EX.NO:05
22.08.25

# STUDY OF ACTIVATION FUNCTION AND ITS ROLE

## Aim

To study different activation functions used in neural network and analyze their role in learning and performance.

## Objective

To understand the purpose of activation functions in neural networks.

To implement and visualize commonly used activation function.

To compare their behaviour and significance in training deep learning models.

To evaluate how different activation function affect model performance.

## Pseudocode

Import required Libraries.

Define mathematical function for Sigmoid, Tanh, relu, leaky relu, softmax

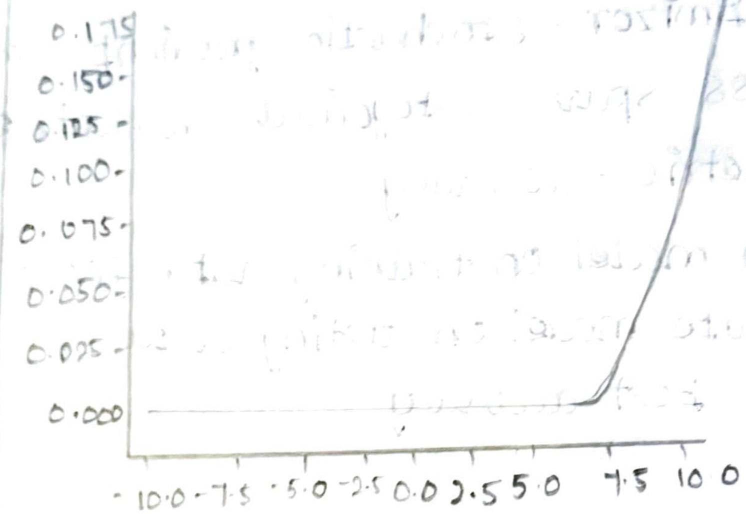
generate a range of input values (x)

compute outputs of all activation functions

plot graph of each activation functions

Compare their behaviour and note observation.

Softmax - Range (0,1) $\frac{e^{x_i}}{\sum_j e^{x_j}}$

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| Activation fn | output range | Advantage | usecase |
|---|---|---|---|
| sigmoid | (0,1) | smooth, probabilistic output. | Binary classification |
| Tanh | (-1,1) | centred amount 0, better than sigmoid | Hidden layer (older network) |
| Relu | (0,∞) | Fast, reduce computation time | Hidden layer (moder NN / ANN) |
| Leaky Relu | (-∞,∞) | First Relu (dying) issues | Deep hidden layer |
| softmax | (0,1), Sum = 1 | give probability distribution | output layer for multi class |

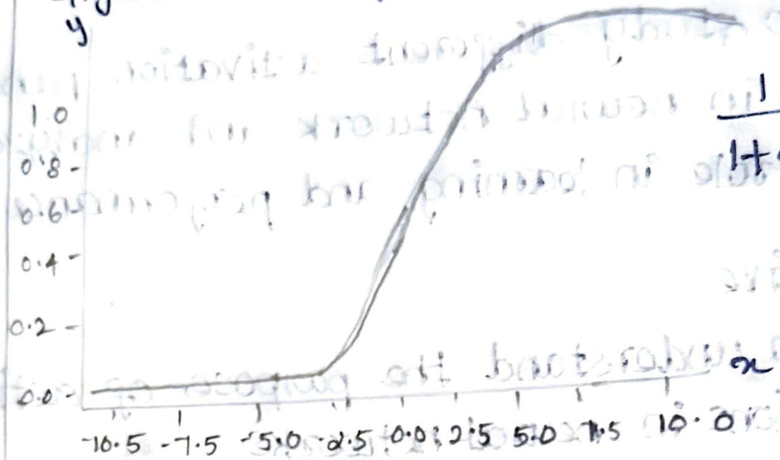
* Relu and Leaky Relu are most effective in hidden Layer
* sigmoid and Train are rarely used today due to vanishing gradient
* softmax for multiclass classification problem

Result

studied different activation function & their roles

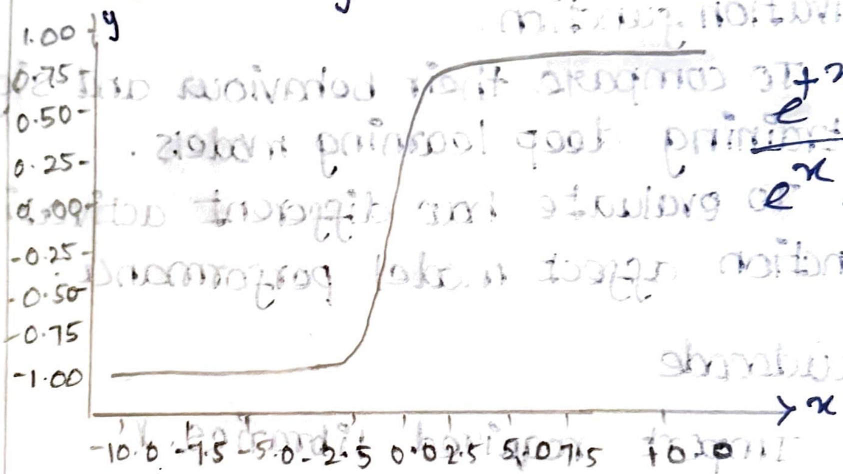
Sigmoid (Range 0 to 1)

$$\frac{1}{1+e^{-x}}$$



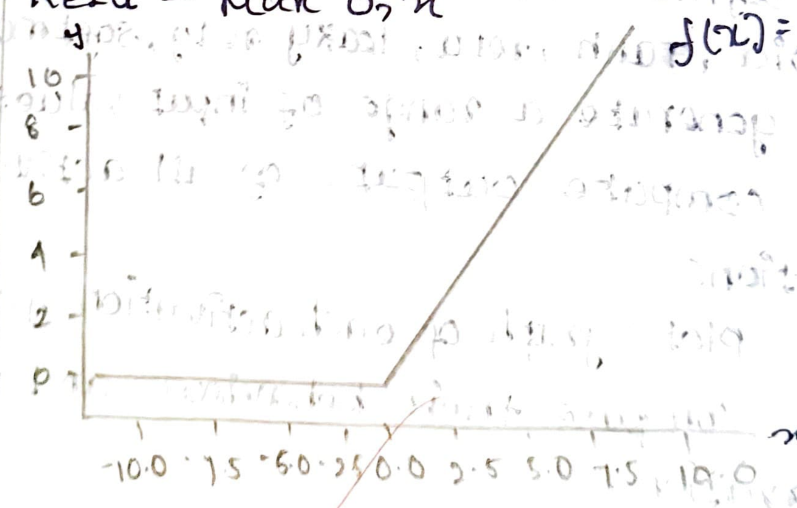

Tanh – Range (-1, 1)

$$\frac{e^{x}-e^{-x}}{e^{x}+e^{-x}}$$




Relu – Max 0, x

$$f(x) = \begin{cases} 0 & \text{for } x < 0 \\ x & \text{for } x \geq 0 \end{cases}$$



[1]:
```python
import torch
import torch.nn.functional as F
```

[2]:
```python
x = torch.tensor([-2.0, -1.0, 0.0, 1.0, 2.0])
```

[3]:
```python
sigmoid = torch.sigmoid(x)
tanh = torch.tanh(x)
relu = F.relu(x)
leaky_relu = F.leaky_relu(x, negative_slope=0.1)
softmax = F.softmax(x, dim=0)  # Softmax over the tensor elements
```

[4]:
```python
print("Input:", x)
print("Sigmoid:", sigmoid)
print("Tanh:", tanh)
print("ReLU:", relu)
print("Leaky ReLU:", leaky_relu)
print("Softmax:", softmax)
```

```
Input: tensor([-2., -1.,  0.,  1.,  2.])
Sigmoid: tensor([0.1192, 0.2689, 0.5000, 0.7311, 0.8808])
Tanh: tensor([-0.9640, -0.7616,  0.0000,  0.7616,  0.9640])
ReLU: tensor([0., 0., 0., 1., 2.])
Leaky ReLU: tensor([-0.2000, -0.1000,  0.0000,  1.0000,  2.0000])
Softmax: tensor([0.0117, 0.0317, 0.0861, 0.2341, 0.6364])
```

•[5]:
```python
import numpy as np
import matplotlib.pyplot as plt
def sigmoid(x):
    return 1 / (1 + np.exp(-x))
def tanh(x):
```

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Code Notebook Python 3 (ipykernel)

[5]:
```
import numpy as np
import matplotlib.pyplot as plt
def sigmoid(x):
    return 1 / (1 + np.exp(-x))
def tanh(x):
    return np.tanh(x)
def relu(x):
    return np.maximum(0, x)
def softmax(x):
    exp_x = np.exp(x - np.max(x))
    return exp_x / exp_x.sum()
x = np.linspace(-10, 10, 100)
y_sigmoid = sigmoid(x)
y_tanh = tanh(x)
y_relu = relu(x)
y_softmax = softmax(x)
plt.figure(figsize=(10,8))
plt.subplot(2,2,1)
plt.plot(x, y_sigmoid, 'b')
plt.title("Sigmoid")
plt.subplot(2,2,2)
plt.plot(x, y_tanh, 'r')
plt.title("Tanh")
plt.subplot(2,2,3)
plt.plot(x, y_relu, 'g')
plt.title("ReLU")
plt.subplot(2,2,4)
plt.plot(x, y_softmax, 'm')
plt.title("Softmax (on vector)")
plt.tight_layout()
plt.show()
```

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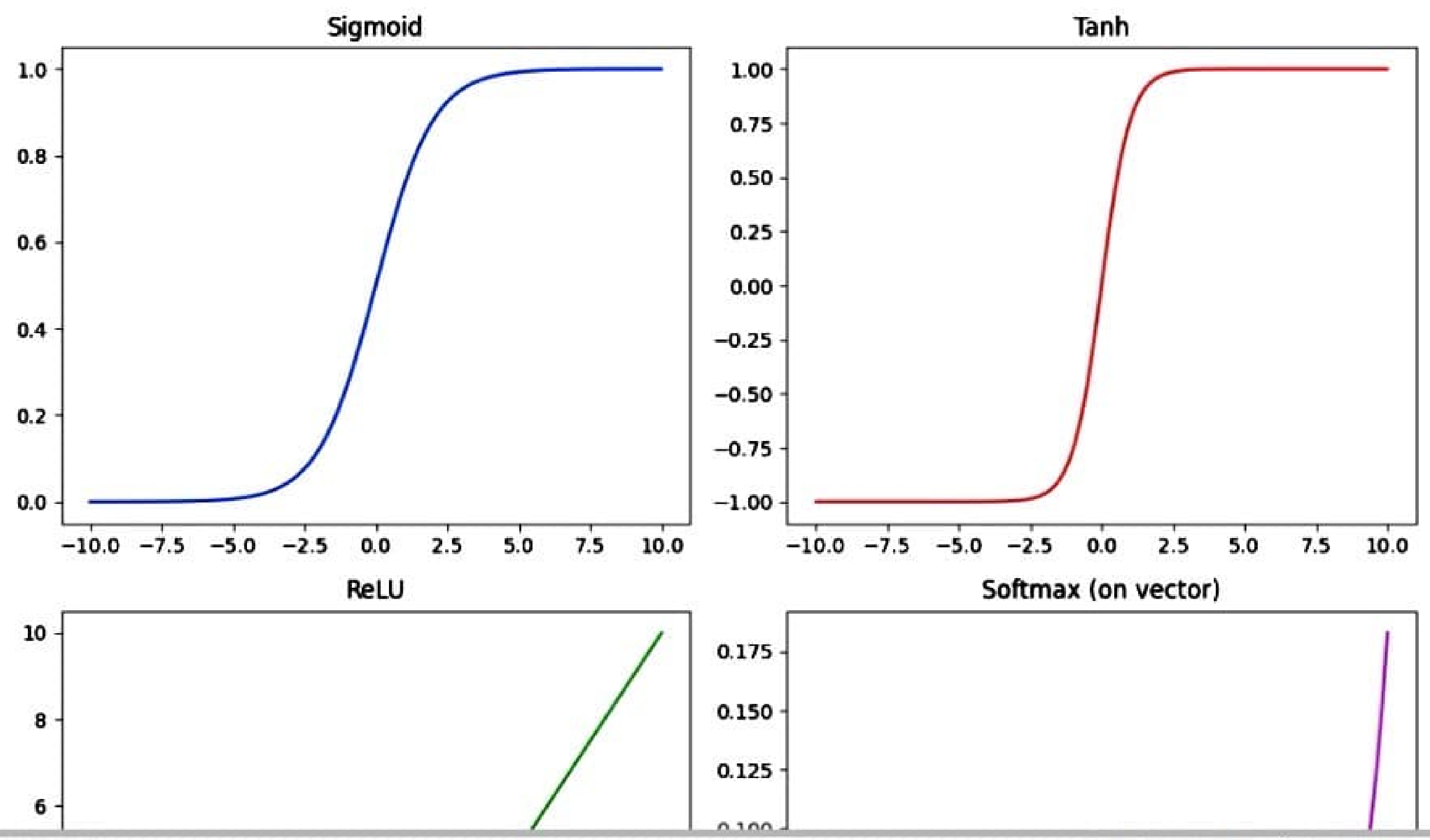
Code — Notebook — Python 3 (ipykernel)

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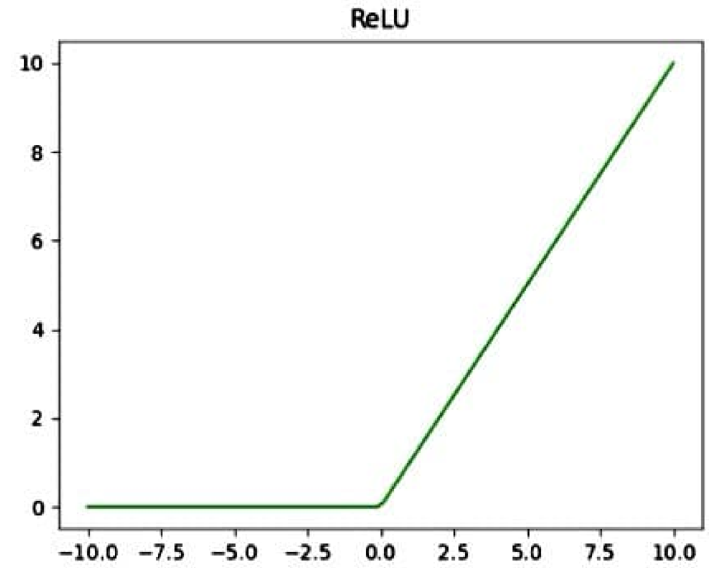


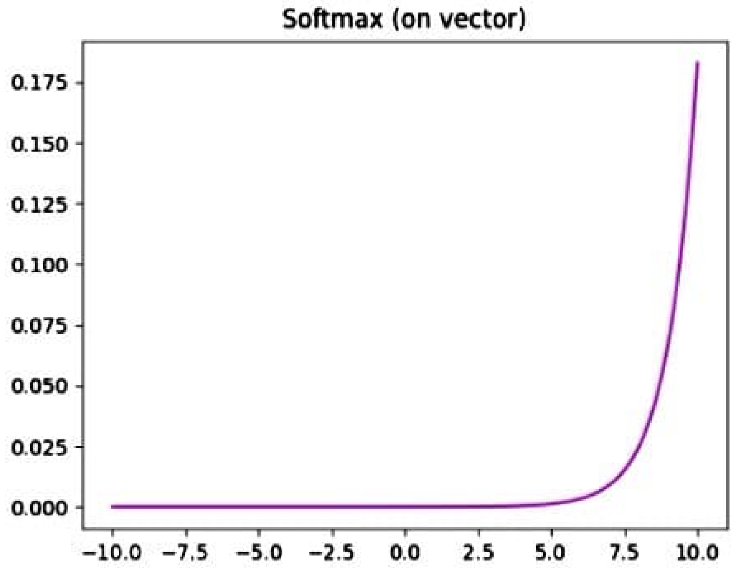


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