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# Recipe Generator using Deep Learning

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***Abstract: Finding new recipes daily with the ingredients in hand is a difficult task that leads to people looking at different recipe websites and cookbooks.***
***But it is often not possible to find the recipe one is looking for with the constraint of ingredients. The objective of this paper is to build a web application so asto cater to this specific problem faced by people. The proposed system takes ingredients as an input and gives machine generatedrecipes with the help of deep learning to the user.***
***The recipe generated model will consist of title, ingredients and instruction reflecting the dataset used to prepare the model for deep learning. The system also consists of interactive features in the user interface enabling the user to save and access the generated recipelater on.***
***Index Terms: Recipe generator system, web application, cook-ing, deep learning , recipes, ingredients***

## I. INTRODUCTION

Everyone enjoys new, delicious, healthy food and prefers homemade meals over food brought from outside. But whenit comes to cooking we don't want elaborate, long complex recipes instead we want quick, easy and efficient options. Even in terms of obtaining ingredients, sometimes getting ingredients can be tough as we experienced recently in pan- demic. Hence, it is often preferable to have recipes that use limited ingredients or to have recipes that match with personalavailability.
With the ever growing popularity of various cooking sites, blogs and books it is evident that people are always ona lookout for innovative and interesting recipes.
It is alsoobserved that the use of online media and digital medium makes cooking more accessible.This gives us more reason to find solutions to simple problems such as recipe generation using deep learning.
Cooking is considered no less than art, it is a creative process, procuring recipes consisting of the right combination of flavors. By creating a recipe generator we can allow the creation of unique dishes with unique combinations, it is a system that combines deep learning along with knowledge contributing to computational creativity. The system should be able to learn how to imitate human creativity, to be able to generate a recipe.
In this paper, we propose a cooking recipe generator which will produce a recipe as output when the user inputs ingredi- ents. A deep learning model is created and trained to generate the recipe. Our project focuses on creation of a number of unique and creative recipes based on the ingredients enteredby the user, thus providing recipes as per the user's ingredient availability.

### *A. Recipe Generation Using Deep Learning*

With the use of deep learning it is possible to train the model based on the dataset and generate system derived unique recipes. The model is trained with the dataset thatconsists of three logical sections namely title, ingredients and instructions. The model learns how to generate instruction for a given set of ingredients in the training process. The titlefor the generated recipe is developed by the system using the ingredients along with a random generated word. With the useof Natural Language Generation the model is able to produce the instruction in the form of steps for the generated output recipe.

1) *Natural Language Generation:* Natural Language gen- eration is a concept of producing text from data. In Recipe Generation it can take some data and generate a recipe out of it. [13]OpenAI is a non-profit AI research company, and has built this model to generate a para of text for industry usage. This model learns how to generate text by scraping each and every webpage. It is the most popular NLG text generation model that is used to generate human-written like text.
2) *LSTM:* LSTM is short for Long Short Term Memory. It is an updated version of RNN which solves the problem of lowmemory. While generating text, LSTM remembers the data fora longer period of time and has the ability to "remember" or "forget" the information according to the importance. This is possible because of its architecture thus it is ideal for text generation.

 

## II. RELATED WORK

In this section we discuss about related works in terms of recipe generator. To get the better understanding of the methodsused and how they are different from the existing recipe generation methods an overview of machine learning techniques which are applicable are given as a background. Our topic of recipe generation using machine learning algorithm is quite novel and, as a result, there were not too many previous worksfound.But there are few projects which are somewhat similar to our work.

In [1] a paper by Florian Pecune,Lucile Callebert,StacyMarsella at Scotland,UK,proposed a model where their ap- proach was to use collaborative filtering and the algorithms they used were ALS,BPR, LMF in that they are basicallyinclined towards healthy dishes also,they have an additional feature wherein the users can rate the recipes on how it turns out. Our intake on this paper was to add a rating feature tothe recipes generated by our machine.

In [2], the authors Keiji Yanai, Takuma Maruyama andYoshiyuki Kawano at Tokyo,Japan,have proposed the model which was designed to scan a particular food item and give related recipes to the user. They used object recognition for allowing the system to suggest recipes and the algorithm they used is SVM classifier and from this we got an idea to scan multiple items collectively and come to a single recipe as a conclusion.

In[10] the authors Chloe Kiddon, Luke Zettlemoyer, Yejin Choi, has proposed a system where their main aim is to build neural checklist model, a recurrent neural network that transforms data by storing and updating the outupt of text recipes which should be mentioned somewhere in the BLEU, METEOR, LSTM, HDC algorithms and techniques, thus the use of Recurrent Neural Network(RNN) language model can generates globally coherent text by keeping track.

In[4] the author Neha Setia, has proposed a system where they generate chains of cooking events that fit to a list of ingredients given beforehand without direct supervision and experimented with generating novel chains of events that are still coherent on the same list and they further used LSTM, BLEU score(evaluation) algorithms. So we can use Neural Machine translation approach which can be further elaborated for recipe generation.

In paper ”Building a Food Recommendation System” the author Lu´ıs Rita [3] has proposed the system where their maingoal was to collect as large as possible and freely available collection of recipe data (Recipe1M+) and build a recommen- dation system.They used Word2Vec, SVC algorithms to build their model and our take on this paper was to build a dataset which includes varieties of food recipes which will enhance our model’s accuracy.

In paper[5] they build a model using computational NLP solution based on the modern machine learning techniquesto generate recipe.They used techniques such as SpaCy framework,GPT-2, TPU. From this we got to know the trainingon faster accelerators such as TPU cloud allowed this project to train larger GPT-2 versions, which may improve quality of generated recipes even further. Similar to the above paper the next one [7] where theirmain aim was to build a novel online recipe generation and evaluation system. That can provide two modes of text generation, namely instruction generation from given title and ingredients and next ingredient generation from recipe titleand cooking instructions. They also used similar techniqueof Fine tuning GPT-2 and Tensorflow.The model opted in the paper consist of feature of saving the recipes in favorite sectionfor future references and their recipe evaluation module also enabled the users to easily check the quality of the generated recipe and store the results for later reference.

Also there are similar works related as in [9] the authorsof this paper has build and trained the model using NLPTechniques and then use character-based RNN to generatenew ingredients .The NLP technique which the used is NLTK Unigram Tagger and this paper inspired us to use different techniques of NLP to generate list of ingredients.

## III. PROPOSED METHODOLOGY

### A. *Overview*

The objective of our project is to develop a recipe generatoraccessible to users that can input ingredients and receive an innovative recipe as output. The goal is to use the most efficient algorithm for recipe generation in order to generate a valid and coherent output. The proposed system will provide recipe by ingredient search to the users thus minimizing the hassle to find a recipe suitable for every individual user.

### B. *Project flow*

Finding and gathering the most favorable dataset for the project in terms of content and size. Preparing the data to ensure it is ready to feed into the model and developing the model using deep learning.

The project flow from the user end can be perceived as the following: The user interface consists of a text box to inputa number of ingredients, the input is processed into the back- end by the model and 3 different recipes will be displayed as output to the user.

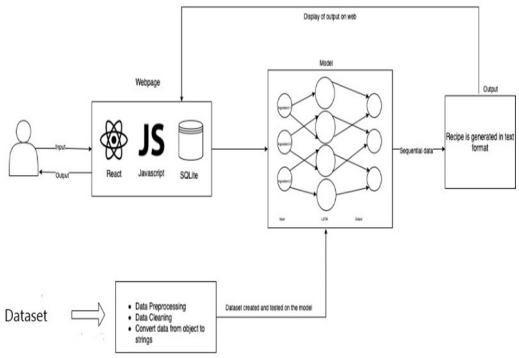


Fig. 1. Project Flow

### C. *Use Case*

The user inputs ingredients and receives system generated recipes. The signup and login feature enables the user to save the generated recipes and retrieve them later from the favoritessection.

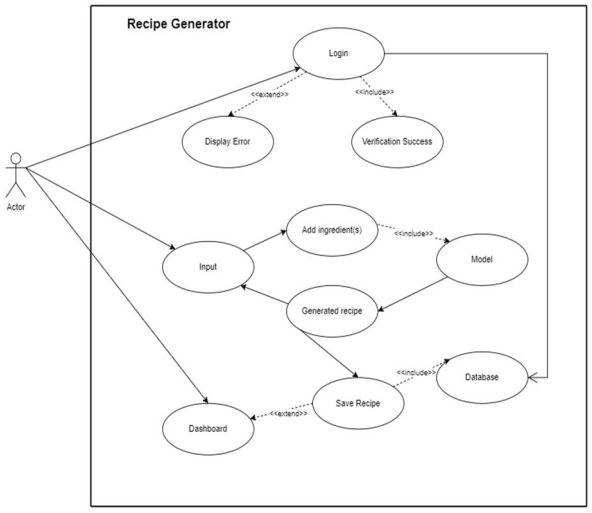


Fig. 2. Use case diagram

## IV. IMPLEMENTATION

### A. *Dataset*

For deep learning algorithms a large amount of data isrequired to train the model to perform well. Hence, a dataset that consists of data from Epicurious and recipe box which were freely available online is used in this project. The dataset has a combination of 20k recipes along with ratingand nutrition from Epicurious and 125k recipes along with ingredients with proportions from Recipe box. The dataset wasreduced to 3 attributes as title, ingredients and instructions (as in the procedure of the recipe).

### B. *Data Pre-Processing Steps*

For creation of the model, in order for the data to be processed by the model it is essential to clean and preprocess the data. The data preprocessing for recipe generation model consisted of a number of steps such as:

1) Data Cleaning: getting rid of incorrect, incomplete, duplicated , inaccurate, irrelevant part of the data to make the dataset uniform by cleaning empty data.
2) Filtering out large recipes: converting all the recipes intoone hard-coded sequence length limit making it as smallas possible for training performance. Thus setting a range for every recipe in the dataset in terms of characterlength. We were able to determine the desired range for our dataset to be between 500-2000.
3) Vocabulary generation: creating vocabulary size and a separate vocabulary is created which contains unique tokens.
4) Vectorizing dataset: word Embedding into dense vectorsalso called as vectors or numerical representation for words.

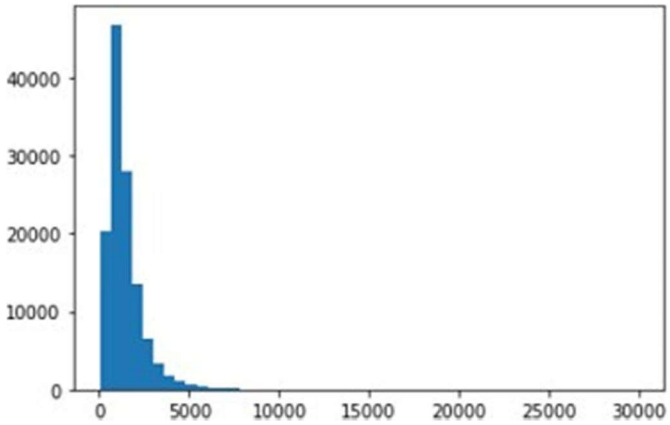

Fig. 3. Finding threshold to filter out large recipes

5) Add padding to the sequence: [12]adding a stop wordto the end of each recipe with the use of utility function and to make them have the same length overall.
6) Split examples on 'input' and 'target' texts: creating a copy and forming the input and target texts.

*C. Model Developement*

Creating a text generation model using LSTM in keras tensorflow, making use of character based LSTM which essen- tially generates the entire text by predicting the next character. Use of different hyperparameters helps find the best suited to approach for next character prediction thus text generation. The number of layers used in the model development as well as the number of training epochs set were found to be defining factors in model performance. The project also made use of different optimizer and loss functions in order to improve the model performance.

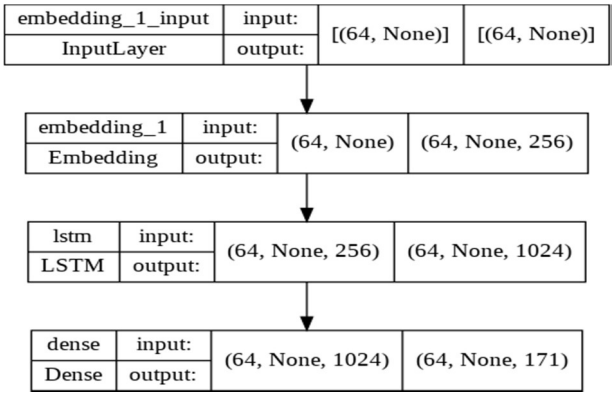

Fig. 4. Model Summary

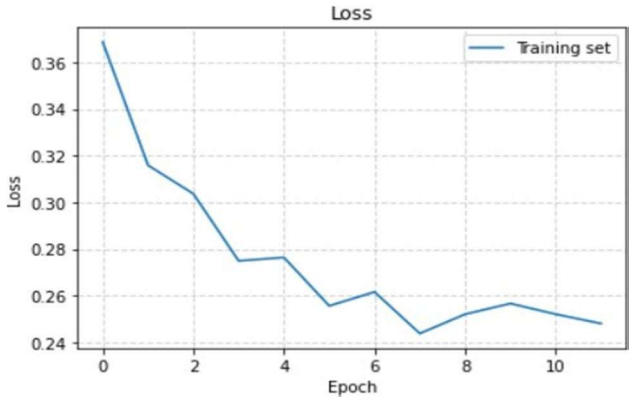

Fig. 5. Visualizing the training process

### *D. Result*

For the minimization of loss a number of changes were made in terms of layers, epochs, learning rate, optimizers and loss functions. We made use of different optimizer namely Adam optimizerand RMSProp that were trained and tested against different epochs, no of steps, learning rate to gauge the respective loss and accuracy so as to develop the most accurate model. Useof Adam optimizer with 500 epochs and learning rate 0.0005 resulted in the least loss.

Once ideal parameters were set and valid output was gen- erated by the model, it was deployed into a web application.


Fig. 6. User entered input

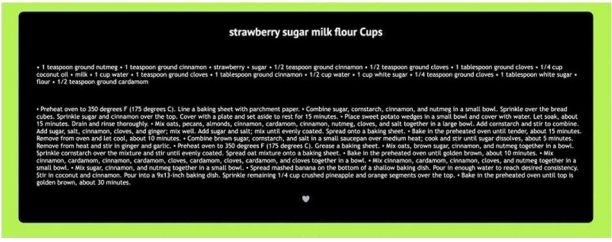


Fig. 7. Output generated at Home page


Fig. 8. Favorites page

## V. CONCLUSION

We were able to develop and deploy a recipe generator that is able to generate a logically sound, valid with semantic mean-ing recipes. The project enabled understanding the changes in output affected by the change made in hyperparameters. After successful creation of the model generating seemingly precise model we can move ahead to the next step of adding features to enhance user interactions.

In future the model can make use of pre-trained transformers for definite and cohesive text generation thus correcting the model prediction and accuracy. Furthermore to make the project ideal and efficient other filters for searching along with search by ingredients can be added, such as search by image, search by cuisine type, health monitoring of recipes generated. Adding another approach to recipe generation such as recipe generation from title rather than ingredients, canbe an innovative direction to recipe generation using deeplearning.

## VI. ACKNOWLEDGEMENT

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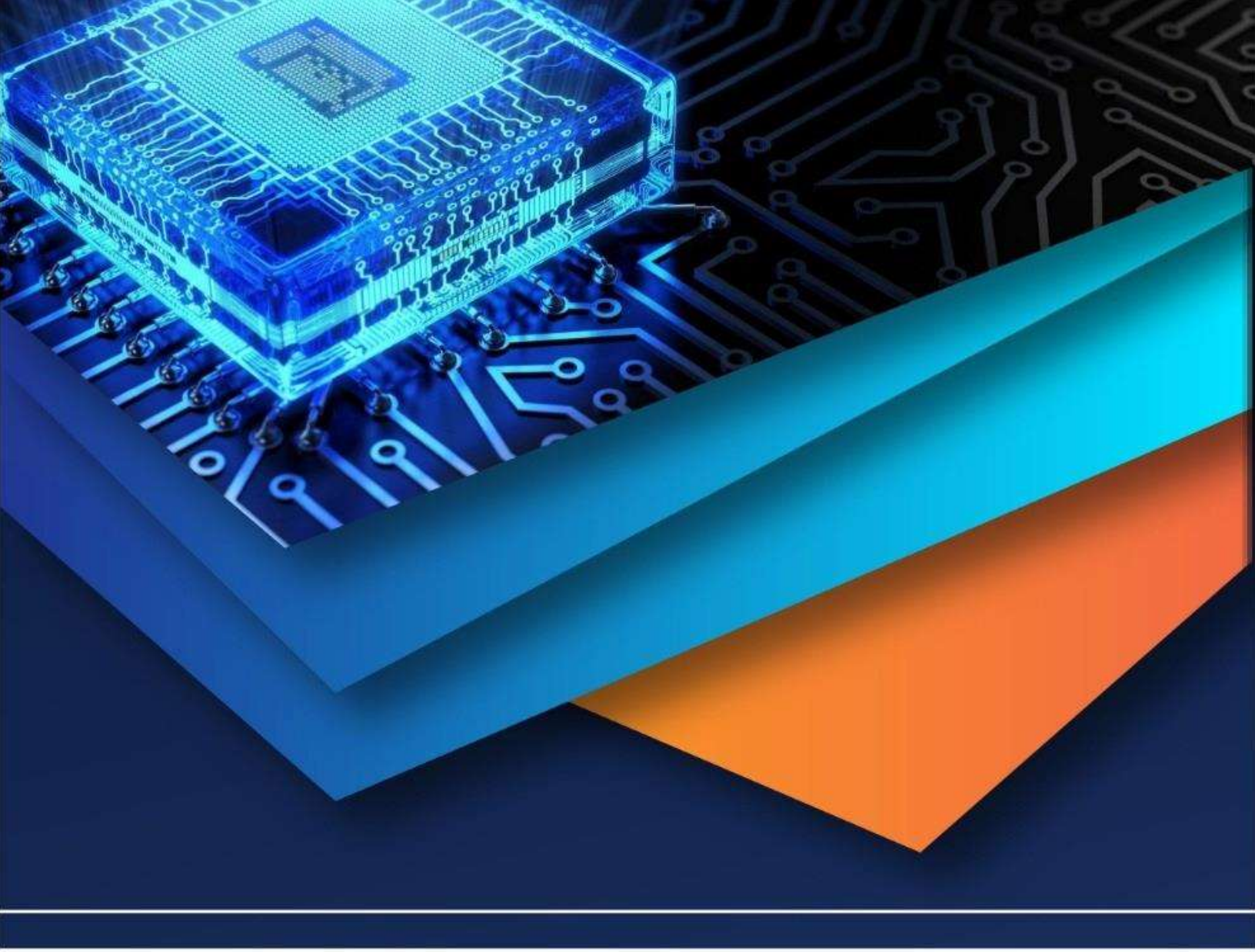

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