This differences between
Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL).

Definitions and Hierarchy

- AI is the broad field aimed at making machines smart and capable of mimicking human intelligence, which includes reasoning, problem-solving, and creativity.
- ML is a subset of AI focused on self-learning algorithms that improve over time using data, without explicit programming for each decision.
- DL is a specialized area within ML that handles very large datasets and uses multi-layer neural networks inspired by the human brain for tasks like image and speech recognition.

Visual Analogy

- AI, ML, and DL are illustrated as concentric circles: AI as the largest umbrella, ML as a circle inside AI, and DL as a smaller circle within ML.
- Most practical advances in AI result from ML, and highly data-intensive tasks (like automatic feature extraction) are tackled by DL.

Historical and Practical Context

- Early AI relied on rule-based expert systems, encoding human knowledge and logic, which worked only for narrow, well-defined problems.
- ML emerged to tackle broader, data-driven challenges where explicit programming wasn't feasible (e.g., detecting spam, facial recognition).
- ML requires crafting features from data, but DL automates feature extraction using multi-layer neural networks, making it superior for tasks like image classification and natural language processing when large data is available.

Application Differences

- ML is preferred for moderate data sizes and problems where feature engineering is possible and well understood.
- DL excels with massive, complex data, learning useful representations automatically, but requires substantial computation resources.
- Some real-world tasks still rely heavily on traditional ML due to limited data or domain knowledge, especially in industries not rich in data.

Key Insights

- The strength of DL is in learning features automatically, improving predictions with more layers and data.
- While DL is transformative, it's not universally better; optimal use depends on the problem scale, data volume, and available resources.
- Ultimately, deployment and practical implementation (engineering aspect) is crucial for real-world success in both ML and DL.

Types of Machine Learning Based on Supervision

- Supervised Learning
  - Learns relationships between input (features) and output (labels) with labelled data.
  - Can be subdivided into Regression (predicting numerical values) and Classification (predicting categorical labels).
  - Example: Predicting if a student is placed based on IQ and CGPA using historical labelled data.
- Unsupervised Learning
  - Works only with input data, discovering hidden structure without labelled outputs.
  - Includes techniques like Clustering (grouping similar items), Dimensionality Reduction (reducing number of features), and Association Rule Learning (finding relationships between variables/products).
  - Example: Business discovers that customers often buy beer and diapers together using association rules.
- Semi-supervised Learning
  - Involves mostly unlabelled data with a small amount of labelled data; labels are expensive or difficult to obtain.
  - Algorithms extrapolate from few labelled examples (like Google Photos auto-organizing faces after one or two are labelled).
- Reinforcement Learning
  - Agents learn by interacting with an environment, receiving rewards or punishments for actions, gradually improving their policies.
  - Example: AlphaGo learned to play Go through trial and error and became world champion.

Subtypes and Techniques

Type	Key Subtypes and Concepts	Real-world Examples
Supervised Learning	Regression, Classification	Student placement, weather prediction
Unsupervised	Clustering, Dimensionality Reduction, Association	Customer segmentation, product recommendations
Semi-supervised	Label Propagation, Self-training	Auto-labelling faces in photos, some web search
Reinforcement	Policy Gradients, Q-learning	Game playing (AlphaGo), robotics, self-driving cars