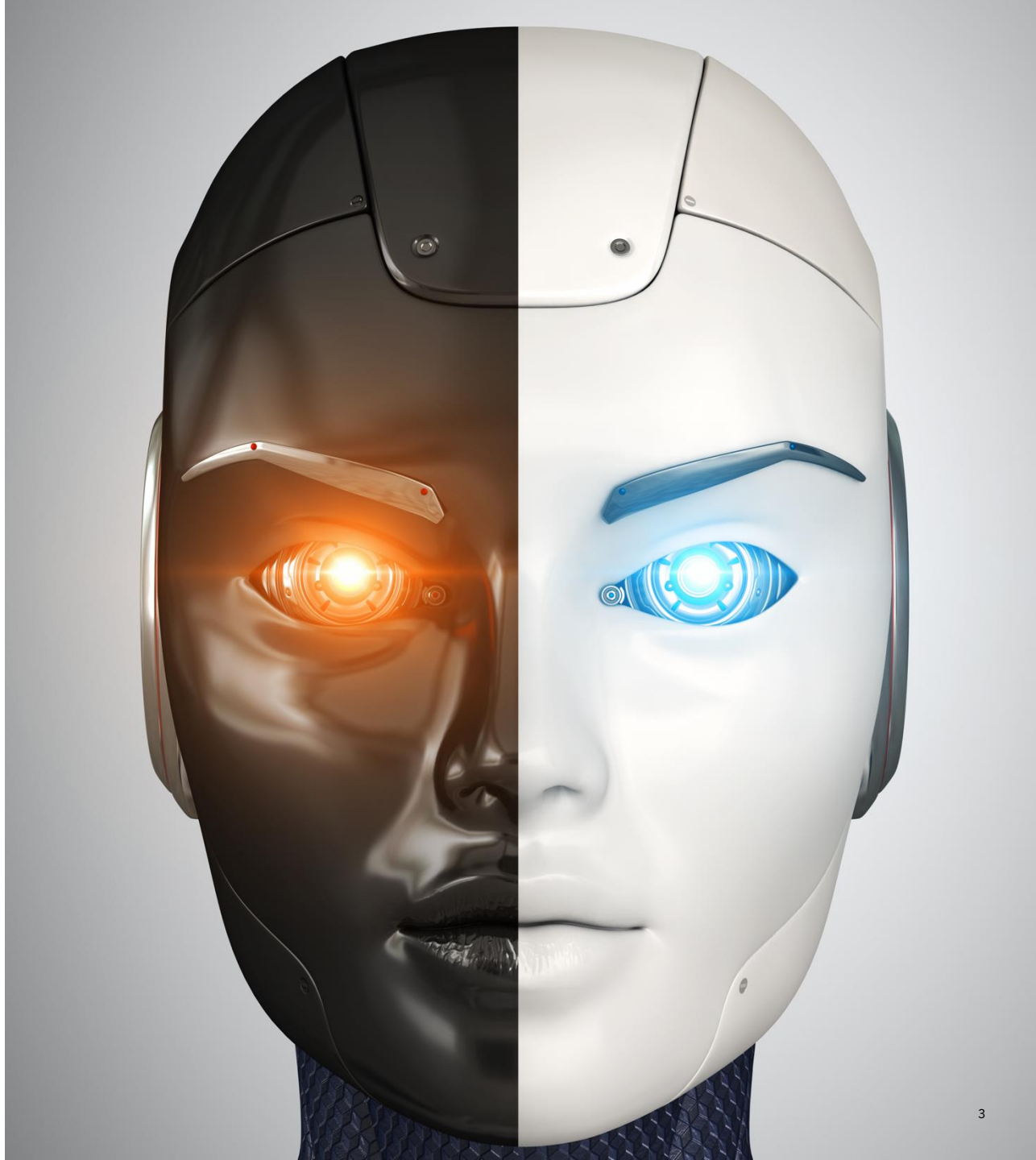
The Evolution of Artificial Intelligence

LECTURE 1

The Evolution of Artificial Intelligence

1. AI impact in the world today
2. History and Evolution of AI
3. AI is Good at Finding the Needle in the Haystack
4. Machine Learning Methods
5. Resources

What is your definition of **Artificial Intelligence?**



ARTIFICIAL INTELLIGENCE

Perception *TODAY*

Highly influenced by media and entertainment industry

Atlasiko Inc

3 TYPES OF ARTIFICIAL INTELLIGENCE

Artificial Narrow Intelligence (ANI)

Stage-1

Machine Learning

Artificial General Intelligence (AGI)

Stage-2

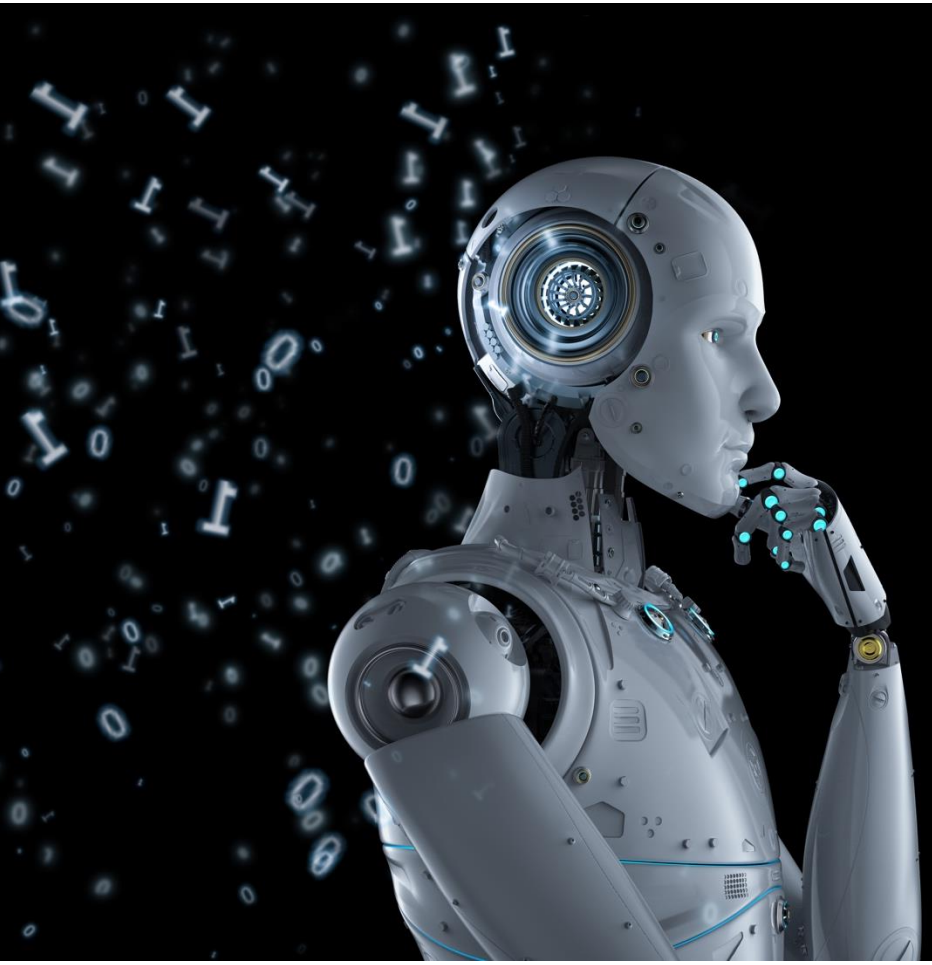
Machine Intelligence

Artificial Super Intelligence (ASI)

Stage-3

Machine Consciousness

Artificial Intelligence: Definition



"Artificial Intelligence (AI) is a science and a **set of computational technologies** that are *inspired* by — but typically operate quite differently from —the ways people use their nervous systems and bodies to **sense, learn, reason and take action**."

AI - TODAY

AI applications are transforming every industry

Government
Campaign Content and Planning, Citizen Experience, Public Security, Policy Planning Support

Finance
High Frequency Trading, Risk Modeling, Equity Research, Asset Mgmt, Underwriting, Investment Planning, Security

Agriculture
UAV / Satellite Crop Field Analysis, Disease Recognition, Comprehensive Strategic Crop Planning

Energy
Strategic Oil Drilling, Risk Minimization, Geological Analysis, Demand Prediction, Adjustment of Resource Generation

Healthcare
Personalized Healthcare, Diagnostic Tools, Integrated Wellness and Health Systems, Behavior Tracking, Security

Education
Personalized Education, Learning Content Indexing-to-Skill & Search, Custom Teaching Methods, Smart View Devices

Science
Data Analysis, Experiments, Predictive Modeling, Theorem Proving, Deductive Reasoning, Experiment Planning

Business Solutions
Interactive Chatbots that Learn from Experience with Customers, Regulatory Support, Prediction, Marketing

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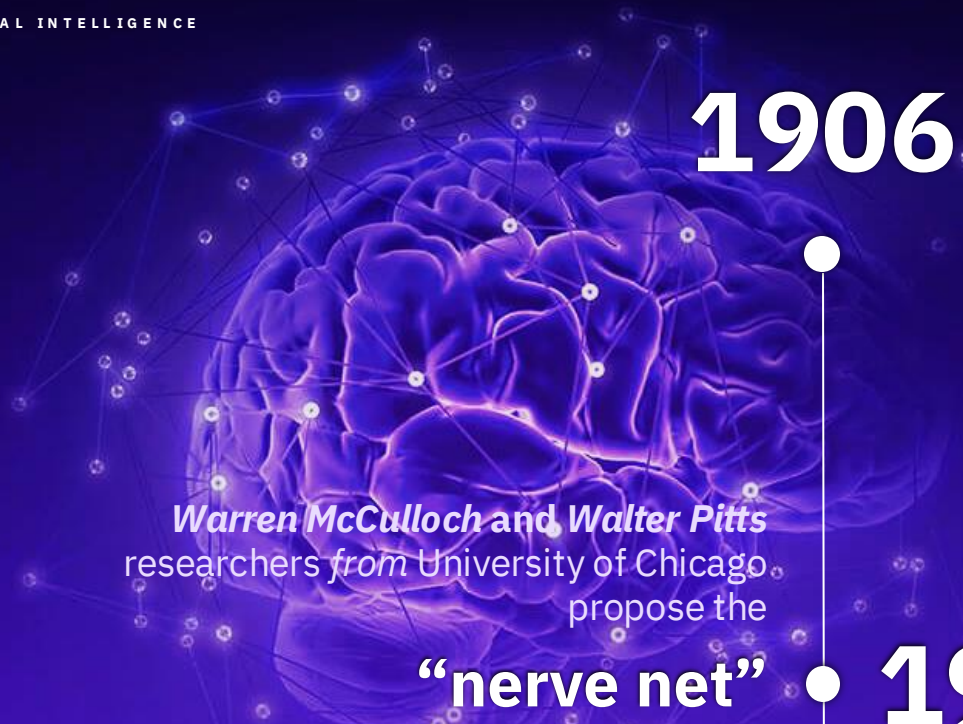
Abraham Wald and the missing bullet holes

Abraham Wald was a Hungarian mathematician (1902-1950) founded the field of statistical sequential analysis. He spent his research years at Columbia University.

History and Evolution of Artificial Intelligence



1906

Camilo Golgi **and** ***Santiago Ramon y Cajal*** receive the Nobel Prize for developing the

“neuron doctrine” – the theory that the brain operates through interconnected individual cells.

1943

Warren McCulloch **and** ***Walter Pitts*** researchers *from* University of Chicago propose the

“nerve net” – the first mathematical model of neurons and connections in the brain.

1950

Alan Turing publishes the paper “Computing Machinery and Intelligence” introducing the

“Turing Test” – to determine machine’s human ability.

Artificial Intelligence Evolution

Darthmouth College summer workshop with top scientists

1956

“Field of A.I. was born” – predicted that a machine as intelligent as a human being would exist in no more than a generation.

1957

Frank Rosenblatt first demonstrated the Perceptron on an IBM 704 before building a custom machine.

“Perceptron” – the first trainable neural network algorithm, included photocells for image recognition.

MIT researchers *Marvin Minsky* and *Seymour Papert* publish

1969

“Perceptron's critique” – which drew very pessimistic conclusions about prospects for improving the Perceptron model of artificial intelligence.

Artificial Intelligence Evolution

1974-1980

"FIRST AI Winter"
– the Lighthill report and governments' funding restrictions.

Several researchers independently invent backpropagation training of neural nets. The algorithm successfully learned in many areas which Minsky and Papert had predicted would be impossible, helping launch a revival of interest in neural nets

1985

"AI Renaissance"
– The Snowbird neural networks workshop and the NIPS (Neural Information Processing Systems) conference.

IBM researcher *Gerald Tesauro creates a self-teaching neural net that learns to play backgammon*

1992

"TD-Gammon"
– solely by playing against itself and learning from the game outcomes.

Artificial Intelligence Evolution

1987-1993

"SECOND A.I. Winter"
– Collapse of the Lisp machine market.

1993

Yann LeCun demonstrates a **Convolutional Neural Network**.

"LeNet 1" – capable of recognizing handwritten digits quickly and accurately.

1997

IBM's Deep Blue, a computer capable of analyzing 200 million moves per second.

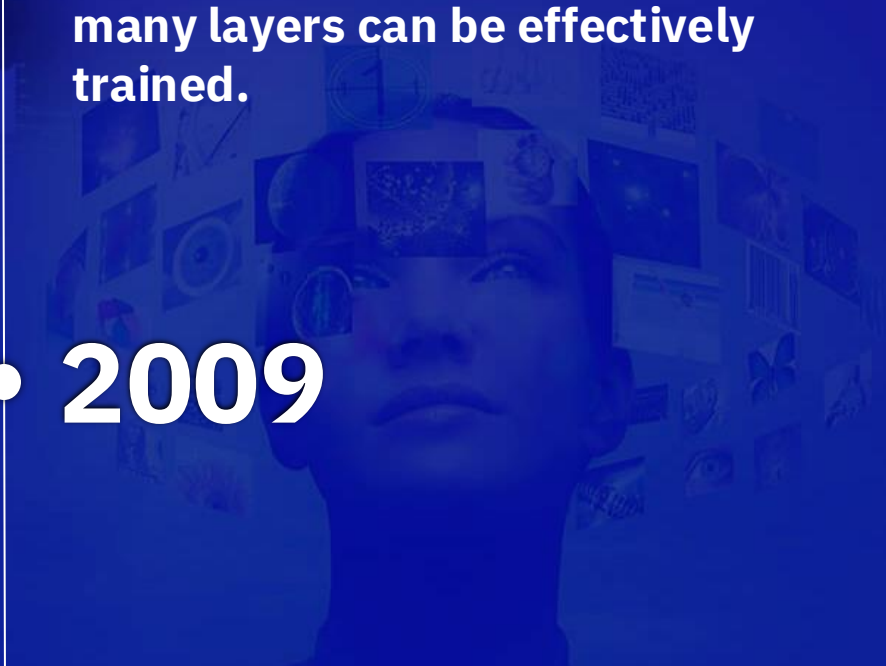
"Deep Blue"
– defeats reigning world chess champion *Garry Kasparov*.

Artificial Intelligence Evolution

2006

Hinton and colleagues demonstrate that so-called "Deep Belief Nets" Their work launches today's the movement

"Deep Learning" – with many layers can be effectively trained.



2009

Researchers unveil a massive collection of human-annotated images

"ImageNet" – the definitive data set for teaching deep learning algorithms that can *see*.

2011

IBM makes international headlines when their system appears on Jeopardy!—and wins

"Watson" – Natural Language Processing

Artificial Intelligence Today

For the first time, deep neural networks classify ImageNet images with greater accuracy than humans

“Open Source A.I.” – Open Source Frameworks and data available to everyone.

2015

Uber pilots self-driving cars program in Pittsburgh, PA

2016

“Self-driving cars” – capable of transit through city traffic without a driver.

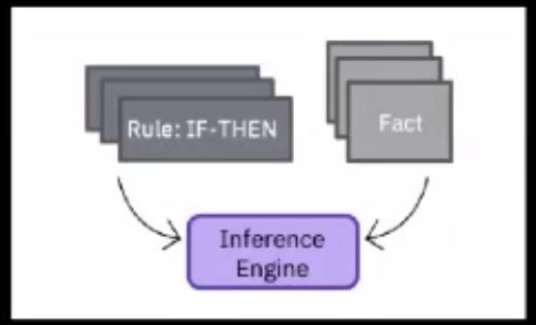
IBM unveils Deep Learning as a Service, which allows anyone with an internet connection to take advantage of sophisticated AI algorithms, rich data platforms, and immense computing power.

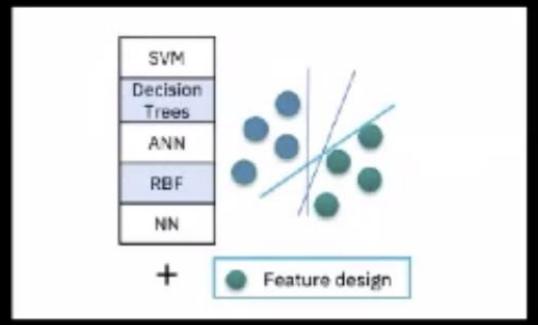
“Deep Learning as a Service”

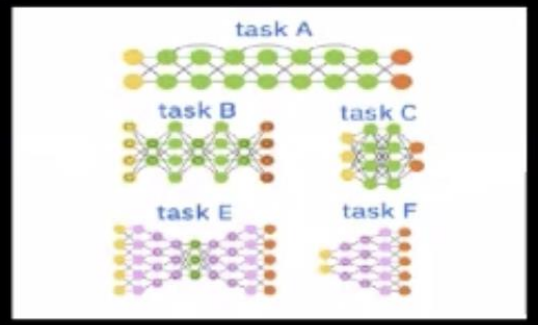
2018

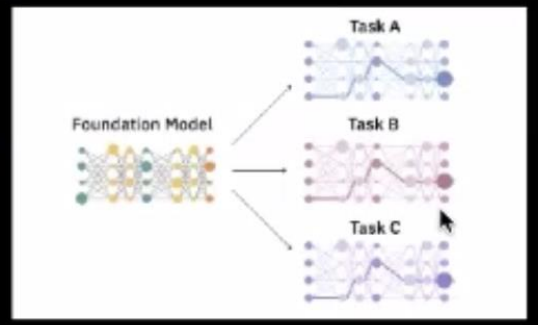
The history of AI can be described in terms of the evolution of representations

80s | Big data | **80s to ~2010** | Massive data + Compute | **2010 -2017+** | Self-supervision at scale + Massive data + Compute









Expert Systems

Hand-crafted symbolic representations

Machine Learning

Task-specific hand-crafted feature representations

Deep Learning

Task-specific learnt feature representations

Foundation Models

Generalizable & adaptable learnt representations

NATURAL LANGUAGE PROCESSING

IBM WATSON and **Jeopardy**

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Watson beyond Jeopardy!

// IBM WATSON

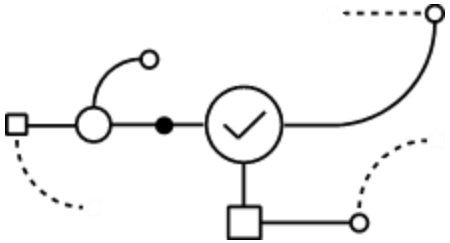
Watson is augmented intelligence: helping people and machine work together to create knowledge from data that enhances human expertise

AI systems can go beyond knowledge, they **understand, reason, learn, and interact**

UNDERSTAND

AI systems can understand unstructured information the same way humans do

REASON



They can reason, grasp underlying concepts, form hypotheses, and infer to extract ideas

LEARN

Each data point, interaction and outcome helps to continuously sharpen expertise

INTERACT

With abilities to see, talk and hear, AI systems interact with humans in a natural way

Data evolution – growing at an exponential rate

4 billion pieces of content shared daily

30 million smart meters in Italy

200mb of data per cow per year

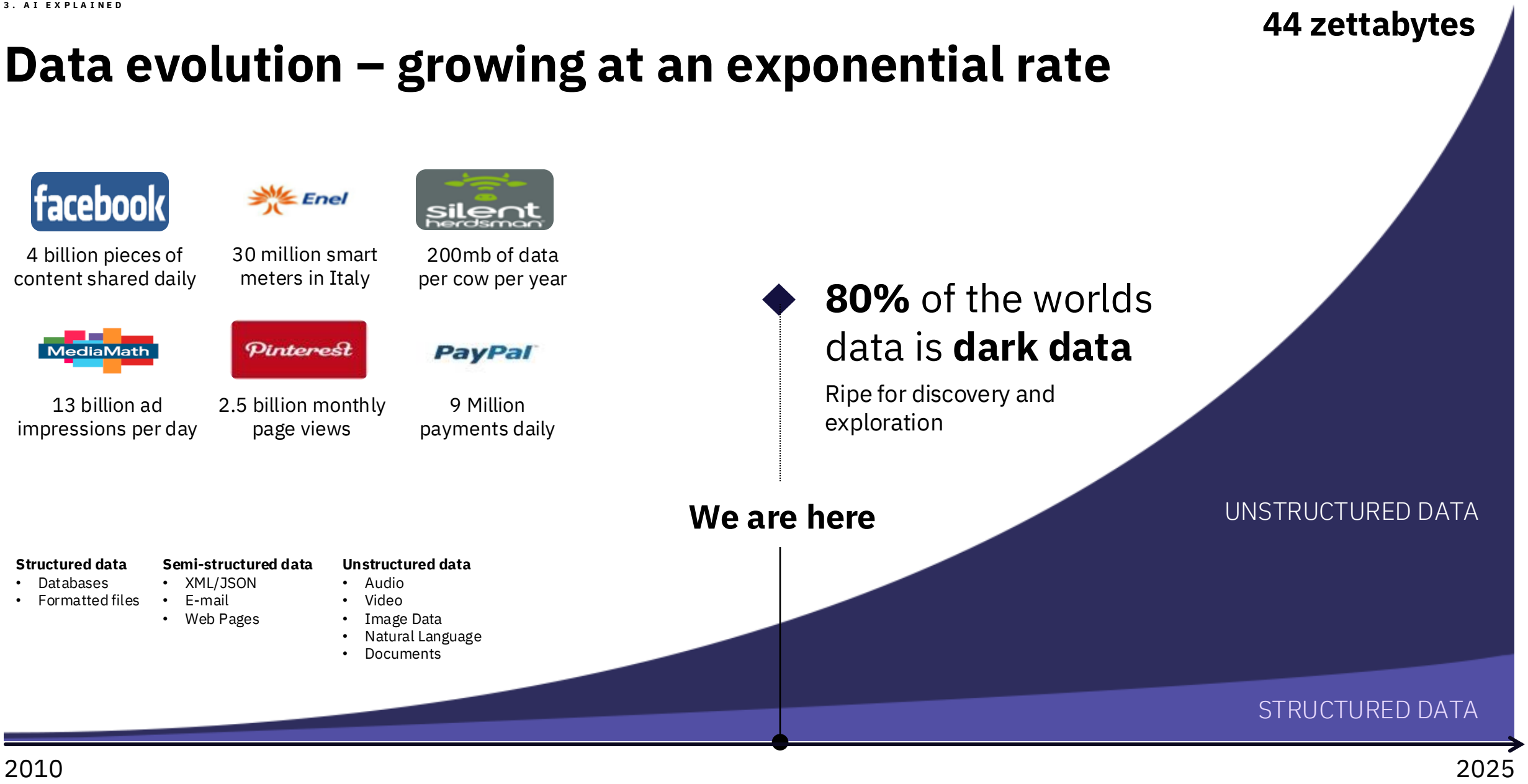
13 billion ad impressions per day

2.5 billion monthly page views

9 Million payments daily

80% of the worlds data is **dark data**

Ripe for discovery and exploration



Structured data
- Databases
- Formatted files

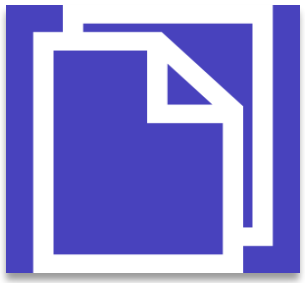
Semi-structured data
- XML/JSON
- E-mail
- Web Pages

Unstructured data
- Audio
- Video
- Image Data
- Natural Language
- Documents

How to provide insights on complex and volatile data?

Data is growing with time, but only a fraction of it is usable through traditional analytics

DATA



How to keep up with the mountains of contextual data available to you, even when most of it is unstructured in format

COMPLEXITY

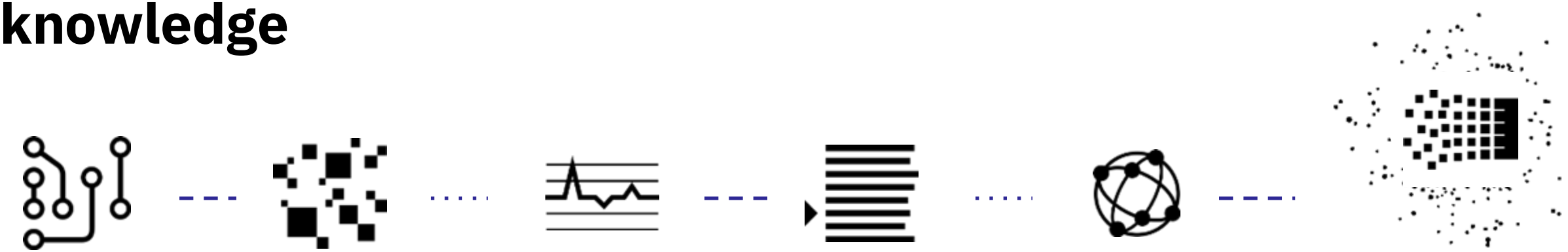
How to overcome and solve for great complexity by giving the skill and knowledge of the informed few to the empowered many

VOLATILITY

How to stay ahead of the ever-changing expectations customers have for what's possible, leading your market segment in new ways

WHAT IS THE SOLUTION?

AI systems can transform unstructured data into knowledge



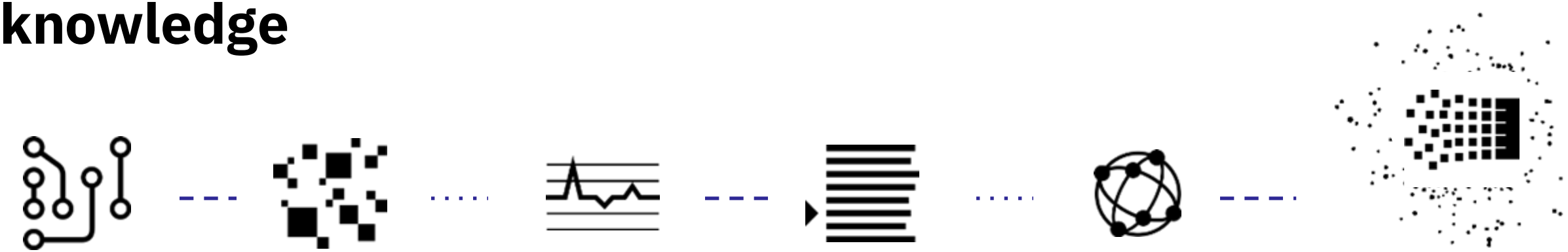
SENSORS **DATA** **ANALYTICS** **INFORMATION** **COGNITIVE** **Knowledge**

UNSTRUCTURED **DATA**

- Reports
- Tweets
- Social media
- Maps
- Weather
- Industry Documents
- Streaming Data
- Patents
- Legislation
- Regulation
- Newspapers
- Blogs & Wiki
- Economic reports
- Forecasts
- College classes
- Video libraries
- News libraries
- Health data
- Sensors, Machine Logs

WHAT IS THE SOLUTION?

AI systems can transform unstructured data into knowledge



SENSORS DATA ANALYTICS INFORMATION COGNITIVE **Knowledge**

UNDERSTAND REASON LEARN

How does an AI system learn?

AI LEARNING PROCESS

HUMAN

1. Identify the data-analytics problem
2. Defines the right algorithm and tools
3. Collect and clean relevant problem data
4. Define hyperparameters
5. Engineer the features in a way that it fits the model

MACHINE

6. Learns to recognize patterns in the fed data
7. Maps these patterns to future outcomes

8. Analyze the data provided by the model
9. Provides feedback on the model

Loop

10. Learns by adjusting weights & biases
11. Model iteration to decrease error

12. Identifies patterns and trends
13. Share results with stakeholders

AI enables a partnership between humans and technology

Humans
excel at

Morals

Imagination

Compassion

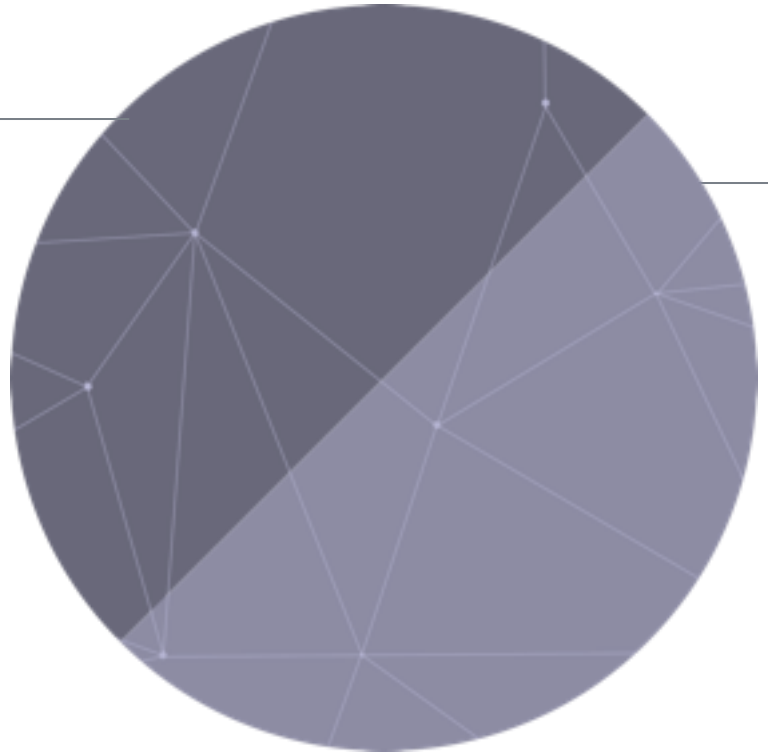
Dilemmas

Abstraction

Dreaming

Generalization

Common sense **(but with many biases)**



AI Systems
excel at

Locating knowledge

Natural language

Pattern identification

Machine learning

Providing endless capacity

Eliminating Biases

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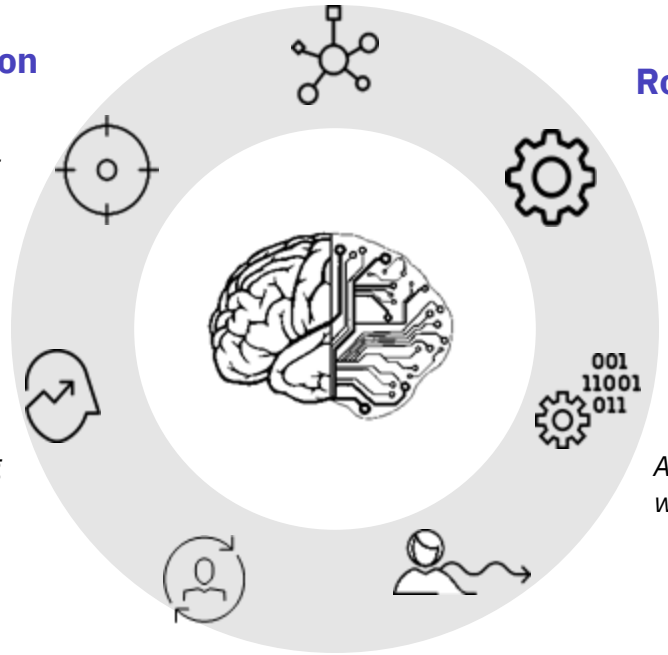
AI systems are underpinned by advanced technologies

Cognitive/AI Technologies

Artificial intelligence

Simulation of human intelligence processes



Recommendation engines

Analyze data and suggest something as per user's interest

Robotics

Conception, design, manufacture, and operation of robots

Predictive analytics

Predicting outcomes using statistical algorithms and machine learning

Machine learning systems

Ability to learn and improve without explicit instructions

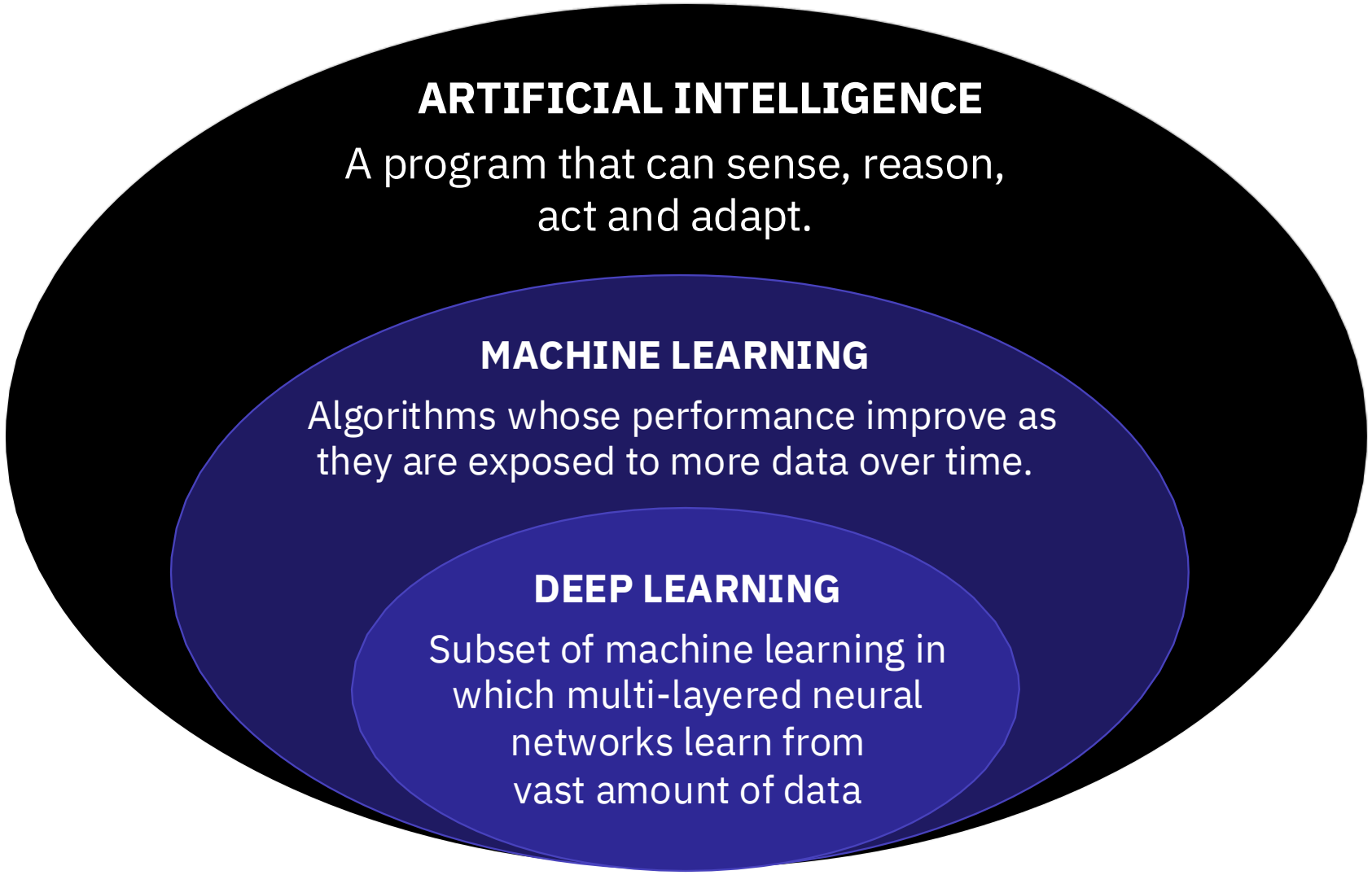
Deep learning

Machine learning with artificial neural network algorithms

Natural language processing

Ability to understand human speech as it is spoken

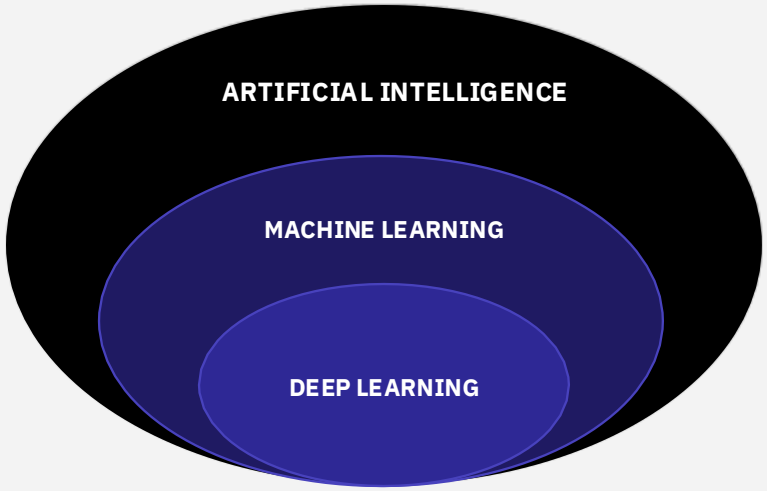
Difference between AI, Machine Learning and Deep Learning



Machine Learning

Machine Learning algorithms iteratively learn from data, thus allowing computers to find hidden insights without being explicitly programmed where to look.

Machine Learning is essentially teaching the computer to solve problems



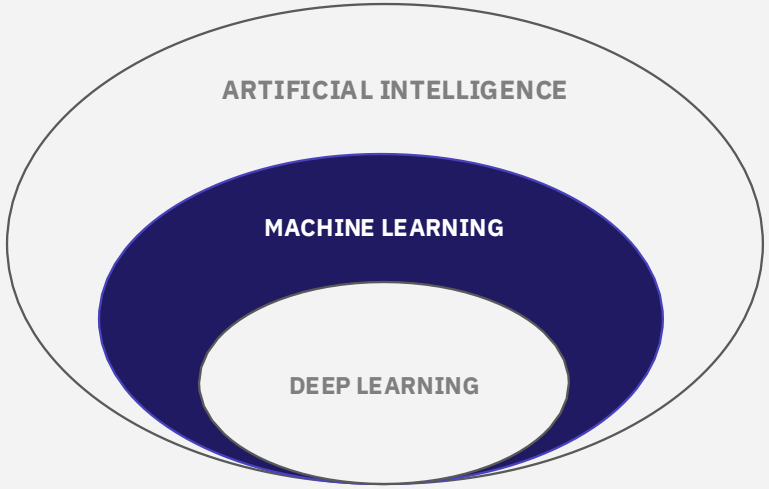
Three broad categories:

1. **Supervised learning**
2. **Unsupervised learning**
3. **Reinforcement learning**

1. Supervised Learning

Supervised learning trains on large volumes of historical data and then builds general rules to be applied to future problems.

Example: Voter details labeled with their votes (label) in the previous years

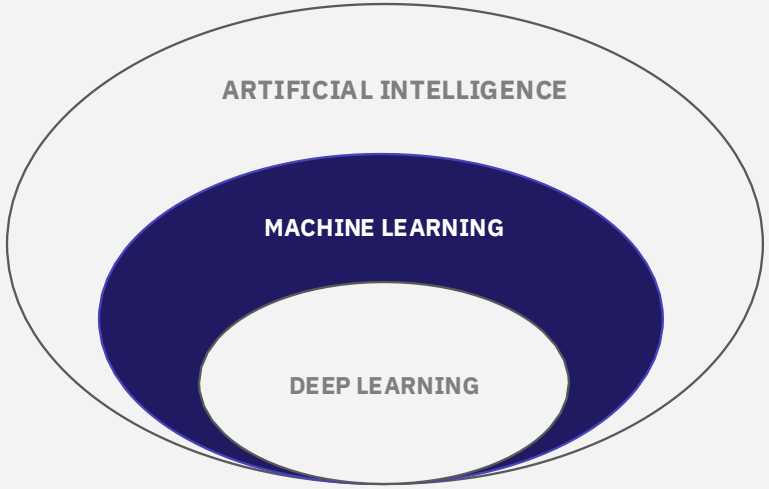


The most widely used supervised learning algorithms are Support Vector Machines, Linear Regression, Logistic Regression, Naive Bayes, and Neural Networks (multilayer perceptron).

2. Unsupervised Learning

While supervised learning relies on labeled or structured data (think rows in a database), unsupervised learning trains on unlabeled or unstructured data (the text of a book).

These algorithms explore the data and try to find structure.

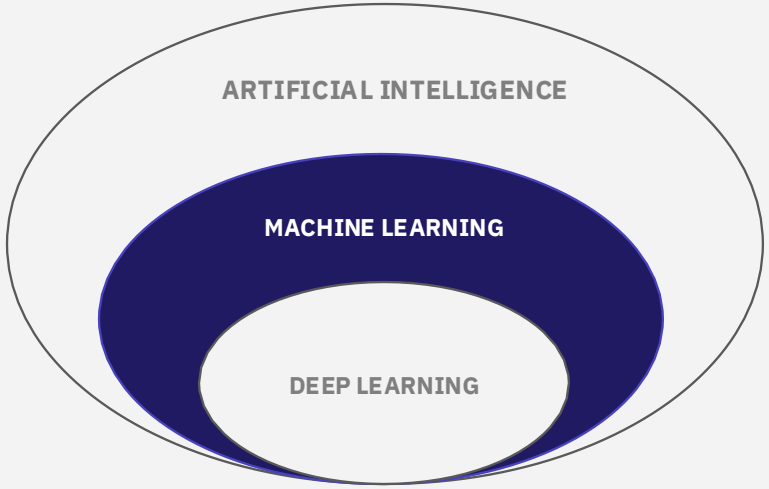


Here, widely used unsupervised learning algorithms are cluster analysis and market basket analysis.

3. Reinforcement Learning

It is not given a specific goal, but rather learns from trial and error.

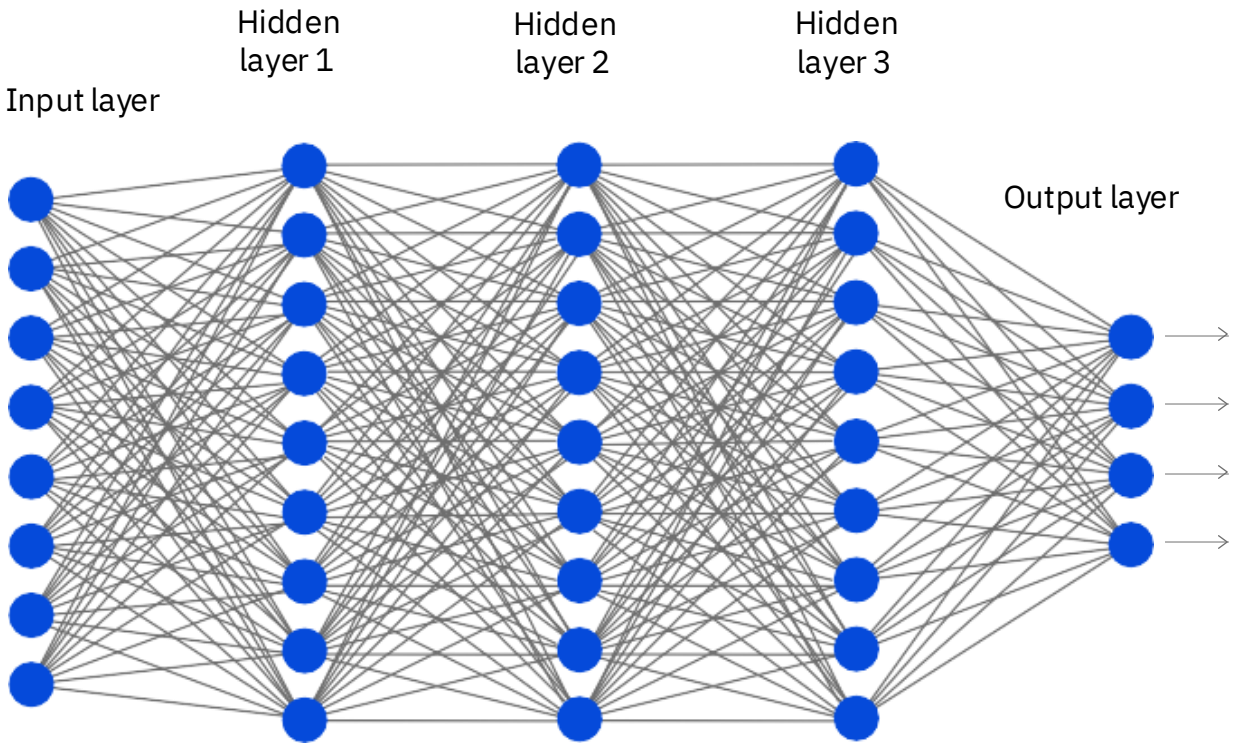
Reinforcement learning rewards the algorithm when it performs the correct action (behavior), and assigns a penalty when incorrect.

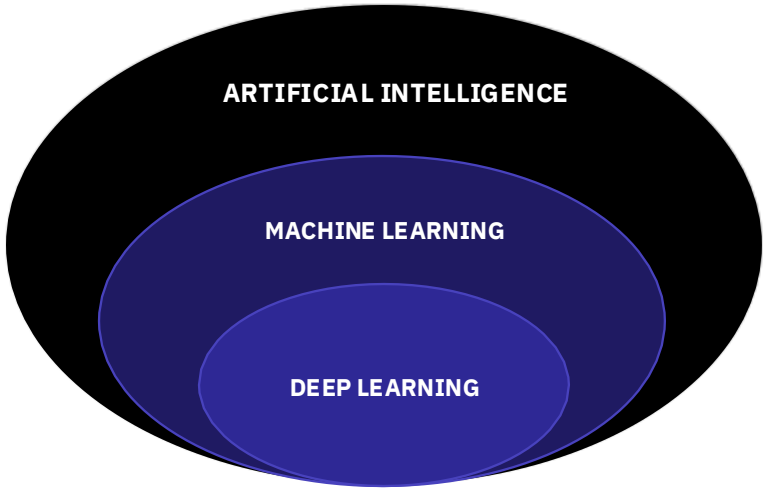


Reinforcement learning is most widely used in self-driven cars, drones, and other robotics applications.

Deep Learning

Is a family of algorithms that implements deep networks (many layers)





DL almost always outperforms the other types of algorithms when it comes to:

- Image classification
- Natural language processing
- Speech recognition.

Example:

Recognizing melanoma or conducting machine translation, which was not possible using previous techniques.

Transfer Learning

Transfer learning is the method of starting with a pre-trained model and training it for a new — related — problem domain.

The pre-trained network serves as transferred knowledge to be applied in another domain.

Available pre-trained models:

MobileNet is model-trained on the ImageNet database (covering millions of images with 20,000 classifications). It can perform object detection, landmark recognition

Object Detection is capable of localizing and identifying multiple objects in a single image.

Sentiment Discovery This NLP model can identify sentiment of natural language, but also indicate through a heat map the positive and negative elements of text.

YOLO for TensorFlow++ is a real-time object detection on mobile devices, can detect people and other objects in its field of view.

Car Classification, using the Core ML framework (Apple Devices), takes images and can output a prediction of the vehicle present (up to 431 vehicle models)

Lip Reading is a model that can correlate an audio track to a video to properly orient the audio to the video based upon lip reading.

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Resources

8. Martin Keen: five steps to build an AI model
   https://www.youtube.com/watch?v=jcgaNrC4ElU

9. Global Mobile Data Traffic Growth
   http://www.telecomtv.com/articles/mobile/cisco-predicts-292-exabytes-of-mobile-data-by-2019-12153/

10. What Do Data Scientists Do?
    https://datasciencedegree.wisconsin.edu/data-science/what-do-data-%20%20scientists-do/

11. The future of Cognitive computing
    https://www.ibm.com/blogs/bluemix/2015/11/future-of-cognitive-computing/

12. Dario Gil: Cognitive systems and the future of expertise
    https://www.youtube.com/watch?v=0heqP8d6vtQ

13. Why are deep neural networks hard to train?
    http://www.neuralnetworksanddeeplearning.com/chap5.html

14. Transfer learning for deep learning
    https://developer.ibm.com/articles/transfer-learning-for-deep-learning/