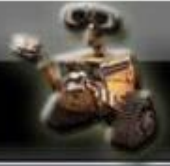

Artificial Intelligence

Introduction

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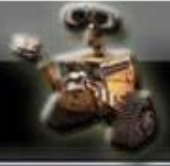
AI Institute@ZJU
2015.03

Contents

- What's AI?
- The history of AI
- The state of the art
- ML: What and why?

What's AI?



What's AI?

- *"We call ourselves Homo sapiens — man the wise — because our intelligence is so important to us. For thousands of years, we have tried to understand how we think; that is, how a mere handful of matter can perceive, understand, predict, and manipulate a world far larger and more complicated than itself. "*

  ------ *《Artificial Intelligence》*

- The field of artificial intelligence, or AI, goes further still: it attempts not just to understand but also to build intelligent entities.

What's AI?

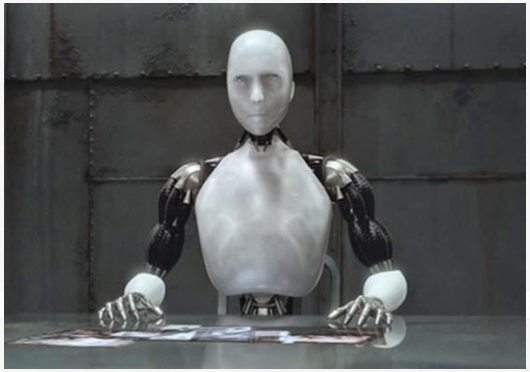
- Hollywood movies
  - The Terminator
  - The Matrix
  - iRobot
  - ……

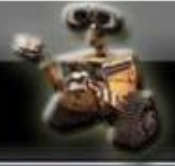
- Scientific research
  - four approaches

What's AI?

- Hollywood movies:
  - Mostly about androids, humanoids, and robots
  - Can speak, see, think, act like human behavior …
  - Can feel human emotions…
  - Can create new things…





What's AI?

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Figure 1.1 Some definitions of artificial intelligence, organized into four categories.

What's AI?

- Acting humanly: The Turing Test approach
  - The Turing Test, proposed by Alan Turing(1950), was designed to provide a satisfactory operational definition of intelligence.
  - A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer.
  - Total Turing Test
    - Natural language processing
    - Knowledge representation
    - Automated reasoning
    - Machine learning
    - Computer vision
    - robotics

We don't want to make machines that fly so exactly like pigeons that they can fool even other pigeons.

What's AI?

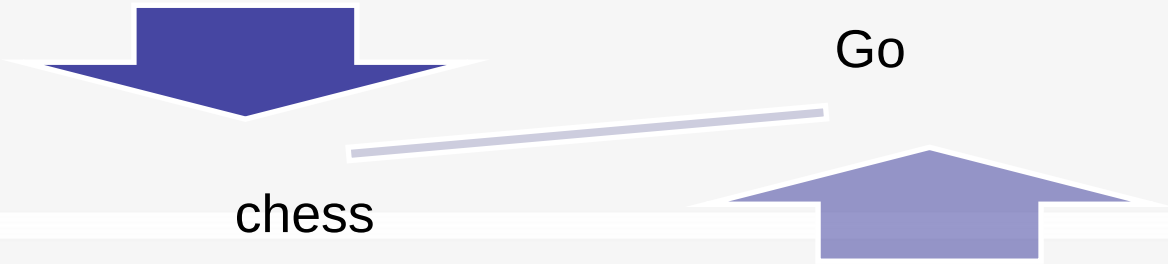
- Thinking humanly: The cognitive modeling approach
  - To get a sufficiently precise theory of the mind and build a program thinks like a human.
  - How humans think?
    - Introspection
    - Psychological experiments
    - Brain imaging

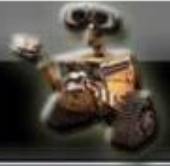
  - The interdisciplinary field of cognitive science brings together computer models from AI and experimental techniques from psychology to construct precise and testable theories of the human mind.

  - In the early days of AI there was often confusion between the approaches: an author would argue that an algorithm performs well on a task and that it is therefore a good model of human performance, or vice versa.

What's AI?

- Thinking rationally: The "laws of thought" approach
  - There are some laws of thought to govern the operation of the mind: logic
  - Aristotle's syllogisms
  - Two main obstacles to this approach:
    - it is not easy to take informal knowledge and state it in the formal terms required by logical notation, particularly when the knowledge is less than 100% certain.
    - there is a big difference between solving a problem "in principle" and solving it in practice.



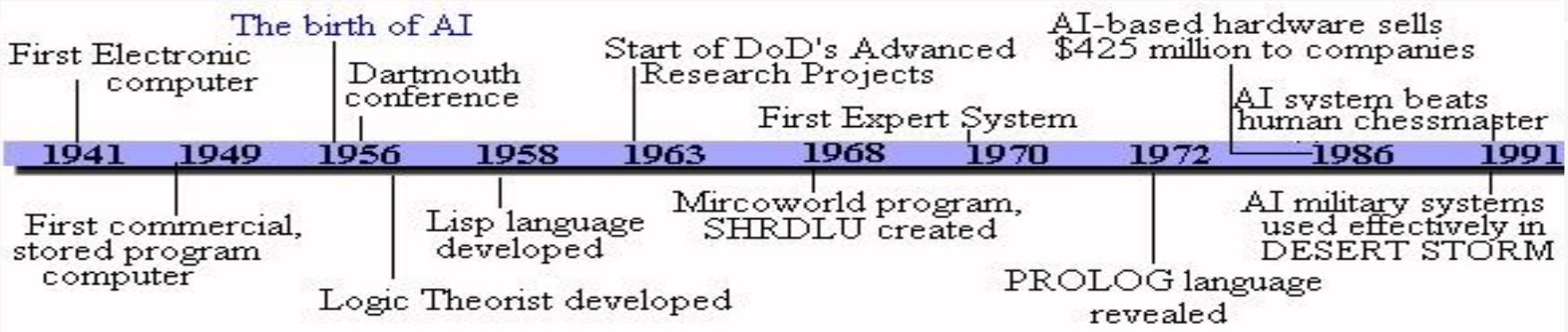


What's AI?

- Acting rationally: The rational agent approach
  - Computer agents operate autonomously, perceive their environment, persist over a prolonged time period, adopt to change, and create and pursue goals.
  - A rational agent is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.
  - Acting rationally > Thinking rationally
    - Simple reflex action

The history of AI

The history of AI



- The gestation of artificial intelligence (1943–1955)
- The birth of artificial intelligence (1956)
- Early enthusiasm, great expectations (1952–1969)
- A dose of reality (1966–1973)
- Knowledge-based systems: The key to power? (1969–1979)
- AI becomes an industry (1980–present)
- The return of neural networks (1986–present)
- AI adopts the scientific method (1987–present)
- The emergence of intelligent agents (1995–present)
- The availability of very large data sets (2001–present)

The history of AI

- Strong AI and weak AI
  - Strong AI is artificial intelligence that matches or exceeds human intelligence - the intelligence of a machine that can successfully perform any intellectual task that a human being can.

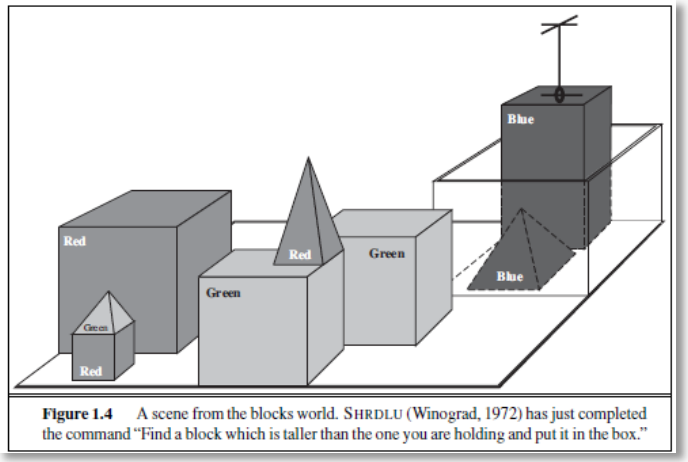


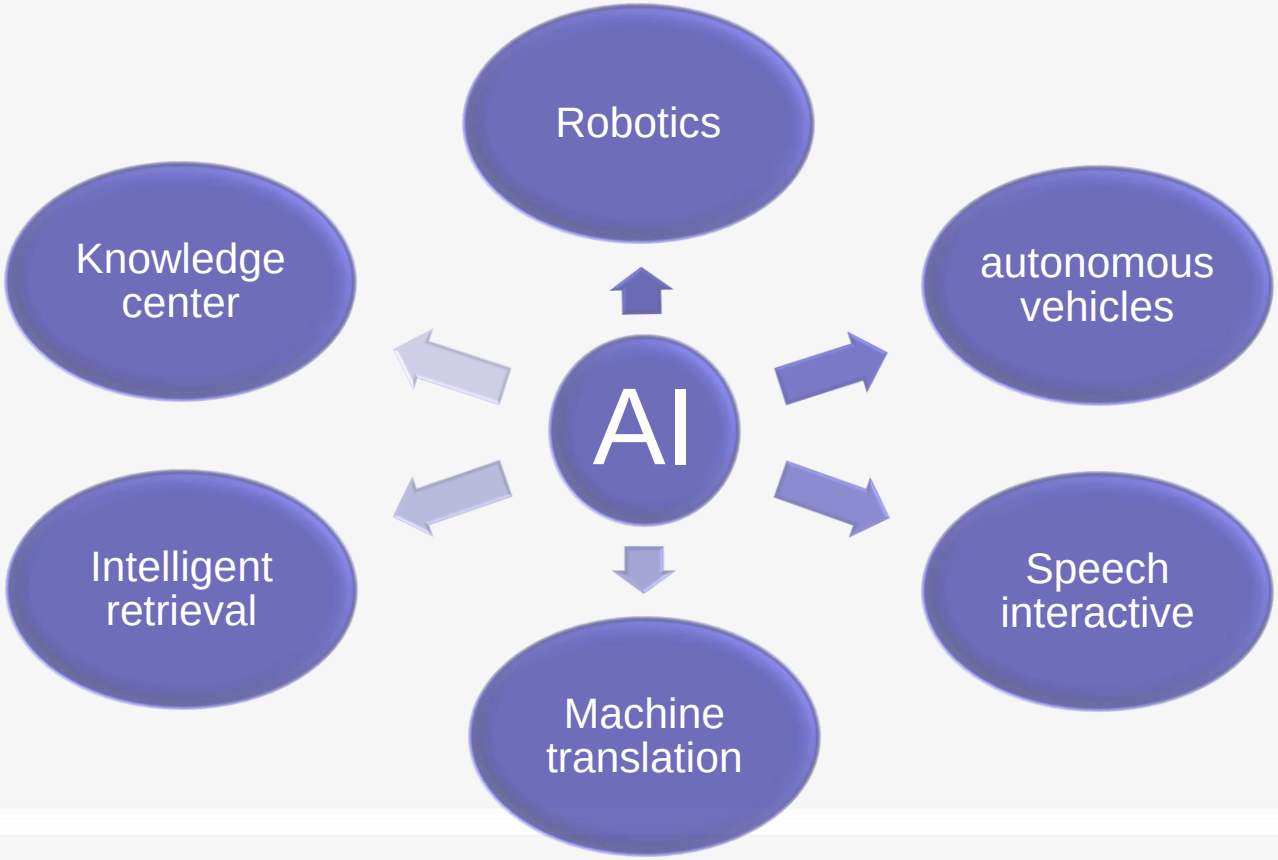
Figure 1.4 A scene from the blocks world. SHRDLU (Winograd, 1972) has just completed the command "Find a block which is taller than the one you are holding and put it in the box."

  - Weak AI (also called *narrow AI* or *applied AI*): the use of software to study or accomplish specific problem solving or reasoning tasks. Weak AI, in contrast to strong AI, does not attempt to simulate the full range of human cognitive abilities.

The state of the art

The state of the art

- What can AI do today?



The state of the art

- Game playing
  - Deep Blue by IBM
    - brute force computing power
    - massively parallel, RS/6000 SP Thin P2SC-based system with 30 nodes
    - chess playing program was written in C and ran under the AIX operating system
    - typically search to a depth of between six and eight moves to a maximum of twenty or even more moves in some situations.

Garry Kasparov and Deep Blue. 1997.

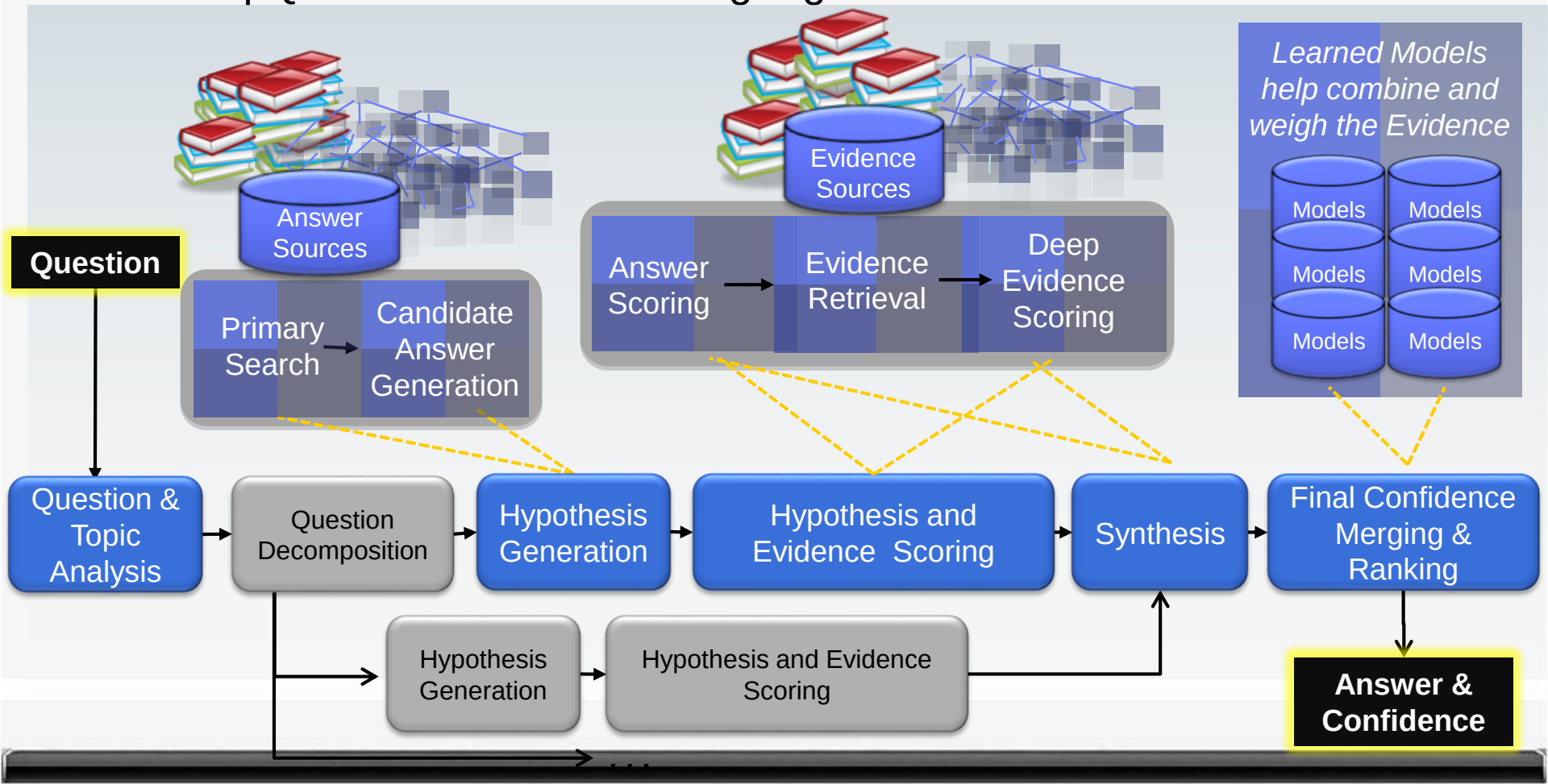
The state of the art

- Game playing
  - IBM Watson: Automatic Open-Domain Question Answering (2011)
    - Given
      - Rich **Natural Language Questions**
      - Over a **Broad Domain of Knowledge**
    - Deliver
      - **Precise Answers:** Determine what is being asked & give precise response
      - **Accurate Confidences:** Determine likelihood answer is correct
      - **Consumable Justifications:** Explain why the answer is right
      - **Fast Response Time:** Precision & Confidence in <3 seconds

Jeopardy!

The state of the art

- Game playing
  - DeepQA: NLP+ML+Reasoning Algorithms...



The state of the art

- Robotics
  - ASIMO, Bigdog…

The state of the art

- Robotics
  - ASIMO, Bigdog…

The state of the art

- Robotics
  - ASIMO, Bigdog…

The state of the art

- Autonomous vehicles
  - 2007 DARPA Urban Challenge, Stanley by Stanford Univ.

The state of the art

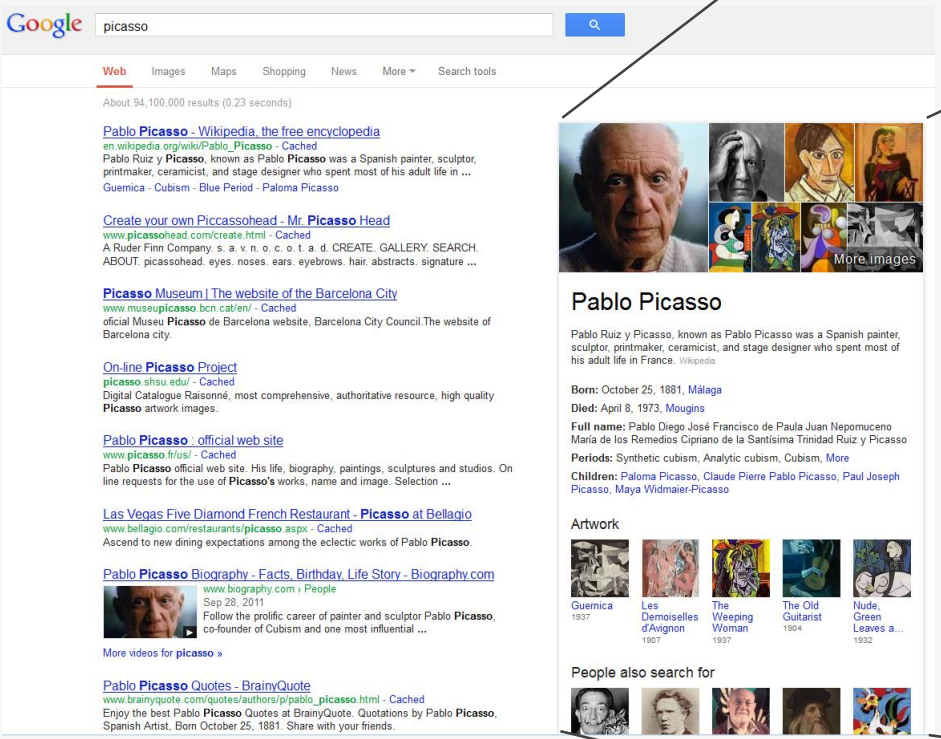
- Autonomous vehicles
  - Google self-driving car

The state of the art

- Speech interactivity / natural language UI
  - Siri by Apple
  - intelligent personal assistant and knowledge navigator

The state of the art

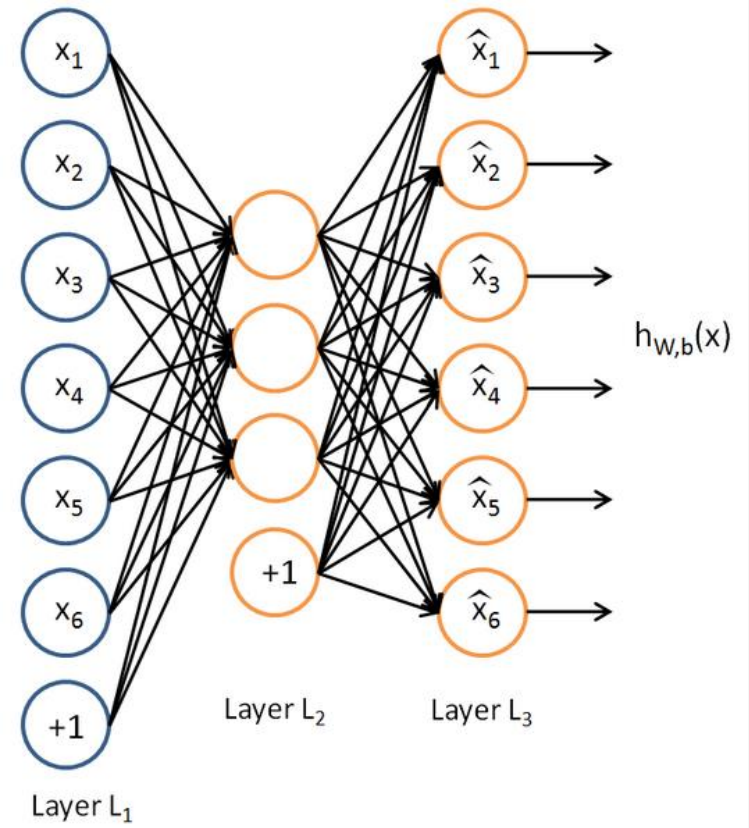
- Intelligent retrieval
  - Google knowledge graph

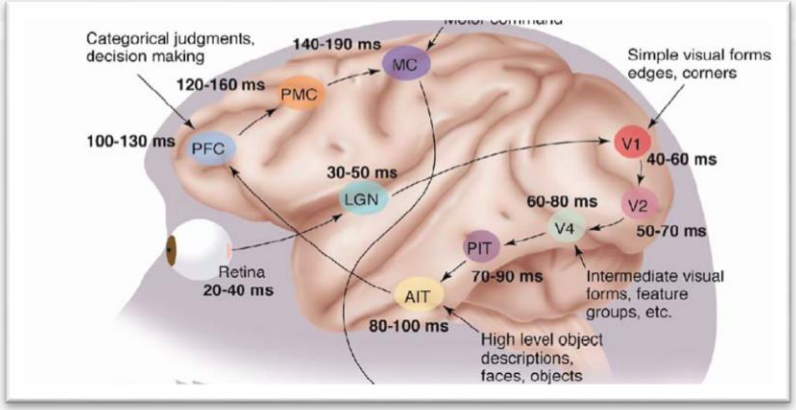


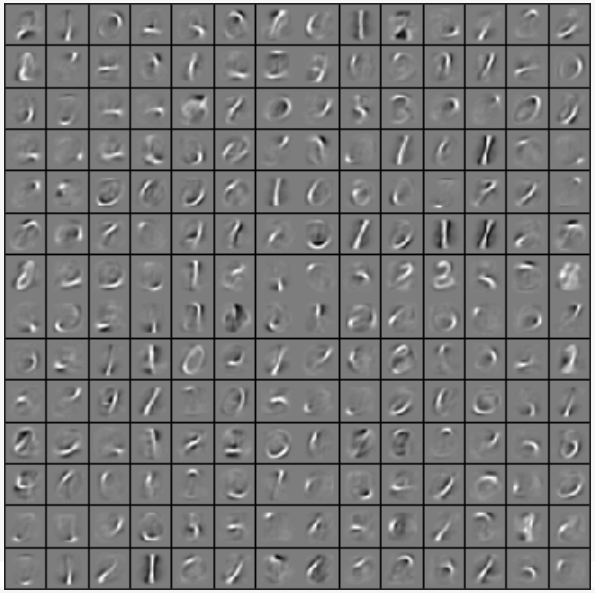
http://www.google.com/insidesearch/features/search/knowledge.html

The state of the art

- Deep Learning



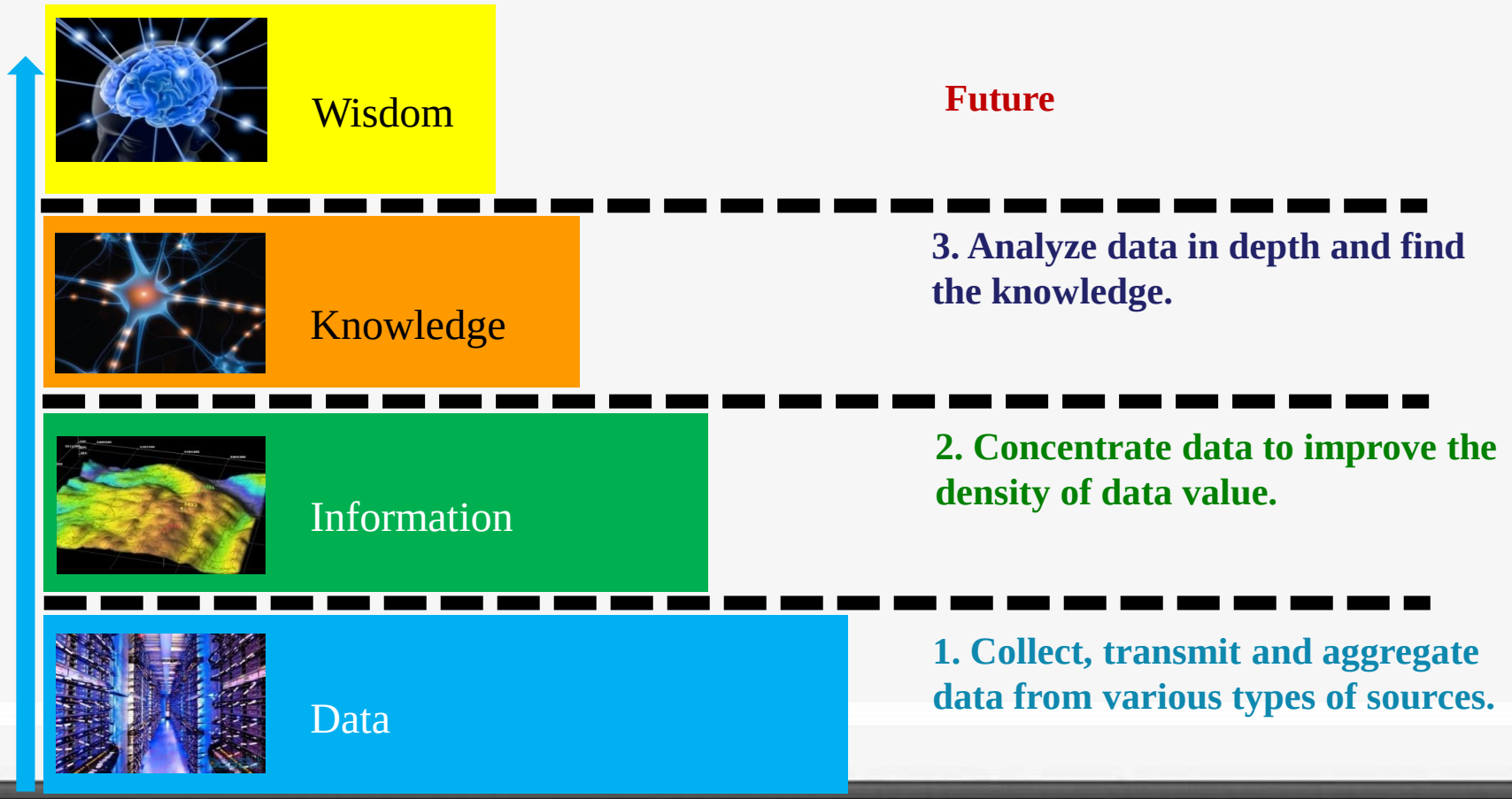




http://deeplearning.stanford.edu/wiki/index.php/UFLDL_Tutorial

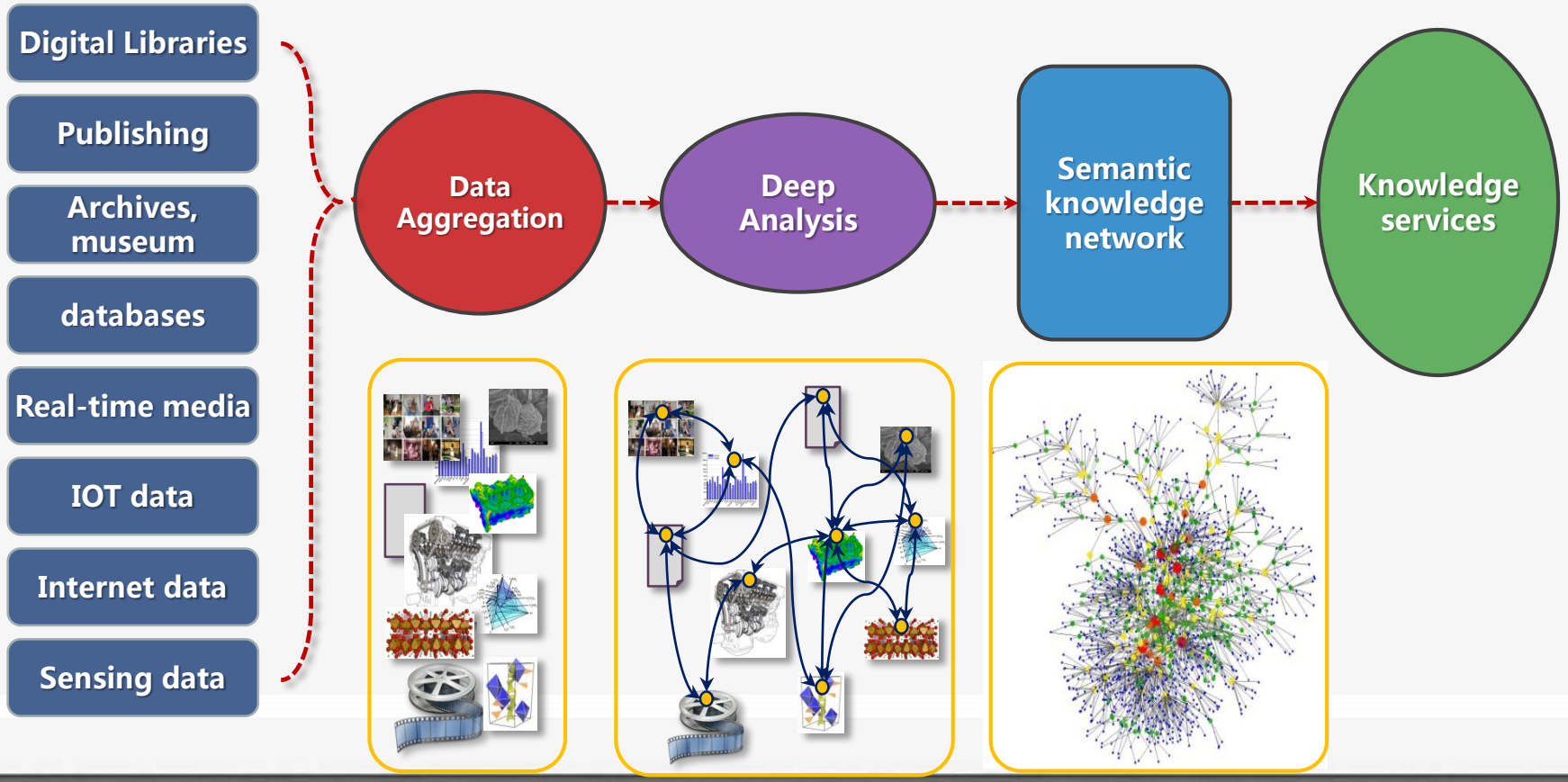
The state of the art

- Knowledge center
  - CKCEST project proposed by Prof. Pan, ZJU



The state of the art

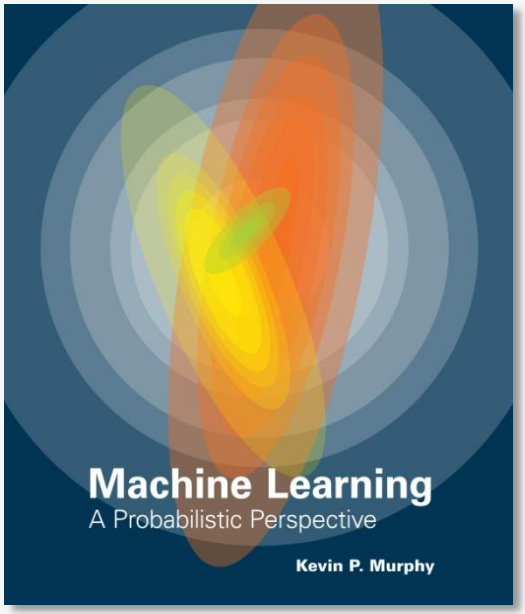
- Knowledge center
  - From data aggregation to knowledge services



Machine learning: what and why?

Machine learning: what and why?

- “We are drowning in information and starving for knowledge.”
  ---- John Naisbitt.

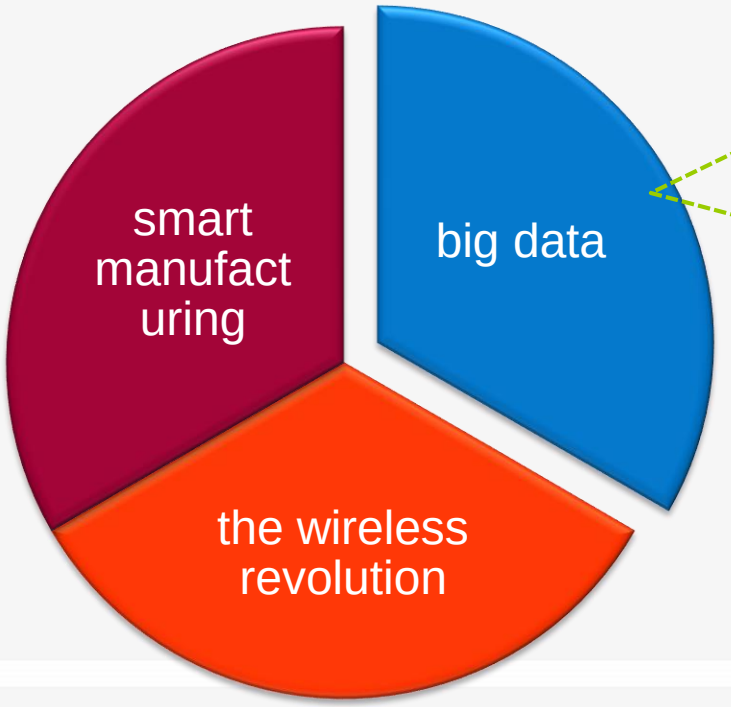


Kevin Patrick Murphy. "Machine Learning: a Probabilistic Perspective", The MIT Press,2012.

http://www.cs.ubc.ca/~murphyk/MLbook/index.html

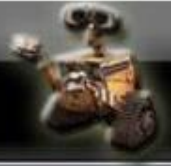
Machine learning: what and why?

- Big data and machine learning
  - This deluge of data calls for automated methods of data analysis, which is what machine learning provides.



Examples:

- Web log
- RFID
- Sensor network
- Social network
- Social data, Internet text & documents
- Internet search indexing
- Call detail records
- Astronomy, atmospheric science, genomics, biogeochemical, biological, and other complex and/or interdisciplinary scientific research
- Military surveillance
- Medical records
- Photography archives
- Large-scale ecommerce



Machine learning: what and why?

- What is machine learning?
  - In particular, we define machine learning as a set of methods that can automatically detect patterns in data, and then use the uncovered patterns to predict future data, or to perform other kinds of decision making under uncertainty (such as planning how to collect more data!).
  - Solving problems with uncertainty in many forms:
    - what is the best prediction about the future given some past data?
    - what is the best model to explain some data?
    - what measurement should I perform next?

Machine learning: what and why?

- About textbook:

- I: Artificial Intelligence
- II: Problem-solving
  - 3 Solving Problems by Searching
  - 4 Beyond Classical Search
  - 5 Adversarial Search
  - 6 Constraint Satisfaction Problems
- III: Knowledge, reasoning, and planning
  - 7 Logical Agents
  - 8 First-Order Logic
  - 9 Inference in First-Order Logic
  - 10 Classical Planning
  - 11 Planning and Acting in the Real World
  - 12 Knowledge Representation
- IV: Uncertain knowledge and reasoning
  - 13 Quantifying Uncertainty
  - 14 Probabilistic Reasoning
  - 15 Probabilistic Reasoning over Time
  - 16 Making Simple Decisions
  - 17 Making Complex Decisions
- V: Learning
  - 18 Learning from Examples
  - 19 Knowledge in Learning
  - 20 Learning Probabilistic Models
  - 21 Reinforcement Learning
- VI: Communicating, perceiving, and acting
  - 22 Natural Language Processing
  - 23 Natural Language for Communication
  - 24 Perception
  - 25 Robotics
- VII: Conclusions

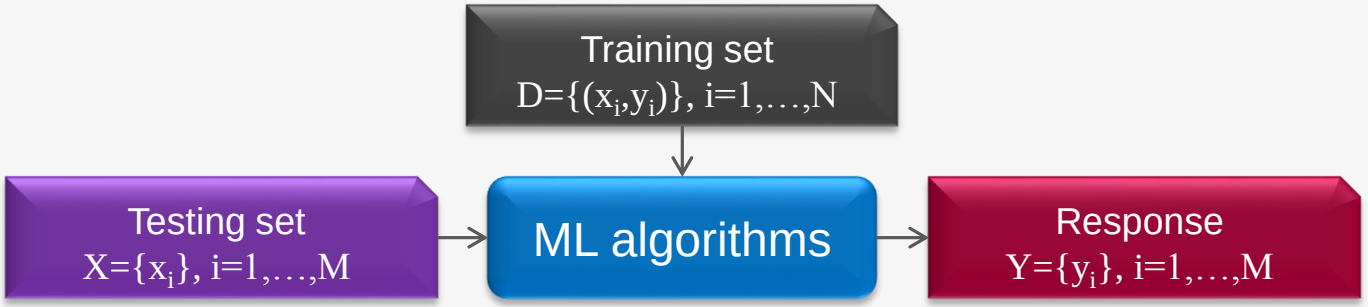
AI

- 01.Introduction
- 02.Probability Distributions
- 03.Linear Models for Regression
- 04.Linear Models for Classification
- 05.Neural Networks
- 06.Kernel Methods
- 07.Sparse Kernel Machines
- 08.Graphical Models
- 09.Mixture Models and EM
- 10.Approximate Inference
- 11.Sampling Methods
- 12.Continuous Latent Variables
- 13.Sequential Data
- 14.Combining Models
- 15.Back Matter

PRML

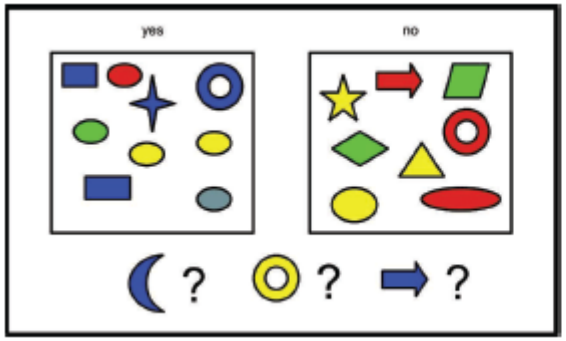
Machine learning: what and why?

- Types of machine learning
  - Supervised learning (predictive)
    - Classification (PR) : the output is categorical or nominal variable
    - Regression : the output is real-valued variable
  - Unsupervised learning (descriptive)
    - Knowledge discovery: “interesting patterns”, clusters, latent factors, graph structure…
  - Reinforcement learning



Machine learning: what and why?

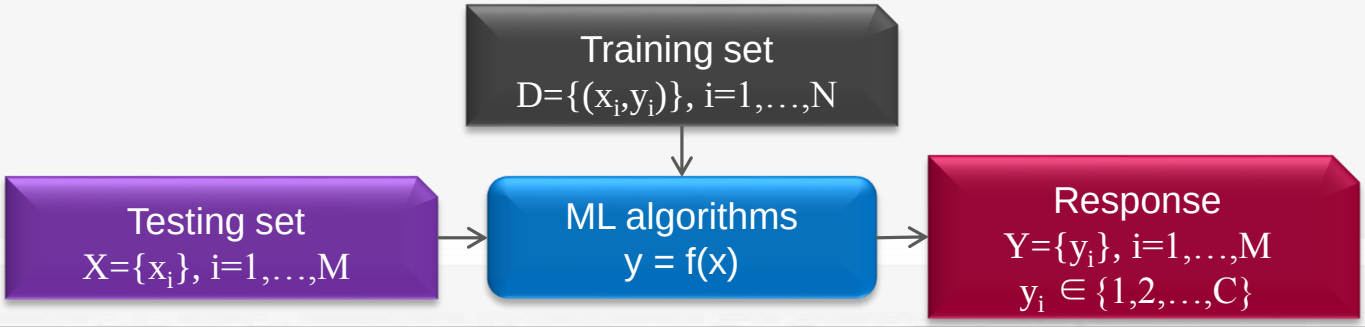
- Supervised learning: Classification
  - Binary classification: C=2
  - Multiclass classification: C>2



D features (attributes)

N cases

Color	Shape	Size (cm)	Label
Blue	Square	10	1
Red	Ellipse	2.4	1
Red	Ellipse	20.7	0



Machine learning: what and why?

- Supervised learning: Classification
  - Real-world applications are difficult.

(a)

(b)

(c)

Figure 1.3 Three types of iris flowers: setosa, versicolor and virginica. Source: `http://www.statlab.uni-heidelberg.de/data/iris/` . Used with kind permission of Dennis Kramb and SIGNA.

Machine learning: what and why?

- Supervised learning: Classification
  - Real-world applications are difficult.

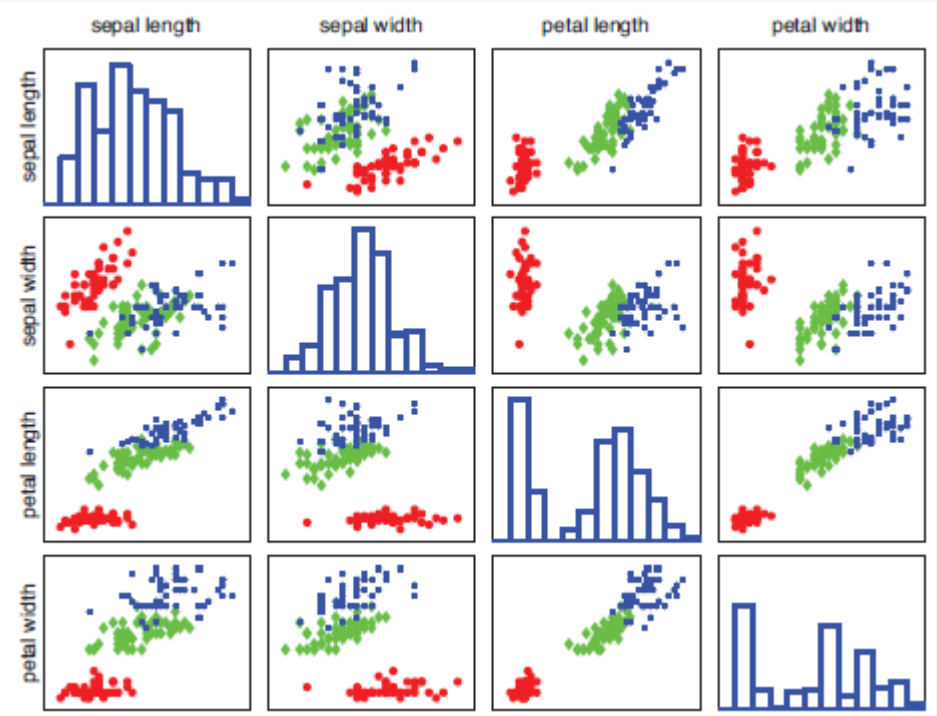
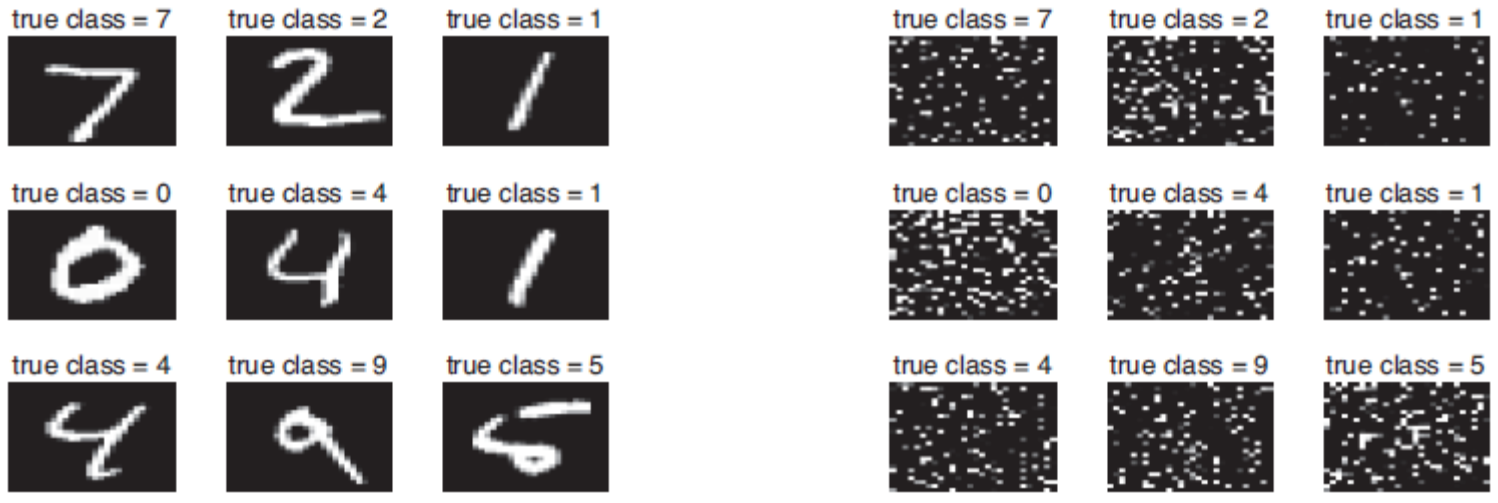


Figure 1.4 Visualization of the Iris data as a pairwise scatter plot. The diagonal plots the marginal histograms of the 4 features. The off diagonals contain scatterplots of all possible pairs of features. Red circle = setosa, green diamond = versicolor, blue star = virginica. Figure generated by `fisheririsDemo`.

Machine learning: what and why?

- Supervised learning: Classification
  - Real-world applications are difficult.

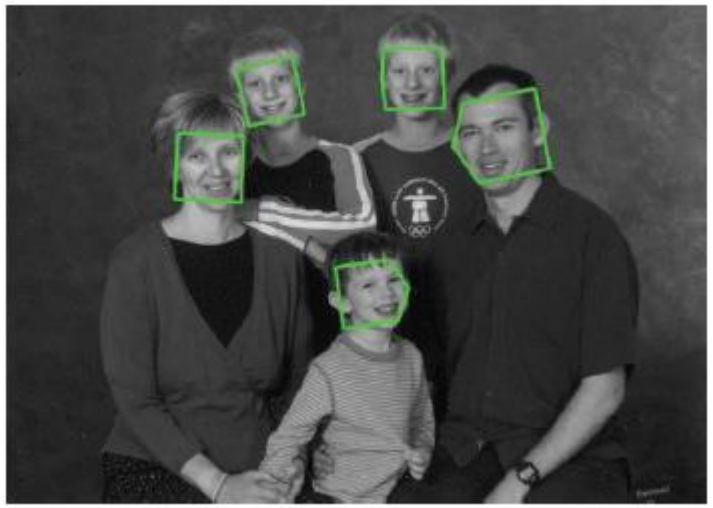


The images are size 28×28 and have grayscale values in the range 0 : 255

Figure 1.5 (a) First 9 test MNIST gray-scale images. (b) Same as (a), but with the features permuted randomly. Classification performance is identical on both versions of the data (assuming the training data is permuted in an identical way). Figure generated by `shuffledDigitsDemo`.

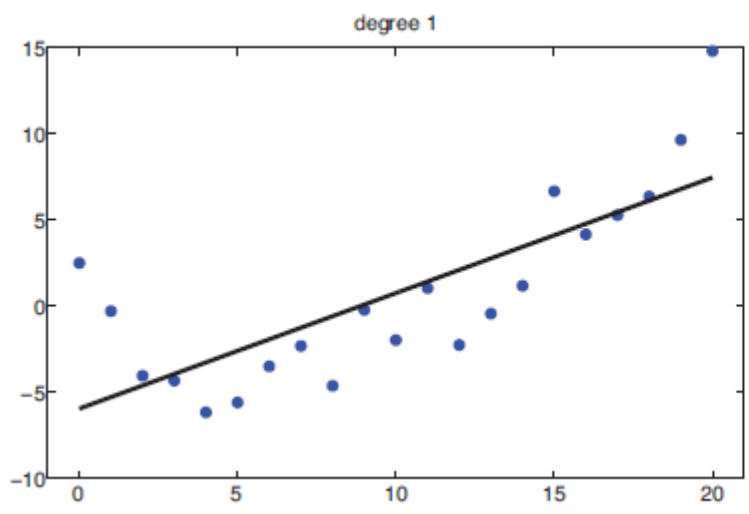
Machine learning: what and why?

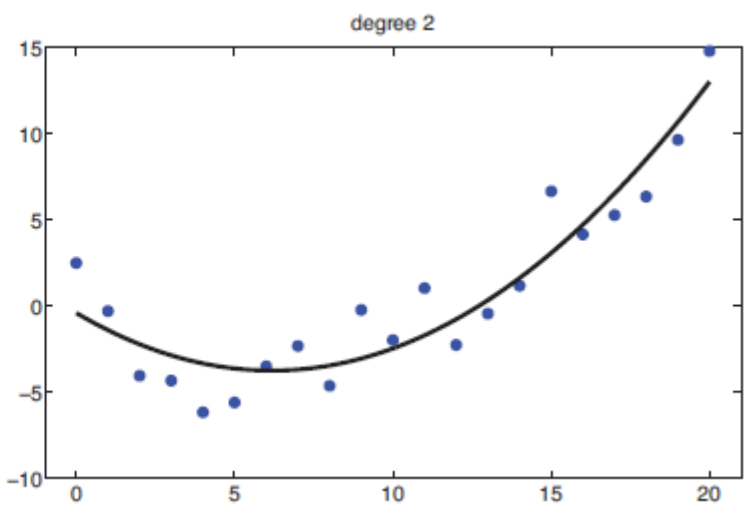
- Supervised learning: Classification
  - Real-world applications are difficult.

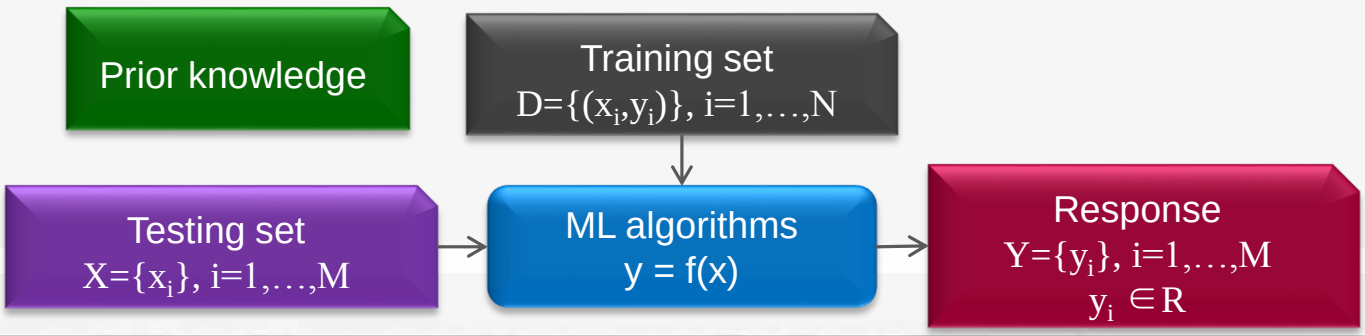


Machine learning: what and why?

- Supervised learning: Regression





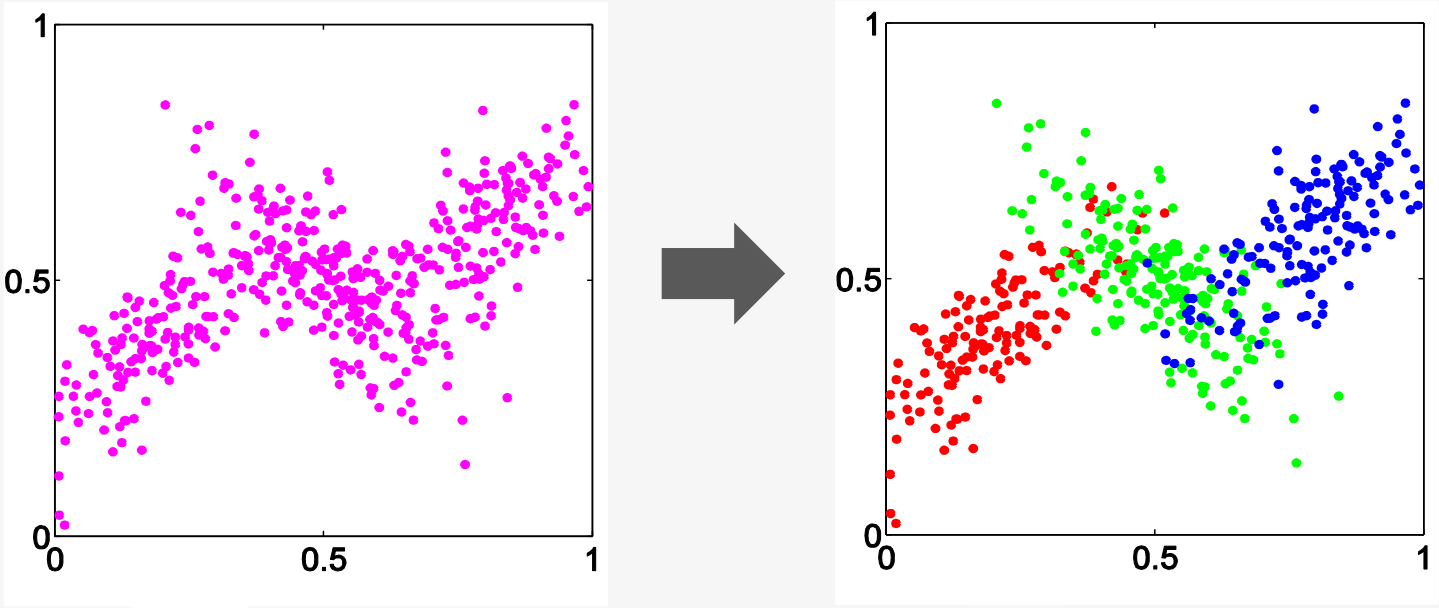


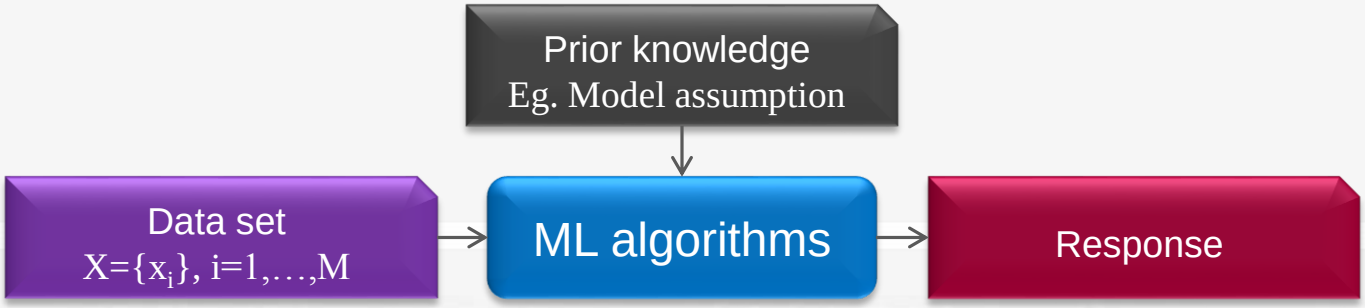
Machine learning: what and why?

- Supervised learning: Regression
  - Real-world applications are also difficult.

Machine learning: what and why?

- Unsupervised learning





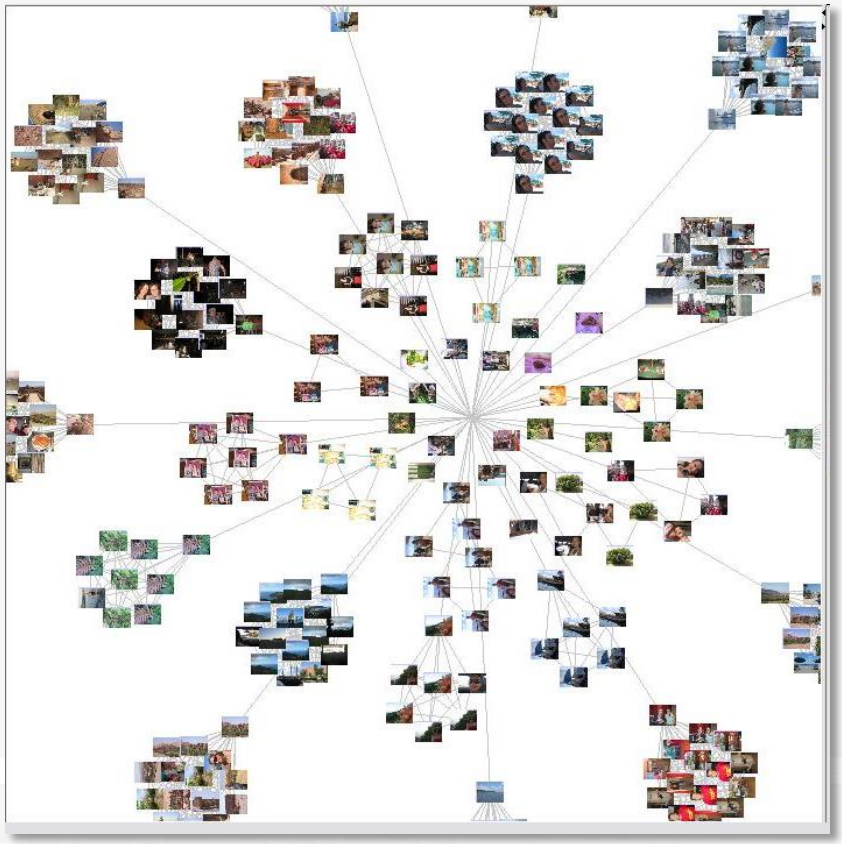
Machine learning: what and why?

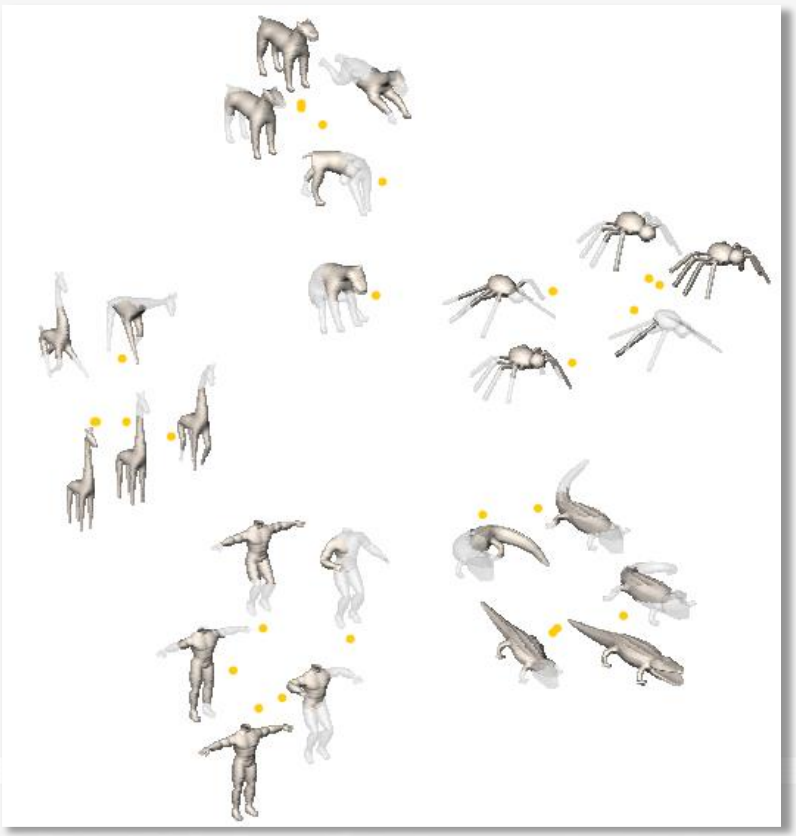
- Unsupervised learning
  - Real-world applications are difficult.

Stanford 40 Actions

Machine learning: what and why?

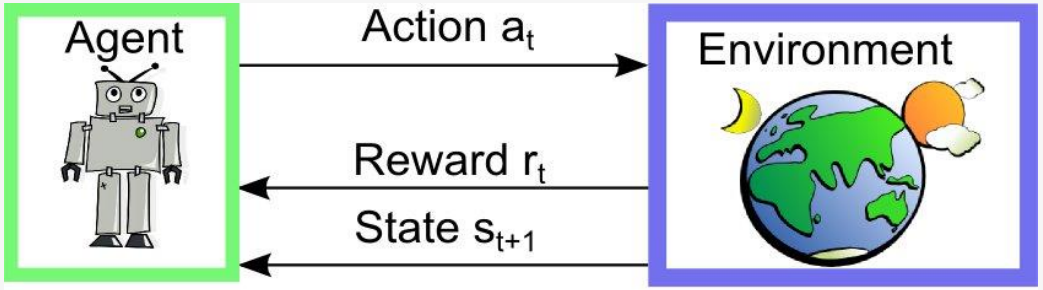
- Unsupervised learning
  - Real-world applications are difficult.





Machine learning: what and why?

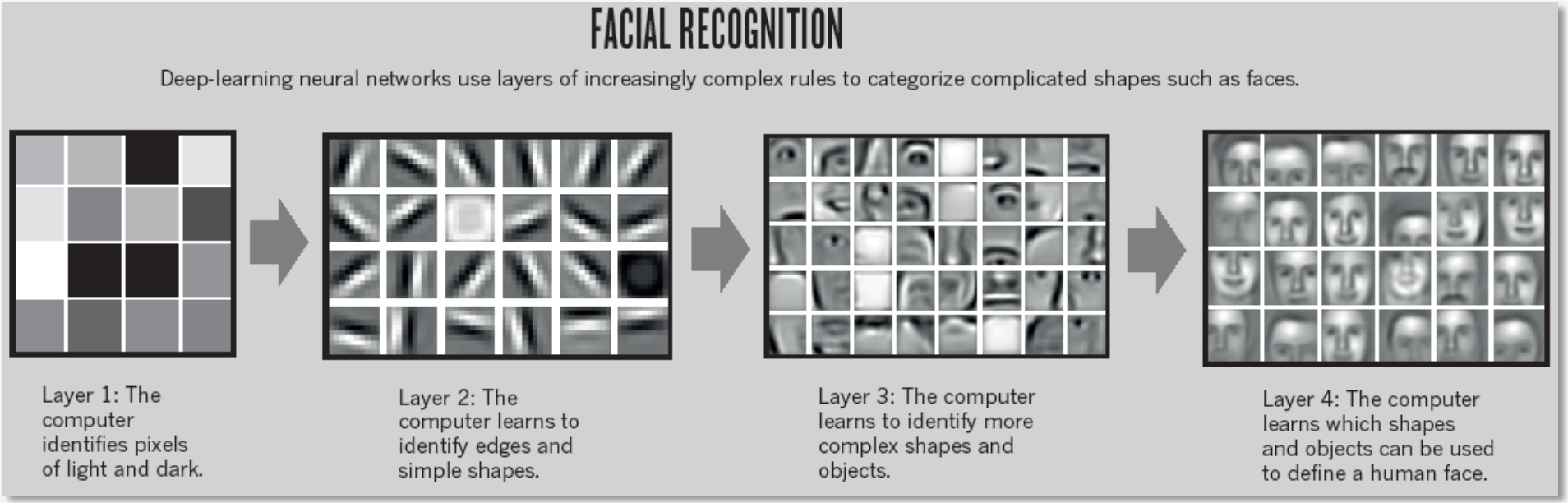
- Reinforcement learning
  - Learn from close interaction
  - Stochastic environment
  - Noisy delayed scalar evaluation
  - Maximize a measure of long term performance



Reinforcement Learning Setup

Machine learning: what and why?

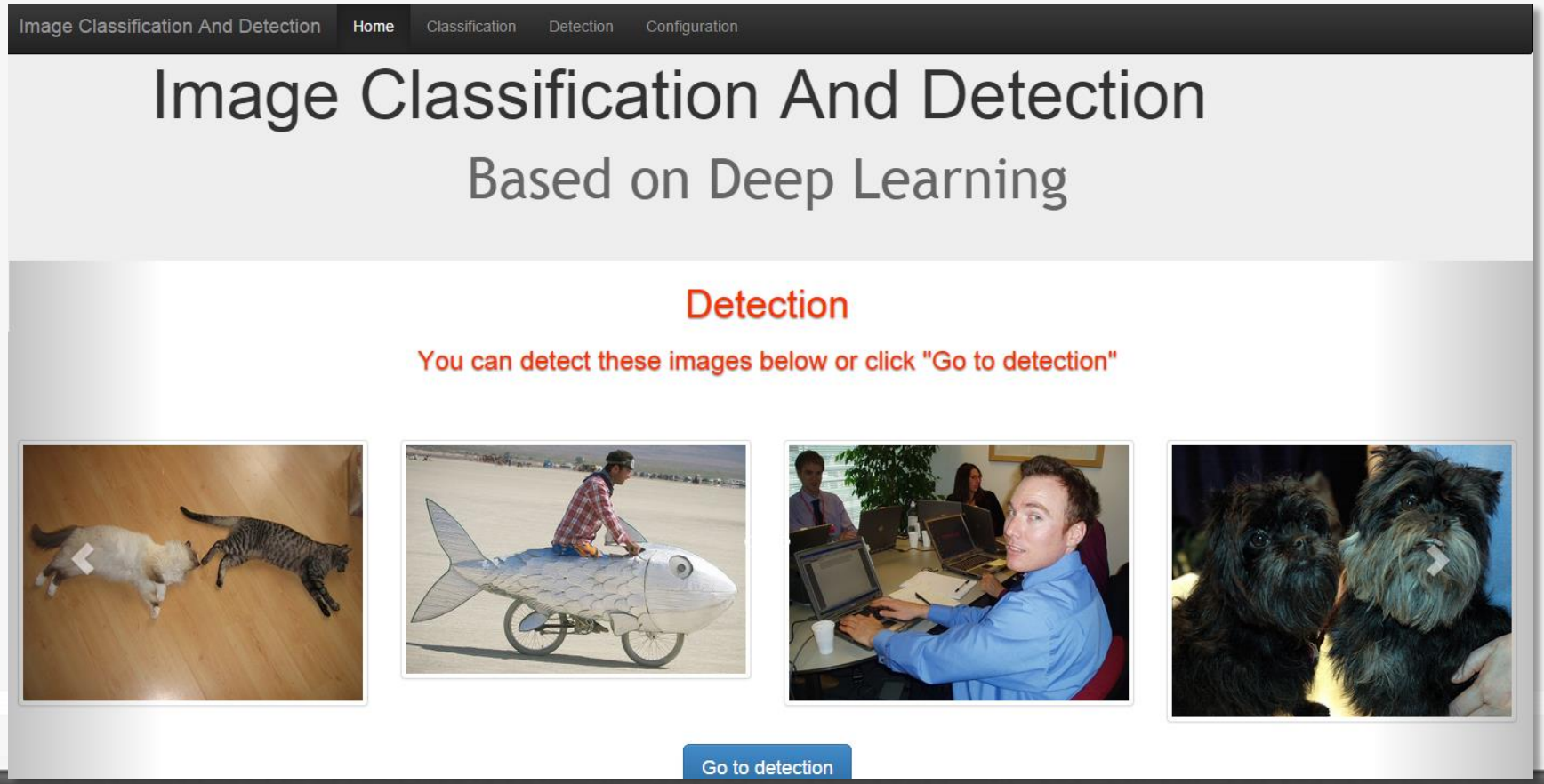
- Deep learning
  - It has the property that if you feed it more data, it gets better and better.



NICOLA JONES, "THE LEARNING MACHINES", NATURE, vol 505:146-148, January 2014.

Machine learning: what and why?

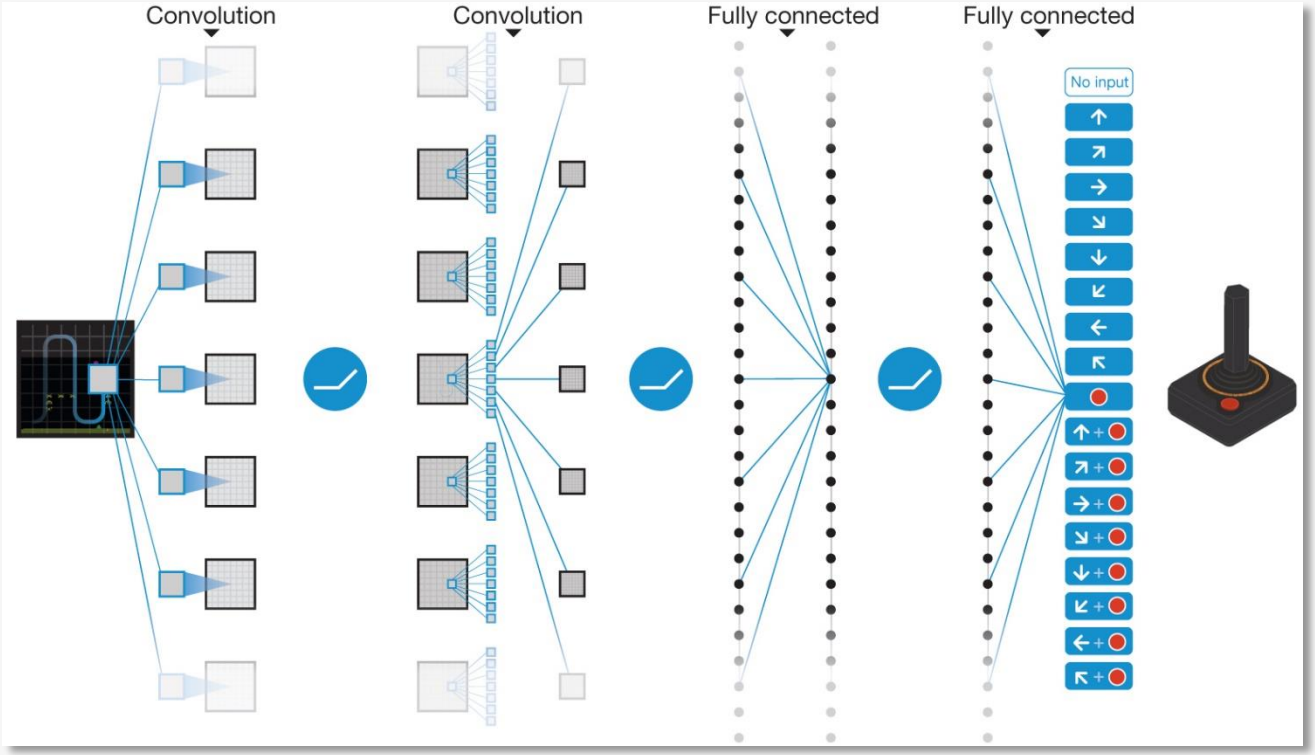
- Deep learning
  - Image Classification And Detection. *http://10.15.62.79:8080/deepsearch/*



Machine learning: what and why?

- Deep reinforcement learning

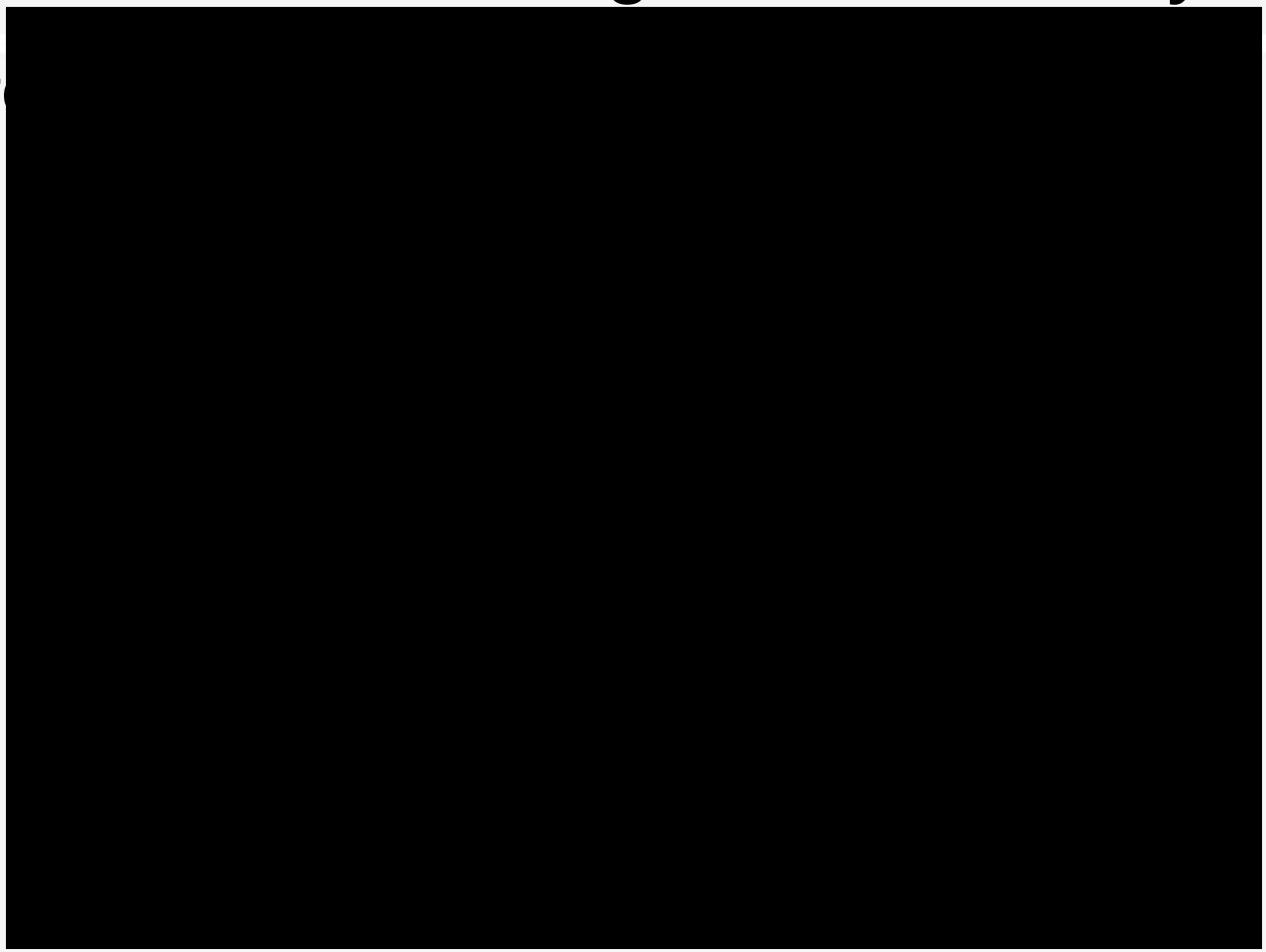
Schematic illustration of the convolutional neural network



Mnih, Volodymyr, Koray Kavukcuoglu, David Silver, Andrei A. Rusu, Joel Veness, Marc G. Bellemare, Alex Graves et al. "Human-level control through deep reinforcement learning." Nature 518, no. 7540 (2015): 529-533.

Machine learning: what and why?

- Deep r



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Infinite monkey theorem

- *A monkey hitting keys at random on a typewriter keyboard for an infinite amount of time will almost surely type a given text, such as the complete works of William Shakespeare.*

Given enough time, a chimp punching at random on a typewriter would almost surely type out all of Shakespeare's plays.

Next

- Math Review & Basic Concept