Spring 2025
STAT 5350/4350 Applied Deep Learning

Module 2 - AI Fundamentals

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IBM

5350/4350 Applied Deep Learning

- This course will give students the language, knowledge, and actionable methods to work alongside technical and non-technical members of your team to create AI solutions.

- Students will explore what it means to design artificial intelligence systems as a team, guided by a clear intent and a focus on people. This course will give you the framework and tools you need to recognize responsible AI design, align your team, and work with data sources to start building AI solutions.

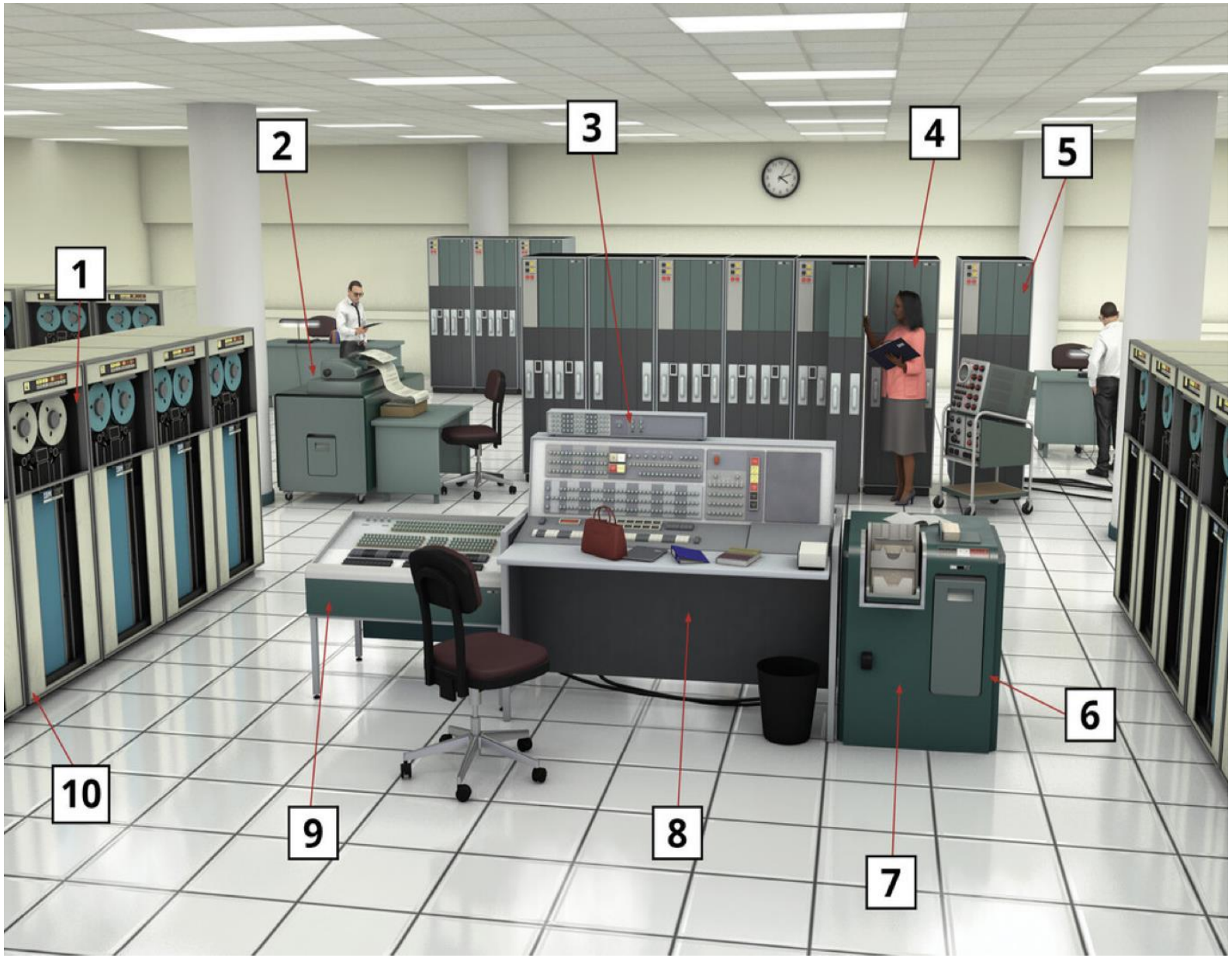
- Students will learn the tools, technology, and practices that enable cross-functional AI teams to efficiently deploy, monitor, retrain, and govern models in production systems.

Objectives of This Module

Upon completion of this module, you will understand:

1. Brief history of Artificial Intelligence (AI) & Deep Learning (DL)
2. AI Project Roles
3. AI Essentials Pre-req - Enterprise Design Thinking: https://www.ibm.com/design/thinking/page/courses/Practitioner
4. The AI Essentials Framework: https://www.ibm.com/design/thinking/page/badges/ai
5. AI methodologies (CRISP-DM Primer)
   a. Business Understanding
   b. Data Understanding
   c. Data Preparation
6. Lab: AI Project Executive Summary
7. Developing AI Models
   a. Agile SW development – AI Projects
   b. Tooling Review (IBM, Microsoft, AWS AI environments)
   c. ML Python Libraries review, Numpy, scikit-learn, TensorFlow, Pandas
   d. Development Resources (Low Code/No Code)
   e. Best Practices

First modern-age computer



https://apple.news/APyG-fJyzQtmq6dsEjinNBA

Recap

What is AI?

AI Perception

What do people feel about AI?

Fearful

Skeptical

Fascinated

Understood

Exposed

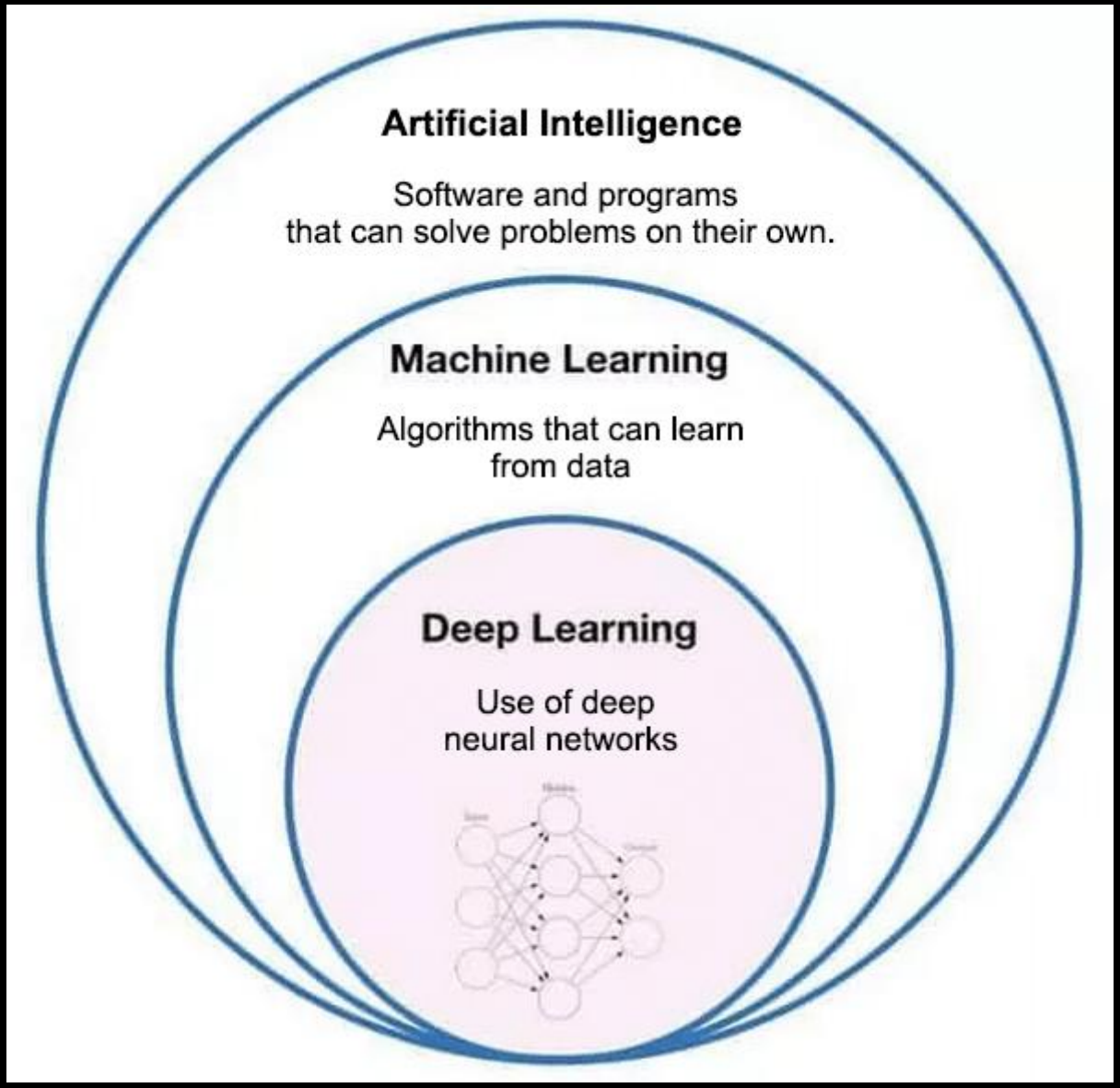
Apprehensive

Curious

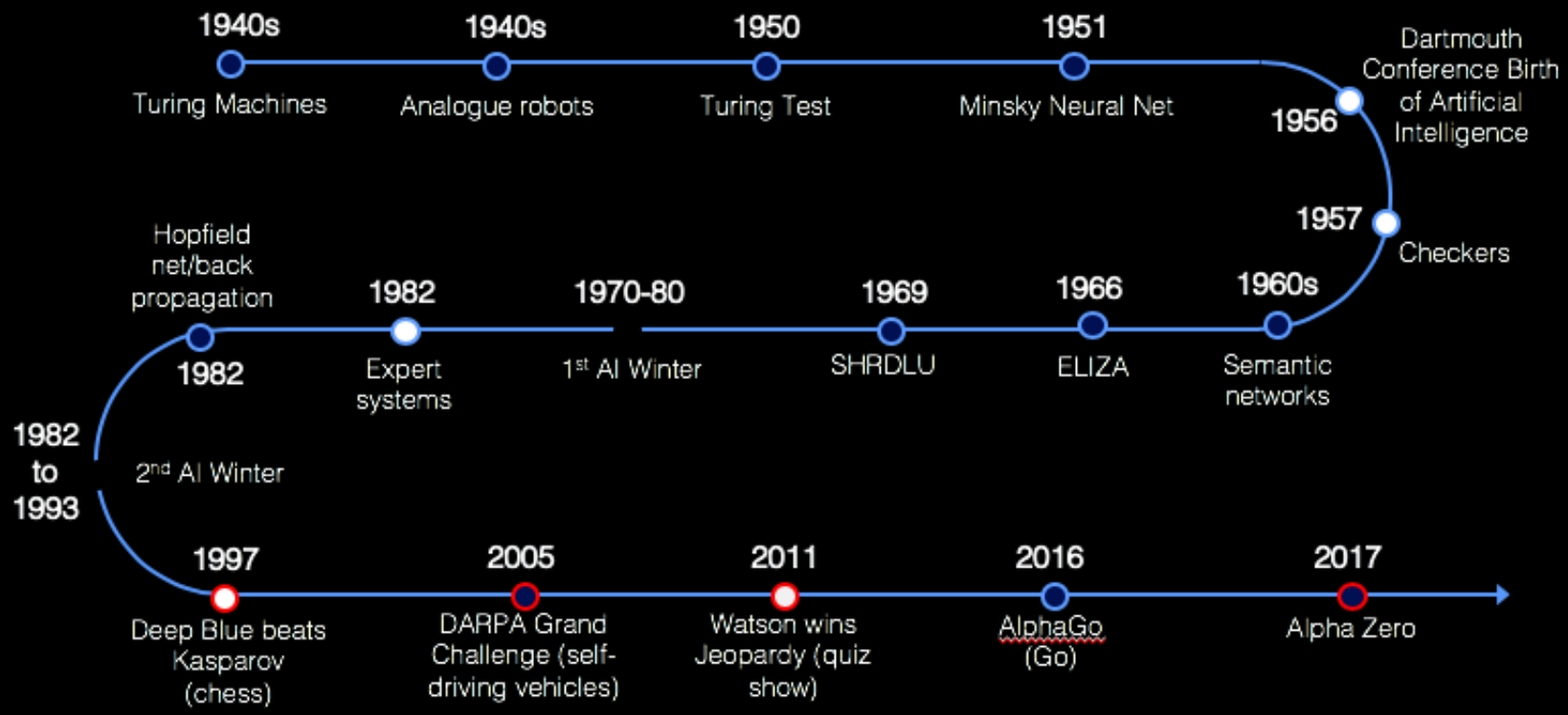
Excited

Well-served

What we know


Artificial Intelligence
Software and programs
that can solve problems on their own.
Machine Learning
Algorithms that can learn
from data
Deep Learning
Use of deep
neural networks

A brief history of AI



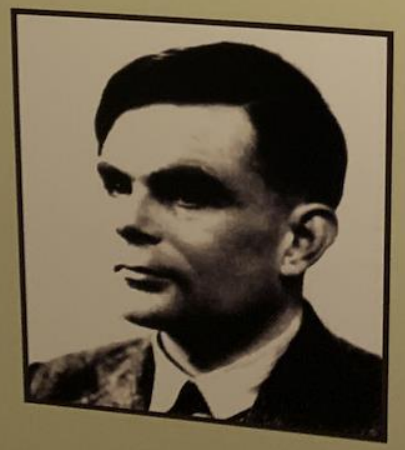
ALAN TURING'S OFFICE

Here at his desk in Hut 8, Turing took the lead on breaking naval Enigma ciphers – something few thought could ever be done. His mathematical skills also enabled him to break other ciphers, including the complex Lorenz cipher where he used a method that became known as Turingery. Together with his fellow Codebreaker Gordon Welchman, he developed the Bombe machine to help speed up the codebreaking process.

IN THEIR WORDS

If anyone was indispensable to Hut 8 it was Turing. The pioneer work always tends to be forgotten when experience and routine later make everything seem easy, and many of us in Hut 8 felt that the magnitude of Turing's contribution was never fully realised by the outside world.

Hugh Alexander, Codebreaker, Hut 8



Why AI/Machine Learning?

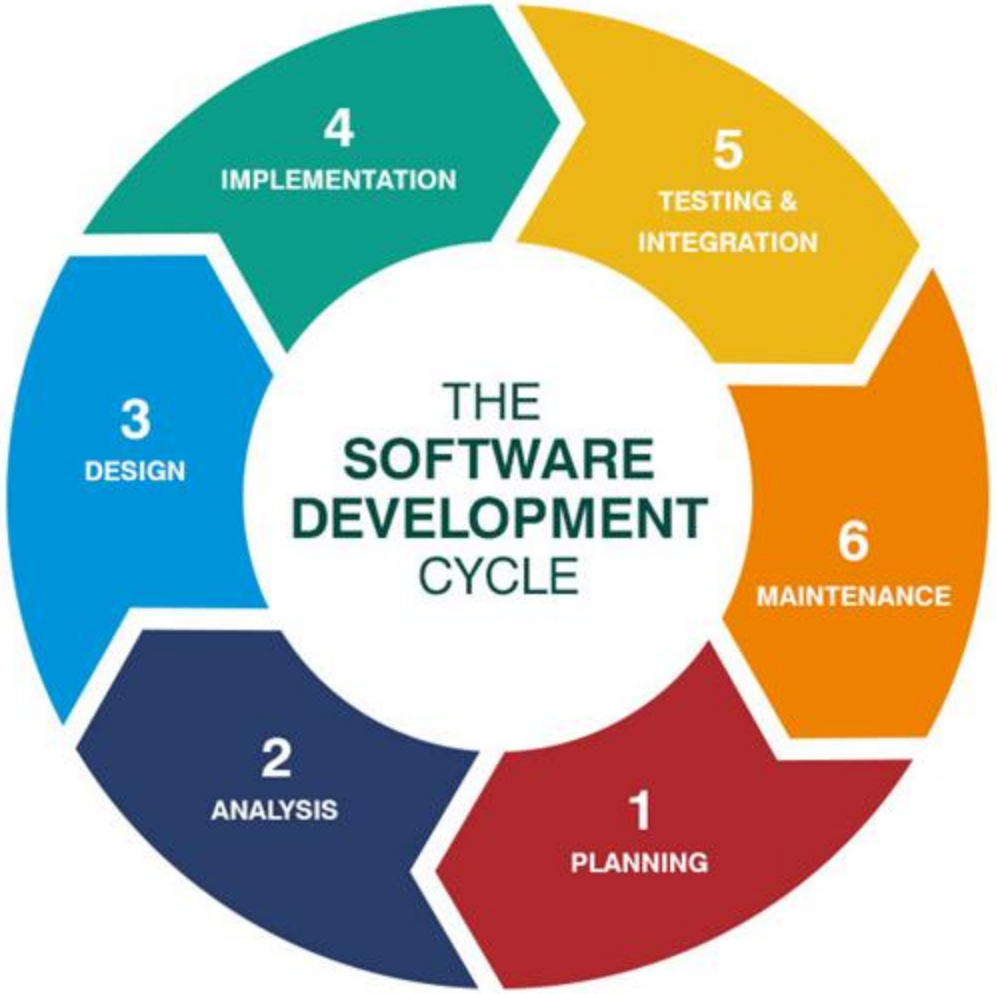
Traditional Programing

AI-Machine Learning

ML provides systems the ability to automatically learn from experience (without being explicitly programmed)

Agile

The Software Development Life Cycle

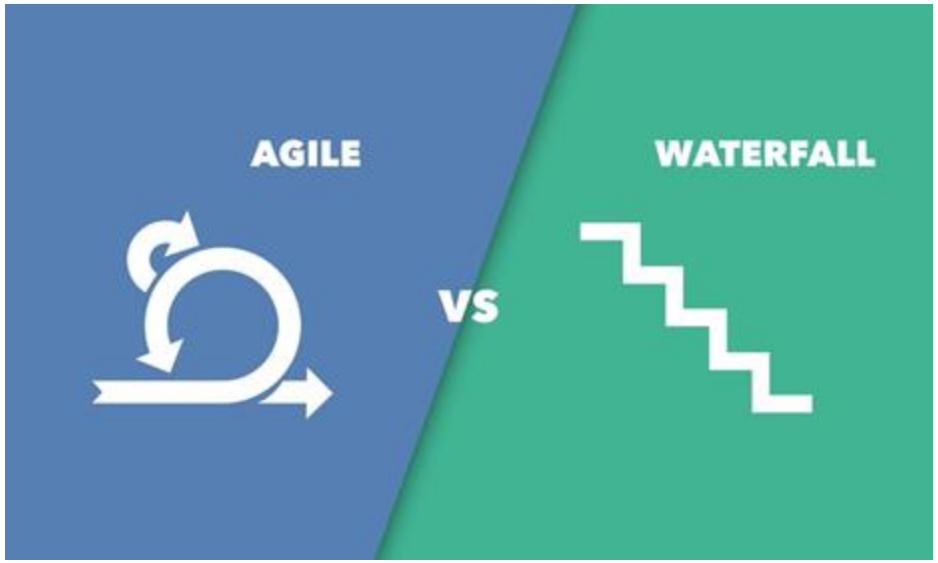


Waterfall vs Agile

Waterfall and **Agile** are two of the main SDLC models.

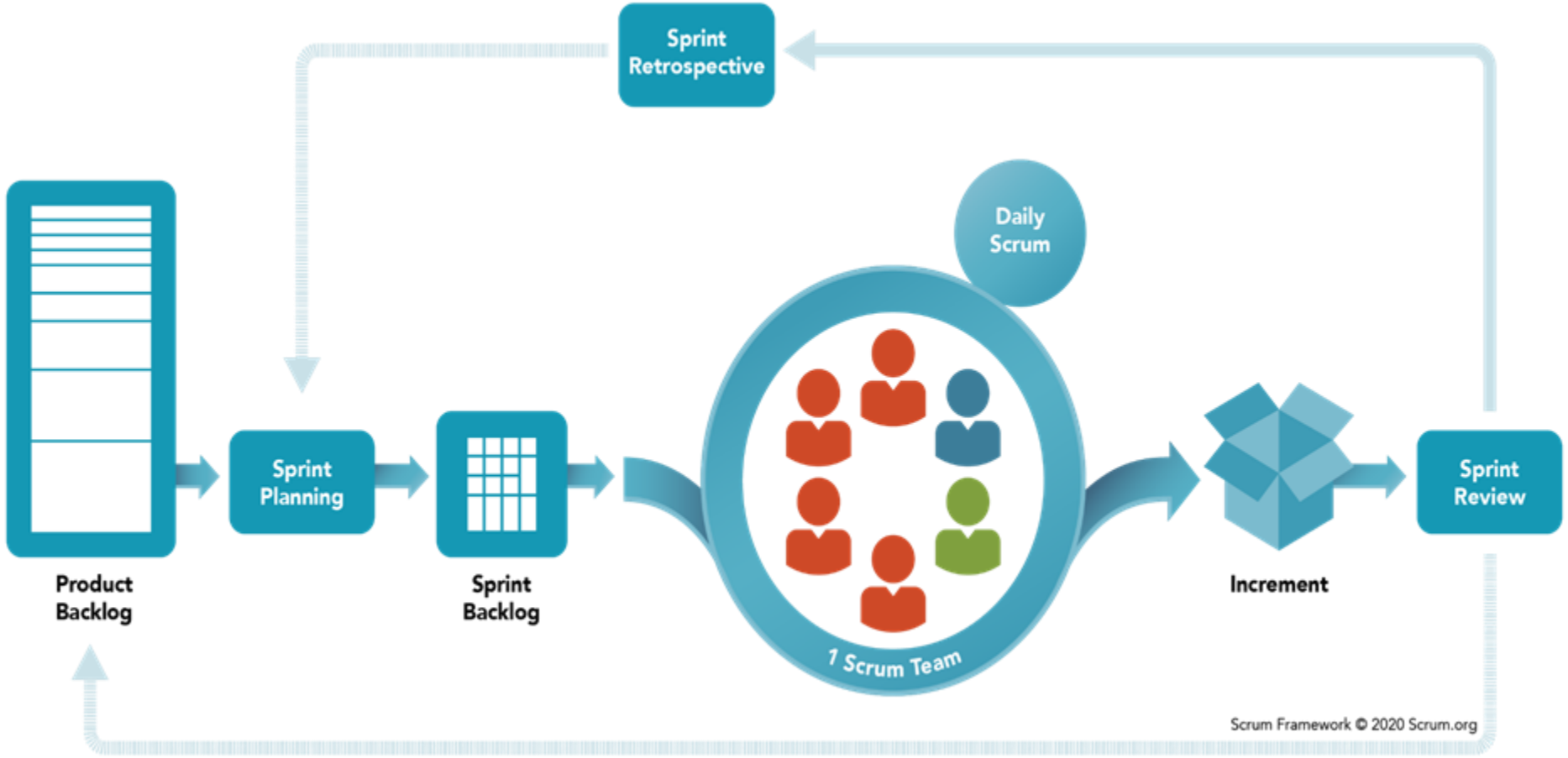
- Waterfall: Follows a sequential model of phases, each of which has its own tasks and objectives

- Agile: Uses cyclical, iterative progression to produce working software

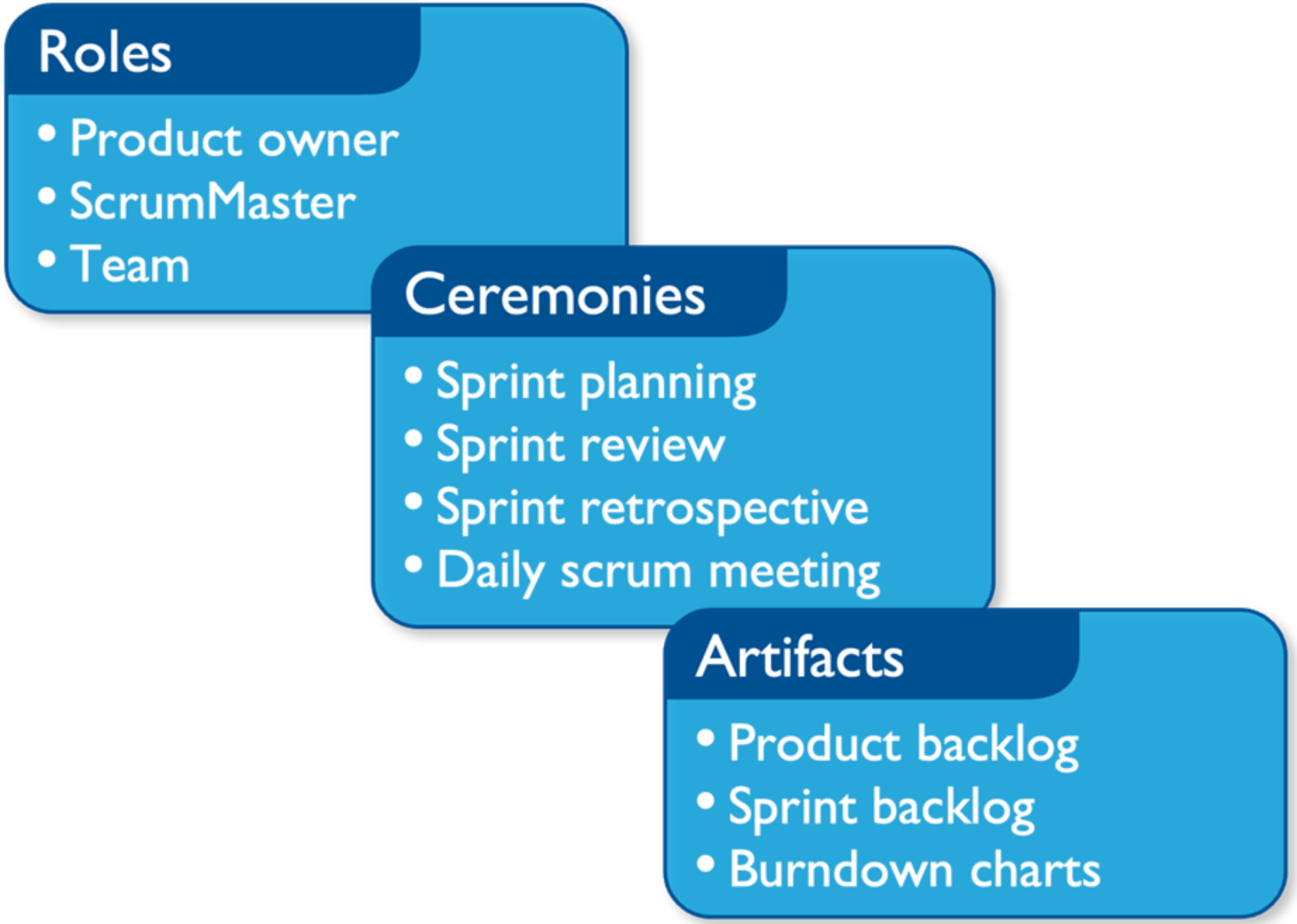


Agile Model

Scrum is an implementation of the **Agile Model** and it is the most widely-used one.

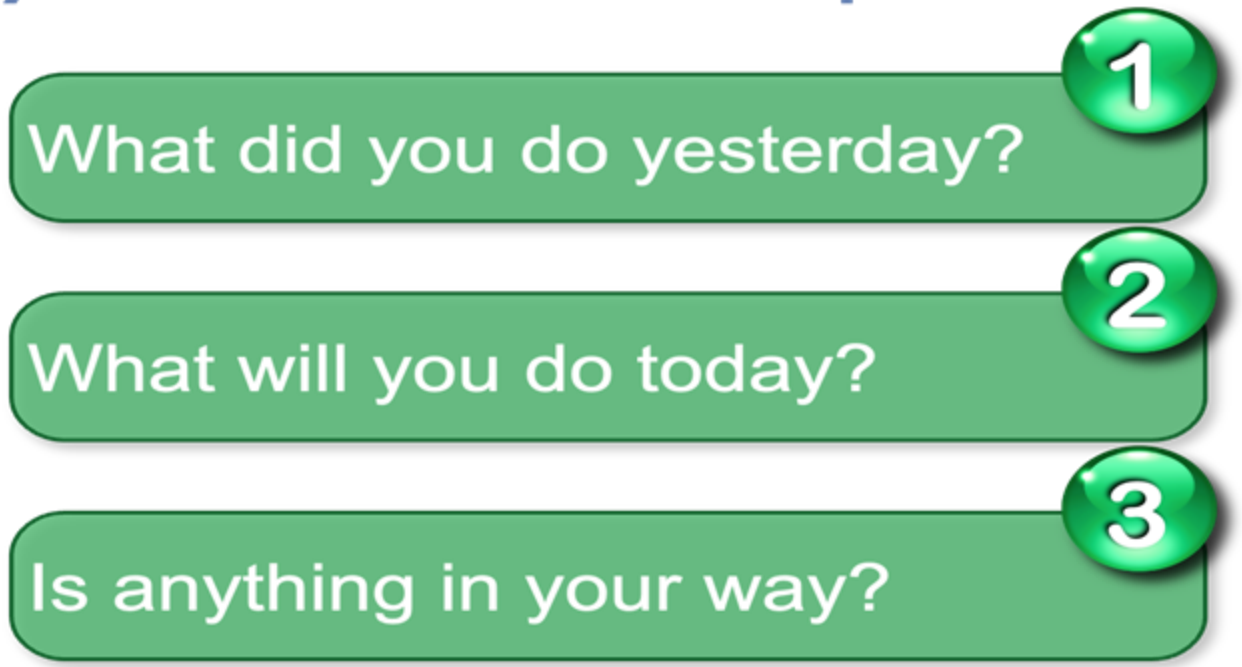


Scrum Framework



Daily Scrum

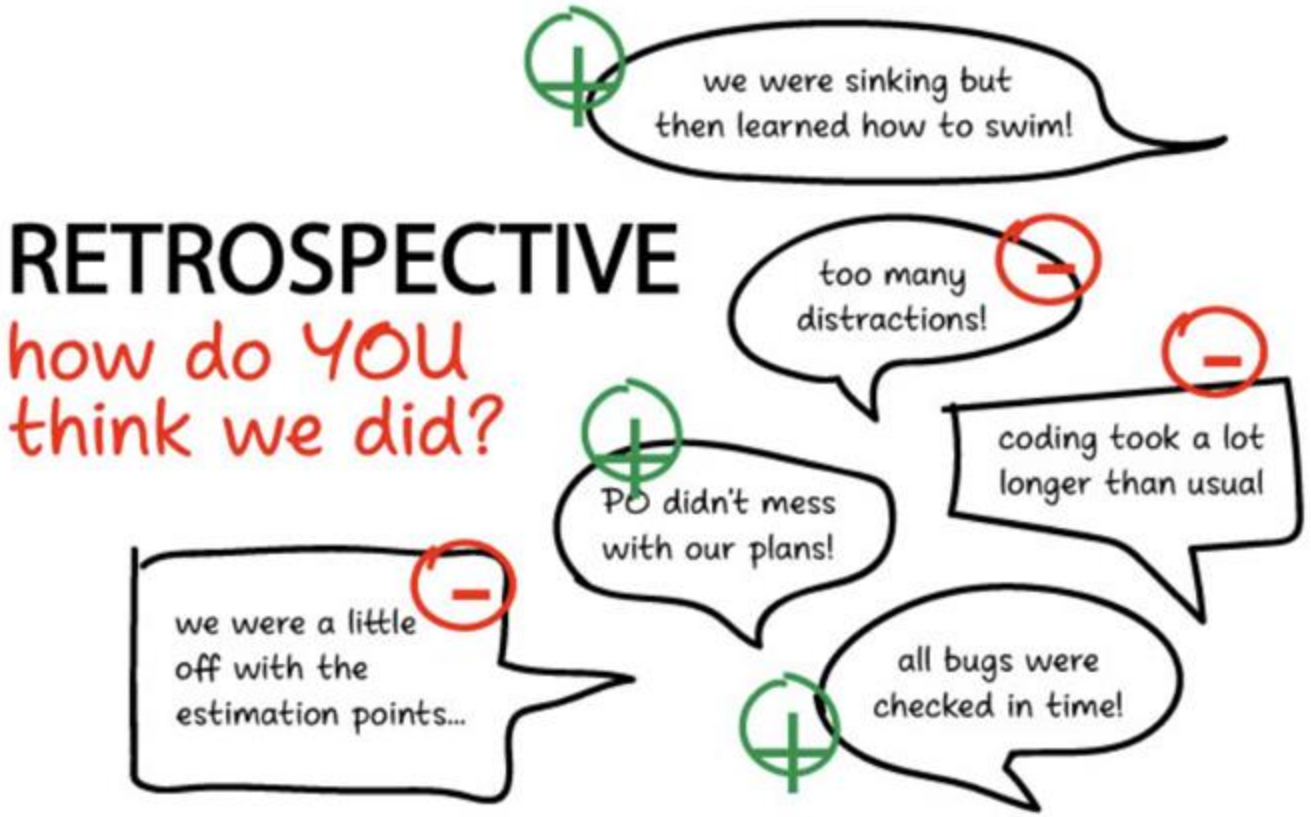
Everyone answers 3 questions



- These are *not* status for the ScrumMaster
  - They are commitments in front of peers

Sprint Retrospectives

"I have not failed.
I've just found
10,000 ways that
won't work."
-- Thomas A. Edison



Lab Results

Product Owner

Create a students' flyer/brochure for parents wanting to send their kids to CU

- Non-native English speakers
- Interested in support for neuro divergent students
- Live in/near the Equator (never seen snow)
- Alumni donated large sum for future students tuition ($10 MM)

https://app.mural.co/t/badm48308688/m/badm48308688/1738006647107/777b57496a10bae381fe6721536db41c3a6fc031?sender=uc418b717494c964835994700

Agenda

1. Artificial Intelligence
2. Demos & Labs
3. Deep Learning

AI in practice

Why are enterprises struggling to capture the value of AI?

Data

- Data resides in silos & is difficult to access
- Unstructured and external data isn't considered

Governance

- If the data isn't secure, self-service isn't a reality
- Understanding data lineage and getting to a system of truth is a challenge

Skills

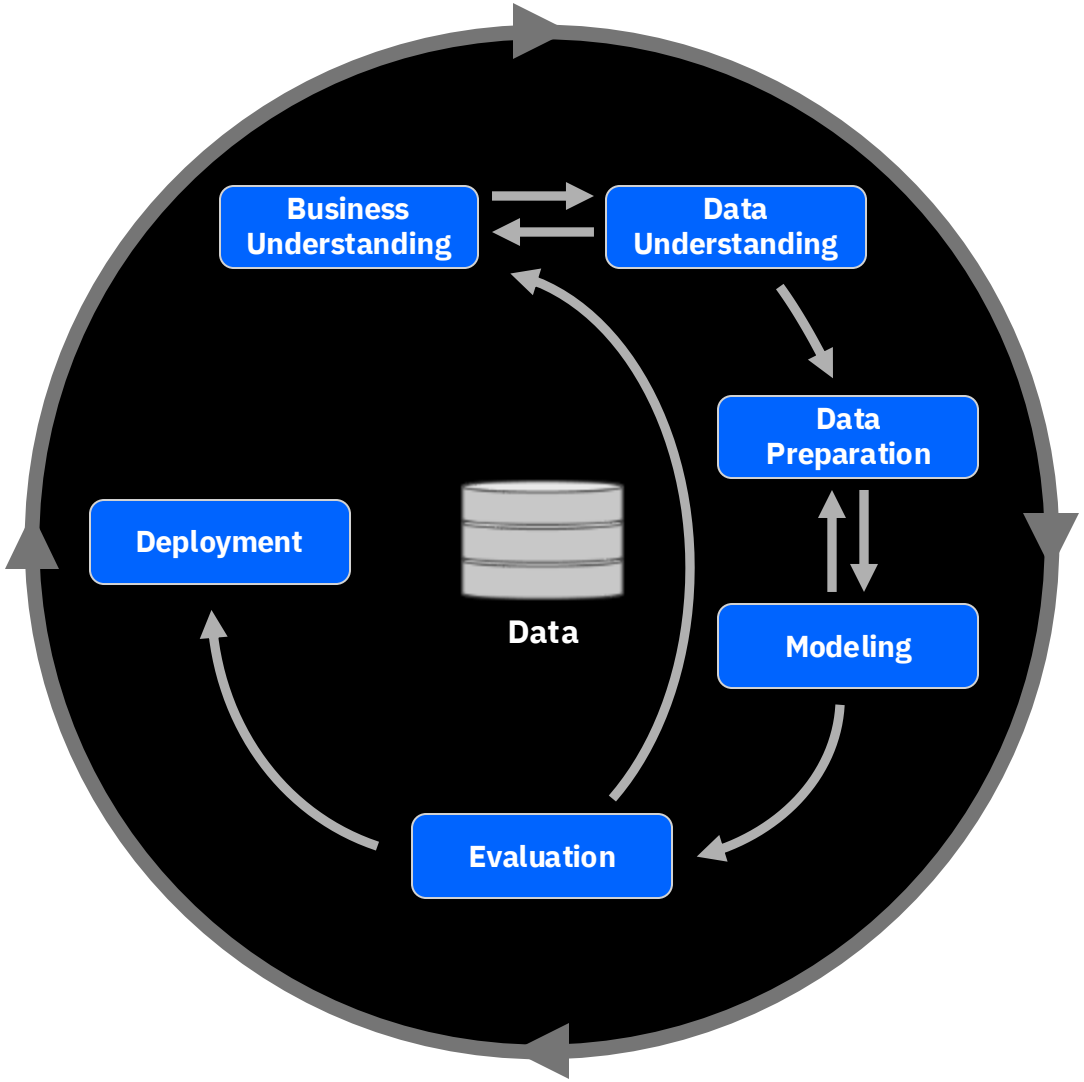
- Data Science skills are in low supply and high demand
- Nurturing new data professionals is challenging

Tools & Infrastructure

- Need an environment that enables a "fail fast" approach
- Discrete tools present barriers to productivity

Solution Development Method Approach

Cross Industry Standard Process for Data Mining (CRISP-DM)



Seven steps to successful Data Mining/Predictive Analytics

1. Define the business challenge in a precise statement
2. Define the data model and data requirements
3. Source data from all available repositories
4. Evaluate the data quality
5. Select the predictive algorithm
6. Interpretation of the results and iterative cycles of improvement
7. Deploy the model into your business

Drives governance policy effectiveness while tracking how data is used and its value to the company

Data Steward

Builds data pipelines that power dashboards and data platforms while ensuring high quality

Data Engineer

Prepares data to tease out the insights they're looking for, without IT involvement

Data Scientist

Business Analyst

Works with data to apply insights to the business strategy

App Developer

Makes insights immediately actionable and adds intelligence to apps in straightforward manner

Where is AI going?

AI is Everywhere

Everyone working with information technology is already relying on AI, and if not, will be soon.

AI is Everywhere

AUTOMATION	CONVERSATION	OPTIMIZATION	RECOMMENDING AND INSIGHTS	PERSONALIZING	VISUAL RECOGNITION
					
Automating actions, processes, and alerts	Understanding text and answering questions in natural language	Analyzing data for patterns and outliers and deriving insights	Understanding needs and recommending solutions	Personalizing experiences	Recognizing objects in images and videos

https://medium.com/design-ibm

What Machine Learning Can Do

A simple way to think about supervised learning.

INPUT A	RESPONSE B	APPLICATION
Picture	Are there human faces? (0 or 1)	Photo tagging
Loan application	Will they repay the loan? (0 or 1)	Loan approvals
Ad plus user information	Will user click on ad? (0 or 1)	Targeted online ads
Audio clip	Transcript of audio clip	Speech recognition
English sentence	French sentence	Language translation
Sensors from hard disk, plane engine, etc.	Is it about to fail?	Preventive maintenance
Car camera and other sensors	Position of other cars	Self-driving cars

SOURCE ANDREW NG

https://www.ibm.com/thought-leadership/institute-business-value/en-us/report/business-trends-2025

Your top 3 AI predictions?

The Evolution of AI

General AI
Revolutionary

Broad AI
Disruptive and Pervasive

Narrow AI
Emerging

▼ We are here

2050 and beyond

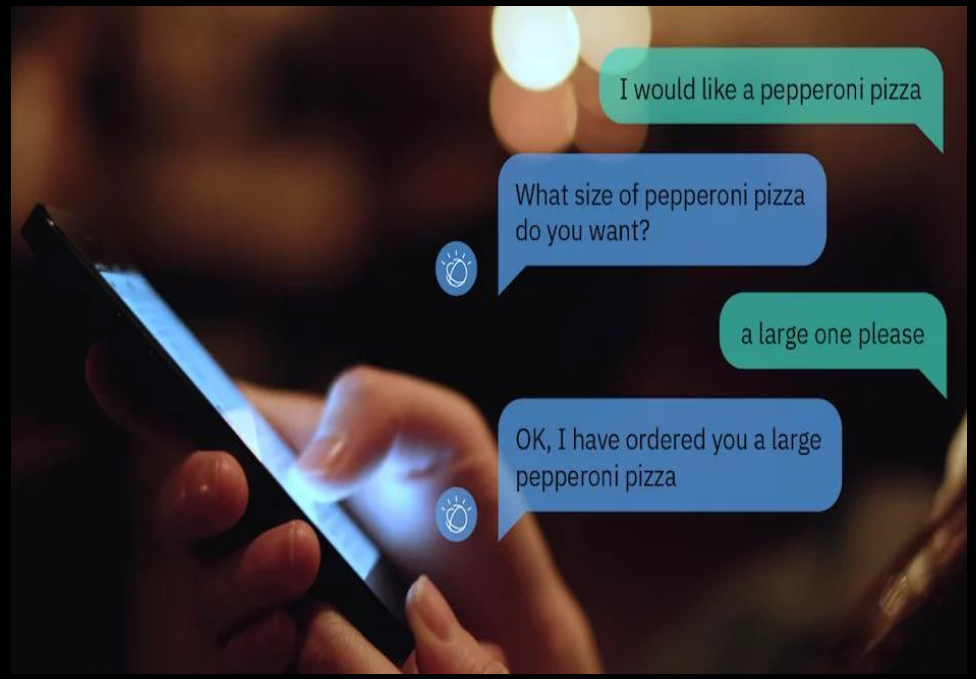
Enterprise AI

Let’s look at some interesting trends.

Consumer Behavior AI Trends

The top trends in consumer AI give us a hint of where AI is going, and how to make use of it today.

- **Voice Activation:** Voice assistant software is the No. 1 AI app today.
  4 billion devices will carry AI-powered voice assistants this year
- **Chatbots:** AI bots will power 85% of customer service interactions by 2026
- **Personalization:** Digital Assistants will “know you” by end of 2025



The Motley Fool

$ocialnomics

AI Means Business Across All Industries

E-COMMERCE:
Recommender Systems

EDUCATION:
Research Insight

FINANCE:
Fraud Detection

GOVERNMENT:
Smarter Services

HEALTHCARE:
Patient Diagnosis

- **Opportunity Identification**
- **Competitive Advantage**
- **Intelligent Content**
- **Sales Growth**

MANUFACTURING:
Anomaly Detection

MEDIA:
Interaction & Speed

NETWORKS:
Intrusion Detection

RETAIL:
Inventory Optimization

TRANSPORTATION:
Demand Forescanting

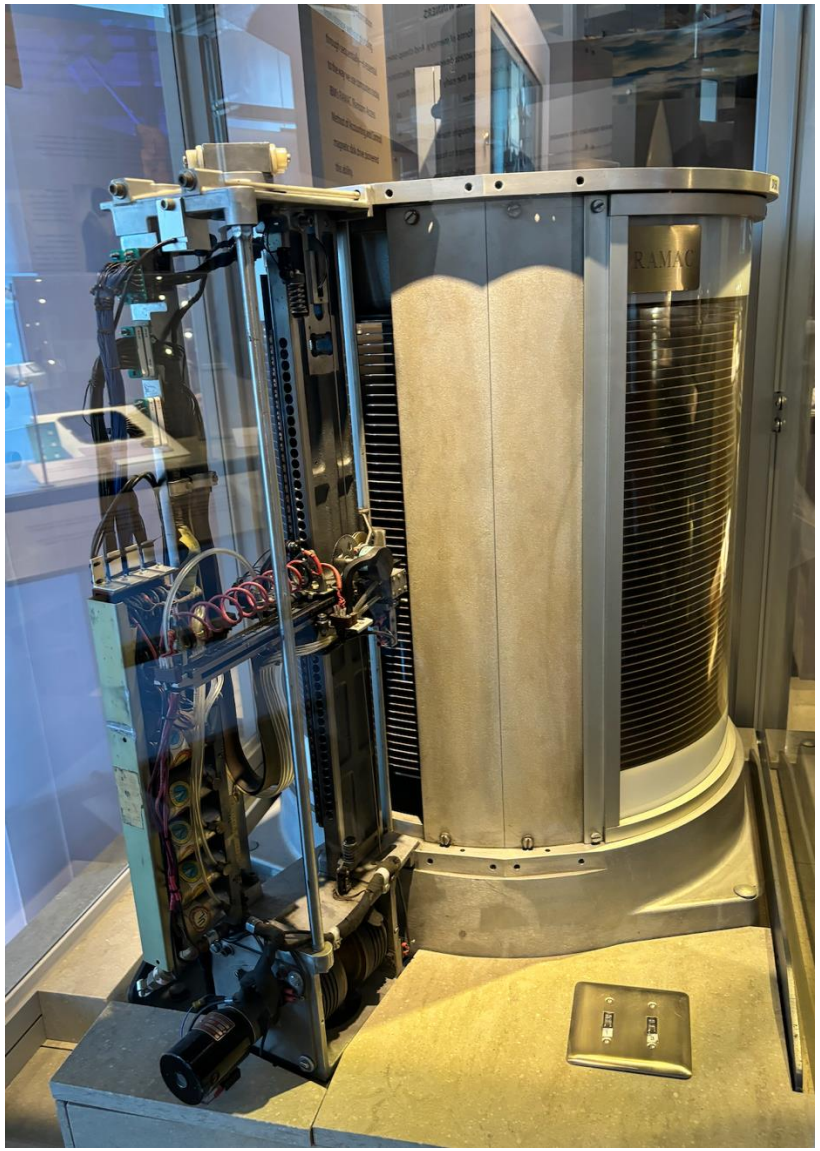
How can AI power smart consumer experiences?

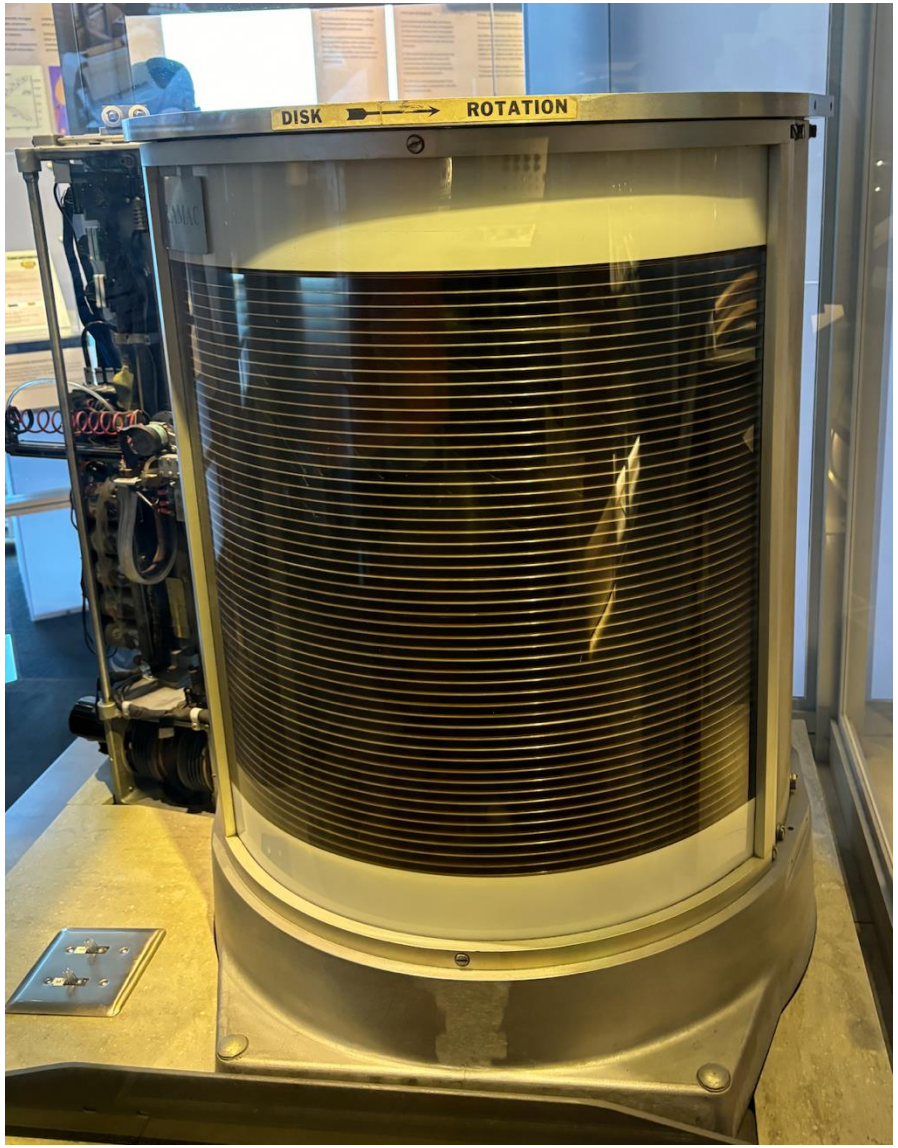
Today		Future
smart banking all digital consumer bank supported by virtual assistants	→	intelligent and proactive financial advisor
smart product intelligence Trained on 62 products and answers 283,000 questions a month with a 95% accuracy rate	→	end to end product recommendations on any channel
smart shopping Intelligent shopping assistant that increased web traffic by 21%	→	proactive shopping advisor that analyzes consumers' needs and preferences

Big Data

Understanding Big Data

https://computerhistory.org/





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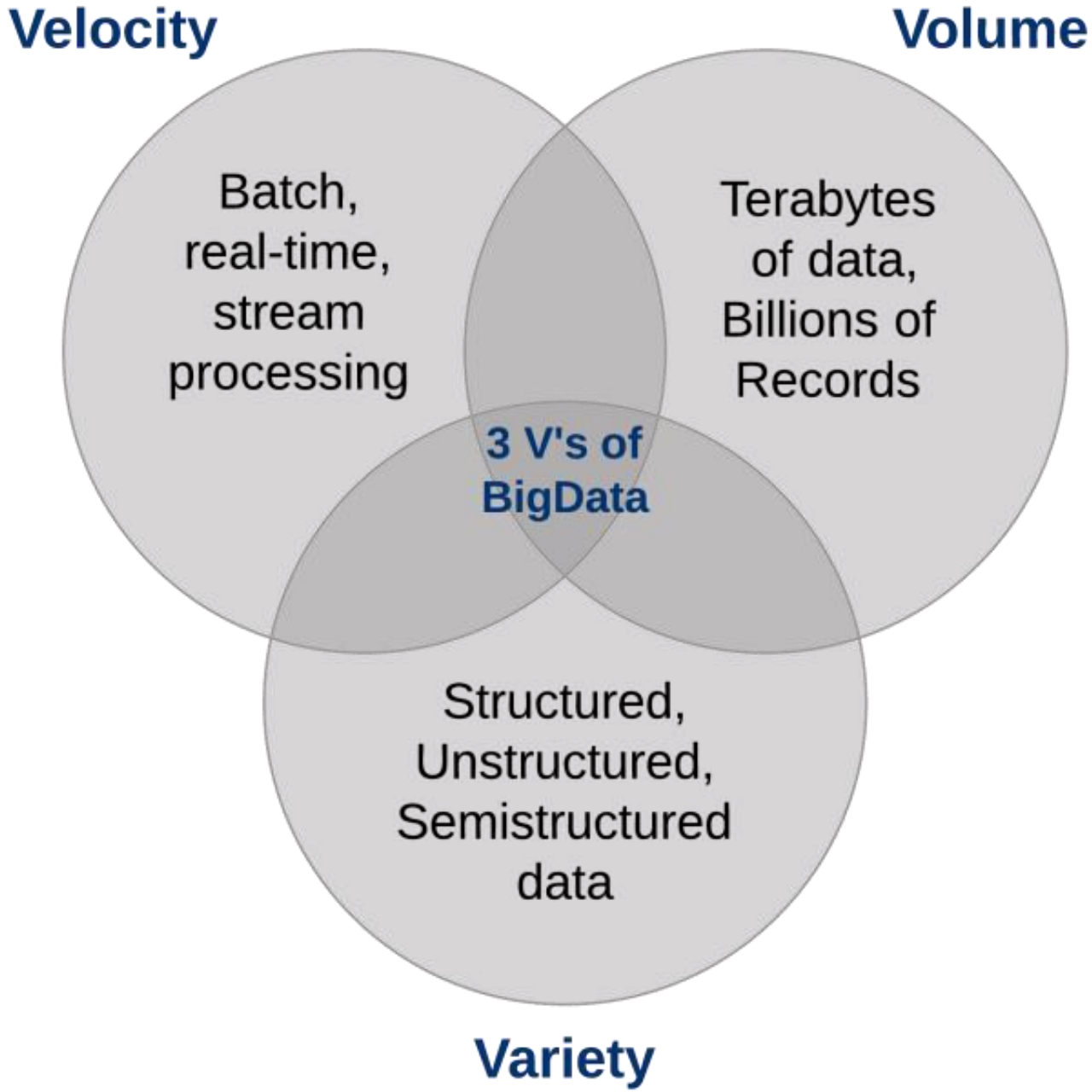
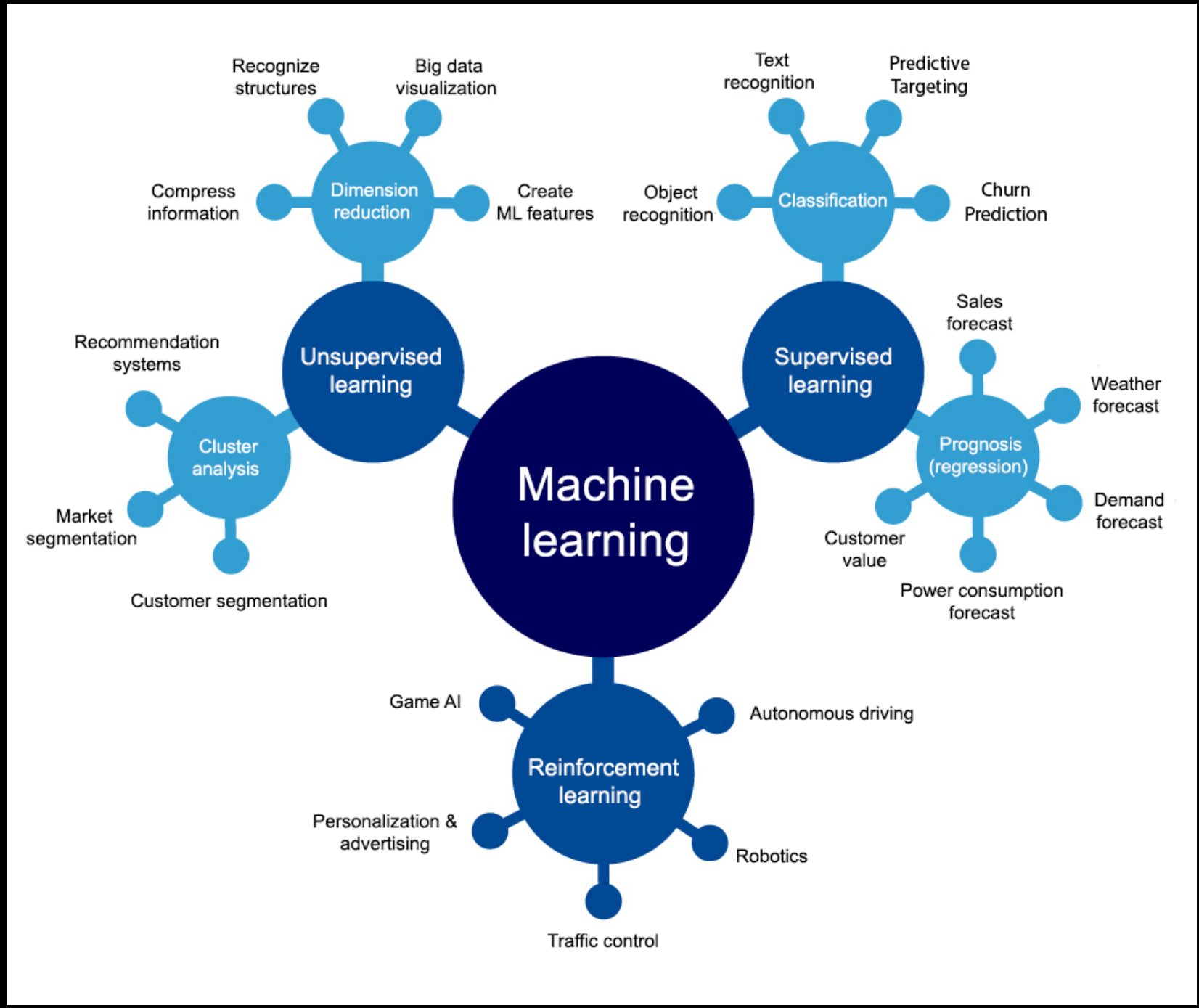
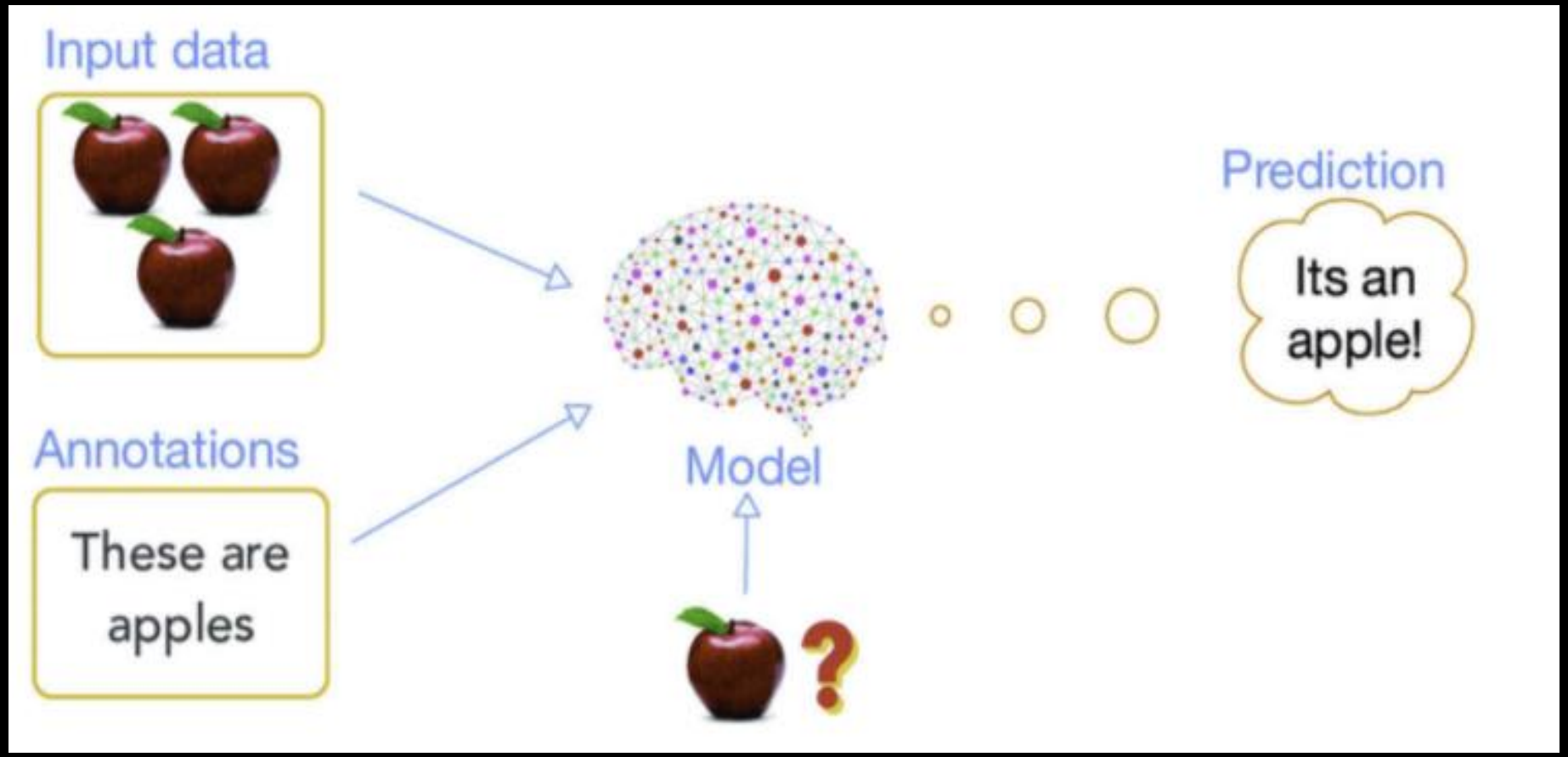

Velocity
Volume
Batch, real-time, stream processing
Terabytes of data, Billions of Records
3 V's of BigData
Structured, Unstructured, Semistructured data
Variety

Machine Learning

Machine Learning



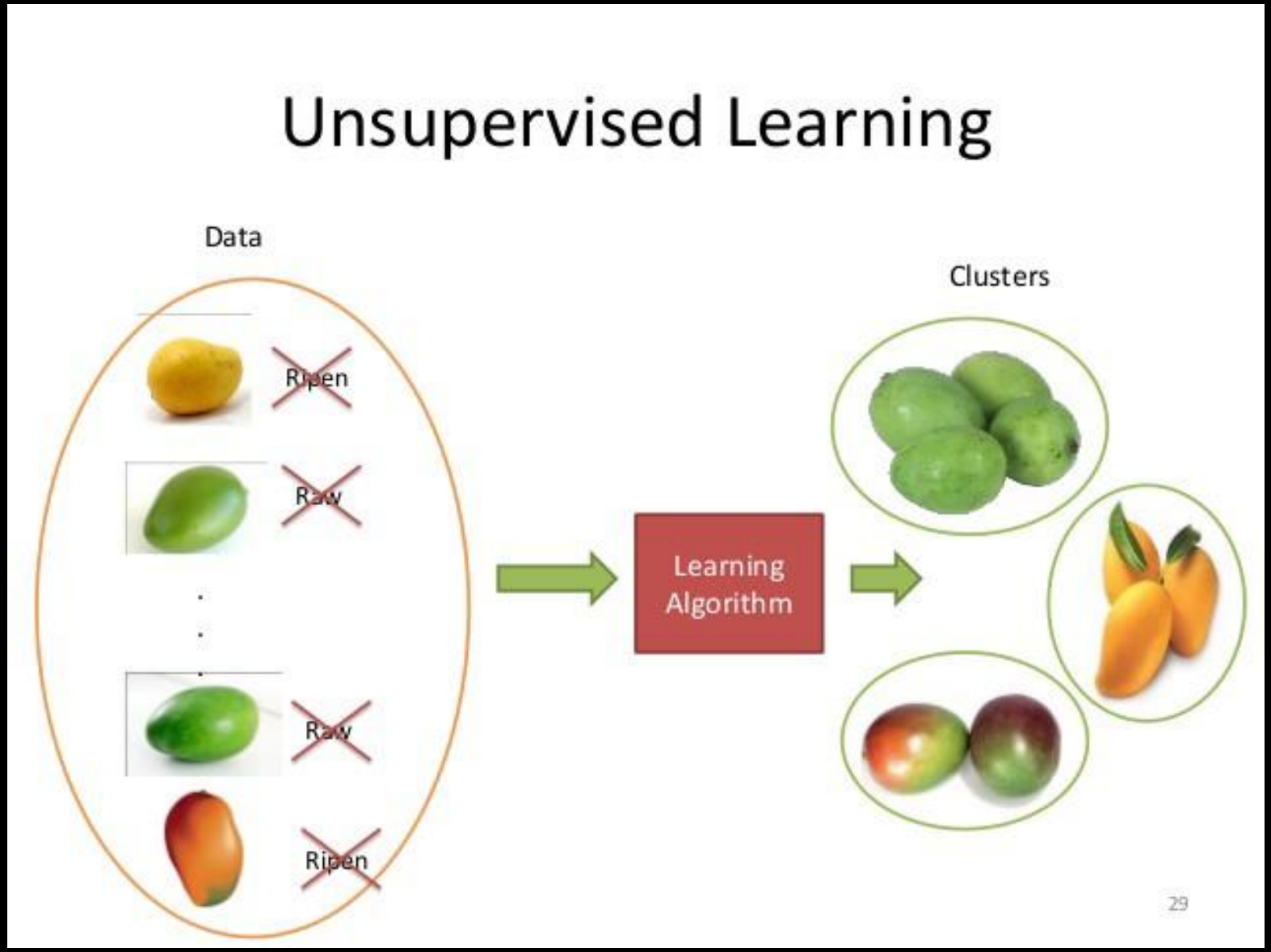
Supervised Machine Learning



Supervised machine learning algorithms can apply what has been learned in the past to new data using labeled examples to predict future events

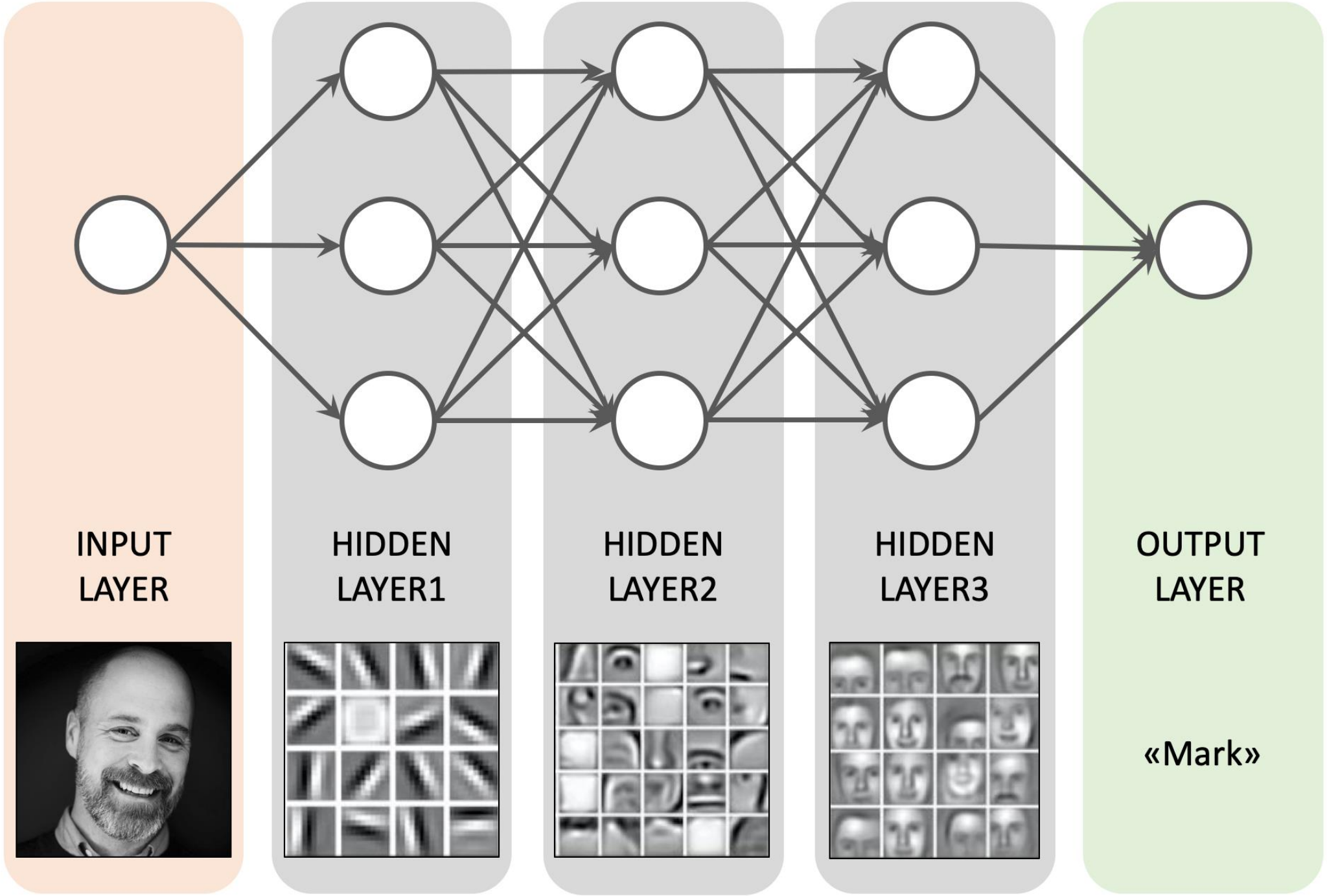
Unsupervised learning

A type of machine **learning** that uses data with no pre-existing labels, for the purpose of searching for undetected patterns.



Deep learning

A subset of **machine learning** where artificial **neural networks**, algorithms inspired by the human brain, learn from large amounts of data



Demos

Future of AI Example (Semantic Analysis)

The Wining Shot

The soccer game was nearly over. The two teams were tied, one to one.

Alice kicked the ball. Oops! She kicked it the wrong way.

”What a bad kick,” Alice thought.

But wait!. Her teammate John jumped to stop the ball. The ball went off John into the goal!.

Alice’s team won the game. Hooray! It was not a bad kick, after all.

Who won the game?

Why?

https://www.youtube.com/watch?v=vsyPZdt6noE

Future of AI Example

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Who won the game?

Answer: Alice’s team
✓Correct

Explanation: Alice’s team won the game because Alice’s team had more points than the other team
✓Correct

https://www.oreilly.com/radar/machines-as-thought-partners/

ChatGPT

JE

read this: The Wining Shot

The soccer game was nearly over. The two teams were tied, one to one.

Alice kicked the ball. Oops! She kicked it the wrong way.

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LLM

JE

who won the game

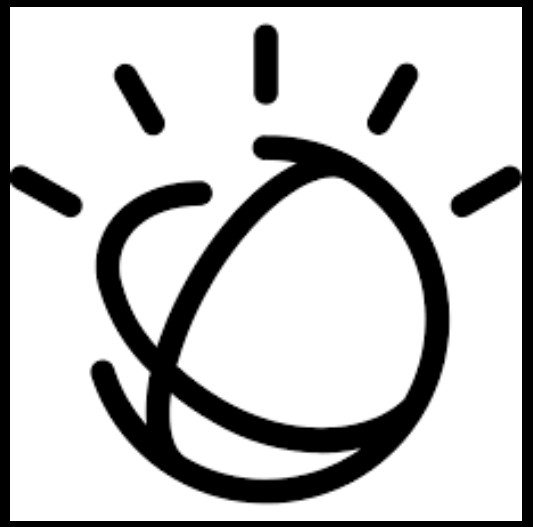
Alice's team won the game, even though Alice initially thought she had made a bad kick. John's quick thinking and intervention helped the team to score the winning goal, and they were able to secure victory in the game.

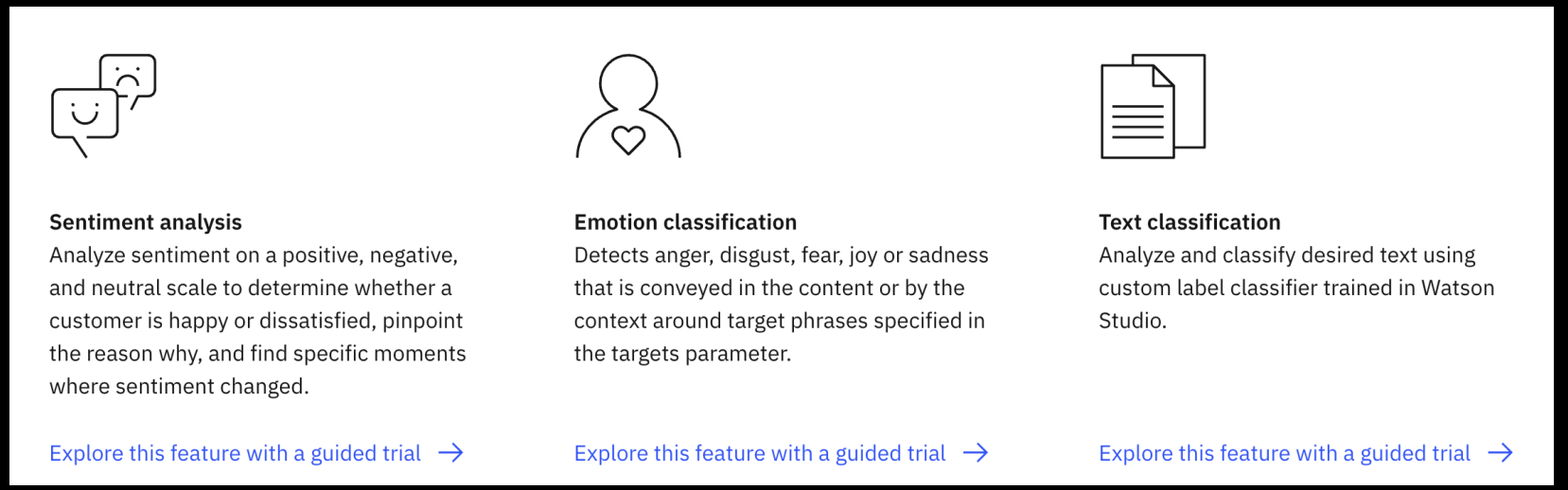
JE

why?

Alice's team won the game because John was able to use his skills and reflexes to intercept the ball, even though Alice's kick was not aimed in the right direction. John's intervention caused the ball to go into the goal, which resulted in a score for Alice's team. Since this happened near the end of the game and there was no time left for the other team to catch up, Alice's team won the game with a score of 2-1.

Natural Language Processing Demo



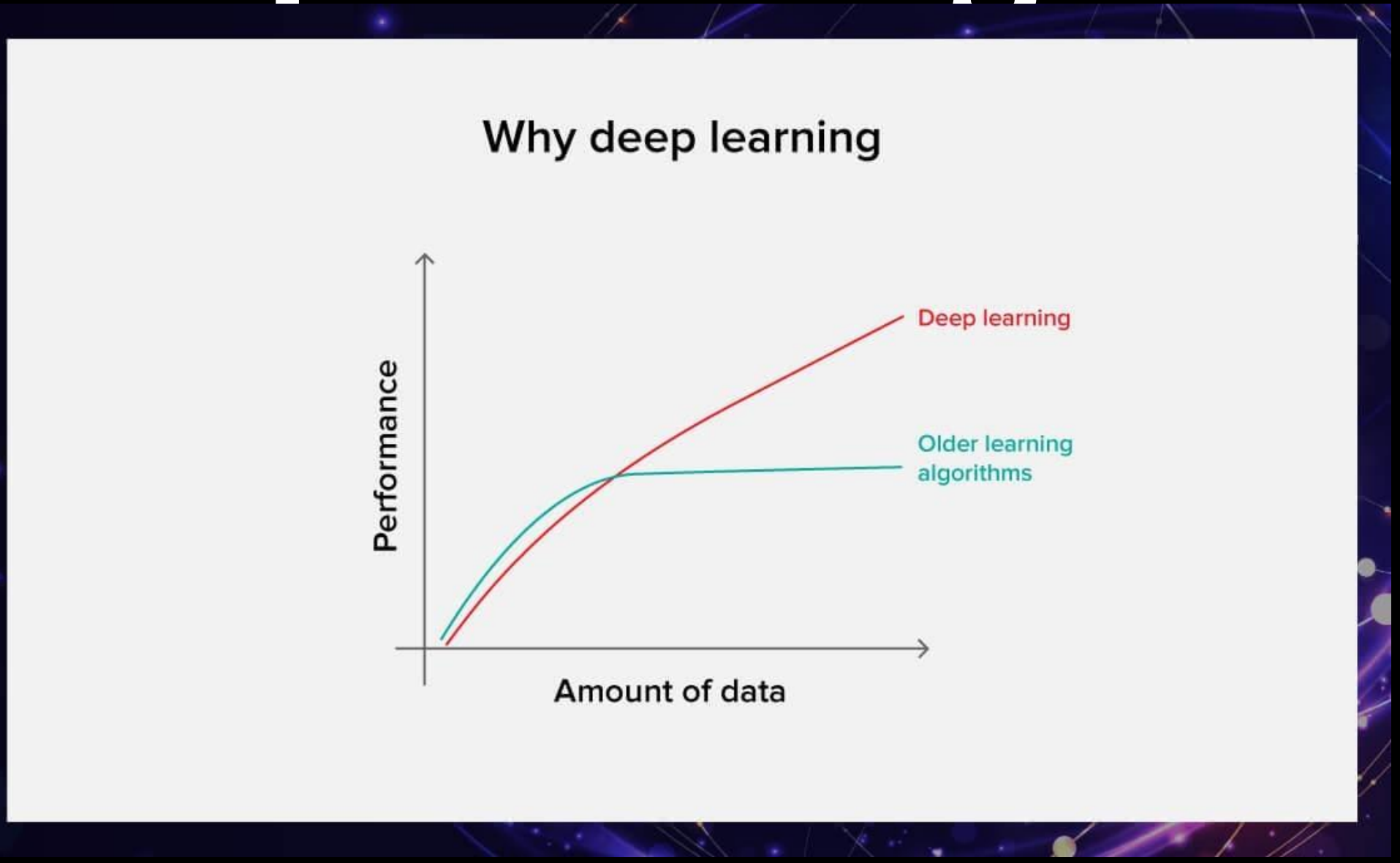


https://www.ibm.com/products/natural-language-processing

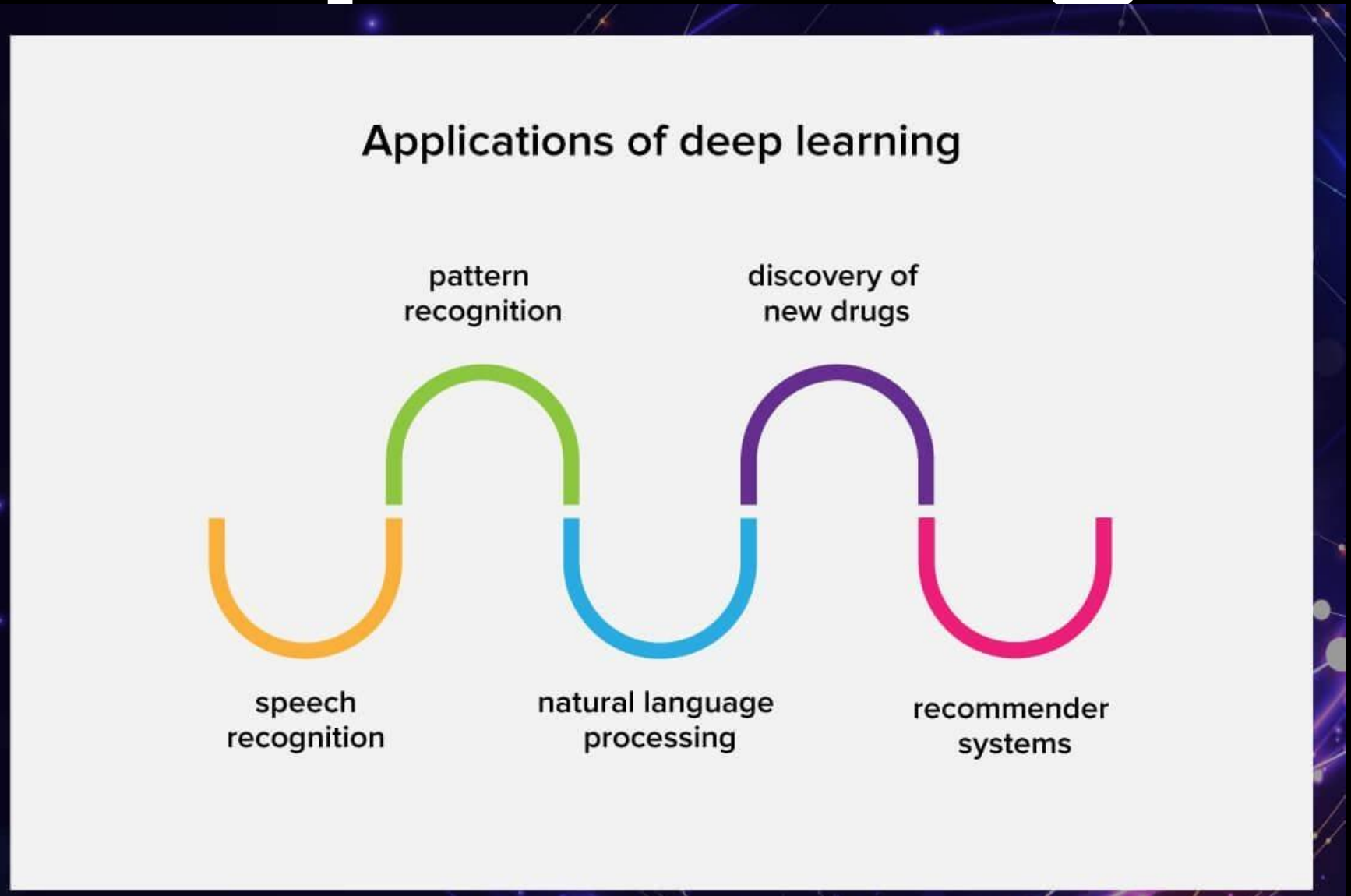
https://classification.dsceapp.buildlab.cloud/

Deep Learning

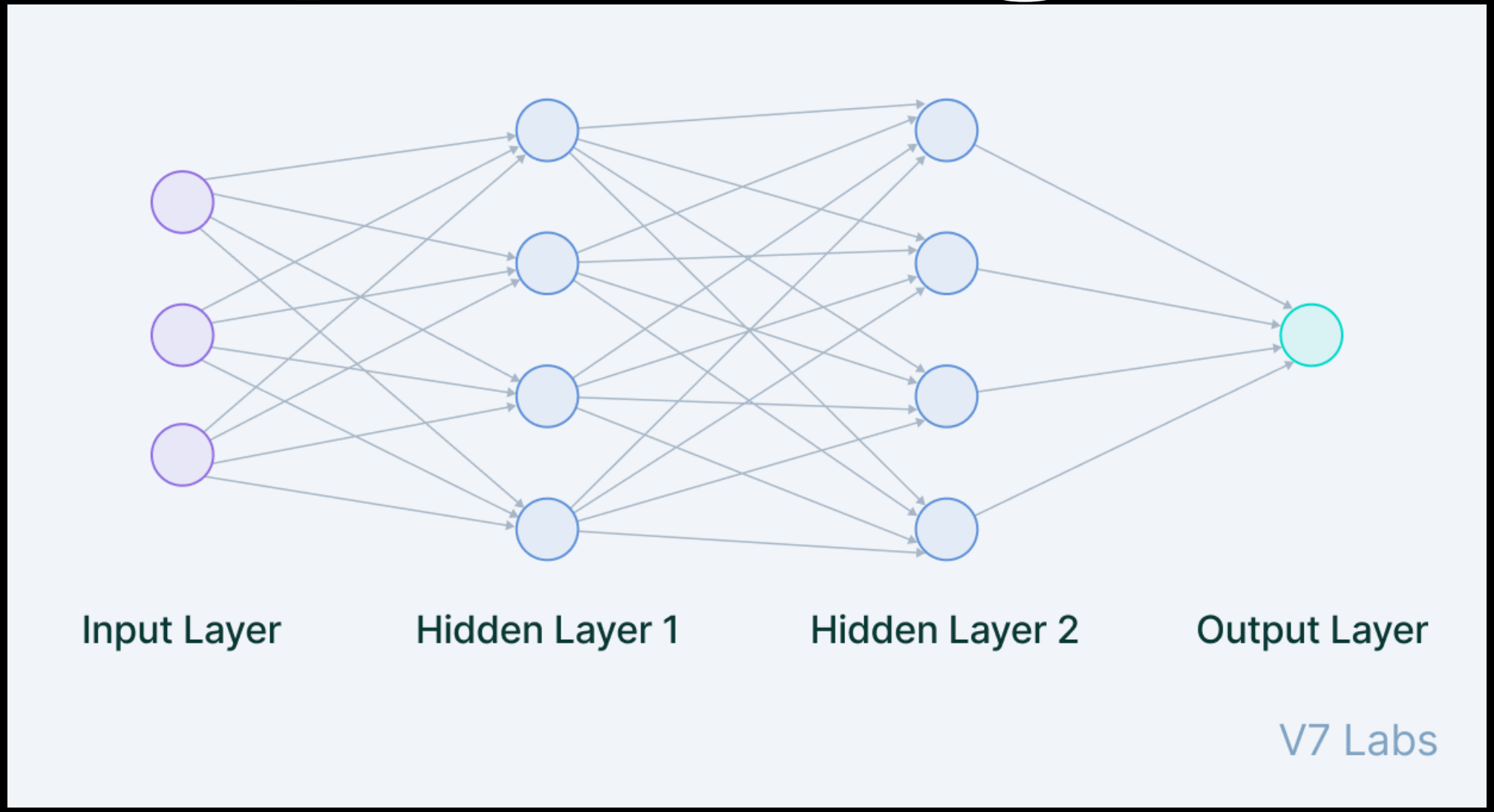
Deep Learning



Deep Learning



Deep Learning



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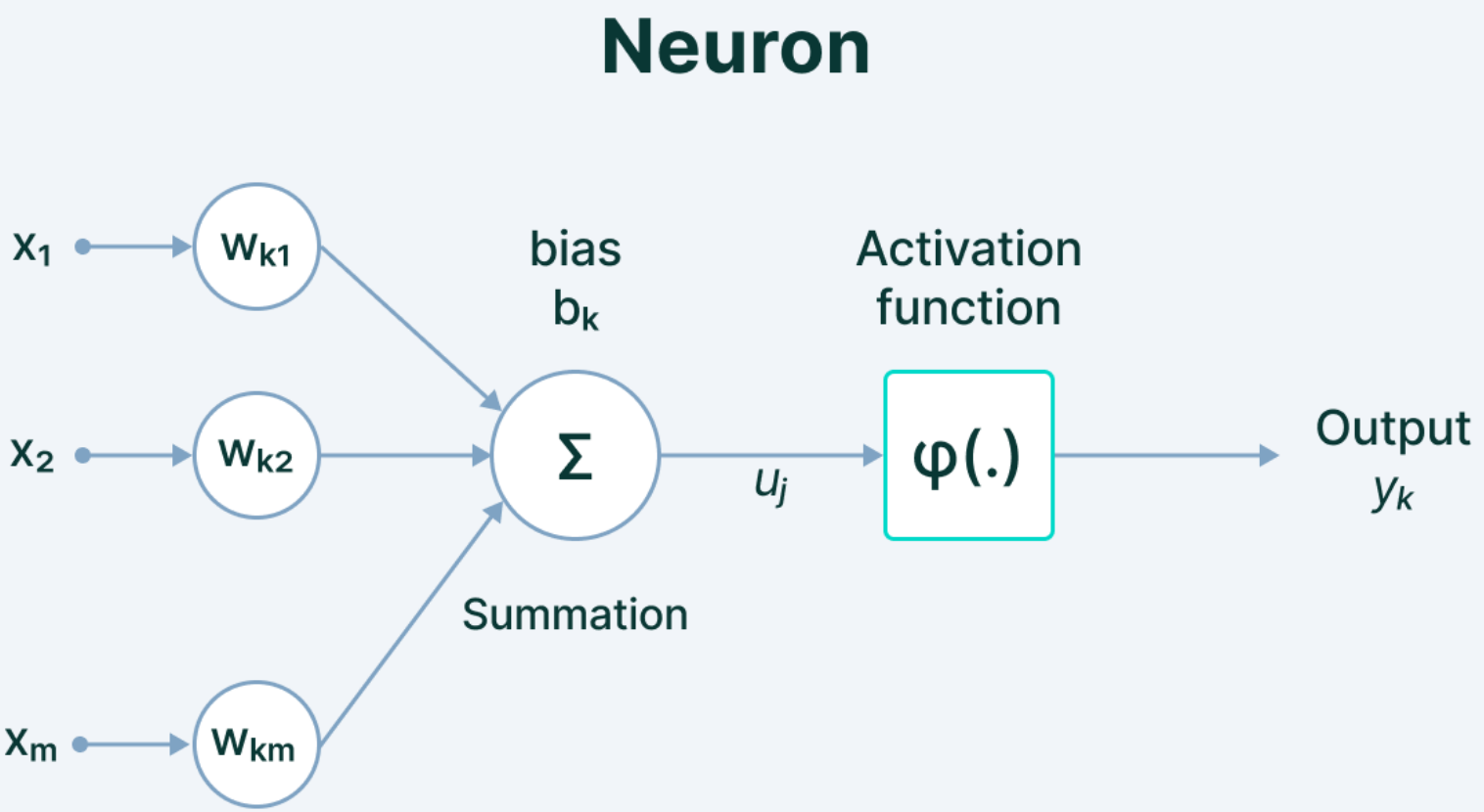
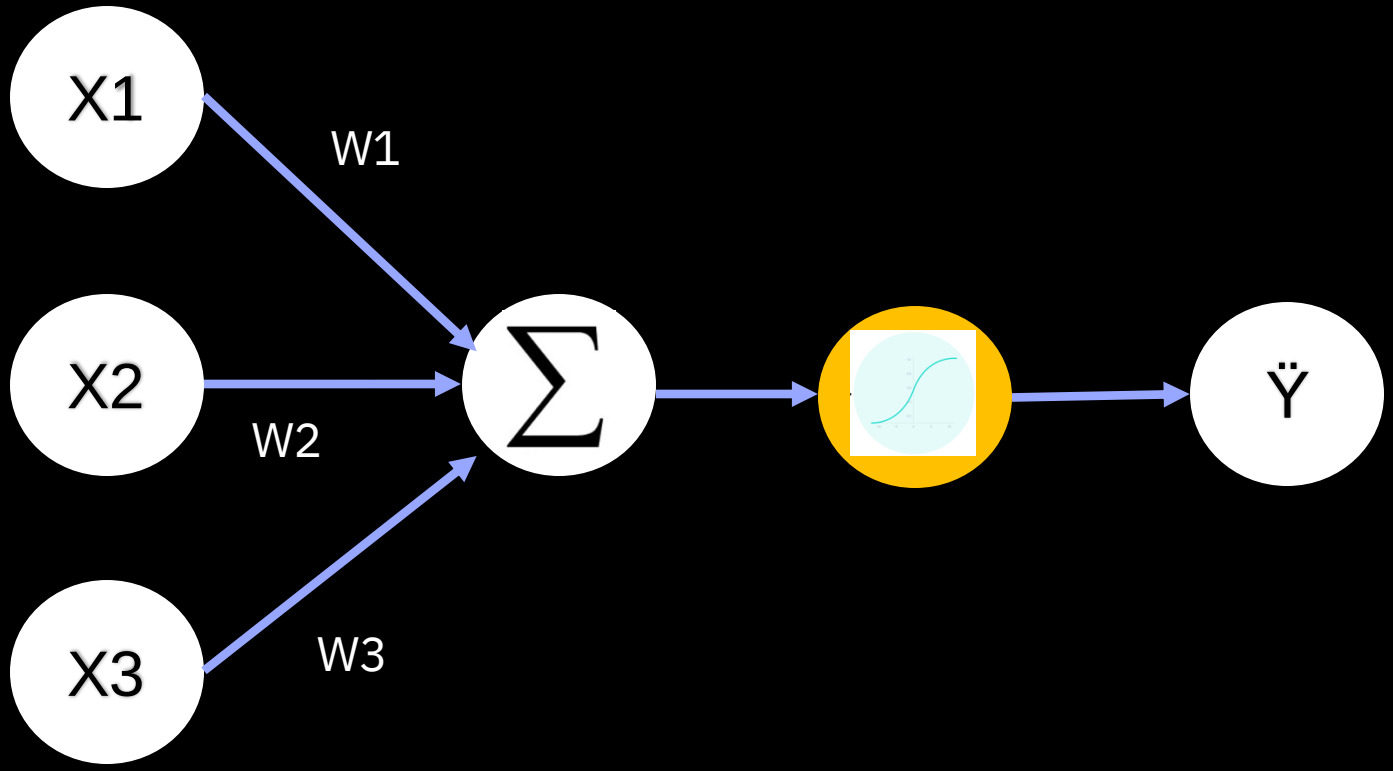
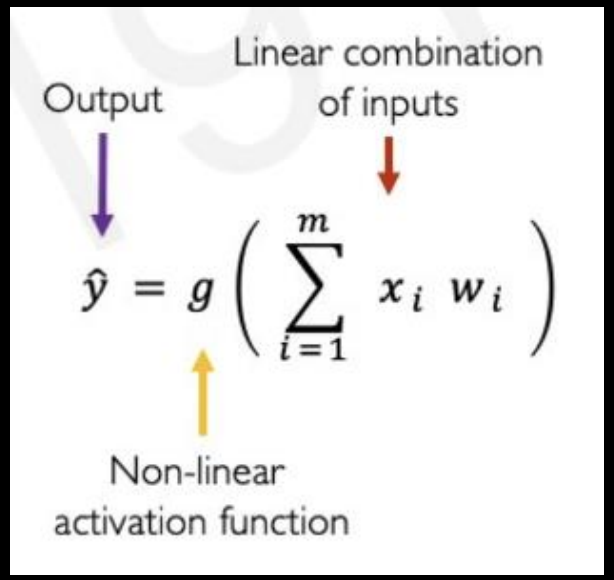
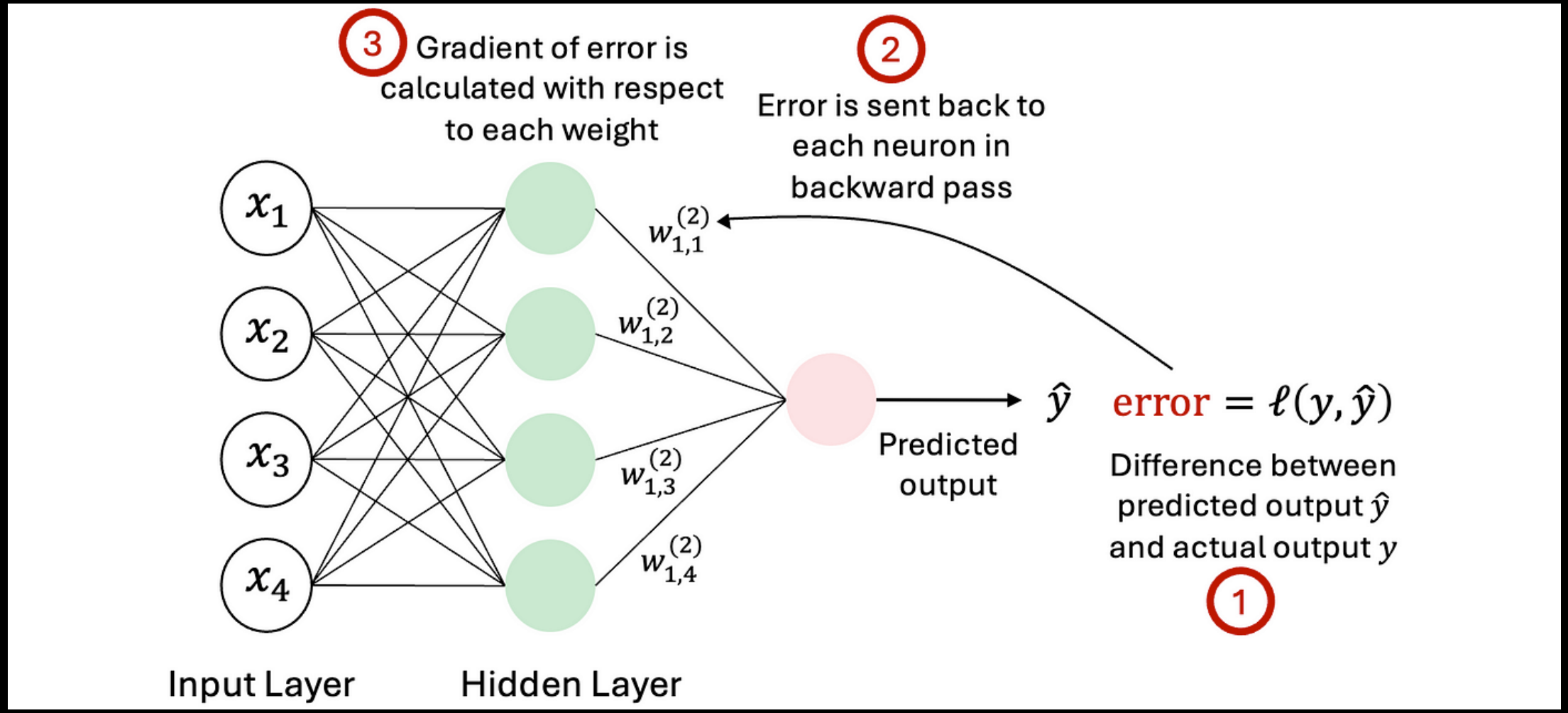


The Perceptron: Forward propagation

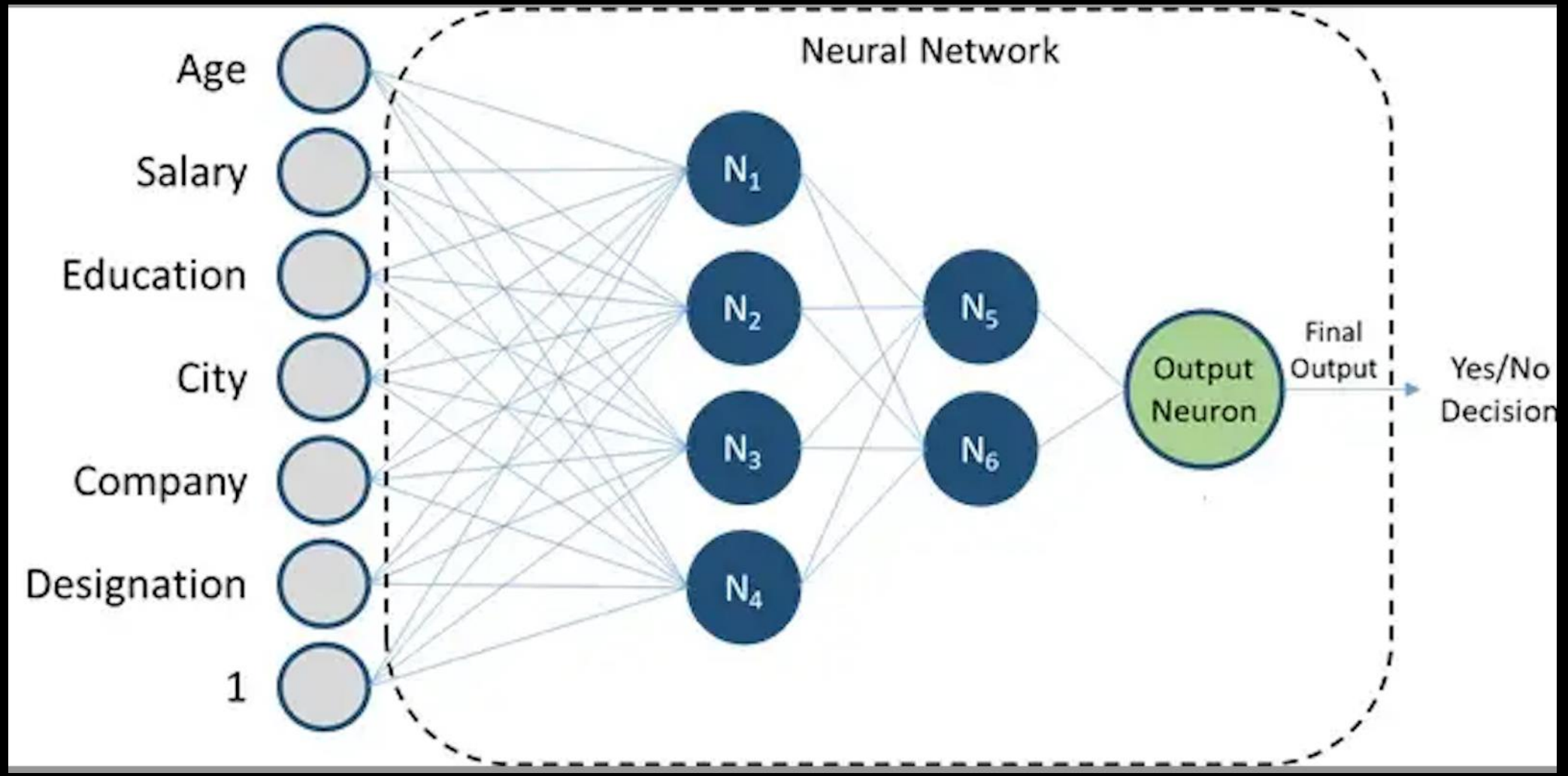




The Perceptron: Back propagation



Deep Learning



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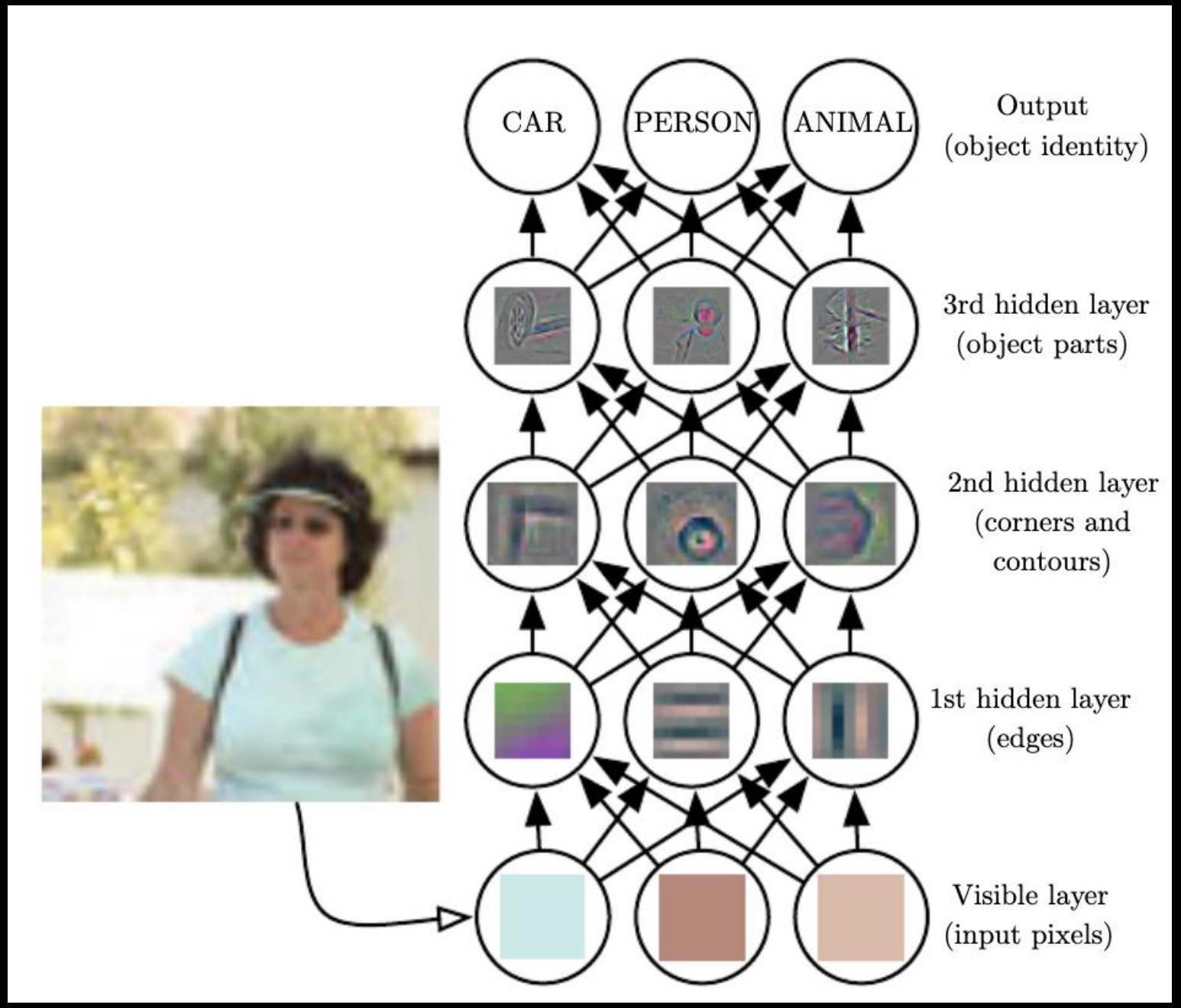

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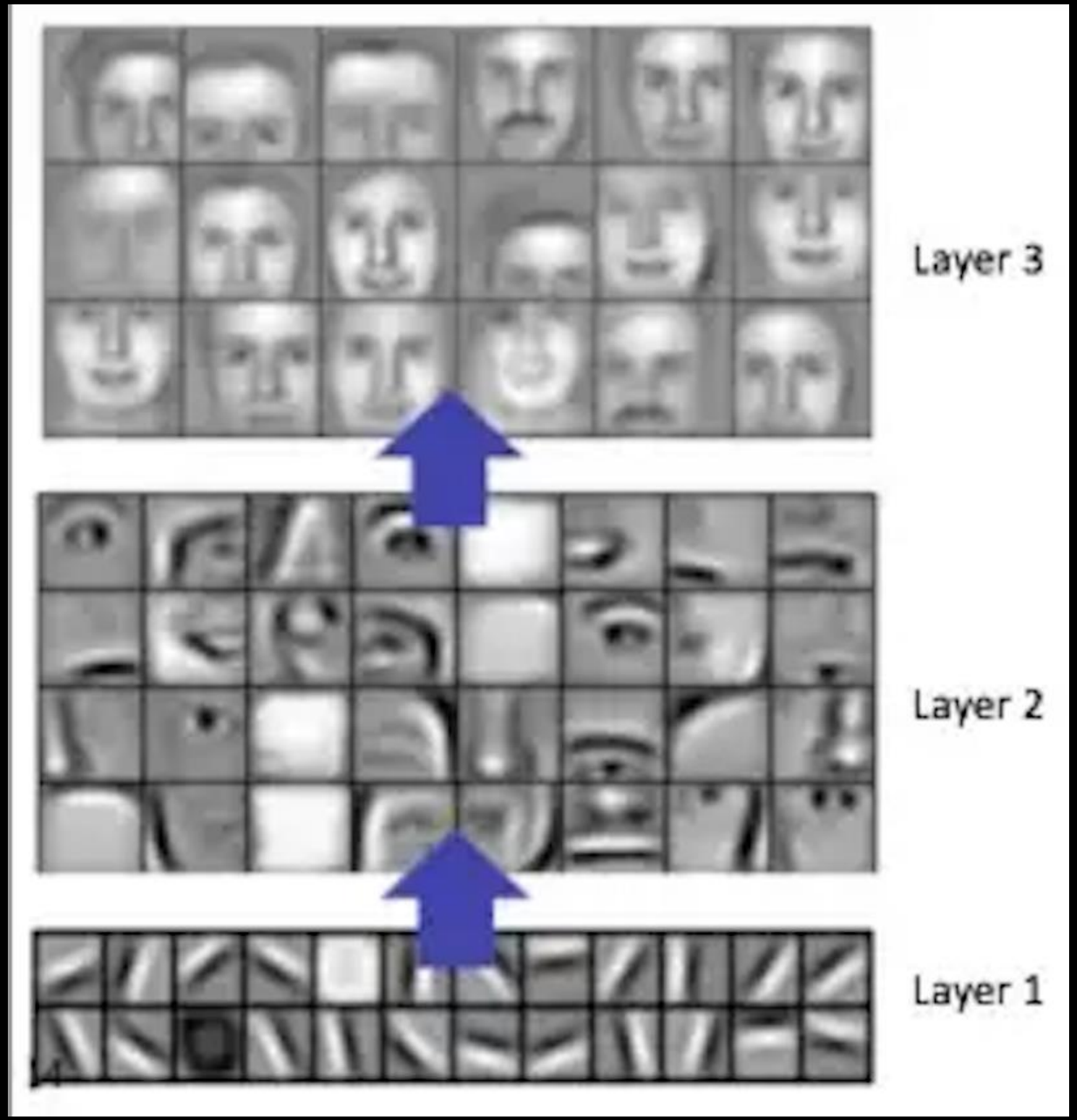
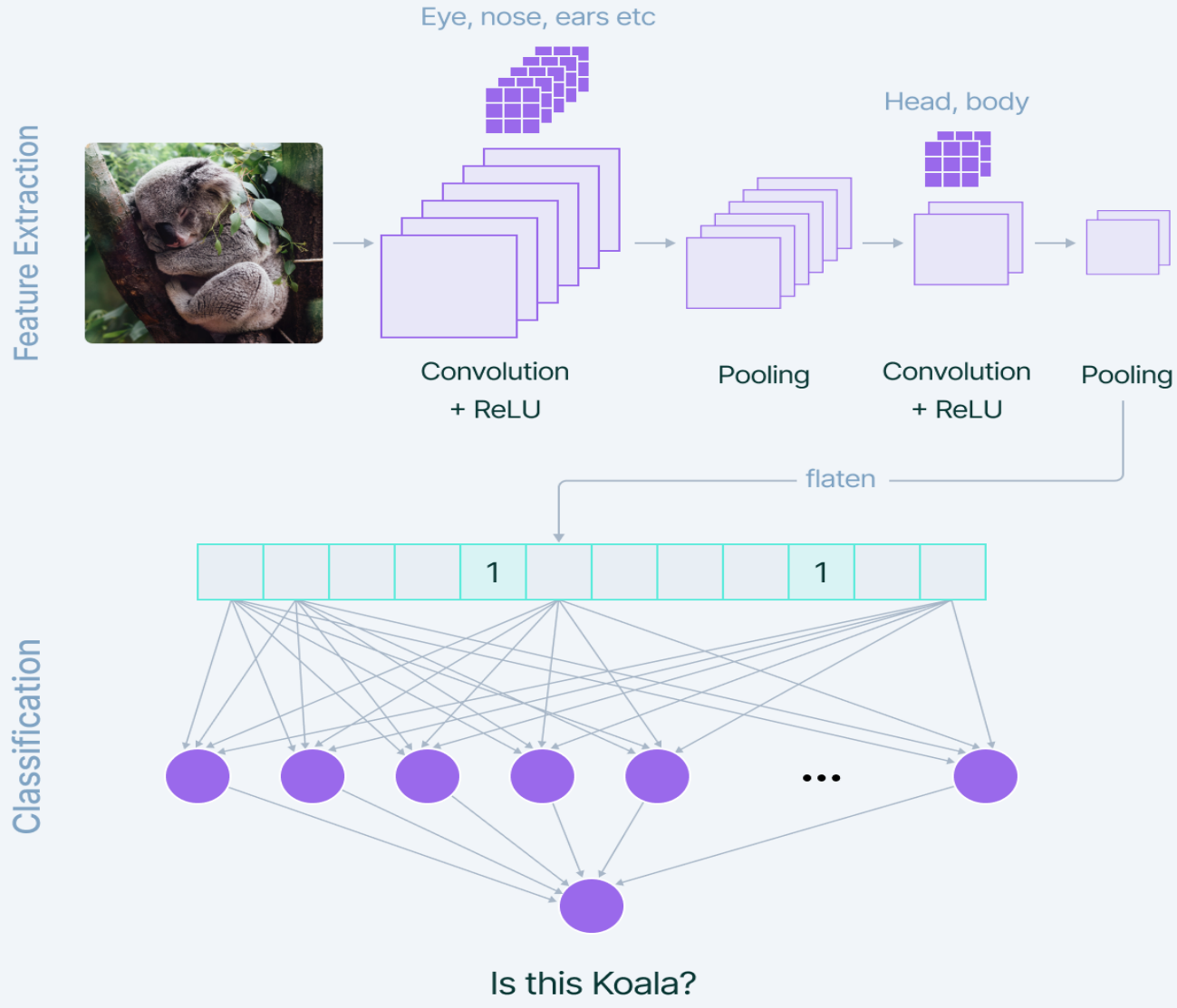


Deep Learning

Convolutional Neural Networks



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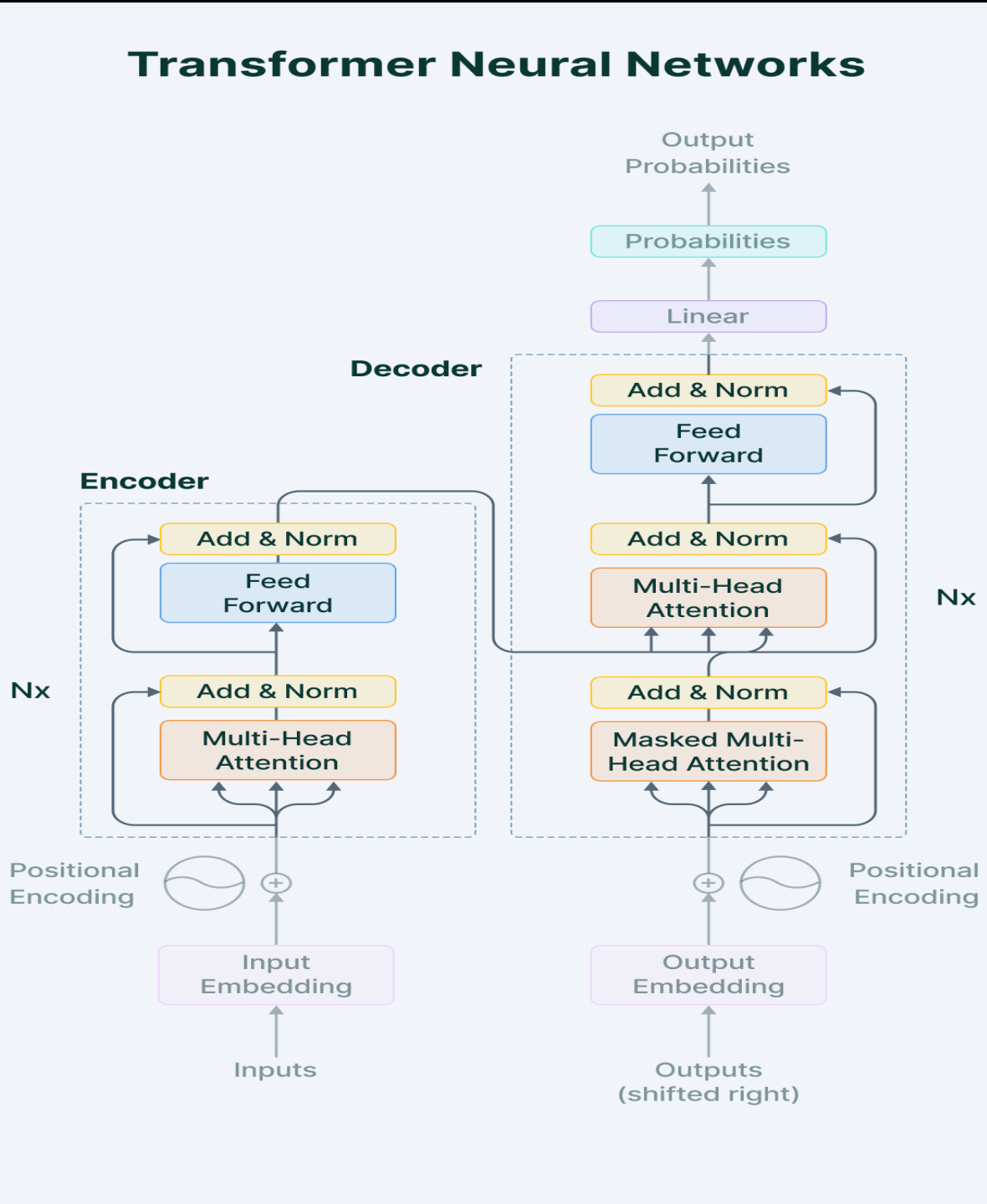

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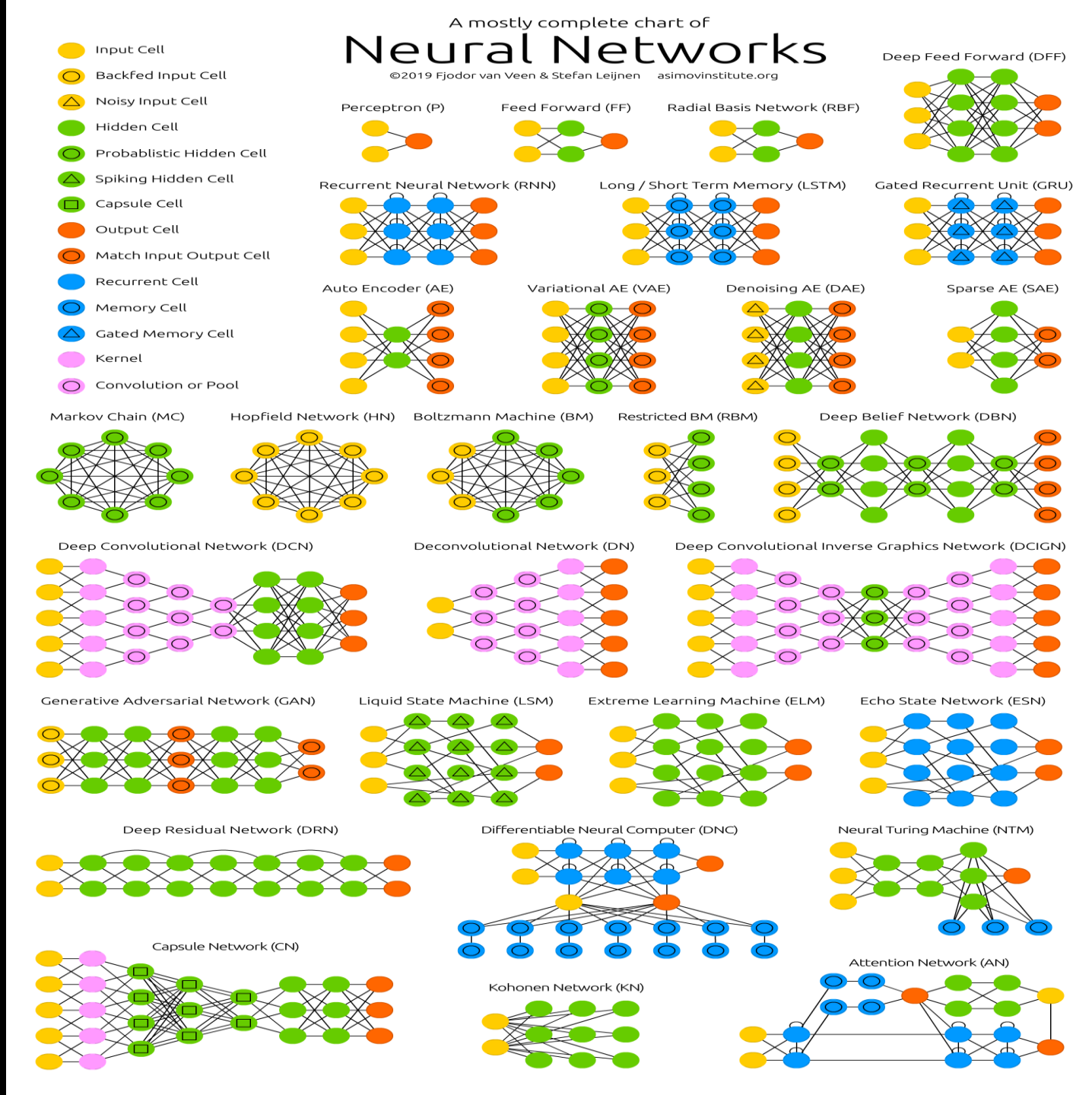

Resources

https://www.ibm.com/think/insights/ai-skills-you-need-for-2025

https://www.ibm.com/think/insights/ai-ethics-and-governance-in-2025

https://www.ibm.com/thought-leadership/institute-business-value/en-us/report/business-trends-2025

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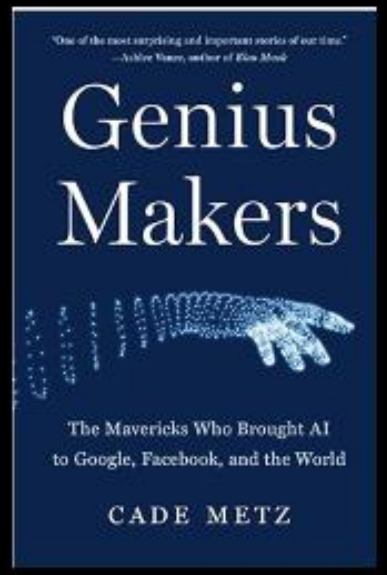
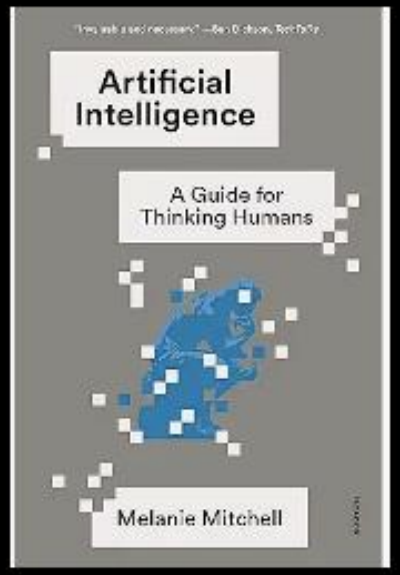
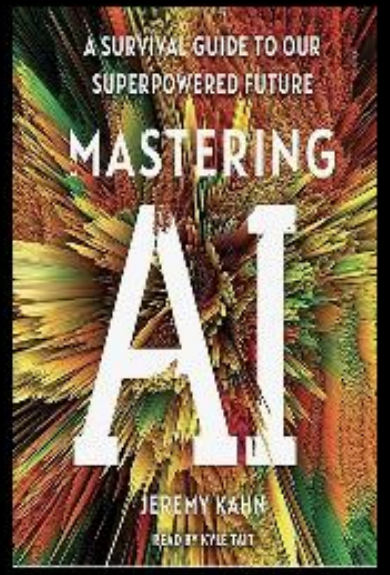
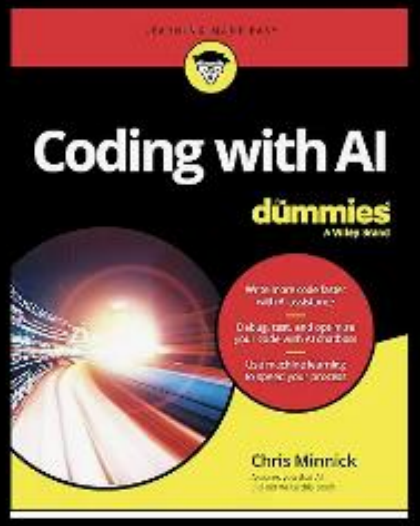
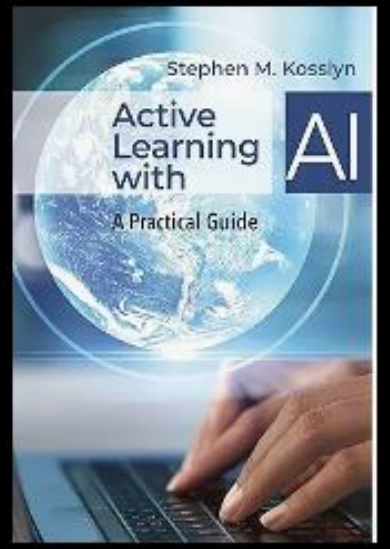


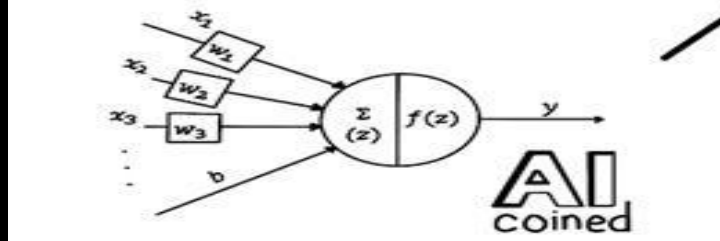


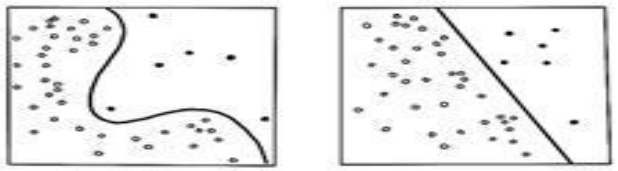


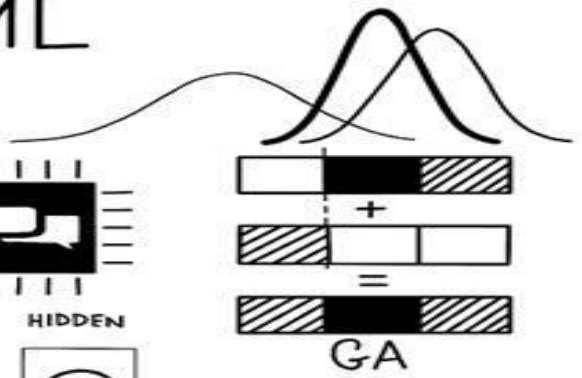


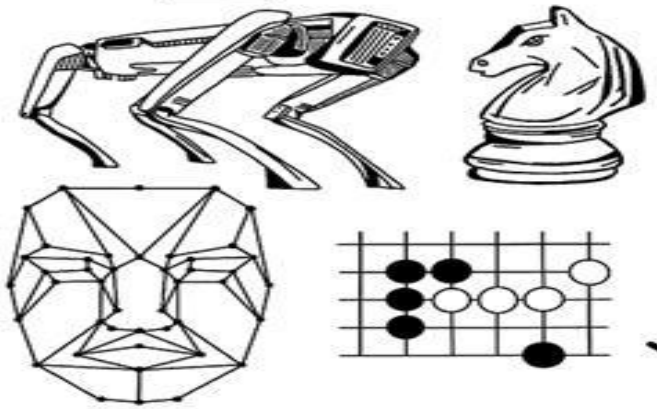


Backup









1950s
- The term "Artificial Intelligence" in coined.
- Concept of artificial neural network is introduced.
- Model of the Perceptron is invented.
- LISP programming language is invented.

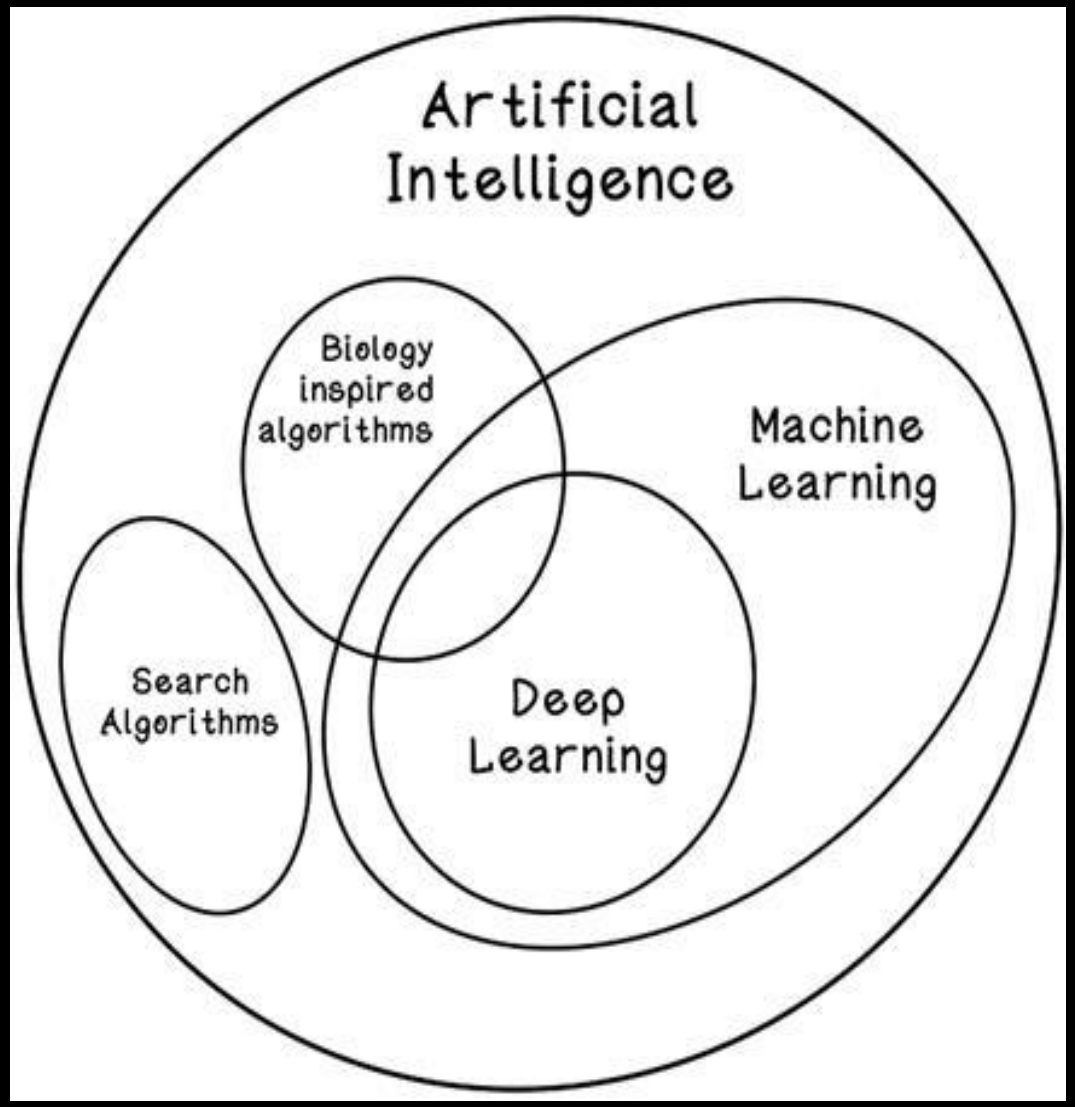
1960s
- ML models for prediction introduced.
- Unimat robot works on a car assembly line.
- Shakey the robot has natural movement, and problem solving abilities.
- Paper highlighting the flaws of Perceptrons creates doubt of the concept.

1970s
- BKG wins at Backgammon (with luck).
- Evolutionary algorithms popularized.
- Freddy the robot is able to use "visual perception".
- Prolog programming language invented.

1980s
- LISP machines for expert systems.
- Hope for neural networks via the introduction of backpropagation.
- Swarm intelligence is popularized.

1990s
- TD-Gammon shows the power of reinforcement learning.
- Experiments with autonomous cars.
- IBM's Deep Blue champions chess.
- Rise of Internet bots and search.

2000s
- Game of checkers solved.
- Face recognition with neural networks.
- IBM's Watson wins at Jeopardy.
- XBox Kinect's advanced motion detection.
- Smart voice assistants by tech giants.
- Google's Alpha Go champions Go.
- AI specific hardware and IoT devices.
- Tumor detection better than doctors.
- Self-driving cars.


Artificial Intelligence
Biology inspired algorithms
Machine Learning
Search Algorithms
Deep Learning


Super Intelligence
Unknown
General Intelligence
Humans
Narrow Intelligence
Pong playing program
Map routing program
Fraud detection program