Project Specification Document

CS491 Senior Project

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MindJournal (Group T2505)

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1.Introduction

1.1.Description

In today's fast paced and psychologically demanding world, individuals are increasingly seeking tools that help them understand their thoughts, manage mental patterns, and develop emotional resilience. While traditional journaling and meditation applications offer surface level support, they often fail to provide deeper insights into users' recurring thoughts, underlying triggers, and long-term behavioral patterns. As daily cognitive load increases, people struggle to identify why certain thoughts repeat, which behaviors help them improve, and how their emotional state evolves over time. This leads to a fragmented self-understanding and prevents users from gaining meaningful psychological clarity.

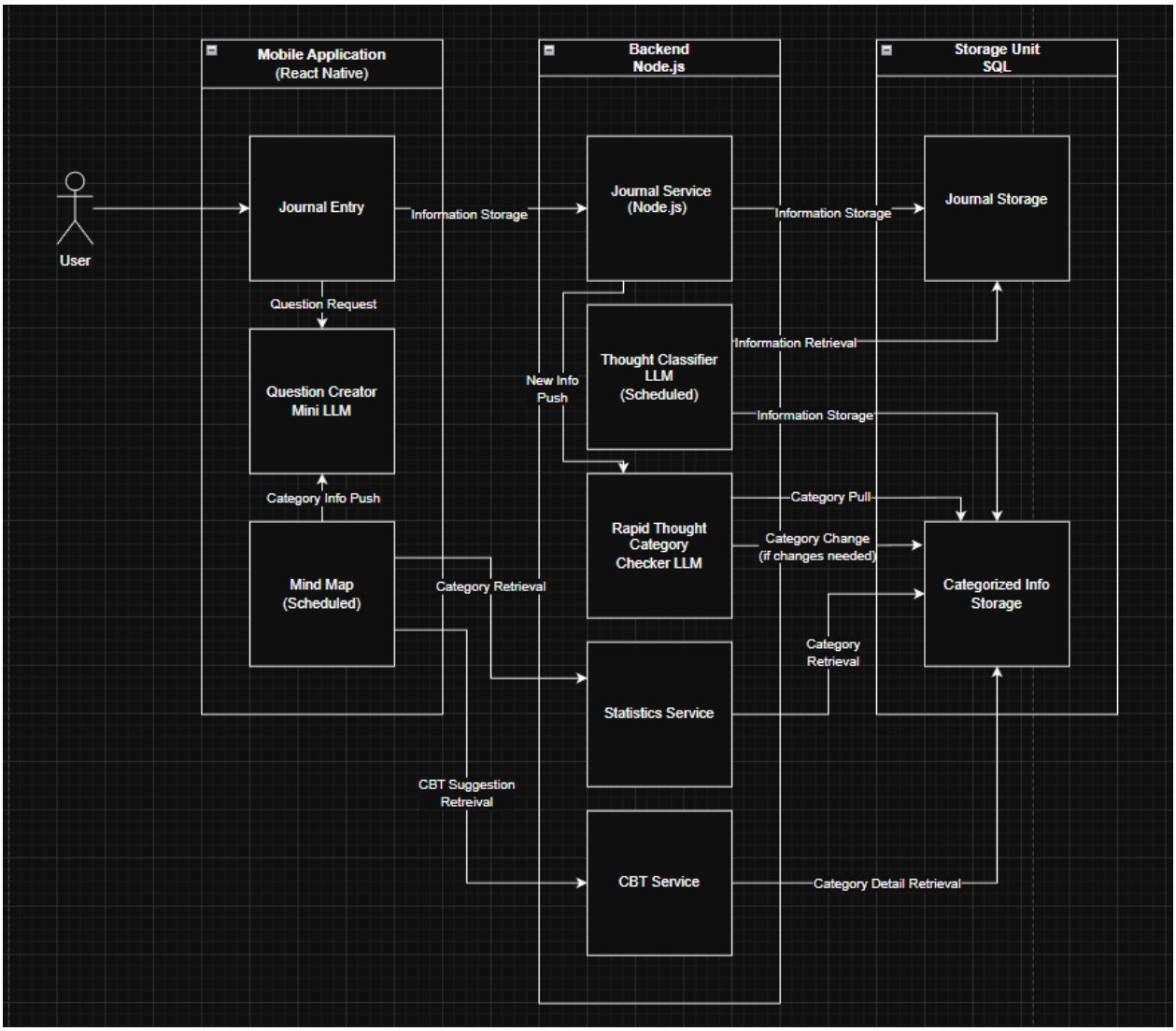
MindJournal is designed to address these challenges by offering a comprehensive AI assisted thought analysis platform that helps users explore, organize, and understand their thinking patterns. Leveraging conversational AI, the system collects thoughts through natural chat-based interactions, asks reflective and open-ended questions, and automatically identifies recurring cognitive themes. By combining intelligent thought categorization, behavioral intervention tracking, and interactive data visualizations, MindJournal enables users to gain a structured and data-driven understanding of their internal experiences.

MindJournal is a mobile application that allows users to record or type their thoughts, which are then processed through an AI powered journaling engine. Unlike conventional journaling tools, MindJournal does not simply store entries; it analyzes each thought, identifies its underlying theme, and groups related thoughts under dynamic categories. During journaling sessions, the chatbot guides users with context-aware questions and invites them to share additional thoughts, enabling the system to capture multiple interconnected ideas within a single session.Once collected, thoughts undergo additional processing to determine their relationships, emotional characteristics, and recurrence patterns. The platform constructs a category-based mind map where each node represents a recurring cognitive theme. Users can explore these categories, access all associated thoughts, and analyze changes in thought frequency or emotional tone over time. MindJournal also includes a "Thought Chain" visualization that reveals how specific

thoughts trigger or reinforce one another, offering deeper insight into cognitive pathways and mental loops.

In addition to thought analysis, MindJournal integrates CBT inspired reframing and behavioral intervention features. When users select a negative or distorted thought, the system provides a rational and balanced alternative interpretation, followed by personalized behavior suggestions. Over time, the application learns which behaviors were effective based on user feedback and re-suggests successful interventions when similar thoughts recur. These insights are consolidated into an improvement-tracking module, allowing users to monitor long-term progress such as reduced thought frequency, emotional stabilization, and increased behavioral effectiveness. By combining AI driven journaling, dynamic categorization, behavior analysis, and interactive visualizations, MindJournal transforms traditional journaling into a continuous self-reflection and cognitive awareness system. This integrated approach helps users understand the structure of their minds and supports long-term psychological growth through structured insight, personalized feedback, and actionable guidance.

1.2.High-Level System Architecture & Components of Proposed Solution



We propose a 3 layered architecture: Mobile Application Layer, Web Server Layer, and Data Unit. Layering outlines the hardware mapping of the project. Mobile side and web side are clearly separated.

Journal Entry(Mobile Layer):

User Interface for journaling. User chats with journaling UI, submits journal sessions, displays guiding questions.

Question Creator Mini LLM(Mobile Layer)

Mobile side, light weight LLM for generating guiding questions for a specific journaling session's context.

Mind Map(Mobile Layer)

Thought statistics visualized on a Mind Map.

Journal Service(Web Layer)

The mobile side pushes journal sessions on this service. Journal sessions are forwarded to the storage unit.

Thought Classifier LLM

Perform LLM inference on a group of journal sessions. This component receives session information as batches, it is scheduled.

Rapid Thought Category Checker

Checks whether a given journal session contains thoughts that can be mapped to one of the existing categories.

Statistics service

Obtain thought categories, and related statistics about the whole journal.

CBT Service

Perform CBT reframe on one of the selected categories.

Journal Storage & Categorized Info Storage:

Storage for raw journaling sessions and processed journaling sessions.

1.3.Constraints

1.3.1. Implementation Constraints

Question Generator Mini LLM and CBT Reframe LLM components are planned to be implemented on the mobile side. These models should be lightweight, at the same time accurate. The specific models will be determined based on tests and evaluation of benchmarks on the candidate contemporary models.

1.3.2. Economic Constraints

- The application will follow a subscription model that will change the user's capability for journaling depth and input number.
- Public API's, database and libraries will be used in order to minimize development costs.
- Database capacity might be problematic in terms of cost in further stages as the users start to journal their thoughts and these are categorized.

1.3.3. Ethical Constraints

- The application will be working with sensitive data (people's thoughts, experiences and names of people around them etc.) the application will have to be developed with extra caution of data privacy in mind.

1.3.4. Professional and Ethical Issues

- We should carefully consider the culture of the region the app is to be launched for. Privacy is a paramount concern. We should enjoy and appreciate the fact that ethical responsibility and a professional approach on product development have great importance.

1.4.Standards

IEEE 830: IEEE 830 provides a recommended practice for Software Requirements Specifications (SRS), emphasizing correctness, completeness, and consistency. By following this standard, the project minimizes ambiguity and establishes a structured baseline for validation by clearly documenting both functional and non-functional requirements.

ISO/IEC25010: ISO/IEC 25010 defines a product quality model to evaluate software systems. The project utilizes this framework to assess nine critical characteristics, including security,

reliability, performance efficiency, and interaction capability, ensuring the software meets rigorous quality standards and user expectations.

UML 2.5.1: UML 2.5.1 serves as the standard visual modeling language for documenting system artifacts. The team employs UML behavioral and structural diagrams to visualize the architecture, ensuring precise communication of the system's design logic among developers and stakeholders.

KVKK (Law No. 6698) The Law on the Protection of Personal Data (KVKK No. 6698) establishes the legal framework for data privacy in Turkey. The system ensures compliance by adhering to strict obligations regarding explicit consent and data security, implementing necessary technical and administrative measures to guarantee lawful processing and the protection of personal rights.

Object-Oriented Design Principles: Object-Oriented Design (OOD) principles guide the system's architecture to ensure modularity and maintainability. By adhering to the SOLID principles and utilizing encapsulation and polymorphism, the design achieves a separation of concerns that facilitates future scalability and code reuse.

2.Design Requirements

2.1.Functional Requirements

2.1.1. User Account & Personal Profile Management

- The user must be able to create an account using an email and password combination.
- The user must be able to securely log in and log out of the application at any time.
- The user must be able to reset their password via email based verification.
- The user must be able to update personal settings.
- The user must be able to permanently delete their account, which must remove all associated thoughts, categories, behaviors, and progress history.
- All user data must be stored separately so that each user interacts only with their own journaling content, categories, and statistics.

2.1.2. Thought Journaling

- The user must be able to start a new journaling session from the “Start Journal” interface.
- At the beginning of each session, a chatbot must greet the user with an initial prompt such as “What’s on your mind right now?”.
- The user must be able to submit thoughts by recording audio or typing.
- After the user shares a thought, the chatbot must respond with context-aware, reflective, and open-ended guiding questions to help the user explore the thought further.
- The chatbot must additionally ask whether the user has any other thoughts they would like to share, enabling the journaling session to collect multiple thoughts within the same conversation flow.
- Every thought expressed by the user during the session must be automatically analyzed and associated with the most relevant category, ensuring that recurring or thematically similar thoughts are grouped under the same category node.
- The user must be able to end the journaling session at any time by selecting the provided exit option.
- The user must be able to review previously completed journaling sessions, including all thoughts captured during the conversation.

2.1.3. Mind Map Visualization of Thought Categories

- The user must be able to access the “Mind Map” screen from the main menu.
- The mind map must display categories as nodes, visually representing groups of similar or recurring thoughts.
- The user must be able to zoom in, zoom out, and drag across the graph to explore different regions of the map.
- The user must be able to view the list of thoughts associated with any selected category node.
- The size and visual prominence of each node must directly reflect the number of thoughts associated with that category.

2.1.4. Thought Statistics

- The user must be able to select any category to view detailed statistical information.
- The user must be able to view the recurrence frequency of thoughts within that category.
- The user must be able to filter statistics by daily, weekly, monthly, or custom date ranges.
- The user must be able to view the emotional patterns associated with the thoughts in that category.

2.1.5. Thought Chain & Trigger Relationship Analysis

- The user must be able to access a “Thought Chain” view that visualizes how thoughts influence or trigger one another.
- The user must be able to see directed edges (arrows) showing relationships such as cause, trigger, or reinforcement.
- The user must be able to select any connection to view the initiating thought and the emotional state reflected in that chain.
- The user must be able to click the “Break the Chain” button to request cognitive reframing assistance.

2.1.6. CBT Reframing

- The user must be able to select a specific negative or distorted thought to request a CBT-based reframing.
- The user must receive a reconstructed, rational, and balanced alternative interpretation of the thought.
- The user must be able to compare their original thought with the reframed version.

2.1.7. Behavioral Intervention Selection & Feedback

- The user must be offered behavior suggestions that align with the thought after receiving a CBT reframing.

- The user must be able to either select an AI-suggested behavior, enter a custom behavior of their own, or skip the step entirely.
- The user must be able to associate the selected behavior with both the specific thought and its corresponding category.
- The user must be able to provide effective feedback for any chosen behavior using “It worked”, “It didn’t work”, or “Remind me later.”
- When a new thought is added to a category that contains previously recorded behaviors, the user must be presented with previously successful behaviors as suggestions.
- The user must receive reminders when the system detects a recurring thought pattern that previously required behavioral intervention.
- The user must be able to view a complete history of selected behaviors, their associated thoughts/categories, and success rates in the “Behavior Progress” section.

2.1.8. Improvement Tracking & Psychological Trend Monitoring

- The user must be able to select a category to view long-term improvement trends.
- The user must be able to view both the reduction in thought frequency and the behavioral success percentages.
- The user must receive positive reinforcement notifications when improvement is detected (e.g., “Great job! This category shows a 25% reduction this month.”).
- The user must receive early warning notifications when a category becomes more active again.
- The user must be able to see weekly or monthly summaries of mental progress.

2.1.9 Onboarding QA

- The user must be able to answer onboarding questions asked to them.
- The age, gender, preferences and any other related attribute that would contribute to the thought classification process for a user must be obtained.

2.2.Non-Functional Requirements

2.2.1. Usability

- The system shall provide an easy to use interface for users to journal their thoughts, navigate through different segments and follow categories in the mindmap.
- All the occurring functionality must be easy to use, find and learn. The user shall not struggle to understand any feature.
- When logged in for the first time, users shall be welcomed by a tutorial to the app, minimizing any possible reasons for question marks.
- MindJournal shall be compatible both for IOS and Android devices without any component losses or disintegrations.

2.2.2. Reliability

- The system must deliver accurate analysis for input thoughts and connect them to related categories.
- There must never be any treatment statements in the given report to the user due to legal reasons.
- Comments given by the LLM must strictly follow the required structure that is retrieved either from datasets or training strategies.
- The app should be able to keep on working when faced with any errors or problems.

2.2.3. Performance

- Our chatbot will take 3 seconds to respond based on context to the given thought input.
- Mind map creation and the chains between the thoughts will take a longer time as there will be a large number of parameters to check while generating. It will still take less than a minute.

2.2.4. Supportability

- The system should be object oriented and follow best practices of software development.
- DRY and SRP principles should be followed in order to prevent any redundancies.
- The code should be easy to follow and understand for the existing functionalities.
- The codespace should be well documented for others to act in accordance with the implementation logic.

2.2.5. Scalability

- The bottleneck of the proposed system under heavy load is LLM inference. Therefore, for scalability purposes, we propose a batched and scheduled LLM processing on journaling sessions. Moreover, selecting node as web server layer to enable multi-threaded processing of requests.

3.Feasibility Discussion

3.1.Market & Competitive Analysis

The mental wellness and self-reflection market is populated by numerous journaling applications, AI-based companions, and CBT-oriented therapeutic tools. While these solutions offer emotional support, guided journaling, or structured well-being exercises, they generally lack a unified system that connects thoughts, categories, behavioral patterns, and long-term cognitive development. MindJournal addresses this gap by combining AI-assisted journaling, automatic thought categorization, personalized behavioral feedback loops, and mind-map visualization into one integrated platform. Below is an analysis of key competitors and how MindJournal differentiates itself:

Wysa

Wysa offers an AI chatbot designed to provide emotional support, basic CBT tools, mood tracking, and guided therapeutic exercises. It excels at empathetic conversation and short-term emotional regulation. However, it does not automatically cluster user thoughts, analyze recurring themes, or maintain long-term cognitive patterns across sessions.

Differentiation: MindJournal goes beyond conversational support by building evolving thought categories, mapping thought chains, tracking emotional trends, and connecting behaviors with recurring cognitive themes. This creates continuity and structured insight, unlike Wysa's session-by-session approach.

Mindsera

Mindsera provides AI-guided journaling with cognitive reframing, identity prompts, and psychological insights. It has strong reflection tools but organizes entries mostly in a linear journaling structure rather than forming interconnected thought categories or behavioral histories.
Differentiation: MindJournal offers a more analytical foundation by automatically grouping similar thoughts, visually mapping categories, tracking behavior effectiveness, and detecting repeated patterns over time. Unlike Mindsera, which focuses on isolated journal entries, MindJournal builds a cognitive structure that evolves with the user.

Reflectly / Clearful

Reflectly and Clearful are designed around journaling prompts, gratitude reflections, and mood questionnaires. They provide aesthetically guided journaling experiences but lack deeper psychological analysis, category clustering, or behavioral intervention tracking.
Differentiation: MindJournal transforms journaling into a dynamic analytical model using AI to identify recurring thought themes, emotional trends, and triggers. It also links behaviors to specific thought categories, enabling users to understand what works over time, a capability not offered by Reflectly or Clearful.

MindDoc & Bloom

MindDoc and Bloom provide structured CBT exercises, emotional assessments, and therapeutic lessons. They serve as digital mental-health programs but function primarily through predefined modules rather than user-generated thought exploration. Neither platform offers a conversation-based journaling interface nor automatic detection of recurring thought patterns.
Differentiation: MindJournal allows users to express organic, unstructured thoughts through a conversational AI and then organizes them into categories, helping users understand their mental patterns. The dynamic behavior-suggestion memory also ensures personalized interventions, something module-based apps cannot replicate.

Stoic

Stoic focuses on daily reflections, mood logs, and philosophical prompts. While visually refined, it lacks automated cognitive analysis, category-building, or connections between thoughts. It helps users reflect daily but does not reveal hidden cognitive patterns or thought chains.

Differentiation: MindJournal surfaces deeper insight through thought-trigger mapping, category-based emotional patterns, and behavioral history. It provides a cognitive structure Stoic does not attempt to build.

Calm

Calm specializes in guided meditation, sleep stories, and mindfulness practices. It addresses stress and emotional regulation but does not include journaling, thought processing, or CBT-style analysis.

Differentiation: MindJournal focuses on cognitive processing, thought structure, and behavioral change areas where Calm provides no tools. Calm helps regulate mood externally; MindJournal helps understand thought mechanics internally.

Headspace

Headspace offers mindfulness training, meditations, and habit-building routines. While effective for emotional balance, it does not analyze thoughts, categorize them, or support AI driven cognitive exploration.

Differentiation: Headspace enhances mindfulness practice, whereas MindJournal enhances cognitive understanding. MindJournal helps users track thought frequency, emotional trends, and behavior effectiveness capabilities Headspace does not support.

3.2.Academic Analysis

Automated Cognitive Restructuring

Research by Sharma et al. [1] demonstrates that Large Language Models can effectively identify cognitive distortions such as "catastrophizing" and generate empathetic reframes. MindJournal utilizes this in its CBT Reframing module. By employing NLP to detect negative patterns and

offer objective, balanced perspectives, the system provides the immediate feedback necessary to break maladaptive thought cycles.

Network Theory of Mental Disorders

The Network Theory of Mental Disorders proposes that psychopathology is a complex network of interacting symptoms rather than a latent condition [2]. MindJournal adopts this framework in its Mind Map module. By representing thoughts as interconnected nodes, the platform visualizes causal loops such as fear triggering avoidance making abstract mental states tangible and manageable for the user.

Longitudinal Affective Computing

Citing Calvo and D'Mello [3], MindJournal prioritizes longitudinal tracking over isolated sentiment analysis to understand emotional baselines. By aggregating sentiment across sessions, the system monitors long-term psychological trends. This allows users to distinguish transient stressors from chronic patterns, fostering self-awareness and tracking emotional stability over time.

Embodied Conversational Agents (ECAs)

Bickmore and Picard [4] highlight that Embodied Conversational Agents significantly enhance the "therapeutic alliance" compared to text-only interfaces. MindJournal leverages this via a 2D avatar with real-time lip-syncing. This multimodal coherence reduces cognitive dissonance, creating a more immersive and empathetic interaction that builds user trust.

Comparative Analysis

While existing tools often focus on passive tracking, they lack the interactivity required for active therapeutic change. By synthesizing the generative capabilities of NLP [1], the structural insights of Network Theory [2], and the relational impact of ECAs [4], MindJournal addresses these limitations, offering a scientifically grounded platform for real-time cognitive intervention.

4.Glossary

Affective Computing: A branch of computer science and engineering that involves the study and development of systems that can recognize, interpret, process, and simulate human affects (emotions).

Cognitive Behavioral Therapy (CBT): A psycho-social intervention that aims to improve mental health by identifying and challenging cognitive distortions (negative thought patterns) and employing behavioral strategies to regulate emotions.

Cognitive Distortion: Irrational or exaggerated thought patterns (e.g., catastrophizing, black-and-white thinking) that are believed to perpetuate the effects of psychopathological states like depression and anxiety.

Cognitive Reframing: A psychological technique used in CBT to identify negative thoughts and replace them with more balanced, rational, and positive alternatives.

DRY (Don't Repeat Yourself): A software development principle aimed at reducing repetition of software patterns, replacing it with abstractions or using data normalization to avoid redundancy.

Embodied Conversational Agent (ECA): An intelligent agent that uses a visual representation (avatar) to interact with users, utilizing both verbal (speech) and non-verbal (facial expressions, gestures) communication.

KVKK (Kişisel Verilerin Korunması Kanunu): The Turkish Law on the Protection of Personal Data (Law No. 6698), which regulates the processing of personal data and ensures the privacy rights of individuals.

Large Language Model (LLM): A type of artificial intelligence algorithm that uses deep learning techniques and massively large data sets to understand, summarize, generate, and predict new content.

Mind Map (in MindJournal context): A visual diagram used to organize information where the central concepts are user-defined categories, and branches represent specific thoughts, tailored to reveal the structure of the user's psyche.

Natural Language Processing (NLP): A subfield of artificial intelligence capable of reading, understanding, and deriving meaning from human languages.

SOLID: An acronym for five design principles (Single Responsibility, Open-Closed, Liskov Substitution, Interface Segregation, Dependency Inversion) intended to make software designs more understandable, flexible, and maintainable.

SRP (Single Responsibility Principle): A computer programming principle that states that every module, class, or function should have responsibility over a single part of the functionality provided by the software.

Thought Chain: A specific visualization feature in MindJournal that connects thoughts via directed edges to illustrate the causal or triggering relationship between them.

5.References

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