WHAT IS ARTIFICIAL INTELLIGENCE?
Artificial intelligence (AI) is a wide-ranging branch of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence.
WHAT ARE THE FOUR TYPES OF ARTIFICIAL INTELLIGENCE?
Reactive Machines
Limited Memory
Theory of Mind
Self-Awareness
WHAT ARE EXAMPLES OF ARTIFICIAL INTELLIGENCE?
Siri, Alexa and other smart assistants
Self-driving cars
Robo-advisors
Conversational bots
Email spam filters
Netflix's recommendations
CONCEPTS USES, EXAMPLES + APPLICATIONS HISTORY FEATURED ARTICLES
CONCEPTS
what is artificial intelligence
GETTING MACHINES TO SIMULATE HUMAN INTELLIGENCE IS THE FUNDAMENTAL GOAL OF AI.

How Does Artificial Intelligence Work?

AI Approaches and Concepts
Less than a decade after breaking the Nazi encryption machine Enigma and helping the Allied Forces win World War II, mathematician Alan Turing changed history a second time with a simple question: "Can machines think?"

Turing's paper "Computing Machinery and Intelligence" (1950), and its subsequent Turing Test, established the fundamental goal and vision of artificial intelligence.

At its core, AI is the branch of computer science that aims to answer Turing's question in the affirmative. It is the endeavor to replicate or simulate human intelligence in machines.

The expansive goal of artificial intelligence has given rise to many questions and debates. So much so, that no singular definition of the field is universally accepted.

Can machines think? – Alan Turing, 1950

The major limitation in defining AI as simply "building machines that are intelligent" is that it doesn't actually explain what artificial intelligence is? What makes a machine intelligent? AI is an interdisciplinary science with multiple approaches, but advancements in machine learning and deep learning are creating a paradigm shift in virtually every sector of the tech industry.

In their groundbreaking textbook Artificial Intelligence: A Modern Approach, authors Stuart Russell and Peter Norvig approach the question by unifying their work around the theme of intelligent agents in machines. With this in mind, AI is "the study of agents that receive percepts from the environment and perform actions." (Russel and Norvig viii)

Norvig and Russell go on to explore four different approaches that have historically defined the field of AI:

Thinking humanly
Thinking rationally
Acting humanly
Acting rationally
The first two ideas concern thought processes and reasoning, while the others deal with behavior. Norvig and Russell focus particularly on rational agents that act to achieve the best outcome, noting "all the skills needed for the Turing Test also allow an agent to act rationally." (Russel and Norvig 4).

Patrick Winston, the Ford professor of artificial intelligence and computer science at MIT, defines AI as "algorithms enabled by constraints, exposed by representations that support models targeted at loops that tie thinking, perception and action together."

While these definitions may seem abstract to the average person, they help focus the field as an area of computer science and provide a blueprint for infusing machines and programs with machine learning and other subsets of artificial intelligence.

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The Four Types of Artificial Intelligence

Reactive Machines
A reactive machine follows the most basic of AI principles and, as its name implies, is capable of only using its intelligence to perceive and react to the world in front of it. A reactive machine cannot store a memory and as a result cannot rely on past experiences to inform decision making in real-time.

Perceiving the world directly means that reactive machines are designed to complete only a limited number of specialized duties. Intentionally narrowing a reactive machine's worldview is not any sort of cost-cutting measure, however, and instead means that this type of AI will be more trustworthy and reliable — it will react the same way to the same stimuli every time.

A famous example of a reactive machine is Deep Blue, which was designed by IBM in the 1990's as a chess-playing supercomputer and defeated international grandmaster Gary Kasparov in a game. Deep Blue was only capable of identifying the pieces on a chess board and knowing how each moves based on the rules of chess, acknowledging each piece's present position, and determining what the most logical move would be at that moment. The computer was not pursuing future potential moves by its opponent or trying to put its own pieces in better position. Every turn was viewed as its own reality, separate from any other movement that was made beforehand.

Another example of a game-playing reactive machine is Google's AlphaGo. AlphaGo is also incapable of evaluating future moves but relies on its own neural network to evaluate developments of the present game, giving it an edge over Deep Blue in a more complex game. AlphaGo also bested world-class competitors of the game, defeating champion Go player Lee Sedol in 2016.

Though limited in scope and not easily altered, reactive machine artificial intelligence can attain a level of complexity, and offers reliability when created to fulfill repeatable tasks.

Limited Memory

Limited memory artificial intelligence has the ability to store previous data and predictions when gathering information and weighing potential decisions — essentially looking into the past for clues on what may come next. Limited memory artificial intelligence is more complex and presents greater possibilities than reactive machines.

Limited memory AI is created when a team continuously trains a model in how to analyze and utilize new data or an AI environment is built so models can be automatically trained and renewed. When utilizing limited memory AI in machine learning, six steps must be followed: Training data must be created, the machine learning model must be created, the model must be able to make predictions, the model must be able to receive human or environmental feedback, that feedback must be stored as data, and these these steps must be reiterated as a cycle.

There are three major machine learning models that utilize limited memory artificial intelligence:

Reinforcement learning, which learns to make better predictions through repeated trial-and-error.
Long Short Term Memory (LSTM), which utilizes past data to help predict the next item in a

sequence. LTSMs view more recent information as most important when making predictions and discounts data from further in the past, though still utilizing it to form conclusions Evolutionary Generative Adversarial Networks (E-GAN), which evolves over time, growing to explore slightly modified paths based off of previous experiences with every new decision. This model is constantly in pursuit of a better path and utilizes simulations and statistics, or chance, to predict outcomes throughout its evolutionary mutation cycle.

Theory of Mind
Theory of Mind is just that — theoretical. We have not yet achieved the technological and scientific capabilities necessary to reach this next level of artificial intelligence.

The concept is based on the psychological premise of understanding that other living things have thoughts and emotions that affect the behavior of one's self. In terms of AI machines, this would mean that AI could comprehend how humans, animals and other machines feel and make decisions through self-reflection and determination, and then will utilize that information to make decisions of their own. Essentially, machines would have to be able to grasp and process the concept of "mind," the fluctuations of emotions in decision making and a litany of other psychological concepts in real time, creating a two-way relationship between people and artificial intelligence.

While addressing a crowd at the Japan AI Experience in 2017, DataRobot CEO Jeremy Achin began his speech by offering the following definition of how AI is used today:

"AI is a computer system able to perform tasks that ordinarily require human intelligence... Many of these artificial intelligence systems are powered by machine learning, some of them are powered by deep learning and some of them are powered by very boring things like rules."

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Artificial intelligence generally falls under two broad categories:

Narrow AI: Sometimes referred to as "Weak AI," this kind of artificial intelligence operates within a limited context and is a simulation of human intelligence. Narrow AI is often focused on performing a single task extremely well and while these machines may seem intelligent, they are operating under far more constraints and limitations than even the most basic human intelligence.

Artificial General Intelligence (AGI): AGI, sometimes referred to as "Strong AI," is the kind of artificial intelligence we see in the movies, like the robots from Westworld or Data from Star

Trek: The Next Generation. AGI is a machine with general intelligence and, much like a human being, it can apply that intelligence to solve any problem.

Narrow Artificial Intelligence

Narrow AI is all around us and is easily the most successful realization of artificial intelligence to date. With its focus on performing specific tasks, Narrow AI has experienced numerous breakthroughs in the last decade that have had "significant societal benefits and have contributed to the economic vitality of the nation," according to "Preparing for the Future of Artificial Intelligence," a 2016 report released by the Obama Administration.

A few examples of Narrow AI include:

Google search
Image recognition software
Siri, Alexa and other personal assistants
Self-driving cars
IBM's Watson

Machine Learning & Deep Learning

Much of Narrow AI is powered by breakthroughs in machine learning and deep learning. Understanding the difference between artificial intelligence, machine learning and deep learning can be confusing. Venture capitalist Frank Chen provides a good overview of how to distinguish between them, noting:

"Artificial intelligence is a set of algorithms and intelligence to try to mimic human intelligence. Machine learning is one of them, and deep learning is one of those machine learning techniques."

Simply put, machine learning feeds a computer data and uses statistical techniques to help it "learn" how to get progressively better at a task, without having been specifically programmed for that task, eliminating the need for millions of lines of written code. Machine learning consists of both supervised learning (using labeled data sets) and unsupervised learning (using unlabeled data sets).

Deep learning is a type of machine learning that runs inputs through a biologically-inspired neural network architecture. The neural networks contain a number of hidden layers through which the data is processed, allowing the machine to go "deep" in its learning, making connections and weighting input for the best results.

Artificial General Intelligence

The creation of a machine with human-level intelligence that can be applied to any task is the Holy Grail for many AI researchers, but the quest for AGI has been fraught with difficulty.

The search for a "universal algorithm for learning and acting in any environment," (Russel and Norvig 27) isn't new, but time hasn't eased the difficulty of essentially creating a machine with a

full set of cognitive abilities.

AGI has long been the muse of dystopian science fiction, in which super-intelligent robots overrun humanity, but experts agree it's not something we need to worry about anytime soon.