# CS 162FZ: Introduction to Computer Science II

## Lecture 15

## Artificial Intelligence and Machine Learning

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# What is Artificial Intelligence?

# Some Definitions (I)

The exciting new effort to make computers think …
*machines with minds*,
in the full literal sense.

Haugeland, 1985

*(excited but not really useful)*

# Some Definitions (II)

The study of mental faculties through the use of computational models.

Charniak and McDermott, 1985

A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes.

Schalkoff, 1990

*(Applied psychology & philosophy?)*

# Some Definitions (III)

The study of how to make computers do things at which, at the moment, people are better.

Rich & Knight, 1991

*(I can almost understand this one).*

# Dimensions in AI Definitions

- Build intelligent artifacts vs. understanding human behavior.
- Does it matter how I built it as long as it does the job well?
- Should the system behave like a human or behave *intelligently*?

The Turing Test

# What Does AI Really Do?

- Knowledge Representation (how does a program represent its domain of discourse?)
- Automated reasoning.
- Planning (get the robot to find the bananas in the other room).
- Machine Learning (adapt to new circumstances).
- Natural language understanding.
- Machine vision, speech recognition, finding data on the web, robotics, and much more.

# A Brief History of AI

- The Dartmouth conference, Summer ‘56.
- Early enthusiasm 52-59:
  - Puzzle solving with the General Problem Solver, Geometry theorem prover, Checkers player, Lisp.
- Reality strikes:
  - Programs don’t scale up.
  - The problem is not as easy as we thought:
    - The spirit is willing but the flesh is weak -->

      *The vodka is good but the meat is rotten.*

# More History

- Knowledge-based systems (expert systems) 1969-1979:
  - Ed Feigenbaum (Stanford): *Knowledge is power!* (as opposed to weak methods)
    - Dendral (inferring molecular structure from a mass spectrometer).
    - MYCIN: diagnosis of blood infections
- AI becomes an industry:
  - R1: configuring computers for DEC.
  - Robotic vision applications

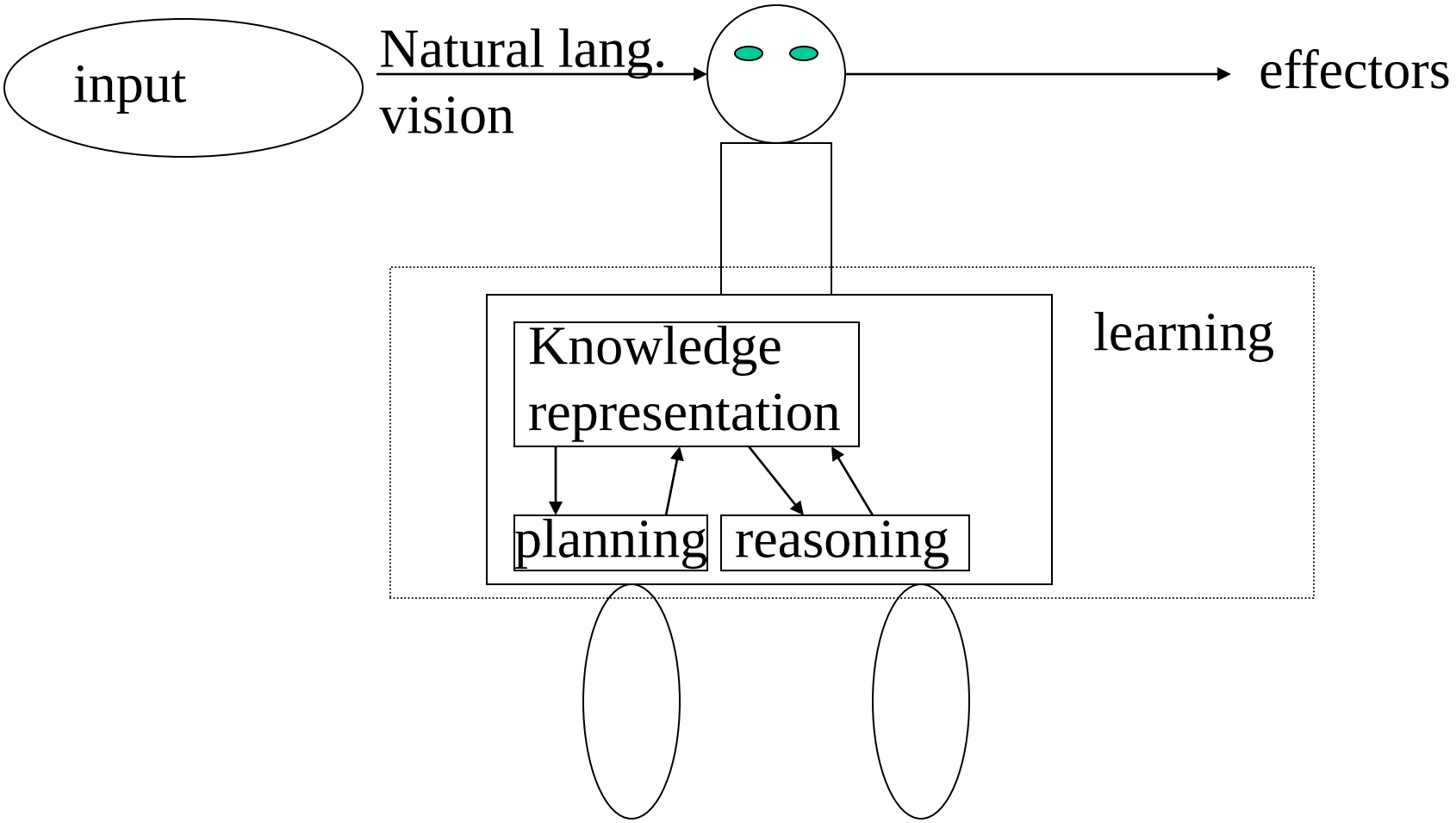
# Recent Events: 1987-Present

- AI turns *more scientific*, relies on more mathematically sophisticated tools:
  - Hidden Markov models (for speech recognition)
  - Belief networks (see Office 97).
- Focus turns to building useful artifacts as opposed to solving the grand AI problem.
- The victory of the *neats* over the *scruffies*?

# Recent AI Successes

- Deep Blue beats Kasparov (AI?)
- Theorem provers proved an unknown theorem.
- Expert systems: medical, diagnosis, design
- Speech recognition applications (in limited domains).
- Robots controlling quality in factories.
- Intelligent agents on board Deep Space 1.

# An Intelligent Agent



# Automation VS Intelligence

- Simplex and repeated works
- Emphasize on execution
- Save labor


- Active work
- Emphasize on analysis
- Save minds

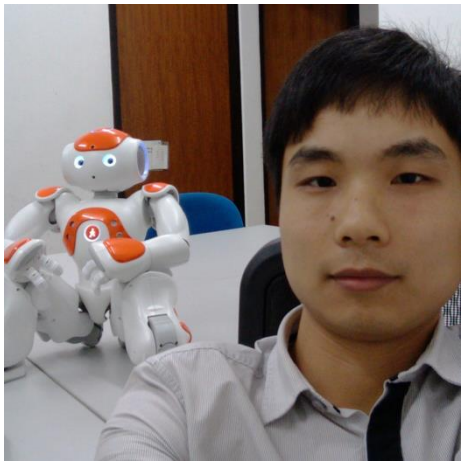
# Artificial Intelligences VS Big Data

Big Data →Technology

AI（Machine Learning）→Technique

# AI Examples

**Example 01** **Robots**



**Humanoid robots**

**Robotic arms**

**Flying robots**

# AI Examples

## Humanoid Robots

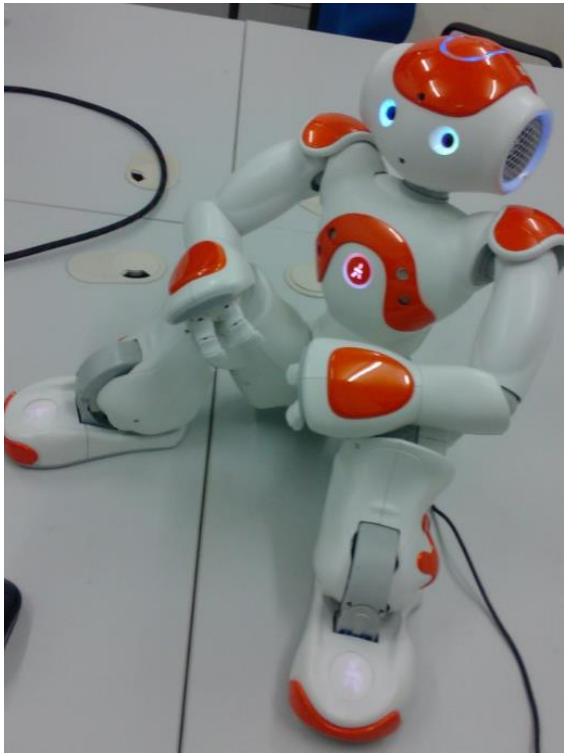
**Imitate human sense organs**

**Name：NAO**
**Origin：France**
**heigh：58 cm**
**Weight：4.3 kg**
**Functionalities：Image Recognition**
**Speech Recognition**
**Actions**

# AI Examples

## Humanoid Robots

**Imitate human sense organs**



**Carma---------Eyes**
**Speaker---------Mouth**
**Microphone---------Ear**
**Motors----------Muscle**
**Computer------Brain**
**Sonar and other sensors**

# AI Examples

Humanoid Robots **Intelligence**

**Speech recognition and generation**
**Image recognition**
**Motions**

**How to obtain these intelligences?**
**To design intelligent algorithms to understand sensory inputs as humans**

# Problems in AI

## Hardware

一 Computing Capability of Computers

二 Capacity of Battery

三 Over-heat of Motors

四 Materials

## Software

一 Accuracy of Image Recognition

二 Accuracy of Speech Recognition

三 Stability of Motions

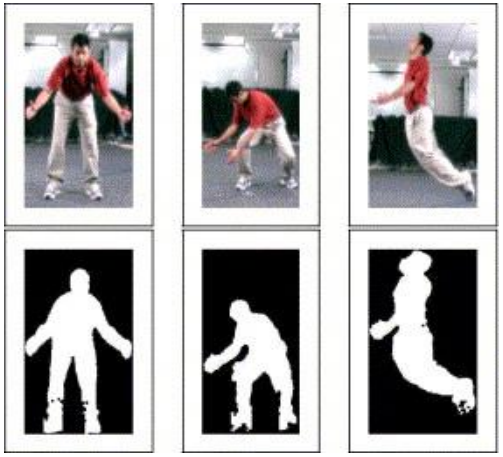
# AI Examples

**AI Example** **AlphaGo**

1. Deep Mind, Google.
2. First program to win human champion in Go.
3. Deep learning
4. Imitate human intelligence of decision making.

# AI Examples

**AI Example** **CV-Object Detection**



一 **Crowd density detection**

二 **Face recognition**

三 **Motion recognition**

# What is Machine Learning?

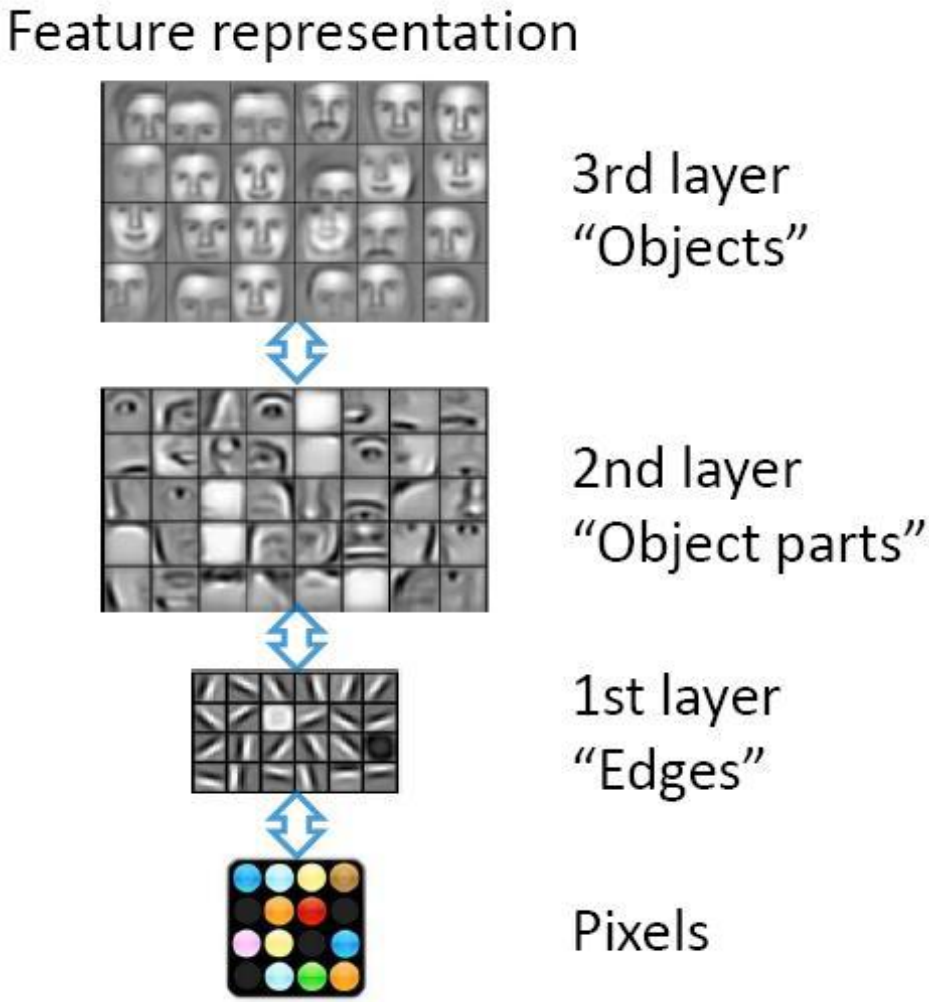
**Machine learning** is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy.

**Learn intelligence from history, experiences and sensory inputs.**

Machine Learning is one of the most important subfields in AI.

It learn features, patterns, representations from sensory inputs.

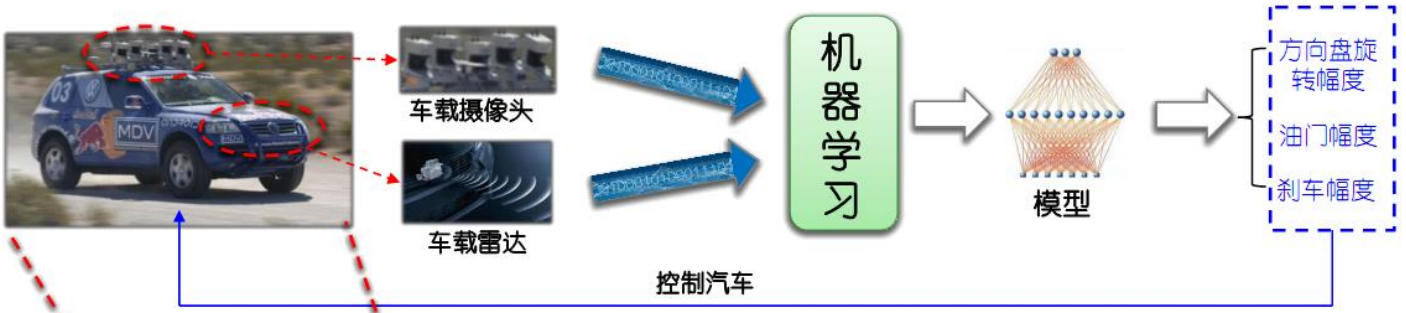
# What are features of Images?

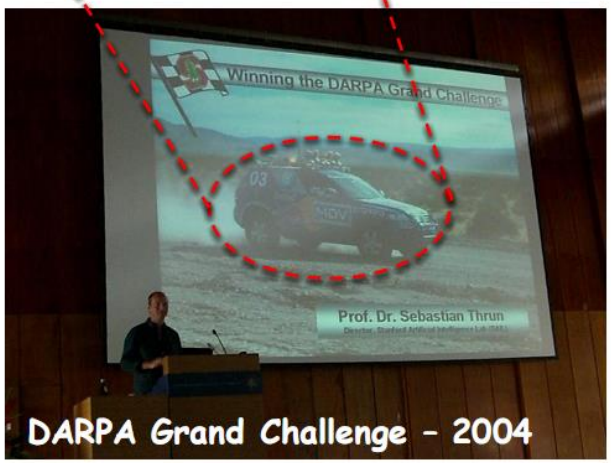


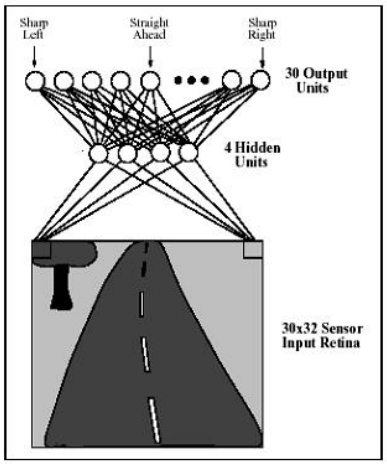
# Machine Learning Examples

**Computer Vision**

## Autonomous car



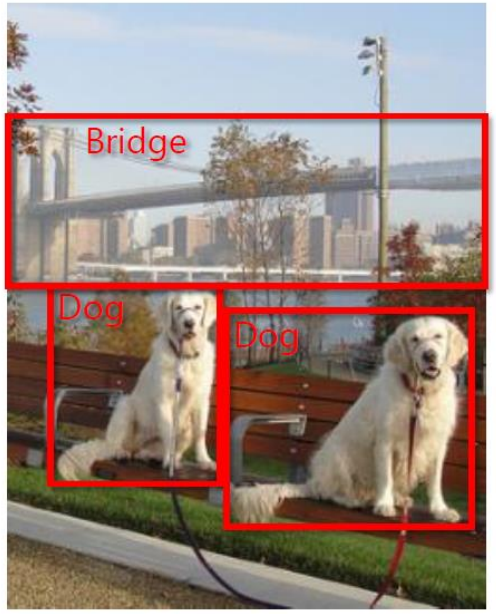




美国在20世纪80年代就开始研究基于机器学习的汽车自动驾驶技术

# Object Detection and Recognition

## Classification vs. Detection


Easyish, these days




Still quite a lot harder

# Action Recognition

(a) Boxing

(b) Handclapping

(c) Jogging

(d) Running

(e) Basketball

(f) Biking

(g) Diving

(h) Golf

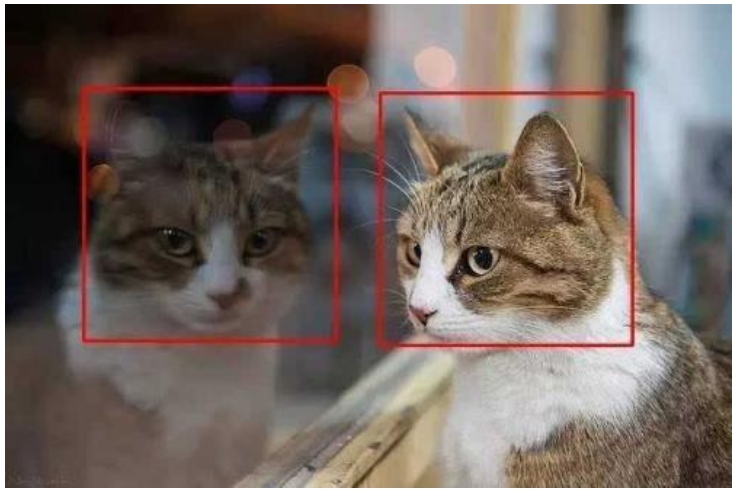
(i) BrushHair

(j) Catch

(k) Chew

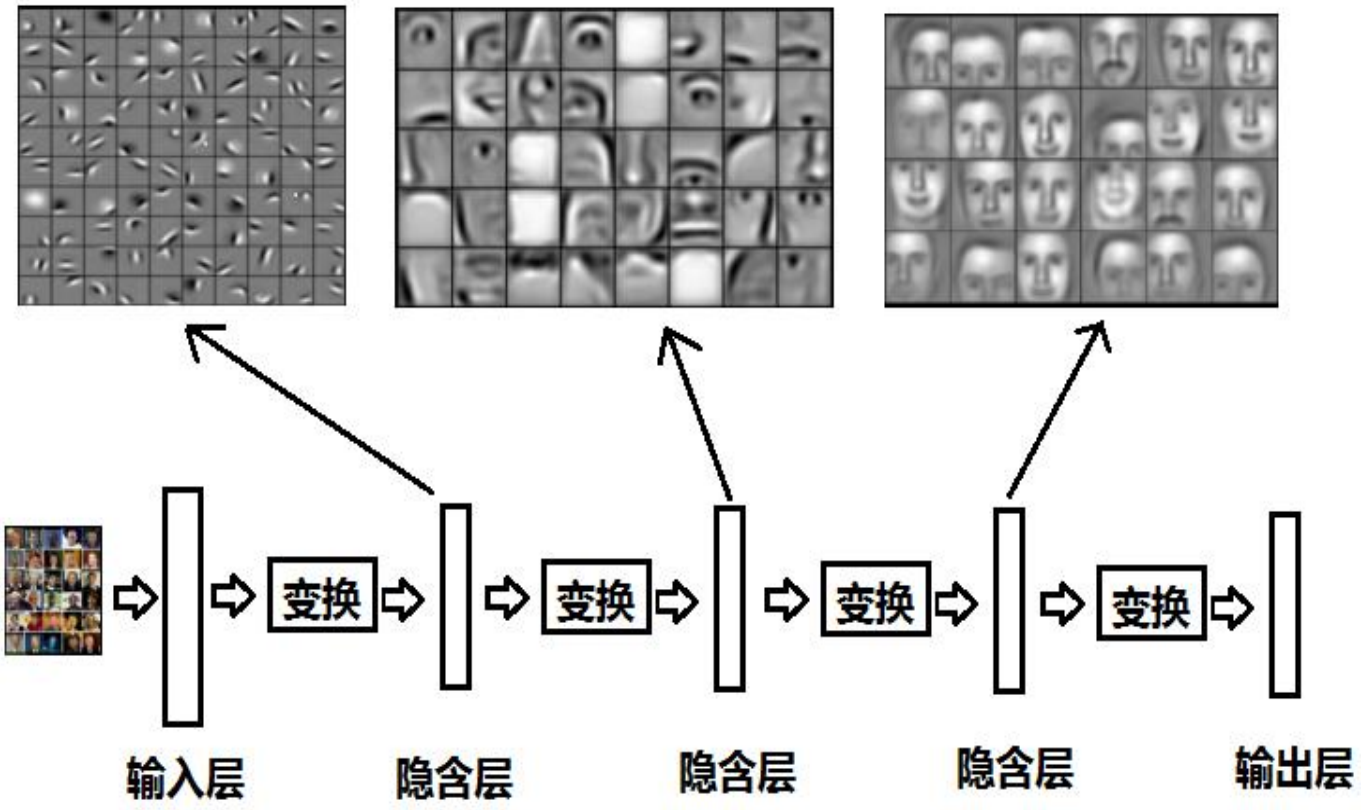
(l) Clap

# (3) Google Brain: Cat Recognition



1. 16000 computing nodes
2. 10 million images
3. Deep neural networks
4. Deep learning algorithms

# Abstract features from Image

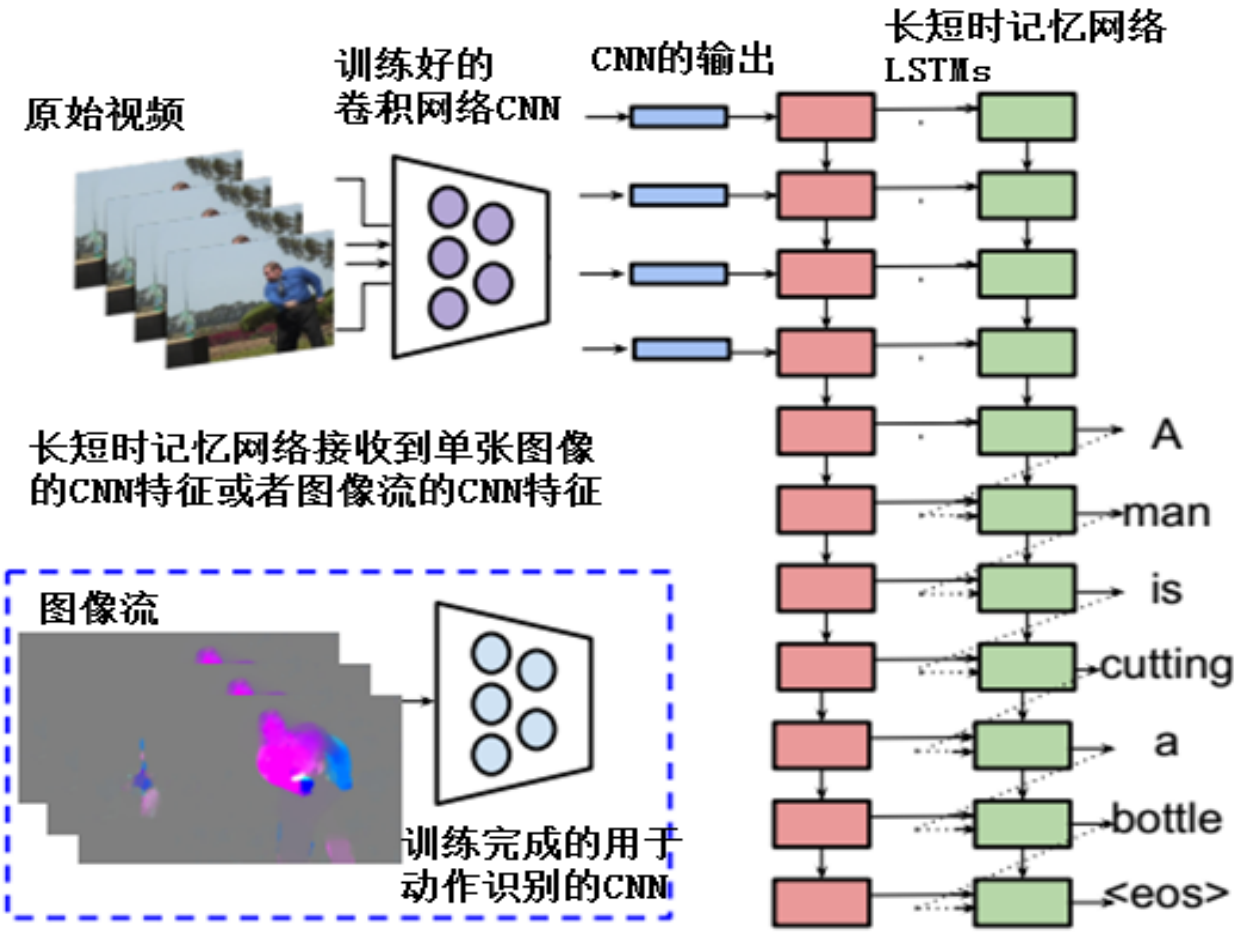


# (4) Image and Video description

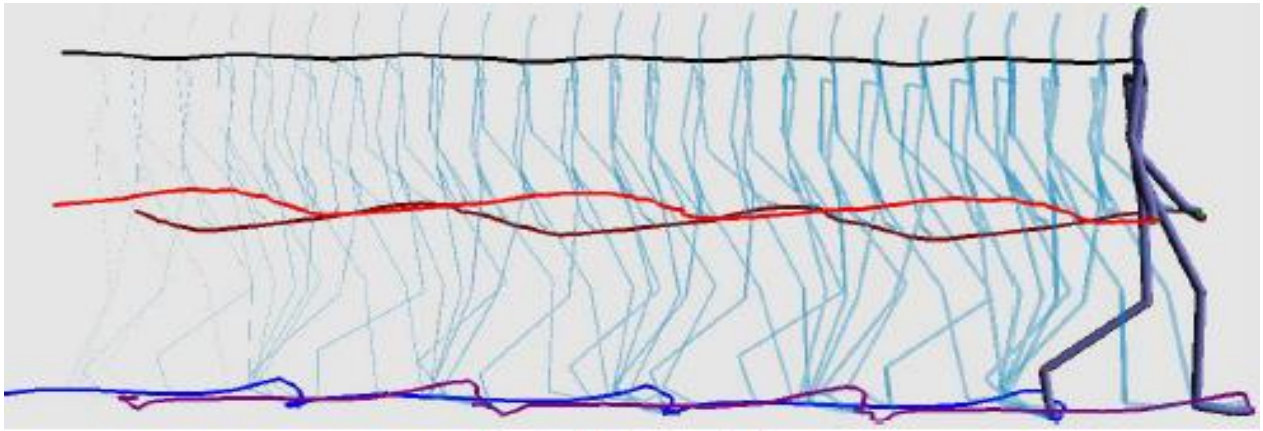
*A dog is playing in a bowl.*

*The person peeled the fruit.*
*The person put the fruit in the bowl.*
*The person sliced the orange.*
*The person put the pieces in the plate.*
*The person rinsed the plate in the sink.*

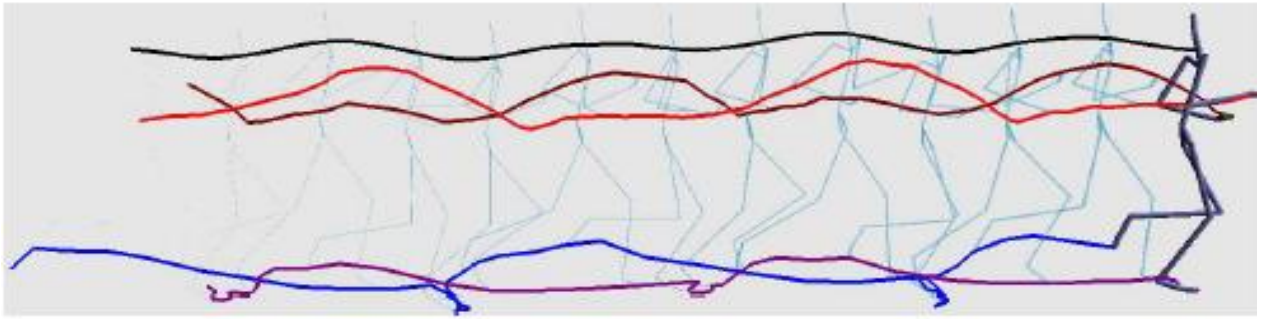
# Video description model



# (5) Video prediction and generation

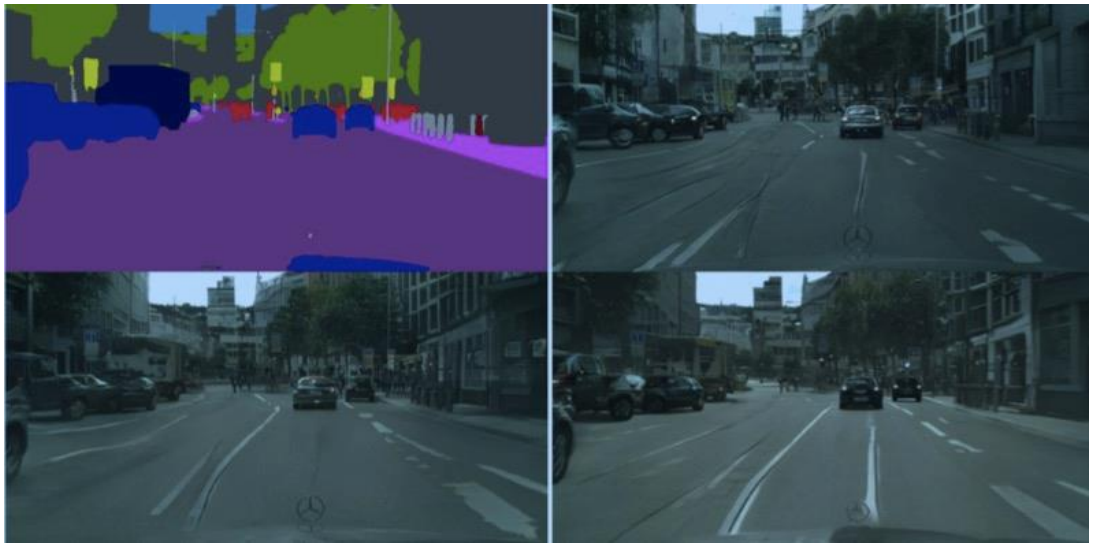


（a）对行走状态的预测



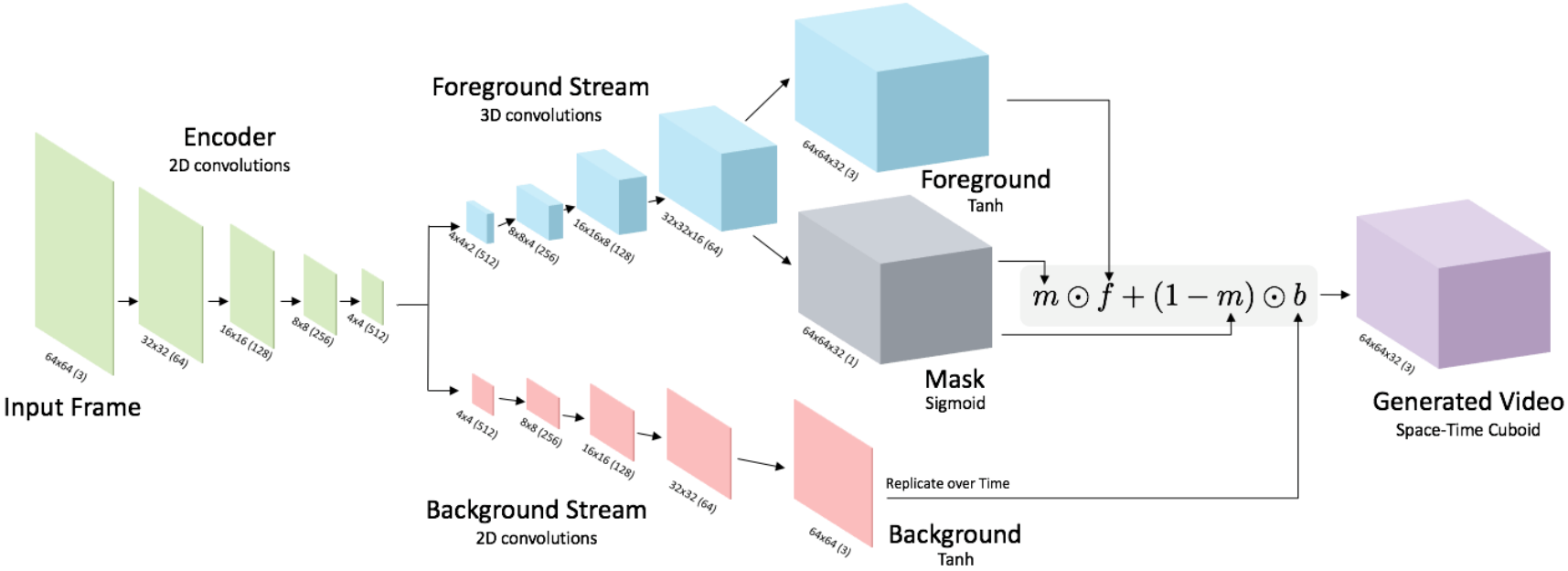
（b）对奔跑状态的预测

# Video Prediction and Generation



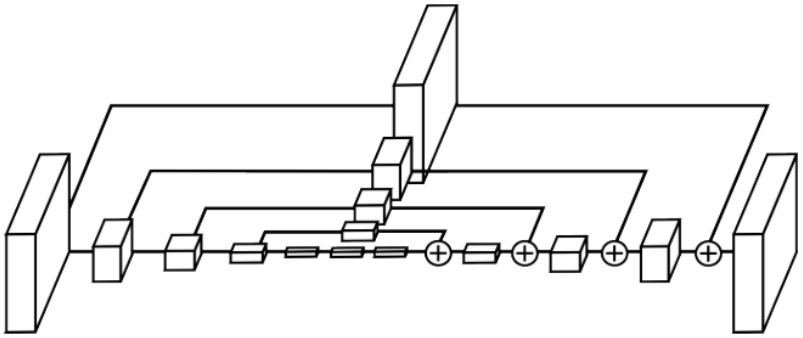
**Transformations between synthetic videos and real-world videos**

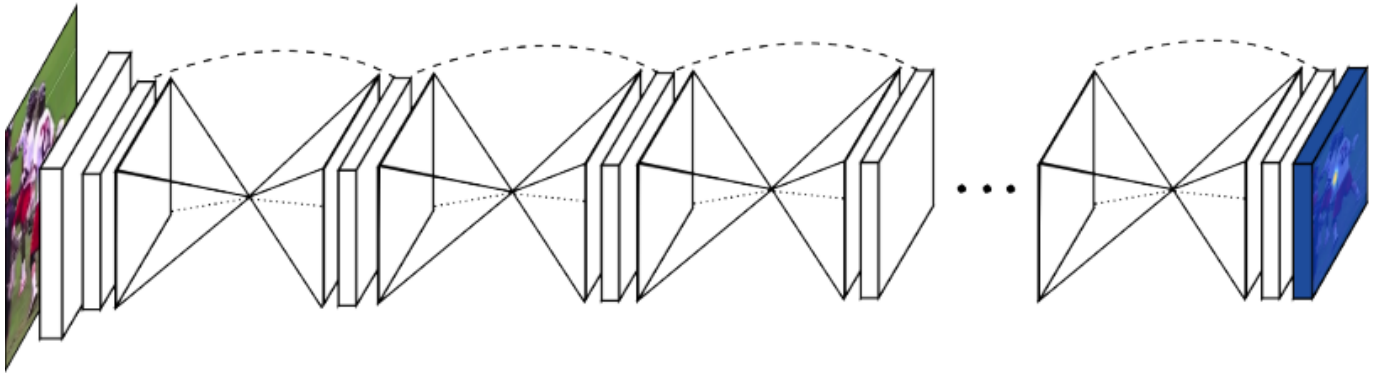
# Video Prediction Model



# (6) Human Pose Estimation

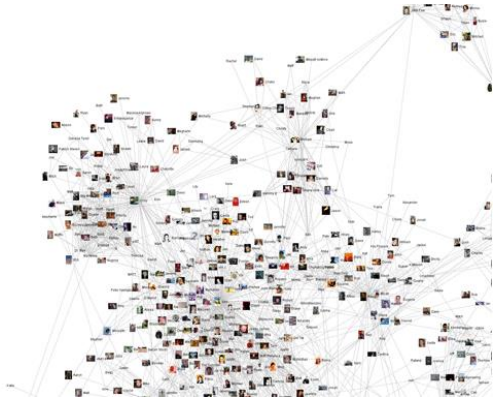
# Human Pose Estimation– Hourglass Network



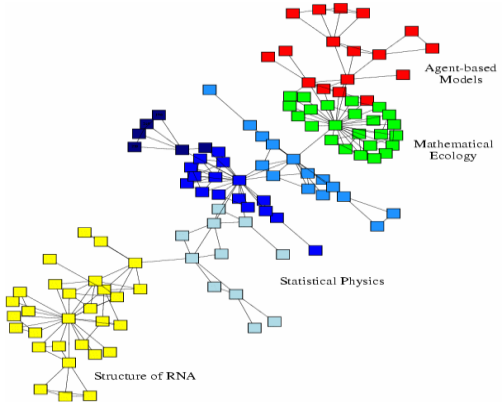


# Graph and Networks

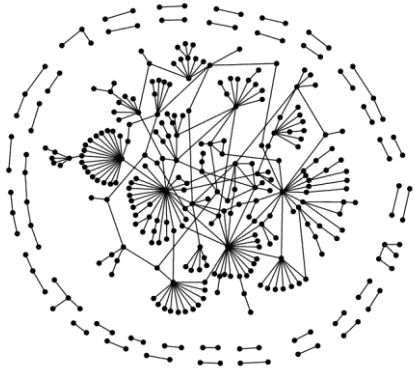
## Structured Data



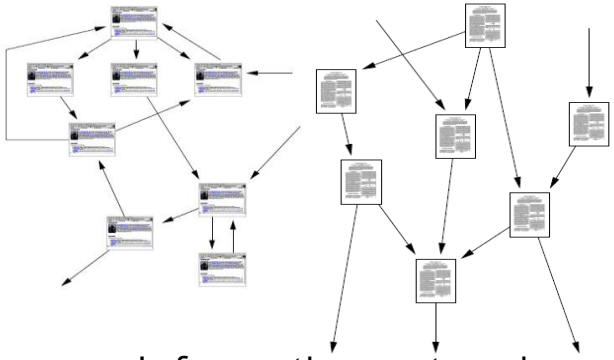
Social networks



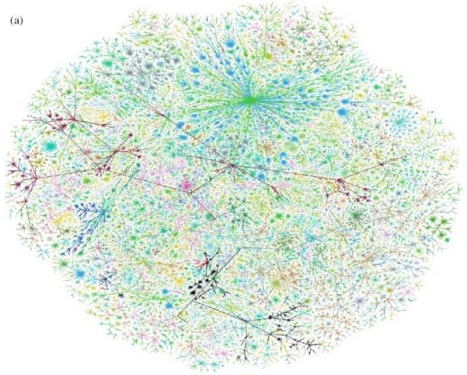

Economic networks



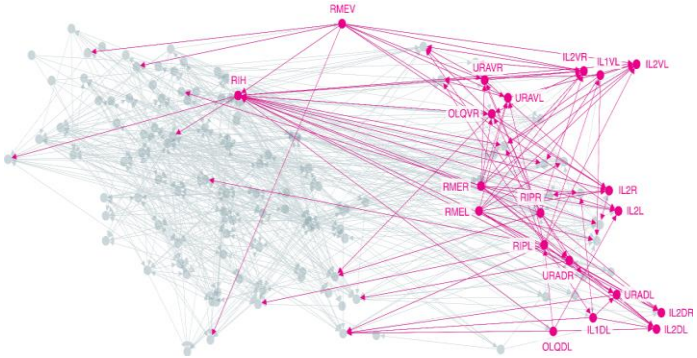
Biomedical networks



Information networks: Web & citations




Internet



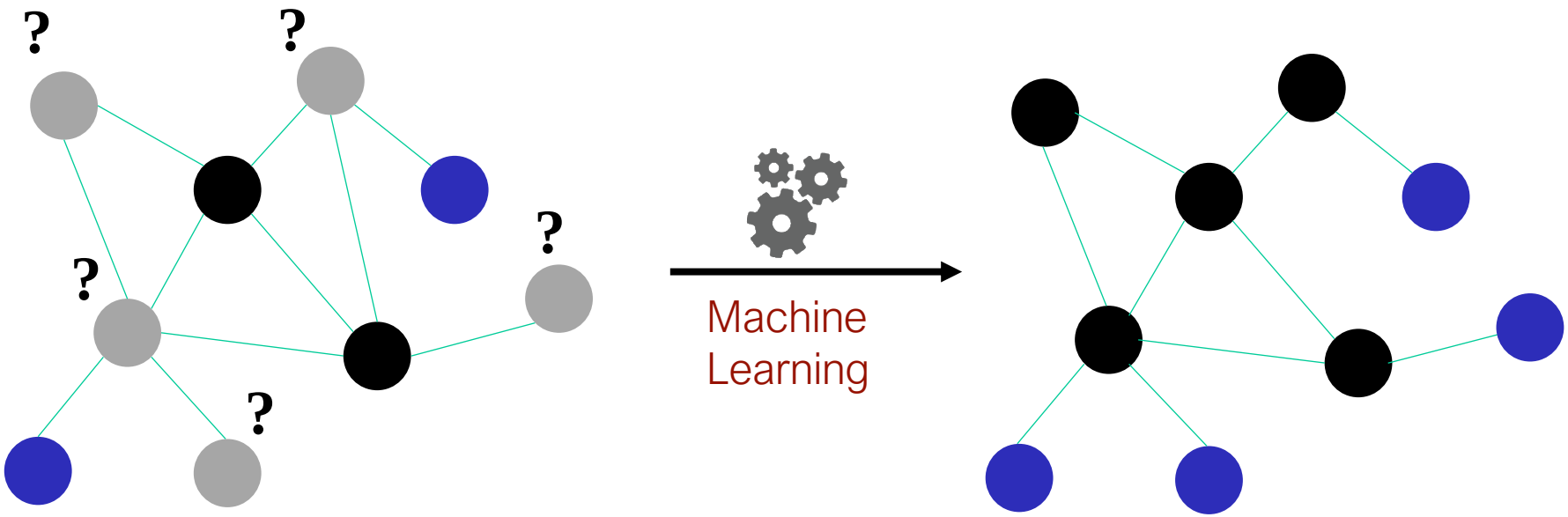

Networks of neurons

# Machine Learning in Graph and Networks

**Graph and Network Tasks:**

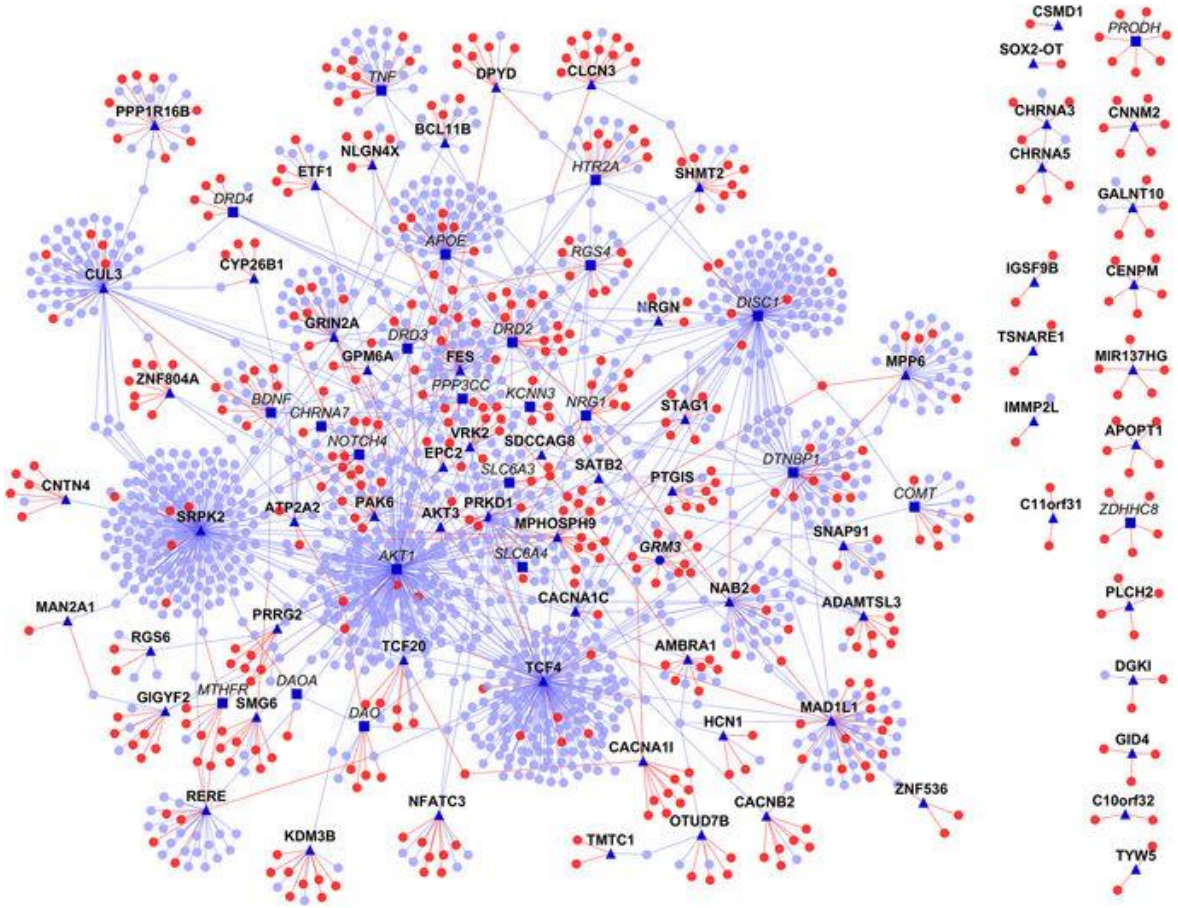
- Node classification
- Link Prediction
- Community Detection
- Networks Similarity
- …

# Node Classification

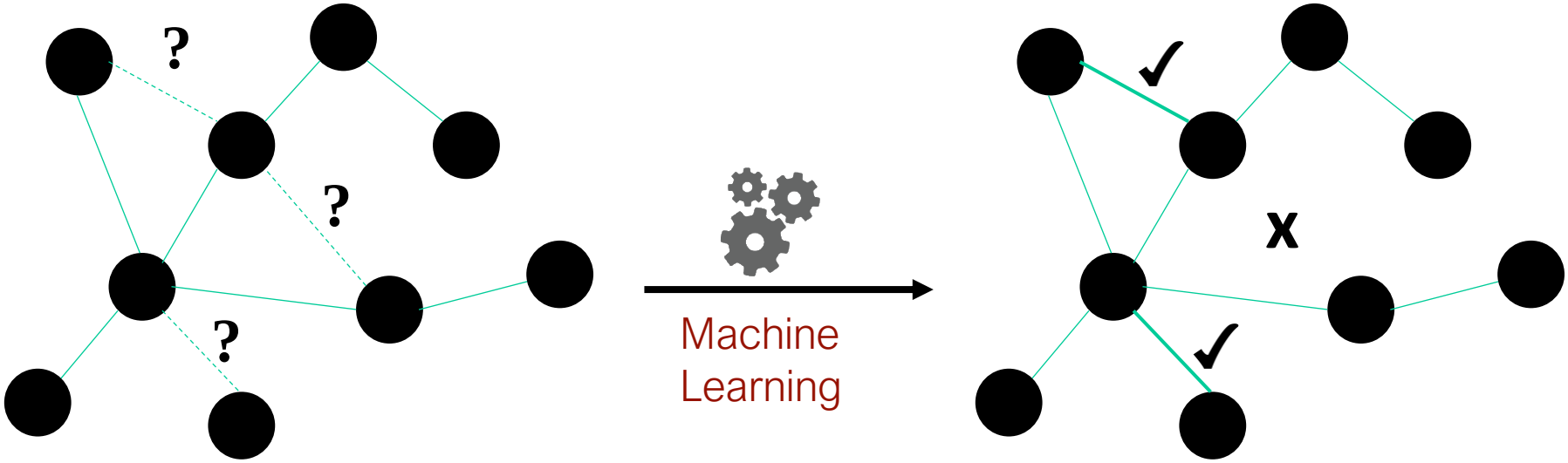


# Node Classification Example

Classify nodes according to their functionalities

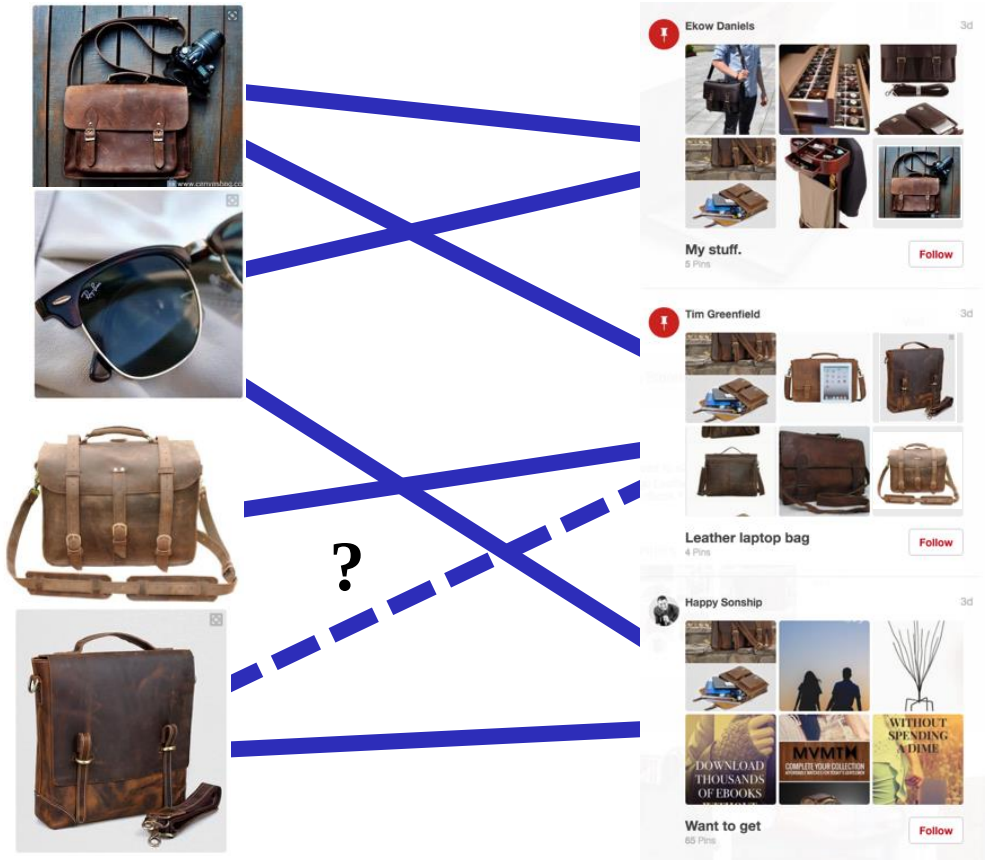


# Link Prediction



# Example for Link Prediction

Link Prediction based recommendation systems



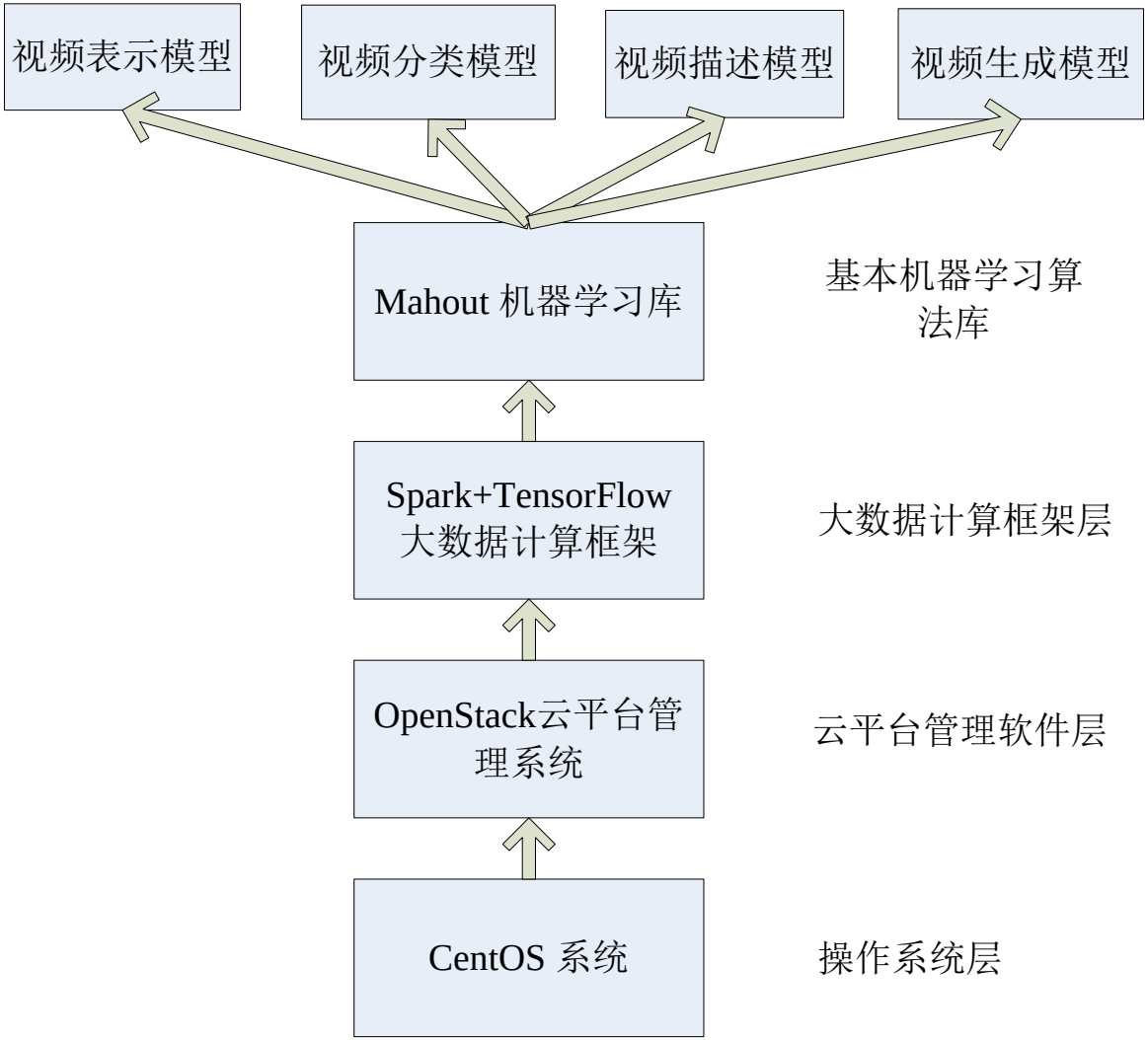
# Public Opinion Analysis


1. **Big data in social networks**
2. **Natural language processing models**
3. **Statistical models**
4. **Analysis public opinion**

# Natural Language Processing Tasks

1. Machine translation
2. Document classification
3. Topic Models
4. Sentiment analysis

# Computer Vision under Big Data Platform



# Machine Learning Models

- Linear and non-linear models
- Deterministic and probabilistic models
- Fuzzy logic systems
- Neural networks
- Probabilistic graph models
- Goble and local optimizations
- Deep learning, reinforcement learning...

# Content

Do you believe that AI will take our jobs?

NO

# Reference


1. Pattern Recognition and Machine Learning， Christopher M. Bishop

2. 机器学习， 周志华

3. The Element of Statistic Learning

4. Machine Learning, Andraw NG

5. Machine Learning, 李宏毅