Recommending with Taste:

A Comprehensive Benchmark of Algorithms for Cooking Recipes with Diversity Considerations

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Abstract

Background: Recommender systems have become essential tools in online platforms. While recipe recommendation has specific challenges such as dietary preferences, ingredient constraints, and content diversity, few works address both accuracy and user novelty simultaneously.

Method: We benchmark several algorithms, including collaborative filtering, content-based, matrix factorization, and hybrid models. Additionally, we integrate re-ranking strategies based on novelty and diversity to improve user experience.

Results: Our results demonstrate that while classic collaborative filtering achieves high accuracy, hybrid models incorporating diversity constraints significantly enhance the variety of recommended recipes with minimal loss in performance.

Keywords: recommender systems, recipe recommendation, collaborative filtering, diversity, evaluation, personalization

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1 Introduction

Recommender systems have become an essential tool in the digital world, enabling platforms to personalize user experiences by predicting preferences and suggesting relevant items. These systems are widely used across various domains, such as e-commerce, video and music streaming services, and social media.

This project focuses on building a recommendation system tailored for a recipe platform, using the open-source **Cornac** library, which is designed for hybrid and probabilistic recommender models. The objective is to develop, evaluate, and enhance several recommendation algorithms, and finally integrate diversification techniques to offer more varied and serendipitous recipe suggestions.

Problem Definition

In the context of a recipe recommendation platform, users interact with a large collection of recipes by leaving reviews or ratings, indicating their preferences or experiences. The core challenge is to predict which recipes an individual user is most likely to enjoy, based on their past interactions and the preferences of similar users. Recipe recommendation presents unique challenges compared to other domains, such as:

- Highly subjective taste preferences,
- Diverse dietary requirements (e.g., vegan, gluten-free),
- Varying ingredient availability and regional cuisine preferences,
- Cold-start issues for new users or newly added recipes.

The problem can be formally defined as follows: given a set of users U, a set of recipes (items) I, and a set of observed interactions $R \subseteq U \times I$ (e.g., ratings or reviews), the goal is to learn a function $f : U \times I \to \mathbb{R}$ that estimates the relevance or utility of an item for a given user. Using this function, the system generates a ranked list of recipe recommendations for each user that maximizes both predictive accuracy and content diversity.

To address this problem, we explore a range of collaborative filtering and matrix factorization algorithms, including those not covered in the course, alongside diversification techniques to ensure recommendation novelty and coverage. Our methodology includes selecting an appropriate dataset, analyzing its characteristics, implementing several algorithms using Cornac, and evaluating their performance using a mix of accuracy and diversity metrics.

Hypothetical Business Applications

Beyond its academic relevance, a recipe recommendation engine has numerous potential applications across different sectors of the food and nutrition industry. By leveraging personalized suggestions, such a system can bring value to both end users and professional stakeholders. Below are several potential application scenarios:

- **Smart Cooking Assistants:** Integration with mobile apps or smart kitchen devices to suggest recipes based on user preferences, available ingredients at home, or nutritional goals. The system could adapt dynamically based on user feedback and cooking history.

- **Health and Nutrition Platforms:** Personalized meal recommendations tailored to individual dietary restrictions (e.g., allergies, diabetes, weight loss) or fitness objectives (e.g., high-protein diets). This could support dieticians or wellness programs with intelligent food planning tools.
- **Educational or Culinary Learning Apps:** Recommendation of recipes based on difficulty, required skills, or cooking techniques for users who want to learn progressively. The engine could adapt suggestions based on the user's mastery level and completed dishes.
- **Cultural and Seasonal Discovery:** Recommendation of seasonal or culturally relevant recipes based on time of year, holidays, or local traditions, which adds a contextual and exploratory dimension to the recommendation process.

These diverse applications illustrate how a well-designed recommendation engine can provide value in both consumer-facing tools and professional services, supporting personalization, convenience, and user satisfaction.

2 Dataset

The project is carried out using the publicly available dataset **"Food.com - Recipes and Reviews"** from Kaggle, which contains over 520,000 recipes and 1,400, 000 reviews from over 270,000 different users. The dataset provides rich information about ingredients, preparation steps, and user feedback, making it ideal for building a context-aware and diversified recommendation system.