COMP 6721 Applied Artificial Intelligence (Fall 2022)
Project - Food Image Classification
One Page Proposal - By Group M

A. Problem Statement

Food classification has several uses, including automated food waste detection, calorie computation and eating patterns. A computerised diet monitoring system, for instance, is a crucial tool for both medical and social science research since it keeps track of patients' daily caloric intake as well as the types of food they consume [9]. On a commercial level, food classification on mobile devices can be used by food ordering services like Uber, DoorDash , Food Panda, etc.

It can be utilised in the medical field so that doctors can monitor patients' diets and assess their calorie and protein consumption to monitor their recovery. From a business viewpoint, it will enable online meal delivery services to provide consumers with better recommendations, which would help them bring in more customers and thus boost their revenue.

Food classification is the focus of our study. The first dataset consists entirely of various food groups. The second one classifies them based on various regions of the world. Third dataset has 101 classes mostly comprise a variety of foods from different areas.

The main challenge of using multiple images is it becomes difficult to make them learn from different type of images. Moreover, food categories are too broad especially when it deals with multi cuisine dishes and the system may not be able to categorise them correctly.

Goal of this system is to make applications capable of distinguishing food items from different parts of the country and of different types into various classes. Expectations throughout developing food classification system is to help end users to identify the type of food item or origin of the food item. Also, the model should be able to classify the item with high confidence.

B. Dataset Selection

Name	Total Images	Classes
Food-11k	16643	11
World Cuisine	13779	6
Food-101	4000	4

Food-11 : [3] This dataset includes 16643 food photos categorised into 11 main food groups. Bread, dairy products, desserts, eggs, fried foods, meat, noodles or pasta, rice, seafood, soup, and vegetables or fruit are among the 11 categories. All images were rescaled to have a maximum side length of 512 pixels. The classes are imbalanced with Rice being the lowest (280) and Soup has the highest number of classes(1500).

World Cuisine : [1] This dataset consists of food images splitted into 6 countries: American, Chinese, European, Indian, Japanese and Korean. All the images are resized into 224*224 dimensions. The dataset is imbalanced with American category having the lowest (1815) and Chinese having the highest number of classes(3030).

Food-101 : [2] We have picked four classes from the dataset which has 101 classes where each class contains 1000 images. All images were rescaled to have a maximum side length of 512 pixels. The selected four classes are: Fried Rice, French Fries, Cheesecake, Garlic Bread.

C. Possible Methodology

Preprocessing Steps

Due to limited capacity of the GPU memory, images will be loaded in batches from the disk memory and pre-processed in batches before feeding it to the model.Following are some of the possible steps:

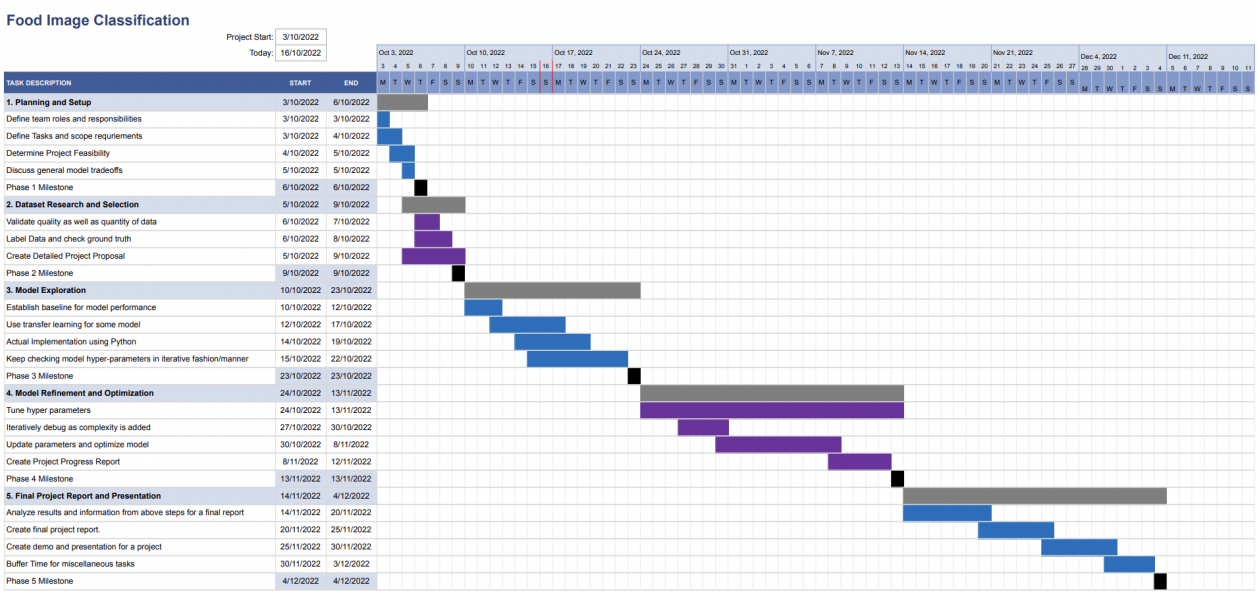
1. **Resizing images :** Images come in different shapes and sizes which needs to be in the same dimensions to feed into the model.
2. **Normalisation :** The pixel values are scaled in order to fit inside a specific range. The problem of high numeric values after computation is one of the reasons for doing this.
3. **Image Augmentation :** It includes transformations like flipping, rotation, cropping, translation, lighting, scaling, adding noise, etc.

Model Training

A Deep Learning model needs to be trained for several epochs and the loss is backpropograted to update the weights in the model. CNN architectures like DenseNet [4], MobileNet [5], Resnet18 [6] etc can be used as a backbone network. These architectures can also be used as feature encoder with pretrained weights of 'imagenet' dataset and train model using the concept of transfer learning. Different hyper parameter like learning-rate, optimizer, batch-size, epochs, etc. needs to be fine tune to converge the loss in the model. [7]

Model Evaluation

In order to assess our classification model, metrics like Accuracy, precision, recall, and F1 score [8] are used. Confusion matrix can also be plotted to determine the performance of the model.



Food Image Classification

Project Start: 3/10/2022
Today: 16/10/2022

TASK DESCRIPTION	START	END
1. Planning and Setup	3/10/2022	6/10/2022
Define team roles and responsibilities	3/10/2022	3/10/2022
Define Tasks and scope requriements	3/10/2022	4/10/2022
Determine Project Feasibility	4/10/2022	5/10/2022
Discuss general model tradeoffs	5/10/2022	5/10/2022
Phase 1 Milestone	6/10/2022	6/10/2022
2. Dataset Research and Selection	5/10/2022	9/10/2022
Validate quality as well as quantity of data	6/10/2022	7/10/2022
Label Data and check ground truth	6/10/2022	8/10/2022
Create Detailed Project Proposal	5/10/2022	9/10/2022
Phase 2 Milestone	9/10/2022	9/10/2022
3. Model Exploration	10/10/2022	23/10/2022
Establish baseline for model performance	10/10/2022	12/10/2022
Use transfer learning for some model	12/10/2022	17/10/2022
Actual Implementation using Python	14/10/2022	19/10/2022
Keep checking model hyper-parameters in iterative fashion/manner	15/10/2022	22/10/2022
Phase 3 Milestone	23/10/2022	23/10/2022
4. Model Refinement and Optimization	24/10/2022	13/11/2022
Tune hyper parameters	24/10/2022	13/11/2022
Iteratively debug as complexity is added	27/10/2022	30/10/2022
Update parameters and optimize model	30/10/2022	8/11/2022
Create Project Progress Report	8/11/2022	12/11/2022
Phase 4 Milestone	13/11/2022	13/11/2022
5. Final Project Report and Presentation	14/11/2022	4/12/2022
Analyze results and information from above steps for a final report	14/11/2022	20/11/2022
Create final project report.	20/11/2022	25/11/2022
Create demo and presentation for a project	25/11/2022	30/11/2022
Buffer Time for miscellaneous tasks	30/11/2022	3/12/2022
Phase 5 Milestone	4/12/2022	4/12/2022

Figure 1. Gantt Chart

Project Milestones

1. Milestone 1 (Completion of planning and setup): During this stage, the complexity of the provided problem statement is studied along with all of its prerequisites. Moreover, at the end of this phase we have finalised the models, datasets and teams responsibilities.

2. Milestone 2 (Completion of Dataset research and selection): This is another critical stage in which we thoroughly analysed the datasets, their image quality, and their quantity. This phase will end up with detailed project proposal that will be refined in response to team and professor comments.

3. Milestone 3 (Completion of Model Exploration): During the Model Exploration phase, we will begin the implementation, which will include writing Python code for all of the models. The deliverable models from this phase will be passed to the next phase for optimization, but it will provide us with tried and tested functional models as well as tuned various parameters for correct outputs.

4. Milestone 4 (Completion of Model Refinement and optimization): At this point, we have a working model and will modify the hyper-parameters for optimization. We'll monitor all assessment indicators and adjust the parameters accordingly. We'll generate a progress report based on this data and deliver it for review.

5. Milestone 5 (Completion of Final report and presentation): At this step, a detailed analysis, as well as the final project report and presentation, will be developed and deployed.

Deliverables

1. Phase 1 (Planning and setup): Finalized team and roles, complete planning.

2. Phase 2 (Dataset research and selection): Project proposal.

3. Phase 3 (Model Exploration): Working models.

4. Phase 4 (Model Refinement and optimization): Trained and optimized models, Project Progress report.

5. Phase 5 (Final report and presentation): Final project, report and presentation.

References

[1] Traditional Food around the world. https://www.kaggle.com/datasets/abhijeetbhilare/world-cuisines.

[2] Food 101 Dataset. https://data.vision.ee.ethz.ch/cvl/datasets_extra/food-101/.

[3] The Food-11 Dataset. https://www.epfl.ch/labs/mmspg/downloads/food-image-datasets/.

[4] Densenet Explaination. https://towardsdatascience.com/review-densenet-image-classification-b6631a8ef803.

[5] MobileNetV3 Explaination. https://towardsdatascience.com/everything-you-need-to-know-about-mobilenetv3-and-its-comparison-with-previous-versions-a5d5e5a6eeaa.

[6] ResNet Explaination. https://towardsdatascience.com/an-overview-of-resnet-and-its-variants-5281e2f56035.

[7] Hyperparameters. https://www.analyticsvidhya.com/blog/2021/05/tuning-the-hyperparameters-and-layers-of-neural-network-deep-learning/.

[8] Model Evalution Metrics. https://www.kdnuggets.com/2020/05/model-evaluation-metrics-machine-learning.html.

[9] Gabrielle M Turner-McGrievy, Michael W Beets, Justin B Moore, Andrew T Kaczynski, Daheia J Barr-Anderson, and Deborah F Tate. Comparison of traditional versus mobile app self-monitoring of physical activity and dietary intake among overweight adults participating in an mHealth weight loss program. *Journal of the American Medical Informatics Association*, (1).