Pelatihan ABCD
Modul 1-1: Introduction to AI

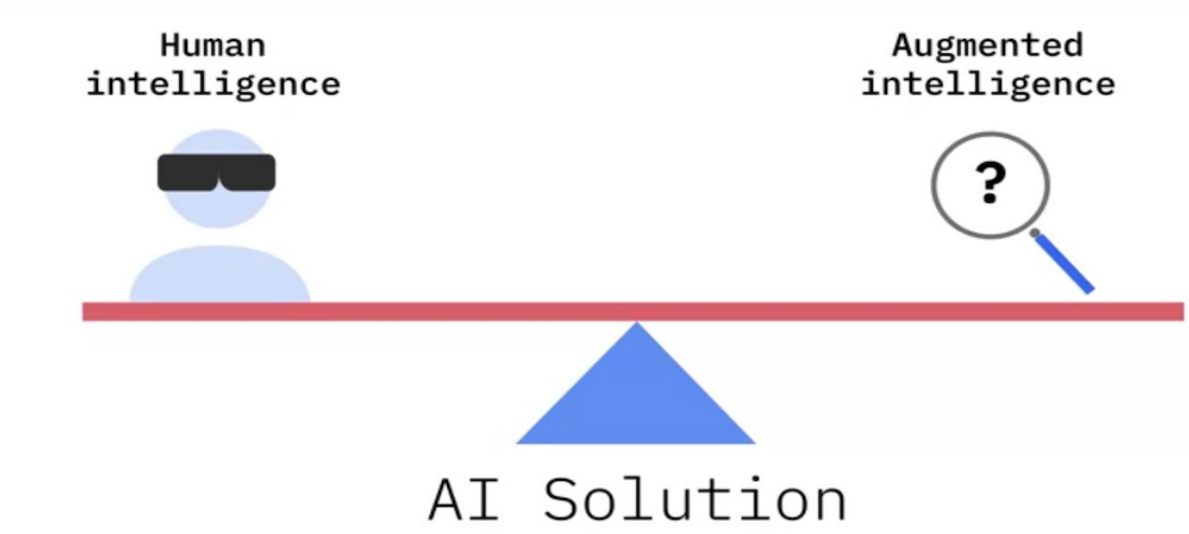
Sekolah Teknik Elektro dan Informatika Institut Teknologi Bandung

Unviersitas Singaperbangsa Karawang

What is AI?

Artificial Intelligence vs Augmented Intelligence

- AI is an anything that makes machines act more intelligently.
- AI also like to think as augmented intelligence.
- AI shoud not attempt to replace human experts, but rather extend human capabilities and accomplish tasks that neither humans nor machines do on their own.



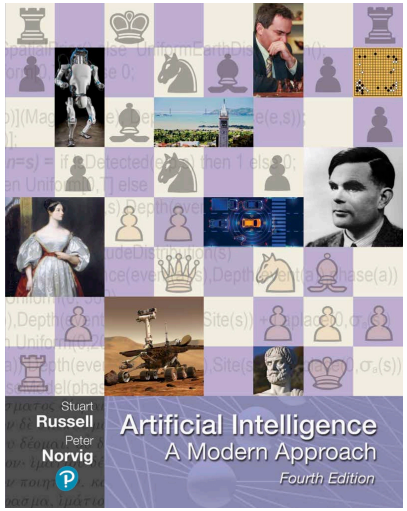
Augmented Intelligence

- The internet has given us access to more information faster.
- Distributed computing and IoT have led to massive amounts of data, and social networking has encouraged most of that data to be unstructured.
- With Augmented Intelligence, we are putting information that subject matter experts need at their fingertips, and backing it with evidence so they can make informed decisions.
- We want experts to **scale their capabilities** and let the **machines do the time-consuming work**.

The Foundation of AI

The Foundation of Artificial Intelligence

Thinking humanly	Thinking rationally
Acting humanly	Acting rationally



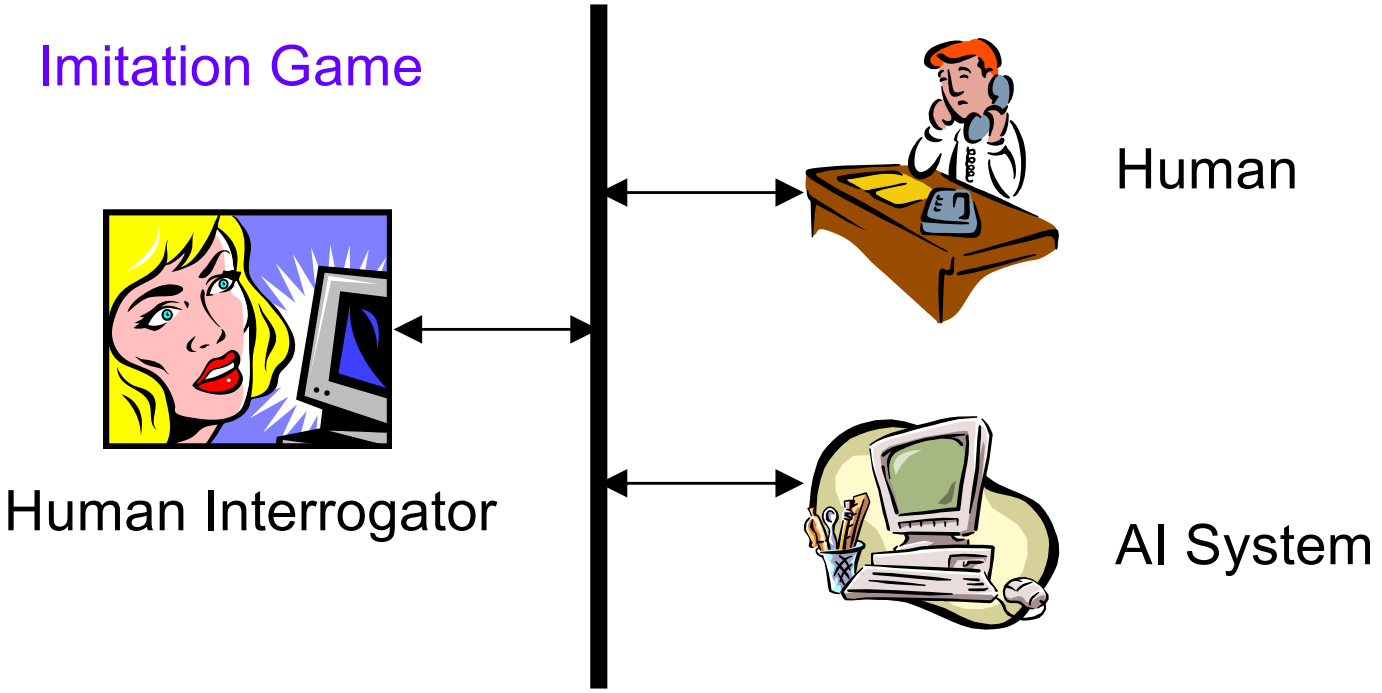
Stuart Russell and Peter Norvig. Artificial Intelligence:
A Modern Approach.
Prentice Hall, fouth ed, 2020

http://aima.cs.berkeley.edu/contents.html

"The exciting new effort to make **computers think** … machines with minds, in the full and literal sense" (Haugeland, '85) "[The automation of] activities that we associate with **human thinking**, activities such as decision making, problem solving, learning …" (Bellman, '78) **Thinking Humanly**	"The study of **mental faculties** through the use of computational models" (Charniak and McDermott, '85) "The study of the computations that make it possible to **perceive**, **reason**, and **act**" (Winston, '92) **Thinking Rationally**
"The art of creating machines that perform functions that require **intelligence** when performed by people" (Kurzweil, '90) "The study of how to make **computers do things** which, at the moment, people do better" (Rich and Knight, '91). **Acting Humanly**	A field of study that seeks to explain and emulate **intelligent behavior** in term of computational processes" (Schalkoff, '90) "The branch of computer science that is concerned with the automation of **intelligent behavior**" (Luger and Stubblefield, '93) **Acting Rationally**

Acting Humanly: The Turing Test

- Alan Turing (1912-1954)
- “Computing Machinery and Intelligence” (1950)



Acting Humanly: The Turing Test

- Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes.
- Anticipated all major arguments against AI in following 50 years.
- Suggested major components of AI: knowledge, reasoning, language, understanding, learning.

Thinking Humanly: Cognitive Modelling

- Not content to have a program correctly solving a problem.

  More concerned with comparing its reasoning steps to traces of human solving the same problem.

- Requires testable theories of the workings of the human mind: cognitive science.

Thinking Rationally: Laws of Thought

- Aristotle was one of the first to attempt to codify “right thinking”, i.e., irrefutable reasoning processes.
- Formal logic provides a precise notation and rules for representing and reasoning with all kinds of things in the world.
- Obstacles:
  - Informal knowledge representation.
  - Computational complexity and resources.

Acting Rationally

- Acting so as to achieve one's goals, given one's beliefs.
- Does not necessarily involve thinking.
- Advantages:
  - More general than the "laws of thought" approach.
  - More amenable to scientific development than human-based approaches.

AI classification

Based on strength, breadth and application, AI can be describe:

- Weak AI or Narrow AI
- Strong AI or Generalized AI
- Super AI or Conscious AI

Weak AI - Narrow AI

- AI that is applied to a specific domain.
- For example: language translators, virtual assistants, self-driving cars, AI-powered web searches, recommendation engines, intelligent spam filters, etc.
- Applied AI can perform specific tasks, but not learn one ones, making decisions based on programmed algorithms, and training data

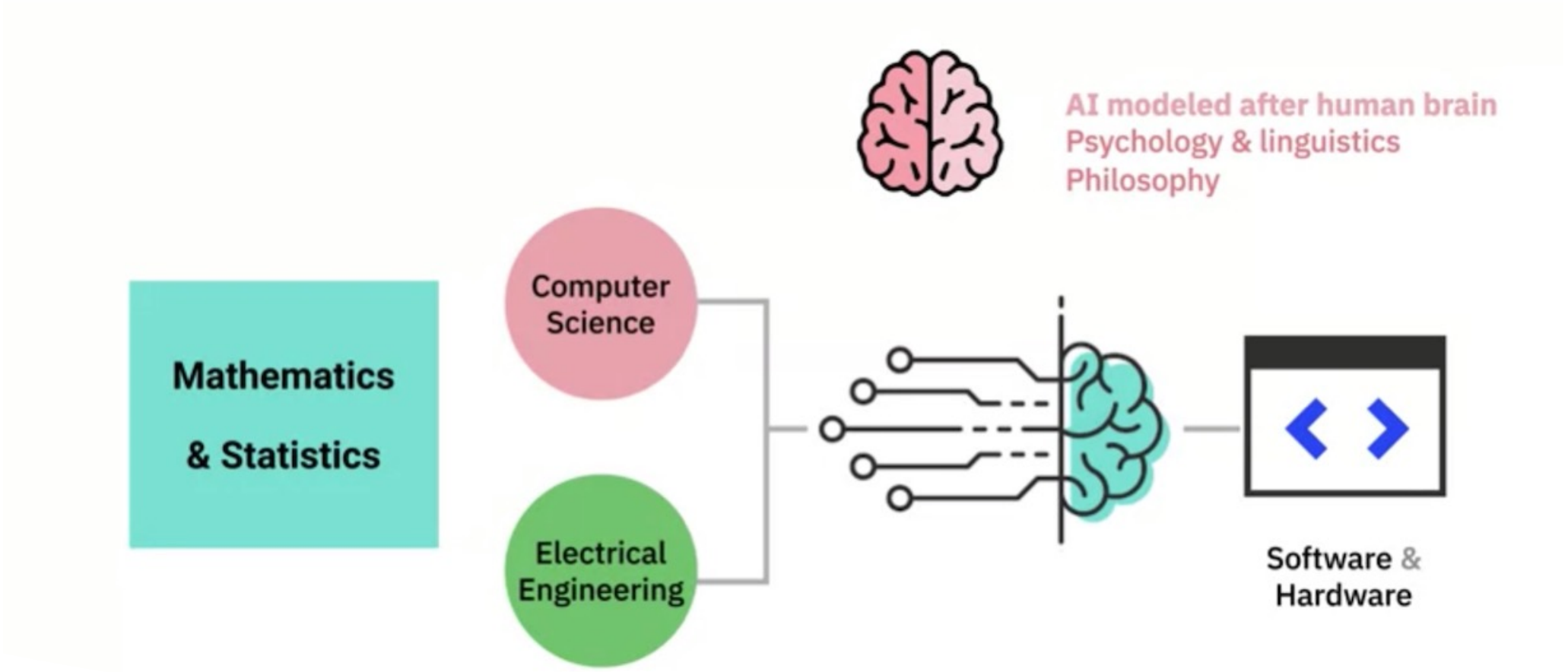
Strong AI - Generalized AI

- AI that can interact and operate a wide variety of independent and unrelated tasks.
- It can learn new task to solve new problems, and it does this by teaching itself new strategies.
- Generalized Intelligence is the combination of many AI strategies that learn from experience and can perform at a human level of intelligence.

Super AI - Conscious AI

- Ai with human-level consciousness, which would require it to be self-aware.
- Because we are not yet able to adequately define what consciousness is, it is unlikely that we will be able to create a conscious AI in the near future.

AI is a Multi-Diciplinary Fields



AI is The Fusion of Many Fields of Study

- Computer science and electrical engineering determine how AI is implemented in software and hardware.
- Mathematics and statistics determine viable models and measure performance.
- Psychology and linguistics play an essential role in understanding how AI might work.
- Philosophy provides guidance on intelligence and ethical considerations.

History and Milestone of Artificial Intelligence

The Foundations of Artificial Intelligence

- Philosophy (423 BC – present):
  - Logic, methods of reasoning.
  - Mind as a physical system.
  - Foundations of learning, language, and rationality.
- Mathematics (c.800 – present):
  - Formal representation and proof.
  - Algorithms, computation, decidability, tractability.
  - Probability.

The Foundations of Artificial Intelligence

- Psychology (1879 – present):
  - Adaptation.
  - Phenomena of perception and motor control.
  - Experimental techniques.
- Linguistics (1957 – present):
  - Knowledge representation.
  - Grammar.

A Brief History of Artificial Intelligence

- The gestation of AI (1943 – 1956):
  - 1943: McCulloch & Pitts: Boolean circuit model of brain.
  - 1950: Turing's "Computing Machinery and Intelligence".
  - 1956: McCarthy's name "Artificial Intelligence" adopted.

- Early enthusiasm, great expectations (1952 – 1969):
  - Early successful AI programs: Samuel's checkers, Newell & Simon's Logic Theorist, Gelernter's Geometry Theorem Prover.
  - Robinson's complete algorithm for logical reasoning.

A Brief History of Artificial Intelligence

- A dose of reality (1966 – 1974):
  - AI discovered computational complexity.
  - Neural network research almost disappeared after Minsky & Papert's book in 1969.

- Knowledge-based systems (1969 – 1979):
  - 1969: DENDRAL by Buchanan et al..
  - 1976: MYCIN by Shortliffle.
  - 1979: PROSPECTOR by Duda et al..

A Brief History of Artificial Intelligence

- AI becomes an industry (1980 – 1988):
  - Expert systems industry booms.
  - 1981: Japan's 10-year Fifth Generation project.

- The return of NNs and novel AI (1986 – present):
  - Mid 80's: Back-propagation learning algorithm reinvented.
  - Expert systems industry busts.
  - 1988: Resurgence of probability.
  - 1988: Novel AI (ALife, GAs, Soft Computing, …).
  - 1995: Agents everywhere.
  - 2003: Human-level AI back on the agenda.

Artificial Intelligence State of the Art

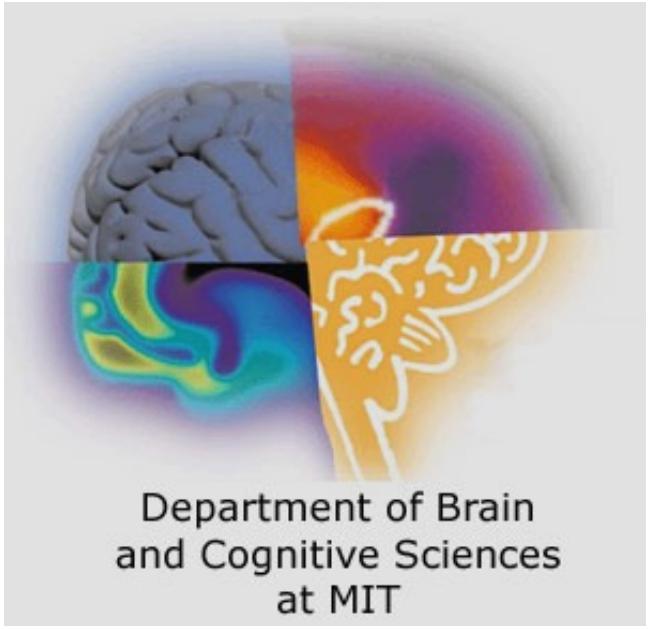
- Computer beats human in a chess game.
- Computer-human conversation using speech recognition.
- Expert system controls a spacecraft.
- Robot can walk on stairs and hold a cup of water.
- Language translation for webpages.
- Home appliances use fuzzy logic.
- Machine Learning
- Deep Learning
- ……

Deep Blue

11-05-1997: Deep Blue Vs. Garry Kasparov, the six-game rematch **3½ – 2½**

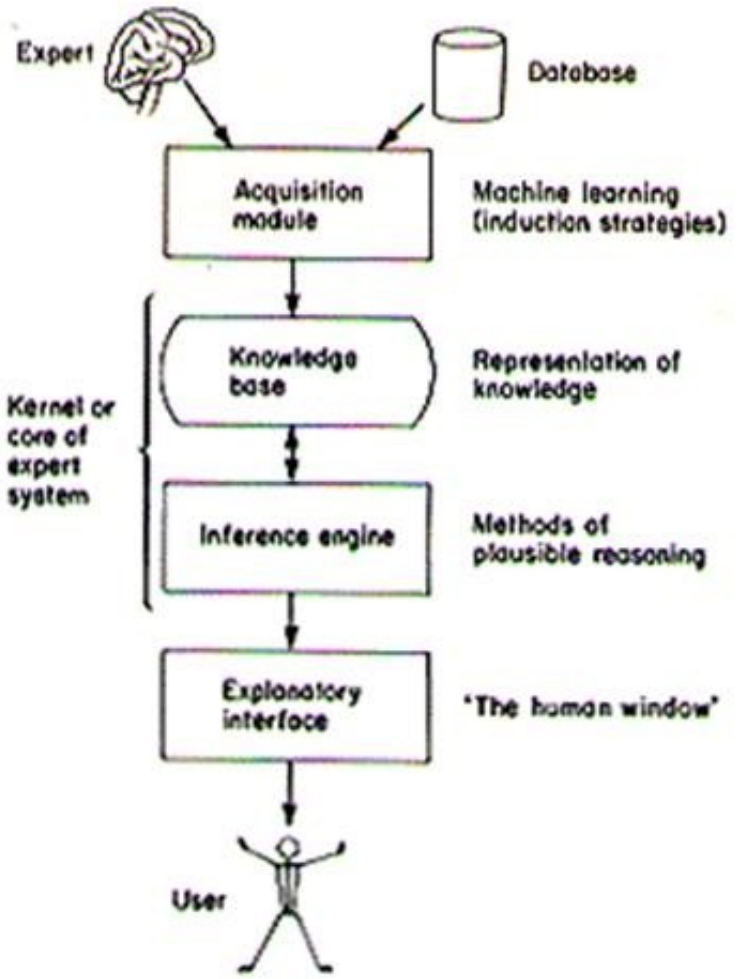
Cognitive Science

- Based on biology, neurology, psychology, mathematics, etc
- Studies how human brain works

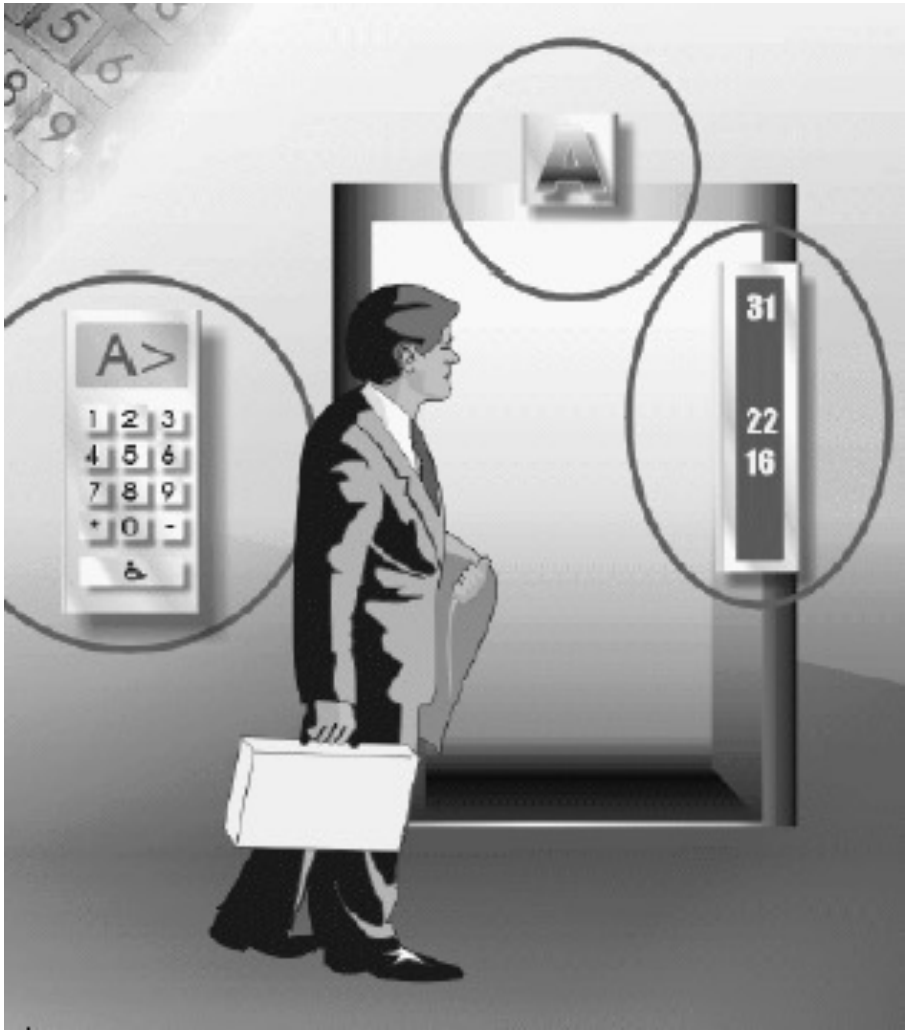


Expert System

- Consist of knowledge base database and inference engine
- First expert system was MYCIN in 1974



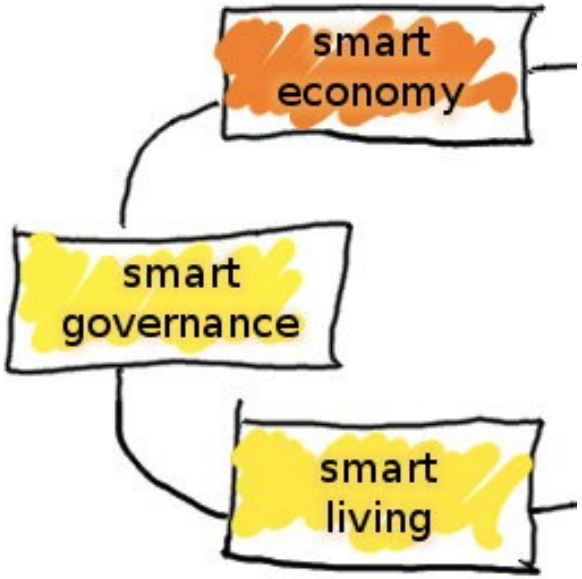
ECS (Elevator Control System)

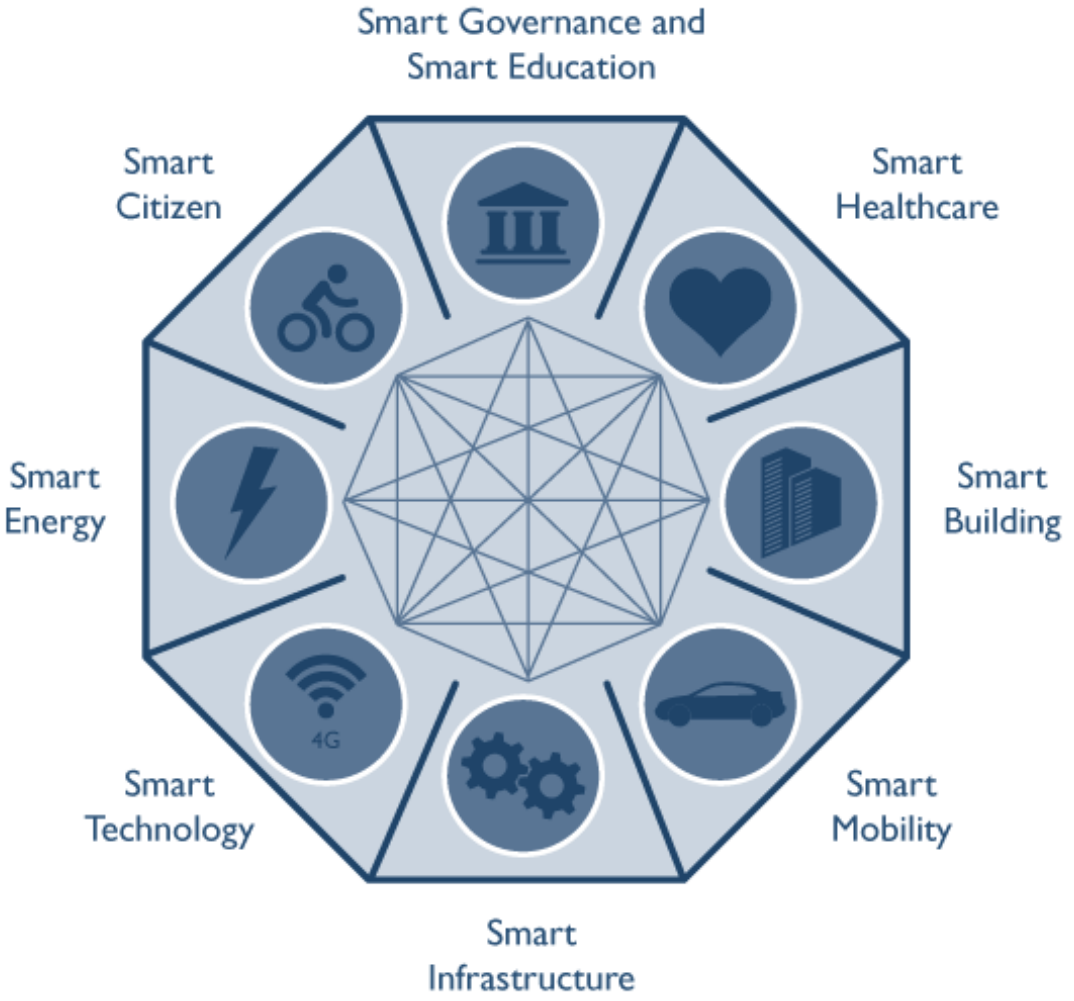


- Rockefeller Ctr (NY)
- Petronas (KL)
- Kebutuhan *users*:
  - Kapasitas ruang
  - Konflik antar pengguna
  - *Attended travel*
  - *Non-stop travel*
  - VIP *services*
  - *Access restrictions*

SmartCity®

SMART CITY CONCEPTS





Source: Frost & Sullivan

Robotics

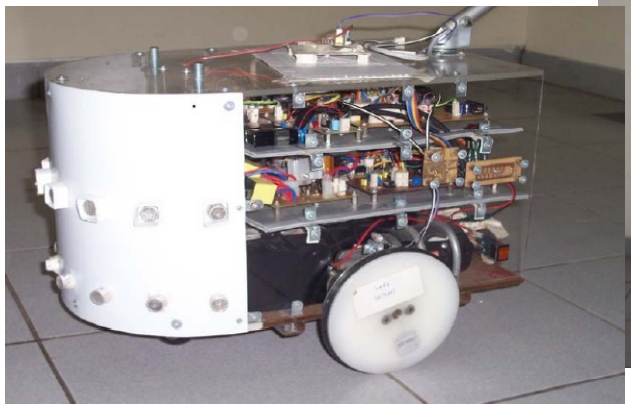
- Based on engineering and physiology
- Produces robots with computer intelligence and computer controlled human like capabilities

Robot Helping People

Patrol Robot

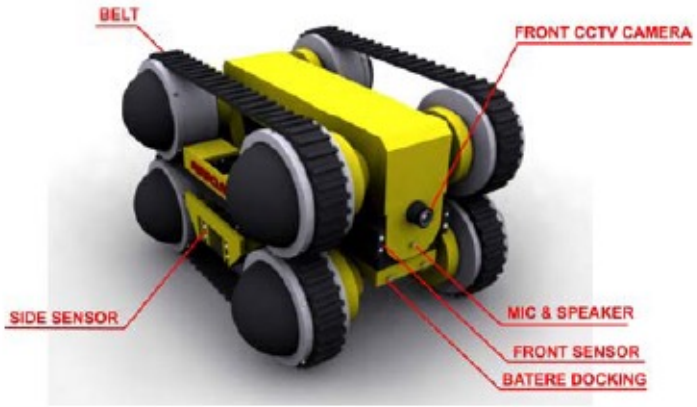
IRMA,
Intelligent Robotic Mobility Aid

Robot Assistant for the Blind



Rescue Robot

Figure 2.3 VIROIDS final design in digital 3D
(source:picture by author)



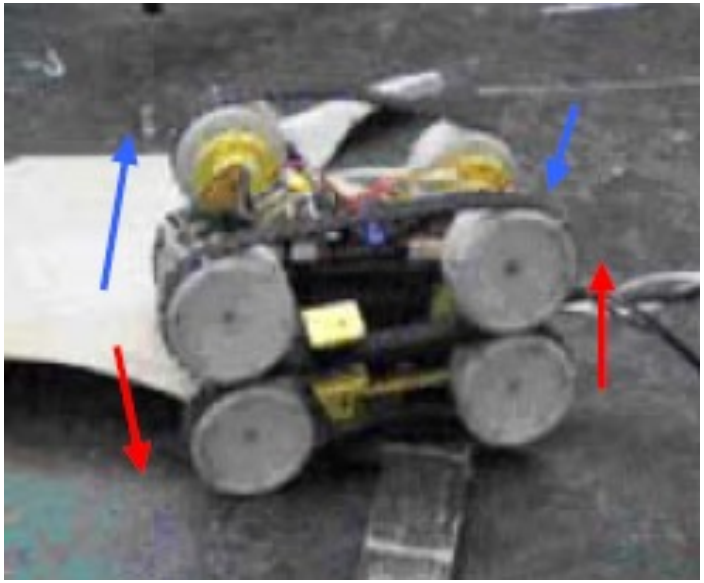
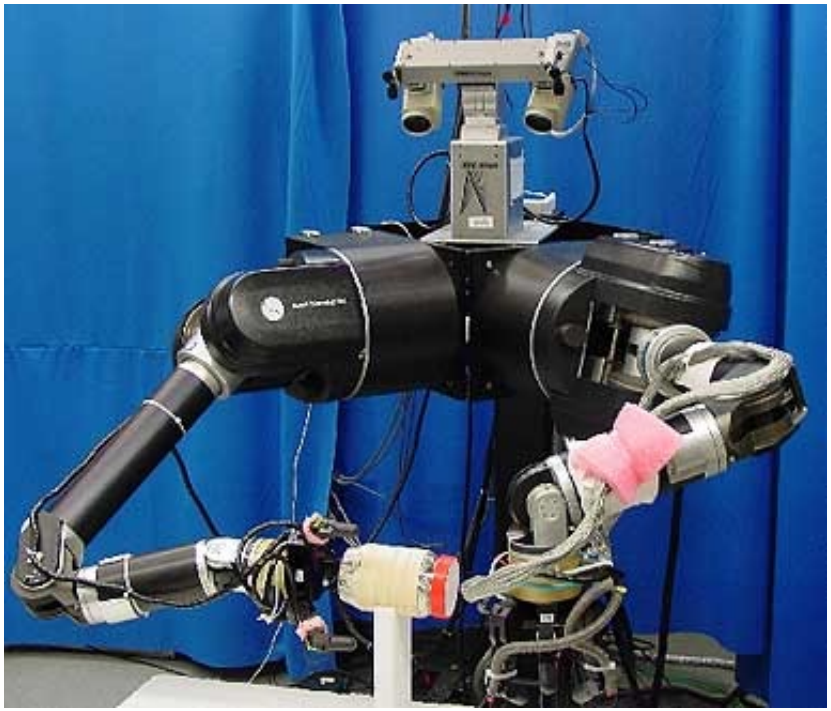


Image Understanding and Computer Vision

- 3 level of vision system – low, medium and high
- AI tools are required in high level vision system

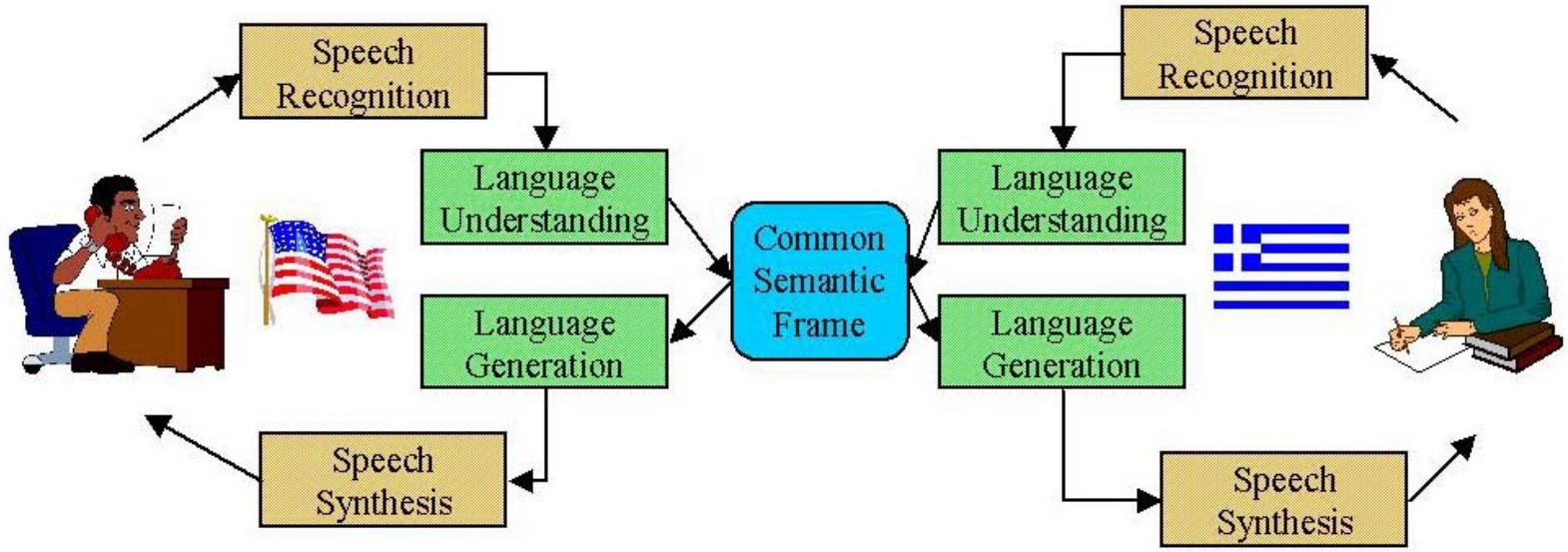


Natural Interface

- Based on linguistic, psychology, computer science, etc
- Natural use of computer by humans

Speech and Natural Language Understanding

- Speech analysis, classifying words from their features.
- Language analysis – syntactic and semantic interpretation
- Eg. Robot and phonetic typewriter



Other Applications

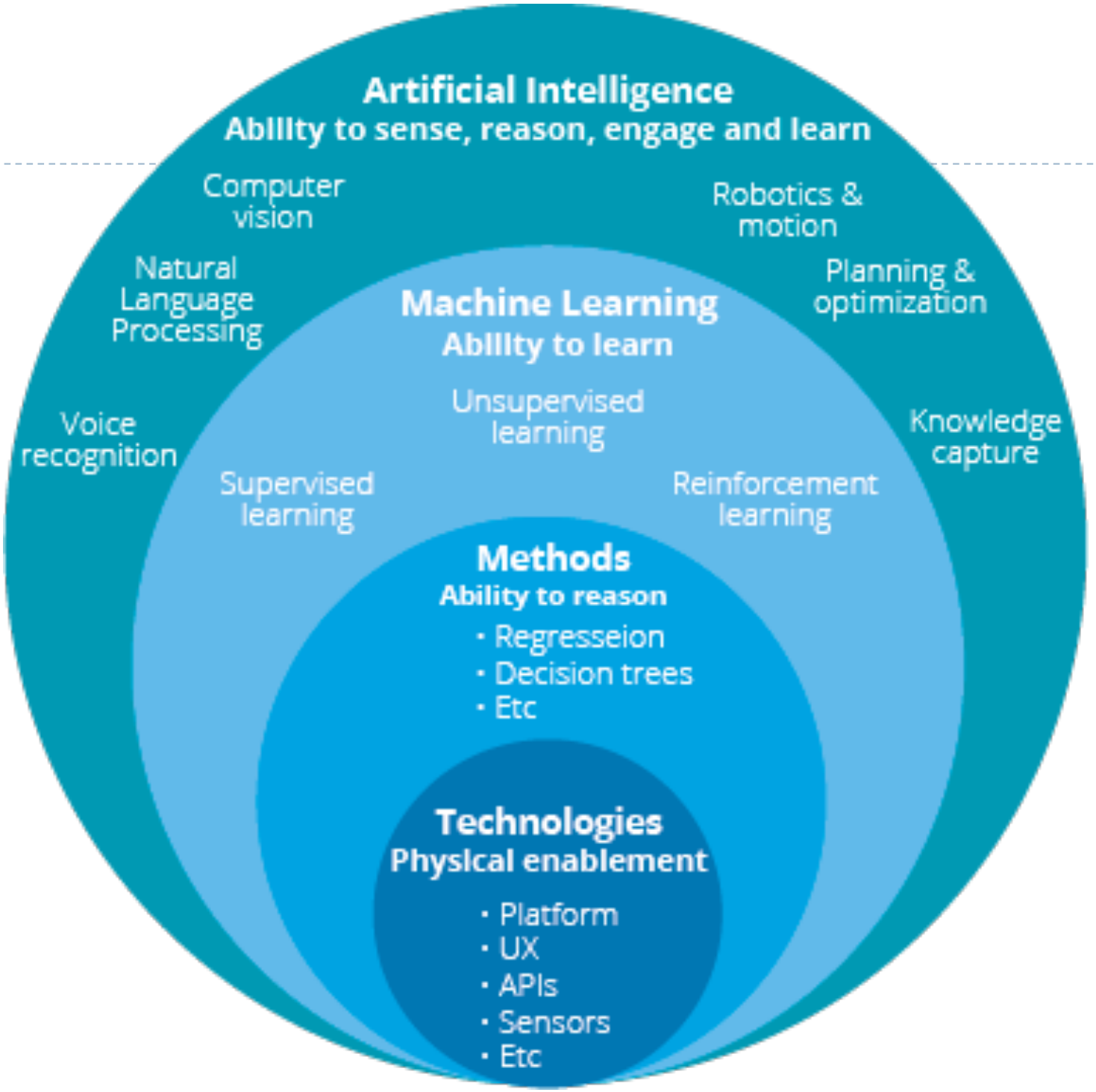
In field of:

- Finance
- Medicine
- Heavy industry
- Telecommunication
- Gaming
- Transportation

AI Saat Ini

- Berkembang menjadi berbagai bidang ilmu yang fokus pada area tertentu
  - ***Global Optimization***
  - ***Expert Systems***: *symbolic & logic*
  - ***Evolutionary Computation***: *numeric*
  - ***Soft Computing***: *fuzzy logic*, *neural network*, dsb.
  - Machine Learning dan Deep Learning
  - ...

AI Trend


Artificial Intelligence
Ability to sense, reason, engage and learn
Computer vision
Robotics & motion
Natural Language Processing
Planning & optimization
Machine Learning
Ability to learn
Unsupervised learning
Voice recognition
Knowledge capture
Supervised learning
Reinforcement learning
Methods
Ability to reason
· Regresseion
· Decision trees
· Etc
Technologies
Physical enablement
· Platform
· UX
· APIs
· Sensors
· Etc

Cognitive System – Perception, Learning, and Reasoning

A new era of computing

Cognitive Computing

- From Conventional Computing to Cognitive Computing
- The forefront of a new era of computing
- It's a radically new kind of computing.
  - Conventional computing solutions, **based on the mathematical principles** that are programmed based on rules and logic intended to derive mathematically precise answers, often following a rigid decision tree approach.
  - But with today's wealth of big data and the **need for more complex evidence-based decisions**, such a rigid approach often breaks or fails to keep up with available information.
- Cognitive Computing enables people to create a profoundly new kind of value, finding answers and insights locked away in volumes of data.

Cognitive Computing

- Cognitive Computing mirrors some of the key cognitive elements of human expertise, systems that reason about problems like a human does.
- Humans seek to understand something and to make a decision through four key steps:
  1. **Observe** visible phenomena and bodies of evidence.
  2. Draw on what we know to **interpret** what we are seeing to generate hypotheses about what it means.
  3. **Evaluate** which hypotheses are right or wrong.
  4. **Decide**, choosing the option that seems best and acting accordingly.
- cognitive systems use similar processes to reason about the information they read, and they can do this at massive speed and scale.

Cognitive Computing

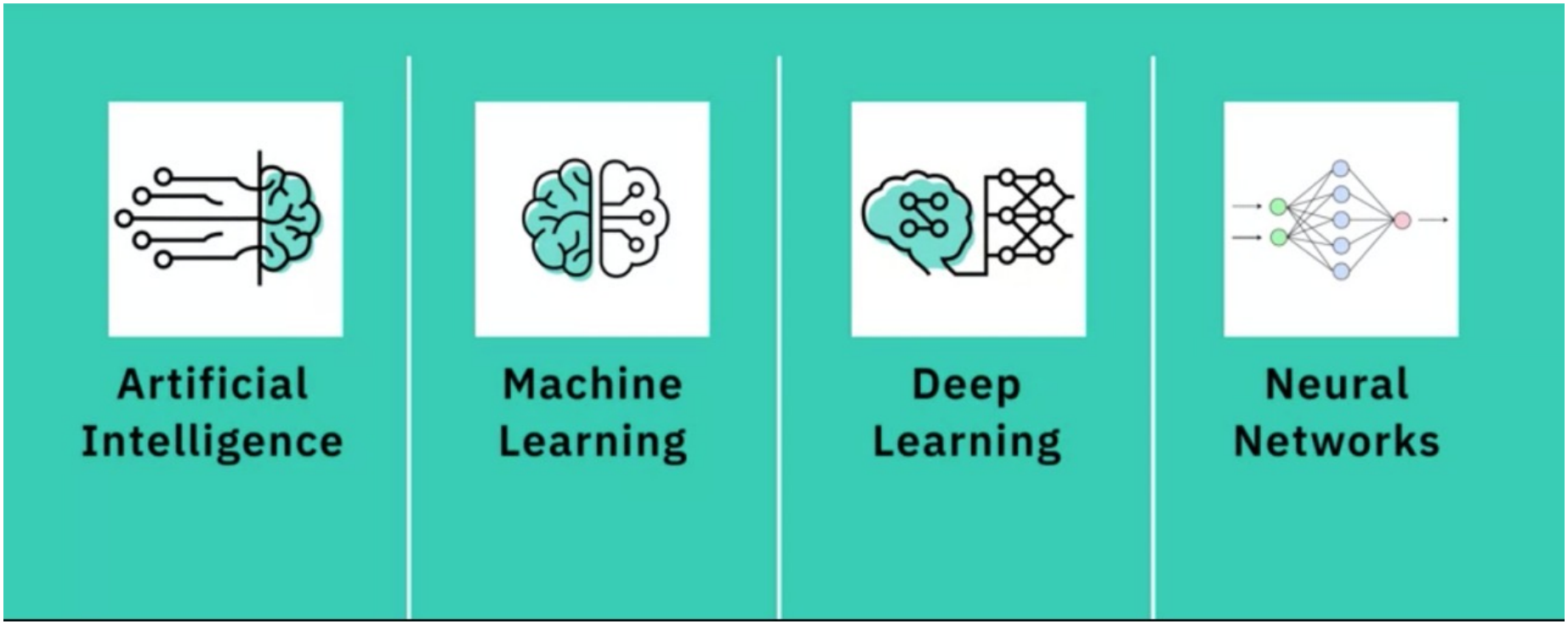
- Understand unstructured data
  - 80 percent of data today are unstructured.
  - All of the information that is produced primarily by humans for other humans to consume. This includes everything from literature, articles, research reports to blogs, posts, and tweets.
- Rely on natural language
  - Governed by rules of grammar, context, and culture.
- Implicit, ambiguous, complex, and a challenge to process
  - While all human language is difficult to parse, certain idioms can be particularly challenging.
- Understand context
  - This is very different from simple speech recognition, which is how a computer translates human speech into a set of words.

Cognitive Computing

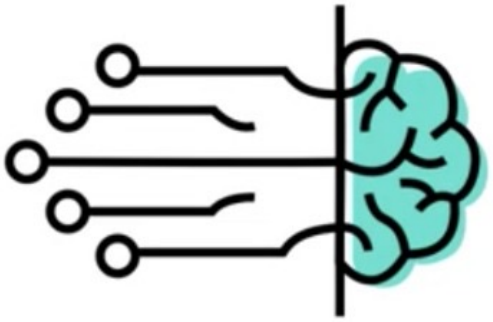
- Cognitive systems try to understand the real intent of the users language, and use that understanding to draw inferences through a broad array of linguistic models and algorithms.
- Cognitive systems learn, adapt, and keep getting smarter.
- They do this by learning from their interactions with us, and from their own successes and failures, just like humans do.

AI Terminology and Related Concepts

Terms and Concepts

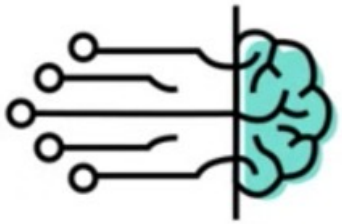


- The terminologies are sometimes used interchangeably, but they do not refer to the same thing.



Artificial Intelligence

A branch of computer science dealing with the simulation of intelligent behavior



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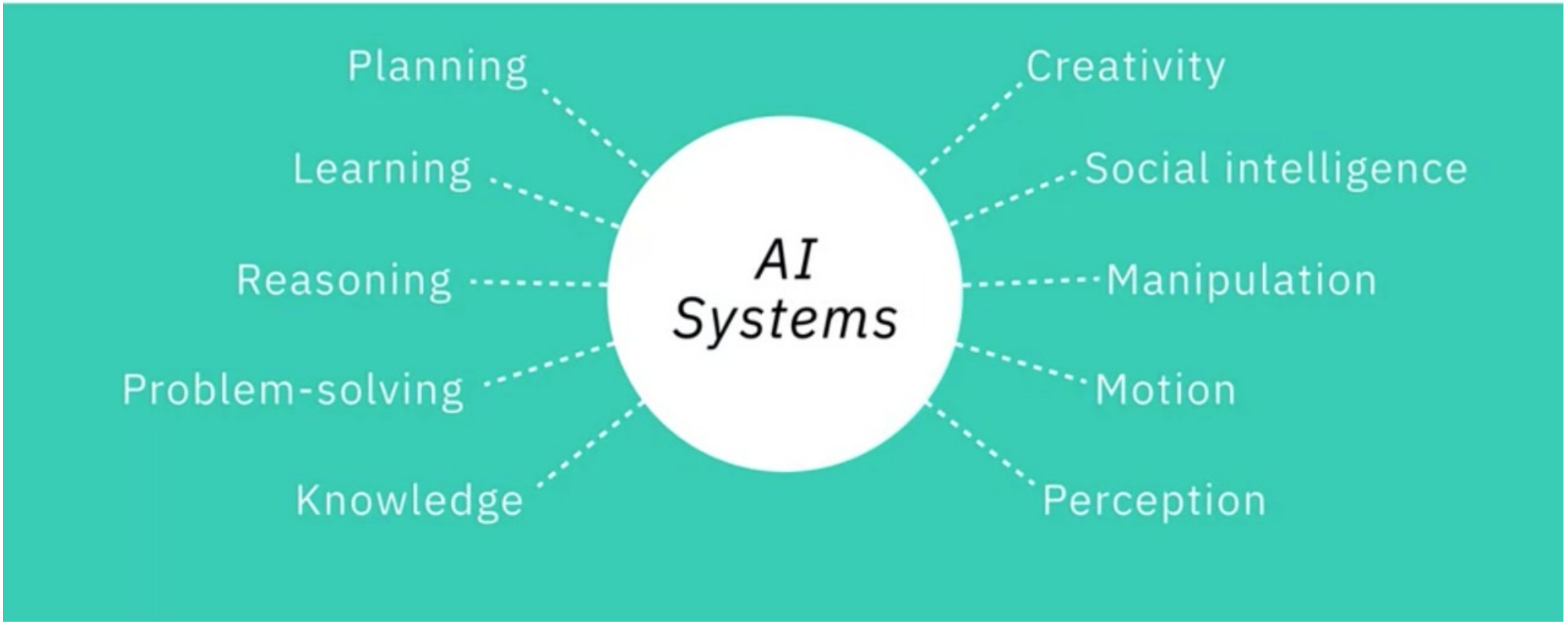


AI systems typically demonstrate behaviors associated with human intelligence

Machine Learning

A subset of AI that uses computer algorithms to analyze data and make intelligent decisions based on what it has learned, without being explicitly programmed

Machine Learning

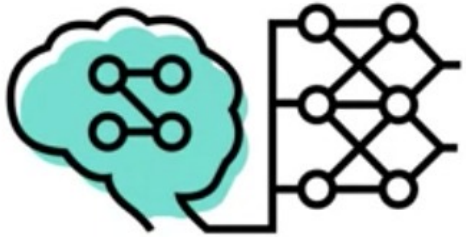
A subset of AI that uses computer algorithms to analyze data and make intelligent decisions based on what it has learned, without being explicitly programmed

Trained with large sets of data

They do not follow rules-based algorithms

They learn from examples

Machine learning is what enables machines to solve problems on their own and make accurate predictions using the provided data



Deep Learning

A specialized subset of Machine Learning that uses layered neural networks to simulate human decision-making

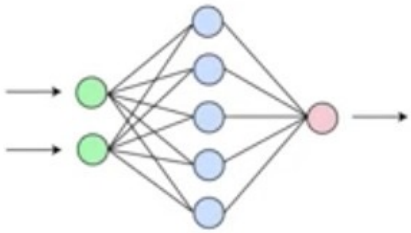
Deep Learning

A specialized subset of Machine Learning that uses layered neural networks to simulate human decision-making

Deep Learning algorithms

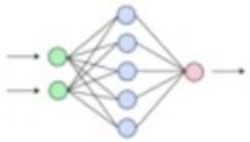
Label and Categorize

- Deep learning algorithms can label and categorize information and identify patterns.
- It is what enables AI systems to continuously learn on the job, and improve the quality and accuracy of results by determining whether decisions were correct.



Neural Networks

Take inspiration from biological neural networks, although they work quite a bit differently



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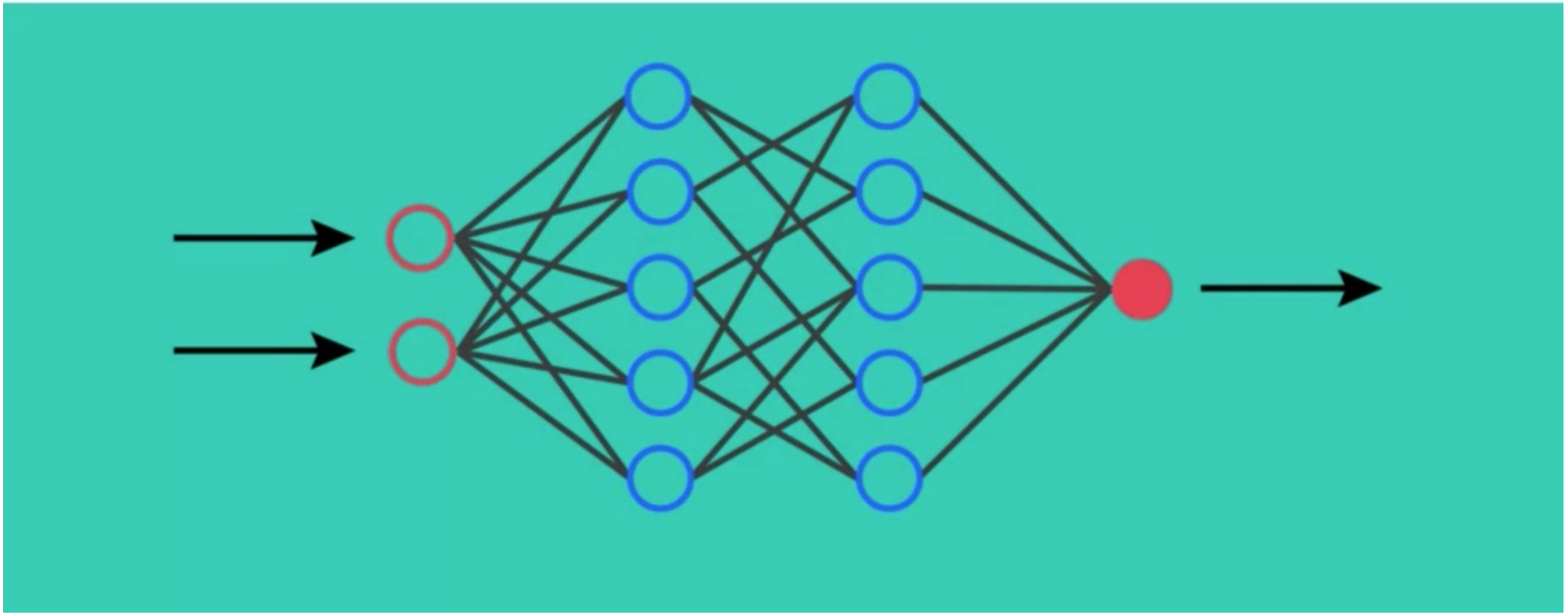
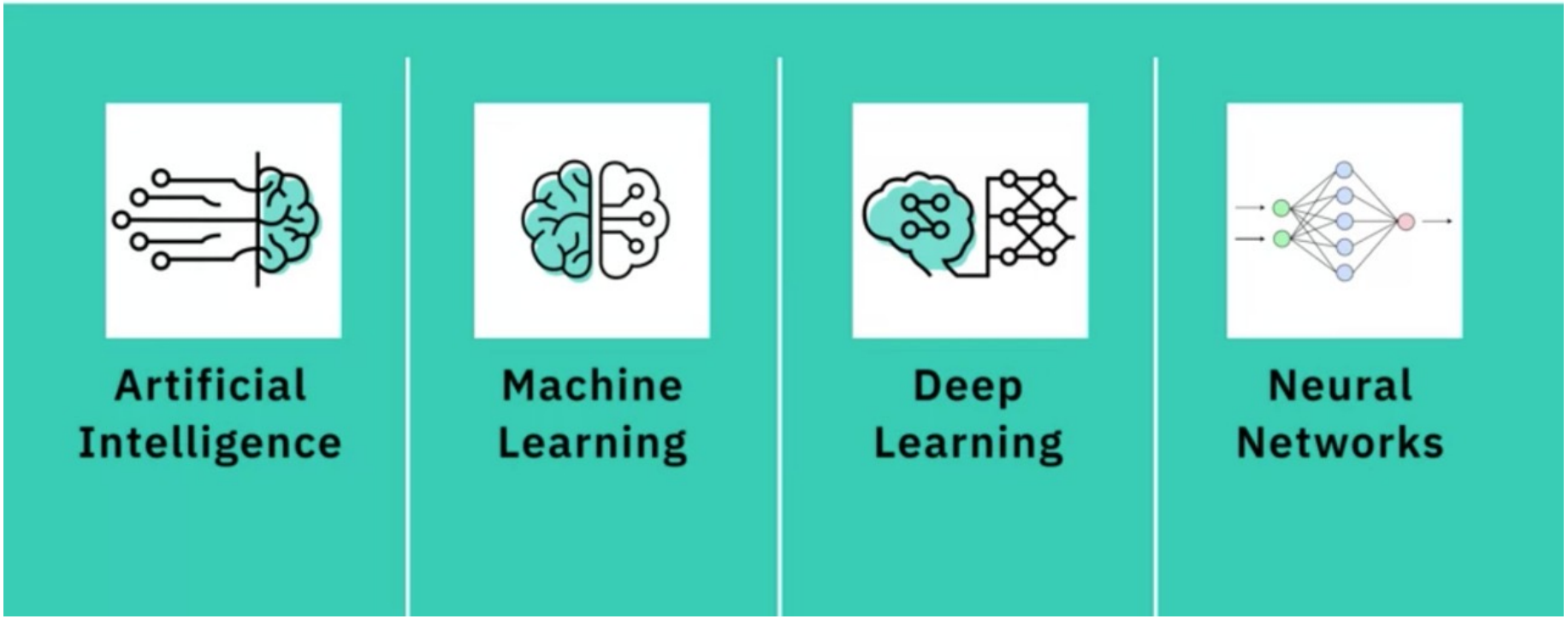
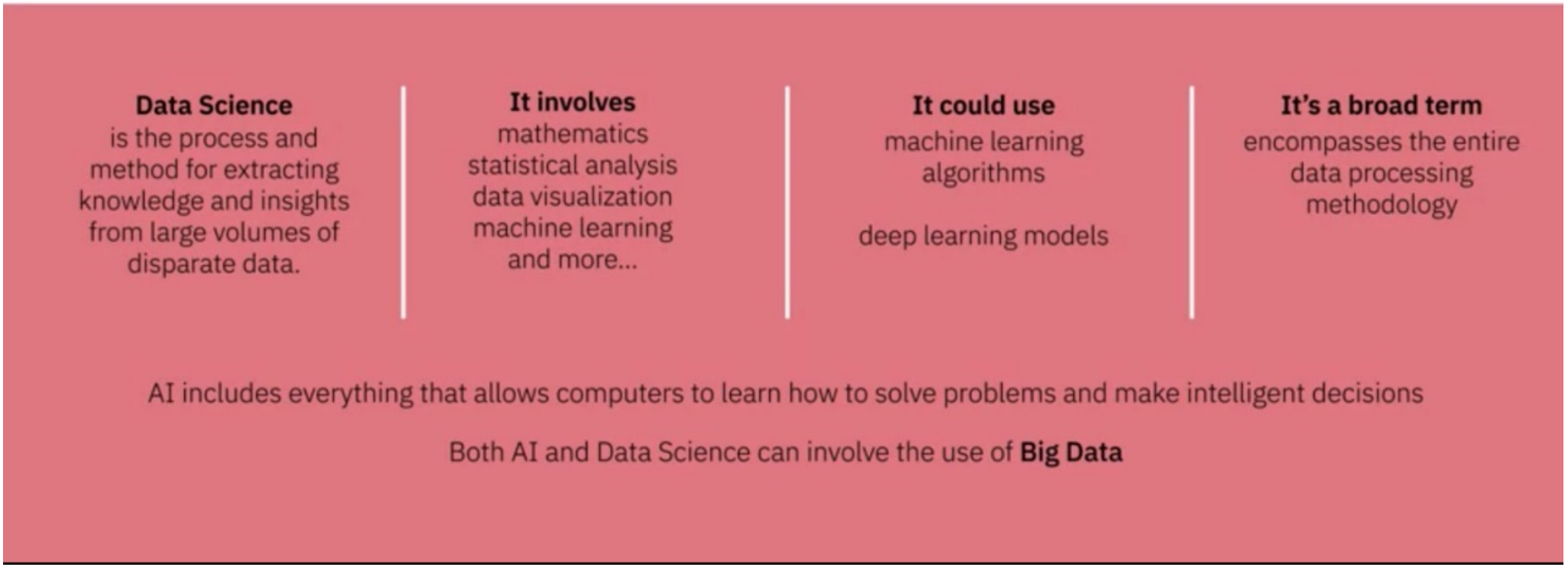


- A neural network in AI is a collection of small computing units called neurons that take incoming data and learn to make decisions over time.
- Neural networks are often layered deep and are the reason deep learning algorithms become more efficient as the datasets increase in volume,
  - Machine learning algorithms may plateau as data increases.



there is one more differentiation that is important to understand, that between **artificial intelligence** and **data science**.

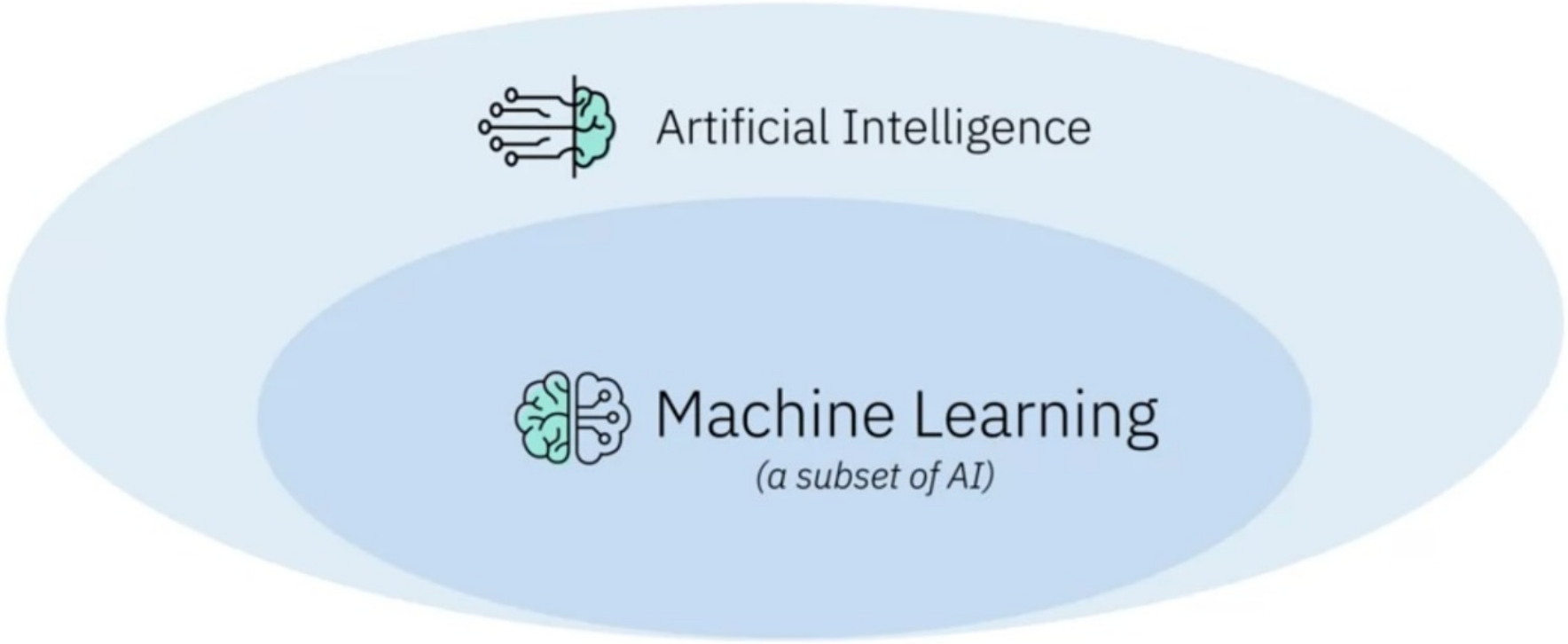
Artificial Intelligence and Data Science



- Data science makes possible to see patterns, find meaning from large volumes of data, and use it to make decisions that drive business. Data science is a broad term that encompasses the entire data processing methodology.
- AI includes everything that allows computers to learn how to solve problems and make intelligent decisions

A Brief Introduction to Machine Learning

Machine Learning



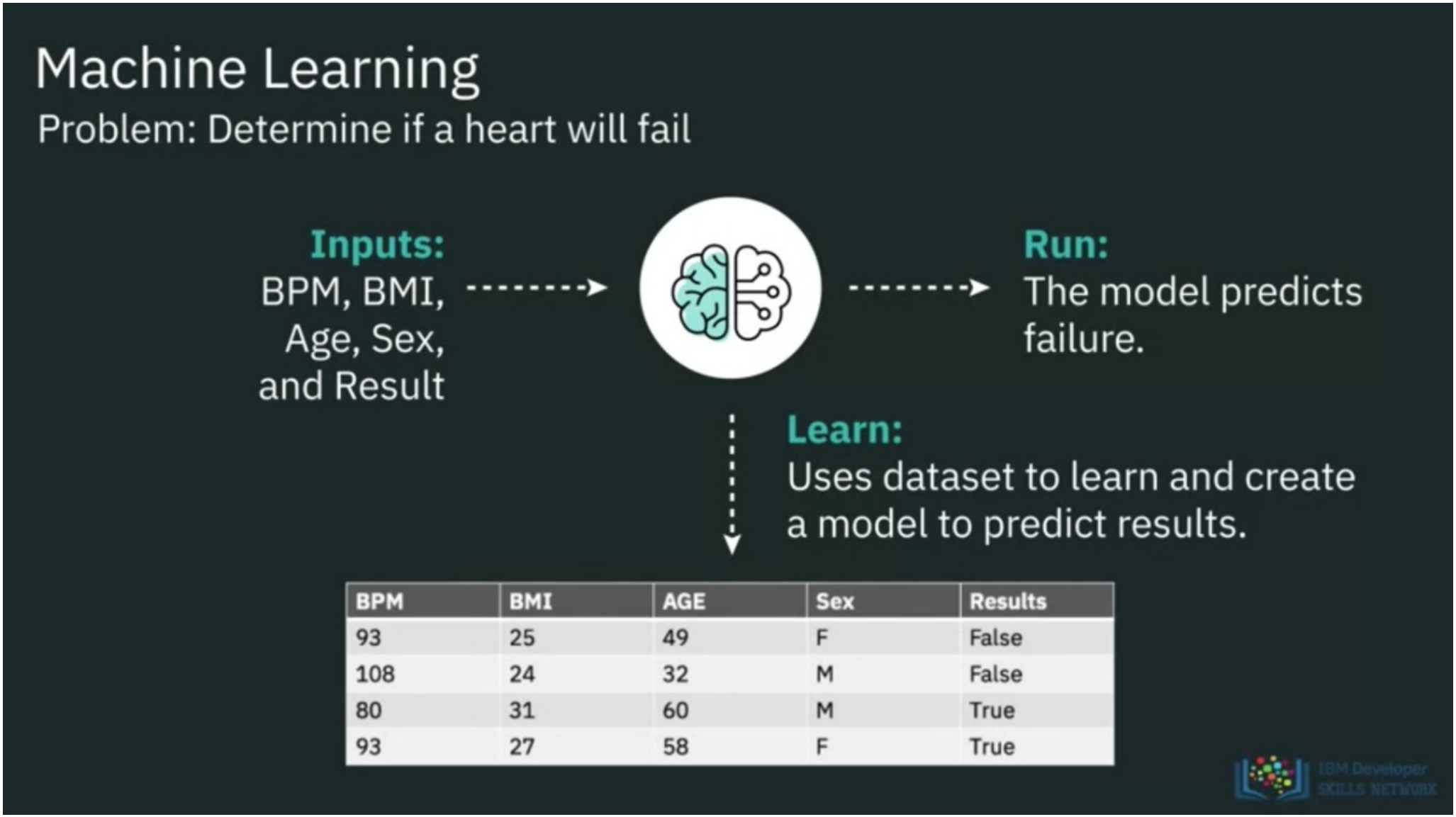
Machine Learning

Builds models to classify and make predictions from provided data

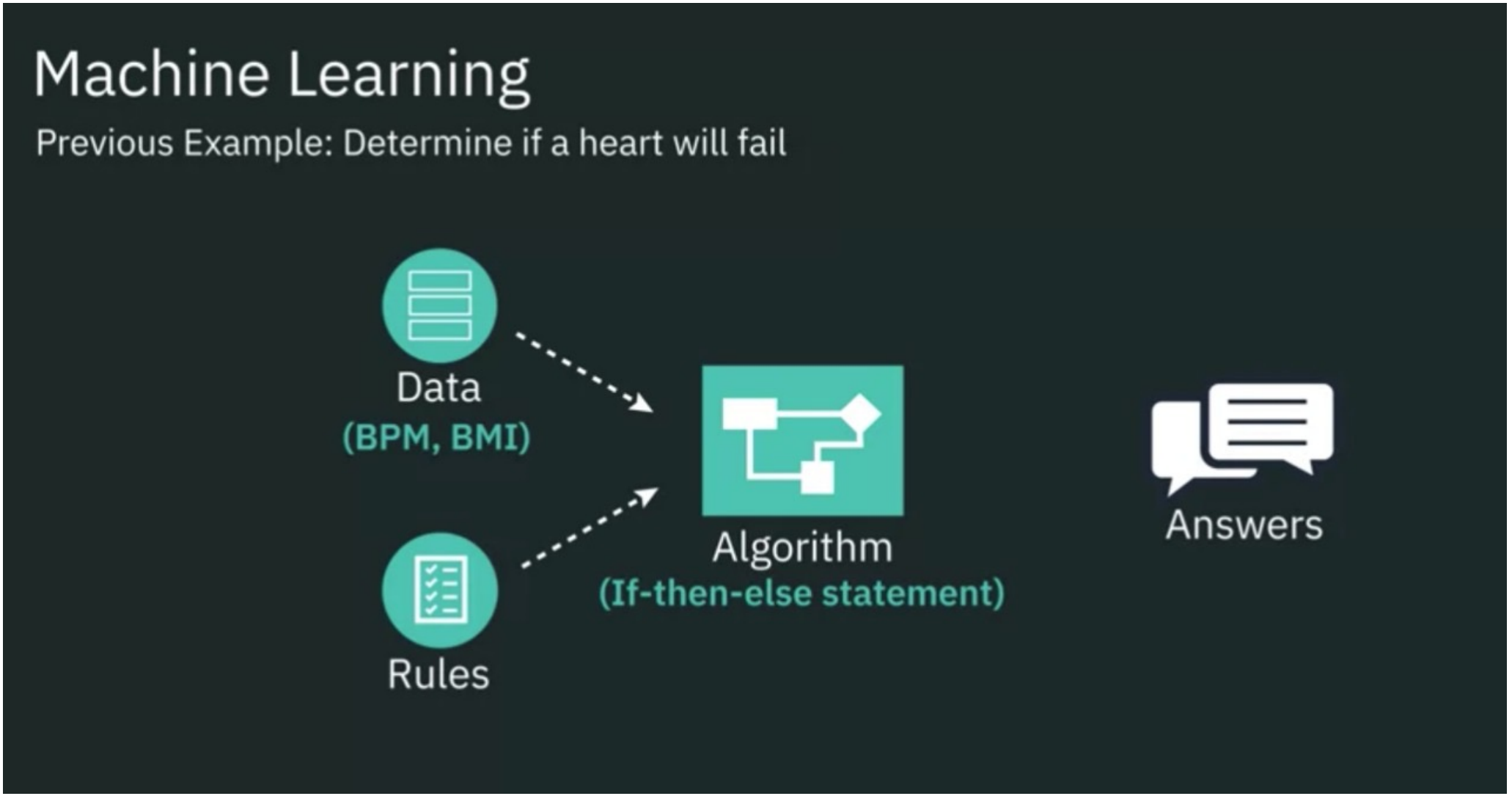
Do not follow rules-based algorithms

Trained with large sets of data

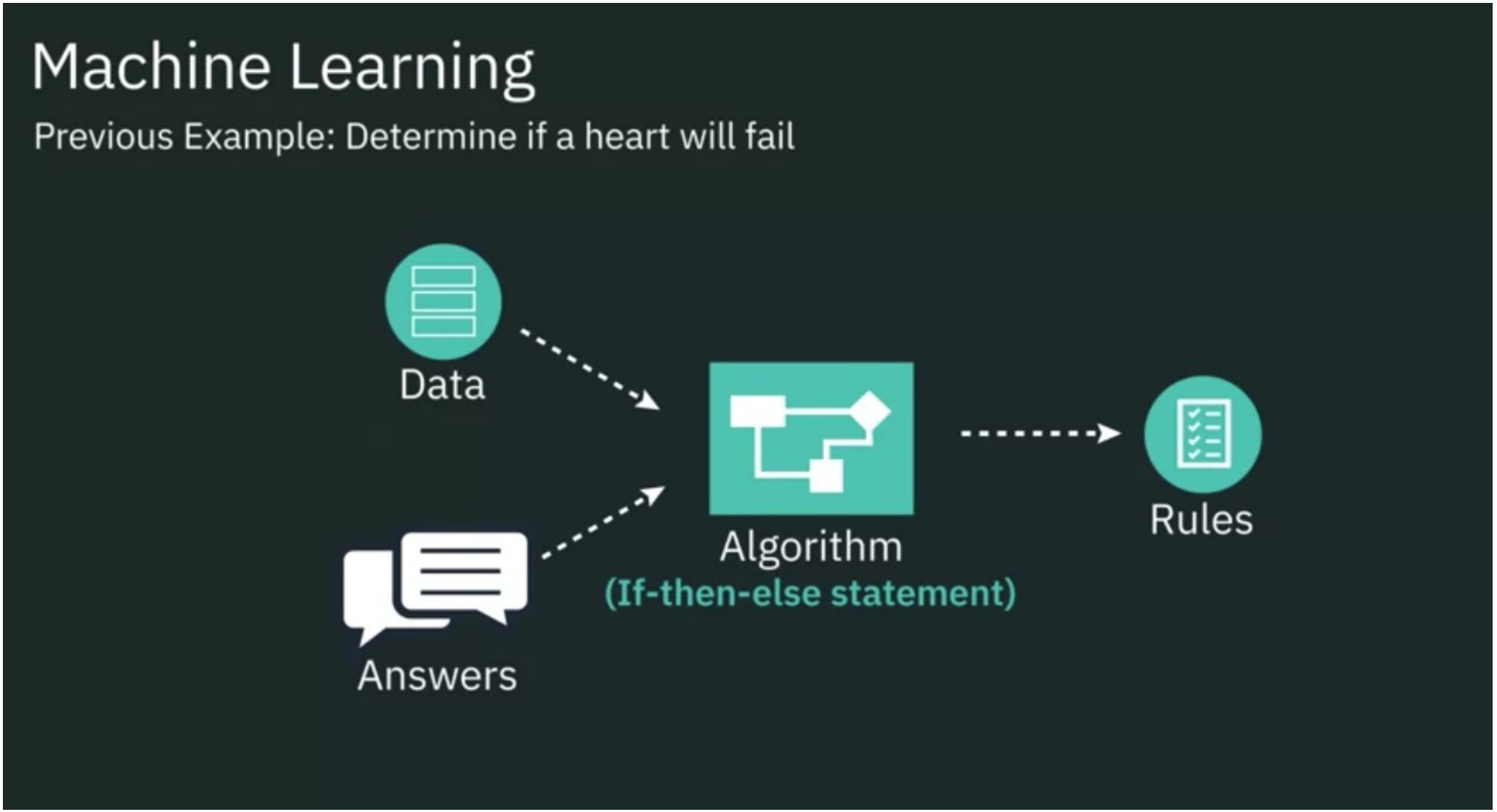
- ML uses computer algorithms to analyze data and make intelligent decisions based on what it has learned.
- Instead of following rules-based algorithms, machine learning builds models to classify and make predictions from data.



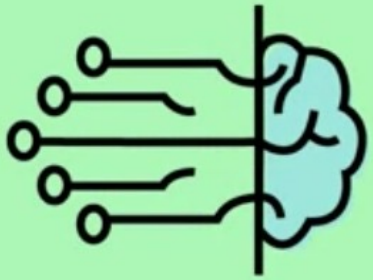
- Given data: Beats Per Minute, Body Mass Index, Age, Sex, and the Result whether the heart has failed or not.
- With **Machine Learning**, using this dataset, we are able to learn and create a model that given inputs will predict results.



- With **traditional programming**, we take data and rules, and use these to develop an algorithm (based on mathematicl technique) that will give us an answer.
- We use the data to create an algorithm that will determine whether the heart will fail or not (it would be an if-then-else statement).
- When we submit inputs, we get answers based on what the algorithm we determined is, and this algorithm will not change.



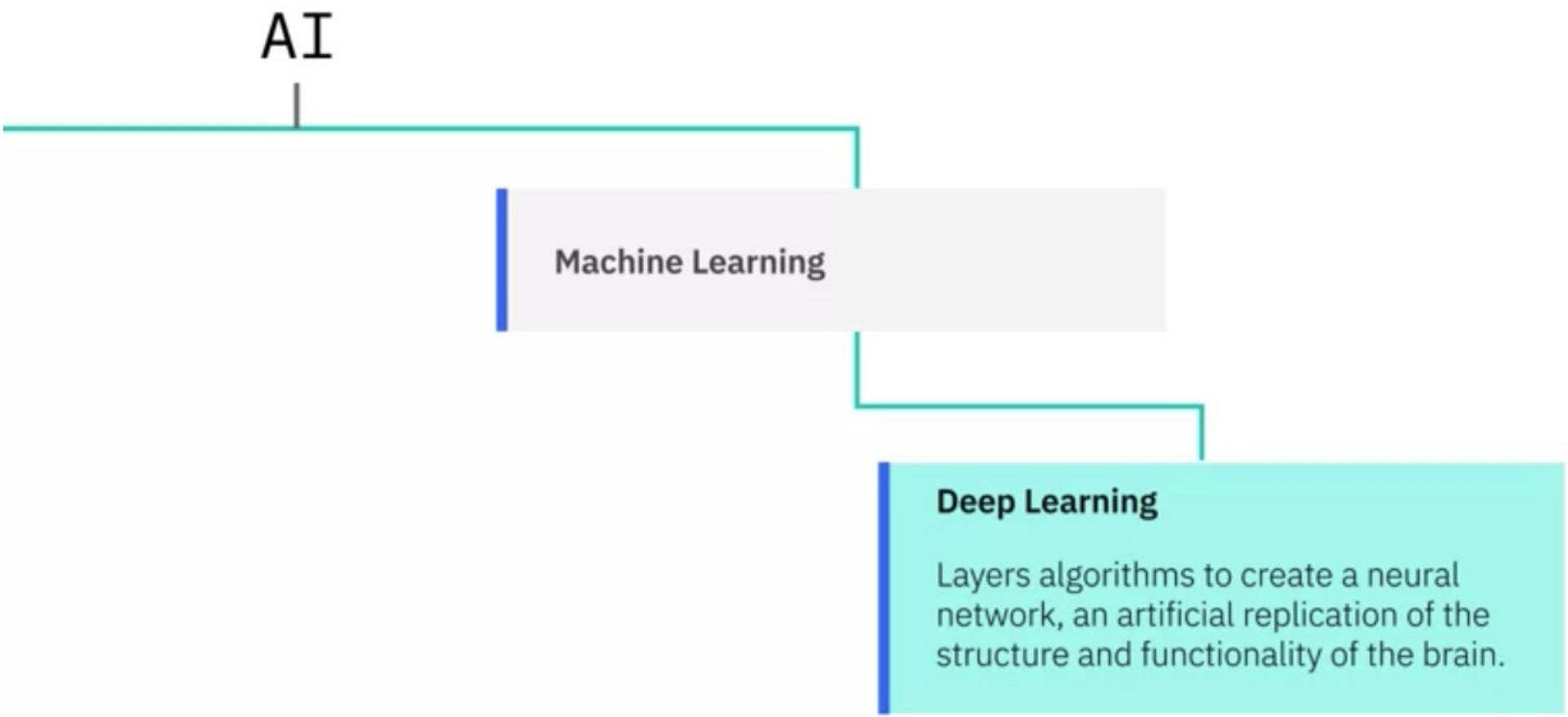
- Machine Learning takes data and answers and creates the algorithm.
- What we get is a set of rules that determine what the machine learning model will be.
- What the model does is determine what the parameters are in a traditional algorithm.
- This model can be continuously trained and be used in the future to predict values.



A machine learning model is the algorithm used to find patterns in the data without the programmer having to explicitly program these patterns.

A Brief Introduction to Deep Learning

Deep Learning



Deep Learning is a specialized subset of Machine Learning

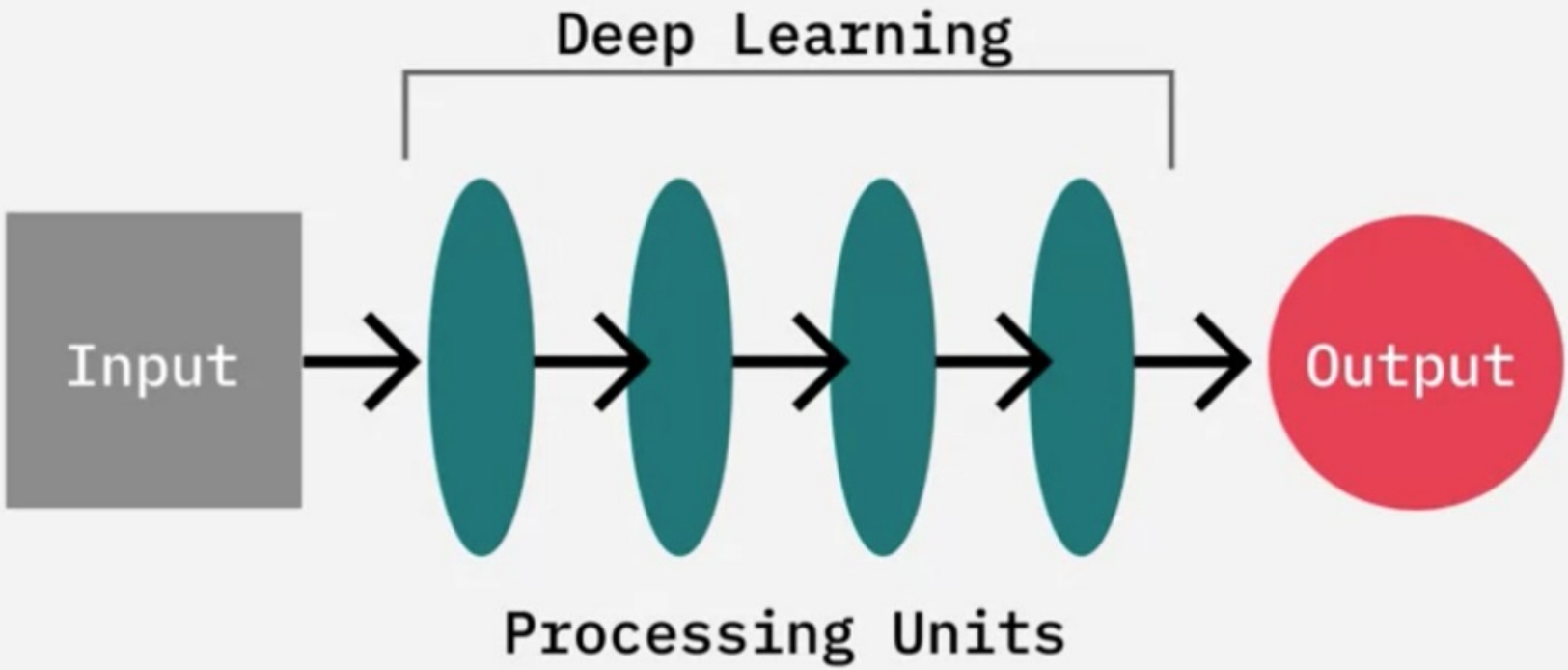
Deep Learning

Enabling AI systems to continuously learn on the job and improve the quality and accuracy of results.



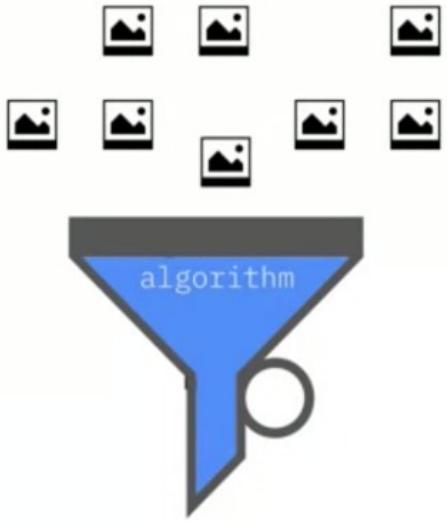
This is what enables these systems to learn from unstructured data such as photos, videos, and audio files.

Deep Learning enables natural language understanding capabilities of AI systems.



- Deep Learning allows the natural language to work out the context and intent of what is being conveyed.
- Deep learning algorithms rely on several layers of processing units. Each layer passes its output to the next layer, which processes it and passes it to the next.
- The many layers is why it's called deep learning.

When creating deep learning algorithms, developers and engineers configure the number of layers and the type of functions that connect the outputs of each layer to the inputs of the next.



- Deep learning algorithm train the model by providing it with lots of annotated examples.
- For instance, you give a deep learning algorithm thousands of images and labels that correspond to the content of each image.

- DL algorithm train the model by providing it with lots of annotated examples.
- For instance, you give a deep learning algorithm thousands of images and labels that correspond to the content of each image.

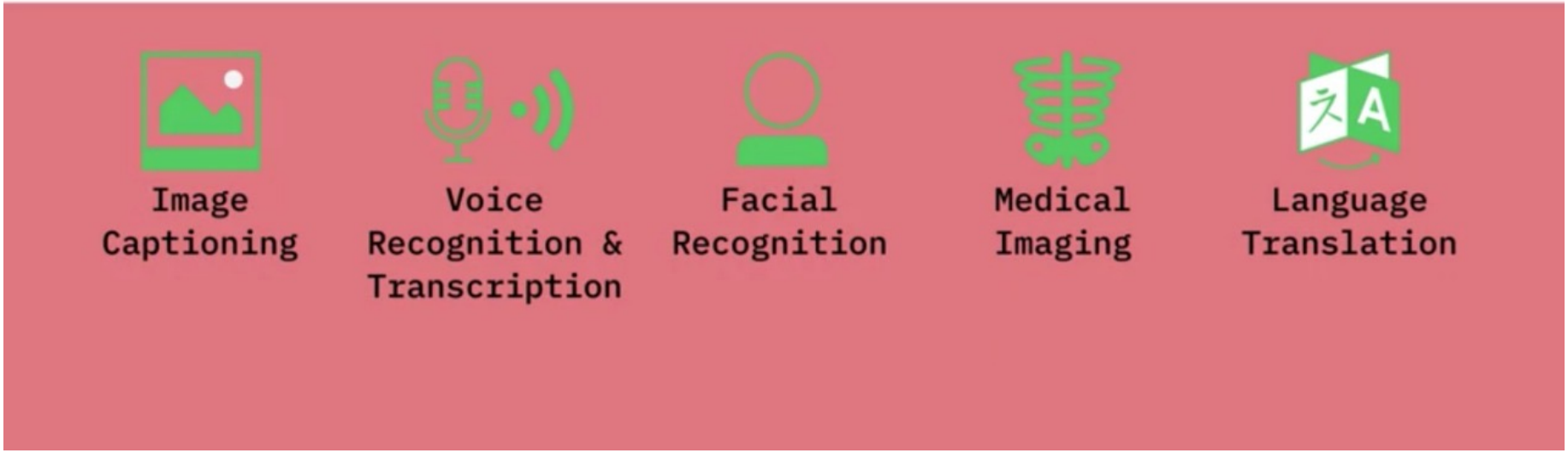
- The algorithm will run the those examples through its layered neural network, and adjust the weights of the variables in each layer of the neural network to be able to detect the common patterns that define the images with similar labels.

Deep Learning fixes one of the major problems present in older generations of learning algorithms.

The efficiency and performance of older machine learning algorithms plateau as the datasets grow.

Deep learning algorithms continue to improve as they are fed more data.

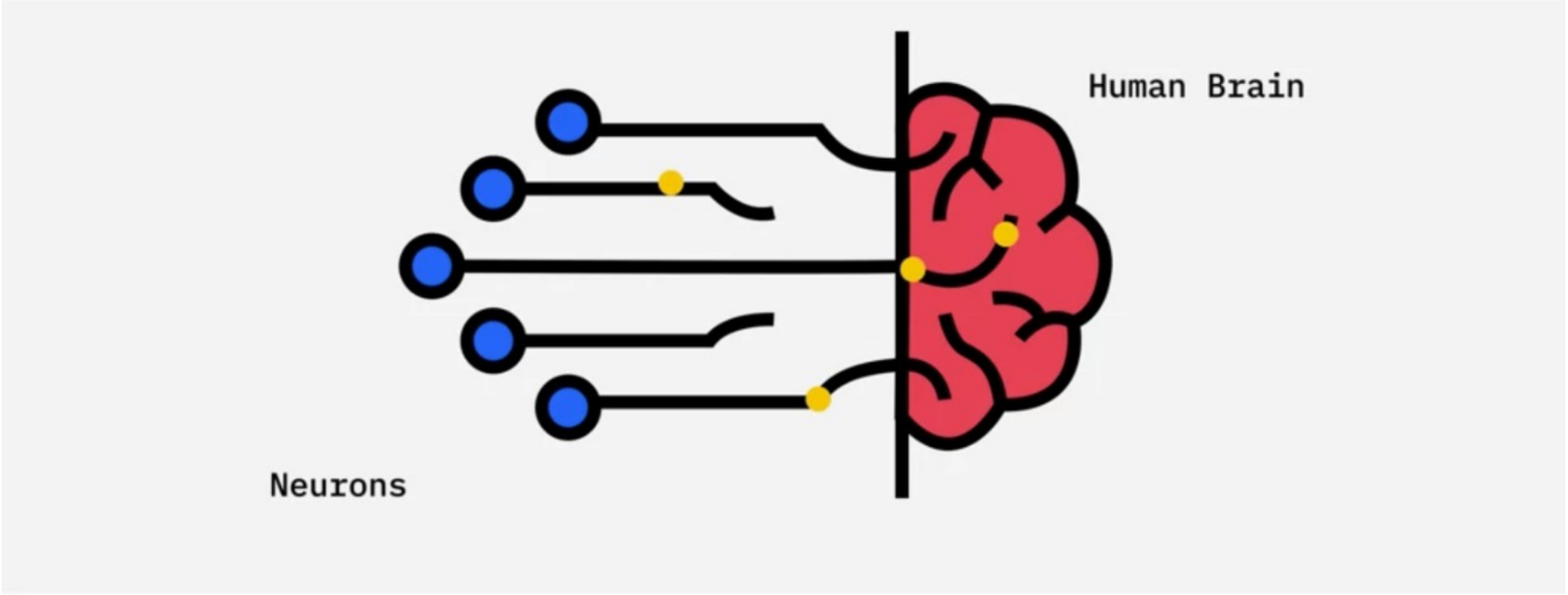
Deep Learning has proven to be very efficient at various tasks, including...



Deep Learning is also one of the main components of driverless cars.

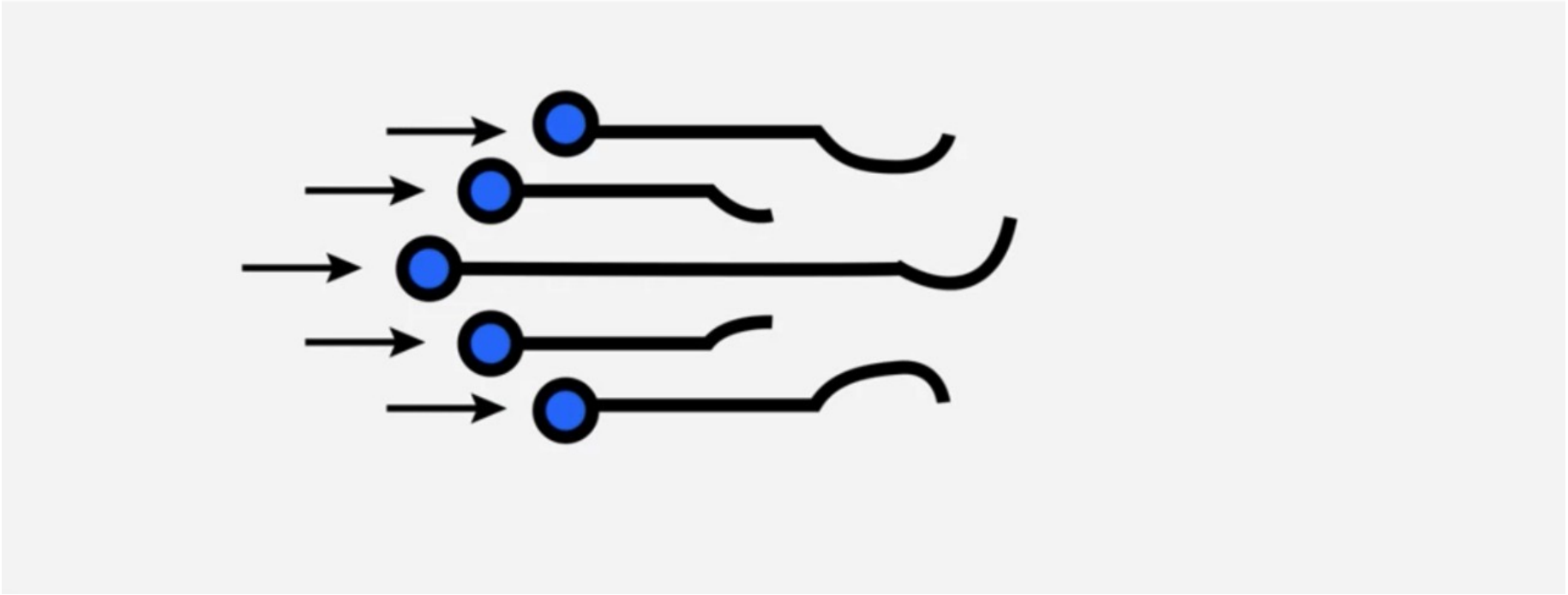
A Brief Introduction to Neural Network

Artificial Neural Network



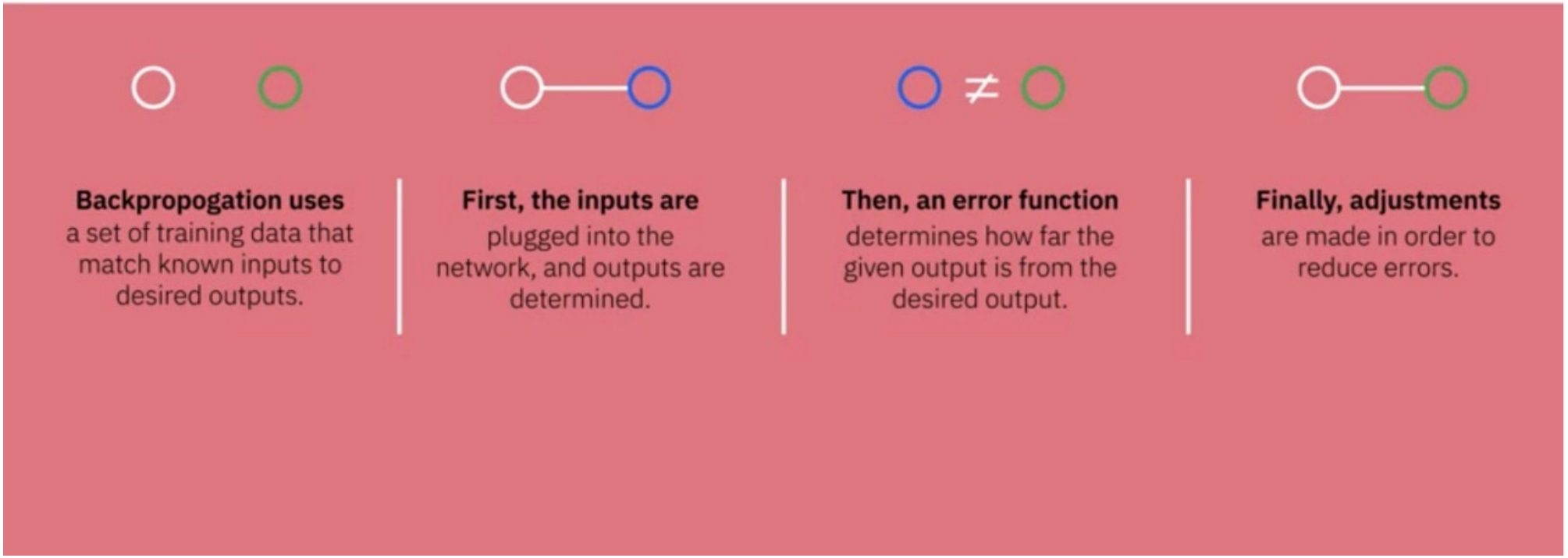
- An artificial neural network is a collection of smaller units called neurons, which are computing units modeled on the way the human brain processes information.

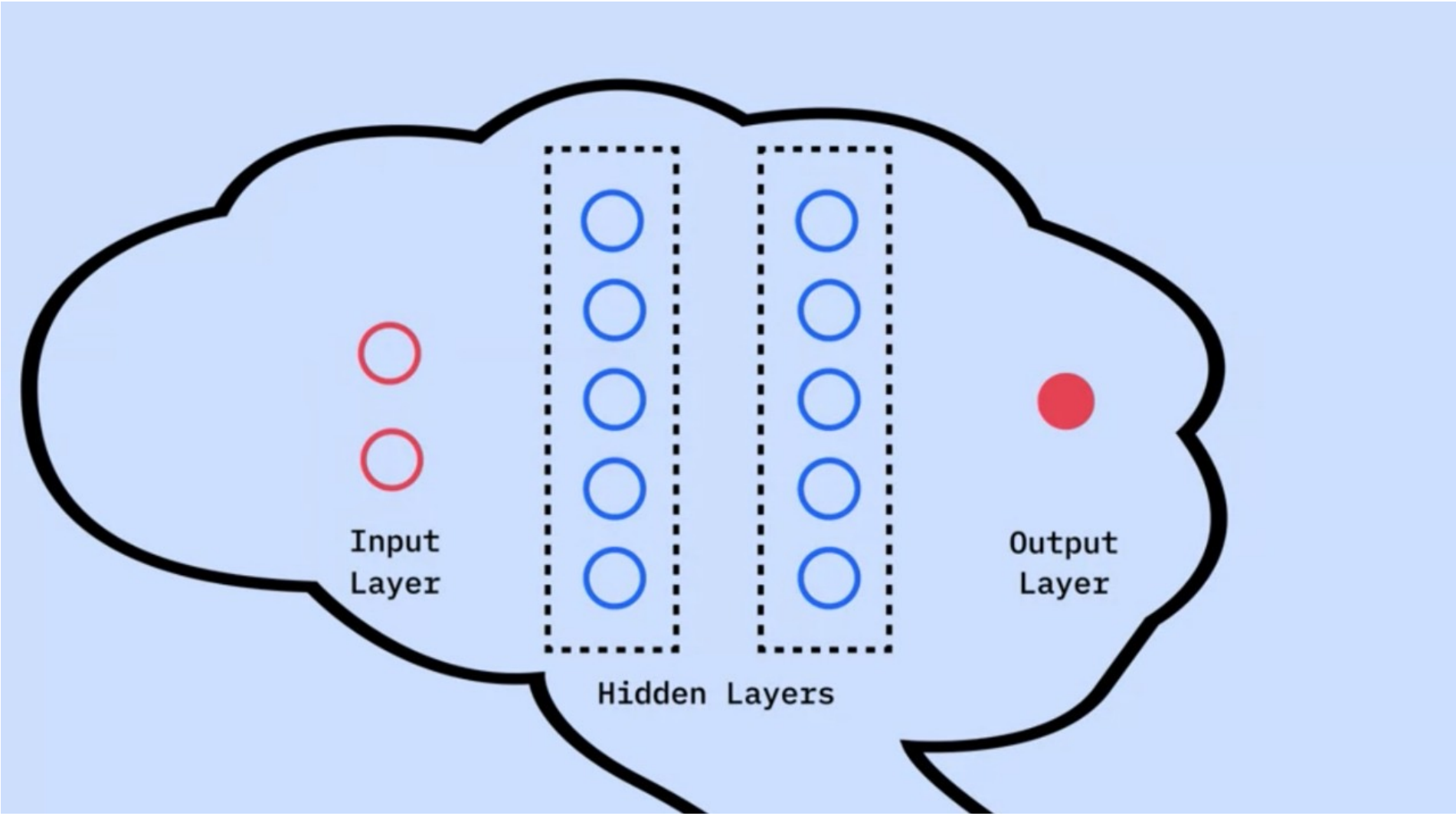
Artificial Neural Network



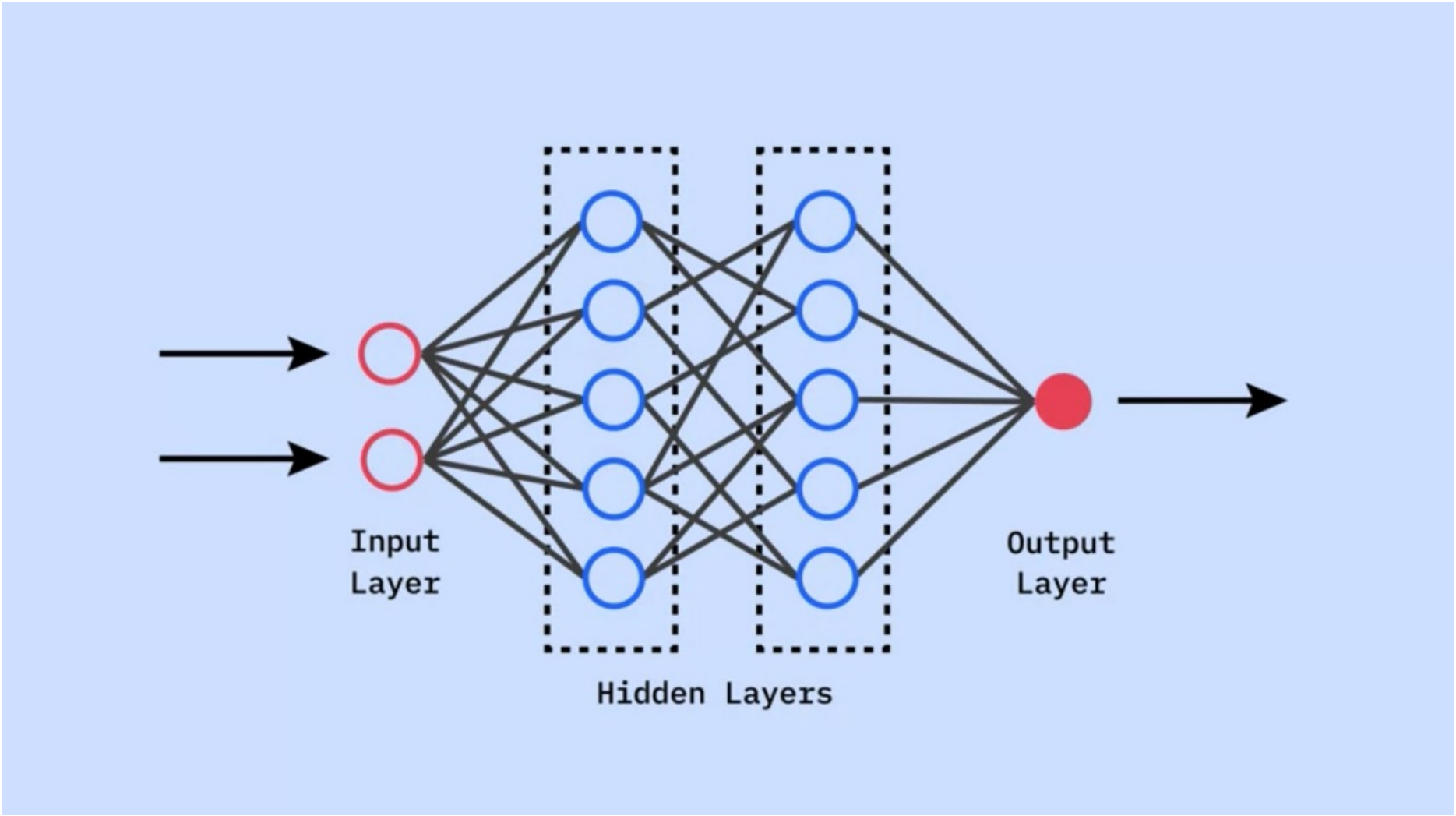
- Artificial neural networks borrow some ideas from the biological neural network of the brain, in order to approximate some of its processing results.
- These units or neurons take incoming data like the biological neural networks and learn to make decisions over time.

Neural networks learn through a process called backpropogation





- A collection of neurons is called a layer, and a layer takes in an input and provides an output.
- Any neural network will have one input layer and one output layer.
- It will also have one or more hidden layers which simulate the types of activity that goes on in the human brain.



- **Hidden layers** take in a set of weighted inputs and produce an output through an activation function.
- A neural network having more than one hidden layer is referred to as a **deep neural network.**

Perceptrons

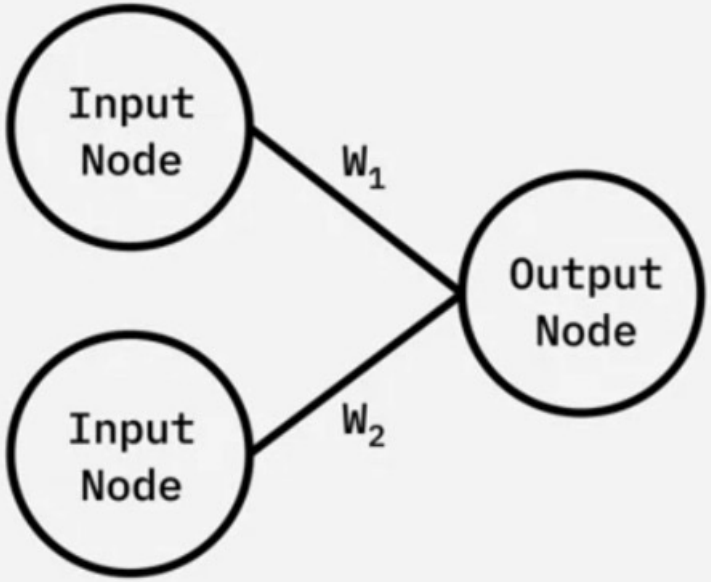
The simplest and oldest types of neural networks.

They are single-layered neural networks consisting of input nodes connected directly to an output node.

Bias is a special type of weight that applies to a node after the other inputs are considered.

Input layers forward the input values to the next layer, by means of multiplying by a weight and summing the results.

An activation function determines how a node responds to its inputs.



Convolutional Neural Networks (CNNs)

Multilayer neural networks that take inspiration from the animal visual cortex.

CNNs are useful in applications such as image processing, video recognition, and natural language processing.

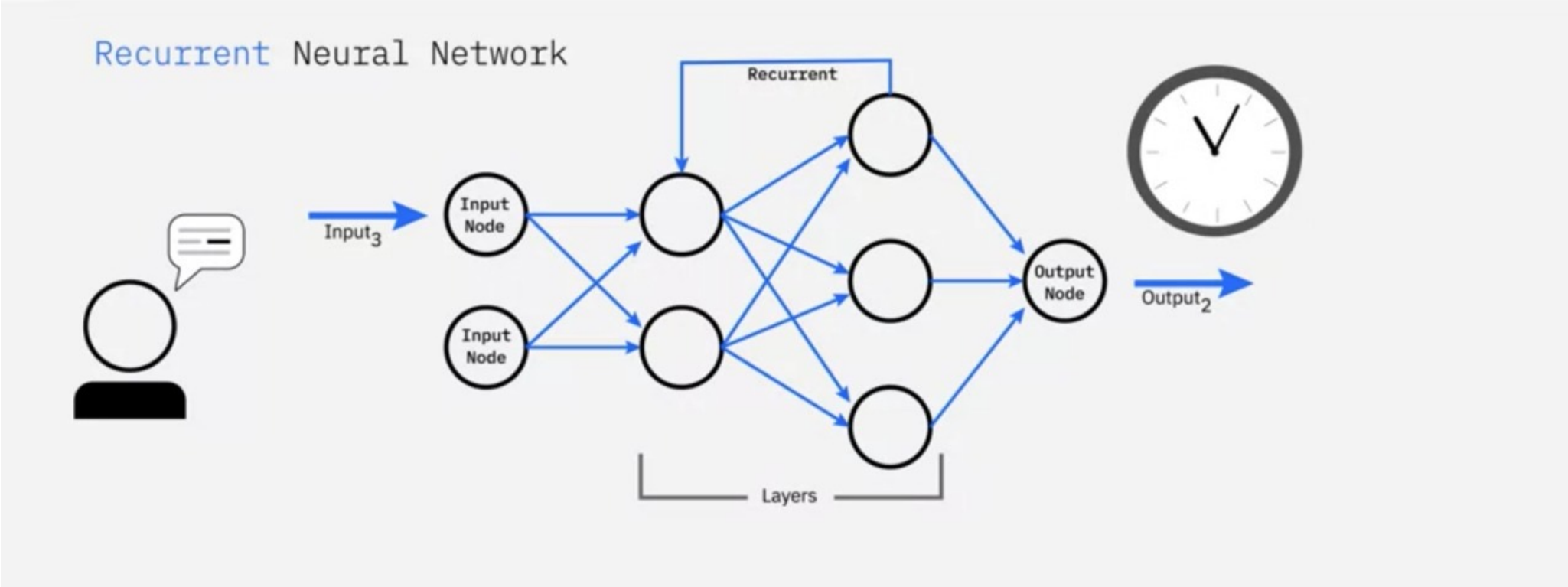
A convolution is a mathematical operations, where a function is applied to another function and the result is a mixture of the two functions.

Convolutions are good at detecting simple structures in an image and putting those simple features together to construct more complex features.

- In a convolutional network, this process occurs over a series of layers, each of which conducts a convolution on the output of the previous layer.
- CNNs are adept at building complex features from less complex ones.

Recurrent Neural Networks (RNNs)

Recurrent because they perform the same task for every element of a sequence, with prior outputs feeding subsequent stage inputs.



- In a RNN, an input is processed through a number of layers and an output is produced with an assumption that the two successive inputs are independent of each other,
- RNNs can make use of information in long sequences, each layer of the network representing the observation at a certain time.

Summary

- Machine Learning, a subset of AI, uses computer algorithms to analyze data and make intelligent decisions based on what it has learned.
- Deep Learning, a specialized subset of Machine Learning, layers algorithms to create a neural network enabling AI systems to learn from unstructured data and continue learning on the job.
- Neural Networks, a collection of computing units modeled on biological neurons, take incoming data and learn to make decisions over time. The different types of neural networks include Perceptrons, Convolutional Neural Networks or CNNs, and Recurrent Neural Networks or RNNs.

References

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- Andrew Ng, *AI For Everyone*, deeplearning.ai