# Algorithms for Data Science
Data Modeling: Neural Networks and Deep Learning

What is a Neural Network?

- **A Neural Network (NN) is a computational model inspired by the structure and functioning of the human brain.**

Nodes: The building blocks of NNs, they receive input, process it, and produce an output.

Connections: Links between nodes depicting the flow of information across layers.
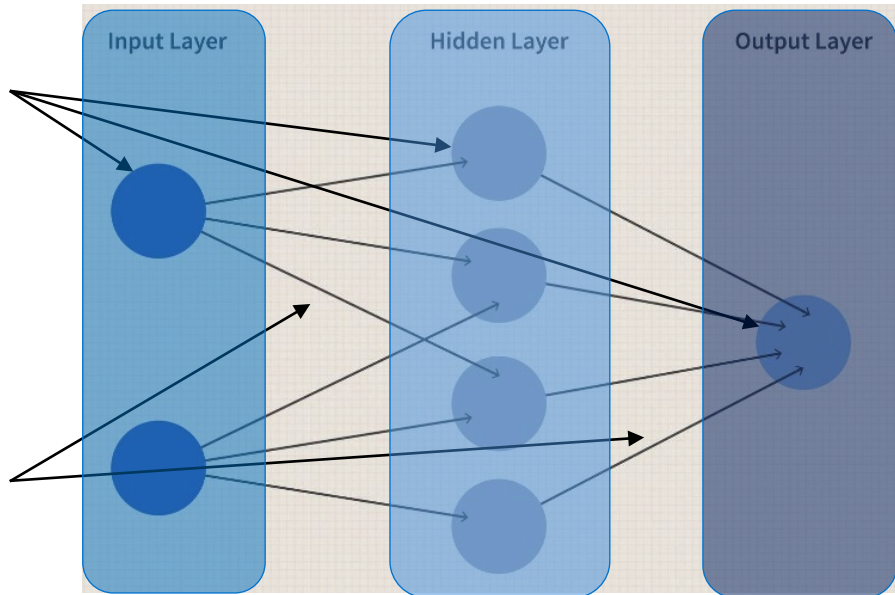
Input Layer: Initial layer that receives raw input data.

Hidden Layer(s): Process information between the input and output layers, performing complex transformation via connections and activation functions.

Output Layer: Final layer the produces the predictions/result

Activation Functions: Functions that introduce non-linearity, enable complex mapping, determine an activation threshold, and assist in the flow of gradient.

How does an NN Learn?　　Strengths of an NN

1. Initialize the NN with random weights/biases.

2. Forward Pass (Inference) data through the input, hidden, and output layers.

3. Calculate Error using error or loss function.

4. Backpropagation involving the adjustment of the weights/biases to minimize error, utilizing optimization algorithms.

5. Repeat to convergence.

- Representation Learning

- Scalability

- Adaptability

- Non-linearity

- Parallel Processing

- Regularization

- Availability of Data

Deep Learning (DL)

► DL is a type of machine learning based on artificial neural networks in which multiple layers of processing are used to extract progressively higher-level features from data.

► Methods used can be either supervised, semi-supervised or unsupervised. Additional hidden layers can help to optimize and refine for accuracy.
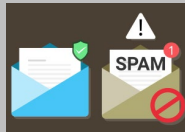
AI
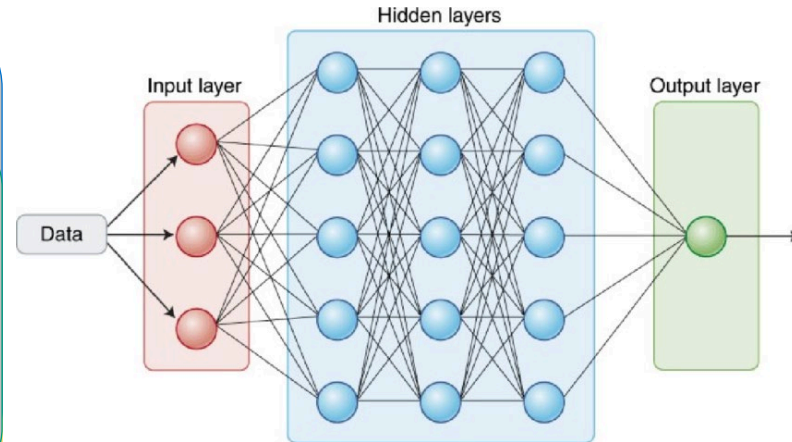Any technique that enables computers to mimic human behaviors
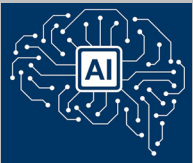
ML
Learning without explicitly being programmed

DL
Extract patterns from data using NN

Recap: The Importance of Data Modeling

Key Takeaways:

- **Models vs. Algorithms:** Algorithms are the process, and models are the product.
- **Types of Models:**
  - **Supervised Learning:** Predict labels or continuous values.
  - **Unsupervised Learning:** Discover hidden patterns in unlabeled data.
  - **Graph Algorithms:** Analyze relationships and optimize connections.
  - **Optimization Algorithms:** Find the best solutions under constraints.
  - **Statistical Algorithms:** Model uncertainty and variability, laying the foundation for generative AI.
  - **Neural Networks and Deep Learning:** Solve complex problems with hierarchical learning and pattern recognition.

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