Differences Between AI, Machine Learning, Deep Learning, and Data Science

Course Notes

Core Definitions

- **Artificial Intelligence (AI)**: Creating systems that can perform tasks that typically require human intelligence.
- **Machine Learning (ML)**: Subset of AI providing *statistical tools* to analyze, visualize, and predict data.
- **Deep Learning (DL)**: Subset of ML using *multi-layered neural networks* to mimic human learning.
- **Data Science (DS)**: Overarching field using math/stats to solve problems across AI, ML, and DL domains.

Detailed Breakdown

Artificial Intelligence (AI)

- **Goal**: Create systems that can perform tasks that typically require human intelligence.
- **Examples**:
  - Netflix recommendations (suggests movies based on viewing history).
  - Self-driving cars (detect traffic/objects autonomously).
  - Amazon product recommendations.
- **Key Equation**:

$$\text{AI System:} \quad f(\text{Input}) \Rightarrow \text{Autonomous Decision}$$

Machine Learning (ML)

- **Relationship**: Subset of AI (ML $\subseteq$ AI).
- **Purpose**: Provides statistical tools for:
  1. Data analysis and visualization.
  2. Predictive modeling.
  3. Forecasting.
- **Mechanism**: Uses algorithms like regression, clustering, and classification.

Deep Learning (DL)

- **Relationship**: Subset of ML (DL $\subseteq$ ML).
- **Inspiration**: Mimics human brain learning (1950s concept).
- **Structure**: Uses *multi-layered neural networks*:
  - Input Layer.
  - Hidden Layers (multiple).
  - Output Layer.
- **Examples**: Image recognition, natural language processing.

Data Science (DS)

- **Relationship**: Overlaps all domains, but not all component ($\text{DS} \cap (\text{AI} \cup \text{ML} \cup \text{DL})$).
- **Role**: Utilizes mathematics, statistics, and domain knowledge to:
  - Preprocess data (EDA, feature engineering).
  - Build ML/DL models.
  - Deploy AI applications.
- **Skills**: Linear algebra, calculus, programming, domain expertise.

Key Takeaways

1. **AI** is the broad goal of autonomous systems.
2. **ML** uses statistics to achieve AI goals.
3. **DL** uses neural networks for complex pattern recognition.
4. **Data Science** is the toolbox enabling all three.
5. Ultimate goal: Build **AI applications** requiring no human intervention.