Indian Food Image Classification Using Deep Learning: Identifying Recipe/Dish

INTERNSHIP REPORT

panace.ai

10.07.2023 - 21.08.2023

SUBMITTED TO:

Smt. CH. MADHAVI SUDHA

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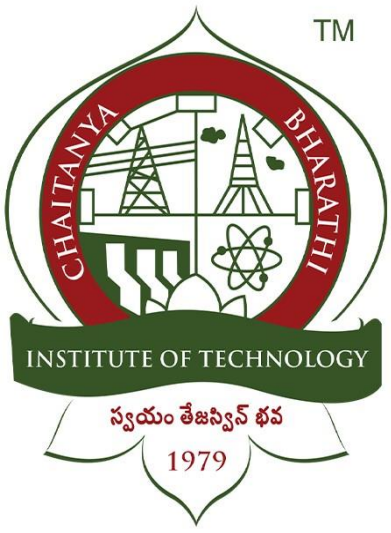
Department of Computer Science and Engineering

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)



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Kokapet Village, Gandipet Mandal, Hyderabad, Telangana-500075, www.cbit.ac.in

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INTERNSHIP REPORT 2023

SUBMITTED BY:

NAME & ROLL NUMBER: SAPHALYA PETA & 1601-20-733-**134**

BRANCH & SECTION: CSE & **C-3**

COLLEGE: CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY(CBIT)

DATE: 11.11.2023

Mentor Signature
(Smt. Ch. Madhavi Sudha)

Company Logo and information

Company Details

LLP Identification Number	AAY-2484
Company Name	PANACE.AI LLP
Company Status	Active
RoC	RoC-Hyderabad
Main division of business activity to be carried out in India	Health and Social Work
Description of main division	Health and Social Work
Number Of Partners	0
Number of Designated Partners	2
Date of Incorporation	19 August 2021
Age of Company	2 years, 2 month, 17 days

Organization Information:

Panace.ai is a startup company that attempts to democratize medical interventions by making them affordable and ubiquitous by making the most accurate diagnosis driven by state-of-the-art artificial intelligence, identifying, and providing highly personalized medical treatment for patients. Through this MOU, panace.ai initiates activities of research and development with students, faculty, and researchers in providing the projects, research studies and internships and interaction sessions with students on innovative ideas and scaling up the startup thoughts and ideas.

OFFER LETTER

panace.ai
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To,
The Principal
Chaitanya Bharathi Institute of Technology (Autonomous)
Hyderabad

Dear sir,

I am very pleased to inform you that your students of Computer Science and Engineering Department were selected for our internship program. They are offered the position of *Software Developer Intern* with panace.ai.

The Internship is for 5 or 6 weeks to work on a live project with a proposed start date as July 10th 2023. They will utilize state of the art techniques in software engineering and architecture.

Project :

Selected Students :

S.No	Name	Roll number	Section
1	*Sai Praveena Karnati*	160120733013	CSE 1
2	*Aleti snigdha*	160120733305	CSE 1
3	*Saphalya Peta*	*160120733134*	*CSE 3*
4	*Siddireddy Shirisha*	160120733015	CSE 1
5	*Neha Krishna Karampuri*	160120733011	CSE1
6	*Nenavath Nandini*	160120733010	CSE 1
7	*Vikram Mali*	16012073359	CSE 1

Reporting Relationship/Supervisors :
1. Surya Putchala (Director) and Vasu Thumati (Chief Architect) at panace.ai and
2. Allotted mentors of the CBIT(A) .

Looking forward to a very productive outcome!

Best regards,
Surya Putchala
Director

Healthcare Products | AI Centers of Excellence
48, Lilac Tower, Serene County, Telecom Nagar
Gachibowli, Hyderabad - 500032
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COMPLETION CERTIFICATE

panace.ai

democratizing precision medicine

Certificate of Internship Completion

Saphalya Peta

160120733134

of Computer Science and Engineering Department from CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A) has successfully completed internship as a SOFTWARE DEVELOPER at Panace.ai from 10-JUL-2023 to 21-AUG-2023.

Surya Putchala
Executive Director

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ACKNOWLEDGEMENTS

I would like to convey my gratitude to Dr Raman Dugyala, HOD of the CSE Dept. and Mrs. G. VANITHA, and Smt. Ch. MADHAVI SUDHA, our mentor from CBIT for motivating me to apply for the internship.

I would like to thank the team at Panace.ai company Name for giving me the internship opportunity and the proper technical guidance which helped me successfully complete the project.

This internship provided a glimpse of the work-life in the software industry and the experience of working with mentors and fellow colleagues, and most importantly the encouragement to learn new things without hesitation.

This exposure has been a great learning experience and I will be looking forward to more such opportunities in the future

ABSTRACT

Using Deep Learning methods like Inception to identify recipes from photos is a game-changing advancement in computer vision and culinary arts. The cutting-edge deep neural network architecture Inception is skilled at removing minute details from photos so that different types of dishes, components, and cooking methods may be identified. This abstract explores the novel application of Inception-based Deep Learning to automatically classify recipes from pictures, including an overview of the underlying technology, difficulties, and promising applications for recipe recognition and the food industry. Moreover, this method has the ability to completely transform our relationship with food, from simplifying meal preparation to offering creative culinary ideas. The combination of technology and cuisine creates interesting opportunities for both professionals and food aficionados as Deep Learning techniques advance.

INDEX

INTRODUCTION

1.1. Identified Problem

The identified problem for a recipe identification system is the difficulty in accurately and efficiently identifying and categorizing recipes based on various factors, including ingredients, cuisines, dietary preferences, and cooking methods. This challenge arises due to the vast diversity of recipes available, language barriers, inconsistent naming conventions, and the need to accommodate various cultural and regional nuances in cooking styles and ingredients. As a result, creating a robust recipe identification system that can reliably and quickly classify and retrieve recipes to meet the specific needs of users presents a significant problem to be addressed.

1.2. Proposed Solution

The proposed solution for the recipe identification system involves leveraging the Inception v3 deep learning algorithm, a state-of-the-art convolutional neural network (CNN), to address the identified problem. Inception v3 will be used to develop a recipe image recognition system. The system will process recipe images and extract valuable features from them, enabling accurate categorization based on ingredients, cuisines, and other factors. By fine-tuning the Inception v3 model on a large and diverse dataset of recipe images, the system will learn to recognize intricate details and patterns associated with various recipes. This approach will enhance the efficiency and accuracy of recipe identification, catering to the specific needs of users, and significantly improving the user experience when searching for or categorizing recipes.

SOFTWARE REQUIREMENTS

Hardware Requirements:

1) RAM: 4GB and above

2) PROCESSOR: 64-bit

3) HARD DISK: 2.5GB is minimum

Software Requirements:

1) OS: windows 7 or above

2) IDE: vs code

3. TECHNOLOGY

3.1 Programming Language

In the proposed solution you described, the following programming languages are used:

1. **Python (Flask)**: Flask, a micro web framework for Python, was chosen as the foundation for building the web application. Its simplicity, flexibility, and robustness make it an ideal choice for this project.
2. **Python for Machine Learning:** Python is a popular programming language for machine learning and data science due to its rich ecosystem of libraries and tools. Here are some key libraries and frameworks commonly used for machine learning in Python:

- NumPy: NumPy is a fundamental library for numerical and matrix operations in Python. It provides support for multi-dimensional arrays and various mathematical functions, making it essential for handling data in machine learning.
- Pandas: Pandas is a powerful library for data manipulation and analysis. It provides data structures such as Data Frames and Series, making it easier to work with structured data, clean and preprocess it.
- Matplotlib and Seaborn: Matplotlib is a popular library for creating static, animated, and interactive plots, and charts. Seaborn is built on top of Matplotlib and provides a higher-level interface for creating attractive statistical graphics.
- Scikit-Learn: Scikit-Learn is a versatile machine learning library that includes a wide range of algorithms for classification, regression, clustering, dimensionality reduction, model selection, and preprocessing. It also provides tools for model evaluation and hyperparameter tuning.
- TensorFlow: Developed by Google, TensorFlow is an open-source deep learning framework. It allows you to build and train deep neural networks and is widely used for tasks such as image and natural language processing.
- Keras: Keras is a high-level neural networks API that runs on top of TensorFlow and other deep learning frameworks. It simplifies the process of building and training deep learning models.
- PyTorch: PyTorch is an open-source deep learning framework developed by Facebook's AI Research lab. It is known for its dynamic computation graph, making it more flexible for research and development of custom models.
- XGBoost: XGBoost is a popular library for gradient boosting, a powerful machine learning

technique that often yields state-of-the-art results in structured data problems.

- Scipy: Scipy builds on NumPy and provides additional functionality for scientific and technical computing. It includes optimization, integration, interpolation, and other tools often used in machine learning.
- Jupyter Notebooks: Jupyter is an interactive computing environment that allows you to create and share documents containing live code, equations, visualizations, and narrative text. It's widely used for experimenting with and documenting machine learning projects.
- Pillow (PIL): The Python Imaging Library (PIL) allows you to work with images, making it valuable for computer vision tasks.

3. **HTML:** HTML, which stands for HyperText Markup Language, is the standard markup language used to create web pages. It is the backbone of most web content and defines the structure and layout of a web page by using a system of elements and tags. These elements and tags are used to format text, add multimedia elements, create hyperlinks, and structure the overall content of a webpage.

4. **CSS:** CSS, which stands for Cascading Style Sheets, is a stylesheet language used for describing the presentation and formatting of HTML and XML documents. CSS allows you to control the layout, appearance, and design of web pages. It's a crucial part of web development as it separates the content (HTML) from its presentation (CSS), making it easier to maintain and style web pages consistently.

3.2. Framework

Backend Framework: Python with Flask

Python with Flask, a micro web framework, was chosen as the backbone of our backend development. This lightweight yet robust framework provided a solid foundation for building the server-side logic and handling HTTP requests. Flask's simplicity and flexibility allowed us to focus on creating a scalable and efficient backend architecture.

Key Advantages of Python with Flask:

1. Simplicity and Flexibility: Flask's minimalist design and intuitive syntax enabled rapid development without unnecessary complexities.
2. Modular and Extensible: Flask's modular architecture allowed us to easily integrate additional functionalities and libraries, ensuring a tailored solution for our specific requirements.
3. Routing and Request Handling: Flask's routing capabilities facilitated efficient request handling, enabling seamless communication between the frontend and backend components.
4. Scalability and Performance: Python's efficiency in handling concurrent tasks, combined with Flask's lightweight nature, ensured that our backend could scale gracefully to meet increasing user demands

Deep learning Framework: Tensorflow

TensorFlow is an open-source machine learning framework developed by Google. It is designed to provide a flexible and comprehensive platform for building and deploying machine learning models, including deep learning models. TensorFlow offers a range of tools and libraries for tasks like data manipulation, model construction, training, and deployment, making it one of the most widely used frameworks in the field of machine learning and artificial intelligence. It supports a variety of hardware accelerators, including CPUs, GPUs, and TPUs, which makes it suitable for a broad range of machine learning tasks and applications.

Keras:

1. Keras is an open-source deep learning framework that was initially developed as an independent project.
2. Keras is known for its user-friendliness and high-level, intuitive API. It allows you to define, compile, and train deep learning models with minimal code.
3. Keras is designed for ease of use and rapid prototyping. It abstracts many complex aspects of deep learning and is particularly suitable for beginners and researchers who want to experiment with neural networks quickly.
4. Keras can run on top of various backends, including TensorFlow, Theano, and Microsoft

Cognitive Toolkit (CNTK). However, as of TensorFlow 2.x, Keras has become the official high-level API for TensorFlow.

5. Keras is focused on model design and training and may not offer the same level of low-level control and flexibility as pure TensorFlow.

Deep Learning Model: InceptionV3

InceptionV3 is a deep convolutional neural network architecture used for image classification and object recognition. It is part of the Inception family of neural networks, which was developed by Google. InceptionV3 is an improvement over its predecessor, InceptionV2 (also known as GoogLeNet), and it incorporates several innovations in the design of convolutional neural networks.

Key features of InceptionV3 include:

1. **Inception Modules**: InceptionV3 introduces a network architecture consisting of multiple Inception modules. These modules contain various convolutional layers of different filter sizes and strides, allowing the network to capture features at different scales. This design helps improve the network's ability to recognize complex patterns and objects in images.
2. **Dimensionality Reduction**: InceptionV3 uses dimensionality reduction techniques to reduce the computational cost. This is achieved through the use of 1x1 convolutions that reduce the number of channels in intermediate feature maps. This helps maintain the efficiency of the model.
3. **Auxiliary Classifiers**: InceptionV3 also includes auxiliary classifiers at intermediate layers of the network. These auxiliary classifiers are used during training to combat the vanishing gradient problem and provide additional supervision signals. They help improve the training process and can lead to better performance.
4. **Pretrained Models**: Pretrained InceptionV3 models are available, which have been trained on large datasets like ImageNet. These pretrained models can be fine-tuned for specific image classification tasks or used as feature extractors in transfer learning.

InceptionV3 is known for its exceptional performance in image recognition tasks, achieving high accuracy on benchmark datasets. It has been widely used in computer vision applications,

including image classification, object detection, and image segmentation. TensorFlow and Keras, popular deep learning libraries in Python, provide easy-to-use implementations and pretrained models for InceptionV3, making it accessible to researchers and developers.

InceptionV3 is just one of the variants in the Inception family, with later versions like InceptionV4 and Inception-ResNet also pushing the state of the art in image recognition. These models are particularly well-suited for tasks where high-quality image feature extraction is crucial, such as in medical imaging, autonomous driving, and various other computer vision applications.

3.3 Database

CSV (Comma-Separated Values) files are a popular and simple way to store structured data, and they are commonly used when training machine learning models in Python. CSV files can be particularly useful in this context for several reasons:

1. **Data Storage**: CSV files provide a tabular data structure that is easy to create, read, and understand. You can use CSV files to store datasets containing features (input data) and labels (output data) in a well-organized format.
2. **Data Preparation**: Before training a machine learning model, you often need to preprocess and clean your data. CSV files allow you to store raw data and apply data preprocessing steps using libraries like Pandas to prepare your data for training.
3. **Data Integration**: Data for machine learning projects can come from various sources, including databases, spreadsheets, or external data feeds. You can export or convert data from these sources to CSV format for easier integration into your Python environment.
4. **Data Sharing**: CSV files are a widely supported and portable format. You can easily share datasets with colleagues or collaborators, as they can be opened and manipulated using a variety of software tools.
5. **Data Exploration**: You can load CSV files into data analysis and visualization tools, such as Jupyter Notebooks, Pandas, or Matplotlib, to explore and understand your data before building and training machine learning models.
6. **Integration with Machine Learning Libraries**: Popular machine learning libraries in Python, like Scikit-Learn and TensorFlow, have built-in support for loading data from CSV

files. You can use these libraries to load data from CSV files directly into your machine learning pipelines.

Here's an example of how you might use CSV files in a typical machine learning workflow:

1. **Data Collection**: You collect data from various sources, possibly in different formats.
2. **Data Preprocessing**: You clean, transform, and preprocess the data as needed, which may include tasks like handling missing values, feature scaling, or encoding categorical variables.
3. **Data Splitting**: You split the data into training, validation, and test sets, which are typically stored as separate CSV files.
4. **Model Training**: You use machine learning libraries to load the training data from a CSV file and train your machine learning models.
5. **Model Evaluation**: After training, you evaluate your models using the validation set and possibly fine-tune hyperparameters.
6. **Model Testing**: Finally, you test the model's performance on unseen data using the test set.

4.TASK

4.1 Test task

The main task of image classification algorithms in the context of guessing the dish name from a picture is to determine the type or category of the dish depicted in the image. This task typically involves identifying and classifying the dish into a predefined set of categories or classes, each representing a different type of food or dish. Here is how the process works:

1. **Input Image**: The input to the image classification algorithm is a photograph or image of a dish.
2. **Preprocessing**: The input image may undergo preprocessing steps, such as resizing, normalization, and color correction, to ensure that it is in a suitable format for the algorithm.
3. **Feature Extraction**: The algorithm extracts relevant features from the image that can help distinguish one dish from another. These features may include color information, texture, shape, and spatial patterns within the image.
4. **Model Inference**: The algorithm uses a trained machine learning or deep learning model to make predictions. This model has been trained on a dataset of labeled images, where each image is associated with a known dish category. The model takes the extracted features as input and produces a probability distribution over the possible dish categories.
5. **Dish Classification**: The algorithm classifies the input image into one of the predefined dish categories based on the highest probability in the output distribution. This category is the algorithm's "guess" for the dish name.
6. **Output**: The output of the algorithm is the predicted dish category, which can be associated with the dish name or label. This dish name represents the algorithm's best guess at the identity of the dish in the image.
7. **Confidence Score**: The algorithm may also provide a confidence score, indicating how certain it is about the classification. A higher confidence score suggests a more reliable guess, while a lower score indicates uncertainty.

The success of image classification algorithms in guessing dish names from pictures depends on the quality and size of the training dataset, the choice of features and model architecture, and the algorithm's ability to generalize to new, unseen images. Deep learning models, such as

convolutional neural networks (CNNs), have been particularly effective in image classification tasks and are commonly used for tasks like food recognition and dish identification. These models can be trained on large and diverse datasets of labeled food images to improve their accuracy and performance.

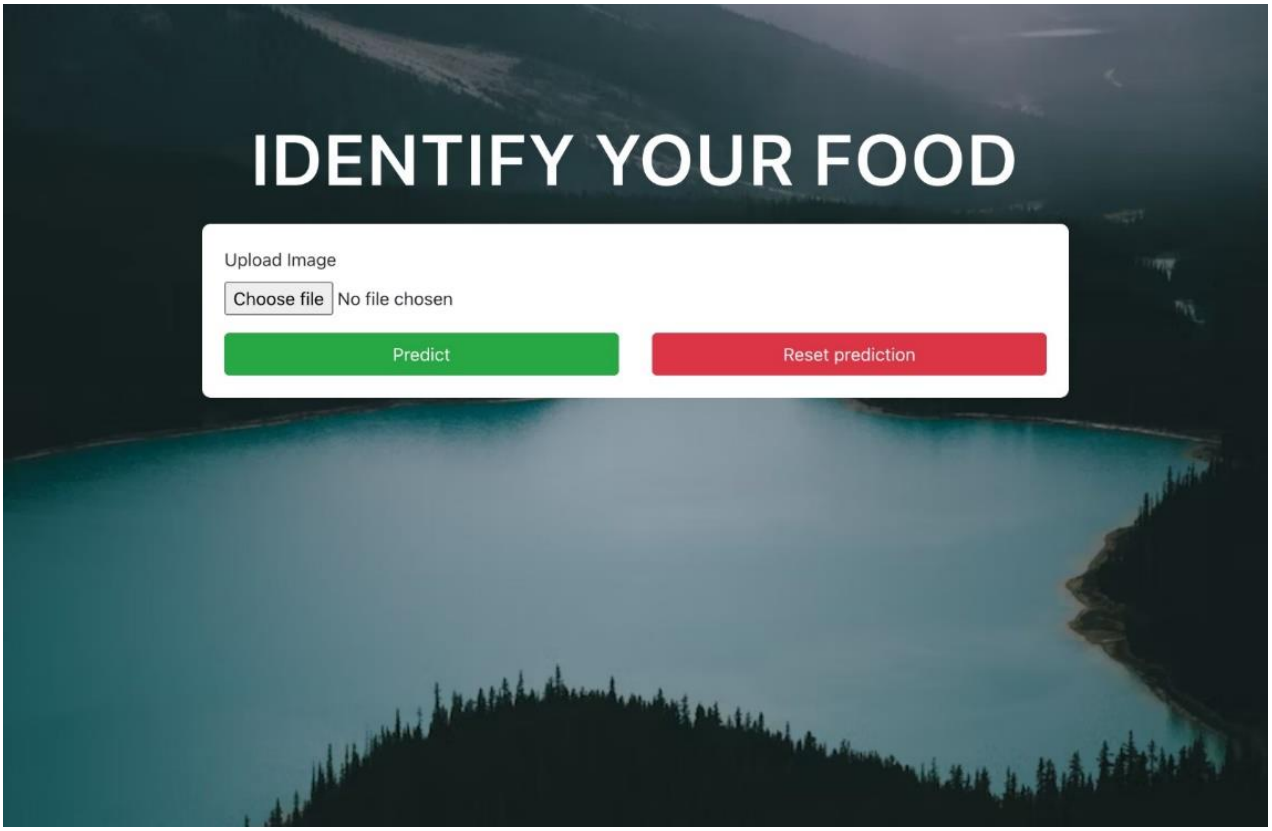
4.2. Sample Pseudo Code

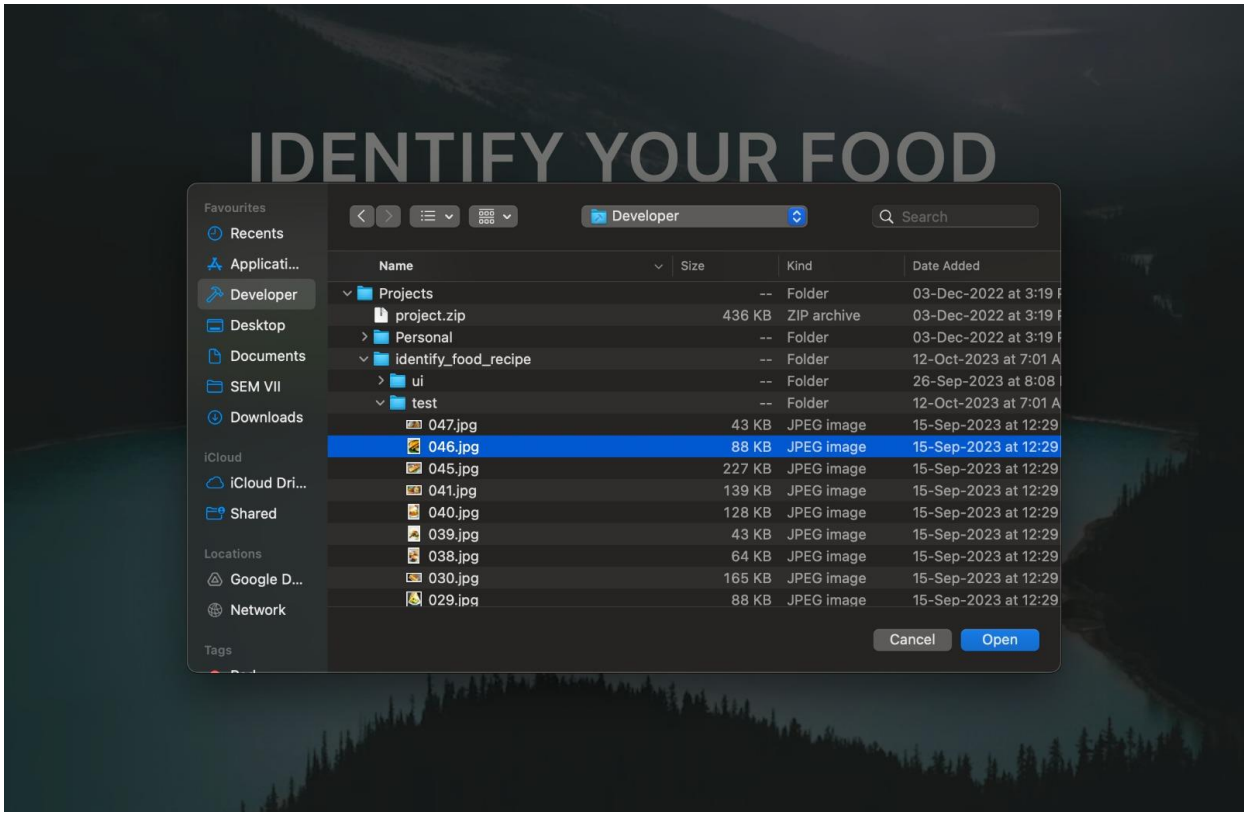
```
import tensorflow as tf
import tensorflow.keras.backend as K
from tensorflow.keras.preprocessing import image
from tensorflow.keras import models
from tensorflow.keras.models import load_model
from tensorflow.keras import models
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import numpy as np
category = { 0: ['burger', 'Burger'], 1: ['butter_naan', 'Butter Naan'], 2: ['chai', 'Chai'],
3: ['chapati', 'Chapati'],  4: ['chole_bhature', 'Chole Bhature'], 5: ['dal_makhani', 'Dal Makhani'],
6: ['dhokla', 'Dhokla'], 7: ['fried_rice', 'Fried Rice'], 8: ['idli', 'Idli'], 9: ['jalegi', 'Jalebi'],
10: ['kathi_rolls', 'Kaathi Rolls'], 11: ['kadai_paneer', 'Kadai Paneer'], 12: ['kulfi', 'Kulfi'],
13: ['masala_dosa', 'Masala Dosa'], 14: ['momos', 'Momos'], 15: ['paani_puri', 'Paani Puri'],
16: ['pakode', 'Pakode'], 17: ['pav_bhaji', 'Pav Bhaji'], 18: ['pizza', 'Pizza'],
19: ['samosa', 'Samosa']   }
def predict_image(filename, model):
                    img_ = image.load_img(filename, target_size=(299, 299))
                    img_array = image.img_to_array(img_)
                    img_processed = np.expand_dims(img_array, axis=0)
                    img_processed /= 255.
                    prediction = model.predict(img_processed)
                    index = np.argmax(prediction)
                    print(category[index][1])
                    return index
```

```
model = None

def init():
        path_to_model = 'model_v1_inceptionV3.h5'
        print("Loading the model..")
        global model
        model = load_model(path_to_model)
        print("Done!")
```

4.3. Output:




IDENTIFY YOUR FOOD
Favourites
Recents
Applicati...
Developer
Desktop
Documents
SEM VII
Downloads
iCloud
iCloud Dri...
Shared
Locations
Google D...
Network
Tags
Developer
Search
Name
Size
Kind
Date Added
Projects -- Folder 03-Dec-2022 at 3:19
project.zip 436 KB ZIP archive 03-Dec-2022 at 3:19
Personal -- Folder 03-Dec-2022 at 3:19
identify_food_recipe -- Folder 12-Oct-2023 at 7:01 A
ui -- Folder 26-Sep-2023 at 8:08
test -- Folder 12-Oct-2023 at 7:01 A
047.jpg 43 KB JPEG image 15-Sep-2023 at 12:29
046.jpg 88 KB JPEG image 15-Sep-2023 at 12:29
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041.jpg 139 KB JPEG image 15-Sep-2023 at 12:29
040.jpg 128 KB JPEG image 15-Sep-2023 at 12:29
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038.jpg 64 KB JPEG image 15-Sep-2023 at 12:29
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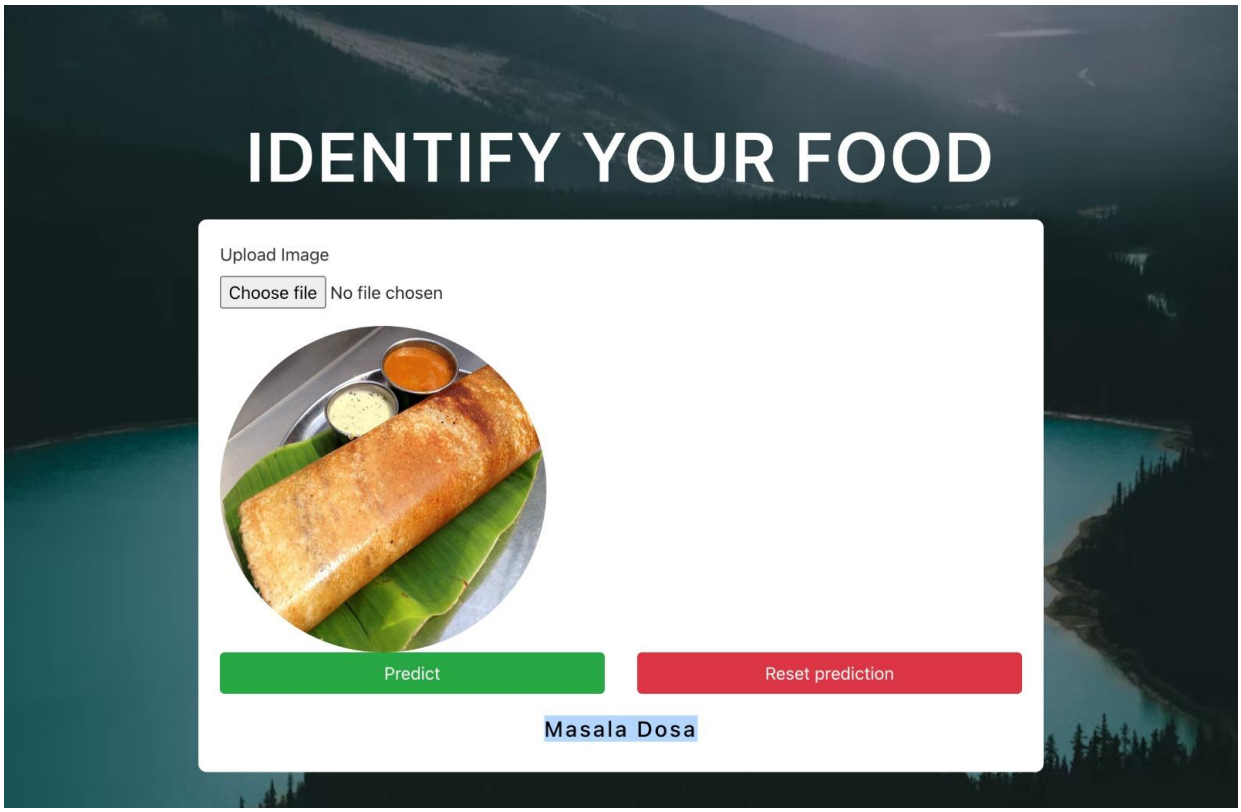
029.jpg 88 KB JPEG image 15-Sep-2023 at 12:29
Cancel
Open


IDENTIFY YOUR FOOD
Upload Image
Choose file
No file chosen
Predict
Reset prediction
Masala Dosa

CONCLUSION

The project, focused on identifying recipes and dishes from photographs while considering nutritional recommendations, represents an innovative approach to address the limitations of current nutritional advice systems. By combining the power of technology, data science, and a comprehensive skill set, the project strives to offer personalized and native food recommendations based on nutritional labeling, as well as consider long-term and preventive health goals.

Key components of the project, including data collection, data cleansing, and knowledge extraction, reflect a multidisciplinary approach to precision nutrition.

The project's activities are organized into distinct stages, with Stage 1 focusing on the design and creation of a nutrition dataset. This stage is crucial, as it lays the foundation for subsequent phases. It involves exploring existing datasets, extracting nutritional information from PDFs and books using OCR and computer vision, and consolidating data from various recommendation datasets. This comprehensive dataset will serve as the backbone for the project's recommendation engine.

The potential impact of the project is substantial. By providing native food recommendations, it addresses the challenge of unavailability of nutritional labeling in many recipes and dishes. Moreover, its consideration of long-term and preventive health goals adds a forward-looking dimension to nutritional advice, promoting holistic well-being.

In addition, the knowledgebase built from the project's research literature is a valuable resource for precision nutrition. It allows for the incorporation of the latest scientific findings and ensures that the nutritional recommendations are up-to-date and evidence-based.

In conclusion, this project combines technology, data science, and nutrition to create a unique system for identifying recipes and dishes while offering personalized, native food recommendations with a long-term health perspective. It has the potential to transform the way individuals receive and apply nutritional guidance, ultimately contributing to improved health outcomes and well-informed dietary choices.

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