Artificial Intelligence & Machine Learning

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What is Artificial Intelligence?

- *"AI is the study of complex information processing problems that often have their roots in some aspect of biological information processing. The goal of the subject is to identify solvable and interesting information processing problems, and solve them."*

  — *David Marr*

- *"The intelligent connection of perception to action"*

  — *Rodney Brooks*

- *"Actions that are indistinguishable from a human's"*

  — *Alan Turing*

- *"The science and engineering of making intelligent machines, especially intelligent computer programs"*

  — *John McCarthy*

- *Artificial Intelligence is a way of making a computer, a computer-controlled robot, or a software think intelligently, in the similar manner the intelligent humans think.*

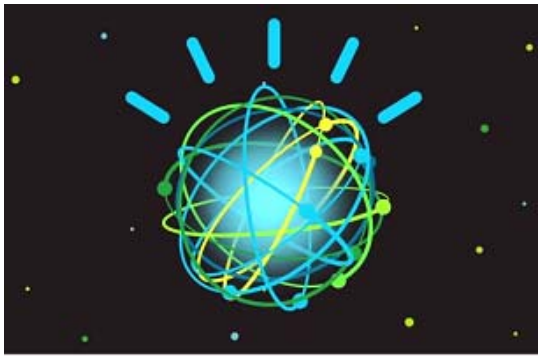
- *AI is accomplished by studying how human brain thinks, and how humans learn, decide, and work while trying to solve a problem, and then using the outcomes of this study as a basis of developing intelligent software and systems.*

Definition of Artificial Intelligence

Views of AI are divided into four categories [Russell and Norvig, 2010]:

1. ***Systems that think like humans***
2. ***Systems that act like humans***
3. ***Systems that think rationally***
4. ***Systems that act rationally***

THOUGHT	*1. Systems that think like humans*	*3. Systems that think rationally*
BEHAVIOUR	*2. Systems that act like humans*	*4. Systems that act rationally*
	HUMAN	*RATIONAL*



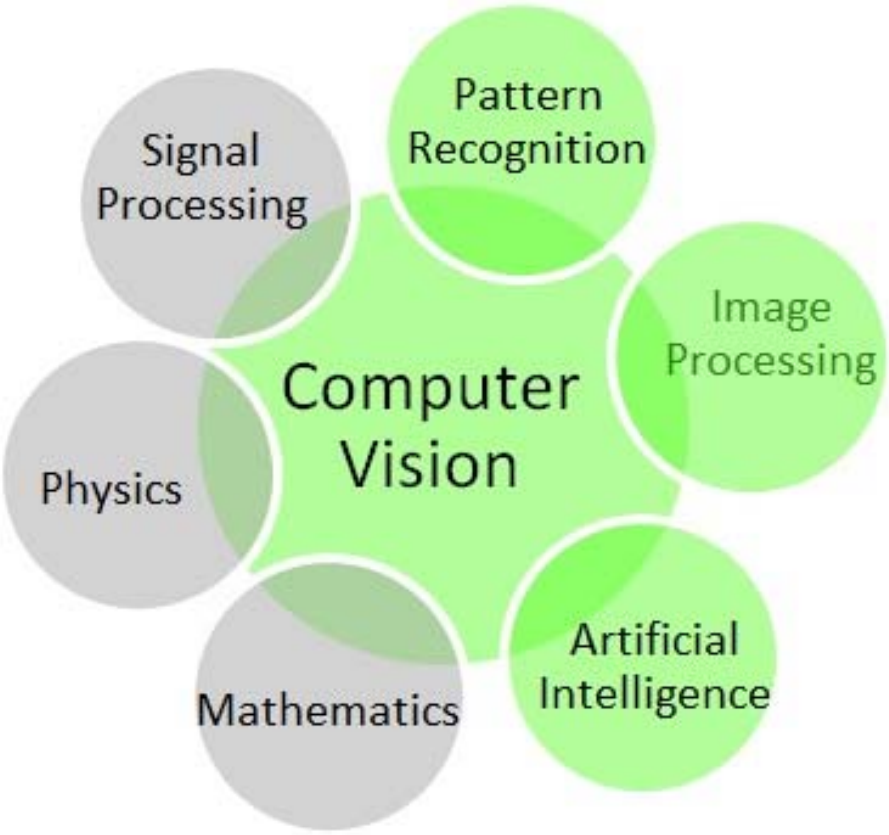
The Main Topics in AI

AI has been dominant in various fields:

1. Computer vision
2. Natural language processing
3. Knowledge representation
4. Machine learning
5. Expert system

Computer Vision

- ***Computer vision is the science that aims to give the capability to see and virtually sense the world to a machine or computer***
- ***Computer vision concerned with the automatic extraction, analysis and understanding of useful information from a single image or a sequence of images***
- ***Image processing is an analysis of images by various disciplines such as computer science and mathematics***



Applications of Computer Vision

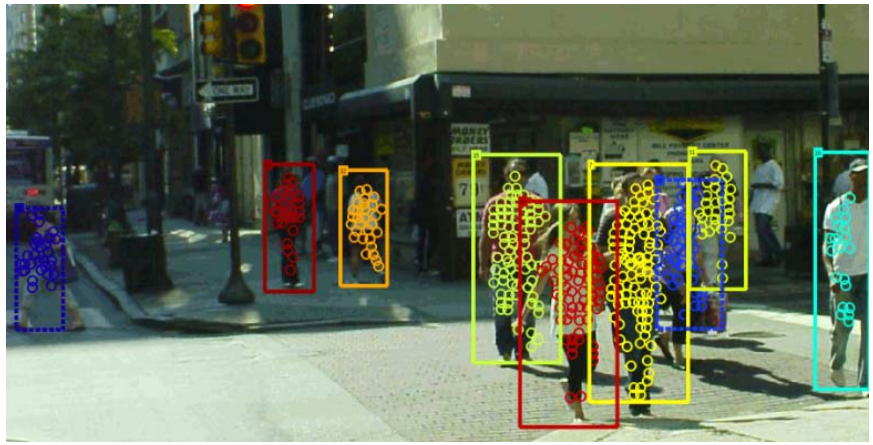
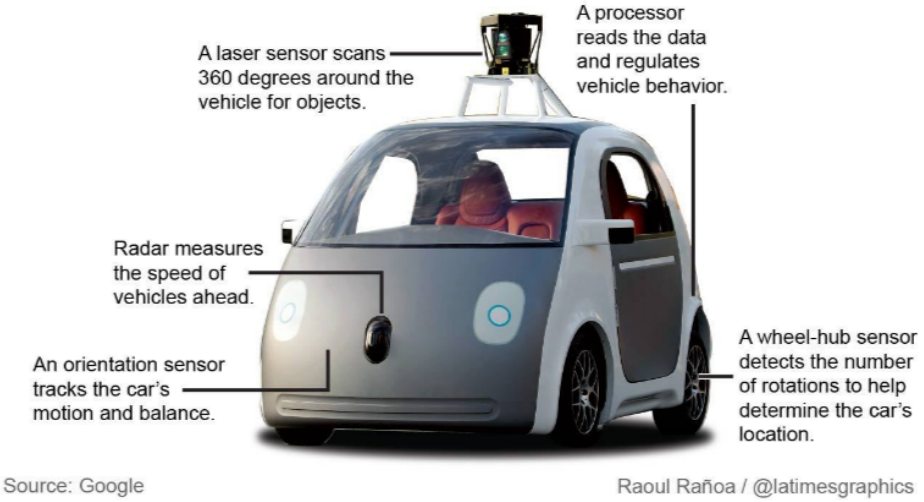
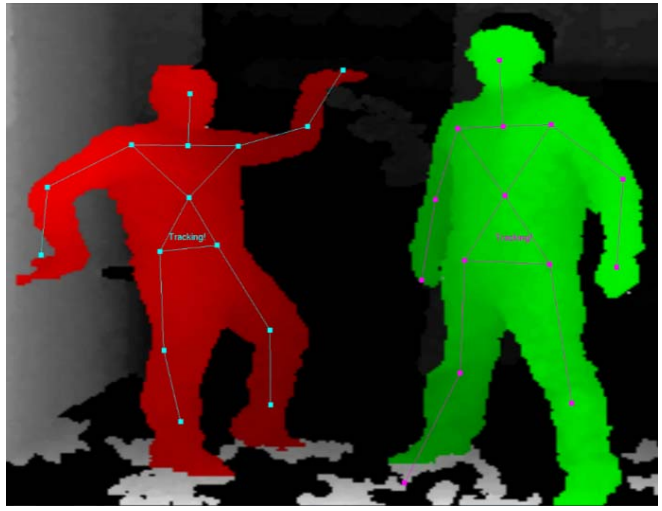


Image processing of CCTV





Motion Detection

Google Self-Driving Car

http://www.google.com/selfdrivingcar/

https://waymo.com/

Natural Language Processing (NLP)

- *NLP is the branch of computer science focused on developing systems that allow computers to communicate with people using everyday language*
- *Also concerns how computational methods can aid the understanding of human language*
- *This field is closely related to Computational Linguistics and Linguistics*
- *Some NLP applications:*
  - *Machine Translation*
  - *Information Retrieval*
  - *Language Detection*
  - *Speech Recognition*

Knowledge Representation

- *The study of how to put knowledge into a form that a computer can reason with*

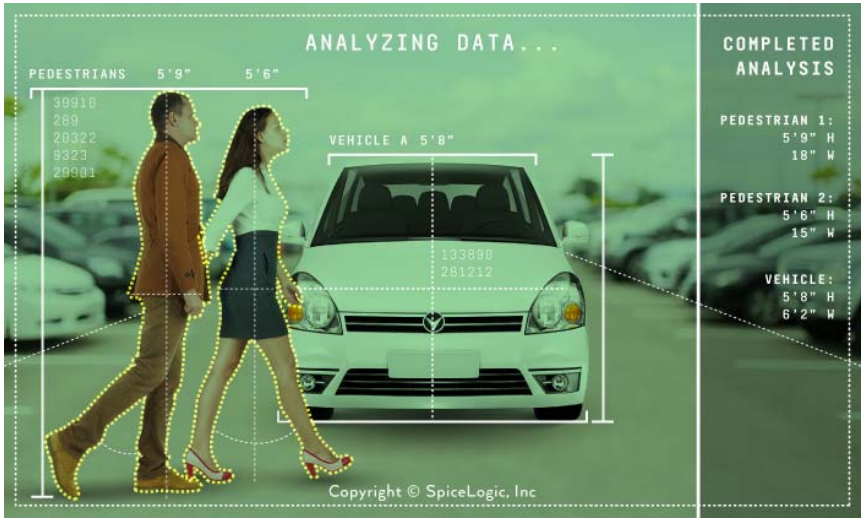
- *Two main categories of Knowledge Representation:*
  - *Certain knowledge includes First order logic or Propositional logic*
  - *Uncertain knowledge includes Fuzzy logic and Bayesian networks*

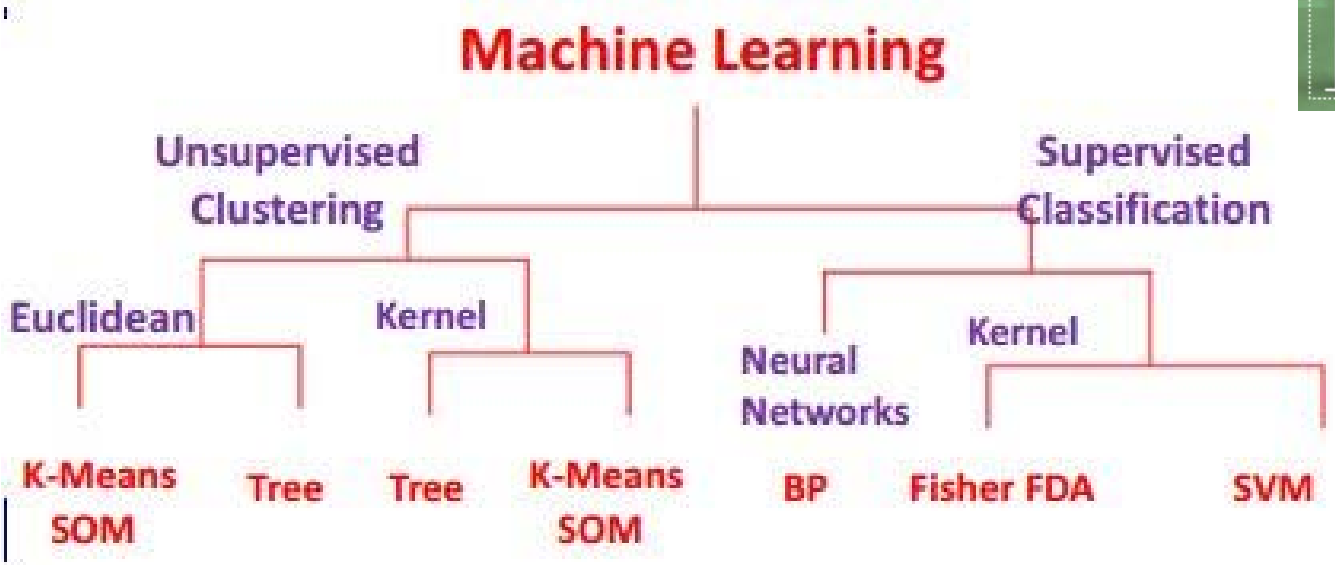
Machine Learning

- *Is a type of artificial intelligence (AI) that provides computers with the ability to learn without being explicitly programmed.*
- *Focuses on the development of computer programs that can change when exposed to new data.*
- *Searches through data to look for patterns*
- *Uses that data to detect patterns in data and adjust program actions accordingly*
- *Examples of machine learning applications:*
  - *Google self-driving car*
  - *Online recommendation offers such as those from Amazon and Netflix*
  - *Facebook's News Feed uses machine learning to personalize each member's feed. If a member frequently stops scrolling in order to read or "like" a particular friend's posts, the News Feed will start to show more of that friend's activity earlier in the feed.*

Types of Learning

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





Supervised Learning

- *Training Data*
- *Classification:*
- ***Given a collection of records (training set)***
  - ***Each record contains a set of attributes, one of the attributes is the class.***
- ***Find a model for class attribute as a function of the values of other attributes.***
- ***Goal: previously unseen records should be assigned a class as accurately as possible.***
  - ***A test set is used to determine the accuracy of the model. Usually, the given data set is divided into training and test sets, with training set used to build the model and test set used to validate it.***

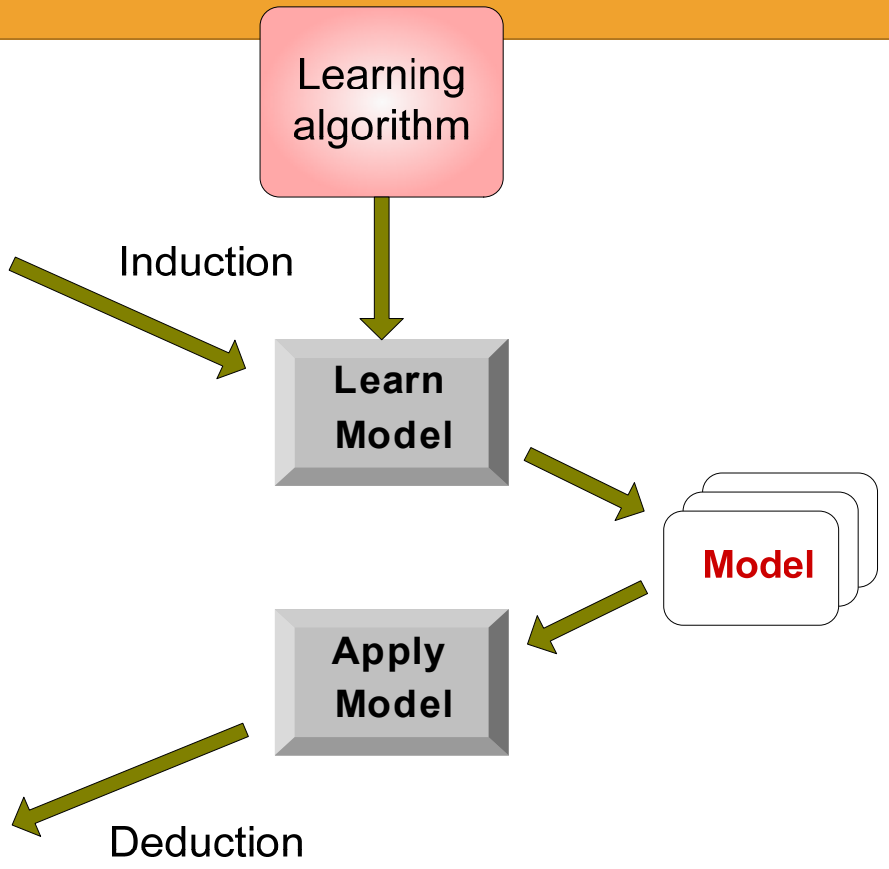
Illustrating Classification Task

Tid	Attrib1	Attrib2	Attrib3	Class
1	Yes	Large	125K	No
2	No	Medium	100K	No
3	No	Small	70K	No
4	Yes	Medium	120K	No
5	No	Large	95K	Yes
6	No	Medium	60K	No
7	Yes	Large	220K	No
8	No	Small	85K	Yes
9	No	Medium	75K	No
10	No	Small	90K	Yes

Training Set

Tid	Attrib1	Attrib2	Attrib3	Class
11	No	Small	55K	?
12	Yes	Medium	80K	?
13	Yes	Large	110K	?
14	No	Small	95K	?
15	No	Large	67K	?

Test Set

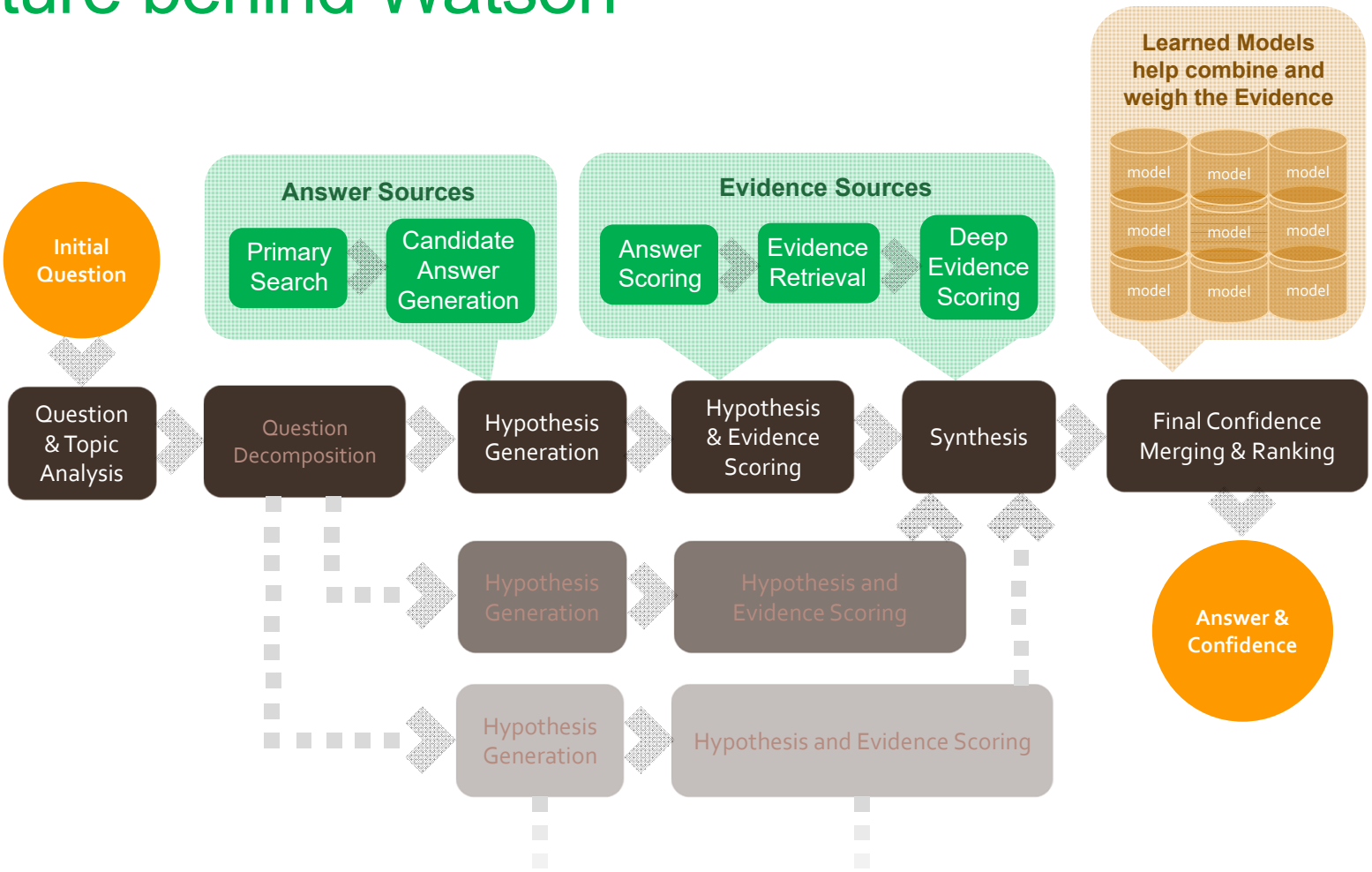


IBM Watson

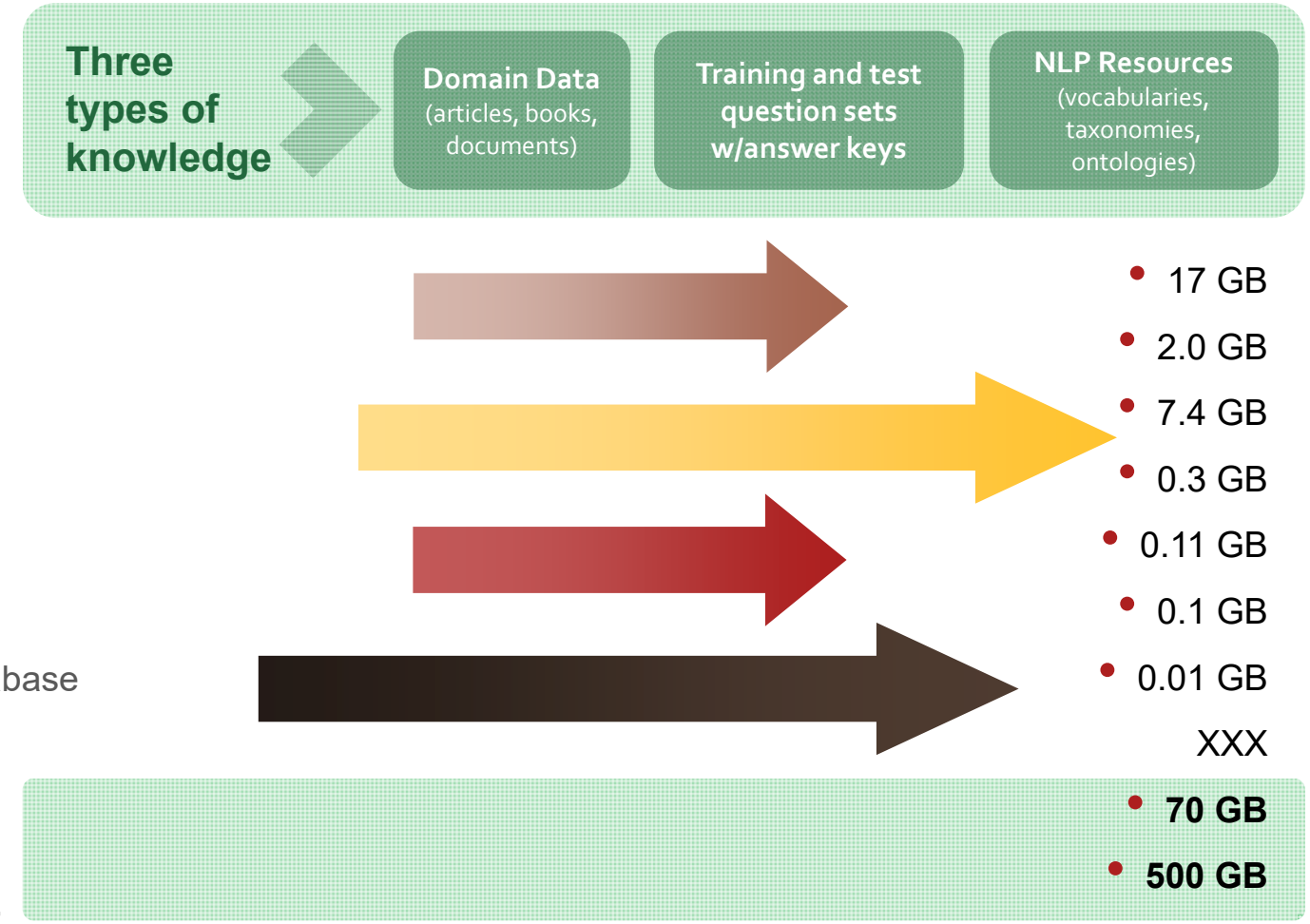
Watson is a question answering (QA) computing system that IBM built to apply advanced natural language processing, information retrieval, knowledge representation, automated reasoning, and machine learning technologies.

A. What is the computer system that played against human opponents on "Jeopardy"… and won.

DeepQA: the technology & architecture behind Watson

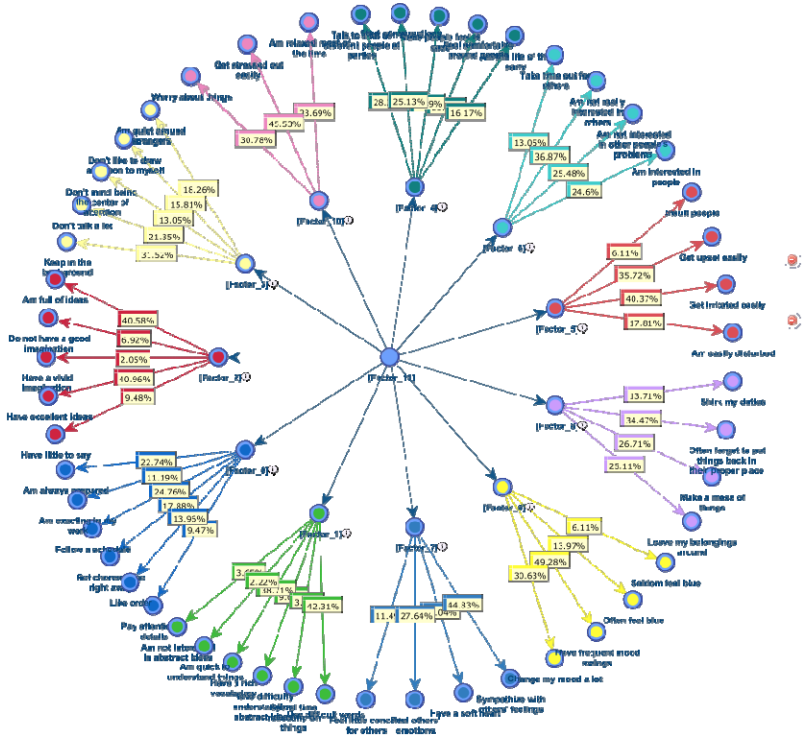


Where did it acquire knowledge?



Unsupervised Learning

- Is the machine learning task of inferring a function to describe hidden structure from "unlabeled" data (a classification or categorization is not included in the observations).
- Since the examples given to the learner are unlabeled, there is no evaluation of the accuracy of the structure that is output by the relevant algorithm

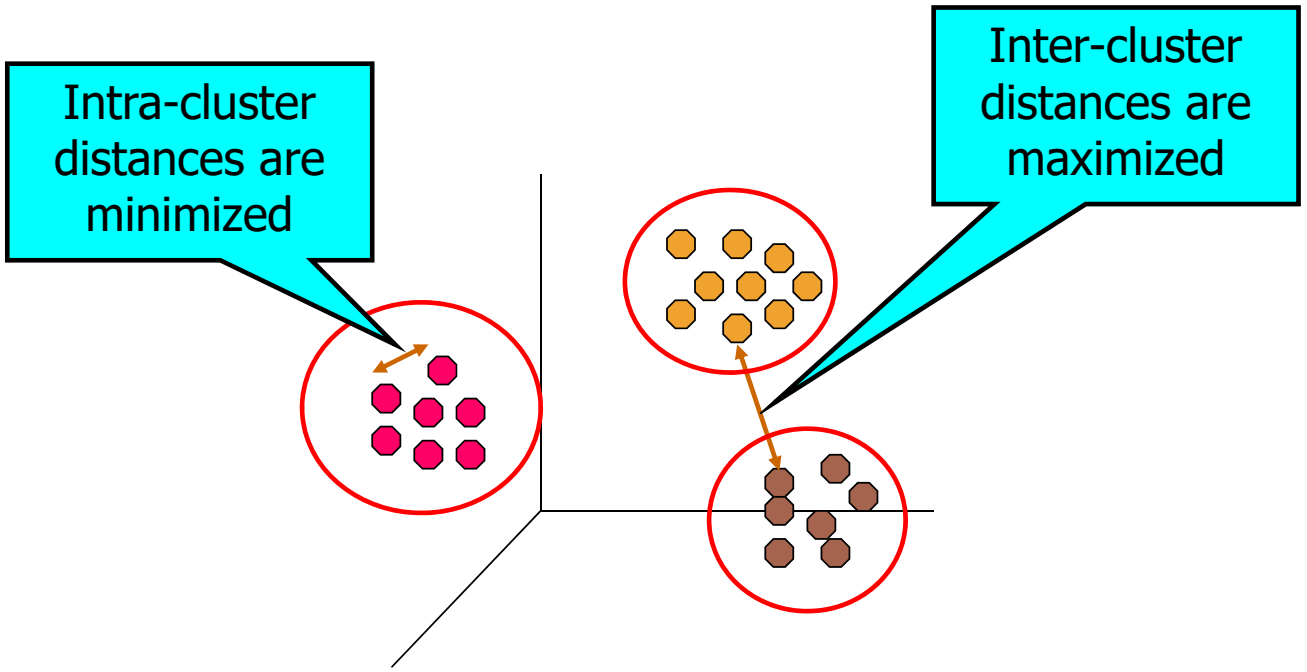


Clustering Definition

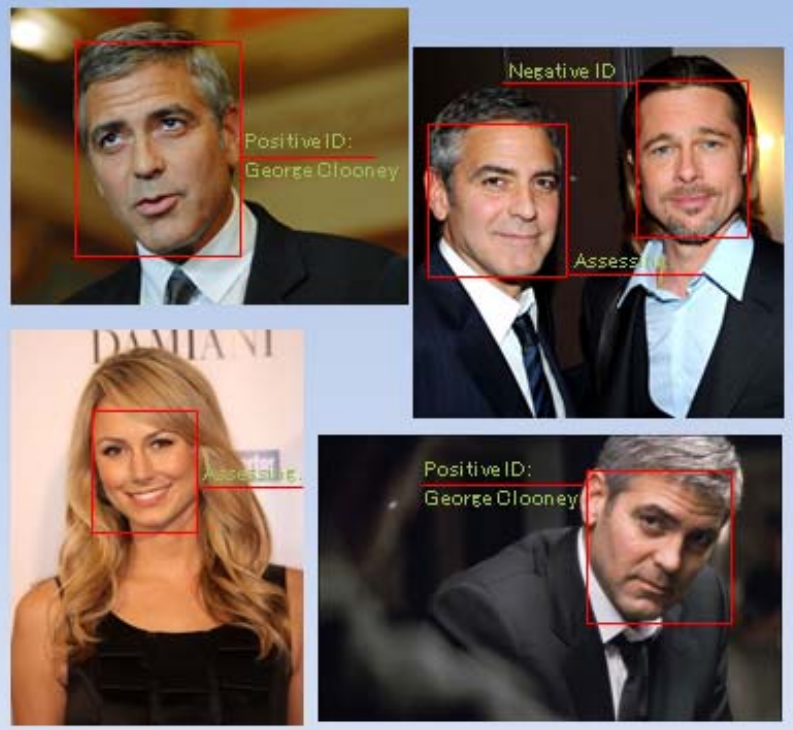
- *Given a set of data points, each having a set of attributes, and a similarity measure among them, find clusters such that*
  - *Data points in one cluster are more similar to one another.*
  - *Data points in separate clusters are less similar to one another.*
- *Similarity Measures:*
  - *Euclidean Distance if attributes are continuous.*
  - *Other Problem-specific Measures.*

Illustrating Clustering

- ***Finding groups of objects such that the objects in a group will be similar (or related) to one another and different from (or unrelated to) the objects in other groups***



Supervised Learning



Unsupervised Learning

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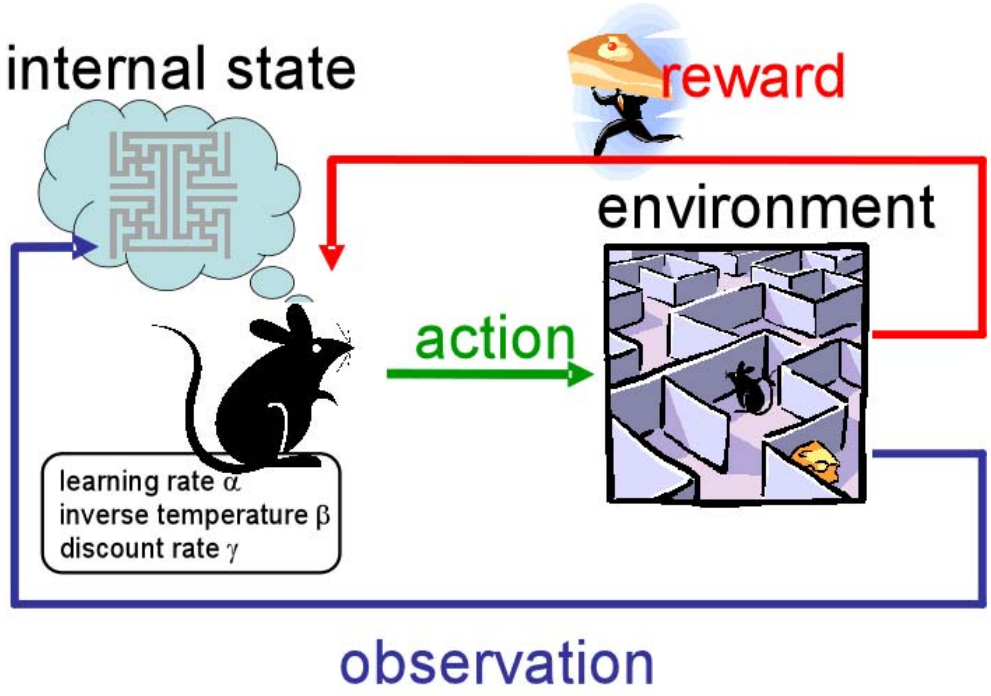
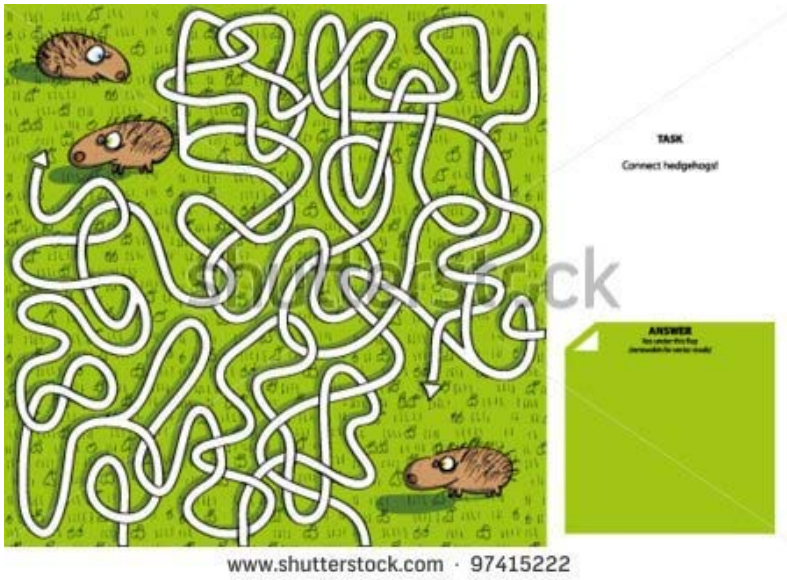
Reinforcement Learning

- Is an area of machine learning inspired by behaviorist psychology, concerned with how software agents ought to take actions in an environment so as to maximize some notion of cumulative reward.
- Example: Google DeepMind's AlphaGo





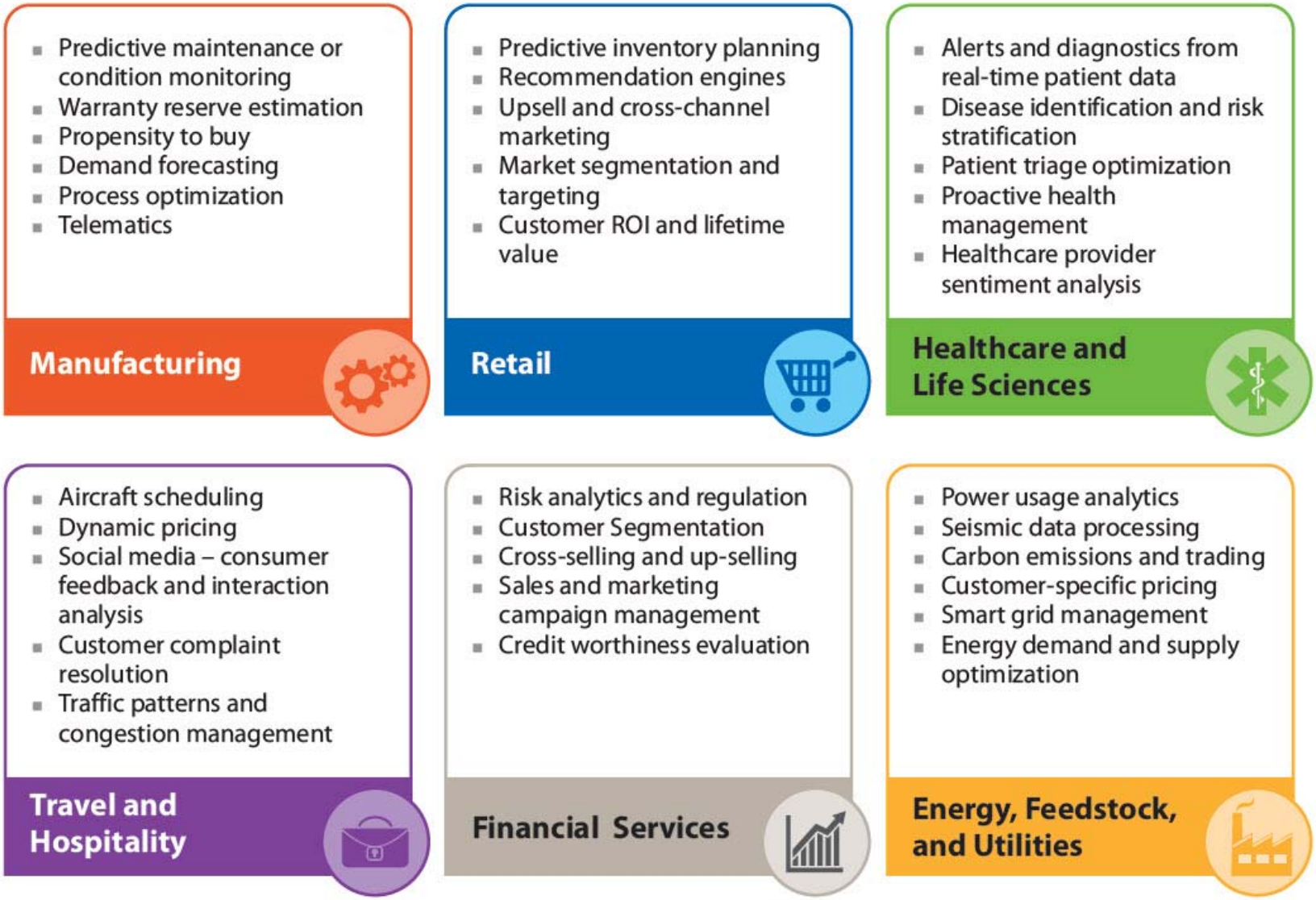
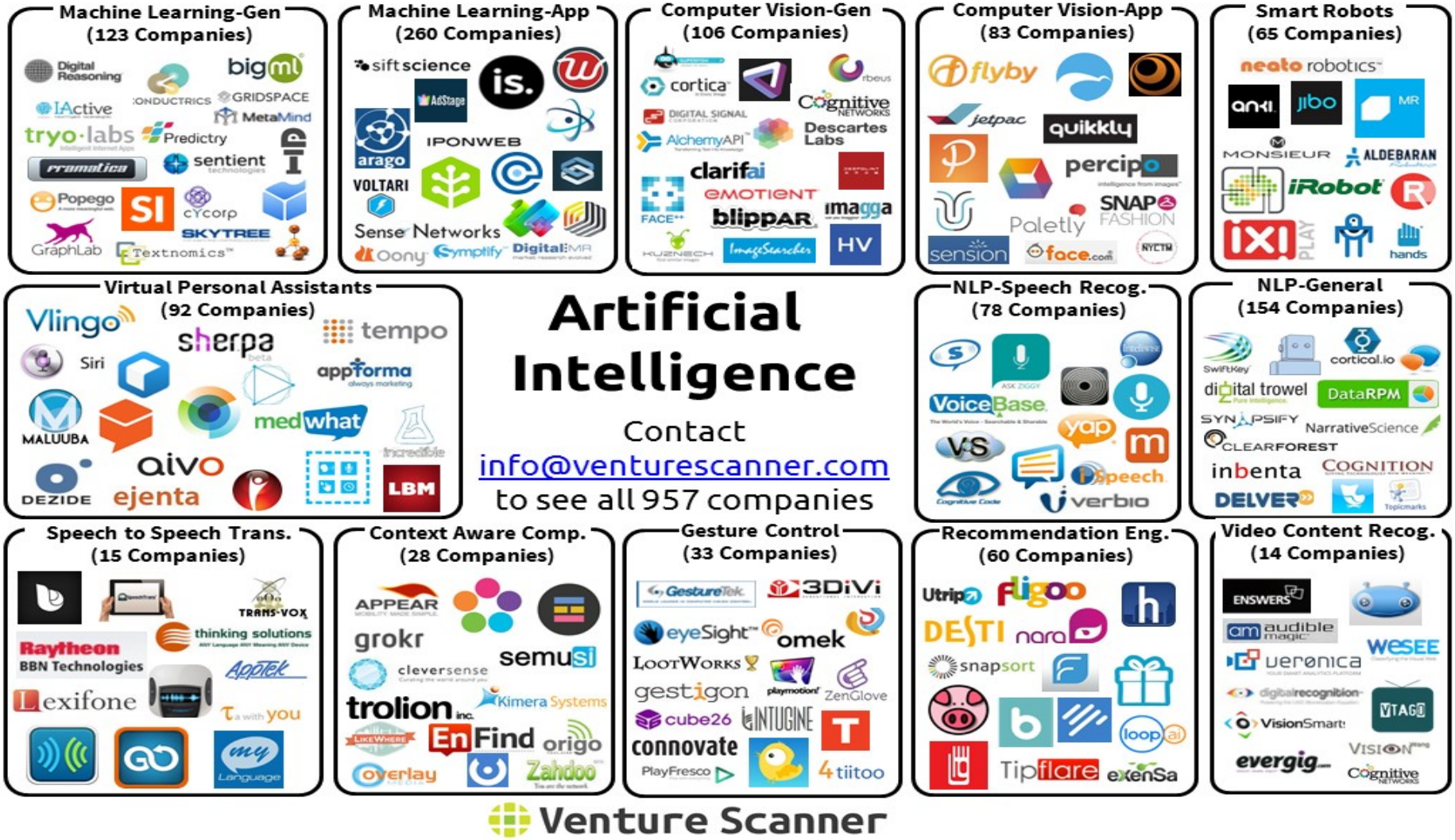
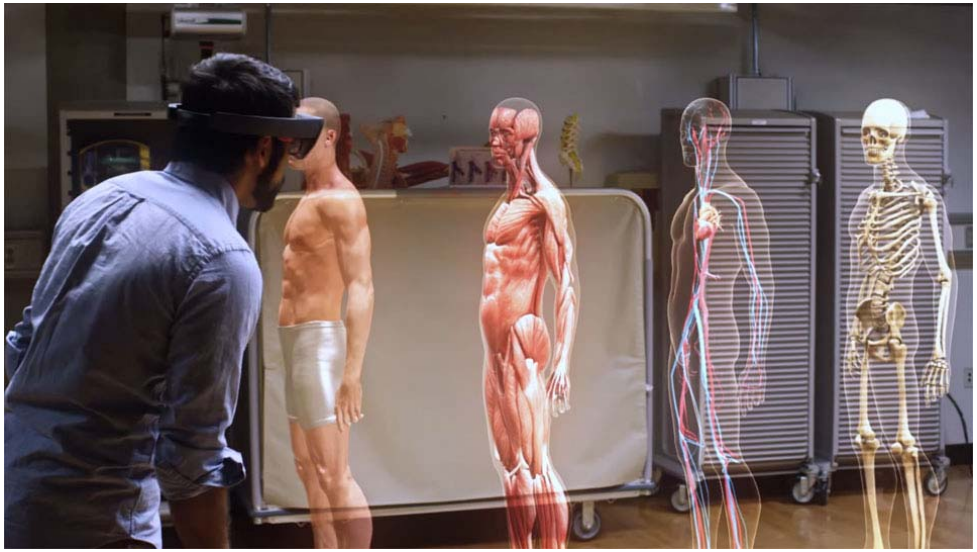
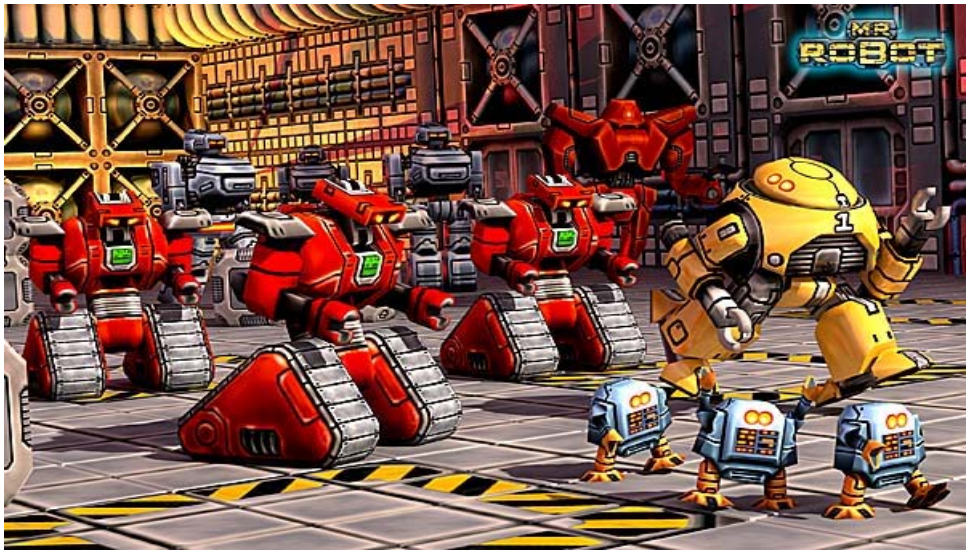


Figure 2: Machine Learning applications across industries

Machine Learning Applications



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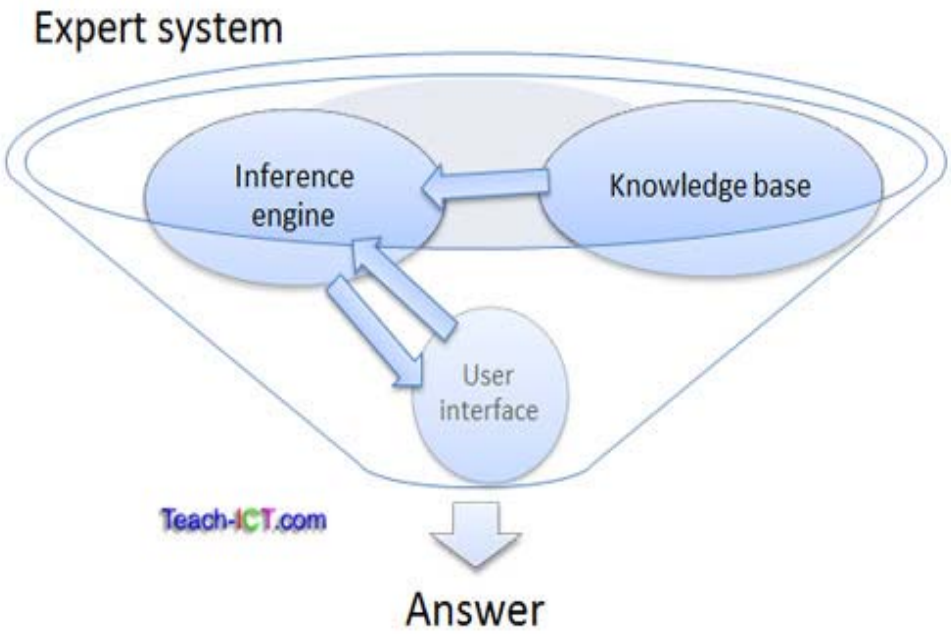
Microsoft HoloLens

Expert System

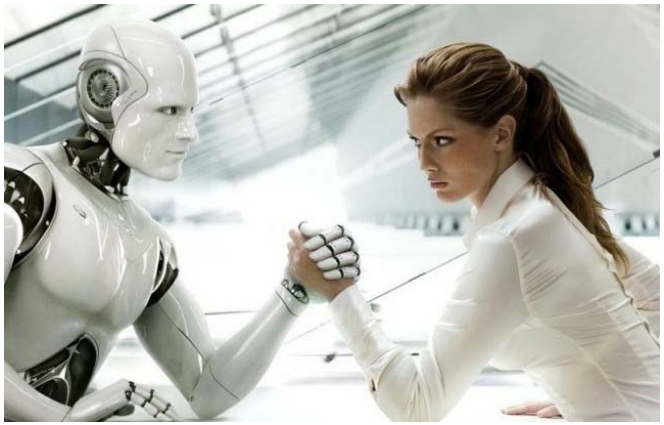
- ***Is a computer system that emulates the decision-making ability of a human expert***
- ***To solve expert-level problems, expert systems will need efficient access to a substantial domain knowledge base, and a reasoning mechanism to apply the knowledge to the problems they are given. Usually they will also need to be able to explain, to the users who rely on them, how they have reached their decisions.***



Some Examples of AI Applications

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

https://www.youtube.com/watch?v=NtU9p1VYtcQ

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