzle sync on join	Puzzle has moved pieces	1. Users rearrange pieces 2. New user joins room	New user sees current puzzle state instantly	Same as Expected Result
TC-016	Logout process	User is logged in	1. Click "Logout" button	User is logged out and redirected to login page	Same as Expected Result
TC-017	User is typing..." indicator in chat	Two or more users are in the same room	1. User A starts typing a message 2. User B observes the chat area	User B sees a "User A is typing..." indicator in real time To be filled during testing	Same as Expected Result
TC-018	Send message while disconnected	Network is off	1. Type a message 2. Click Send while offline	Message is queued or error shown; not sent	Same as Expected Result
TC-019	Block unauthorized room access	Room is private	1. Try joining private room via direct URL	Access denied message shown	Same as

			2. Authenticate if needed		Expected Result
TC-020	Block room access for unauthenticated users	User is logged out or never logged in	1. Copy a valid room URL 2. Paste and access it in incognito or logged-out browser	Redirected to login page or shown "Access Denied" To be filled during testing	Same as Expected Result

7. What Does It Take to Turn This Into a Startup ?

1. Turning the idea into a real, working product that makes an impact in the market – that's the next big step.
   To make *PuzzLink* a successful startup, we now need to move into the active phase of **real-world testing and adoption**. This means bringing the product to real users – like schools, educational organizations, or online communities – collecting feedback, and tracking how people actually use it over time.
2. At the same time, we need to **improve the user experience**, make the system more stable and responsive, and prepare it to handle growth (scaling).
3. On the business side, we should start building a clear **business model**, explore **partnerships**, and look into early-stage funding or joining an **accelerator** – not just to finish development, but to grow our visibility, reach more users, and enter bigger markets.
4. Right now, we're at the point of shifting from "a good project" to **a real product with real users**. That means thinking about operations, support, marketing, and building a community – and taking full responsibility for the entire user experience.

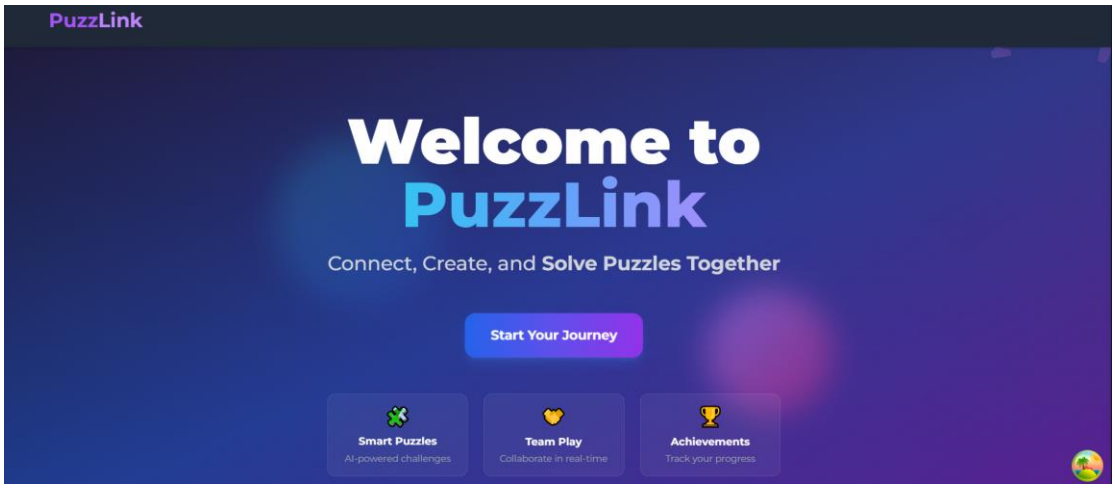
8. Conclusions After Completing the Project

1. **Algorithm Improvements**
   We would consider optimizing some of the algorithms (like puzzle solution detection or user sync) to make the system more responsive, especially during heavy use or real-time collaboration.
2. **Functional Changes**
   Some features (like the login process or room management) could have been simpler and more intuitive – we would spend more time designing the user experience from the beginning.

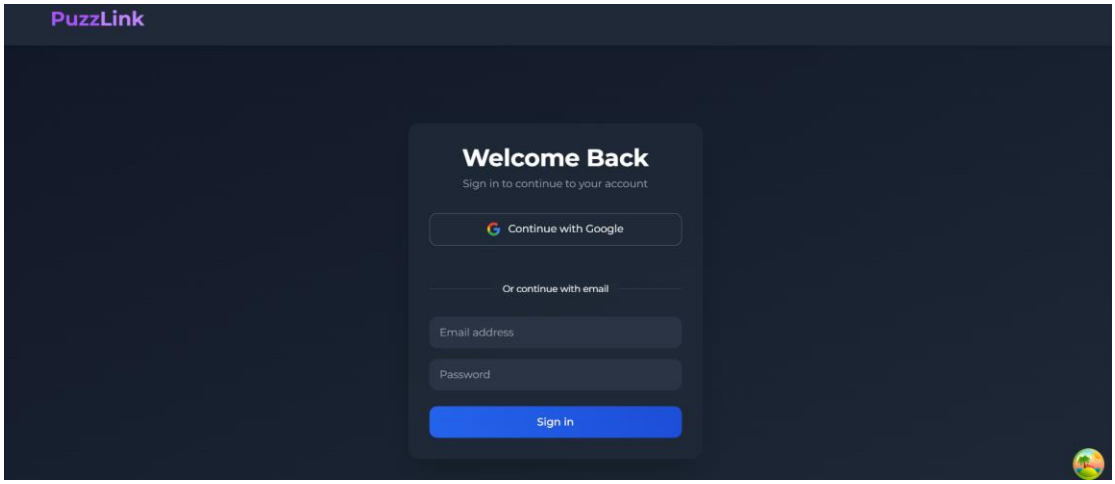
3. **Real-Time User Adaptation**
   We would plan ahead and add usage tracking tools (analytics) to better understand how users interact with the system and improve based on real data.
4. **Technology Choices**
   Using simpler deployment tools (like serverless platforms or managed services) could have saved us time and let us focus more on core development.
5. **More Modular Design**
   If we had built the code in a more modular way, it would be easier to add new features or test new ideas without rewriting existing parts.

9. Screenshots from the Application

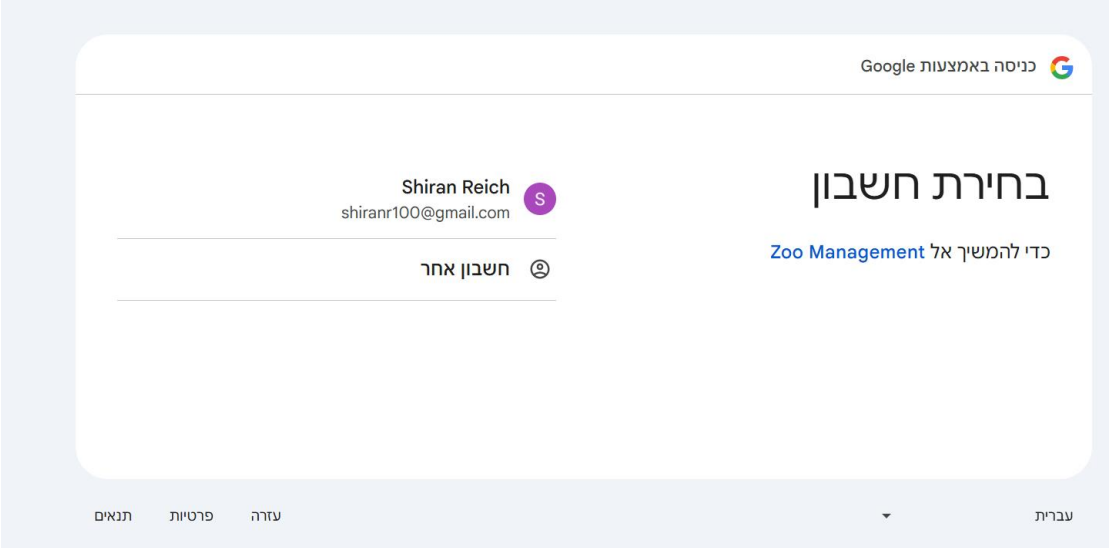
Landing page



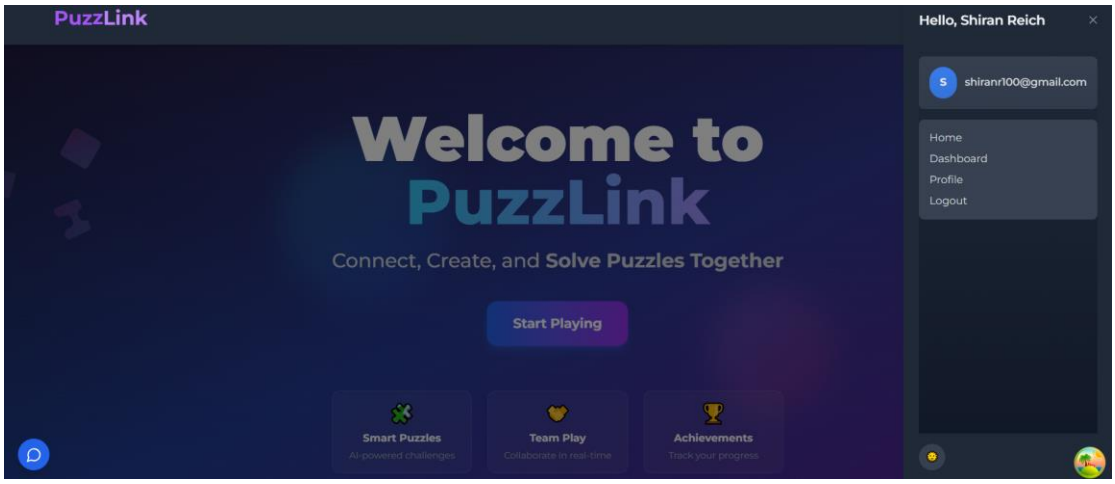
User Login Screen

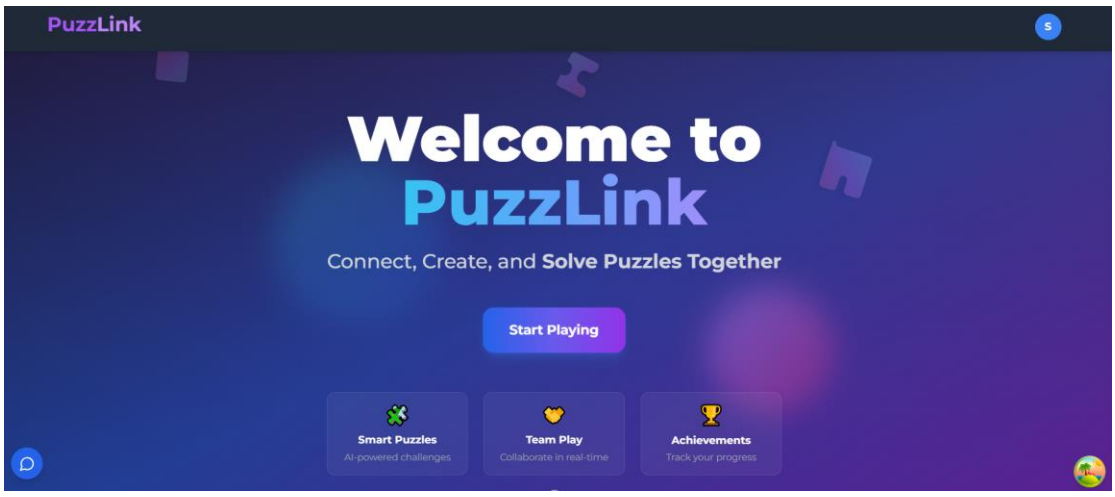


Login and Authentication via Google

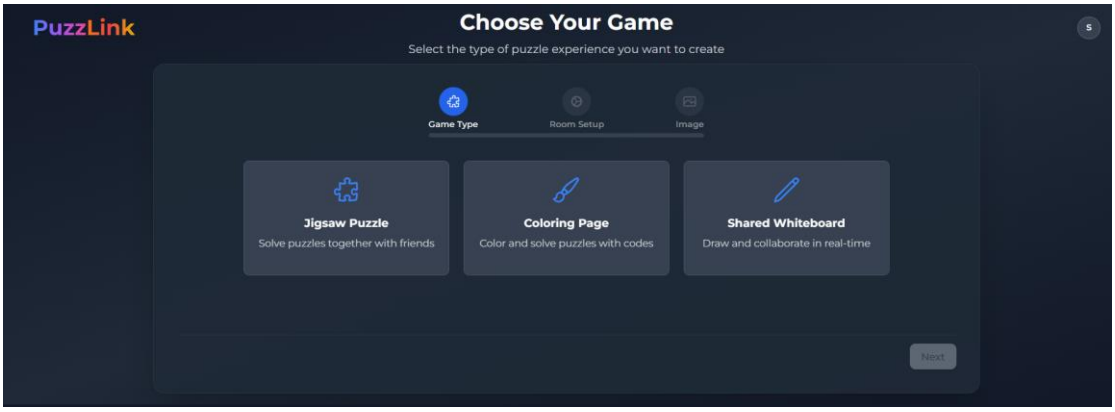


Home Screen

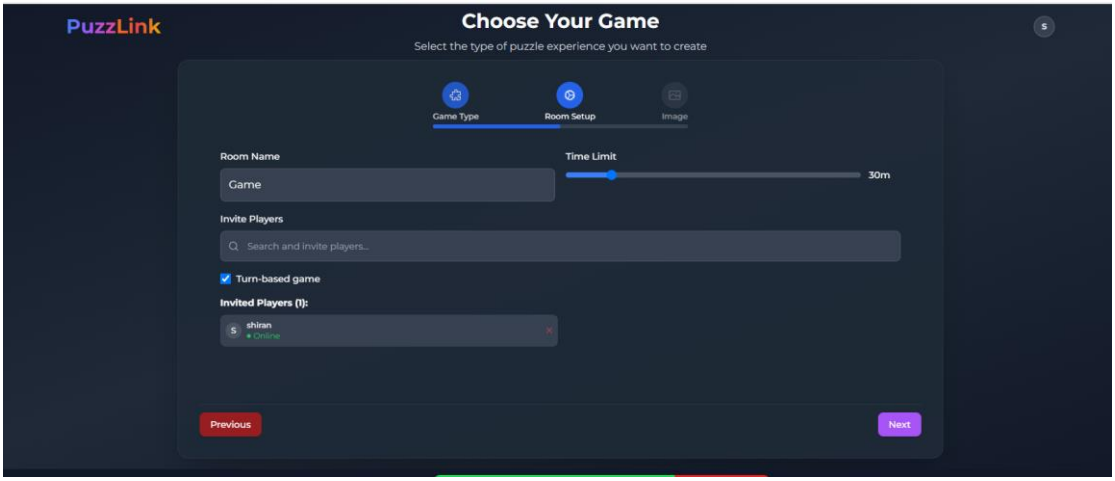




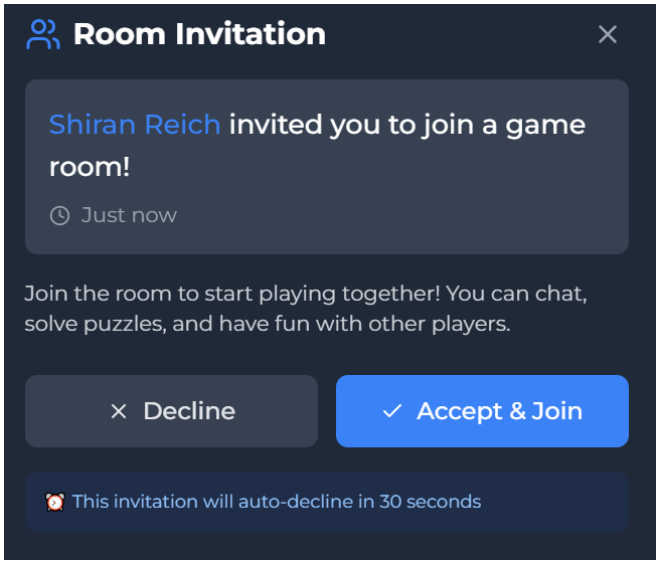
Puzzle Options



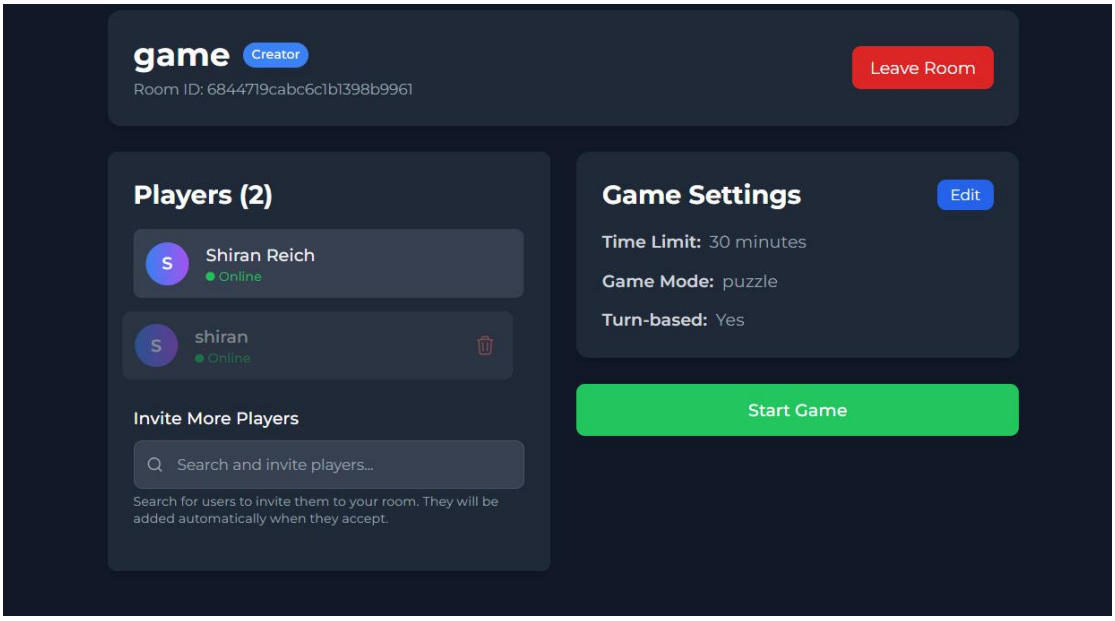
Configure Room Settings[Same to all rooms]



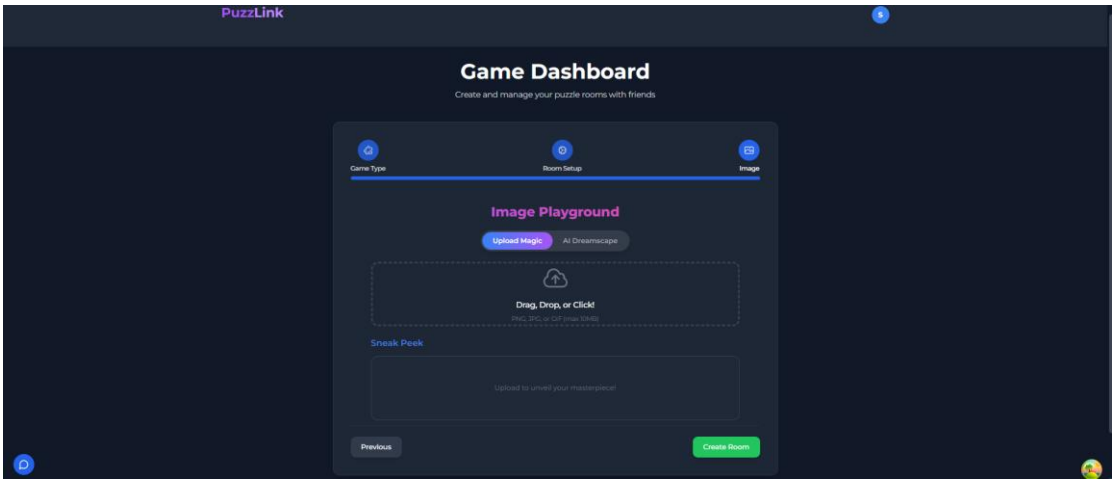
The invited participant must confirm the invitation to the room

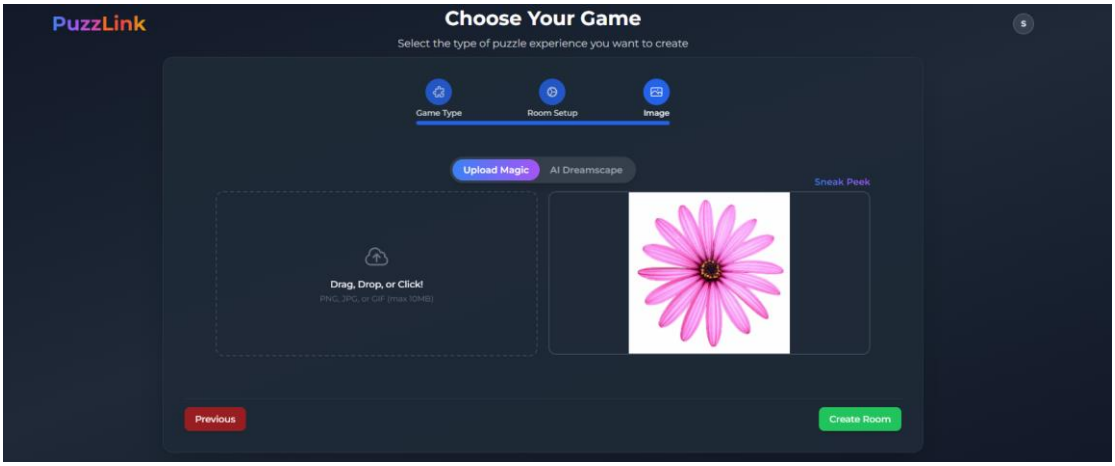


Room settings screen after the participant has confirmed the invitation and before the game starts

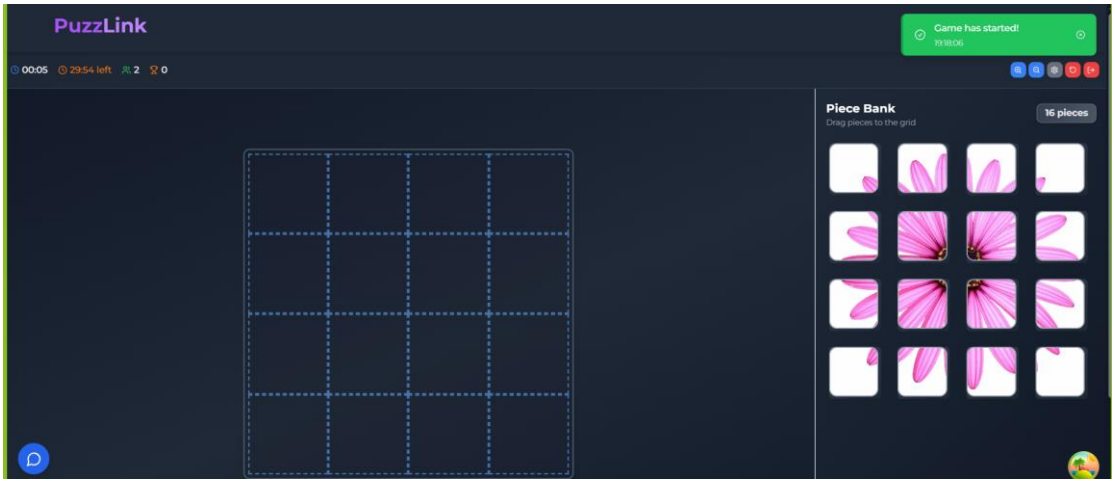


Upload Image [For Jigsaw puzzle]





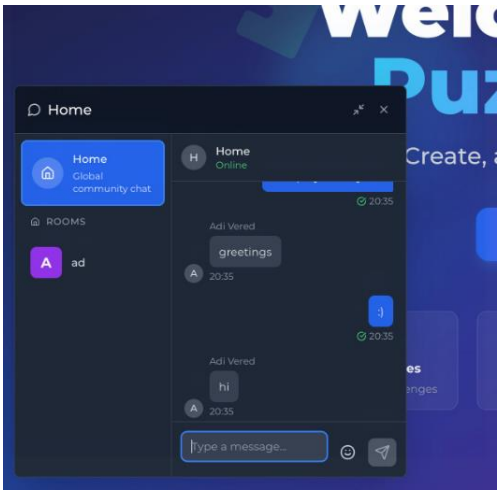
Jigsaw puzzle



whiteboard

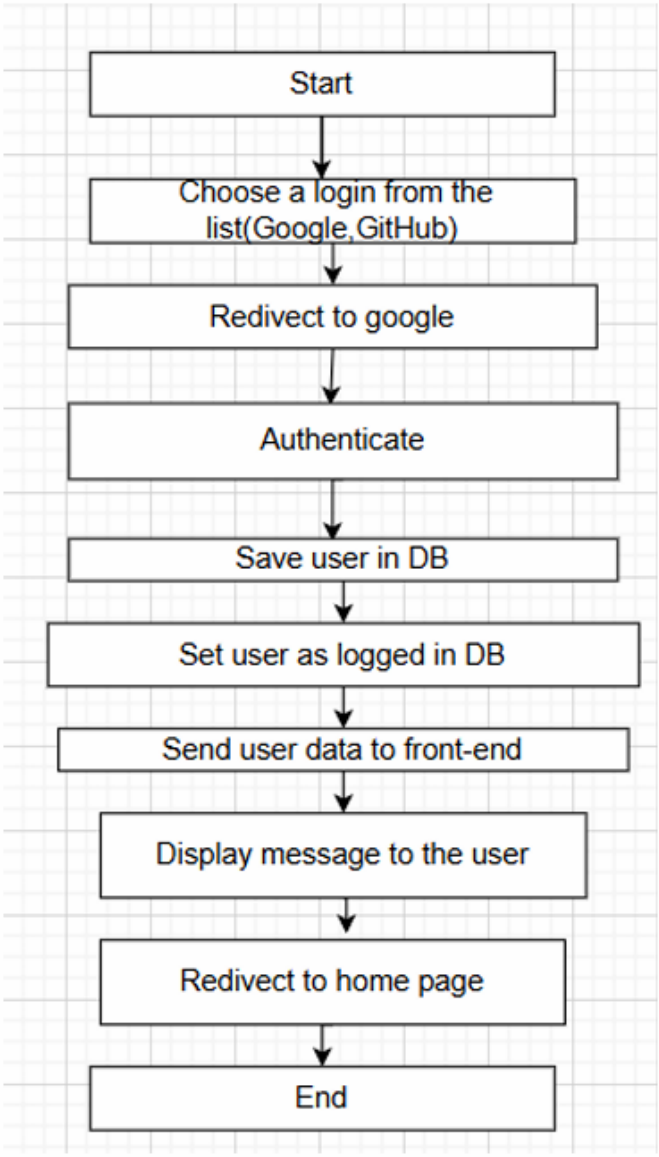
coloringPage

chat



10. Diagrams

Activity Diagram: Sequence of actions in the user login process for the application



- **Class Diagram**