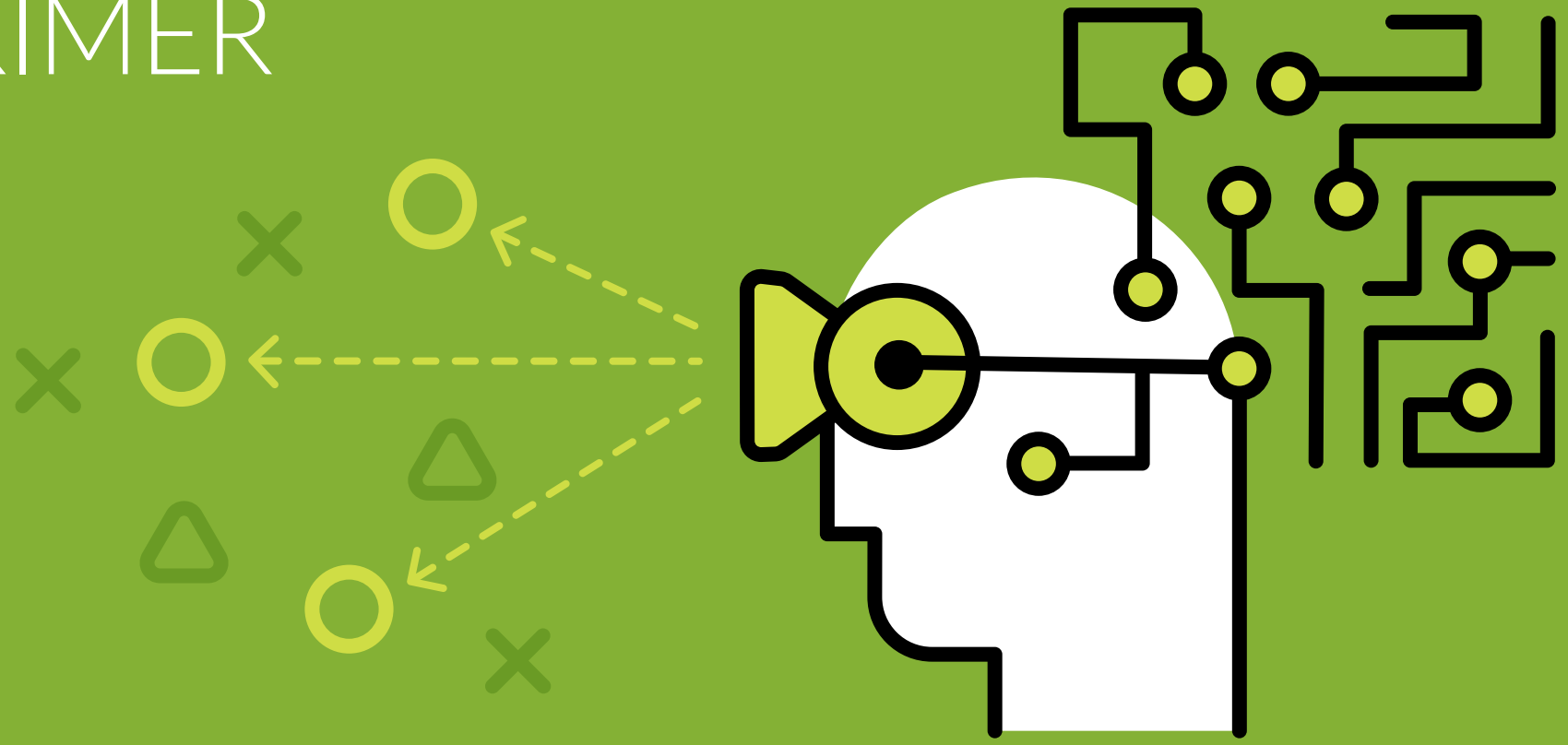
ARTIFICIAL INTELLIGENCE PRIMER



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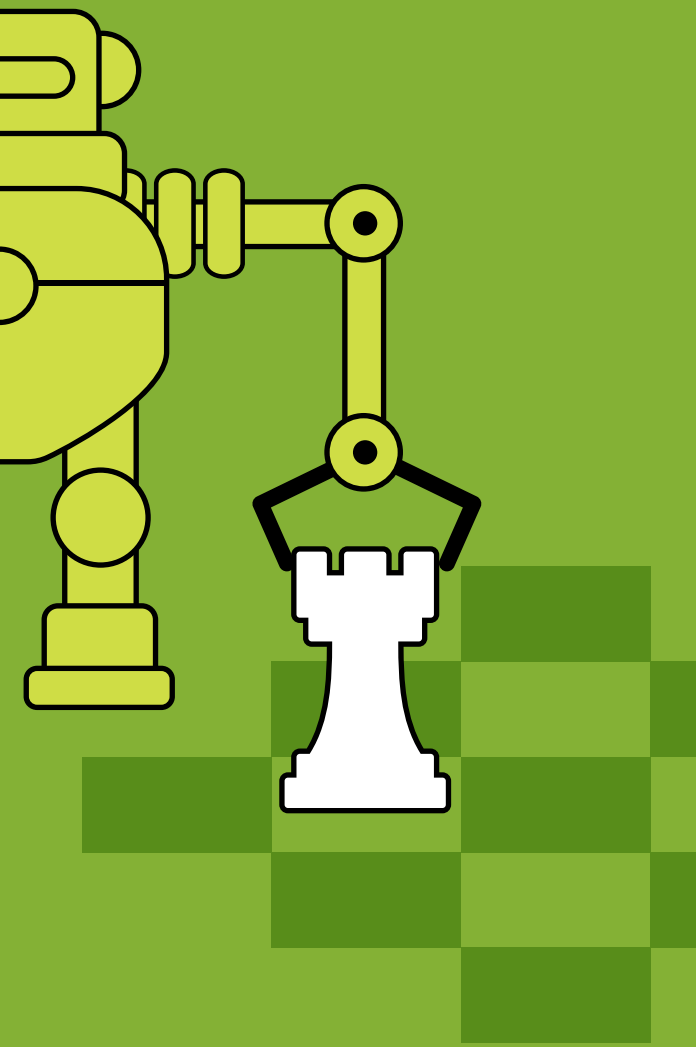
WHAT AI IS



Everywhere around us, there are signs of artificial intelligence (AI). It's identifying objects such as dogs or boats in pictures and recognizing photos of family members and friends. It's navigating self-driving cars in congested urban centers. We interact with it in the morning to get weather updates or during drives to work for email reads as the AI powered automated voice-recognition assistants help our connected lives. We even see it beating the best players at strategic games like chess (IBM Deep Blue vs Garry Kasparov), Jeopardy! (IBM Watson vs Ken Jennings) and Go (Google AlphaGo vs Ke Jie).

In a recent Blumberg Capital Survey , 26% of consumers think they interact with AI at least once a day; when they think of AI, 53% think robots and 40% think self-driving cars; 58% get their information on AI from movies and TV or social media today.

But what exactly is AI? We see it popularized in movies, whether portrayed as helpful assistants in 'Star Wars' (C3PO) or 'Star Trek' (ship's female computer voice or Commander Data, a sentient android) or as malicious machines, threatening our very existence in 'Terminator' (various "T" models) or 'The Matrix' (The Agents). These pop culture portrayals, while compelling, depict highly advanced, machines possessing free will and dominance over mankind. Is this what AI is about?

At its most basic, AI is the science of making intelligent machines by teaching them to do things that previously only humans could do. In the case of self-driving cars, it's processing vast inflows of data from defined sensors and making real-time driving decisions the way a human might with their senses. In certain cases, machines might have an advantage. Where humans are prone to error, machines can be more precise. This is especially true for menial, repetitive tasks such as sifting through firewall log files to look for anomalous behavior.

HOW AI WORKS

One of the most common misconceptions of AI is that machines are becoming self-aware and can rival the creativity and understanding of the human mind. Unfortunately, the powers of Hollywood, via mega-million dollar movies like Terminator and Star Wars, popularized this perception. Today's AI technology is nowhere near this level of maturity. This futuristic notion of AI is referred to as artificial general intelligence (AGI or Strong AI). Most experts agree that we are decades away from achieving a true AGI. Some even question whether it's even possible to achieve it.

Instead, what's currently available is a set of more narrow AI technologies that focus on basic problems and simple tasks. Much of these tasks are often repetitive. With training, machines can relieve people from performing such tasks. When trained well to identify patterns, machines can make decisions faster and more reliably than humans.

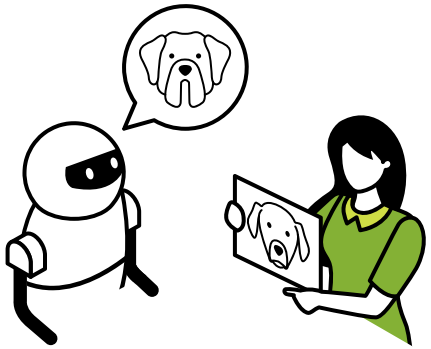
HOW MACHINES LEARN

The process of training machines is called machine learning (ML). This is regarded as a form of AI. One specific subset of ML is called deep learning. ML is one of the fastest-growing AI domains and often underpins advances in other AI technologies. The "raw material" for ML is data, whether structured or unstructured. There are three high-level categories of ML:

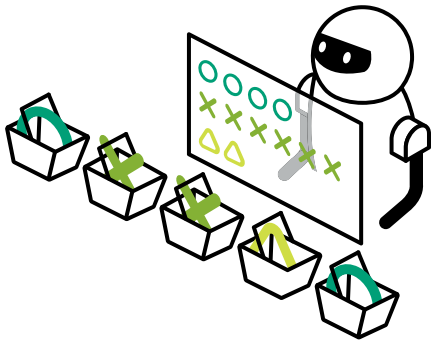
+ **Supervised learning**
+ **Unsupervised learning**
+ **Reinforcement learning**

Each requires some form of training, validation or some sort of signaling with data in order to operate.

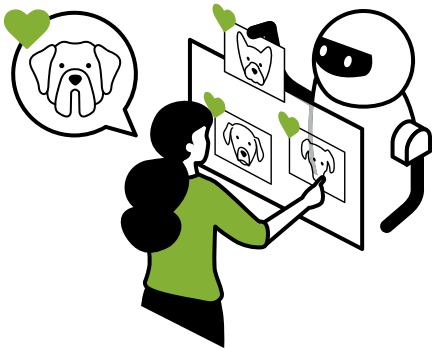
1. **Supervised learning**
   Supervised learning is the most basic form of ML. We teach machines by showing them the answers. For example, common tools such as Captcha use humans to identify the subjects in a picture. This data then provides the information for machines to do this on their own. If we show the machine various pictures of dogs, then the machine begins to learn to identify dogs on its own.

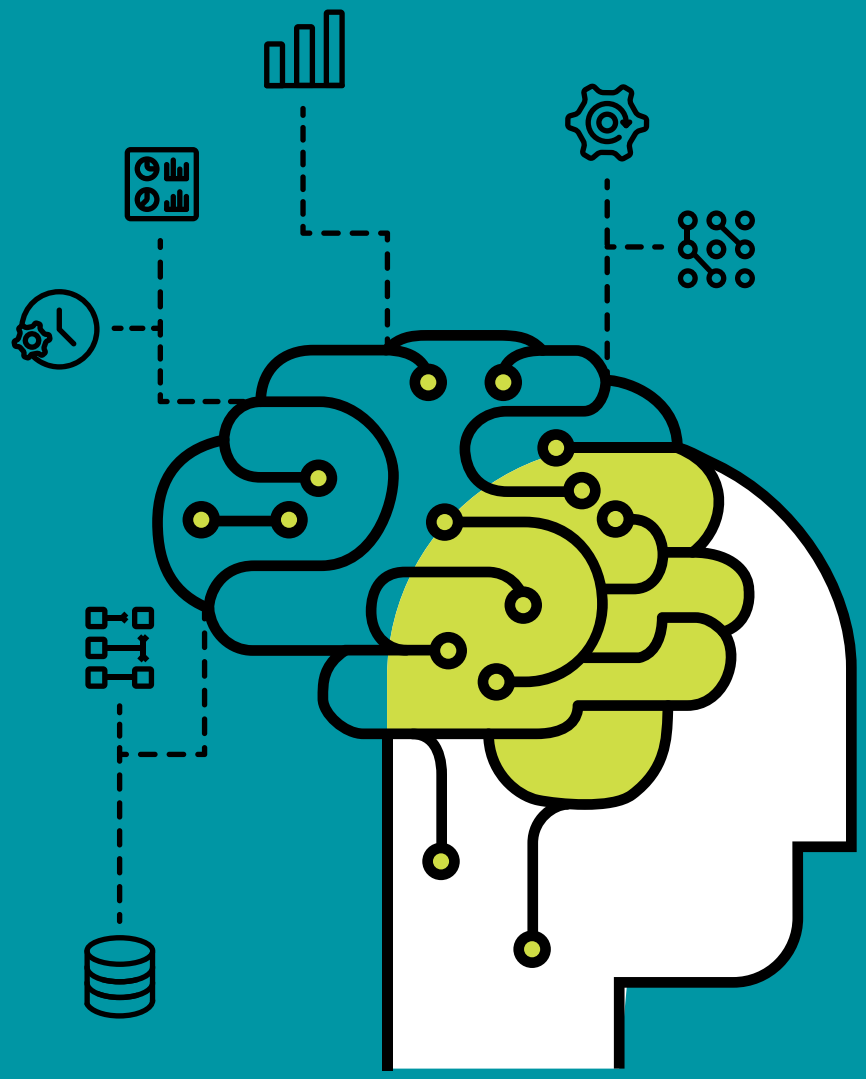


2. **Unsupervised learning**
   With unsupervised learning, a machine is tasked with finding patterns where they are difficult or infeasible to determine. For example, a machine can observe the buying behavior of diverse customers. The machine begins blind as there are no "right" answers. Only by sorting through the data and finding patterns can the machine learn.



3. **Reinforcement learning**
   Reinforcement learning is a form of deep learning (It's also regarded as a common form of ML). A machine is rewarded or given some form of positive indication for achieving a better outcome. For example, every time a person likes an article in their feed, the machine gets positive feedback. This reinforces the decision by the person as important and in turn, this helps the machine to optimize.





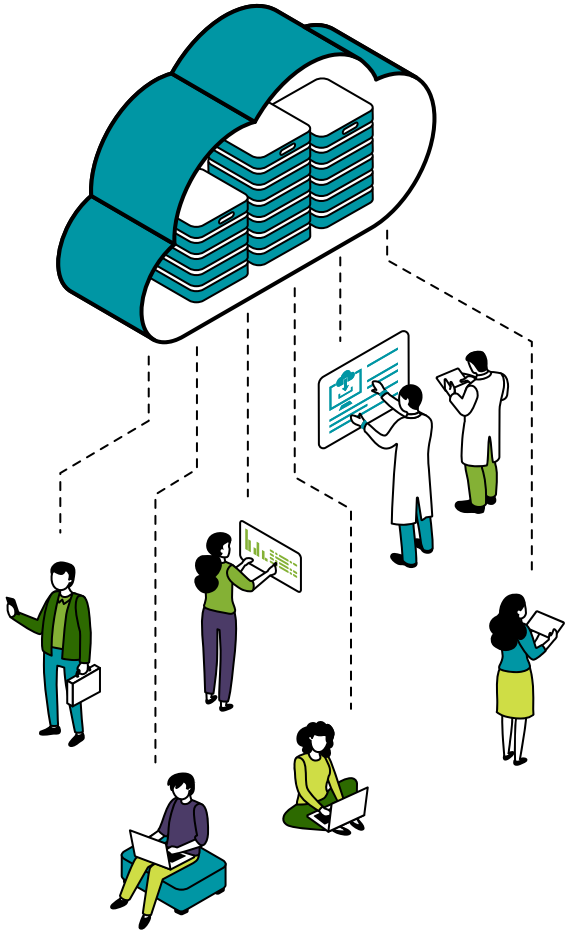
DATA FOUNDATION

Whatever the learning mechanism, all AI requires access to some amount of data to help it learn. This is called training data. And the more and better the training data is, the better the AI will be. Just as the finest meals begin with the best ingredients, so too will the finest AI come from the best data. Note that labeled data is associated with supervised learning whereas unlabeled is used with unsupervised.

THINKING MACHINES

Artificial neural networks (ANNs) are a form of machine learning that tries to mimic aspects of the human brain. Just as the human brain is comprised of a complex network of neurons delivering brain function, ANN models a virtual network with a full mesh between layers of nodes (neurons). Each conceptual edge connection has weights that help determine subsequent output values in the final output layer, where a result emerges. There are multiple hidden layers between the original input layer and the final output layer which can use both, forward or backward propagation of values. The neural network then learns by amending weights and biases across the network to minimize a "cost" function that best matches training data.

Lately, AI and ANNs, in particular, have enjoyed a renaissance since the 1980s and 1990s due to the diminishing costs of the specialized compute resources required. During those days, AI was a domain primarily for researchers and specialists. The rise of cloud and the introduction of massive parallel super compute with GPUs have made AI more relevant to more people.



BEYOND THE HYPE

So, how do you when you see a real AI? And what are the telltale attributes? Today there is much hype around AI. Many technology companies and vendors are "AI-washing" their marketing, including messages and branding that spotlight the words AI and ML.

If you're on the journey to AI, whether you're considering building a homegrown solution or purchasing a product or service, here are some basic questions to ask.

First, AI starts with learning and learning starts with data. So, look for systems that are purpose-built to produce and use this data.

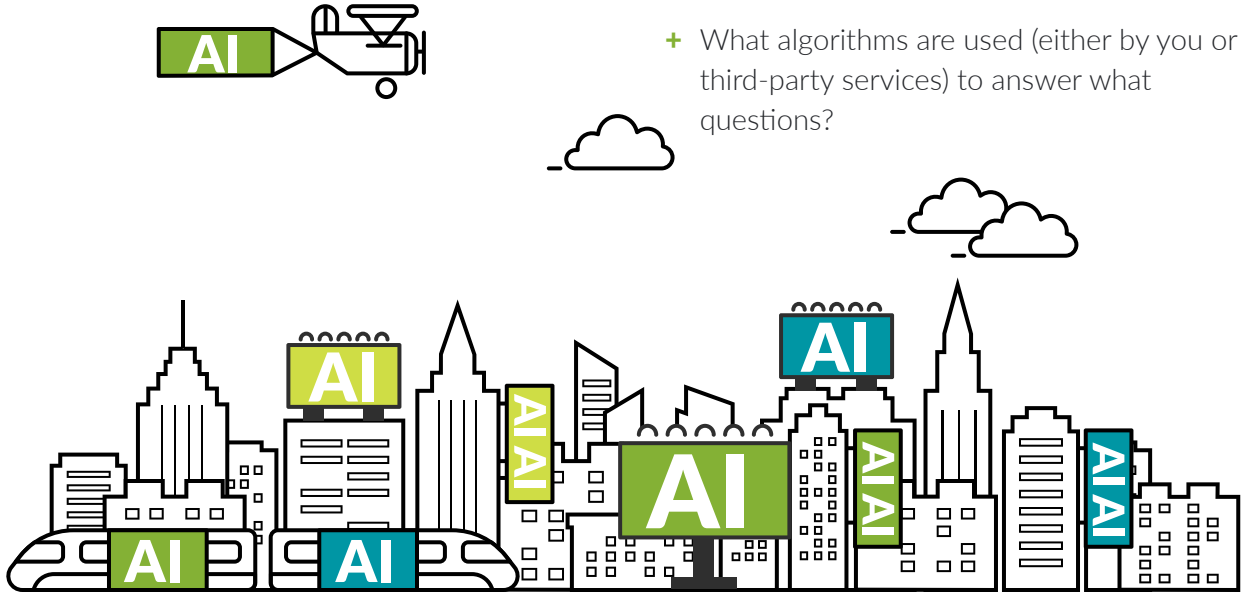
+ Have you currently got access to the right data, where, and how?
+ Is the data readily consumable or must it be processed first?
+ How much work is involved in data acquisition, cleaning, labeling, and training?

And because this data will need to be processed, these systems almost always start in the cloud. A cloud foundation (some times referred to as cloud-native) will be key.

+ Does the system rely on open or standards-based APIs from the cloud?
+ Does it rely on one of the major public cloud IaaS services?

Understand how these systems are trained.

+ What patterns are being identified?
+ And how do they map to a set of well-defined workflows?
+ What algorithms are used (either by you or third-party services) to answer what questions?



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