Deep Learning: Concepts, Code & Applications

This document provides a structured overview of Deep Learning, covering key concepts, neural network architectures, practical coding examples, and real-world applications.

1. Introduction to Deep Learning

Deep Learning is a subset of Machine Learning that uses neural networks with multiple layers to learn from data. It powers applications like image recognition, natural language processing, and self-driving cars.

2. Neural Networks & Their Structure

Neural networks consist of an input layer, hidden layers, and an output layer. Each neuron applies an activation function to process inputs and produce an output. The network is trained using backpropagation and optimization techniques like Gradient Descent.

3. CNNs, RNNs, LSTMs, Transformers

CNNs (Convolutional Neural Networks) are used for image processing.

RNNs (Recurrent Neural Networks) handle sequential data.

LSTMs (Long Short-Term Memory) solve RNNs' vanishing gradient issue.

Transformers (e.g., GPT) enable parallel training for NLP tasks.

4. Deep Learning Code & Logic

Below is a simple neural network using TensorFlow & Keras:

```python
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense

# Define model
model = Sequential([
    Dense(64, activation='relu', input_shape=(10,)),
    Dense(32, activation='relu'),
    Dense(1, activation='sigmoid')
])

# Compile model
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy'])

# Display model summary
model.summary()
```

5. Real-World Applications & Future Trends

Deep Learning is used in various fields:

Healthcare (Disease Detection, Drug Discovery)

Finance (Fraud Detection, Stock Prediction)

Autonomous Vehicles (Self-Driving Cars)

AI Assistants (Chatbots, Virtual Assistants)

Future trends include:

Explainable AI (XAI)

Edge AI (on-device learning)

AI in scientific research