

Scientific Report CSE 455/555 Term Project

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Part 1: CV Engineer, Jacob Szczudlik. ResNet500 Pre trained model

Data Analysis: The goal of this part was to use a state of the art pre-trained model to accomplish 2 objectives. 1.) Fine tune a pre trained model to be able to distinguish between, in our case, 4 different classes of fruit, avocado, banana, pineapple and carrot. 2.) Use a second model to classify the images based on variations. For example can our model distinguish between a whole avocado and one that is diced. To accomplish this I chose to use a pretrained Resnet-50 CNN with a set of hyper parameters that ill describe in the next section.

Model set up: As i mentioned for the image classification task I chose to use a resnet50 pretrained model. For task 1 this needed to be trained on 4 input features, and for the variation classification task it needed 12 features. I chose to use cross entropy for the loss function as this seemed the most consistent among both CV tasks. Adam optimizer was applied with a standard learning rate of 0.001. I tried a few runs of different epochs and it seemed that less than 2 wasn't sufficient and more than 5 wasn't improving accuracy enough so I settled in on 5 epochs. After 1 epoch accuracy was around 80%, after 2 around 90%, and after the full 5 settled in around 98%. This was a very pleasing result. Below I've attached the confusion matrices for the data showing a high degree of accuracy for most classifications.

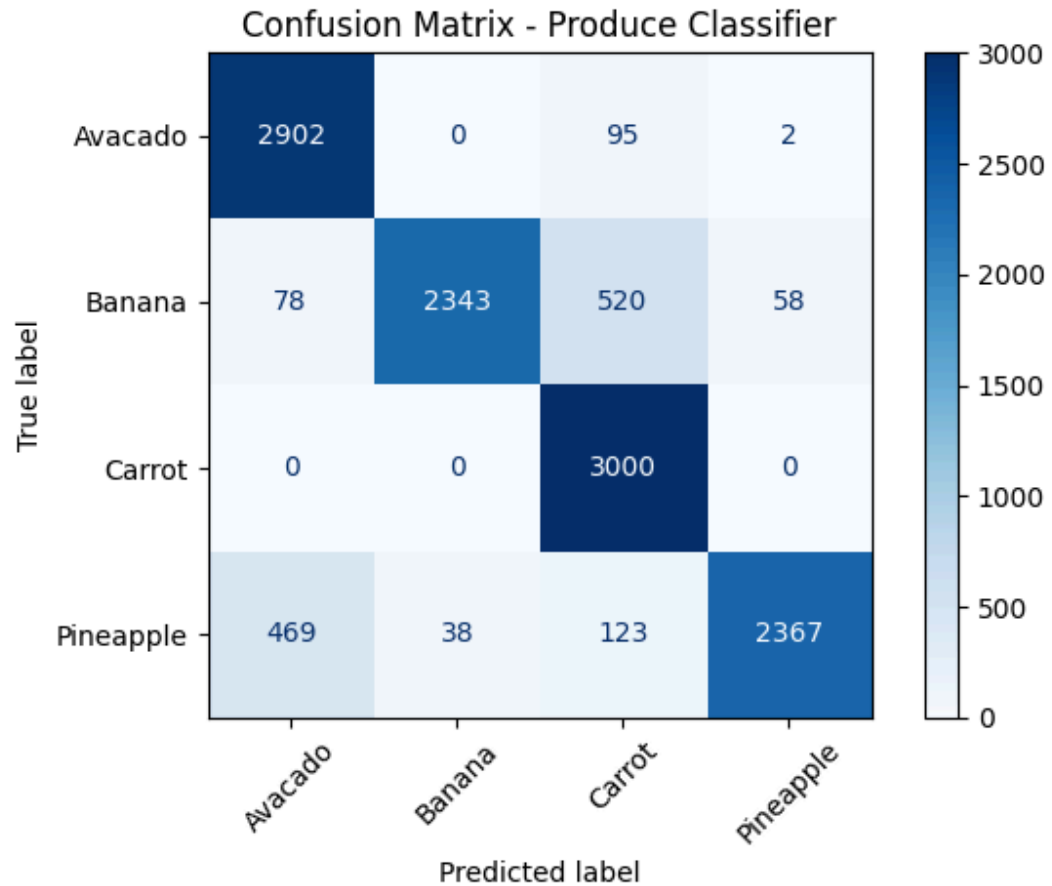


Figure 1: Fruit classification confusion matrix

As you can see by the above chart, there is a high degree of accuracy across the identity diagonal for each class. Most impressive being the carrot with no incorrect predictions. I imagine it is due to multiple factors including image quality and variation, but its probably largely due to its distinction from the other 3 fruits, which are much more similar to each other.

Figure 2:

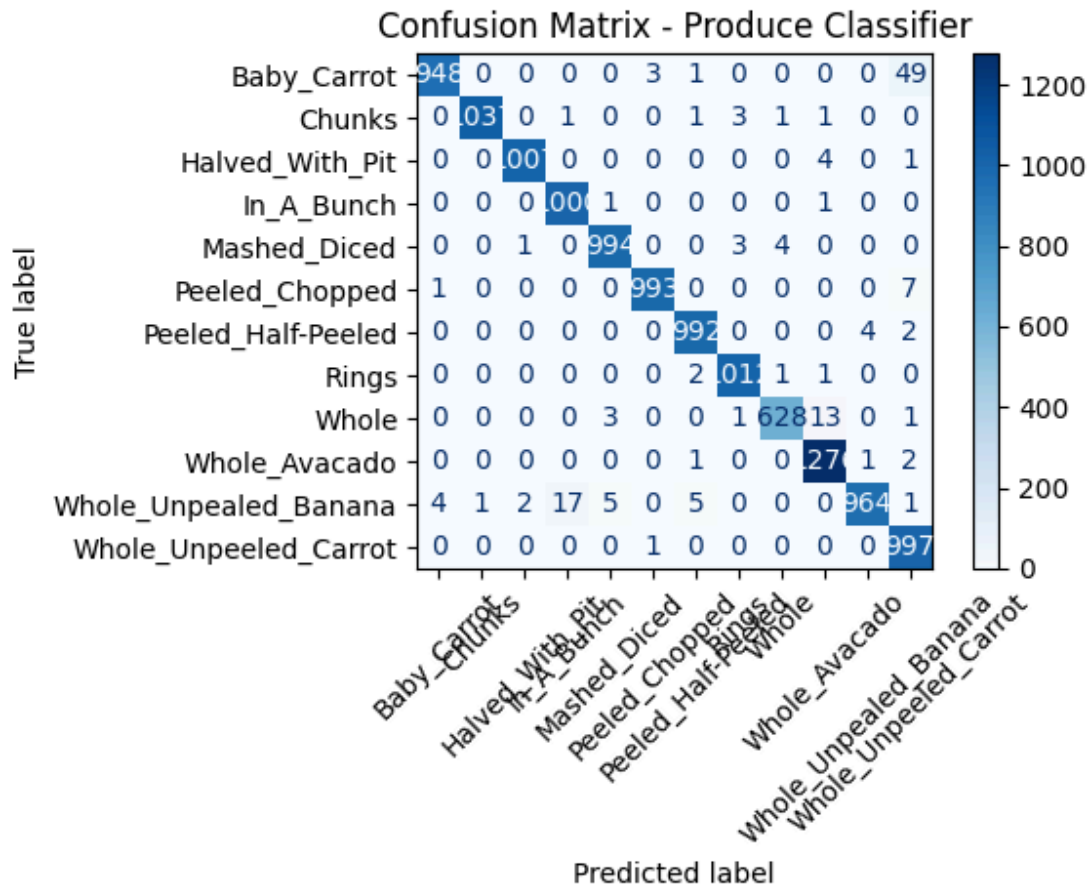


Figure 1: Fruit classification confusion matrix

The data for the variations is impressive. Aside from mistaking variations of the same fruit a few times, the present model performed very well at distinguishing each variation from other classes. The added context and additional classes seems to have allowed the model to do even better fine tuning and learn the difference between the fruits. Although the simple class identifier worked well on the 4 simple classes, the more refined model worked even better.

Part 2: NLP Engineer, Hanwen Dong. BERT-based Recipe Recommendation Model

Data Analysis: I leveraged the RAW_recipes.csv corpus of 231,637 recipes (and optionally RAW_interactions.csv for ratings) to fine-tune a semantic retrieval model. I preprocessed each record by concatenating its tags and ingredients into a single input sequence in the following **format**:

[CLS] tag1 tag2 ... [SEP] ingredient1 ingredient2 ... [SEP]

This step produced the file bert_recipe_inputs.json, which served as my training corpus.

Model Setup: I chose bert-base-uncased from HuggingFace as the foundation. Tokenization and model weights were loaded from the pretrained checkpoint. For fine-tuning, I configured the hyperparameters as follows:

Batch size: 8

Learning rate: 2×10^{-5}

Epochs: 3

Training was executed on a Google Colab A100 GPU through pro, with both model and data tensors moved to CUDA. I optimized the **[CLS]** embedding representations without defining a supervised classification loss, focusing solely on refining the semantic vectors for retrieval.

Evaluation: After training completed, I ran several multi-tag queries to assess retrieval quality. Below are representative **results**:

Top 5:

Query: 'banana', 'bread']

beat this banana bread (0.927)

spicy banana bread (0.915)

say what banana sandwich (0.903)

the best banana bread or muffins (0.892)

bananas 4 ice cream pie (0.879)

Query: ['avocado', 'dip']

sour cream avocado dip vegan (0.912)

a fun and frolic kind of avocado bacon and tomato wrap yippee (0.887)

a 1 steak puffs with corn and avocado salsa a1 (0.865)

a 1 butter deconstructed pinwheel steak with avocado sauce a1 (0.854)

a b l c avocado bacon lettuce crab (0.841)

Query: ['carrot', 'soup', 'ginger']

jiffy extra moist carrot cake (0.919)

the carrot cake (0.906)

german barbecued carrots (0.894)

s wonderful carrot and raisin salad (0.882)

sweet carrots (0.871)

```
{
  "name": "arriba baked winter squash mexican style",
  "input_text": "[CLS] ['60-minutes-or-less' 'time-to-make' 'course' 'main-ingredient'
},
{
  "name": "a bit different breakfast pizza",
  "input_text": "[CLS] ['30-minutes-or-less' 'time-to-make' 'course' 'main-ingredient'
},
{
  "name": "all in the kitchen chill",
  "input_text": "[CLS] ['time-to-make' 'course' 'preparation' 'main-dish' 'chili' 'cro
},
{
  "name": "alouette potatoes",
  "input_text": "[CLS] ['60-minutes-or-less' 'time-to-make' 'course' 'main-ingredient'
},
{
  "name": "amish tomato ketchup for canning",
  "input_text": "[CLS] ['weeknight' 'time-to-make' 'course' 'main-ingredient' 'cuisine'
},
{
  "name": "apple a day milk shake",
  "input_text": "[CLS] ['15-minutes-or-less' 'time-to-make' 'course' 'main-ingredient'
},
{
  "name": "asow marinated olives",
  "input_text": "[CLS] ['15-minutes-or-less' 'time-to-make' 'course' 'main-ingredient'
},
{
  "name": "backyard style barbecued ribs",
  "input_text": "[CLS] ['weeknight' 'time-to-make' 'course' 'main-ingredient' 'cuisine'
},
{
  "name": "bananas 4 ice cream pie",
  "input_text": "[CLS] ['weeknight' 'time-to-make' 'course' 'main-ingredient' 'preparat
},
{
  "name": "beat this banana bread",
  "input_text": "[CLS] ['weeknight' 'time-to-make' 'course' 'main-ingredient' 'preparat
},
{
  "name": "berry good sandwich spread",
  "input_text": "[CLS] ['15-minutes-or-less' 'time-to-make' 'course' 'preparation' 'low
},
{
  "name": "better than sex strawberries",
  "input_text": "[CLS] ['weeknight' 'time-to-make' 'course' 'main-ingredient' 'preparat
},
{
  "name": "better then bush s baked beans",
  "input_text": "[CLS] ['weeknight' 'time-to-make' 'course' 'main-ingredient' 'preparat
```

Query: ['pineapple', 'grilled', 'dessert']

golden circle pineapple upside down cake (0.933)

2 ingredient pineapple cake with pineapple sauce (0.915)

pink stuff cherry pie filling pineapple dessert (0.903)

5 points plus pineapple and honey glazed chicken (0.888)

2blueberry pineapple ring (0.876)

Failure Case:

Query: ['banana', 'gluten-free']

Returned recipes:

beat this banana bread (0.750)

say what banana sandwich (0.742)

jiffy extra moist banana muffins (0.735)

These results show that the 'gluten-free' descriptor is under-represented in the dataset and often overshadowed by popular banana recipes, indicating a need for better ingredient filtering or explicit dietary labels.