Statement of Work

PrepPal

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Background and Motivation

Professionals, students, and stay-at-home parents often struggle to find enough time for meal preparation due to their busy schedules. This becomes even more difficult when considering the need to search for recipes that fit both their preferences and the time they have available. A study revealed that to discover new recipe ideas, individuals often turn to family and friends (71%), cookbooks (41%), or online food communities (45%) (Doub et al., 2016). However, these fragmented sources lack a centralized, personalized approach, making it time-consuming and inefficient for users to filter through multiple recipes to find one that suits their tastes and time availability.

This challenge is further worsened by the inefficient use of ingredients, as many purchased items go unused or spoil before they can be incorporated into meals. According to Lebersorger and Schneider (2011), avoidable food waste constitutes a substantial share of residual waste, accounting for 14.1% by mass. This waste predominantly includes perishable items like vegetables, bread, and meat, highlighting a pressing need for more efficient meal-planning solutions that optimize ingredient use and reduce unnecessary waste.

Our project seeks to address these challenges by developing an application that offers a centralized and personalized solution to meal planning. By utilizing user preferences, available ingredients, and time constraints, the app will generate tailored recipe suggestions, helping users reduce food waste and the time spent searching for meal ideas, ultimately providing a more sustainable and enjoyable cooking experience.

Scope and Objectives

This project aims to develop an AI-powered meal-planning application that simplifies recipe discovery and ingredient management while minimizing food waste. The application leverages a foundational model, a fine-tuned foundational model as well as an extensive recipe knowledge base, to provide a seamless and personalized user experience, making it a complex, yet interesting and rewarding endeavor.

Application Key Features:

- Recipe Management: Users can add and rate recipes through text input or via links, building a personalized collection of meals. These will be made available to the LLM via RAG.
- Pantry Management: Users can update their pantry through text input to ensure real-time tracking of ingredients.
- Meal Recommendations and Ingredient-Based Recipes: The chatbot will provide personalized recipe suggestions by analyzing the ingredients available in the user's pantry or based on specific ingredients provided via text. By integrating an LLM (e.g. Gemini) fine-tuned to re-rank recipes retrieved through RAG by maximizing the use of available ingredients, with an instruct model, the system will suggest appropriate meals.
- Dynamic Pantry Updates: After cooking, the app updates the pantry, dynamically optimizing future recipe recommendations.

To deliver these features, our application will mainly consist of a single chatbot interface, which the user can use to converse about possible recipes. The user will also be able to upload their favorite recipes or use the text input fields to update their pantry/ingredient list, on a separate tab of the application, which will be used by the model to generate recipe recommendations.

Resources We Require

- Pre-trained Gemini 1.5 model, available through GCP Vertex AI
- Extensive recipe dataset (all-recipes; textual data) used for fine-tuning Llama model, available through HuggingFace Datasets. The fine-tuning will allow the Gemini model to re-rank recipes to minimize food waste.
    - This dataset contains 2.2 million recipes. Each recipe has a title, a list of ingredients and their respective quantities, and a list of directions for how to cook the recipe.
- Pre-trained multi-qa-MiniLM-L6-cos-v1 embedding model, available through HuggingFace Sentence Transformers, used to generate recipe embeddings for RAG
- Extensive recipe dataset used as a knowledge base for RAG available through Kaggle.
    - The dataset contains 522,517 recipes from 312 different categories. Each recipe has a title, a list of ingredients and their respective quantities, cooking time, and a list of directions for how to cook the recipe.

High-Level Key Deliverables

- Create synthetic dataset to fine-tune Gemini
- Fine-tune Gemini to re-rank recipes
- RAG pipeline for knowledge-base and user provided recipes
- Create a database to support accurate pantry inventory management
- Scalable backend implementation (s.t. multiple queries can be handled at once)
- Frontend development
- Create Container/Cloud Infrastructure for Development

- Create Cloud Deployment Architecture

Future Features

- Users will be able to dynamically update their pantry using speech
    - powered by a voice-to-text model for speech recognition and transcription (pre-trained Google Cloud Speech-To-Text model)
- Users will be able to ask for recipe recommendations by uploading a picture of the ingredients they would like to use
    - powered by an image-to-text model for object recognition fine-tuned on ingredients images (pre-trained Llava image-text-to-text model)

References

1. Doub, A. E., Small, M. L., Levin, A., LeVangie, K., & Brick, T. R. (2016). Identifying users of traditional and internet-based resources for meal ideas: An association rule learning approach. *Appetite*, *103*, 128–136. https://doi.org/10.1016/j.appet.2016.04.006
2. Lebersorger, S., & Schneider, F. (2011). Discussion on the methodology for determining food waste in household waste composition studies. *Waste Management*, *31*(9–10), 1924–1933. https://doi.org/10.1016/j.wasman.2011.05.023