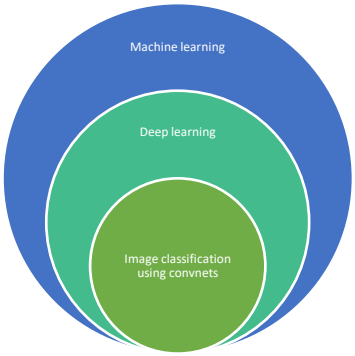
Capstone project

Proposal:

Building an image classifier that could distinguish between different classes of fruits given their image datasets.

Domain background:

The image classifier which is proposed is based on deep learning.

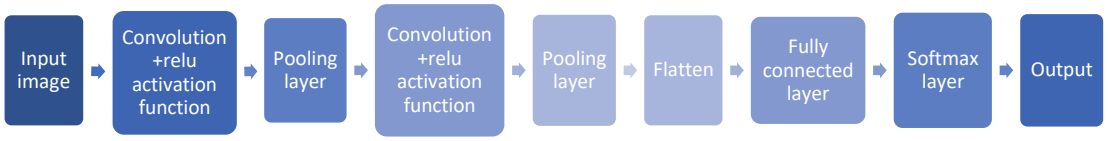


- Machine learning
  a. Machine learning is the study of algorithms and statistical models that computer systems use to effectively perform a specific task without using explicit instructions, relying on patterns and inference instead.
  b. Machine learning is a subset of artificial intelligence.
  c. The main difference between traditional programming and machine learning is shown below:

     i. Traditional programming:
     ii. Data, Rules -> Answers

     iii. Machine learning:
     iv. Data, Answers - > Rules
- Deep learning:
  a) Deep learning is a subset of machine learning.
  b) Deep learning models are based on artificial neural networks.
  c) Deep neural networks work better than machine learning algorithms.
  d) Various applications of deep learning include:-
     i. Speech recognition
     ii. Image recognition
     iii. Natural language processing
     iv. Face recognition
- Convolutional neural networks
  a) A convolutional neural network consists of an input and an output layer, as well as multiple hidden layers.
  b) The hidden layers can be composed of convolutional layers, pooling layers, activation functions, full connected layers, etc.
  c) CNNs are extensively used for image classification.

d) Below figure shows a simple convolutional neural network:



- Applications of image classification
    a) Fruit classification can be used in supermarkets to automatically detect the types of fruits and can also be used to determine the price for the produce.
    b) Image classification is used in classifying satellite pictures of land area taken from space into useful segregators based on geography.
    c) Extensively used in healthcare industry.
    d) Used for cancer detection.
    e) Used in self driving cars

- Some of the academic research done in this field before:
    a) Classification of fruits based on shape, color and texture using image processing techniques-https://www.ijert.org/research/classification-of-fruits-based-on-shape-color-and-texture-using-image-processing-techniques-IJERTV6IS120057.pdf
    b) Fruit classification system using computer vision: a review-http://www.ijtrd.com/papers/IJTRD13382.pdf
    c) Classification of fruits using computer vision and a multiclass support vector machine-https://www.mdpi.com/1424-8220/12/9/12489/pdf
    d) Deep fruits: A fruit detection system using deep neural networks-https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5017387/

Motivation:

There are many varieties within each fruit.

Eg. Apple has many varieties such as Apple Braeburn, Apple Golden, Apple Granny Smith, Apple Red, etc.

Manually classifying and pricing these varieties in supermarket is difficult. Using this project, we can see how well our deep neural networks perform in classifying these different varieties.

By using deep neural network, we can reduce manual work and automate the work of classifying and pricing different varieties of fruits.

Problem statement:

The main aim of this project is to build a classifier that can distinguish different classes of fruits.

Given a new input image of a fruit, the classifier should be able to predict the class.

Here, convolutional neural network will be used since convnets are good for image classification due to its good performance.

Datasets and Inputs:

- Dataset is obtained from Kaggle(Fruits-360).
- There are 65429 images in total.
- Training set size: 489005 images.
- Test set size:16421 images.
- There are 95 different classes(fruits).
- The size of each image is 100x100 pixels.

  This dataset is a balanced dataset as the number of instances of data points in each class is around 490

Examples of images extracted from the dataset:

- Apple Braeburn:

- Banana:

- Grape Blue:

- Orange:

Solution statement:

Here, I am building an image classifier using convolutional neural network that can distinguish different classes of fruits given their image dataset.

CNNs are used here due its high performance in case of image classification.

Our classifier will consist of convolutional layer, max pooling layer, flatten layer, dense layer and activation functions.

The image classifier will be trained using training dataset consisting of 489005 images.

This image classifier will be tested using test dataset consisting of 16421 images.

The goal here is to reduce loss and increase accuracy.

Benchmark model:

This image classifier will be compared with other model results in Kaggle.

This image classifier's performance using normal implementation will be compared with an image classifier built using transfer learning.

Evaluation metrics:

The evaluation metrics that will be used to quantify the performance of both the benchmark model and the solution model presented are:

- Accuracy:
    a) Accuracy is the ratio of number of correct predictions to the total number of predictions.
    b) Accuracy = Number of correct predictions/Total number of predictions.
    c) Since the dataset is balanced, we can use accuracy as an evaluation metric.
- Loss function
    a) Loss function is a measure of how good a prediction model does in terms of being able to predict the expected outcome.
    b) The main aim of neural network is to reduce this loss function.

Project design:

- Data exploration:
  Here the dataset will be explored and visualized using matplotlib library.

- Data pre-processing:
  Here the data set will be normalized.

- Model construction:
  Here the actual model(image classifier) will be constructed. This model will contain convolutional, max pooling, flatten, dense layers and activation functions such as relu and softmax.

- Model training:
  Here the model will be trained using training data.

- Model testing:
  Model will be tested using new unknown images.

- Model evaluation:
  The performance of this model will be evaluated using below evaluation metrics:
  a) Accuracy
  b) Loss

- Transfer learning:
  Transfer learning is the reuse of pre-trained model on a new different problem.

- Model evaluation:
  The model performance will be evaluated after using transfer learning.

Resources:

a) Kaggle dataset: https://www.kaggle.com/moltean/fruits
b) https://en.wikipedia.org
c) https://scikit-learn.org
d) https://developers.google.com/machine-learning
e) https://keras.io/
f) https://www.tensorflow.org/