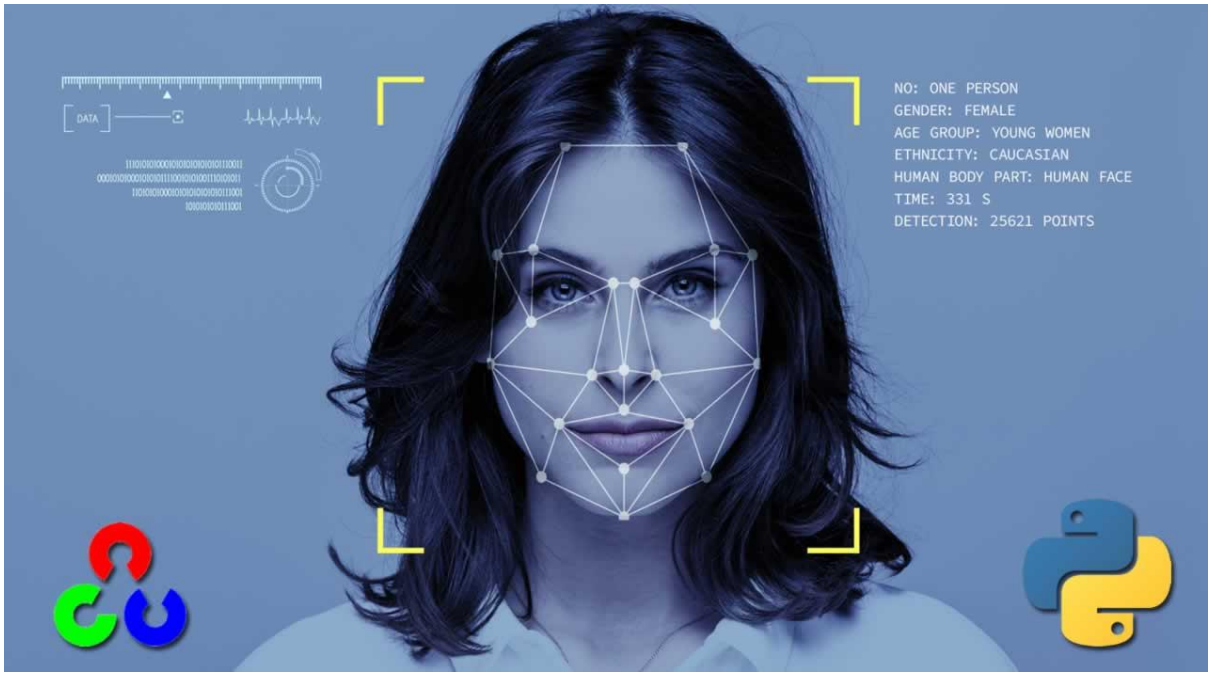
SOC'25 41: Facial Recognition Mid Term Report

*(**THE EYES OF MACHINE:** A journey into face detection)*



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Machine Learning:

1. Introduction:

The main part of project's machine learning includes NLP natural language processing for sentiment analysis which gives positive/negative/neutral based on sentiment the input will be news headlines. And another part of project includes predictive modelling for prediction of stock market. Although this is optional one.

Some Important Terms in ML:

Types of Learning

• Supervised Learning: In this type, the model learns from labeled data, where each example has input features and a corresponding output label. The goal is to predict labels for new, unseen data.

• Unsupervised Learning: Here, the model learns from unlabeled data.

It identifies patterns, clusters, or structures within the data without pre-defined labels.

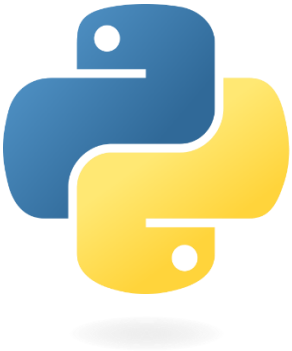
• Reinforcement Learning: This learning paradigm involves an agent interacting with an environment. The agent receives rewards or penalties

1. Software Used:

1.1 Python:

It is a beginner-friendly and easy to use programming language with a vast library for all kinds of applications.

Python is used by most ML developers and data scientists.

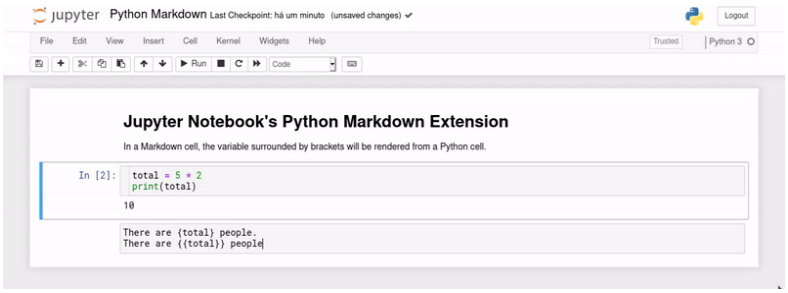


1.2 Jupyter Notebooks:

Jupyter Notebook is an interactive environment for writing and running python code.

It's widely used in data science, machine learning, education, and research.

Contains mainly code cell for running code and markdown cell for writing notes.



1.3 Numpy:

Numpy is a powerful py library used for numerical computing. It provides:

1.Fast and memory-efficent multidimensional arrays (ndarray).

2.Tools for mathematical, logical, and statistical operations.

3.Support for linear algebra, Fourier transformers, and random number generations

Feature	*Example*
Create arrays	*np.array, np.zeros, np.ones*
Array shape/info	*.shape, .dtype, .ndim*
Math ops	*+, -, *, /, np.sqrt()*
Stats	*np.mean(), np.sum()*
Slicing/Indexing	*a[1:3], a[a > 5]*
Matrix operations	*np.dot(), np.matmul()*

1.4 Pandas:

Pandas is also a powerful Python library used for data analysis and manipulating large data.

Why Pandas?
1.Easy-to-use structurers like DataFrames and Series.
2.Tools to load, clean, transform, analyze, and visualize data efficiently.

Feature	***Benefit***
Tabular data handling	*Like Excel/SQL in Python*

Feature	*Benefit*
Fast and flexible	*Built on top of NumPy*
Powerful operations	*Filtering, grouping, merging, etc.*
Works with many formats	*CSV, Excel, JSON, SQL, etc.*

1.5 Matplotlib:

Matplotlib is a Python lib for creating static, animated, and interactive plots.

Feature	Benefit
Basic to complex plots	Supports line, bar, pie, scatter, etc.
Highly customizable	Control every detail (colour, labels)
Integrates with Pandas	Easy plotting from Data Frames

Feature	Benefit
Works with Jupyter	Plots show inline in notebooks

1.6 Tensor Flow:

What are the things we can do with TensorFlow?

1.image classification, data clustering, regression, reinforcement learning, nlp(Natural Language processing) and many more.

How it works? It has mainly two components.

Two main components:

1.graphs, 2. sessions.

Graph is like set operations defined in code.

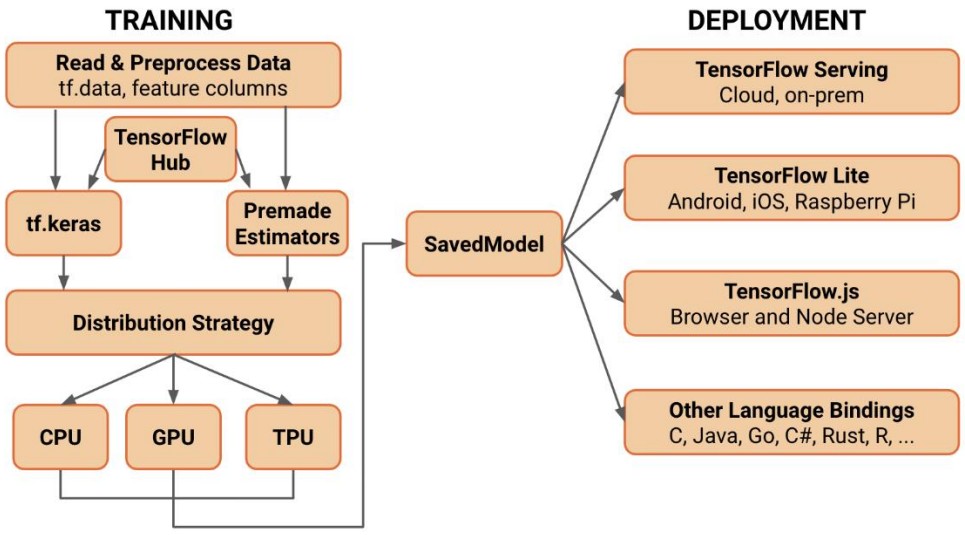
Sessions are simply like executing different components in graph.

Tensors:

Tensor is a generalization of vectors, matrices ... n dimensional arrays.

TensorFlow programs work by building a graph of tensor objects that details how tensors are related. running diff parts of graph allow results to be generated.

Each tensor has a datatype and shape.



Types of Tensors:

1.Variable, 2. Constant, 3. Placeholder, 4. sparse tensor.

Unlike variable remaining types of tensors have constant values.

TensorFlow core learning algorithms:

1.Linear regression, 2. Classification, 3. Clustering, 4. Hidden Markov models.

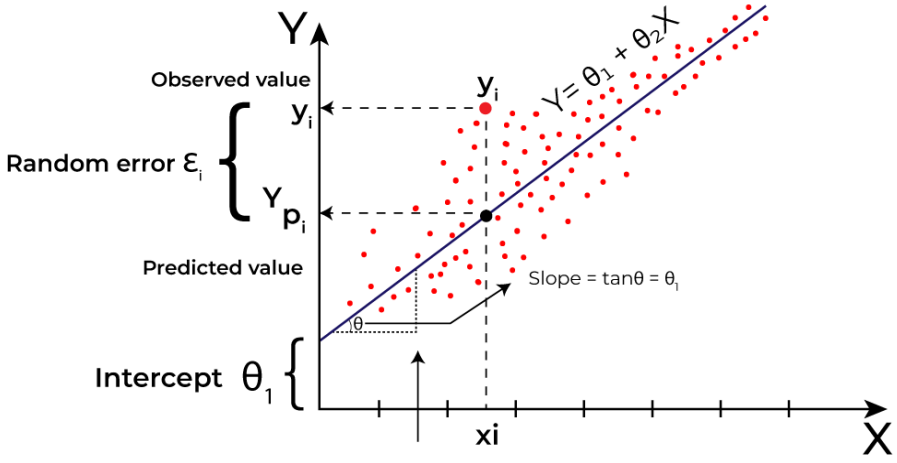
Linear Regression: Linear Regression is a supervised learning algorithm used for predicting continuous values. It models the relationship between a dependent variable (output) and one or more independent variables (inputs) using a linear equation.

Equation:
For simple linear regression:

$$y = mx + c$$

Where:

- y = predicted value
- x = input feature
- m = slope (weight)
- c = intercept (bias)



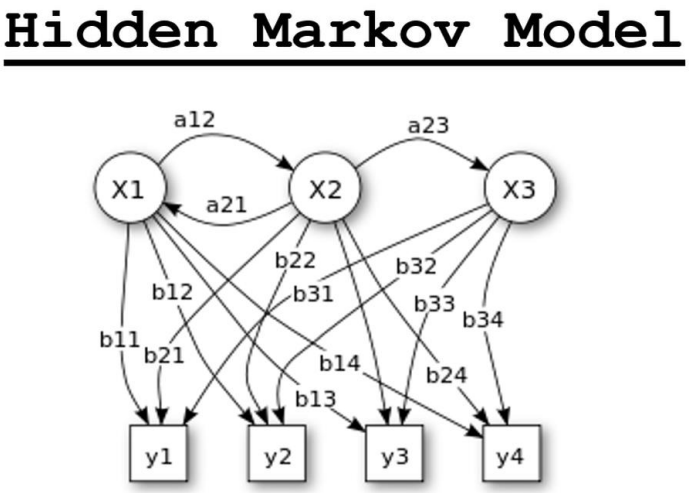
Classification: Classification is a supervised learning technique used to categorize data into predefined classes or labels.

Clustering: Clustering is an **unsupervised learning** technique that groups similar data points together based on patterns or similarities.

Use Cases:

- Customer segmentation
- Document clustering
- Image compression
- Anomaly detection

Hidden Markov Models (HMMs): Hidden Markov Models are probabilistic models used to model sequential or time-series data where the system being modelled is assumed to be a Markov process with hidden states.



1.7 OpenCV:

OpenCV (Open-Source Computer Vision Library) is an open-source library primarily focused on real-time computer vision and image processing tasks. It's widely used in fields like robotics, AI, augmented reality, and machine learning.

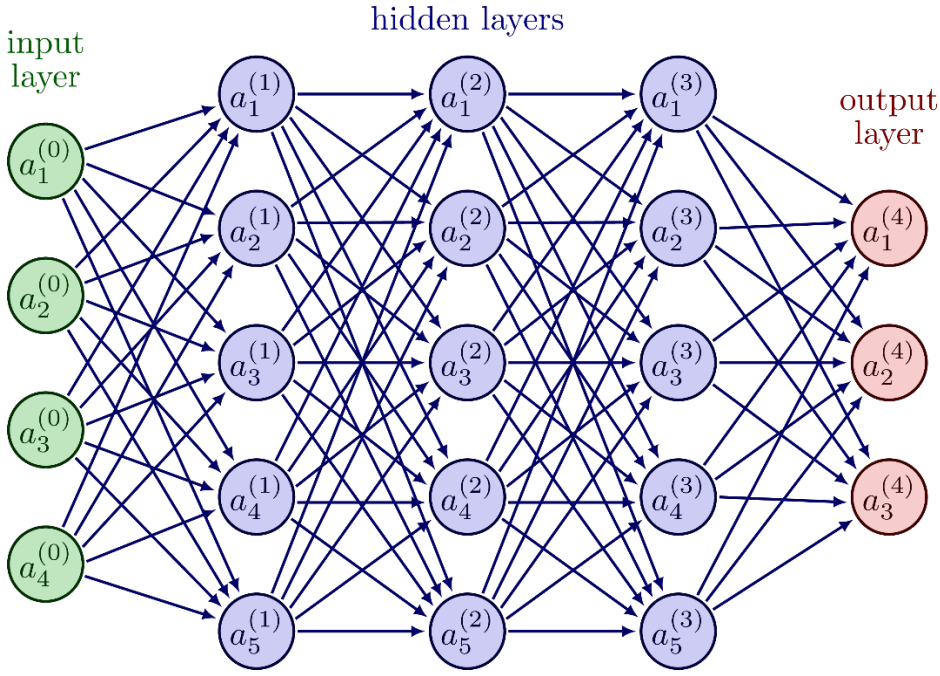
What can you do with it?

1. Image Processing
2. Video Processing
3. Feature Detection
4. Camera Calibration and 3D Reconstruction
5. Machine Learning Integration.

2.Neural Network:

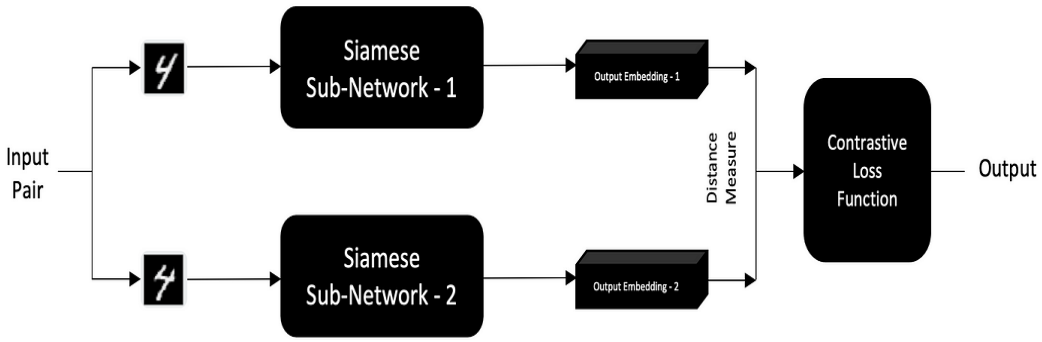
A Neural Network is a type of machine learning model inspired by how the human brain works. It's composed of layers of interconnected nodes (neurons) that can learn patterns from data.

It's the foundation of deep learning.



The neural network which we are going to use in our project is Siamese Neural Network

Siamese Neural Network:



Siamese Neural Network is a type of neural network that learns to compare two inputs and determines how similar or different they are. It consists of two or more identical sub networks with shared weight as shown in the above figure.

Architecture:

Every branch in the Siamese network processes one of the inputs using identical neural network. These branches extract featured vectors from the input. The outputs (embeddings) are then calculated and compared using a distance function like:

- Euclidean distance
- Cosine similarity
- Manhattan distance

Similarity (x1, x2) = ‖ f(x1) − f(x2) ‖

Where f(x) is the output of the shared network.

Training:

The network is trained using pair of inputs:

Positive pair: two similar examples (e.g., image of the same person)

Negative pair: two different examples (e.g., images of different persons)

Loss:

Most common is Contrastive Loss or Triplet loss.

Contrastive Loss (Binary Similarity):

$L = (1-y) \cdot 1/2.D^2 + y \cdot 1/2.\max(0, m-D)^2$

D = distance between outputs

y = 0 if similar, 1 if dissimilar

m = margin

Use Case	Description
Face verification	Are two photos of the same person?
Signature verification	Is this signature real or forged?
Product matching	Are two items visually the same?
Document matching	Are two texts similar in meaning?