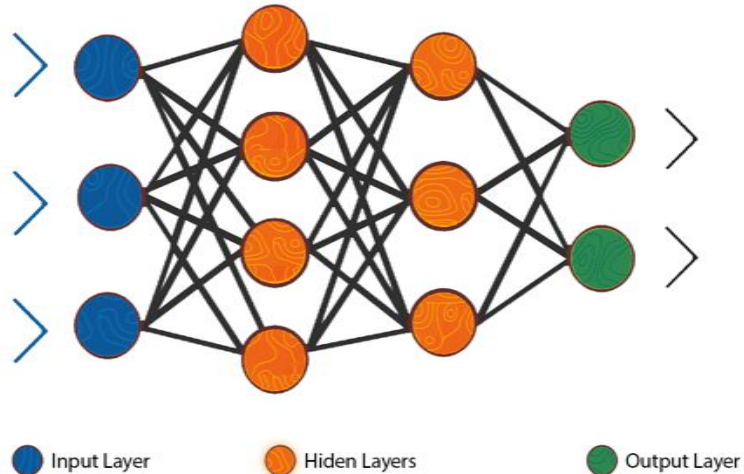
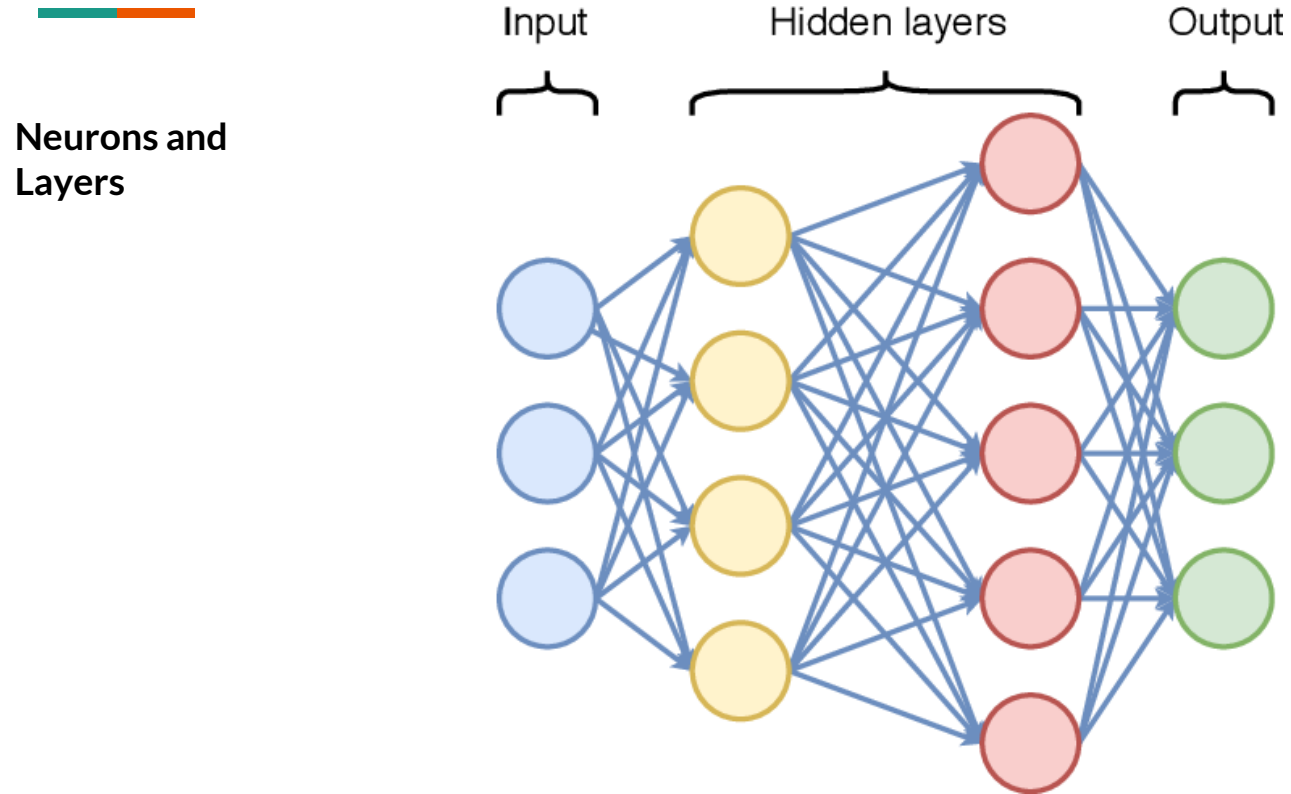


# Handwritten Character Recognition

Ritik  
01196402721



# Neural Networks



# Neural Networks



Neural networks are a fundamental concept in artificial intelligence and machine learning. They are a class of machine learning models inspired by the structure and function of the human brain, composed of interconnected artificial neurons or units.

1. Neurons (Artificial Neurons):
  - At the core of a neural network are artificial neurons, also known as perceptrons or nodes. These are mathematical units that process and transmit information.
  - Neurons take input data, apply a set of weights to the input, add a bias term, and then pass the result through an activation function to produce an output.

# Neural Networks



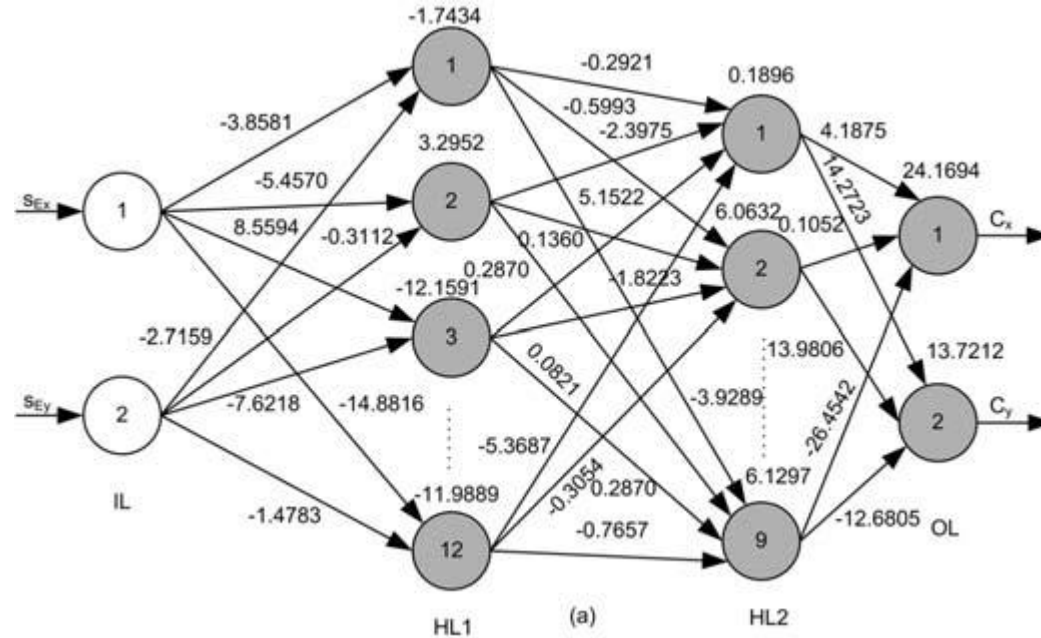
Neural networks are a fundamental concept in artificial intelligence and machine learning. They are a class of machine learning models inspired by the structure and function of the human brain, composed of interconnected artificial neurons or units.

## 2. Layers:

- Neural networks are organized into layers of neurons. The most common types of layers are:
  - Input Layer: Receives input data and passes it to the next layer.
  - Hidden Layers: Intermediate layers between the input and output layers, used for feature extraction and representation learning.
  - Output Layer: Produces the final predictions or outputs.

# Neural Networks

## Weights and Biases



# Neural Networks



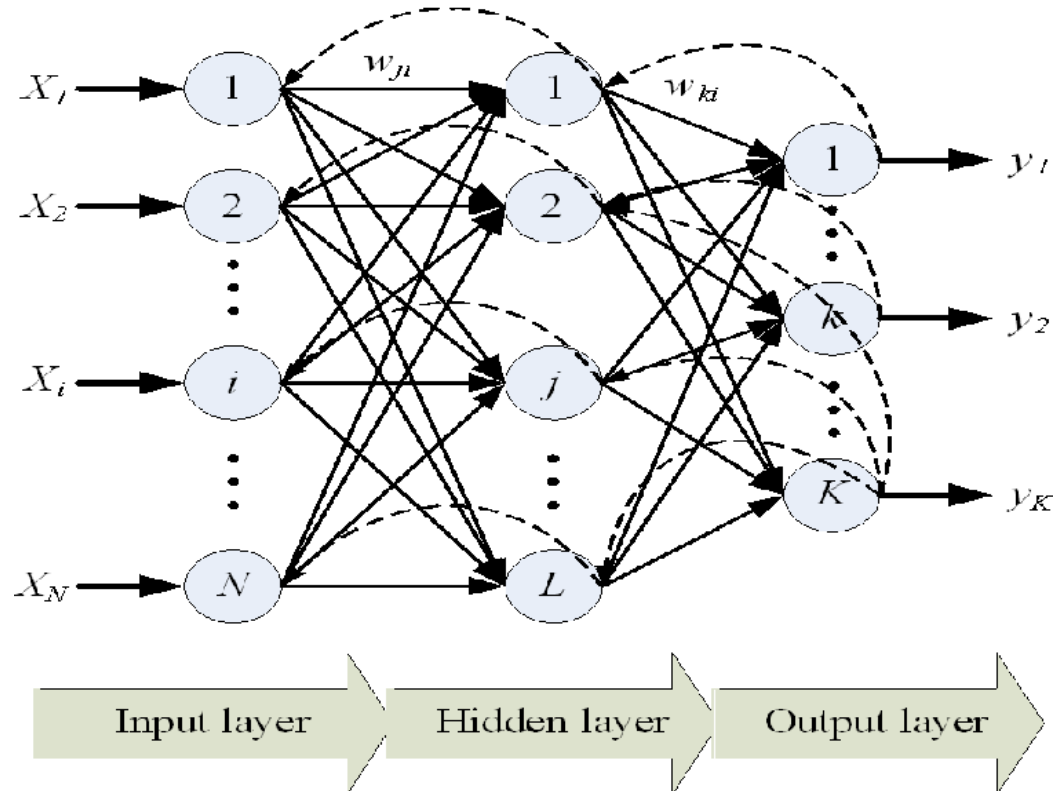
Neural networks are a fundamental concept in artificial intelligence and machine learning. They are a class of machine learning models inspired by the structure and function of the human brain, composed of interconnected artificial neurons or units.

## 3. Weights and Biases:

- Each connection between neurons is associated with a weight, which determines the strength of the connection.
- Each neuron also has an associated bias term that allows it to adjust its output.

# Neural Networks

Backpropagation



# Neural Networks



Neural networks are a fundamental concept in artificial intelligence and machine learning. They are a class of machine learning models inspired by the structure and function of the human brain, composed of interconnected artificial neurons or units.

## 4. Feedforward and Backpropagation:

- In a feedforward neural network, information flows from the input layer through the hidden layers to the output layer.
- Backpropagation is a training algorithm used to adjust the weights and biases of the network to minimize the error between the predicted and actual outputs during training.





# Machine Learning Libraries

- Numpy
- Pandas
- Matplotlib

# Numpy

A popular mathematics library in Python for Machine Learning is 'numpy'. It is the fundamental package for the scientific computation with python.

Keyword to import a library

Keyword to refer to library by an alias (shortcut) name

```
import numpy as np
```

## Used For:

- Powerful N-Dimensional array objects
- Sophisticated (broadcasting) functions
- Tools for integrating C/C++ and other codes
- Useful for matrices, determinants, eigen vectors, transforms (fourier, z) and random number capabilities



## Numpy - Arrays

The most important data structure for scientific computing in python is the **Numpy array**. Numpy arrays are used to store lists of numerical data and to represent vectors, matrices and even tensors.

Numpy arrays are designed to handle large data sets efficiently and with a minimum of fuss. The Numpy library has a large set of routines for creating, manipulating, and transforming Numpy arrays.

Core Python has an array data structure, but it's not nearly as versatile, efficient, or useful as the Numpy array.

# Numpy - Multidimensional Arrays

- Numpy's main object is a **multi-dimensional array**.
- Creating a Numpy array as a **Vector**:

Value is: array([ 1, 2, 3 ])

Numpy function to create a numpy array

```
data = np.array([ 1, 2, 3 ])
```

- Creating a Numpy array as a **Matrix**:

Outer Dimension

Inner Dimension (rows)

```
data = np.array([[ 1, 2, 3 ], [ 4, 5, 6 ], [ 7, 8, 9 ]])
```

Value is: array([ 1, 2, 3 ],  
[ 4, 5, 6 ],  
[ 7, 8, 9 ])

# Pandas

A popular library for importing and managing datasets in Python for Machine Learning is 'pandas'.

Keyword to import a library

Keyword to refer to library by an alias (shortcut) name

```
import pandas as pd
```

## Used for:

- **Data Analysis**
- **Data Manipulation**
- **Data Visualization**

High performance, easy to use data structures and data analysis tool



# Pandas

- Powerful and productive Python data analysis and management library.
- **Panel Data System**
- Open Sourced by AQR Capital Management, LLC in late 2009
- Rich Data Structures and functions to make working with structured data fast, easy and expressive.
- Built on top of Numpy with its high performance array-computing features.
- Flexible data manipulation capabilities of spreadsheets & relational databases.
- Sophisticated Indexing functionality (slice, dice, performance aggregation, select subsets of data)
- Ideal tool for data Scientists.

## Pandas - Series & Data Frames

- Pandas provides indexed arrays (labelled arrays) which are referred to as **Series** (1D) and **Data Frames** (2D). These arrays can be accessed via names (labels).
- **Series** is a 1D labeled (indexed) array and can hold any data type, and mix of data types.

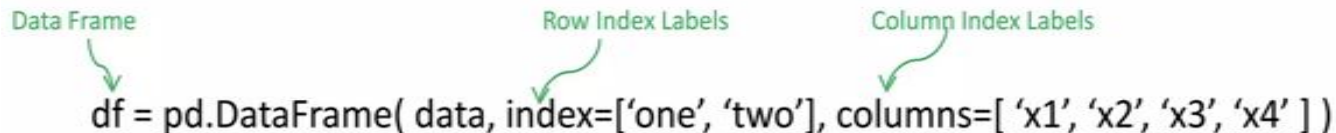
Series                      Raw data                      Column Index Labels



```
s = pd.Series( data, index=[ 'x1', 'x2', 'x3', 'x4' ] )
```

- **Data Frame** is a 2D labeled (indexed) matrix and can hold any data type, and mix of data types.

Data Frame                      Row Index Labels                      Column Index Labels



```
df = pd.DataFrame( data, index=[ 'one', 'two' ], columns=[ 'x1', 'x2', 'x3', 'x4' ] )
```

# Matplotlib

A popular library for plotting and visualizing data in python is 'matplotlib'.

Keyword to import a library

Keyword to refer to library by an alias (shortcut) name

```
import matplotlib.pyplot as plt
```

## Used for:

- **Plots**
- **Histograms**
- **Bar Charts**
- **Scatter Plots**
- **etc**

It is a python 2D plotting library which produces publications quality figures in a variety of hard copy formats and interactive environments across platforms.



# Matplotlib

A popular library for plotting and visualizing data in python is 'matplotlib'.

Keyword to import a library

Keyword to refer to library by an alias (shortcut) name

```
import matplotlib.pyplot as plt
```

## Used for:

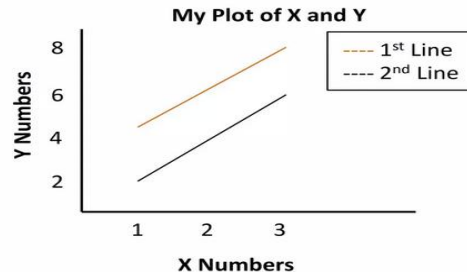
- **Plots**
- **Histograms**
- **Bar Charts**
- **Scatter Plots**
- **etc**

It is a python 2D plotting library which produces publications quality figures in a variety of hard copy formats and interactive environments across platforms.

# Matplotlib - Plot

- The function `plot` plots a 2D graph.

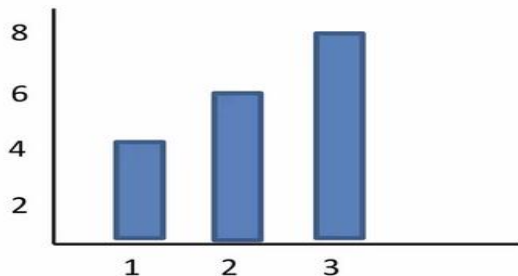
```
plt.plot( [ 1, 2, 3 ], [ 4, 6, 8 ], label='1st Line' ) # Plot for 1st Line
plt.plot( [ 1, 2, 3 ], [ 2, 4, 6 ], label='2nd Line' ) # Plot for 2nd Line
plt.xlabel( "X Numbers" )
plt.ylabel( "Y Numbers" )
plt.title( "My Plot of X and Y" )
plt.legend() # Show Legend for the plots
plt.show()
```



## Matplotlib - Bar

- The function `bar` plots a bar graph.

```
plt.plot( [ 1, 2, 3 ], [ 4, 6, 8 ] ) # Plot for 1st Line  
plt.bar() # Draw a bar chart  
plt.show()
```





## WHY HCR?

HCR (Handwritten Character recognition) models are essential for making digital content accessible to everyone, including people with visual impairments. They are also used to automate tasks in a variety of industries, such as healthcare, finance, and retail. By extracting text from images and videos, character recognition models help us to understand and interact with the world around us more effectively.

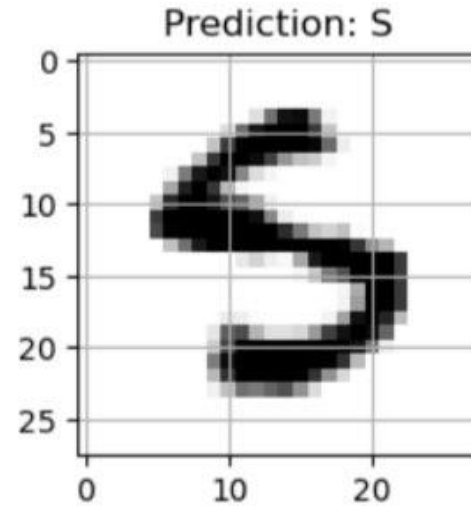
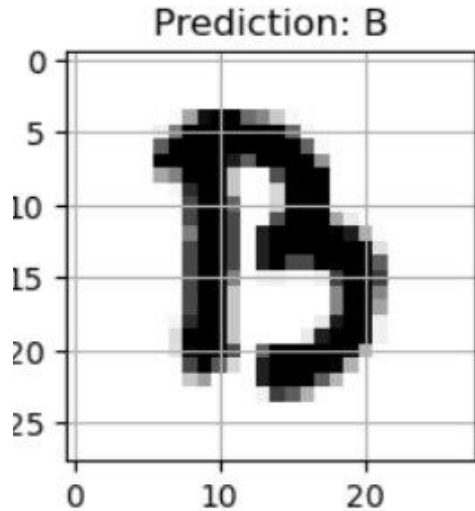


## HCR - Usage

- **Document processing** : Character recognition models can be used to extract text from scanned documents, such as invoices, receipts, and contracts. This can help to automate data entry and improve the efficiency of business processes.
- **Image search** : Character recognition models can be used to index images and make them searchable. This can be useful for finding images of specific text, such as product labels or street signs.
- **Accessibility** : Character recognition models can be used to make digital content accessible to people with visual impairments. For example, character recognition models can be used to transcribe text from images into audio or text format.

## HCR - Results of Training

Trained :





## HCR - How to Improve?

Here's how we are going to approach the improvement of the ongoing model.

1. **Diversify Training Data:** Use a larger and more diverse training dataset to expose the character recognition system to a wider range of characters and fonts, which will improve its accuracy and robustness.
1. **Fine-Tune Model:** Perform **fine-tuning** on the existing model by adjusting hyperparameters, learning rates, and training epochs to enhance its ability to make detections accurate.
1. **Data Augmentation:** Apply data augmentation techniques like cropping, rotation, flipping, and adding noise during training to simulate different parameters and **improve the model's robustness**.



**THANK YOU FOR YOUR ATTENTION**

**Presented by :**

**Ritik**