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FlavorForge – Crafting Detectable Recipes with Recipe NLG

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ABSTRACT: This project, "FlavorForge," is an online application developed using Streamlit that uses PyTorch and the Hugging Face Transformers library to create cooking recipes using a deep learning model based on the transformer architecture. Users can enter ingredients, select a chef, and get recipes that are created dynamically. Using the transformer's capabilities, the basic model, the text creation pipeline, generates recipes that are both contextual and logical. Users can explore different recipe alternatives using an interactive web interface that emphasises culinary creativity.

To sum up, RecipeNLG and related research aims to tackle the difficulties in creating structured texts by concentrating on cooking recipes. In order to gain insight into how well models can capture the nuances of context and common sense in the generation of semi-structured text messages, the dataset and experimental methodologies given here are intended to push the boundaries of current NLG capabilities.

KEYWORDS: FlavorForge: Streamlit, PyTorch, Transformers for NLG; Fine-Tuning, User Feedback, Scaling, Experimentation, Recipe Creativity.

I. INTRODUCTION

FlavorForge is a groundbreaking web application designed to elevate the culinary experience by seamlessly merging the realms of artificial intelligence and gastronomy. Developed using Streamlit, this platform harnesses the power of the transformer architecture, specifically leveraging the Hugging Face Transformers library and PyTorch, to craft dynamic and contextually rich cooking recipes. At its core, FlavorForge is propelled by RecipeNLG, an innovative deep learning model tailored to the intricate art of natural language generation in the culinary domain.

Imagine a virtual kitchen where users can embark on a journey of culinary creativity. With FlavorForge, users can input their desired food ingredients preferences, select a preferred chef persona, and witness the magic unfold as the transformer-based model generates personalised and coherent recipes on-the-fly. The text generation pipeline of this project not only demonstrates the capabilities of transformers in capturing the nuances of context but also delves into the intricacies of common sense, pushing the boundaries of current NLG capabilities.

Our mission extends beyond the mere generation of recipes; FlavorForge is a testament to the fusion of technology and gastronomy, providing an immersive and interactive interface for users to explore a myriad of recipe options. From choosing ingredients to selecting a chef persona, users are invited to tailor their culinary experience to their unique tastes and preferences.

The foundation of FlavorForge lies in a meticulously curated dataset that encompasses diverse cuisines, cooking styles, and ingredients, ensuring that the generated recipes resonate with a broad audience. The project emphasises the importance of pre-trained models on domain-specific data to enhance its ability to produce contextually relevant and engaging recipe suggestions.

As users engage with the web application, they not only witness the marvels of NLG but also enjoy a personalised touch by selecting their favourite chef persona. FlavorForge goes beyond mere recipe

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generation; it encapsulates a holistic culinary experience, embracing user feedback, offering customizable features, and even delving into the visual realm with the possibility of incorporating images or videos into the recipe recommendations.

Join us on this culinary adventure as FlavorForge redefines the landscape of recipe generation, providing a platform where artificial intelligence meets the art of cooking.

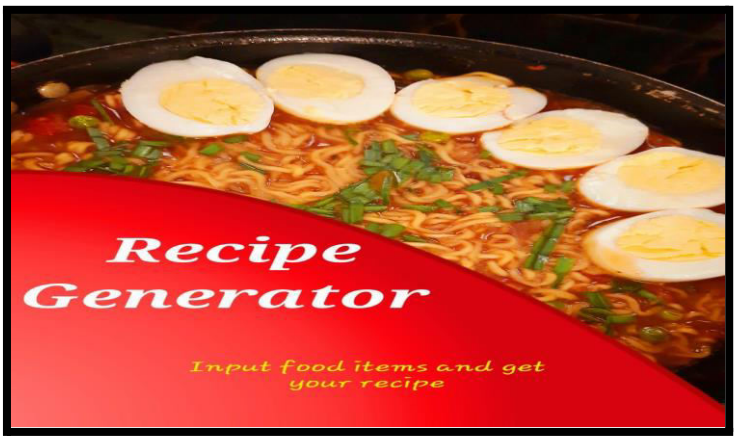

Fig. 1. Recipe Generator

II. LITERATURE REVIEW

The literature survey encompasses a diverse range of contributions in the field of recipe generation, each exploring innovative methodologies and datasets. [8]Taneja et al. (2024) introduce RecipeMC, incorporating Monte Carlo Tree Search and manual rewards to enhance recipe generation with large language models (LLMs), demonstrating superior performance in metrics and user evaluations. [2]Chhikara et al. (2024) present FIRE, a method employing BLIP, Vision Transformer, and T5 models for recipe generation from food images, showcasing versatility and practical applications. Sakib and Shahariar (March 2023) contribute a cooking recipes dataset, employing Active Learning methods for categorization. [4]Komariah et al. (January 2023) introduce SMPT for creating the high-quality FINER dataset, excelling in food entity recognition. Bodekar-Kale's system (May 2022) minimises user hassle by providing recipe searches based on ingredients, utilising different optimizers for model accuracy. Katserelis (September 2022) explores fine-dining recipe generation with GPT-2, aiming for structured outputs. Wu et al. (June 2022) enhance cooking video captioning with an ingredient recognition module, while Sedano Moreno (July 2022) develops a Python application for recipe retrieval. Galanis and Papakostas (2022) present a comprehensive overview of ML approaches for recipe generation, anticipating future advancements. Lastly, Bien et al. (December 2020) contribute to RecipeNLG, providing an opportunity to evaluate model-generated quantities. Each study adds valuable insights to the evolving landscape of recipe generation, addressing challenges and showcasing the potential of advanced techniques in this domain.
[8]Taneja, Segal, and Goodwin (January 2024) introduce a novel approach named RecipeMC, leveraging Monte Carlo Tree Search (MCTS) and manual rewards to enhance recipe generation with large language models (LLMs). This method demonstrates superior performance in both automatic metrics and human evaluations, addressing issues such as repetitiveness and inconsistencies. RecipeMC outperforms traditional methods and is particularly notable for its efficiency in enhancing recipe generation with LLMs like GPT-2.

[2]Chhikara, Chaurasia, Jiang, Masur, and Ilievski (2024) present FIRE, a pioneering system designed for Food Image to Recipe Generation. Using BLIP, Vision Transformer, and T5 models, FIRE excels in generating food titles and instructions from images, surpassing baseline models. The methodology showcases versatility, enabling practical applications such as recipe customization. Rigorous experiments validate the efficacy of FIRE, highlighting its potential for real-world adoption in food computing.

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Sakib and Shahariar (March 2023) contribute to the field by creating a Cooking Recipes Dataset based on Active Learning. Their methodology involves collecting recipes from the RecipeNLG dataset, categorising them with Named Entity Recognition (NER), and employing Active Learning methods, including Query-by-Committee and Human In The Loop. This results in the construction of the (3A2M) cooking recipes dataset, providing an annotated collection of two million culinary recipes categorised by experts.

[4]Komariah, Purnomo, Satriawan, Hasanuddin, Setianingsih, and Sin (January 2023) propose SMPT, a Semi-Supervised Multi-Model Prediction Technique for Food Ingredient Named Entity Recognition (FINER) Dataset Construction. This method involves collecting diverse recipe data, fine-tuning pre-trained language models, and using SMPT for iterative training. The study successfully introduced SMPT, outperforming similar datasets with over 90% precision, recall, and F1-score in food entity recognition.

[5]Prof. Sonali Bodekar-Kale (May 2022) presents a recipe generator using deep learning, aiming to provide users with a hassle-free recipe search experience based on ingredient queries. The proposed system utilises different optimizers, including Adam and RMSProp, and undergoes thorough testing against various epochs, steps, and learning rates to develop an accurate and efficient model.

[3]Konstantinos Katserelis (September 2022) contributes to fine-dining recipe generation with Generative Pre-trained Transformers. The methodology employs character-level Recurrent Neural Networks and the GPT-2 transformer for automatic cooking recipe generation. A novel dataset featuring "fine-dining" recipes is created, and the GPT-2 model is fine-tuned to generate "gourmet" dishes. The experiments aim to produce structured recipes, setting this approach apart from conventional models.

Wu, Chen, Pan, and Jiang (June 2022) propose Ingredient-enriched Recipe Generation from Cooking Videos, enhancing cooking video captioning by introducing an ingredient recognition module with a copy mechanism. The framework leverages ingredient information and sequence correlation, integrating predicted ingredients into sentences. The method achieves promising results on YouCookII and Cooking-COIN datasets, improving semantic accuracy in cooking video captions.

[7]Daniel Sedano Moreno (July 2022) contributes to the field by developing a cooking recipes application with Python. The methodology involves surveying applications, datasets, and algorithms to inform the design of the application, with a focus on searching a large recipe database. The developed Flask app for RecipeNLG in Visual Studio Code is evaluated and compared against existing solutions identified in the survey.

[6]Nikolaos-Ioannis Galanis and George A. Papakostas (2022) provide an update on cooking recipe generation with Machine Learning and Natural Language Processing. The methodology involves investigating various ML approaches, including NLP and Case-Based Reasoning, to offer a comprehensive overview of recipe generation methods. The study acknowledges the potential humour in outcomes but emphasises the valuable inspiration and context that ML brings to culinary solutions. The authors also anticipate a future with a "robotic chef" driven by advancements in DL and NLP.

[1]Michał Bien, Michał Gilski, and Martyna Maciejewska (December 2020) contribute to RecipeNLG: A Cooking Recipes Dataset for Semi-Structured Text Generation. They create a language model based on the Hugging Face implementation of the pretrained GPT-2, providing an opportunity to evaluate if quantities are correctly generated by the model. This dataset offers a valuable resource for evaluating the accuracy of model-generated quantities in recipe texts.

This literature review explores various advancements in recipe generation, featuring methods such as RecipeMC, FIRE, SMPT, and others. The studies cover diverse aspects, including user-friendly retrieval systems, fine-dining recipe generation, and comprehensive overviews of machine learning approaches. Together, these contributions advance the field by addressing challenges and highlighting the potential of advanced techniques in recipe generation.

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III. ANALYSIS OF TECHNIQUES DISCUSSED IN LITERATURE SURVEY

S.no	YEAR	AUTHOR	TITLE	DATASET	METHODOLO GY	RESULT
1.	January 2024	Karan Taneja, Richard Segal, Richard Goodwin	Monte Carlo Tree Search for Recipe Generation using GPT-2	RecipeMC, RecipeGPT, RecipeGM	RecipeMC, using Monte Carlo Tree Search and manual rewards to improve recipe generation with large language models.	Produces recipes human created ones. In a turing test, users prefer recipeMC ingredients 55% & instructions 62%. This underscores the efficiency of MCTS in enhancing recipe generation with LLMs GPT2
2.	January 2024	Prateek Chhikara, DhirajChaurasia1, Yifan Jiang, Omkar Masur, and Filip Ilievski	FIRE: Food Image to REcipe Generation	Recipe 1M	Designs FIRE with BLIP, Vision Transformer, and T5 models for recipe generation from food images.	Generates food titles and instructions from images.
3.	March 2023	Nazmus Sakib, G. M. Shahariar	Cooking Recipes Dataset based on Active Learning	RecipeNLG 3A2M	RecipeNLG dataset, categorizing 300K recipes by using Named Entity Recognition (NER), and employing an Active Learning method (Query-by-Committee and Human In The Loop) for categorizing the remaining 1900K recipes.	Constructed the (3A2M) cooking recipes dataset, an annotated dataset of two million culinary recipes so that people can choose the food recipes according to their preferred categories.
4.	January 2023	Kokoy Siti Komariah, Ariana Tulus Purnomo, Ardianto Satriawan, Muhammad Ogin Hasanuddin, Casi Setianingsih and Bong-Kee Sin	SMPT: A Semi-Supervised Multi-Model Prediction Technique for Food Ingredient Named Entity Recognition (FINER) Dataset Construction	FINER	Involves collecting diverse recipe data, fine-tuning pre-trained language models, and using SMPT for iterative training to create the FINER dataset.	Introduced SMPT for creating the high-quality food entity recognition dataset FINER, outperforming similar datasets with over 90% precision, recall, and F1-score.

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5.	May 2022	Prof. Sonali Bodekar-Kale	Recipe generator using deep learning	Epicurious and recipe box	Adam optimizer and RMSProp to develop the most accurate model.	Provide recipe by ingredient search to the users thus minimizing the hassle to find a recipe suitable for every individual user
6.	September 2022	Konstantinos Katserelis	Towards Fine-Dining Recipe Generation with Generative Pre-trained Transformers	RecipeNLG, RecipeGAN	Character-level Recurrent Neural Networks and the GPT-2 transformer for automatic cooking recipe generation. A novel dataset featuring "fine-dining" recipes is created, and the GPT-2 model is fine-tuned for generating "gourmet" dishes.	Once the model finished training, It is saved and now it is ready to produce recipes. By passing "keywords" (ingredients) as the recipe's first word and then the token, then lets the model figure out what the next characters should be and thus create a recipe character by character.
7.	June 2022	Jianlong Wu, Jingjing Chen, Liangming Pan, Yu-Gang Jiang	Ingredient-enriched Recipe Generation from Cooking Videos	YouCookII and Cooking-COIN	Ingredient recognition module with a copy mechanism.Comprising a video encoder, ingredient module, and caption decoder, it is effective on YouCookII and Cooking-COIN datasets.	The framework leverages ingredient information and sequence correlation for enhanced semantic accuracy.
8.	June 2022	Daniel Sedano Moreno	Development of a cooking recipes application with python	RecipeNLG	Involves surveying applications, datasets, and algorithms to inform the design of a cooking recipe application, with a focus on searching a large recipe database.	Provides users with a functional application for recipe retrieval through string queries.
9.	2022	Nikolaos-Ioannis Galanis, George A. Papakostas	An update on cooking recipe with Machine Learning and Natural Language Processing	Recipe 1M+ RecipeNLG RecipeQA	NLP and Case-Based Reasoning, to provide a comprehensive overview of recipe generation methods.	Brings culinary solutions. Also anticipates a future with a "robotic chef," driven by advancements in DL and NLP.

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10.	December 2020	Michał Bien, Michał Gilski , Martyna Maciejewska	RecipeNLG: A Cooking Recipes Dataset for Semi-Structured Text Generation	Recipe1M+ RecipeNLG	Created a language model based on the Hugging Face implementation of the pretrained GPT-2	It creates an opportunity to evaluate if the quantities are correctly generated by the model.

III. GENERAL METHODOLOGY

This section contains an overview of the generic methodology that is used in A web application built with Streamlit to generate cooking recipes using a deep learning model based on the transformer architecture, specifically using the Hugging Face Transformers library and PyTorch. It allows users to enter food, choose a chef and receive dynamically generated recipes. The base model, the text generation pipeline, uses the transformer's capabilities to create coherent and contextual recipes. The web interface provides an interactive experience for users to explore various recipe options with a focus on culinary creativity. RecipeNLG challenges in generating structured texts by focusing on cooking recipes. The dataset and experimental approaches presented here aim to push the boundaries of current NLG capabilities, providing insights into how well models can capture the intricacies of context and common sense in the generation of semi-structured texts.

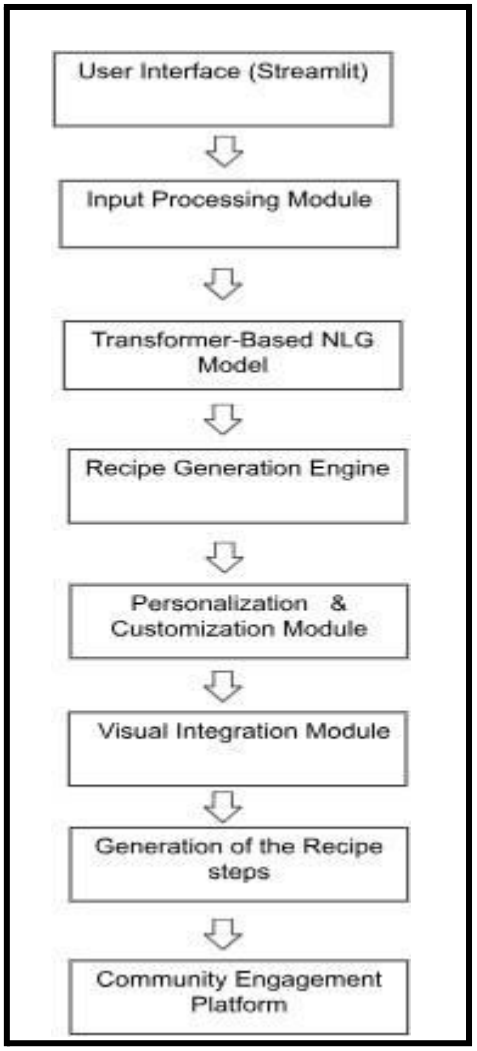

Fig. 2. Flow of General Methodology

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IV. DATASETS

Commonly used datasets RecipeNLG is an extensive collection of over 2 million cooking recipes, meticulously curated and processed for semi-structured text generation. The dataset, totally 2.14GB in size, offers a wealth of culinary information for various gastronomic adventures.Generating semi-structured text poses a challenging problem in natural language generation, despite recent advancements driven by neural models trained on extensive datasets. While these models have shown progress, they still grapple with issues such as producing well-structured, context-aware, and commonsense-rich texts. Additionally, evaluating the quality of generated texts remains unclear. In response to these challenges, we present RecipeNLG, an innovative dataset focused on cooking recipes. Our work includes a detailed exploration of the data collection process and the intricate relationship between semi-structured texts and cooking recipes. We leverage this dataset to address the task of generating recipes and employ multiple metrics to assess the quality of the generated content.

V. DISCUSSIONS AND CHALLENGES

The discussions and challenges in the context of RecipeNLG revolve around the intricacies of generating coherent and context-aware cooking recipes. One primary challenge is the inherent difficulty in imparting commonsense understanding to the model, ensuring that it produces instructions that align with real-world cooking practices. Structuring the generated text in a clear and logical manner, encompassing step sequences, ingredient lists, and other essential components, poses a notable hurdle. Additionally, the variability in language used across different cuisines and cooking traditions requires the model to capture diverse linguistic expressions. Handling ambiguity in terms, measurements, and steps is crucial for the model to provide accurate and user-friendly instructions. The diversity of the dataset, covering a spectrum of cuisines and dish types, is discussed as pivotal for the model's adaptability. Evaluation metrics for assessing the quality of generated recipes, including factors like coherence and adherence to expected structures, are deliberated upon. Furthermore, the document may address the challenge of transferring knowledge gained from cooking recipes to other domains and the ethical considerations surrounding safe and healthy cooking practices.

VI. CONCLUSION

In summation, FlavorForge stands as a groundbreaking initiative at the crossroads of artificial intelligence and the culinary arts, heralding a new era in recipe creation through the ingenious application of transformer-based natural language generation (NLG). This innovative platform redefines the landscape of culinary exploration, offering users a distinctive and dynamic experience driven by cutting-edge technology.

The bedrock of FlavorForge's success lies in its meticulous curation of a diverse and extensive dataset, coupled with the fine-tuning of models that harness the power of advanced transformers. The resultant synergy between AI and culinary expertise is encapsulated in a user-friendly interface powered by Streamlit, providing a seamless and intuitive gateway for individuals to embark on a personalised and interactive culinary journey.

A key feature that sets FlavorForge apart is its commitment to personalization. Users are not mere recipients of predefined recipes; instead, they are active participants in shaping their culinary experience. The platform allows for the customization of recipes based on individual preferences, creating a tailored gastronomic adventure. Moreover, the introduction of a unique chef persona selection adds a layer of personality to the recipes, enhancing the sense of connection and creativity in the cooking process.

FlavorForge's commitment to a holistic user experience extends beyond the realms of text-based interaction. The integration of visual elements elevates the platform, transforming it into not only a functional tool but also a visually captivating culinary companion. The marriage of textual and visual components not only enhances user engagement but also underscores the platform's dedication to delivering a multifaceted and immersive experience

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