National University of Computer & Emerging Sciences

(Karachi Campus)
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PROJECT PROPOSAL

ARTIFICIAL INTELLIGENCE

AI-Powered Scrabble with PDF Based Questioning

Group members:

Name	Roll No	Class
Rushba Khan	22K-6001	BSCS-6M
Zeeshan Uddin	22K-5080	BSCS-6M

1. Project Overview:

Project Topic:
This project introduces an AI-powered Scrabble game where players must interact with an AI to retrieve answers from an uploaded PDF document. The game enhances traditional Scrabble by requiring players to form words using letter tiles earned through correct AI responses. This innovation integrates AI-based learning with strategic word formation.

Objective:
The main objective of this project is to combine knowledge retrieval from PDFs with strategic gameplay mechanics. Players engage in Scrabble, but instead of receiving a random set of tiles at the beginning, they earn letter tiles by correctly answering AI-generated questions from an uploaded PDF. The AI is built using LLaMA 2 and LangChain, ensuring accurate PDF-based knowledge extraction.

2. Game Description:

Original Game Background:
Scrabble is a classic word-based board game where players use letter tiles to create words on a grid. Each letter carries a point value, and players aim to maximize their score by forming high-scoring words while utilizing premium board spaces such as double/triple letter and word scores.

Innovations Introduced:
- **PDF-Based Word Earning:** Players must ask questions from the uploaded PDF, and correct answers grant letter tiles.
- **AI-Based Word Validation:** The game checks if words formed by the player are valid dictionary words using Natural Language Processing (NLP).
- **Dynamic Tile Allocation:** The number of letters awarded depends on the complexity of the AI's answer.
- **AI as an Opponent:** The AI can also play against the human, forming words based on PDF content.

Impact on Gameplay Complexity and Strategy:

- Players must strategize their questions to earn the most useful letter tiles.
- The game rewards complex and meaningful words, encouraging AI interaction for better responses.
- Players must balance knowledge retrieval and word formation, making Scrabble more educational and competitive.

3. AI Approach & Methodology:

AI Techniques to be Used:

- **LLaMA 2 Model:** Utilized for retrieving answers from PDFs.
- **LangChain & FAISS:** Enables semantic search in documents.
- **Natural Language Toolkit (NLTK):** Used for word validation.
- **Minimax Algorithm (for AI Opponent):** If playing against an AI, it chooses optimal word placements.

Heuristic Design:

- **PDF Answer Scoring:** AI assigns a difficulty score to each answer, which affects the number of letter tiles awarded.
- **Word Validation Score:** Words are checked against a dictionary using NLP, with bonus points for rare words.
- **Optimal Word Placement:** If AI is playing, it calculates the best move using board state evaluation.

Complexity Analysis:

- **PDF Retrieval:** O(n) (searching for relevant text in the document)
- **AI Word Generation:** O(m log m) (word scoring and placement selection)
- **Minimax Algorithm (for AI opponent):** O(b^d) (exponential in branching factor and depth)

4. Game Rules & Mechanics:

Modified Rules:

1. Players do not start with letter tiles.
2. Players must ask a PDF-based question, and if AI provides a correct response, they receive random letter tiles.
3. Longer and more complex answers yield more letters.
4. Players use earned letters to form words on the board.
5. AI can play against human players, using document content to construct words.

Winning Conditions:

1. The player with the highest score at the end wins.
2. If tiles run out, the player with the most valid words wins.
3. If a player cannot form a word in 3 turns, they lose.

Turn Sequence:

1. Player asks a question related to the PDF.
2. AI provides an answer.
3. If correct, player receives random letters.
4. Player forms a word on the Scrabble board.
5. Opponent (either AI or another player) follows the same sequence.
6. Game continues until tiles run out or a winning condition is met.

5. Implementation Plan:

Programming Language:
Python

Libraries and Tools:

- Streamlit (for game UI)
- LangChain & FAISS (for document question-answering)
- LLaMA 2 (AI-powered chatbot)
- NLTK (Word validation and dictionary support)
- Pygame (optional) (For GUI improvements)

Milestones and Timeline:

- Week 1-2: Game design, Scrabble mechanics, and PDF integration planning.
- Week 3-4: AI-based question-answering and letter tile allocation.
- Week 5-6: Implementing word validation and AI strategy.
- Week 7: Testing, debugging, and optimization.
- Week 8: Finalizing UI and writing the final report.

6. References:

- Scrabble Official Rules: https://www.scrabble.com/rules
- Research on AI for Word Games: https://arxiv.org/pdf/2004.03705.pdf
- LangChain Documentation: https://python.langchain.com/en/latest/
- FAISS: Facebook AI Similarity Search: https://faiss.ai
- LLaMA 2: Meta AI Language Model: https://llama.meta.com