

Algorithms and AI systems demystified

UNDERSTANDING ARTIFICIAL INTELLIGENCE

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What is an algorithm?

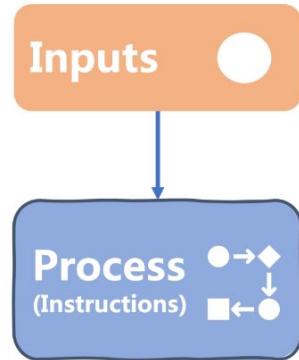
Algorithm: a set of (computer) instructions
to solve a problem or perform an action

Inputs



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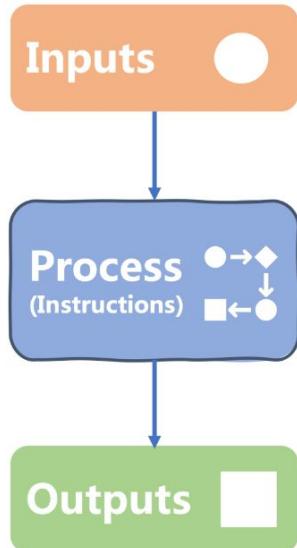


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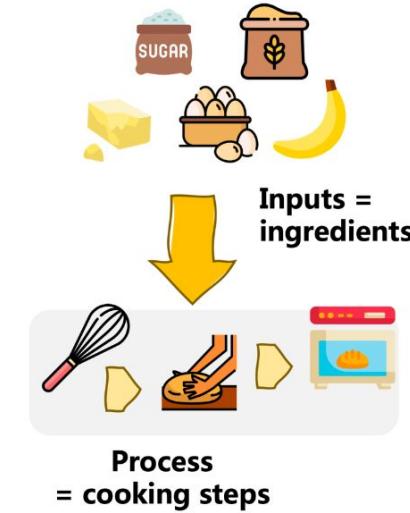
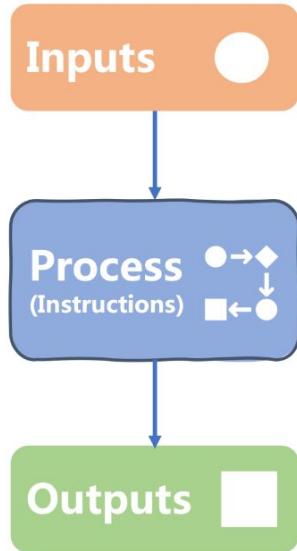


Inputs = ingredients



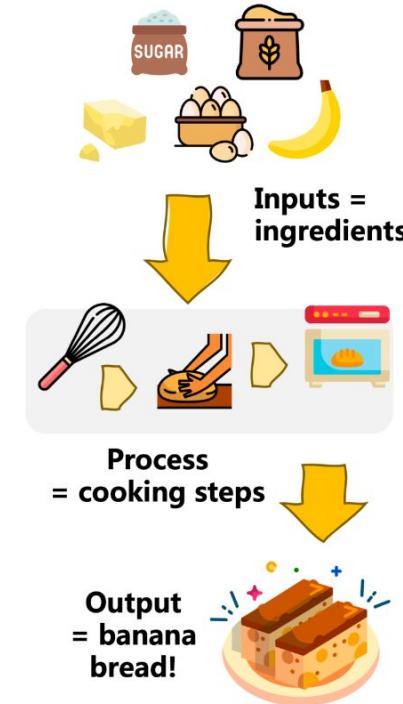
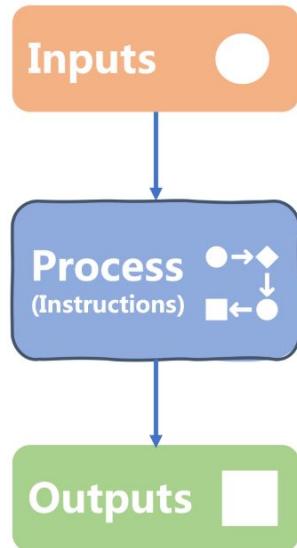
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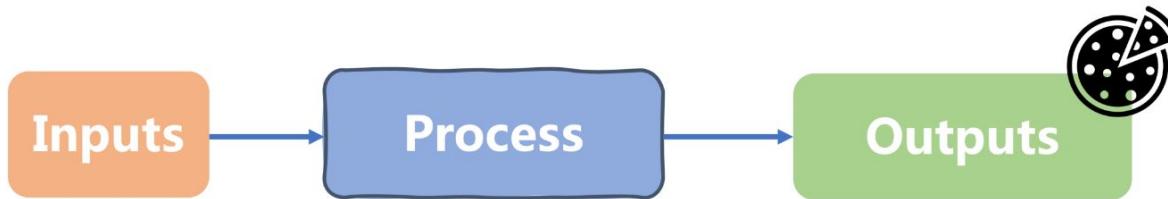


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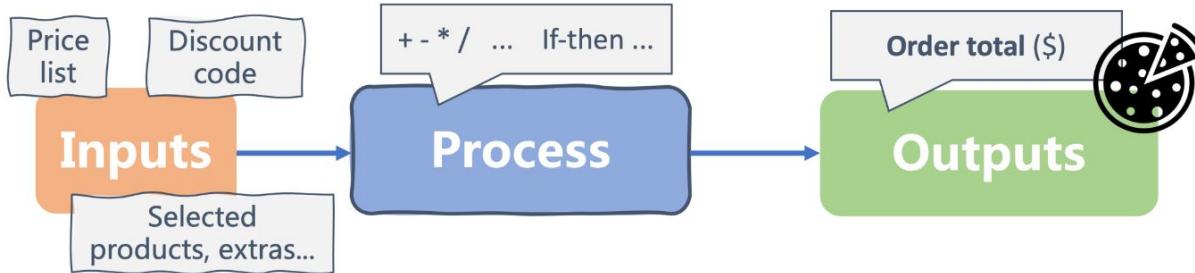
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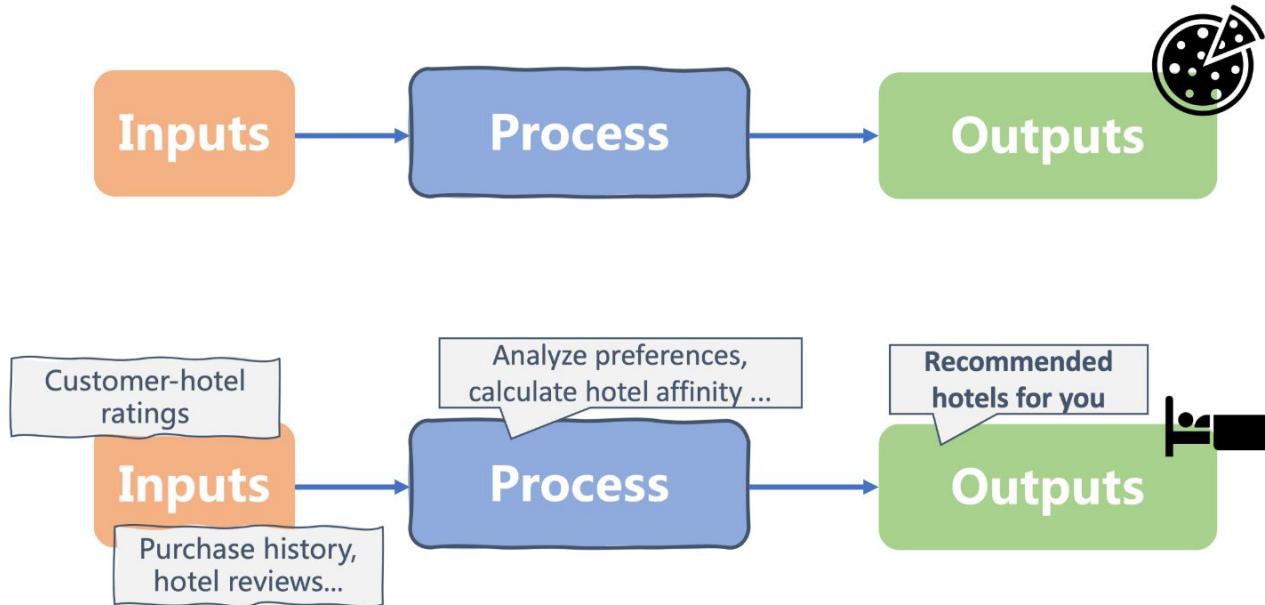
Algorithms in Computer Science vs AI algorithms



Algorithms in Computer Science vs AI algorithms



Algorithms in Computer Science vs AI algorithms



- **AI algorithms:** learn by themselves to produce better outputs or processes from input data

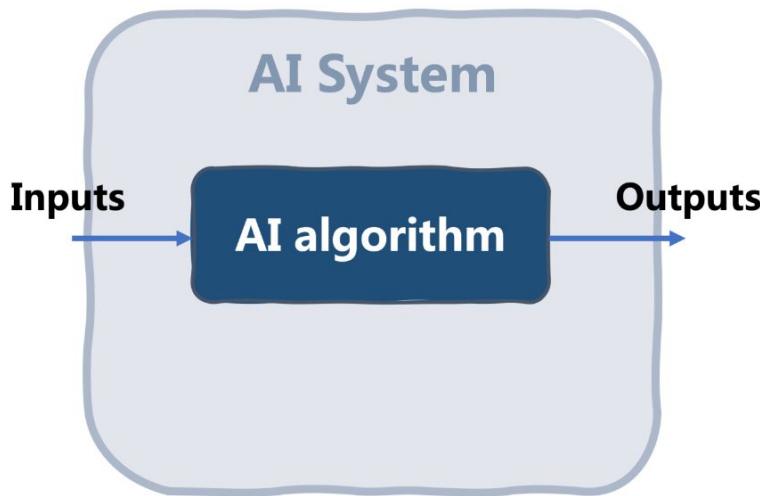
What is an AI system?

AI system: infrastructure and components needed to implement and deploy AI algorithms in the real world



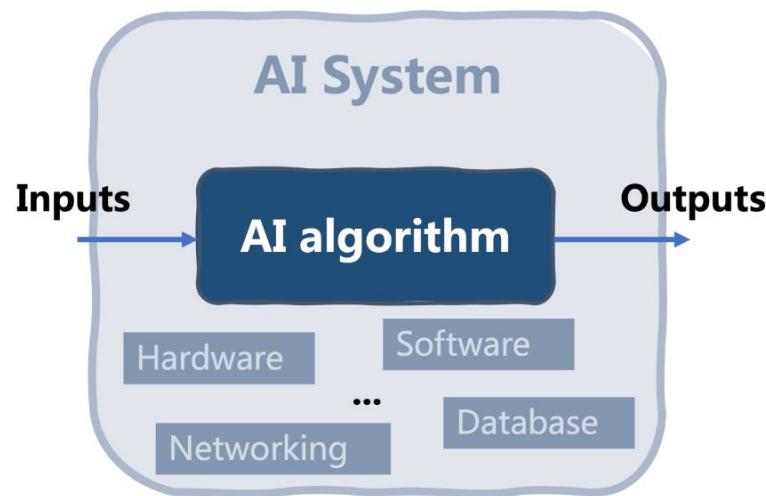
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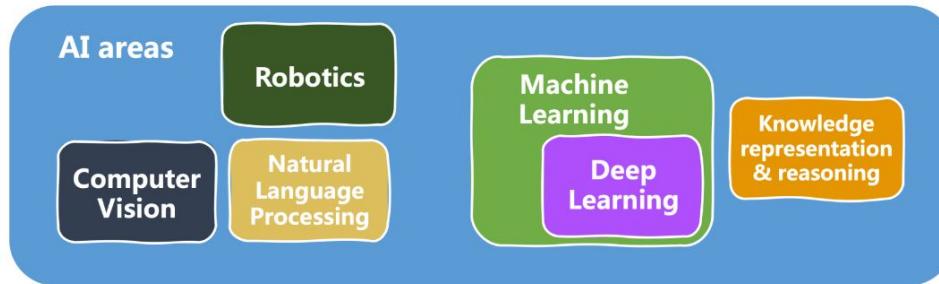
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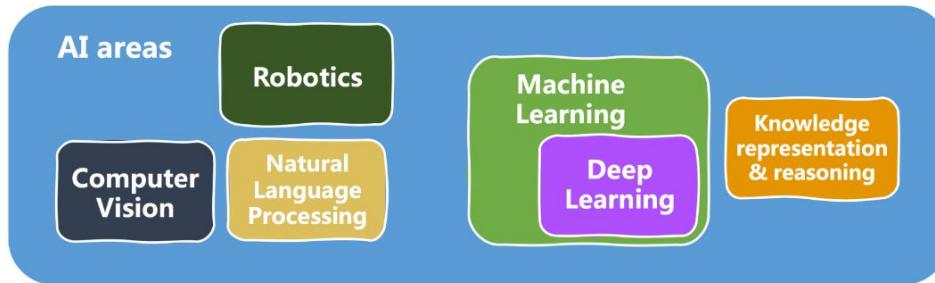
Acquiring data

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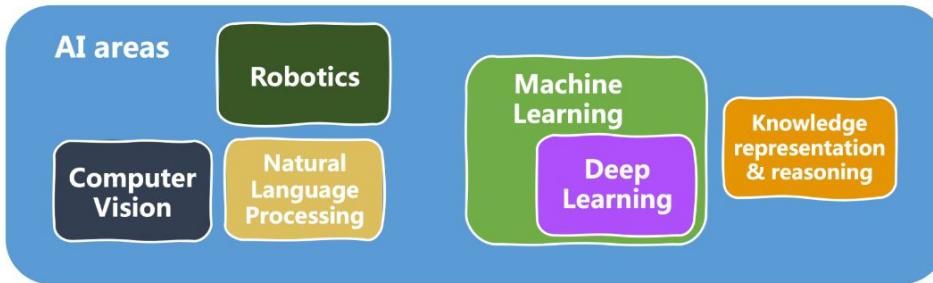
AI functions and areas involved



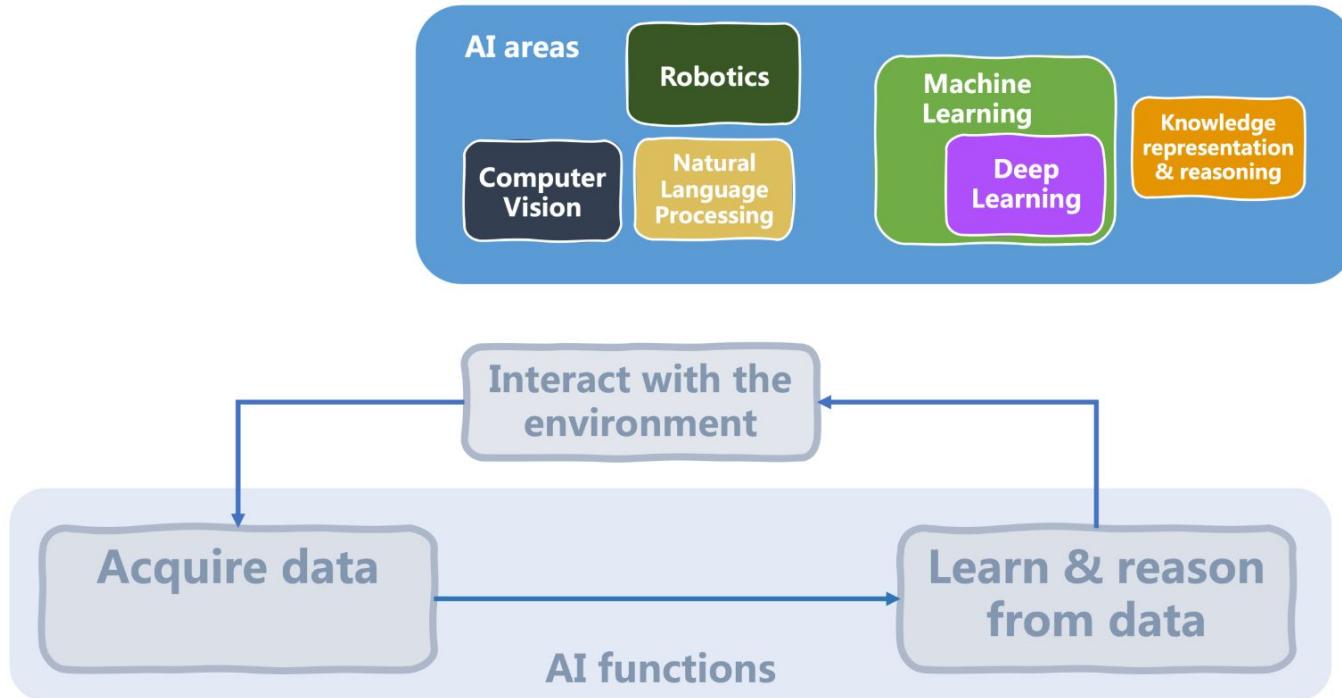
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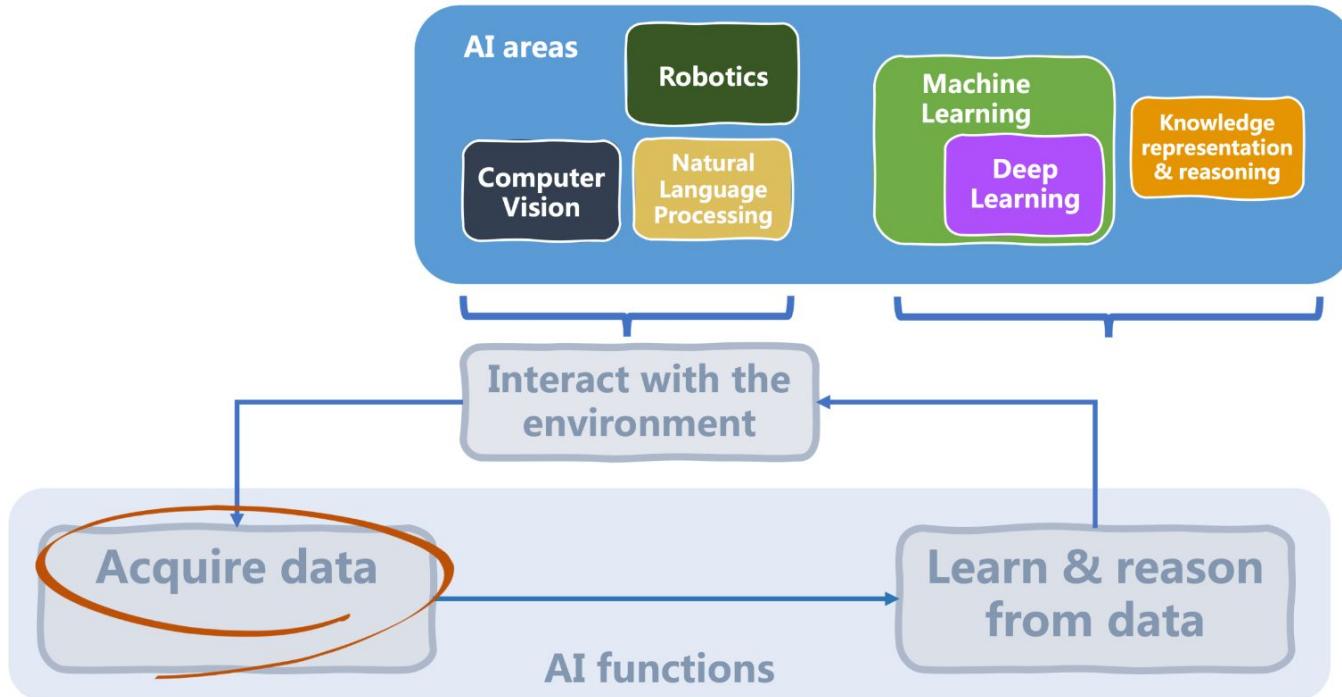
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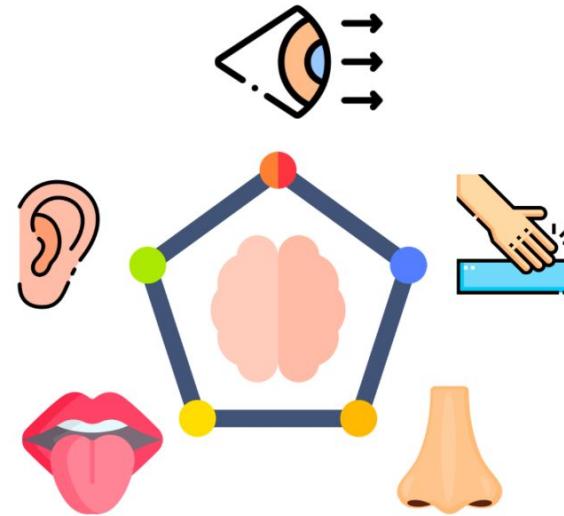
Data acquisition: sensing the environment

Collect outside sensory information through **sensors**: mimic human senses

Transform perceptions into **data**

Occurs in:

- **NLP and audio**: capturing speech, sounds
- **Computer Vision**: satellite images, fingerprint, etc.
- **Robotics and sensors**: temperature, touch, motion, gravity, etc.



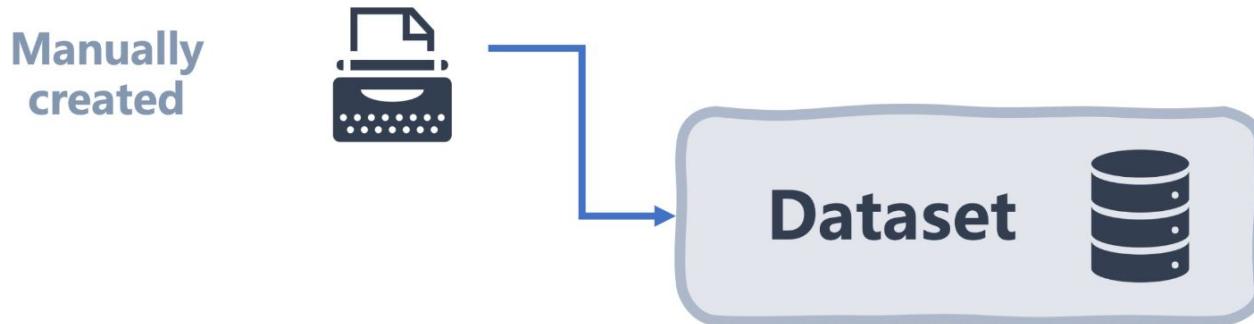
Data acquisition: datasets

- Dataset collection of data: data samples or instances of a given type of data
- Structured: tabular format, spreadsheets
- Unstructured: images, audio, videos, text, ...



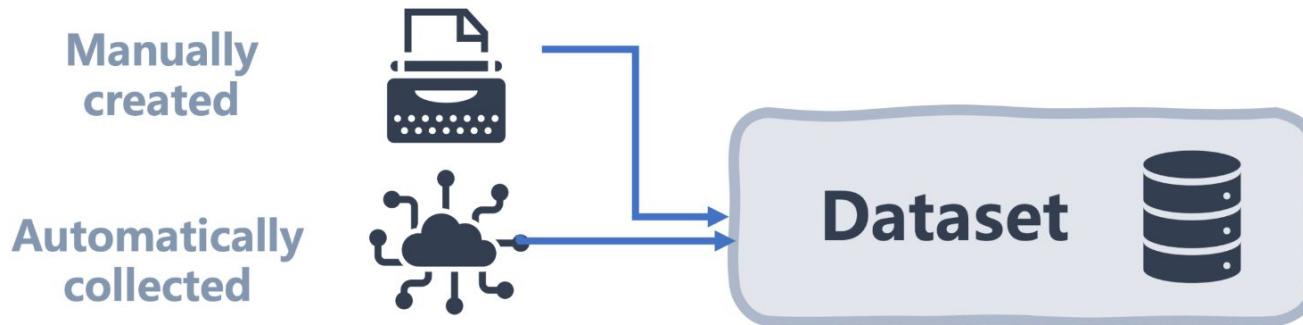
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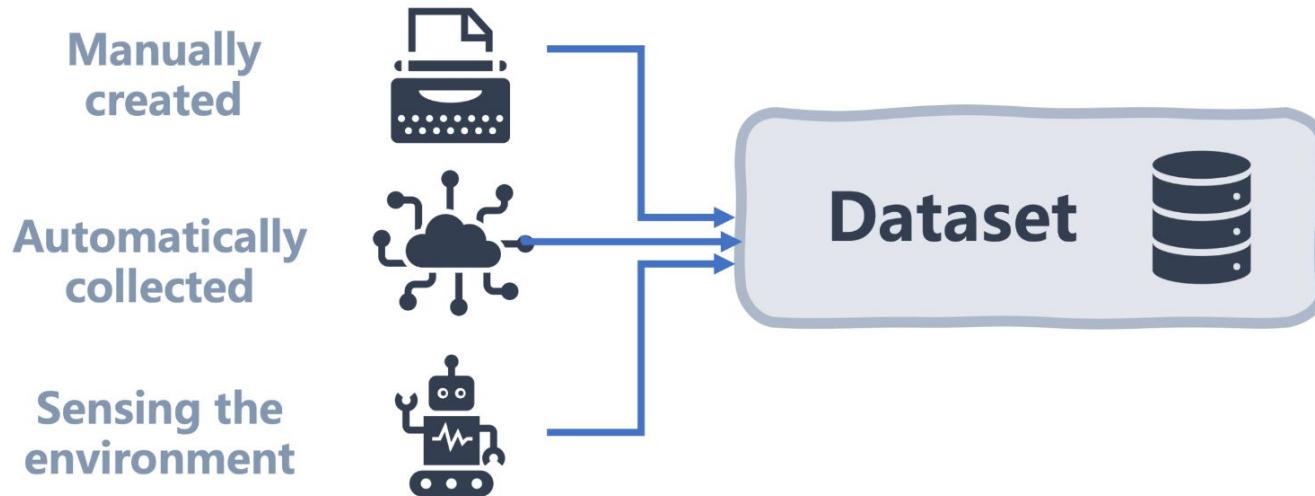
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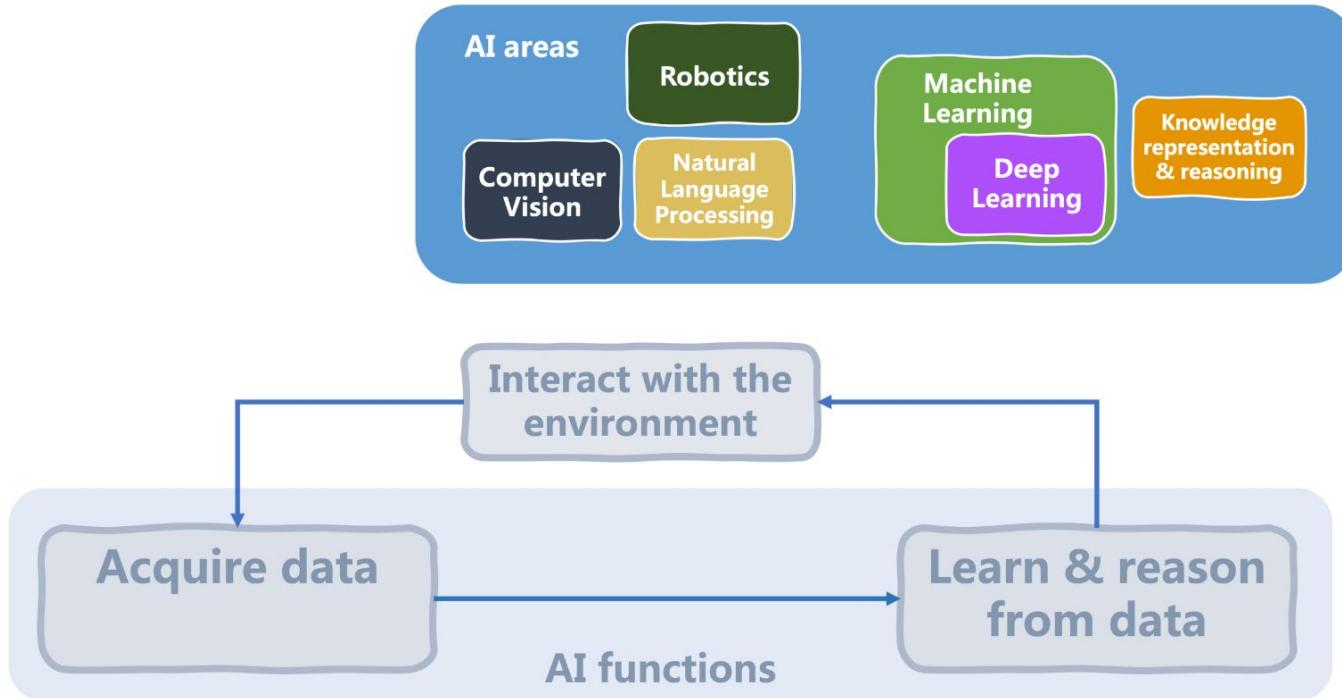
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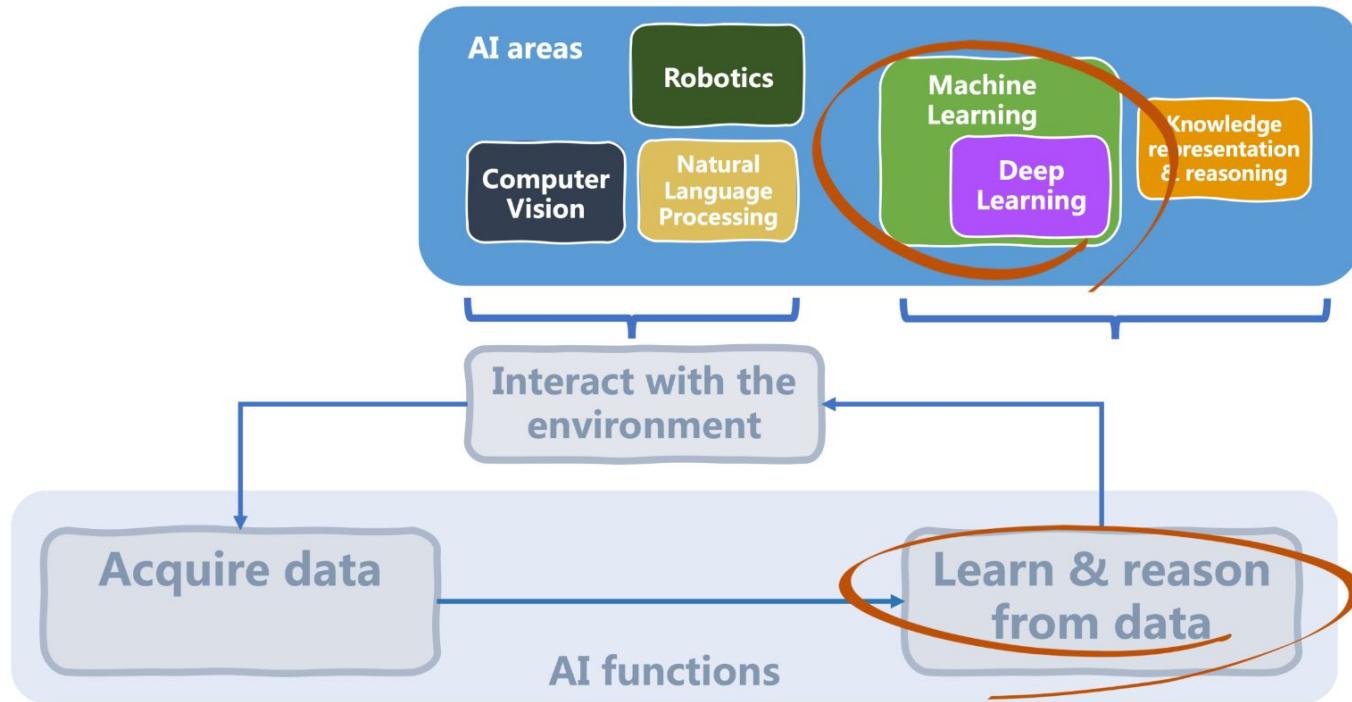
Learning from data

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AI functions and areas involved

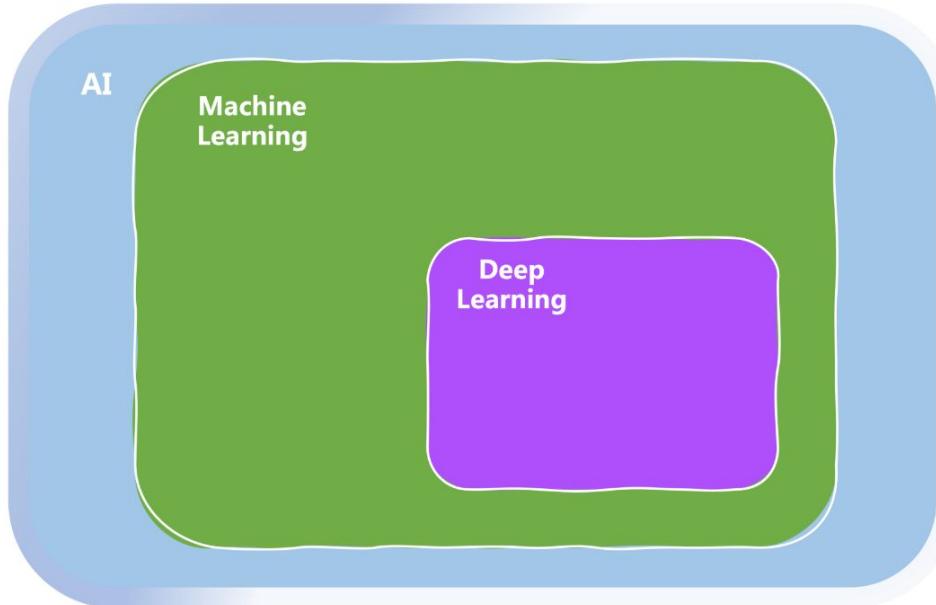


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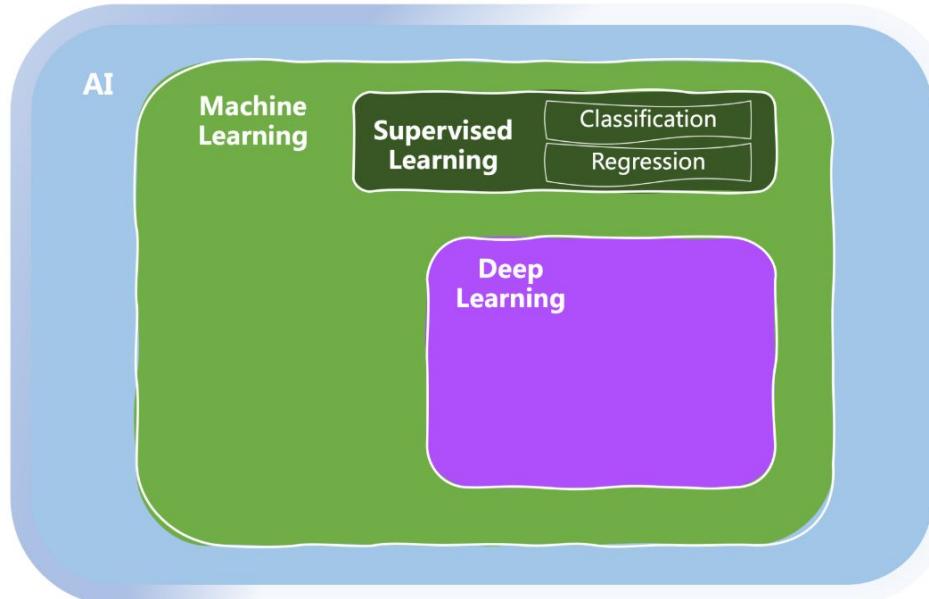
Enter Machine Learning (ML)

Machine Learning: learn from data and identify patterns



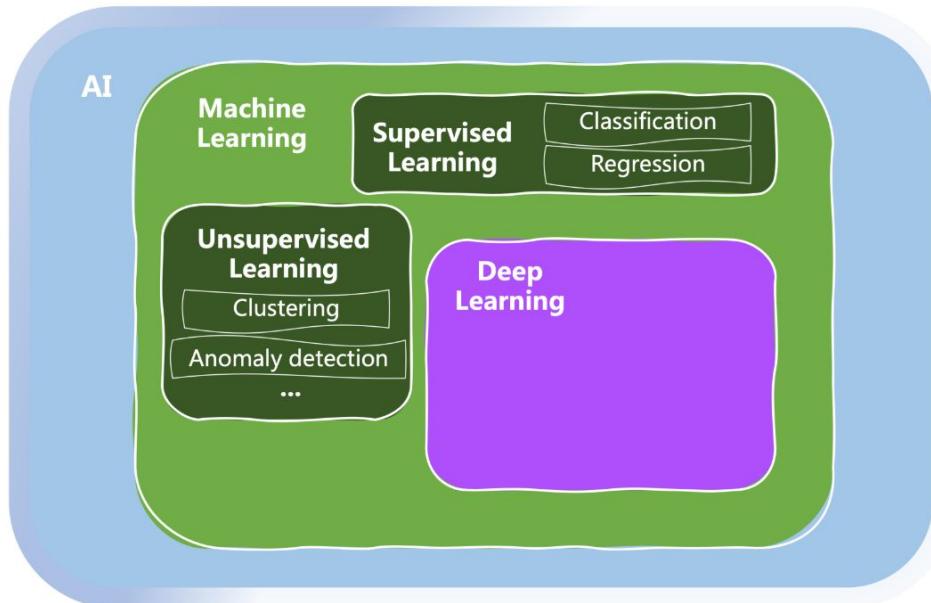
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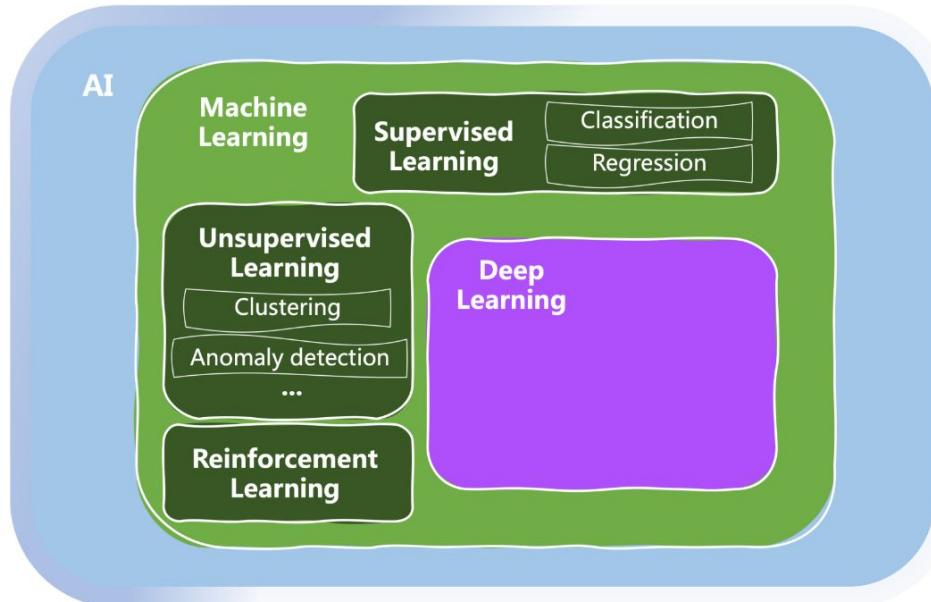
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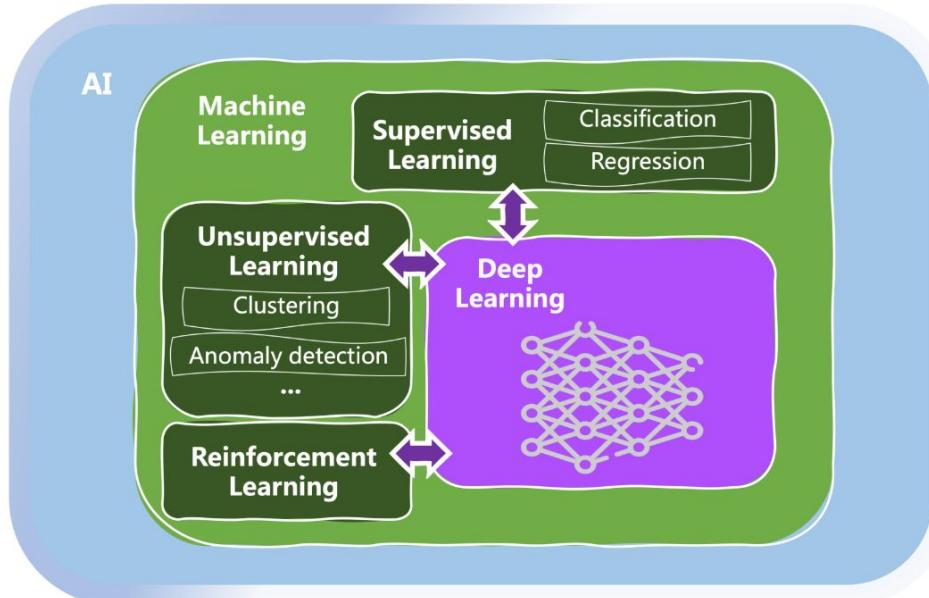
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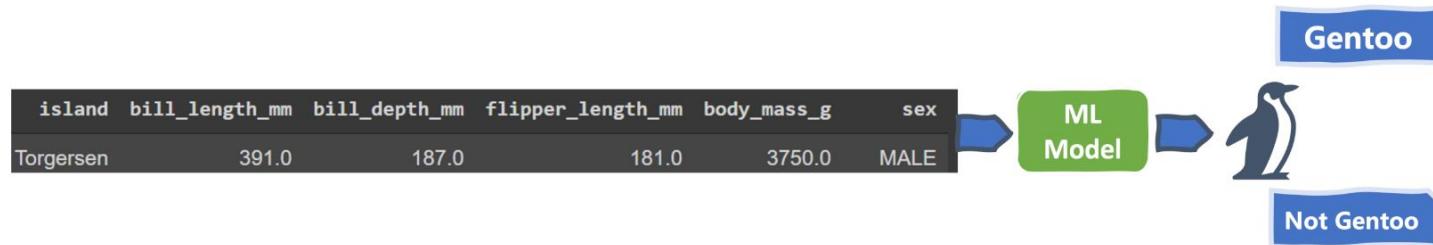
Machine Learning: learn from data and identify patterns



Supervised Learning: classification

Classification: assign each data observation the category (*class*) it may belong to

- **Binary classification:** two classes, e.g. positive/negative, male/female, etc.

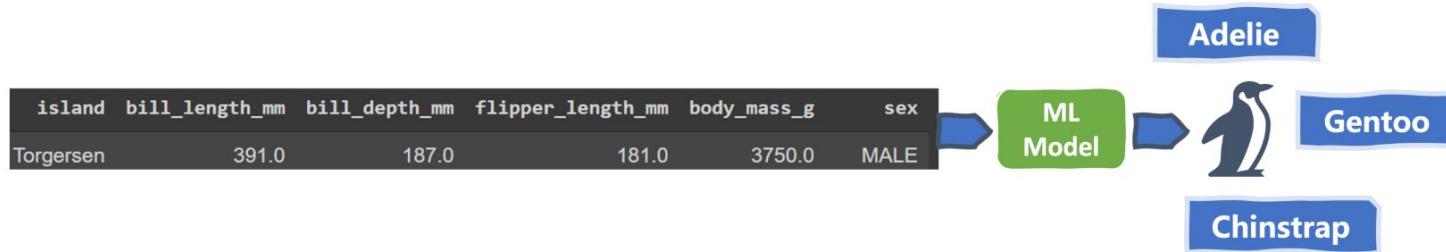


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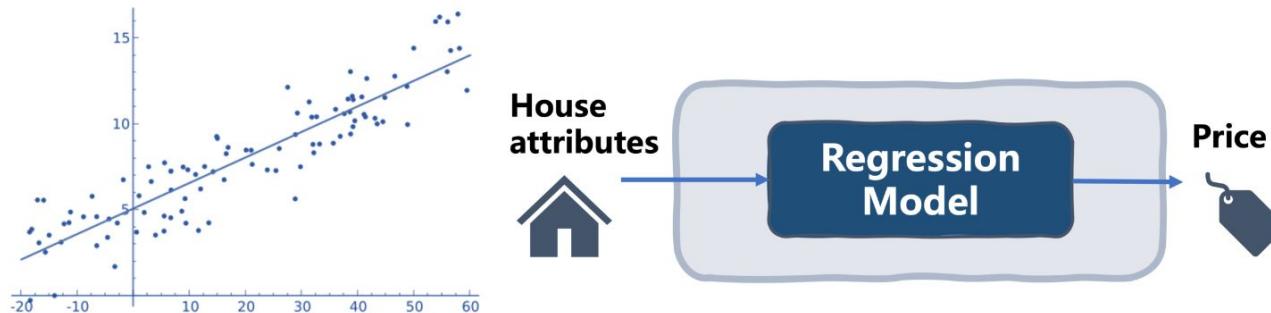
- **Binary classification:** two classes, e.g. positive/negative, male/female, etc.
- **Multi-class classification:** several mutually exclusive classes, e.g. multiple species

Supervised learning: *Data annotation* (getting labelled observations with *known class a priori*) needed to learn/train a **model** capable of making inference

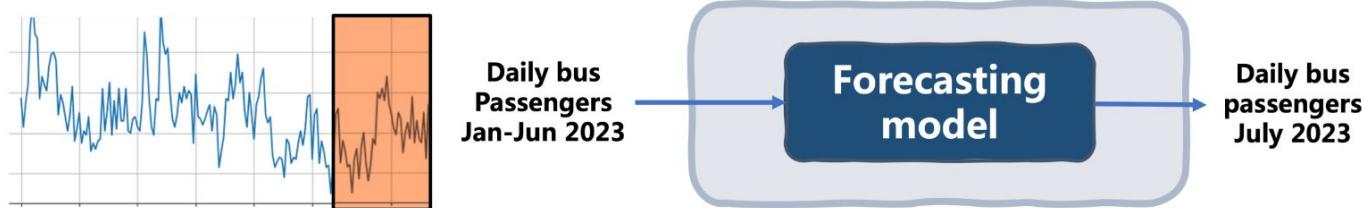


Supervised Learning: regression and forecasting

Regression: assign each data observation a numerical output or *label* based on its inputs

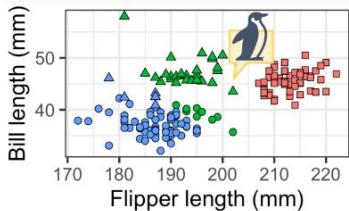


Time series forecasting: predict future values of variable, based on its past behavior

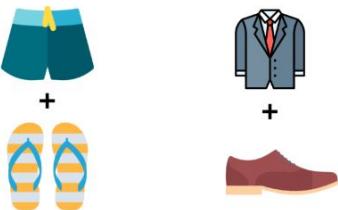


Unsupervised and reinforcement learning

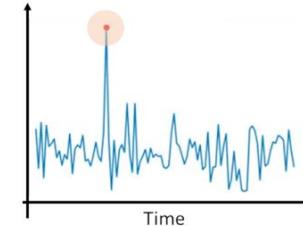
Clustering: find subgroups of data with *similar* characteristics (e.g. *k-means* algorithm)



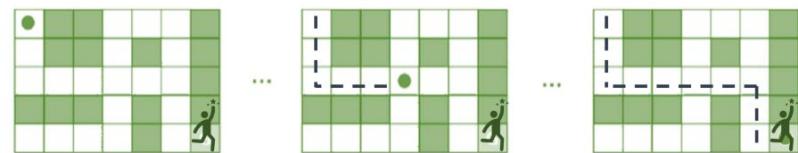
Association rule discovery: find common co-occurrences of items in transaction data



Anomaly detection: detecting *abnormal* data observations e.g. unusual card transactions

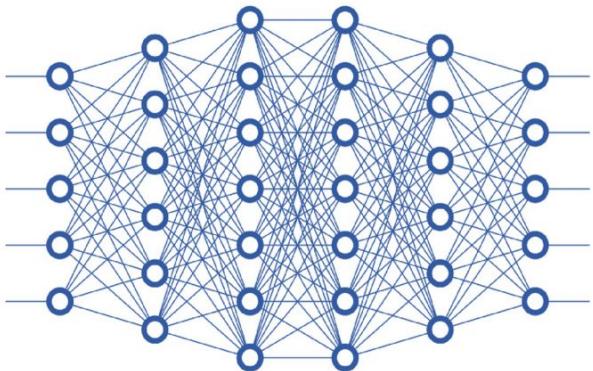


Reinforcement learning: learn by *experience* (trial and error) to master a complex task



How about Deep Learning?

- Highly sophisticated models based on **deep neural networks**: solve very challenging tasks where classical ML models become limited
 - Learn from data as a human brain would do
- Need a lot of data to learn: sometimes *millions* of observations



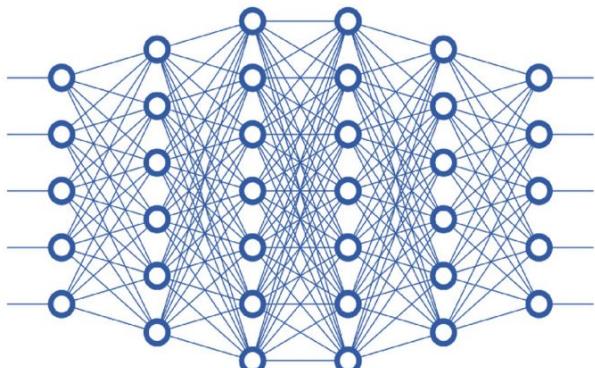
Some tasks Deep Learning can do

Classification
Regression
Forecasting
Clustering
Anomaly detection
...

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Some tasks Deep Learning can do

Classification
Regression
Forecasting
Clustering
Anomaly detection
...

Recognize objects in images/video

Translation, summarization, ...

Generative AI: Large Language Models, image and music generation, ...



你好

Hola

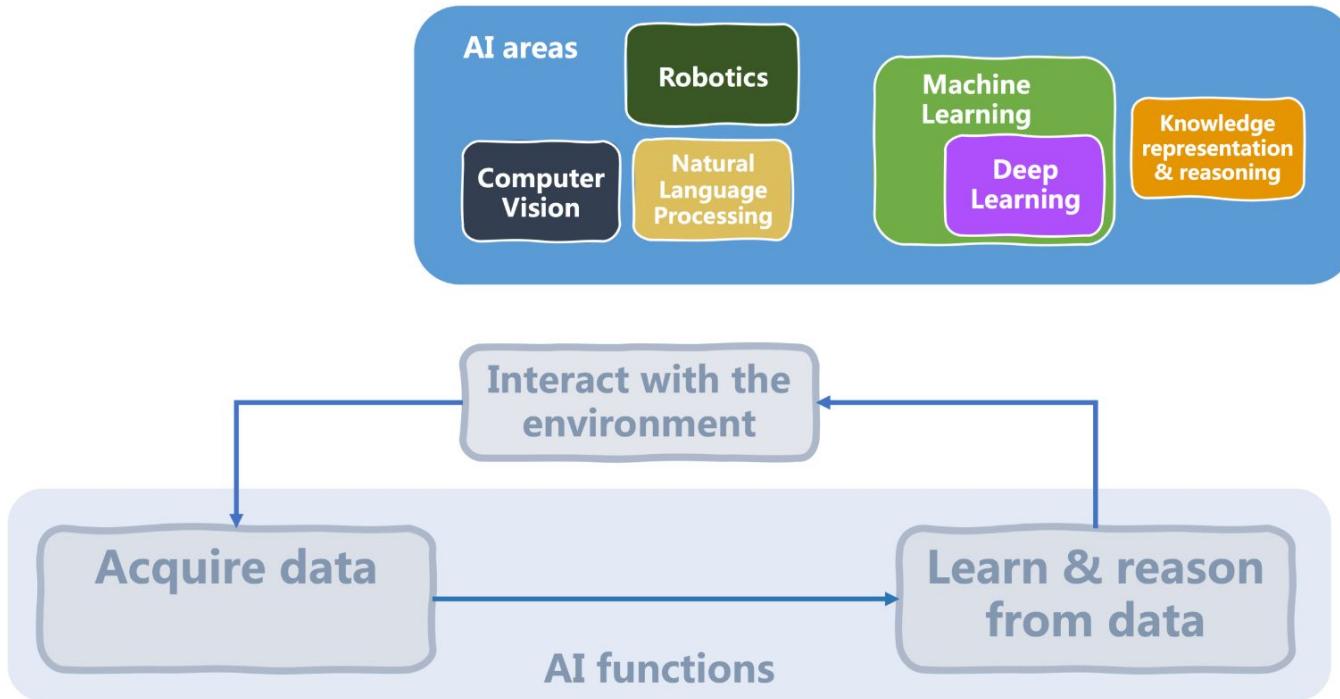
men tropical shirt with blue and yellow motifs



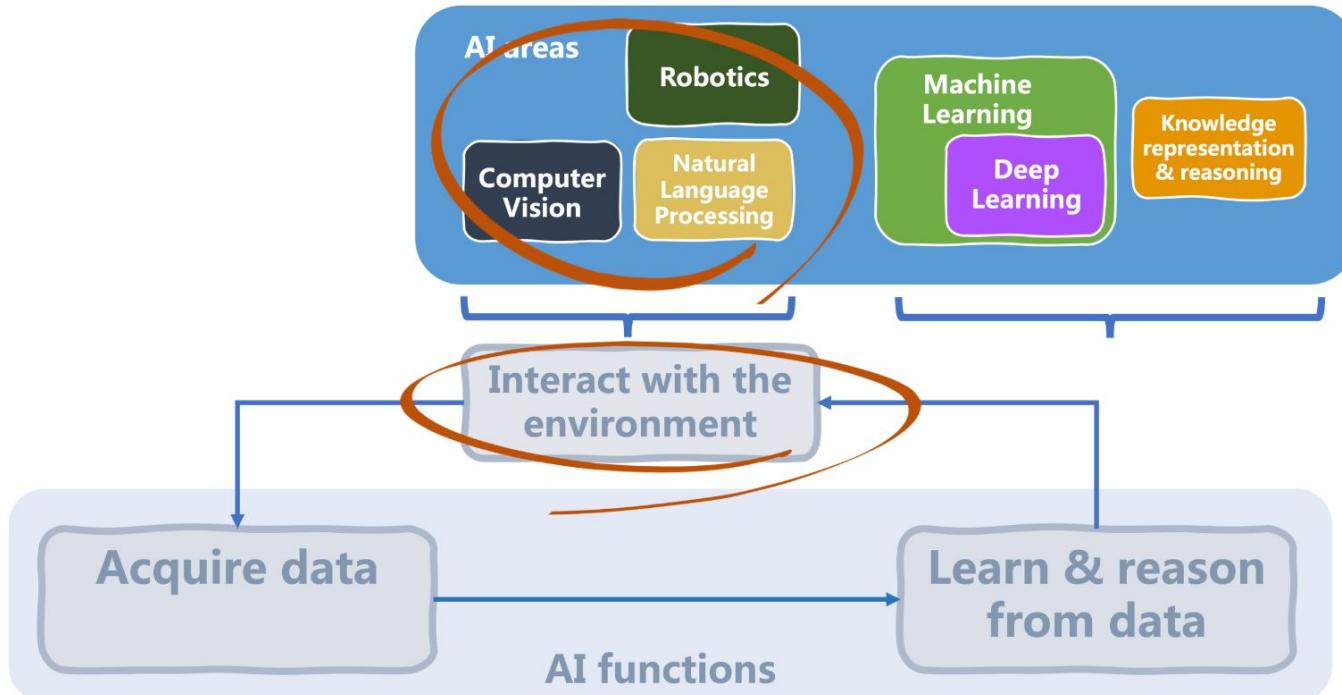
Interacting with the environment

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AI functions and areas involved

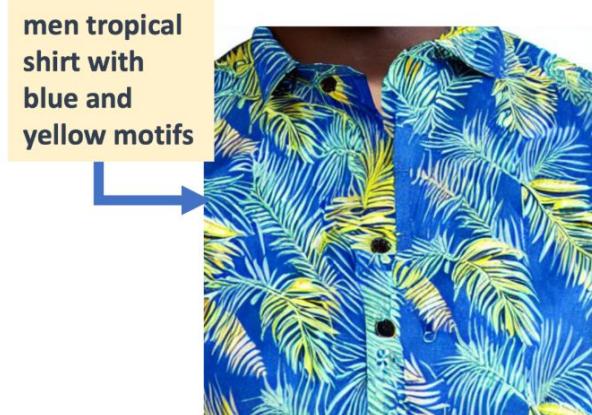


AI functions and areas involved



Computer vision

- **Image processing:** intelligently enhance images and video
- **Object detection:** identify subjects in images/video for surveillance, logistics, etc.
- **Motion analysis:** extract motion information like speed and direction of objects
- **Image and video generation:** create realistic visual data from human text



Natural Language Processing (NLP)

- **Text-based**
 - **Text classification**
 - **Sentiment analysis:** extract positive and negative feelings in text, e.g. customer reviews.
 - **Question answering (*chatbots*)**
 - **Text summarization**
- **Speech-based**
 - **Text-to-speech**
 - **Speech-to-text**



你好
→ Hola



Robotics

- Combine computer vision and NLP
- **Sensing and perception:** collecting data or perceiving signals
- **Mobility:** moving in the environment guided by perceptions of surroundings
- **Manipulation:** the robot modifies its environment
- **Human-robot interaction:** e.g. conversational robots endowed with NLP

