CSE1300

Introduction to Artificial Intelligence (AI)

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What is Artificial Intelligence?

- Artificial intelligence is a field of science concerned with building computers and machines that can reason, learn, and act in such a way that would normally require human intelligence or that involves data whose scale exceeds what humans can analyze.
- AI is a broad field that encompasses many different disciplines, including computer science, data analytics and statistics, hardware and software engineering, linguistics, neuroscience, and even philosophy and psychology.
- On an operational level for business use, AI is a set of technologies that are based primarily on machine learning and deep learning, used for data analytics, predictions and forecasting, object categorization, natural language processing, recommendations, intelligent data retrieval, and more.

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How does AI work?

- While the specifics vary across different AI techniques, the core principle revolves around data. AI systems learn and improve through exposure to vast amounts of data, identifying patterns and relationships that humans may miss.
- This learning process often involves algorithms, which are sets of rules or instructions that guide the AI's analysis and decision-making. In machine learning, a popular subset of AI, algorithms are trained on labeled or unlabeled data to make predictions or categorize information.

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Types of Artificial Intelligence

- Artificial intelligence can be organized in several ways, depending on stages of development or actions being performed. For instance, four stages of AI development are commonly recognized.

1. **Reactive machines:** Limited AI that only reacts to different kinds of stimuli based on preprogrammed rules. Does not use memory and thus cannot learn with new data. IBM's Deep Blue that beat chess champion Garry Kasparov in 1997 was an example of a reactive machine.

2. **Limited memory:** Most modern AI is considered to be limited memory. It can use memory to improve over time by being trained with new data, typically through an artificial neural network or other training model. Deep learning, a subset of machine learning, is considered limited memory artificial intelligence.

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Types of Artificial Intelligence

3. Theory of mind: Theory of mind AI does not currently exist, but research is ongoing into its possibilities. It describes AI that can emulate the human mind and has decision-making capabilities equal to that of a human, including recognizing and remembering emotions and reacting in social situations as a human would.

4. **Self aware:** A step above theory of mind AI, self-aware AI describes a mythical machine that is aware of its own existence and has the intellectual and emotional capabilities of a human. Like theory of mind AI, self-aware AI does not currently exist.

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Artificial Intelligence Training Models

- In broad strokes, three kinds of learning models are often used in machine learning:
- **Supervised learning** is a machine learning model that maps a specific input to an output using labeled training data (structured data). In simple terms, to train the algorithm to recognize pictures of cats, feed it pictures labeled as cats.
- **Unsupervised learning** is a machine learning model that learns patterns based on unlabeled data (unstructured data). Unlike supervised learning, the end result is not known ahead of time. Rather, the algorithm learns from the data, categorizing it into groups based on attributes. For instance, unsupervised learning is good at pattern matching and descriptive modeling.

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Artificial Intelligence Training Models

- **Reinforcement learning** is a machine learning model that can be broadly described as “learn by doing.” An “agent” learns to perform a defined task by trial and error (a feedback loop) until its performance is within a desirable range. The agent receives positive reinforcement when it performs the task well and negative reinforcement when it performs poorly. An example of reinforcement learning would be teaching a robotic hand to pick up a ball.

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Common types of Artificial Neural Networks

- A common type of training model in AI is an artificial neural network, a model loosely based on the human brain.
- A neural network is a system of artificial neurons—sometimes called perceptrons—that are computational nodes used to classify and analyze data. The data is fed into the first layer of a neural network, with each perceptron making a decision, then passing that information onto multiple nodes in the next layer. Training models with more than three layers are referred to as “deep neural networks” or “deep learning.” Some modern neural networks have hundreds or thousands of layers. The output of the final perceptrons accomplish the task set to the neural network, such as classify an object or find patterns in data.

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Some of the most common types of Artificial Neural Networks:

- **Feedforward neural networks (FF)** are one of the oldest forms of neural networks, with data flowing one way through layers of artificial neurons until the output is achieved.
- **Recurrent neural networks (RNN)** differ from feedforward neural networks in that they typically use time series data or data that involves sequences.
- **Long/short term memory (LSTM)** is an advanced form of RNN that can use memory to "remember" what happened in previous layers.
- **Convolutional neural networks (CNN)** include some of the most common neural networks in modern artificial intelligence.
- **Generative adversarial networks (GAN)** involve two neural networks competing against each other in a game that ultimately improves the accuracy of the output.

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Benefits of AI

- Automation
- Reduce human error
- Eliminate repetitive tasks
- Fast and accurate
- Infinite availability
- Accelerated research and development

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Applications and use cases for Artificial Intelligence

- Speech recognition - Automatically convert spoken speech into written text.
- Image recognition - Identify and categorize various aspects of an image.
- Translation - Translate written or spoken words from one language into another.
- Predictive modeling - Mine data to forecast specific outcomes with high degrees of granularity.
- Data analytics - Find patterns and relationships in data for business intelligence.
- Cybersecurity - Autonomously scan networks for cyber attacks and threat

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