Deep Learning: Complete Guide

Introduction to Deep Learning

Deep Learning is a subset of ML that uses deep neural networks to learn patterns.

Difference: Machine Learning vs Deep Learning

Deep Learning uses multiple layers, while ML models are mostly shallow.

How Deep Learning Works?

DL models learn hierarchical representations through multiple layers.

Neural Networks Basics

Composed of input, hidden, and output layers with interconnected neurons.

Types of Neural Networks

Common types: ANN, CNN, RNN, LSTM, Transformer, GANs, Autoencoders.

Perceptron Model

A simple neural network unit used for binary classification.

Activation Functions

ReLU, Sigmoid, Tanh, Softmax - used to introduce non-linearity.

Gradient Descent & Backpropagation

Algorithms for training deep learning models.

Loss Functions

MSE, Cross-Entropy Loss, Huber Loss used for optimization.

Optimizers

SGD, Adam, RMSprop - techniques to adjust model weights.

Deep Learning Frameworks

TensorFlow, PyTorch, and Keras are popular libraries.

Building a Neural Network in TensorFlow

Code:

```
from tensorflow.keras.models import Sequential
model = Sequential([...])
```

Building a Deep Neural Network in PyTorch

Code:

```
import torch
model = torch.nn.Sequential(...)
```

Convolutional Neural Networks (CNNs)

Used for image processing and object recognition.

Implementation of CNNs

Code:

```
from tensorflow.keras.layers import Conv2D
```

Recurrent Neural Networks (RNNs)

Used for sequential data like text and time series.

Understanding LSTMs & GRUs

Variants of RNNs that solve vanishing gradient problems.

Implementation of LSTMs

Code:

```
from tensorflow.keras.layers import LSTM
```

Autoencoders

Unsupervised learning technique for data compression.

Transformers & Attention Mechanisms

Used in NLP tasks like BERT and GPT models.

Generative Adversarial Networks (GANs)

Used for image synthesis and data augmentation.

Implementation of GANs

Code:

```
from torch import nn
class GAN(nn.Module): ...
```

Deep Learning for Computer Vision

Face recognition, object detection, medical imaging.

Deep Learning for NLP

Chatbots, sentiment analysis, text summarization.

Hyperparameter Tuning

GridSearchCV, RandomSearchCV, Optuna.

Transfer Learning & Pretrained Models

Using models like ResNet, VGG, BERT, GPT.

Model Deployment

Deploying models using Flask, TensorFlow Serving, FastAPI.

Challenges in Deep Learning

Data requirements, computational costs, model explainability.

Future Trends

Self-supervised learning, multimodal models, AI ethics.

Thank You

By Md Anique Zzama