# Artificial Intelligence & Machine Learning and Pattern Recognition ——Introduction


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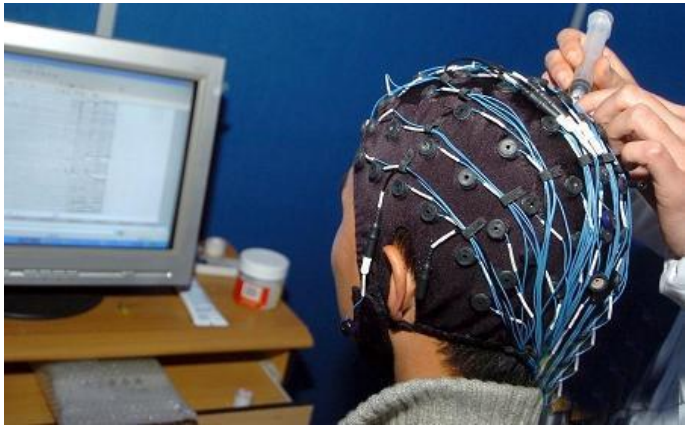
# Computer

- **Camera**: Simulate part functions of eyes
  - images and videos -> electrical signal
  - Computer Graphics (CG), Computer Vision (CV), etc.
- **Microphone**: Simulate part functions of ear
  - audios -> electrical signal
  - Speech Recognition (SR), etc.
- **Computer**: Simulate small part functions of brain
  - computing brain; symbol -> pattern
  - Artificial Intelligence (AI), etc.
- …
- The connection between digital devices and brain
  - Human-Computer Interaction (HCI)

# Human-Computer Interaction

- Substitute some functions of human, make *human* better





# Artificial Intelligence

- Simulate more functions of brain, make *computer* better
  - chess brain, question answering brain, drive brain, etc.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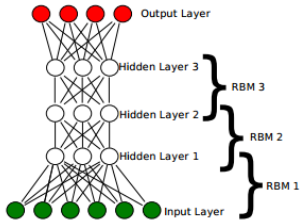
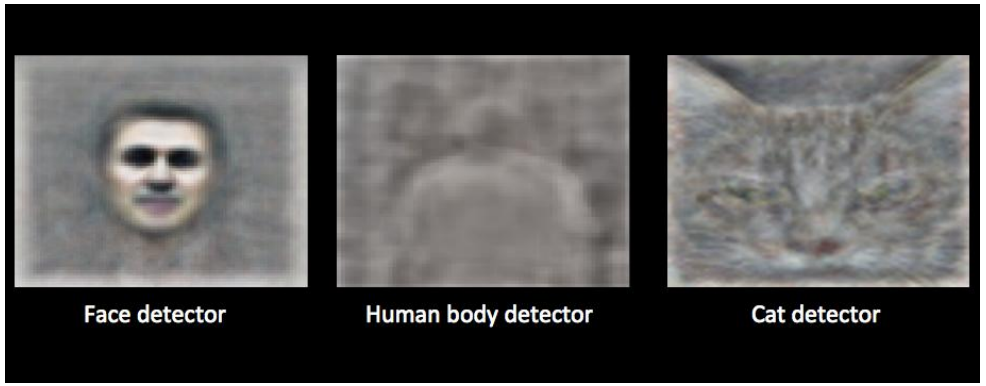



- face detector
- human body detector
- cat detector
- …



# History of AI

- Turing Test, proposed by A.M. Turing in 1950
- Loebner Prize, pledged by Hugh Loebner in 1990
  - "Question Answering"/Chat robots
  - http://www.loebner.net/Prizef/loebner-prize.html
  - 2013, Stephen Worswick
    - No chatbot fooled any of the 4 Judges
    - http://www.mitsuku.com/
  - …
  - 1991, Joseph Weintraub
    - If you say "I need my Mommy", ELIZA will say "Tell me why you need your Mommy?"
    - It employs AI sentence parsing and knowledgebase technology, plus a 70,000 word vocabulary.

# History of AI

"我是谁?"

"你得告诉我你的名字啊!"

"你是不是傻子啊?"

"你才是傻子呢"

"给我背首唐诗?"

"锄禾日当午"

.....

HOW ARE YOU 拟脑机器人

“How Are You”是我的名字
你可以叫我“小白”
3-6岁幼童专属的智能终端

吴义坚 CEO

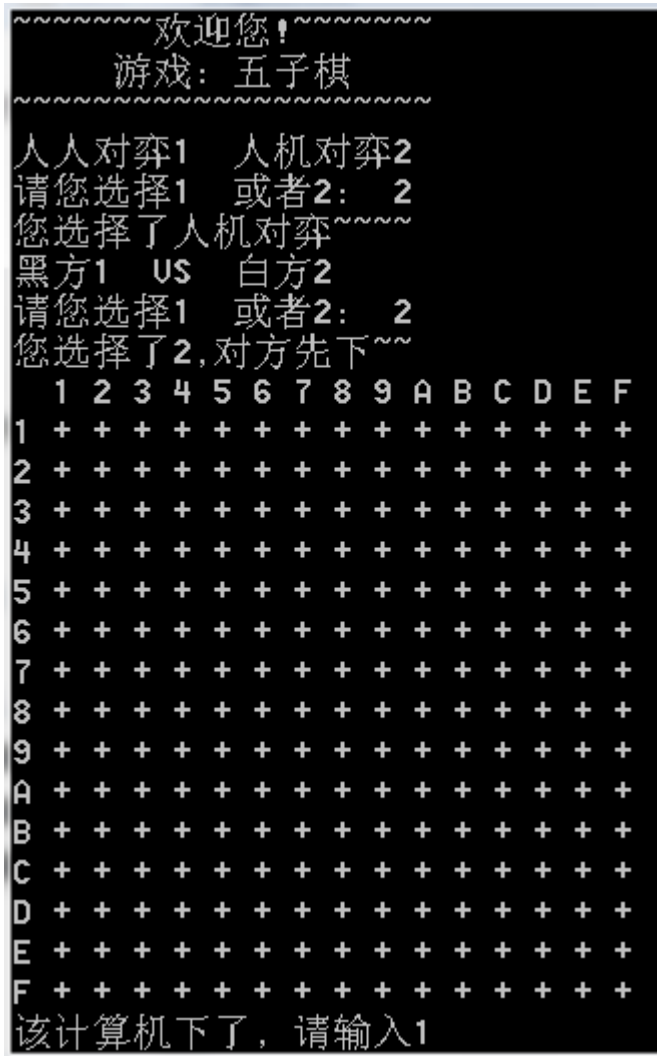
毕业于中国科大少年班，博士，国际知名语音技术专家曾先后在科大讯飞、微软、盛大创新院等国内国际知名研发机构负责语音技术和产品的研发，十年以上的人工智能技术和产品研发经验，拥有数十项国内和国际专利，同时是一个80后的爸爸

# History of AI

- Logic, 1950s
  - “Knowledge” is transferred by experts/humans
  - *propositional* logic (命题逻辑), first-order *predicate* logic (谓词逻辑), *fuzzy* logic…

# Logic

- “true” or “false”
- negation
- conjunction
- disjunction
- implication
- equivalence
- universal quantifier
- existential quantifier
- …



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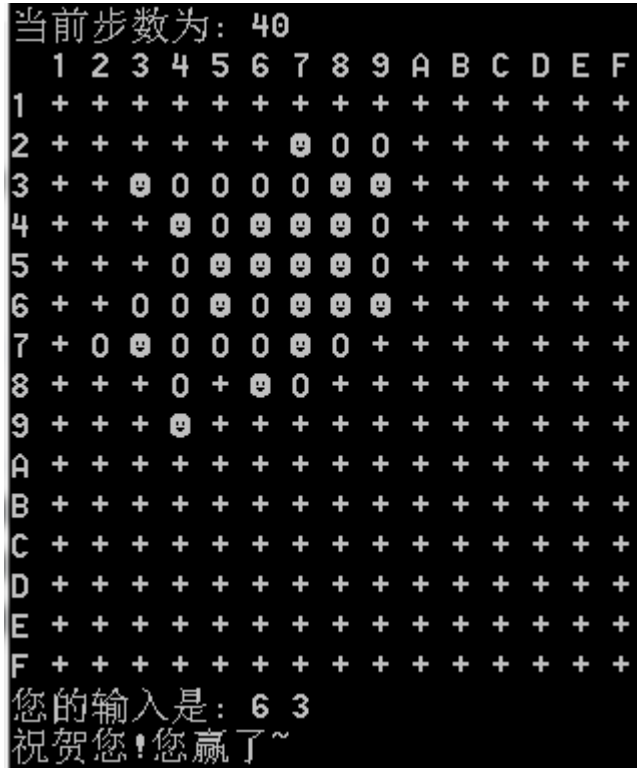

# History of AI

- Logic, 1950s
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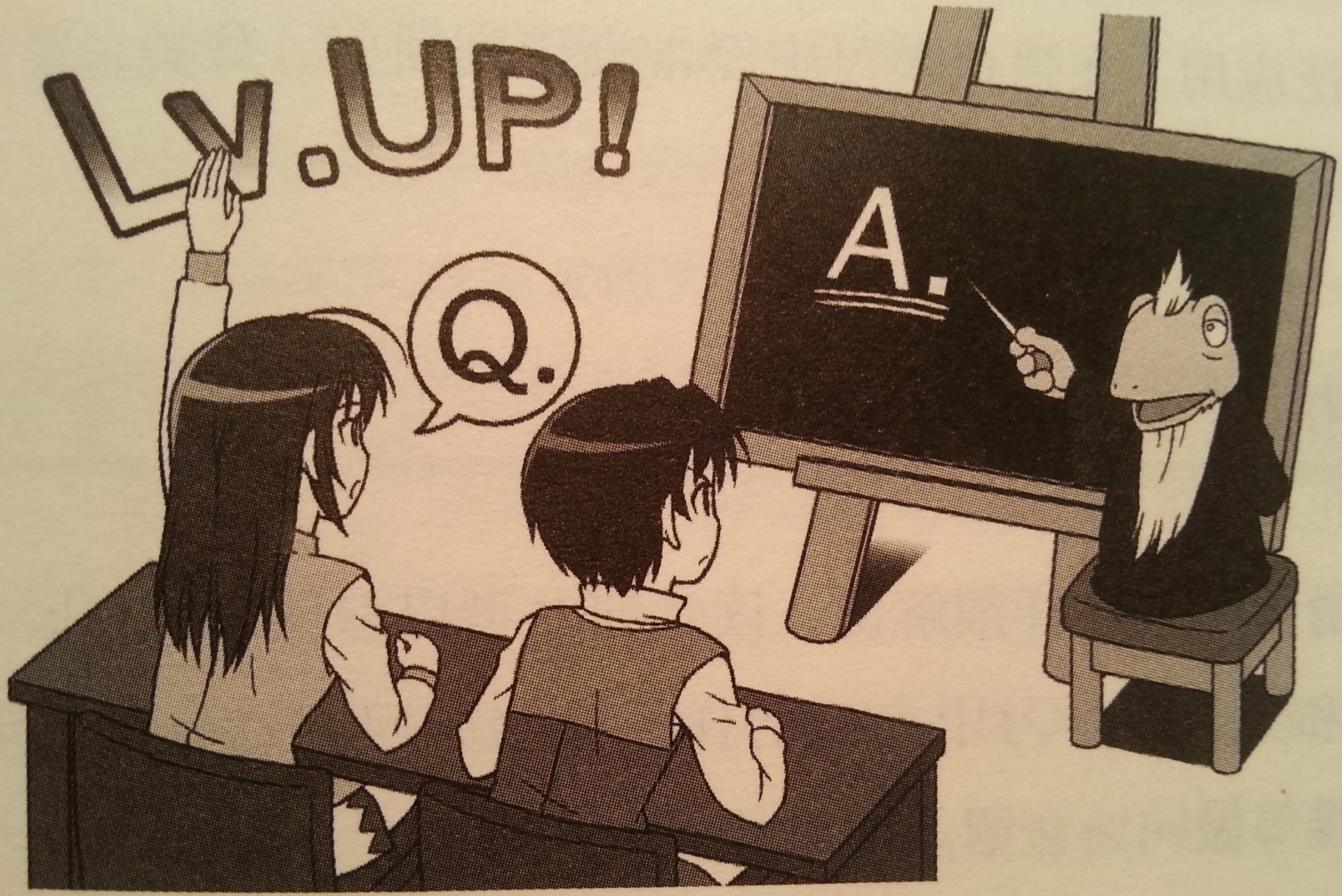
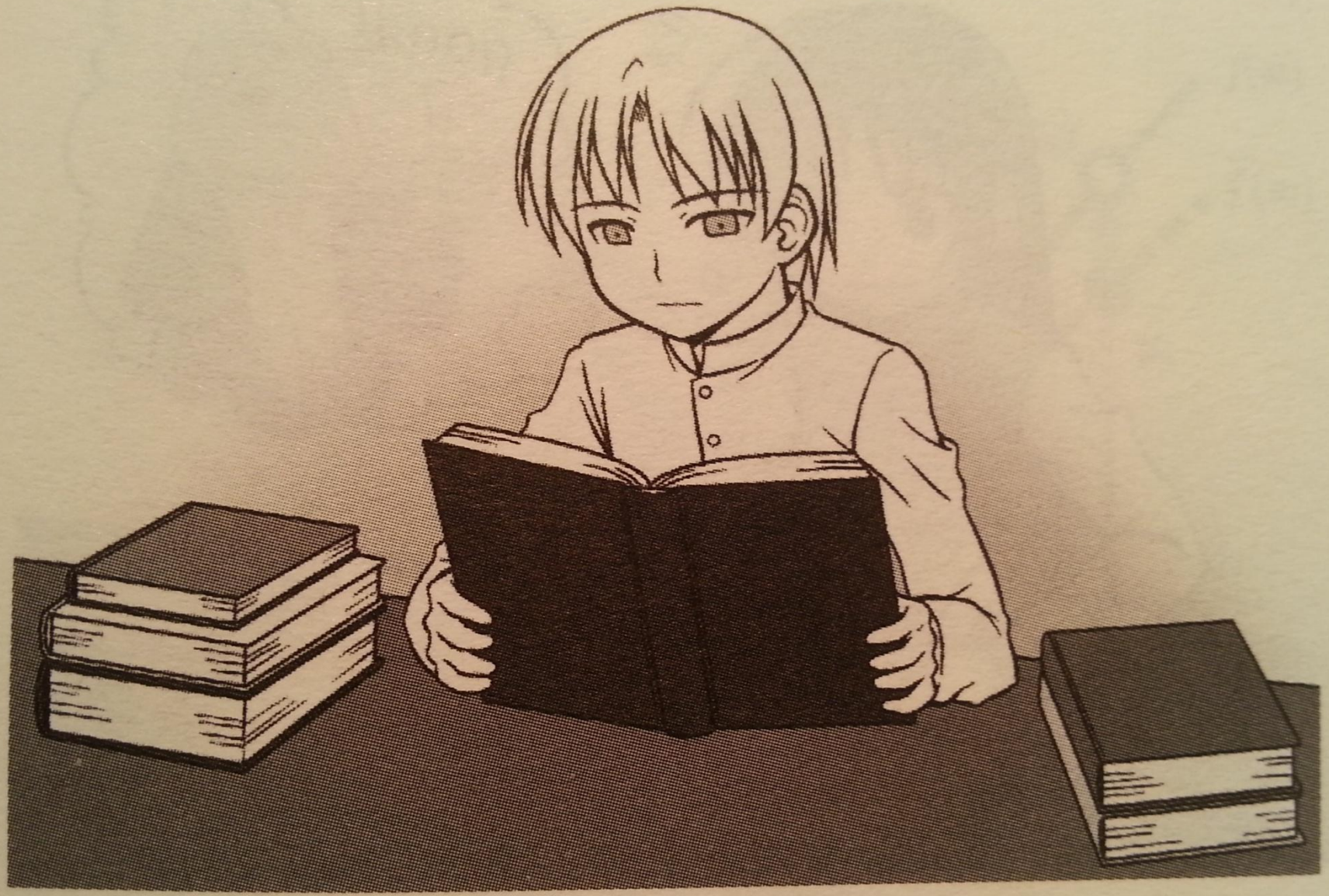
- Machine Learning, 1990~
  - "Knowledge" is learnt by computers primarily
  - *supervised* learning (监督学习): classification…
  - *unsupervised* learning (无监督学习) : clustering, density estimation…
  - *reinforcement* learning (强化/增强学习)




监督学习

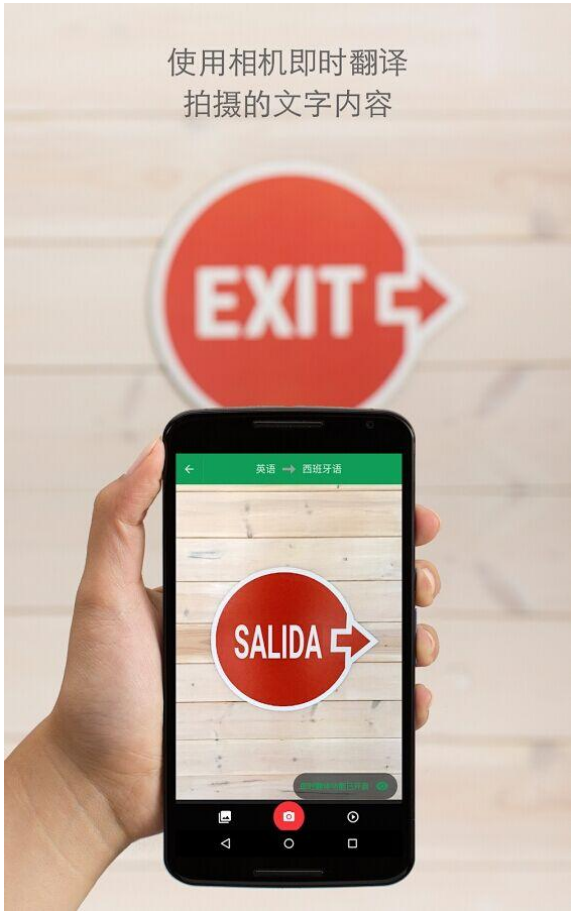


无监督学习


强化学习

# What is Artificial Intelligence

- Compute something that shows **intelligent** behavior
  - Natural language processing, …

# What is Artificial Intelligence

- Compute something that shows **intelligent behavior**
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2015年6月18日下午，日本，Pepper和阿里巴巴集团零售事业群总裁张建锋互动：

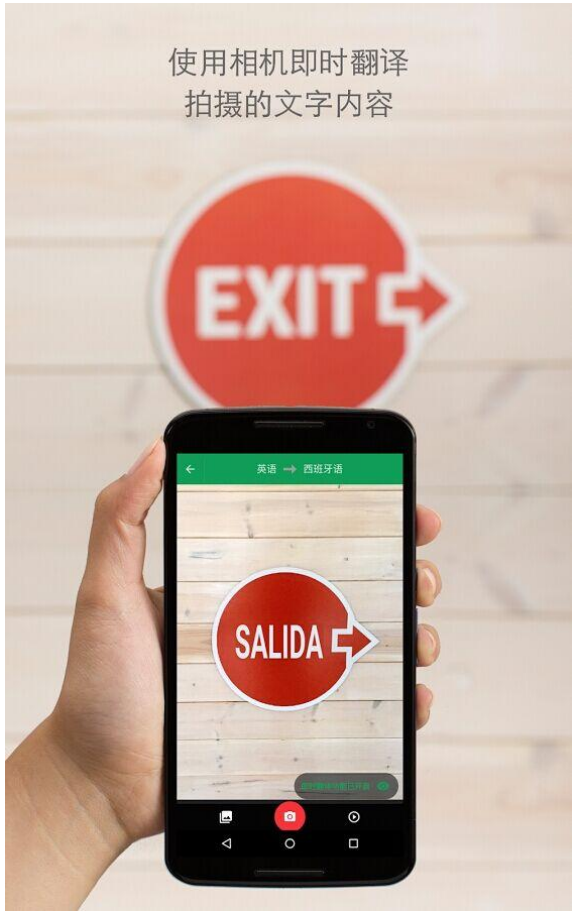
……

Pepper：快乐20，紧张60，生气0，悲伤0，我的情感引擎显示，您好象有点紧张，是吗?

……

Pepper：快乐80，紧张20，生气0，悲伤0。我的情感引擎显示你的心情似乎不错。你是不是开始喜欢我了?

……



# What is Machine Learning

- Tom Mitchell (1997): A **computer program** (vs *human*) is said to **learn** from experience *E* (*e.g.*, labeled data) with respect to some class of tasks *T* (*e.g.*, classification) and performance measure *P* (*e.g.*, precision & recall), if its performance at tasks in *T*, as measured by *P*, improves with experience *E*.

# What is Pattern Recognition

- Christopher M. Bishop (2006): The automatic discovery of regularities in data through the use of computer algorithms (*e.g.*, Machine Learning) and with the use of these regularities to take actions such as classifying the data into different categories

# What Kinds of Regularities?

- **Classification**
  - A loan user: high or low risk? <-> *banker*
  - A person: health or sick? <-> *doctor*
  - An Iris flower: Setosa, Versicolour, or Virginica? <-> *botanist* (植物学家)



# Classification

- Make the computer as intelligent as an expert
  - Classify a person as healthy or sick
  - Identify the author of a piece of art or a book
  - Indentify the variety of an animal or a plant

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- Training data: examples of the input vectors along with their corresponding target vectors
  - Input vectors: height, weight, has a tail? (yes or no)
  - Target vectors: human or monkey

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  - Input vectors: height, weight, has a tail? (yes or no)
  - Target vectors: human or monkey
  - Which attributes are good to classify a bird from others?




# Classification

- Input vectors of birds:
  - can move? (yes or no)
  - can chirp? (yes or no)
  - have feather? (yes or no)
  - size (length, width, height)
  - reaction to sound? (yes or no)
  - …

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  - …

# Classification

- Data set for Machine Learning
  - UCI Machine Learning Repository (http://archive.ics.uci.edu/ml/datasets.html)
- Iris data set
  - http://archive.ics.uci.edu/ml/datasets/Iris
  - Attributes provided by Fisher (experts)
    - sepal (萼) length (cm), sepal width (cm), petal (瓣) length (cm), petal width (cm), class

```
5.3,3.7,1.5,0.2,Iris-setosa
5.0,3.3,1.4,0.2,Iris-setosa
7.0,3.2,4.7,1.4,Iris-versicolor
6.4,3.2,4.5,1.5,Iris-versicolor
6.3,3.3,6.0,2.5,Iris-virginica
5.8,2.7,5.1,1.9,Iris-virginica
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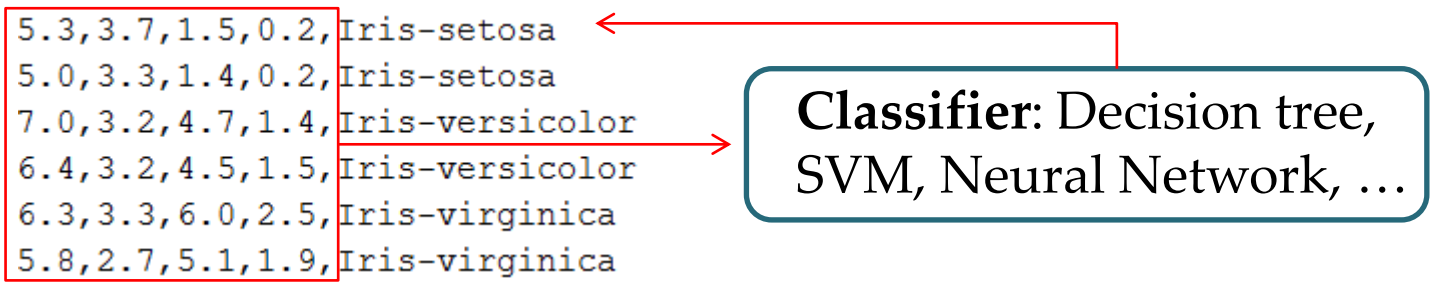
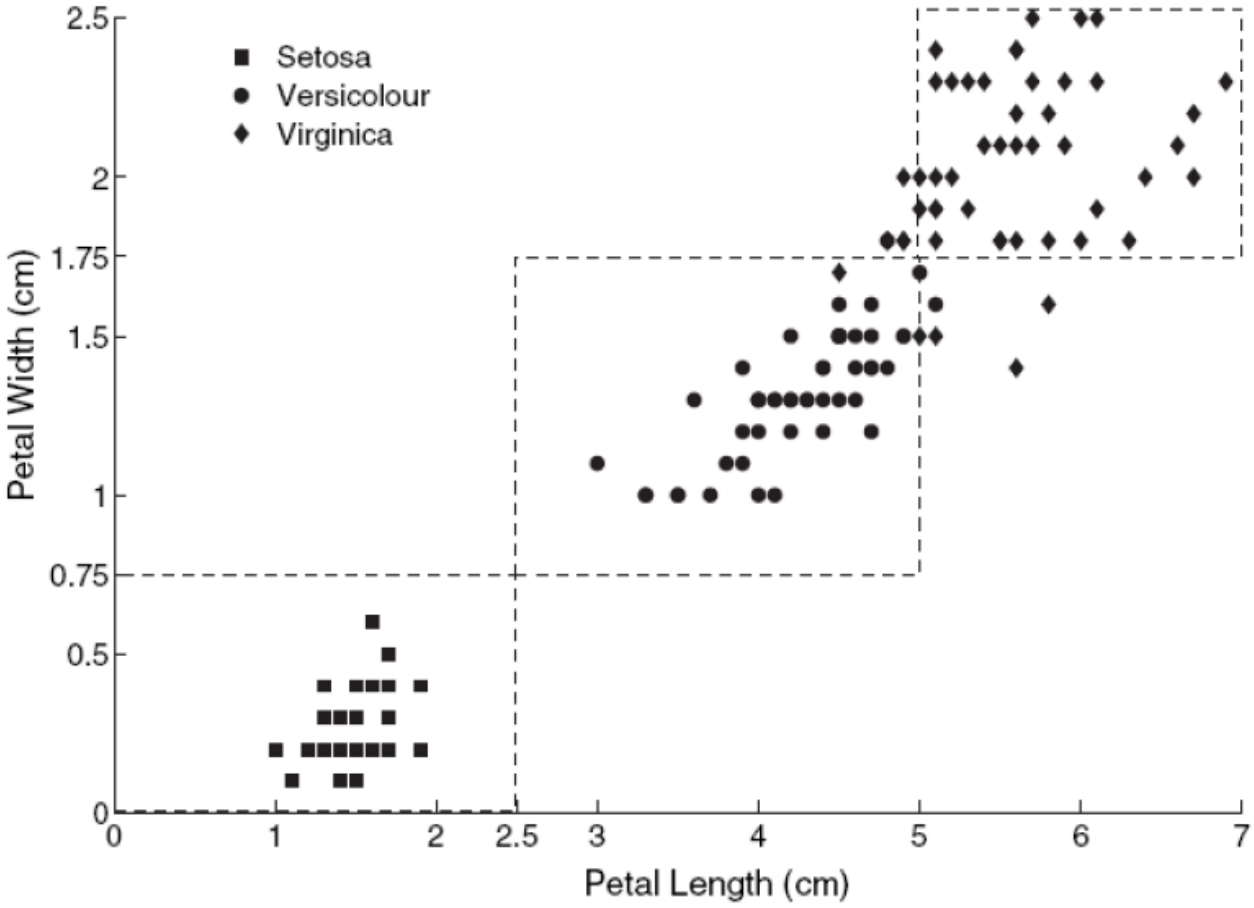


# Classification

- Plot using petal length and width



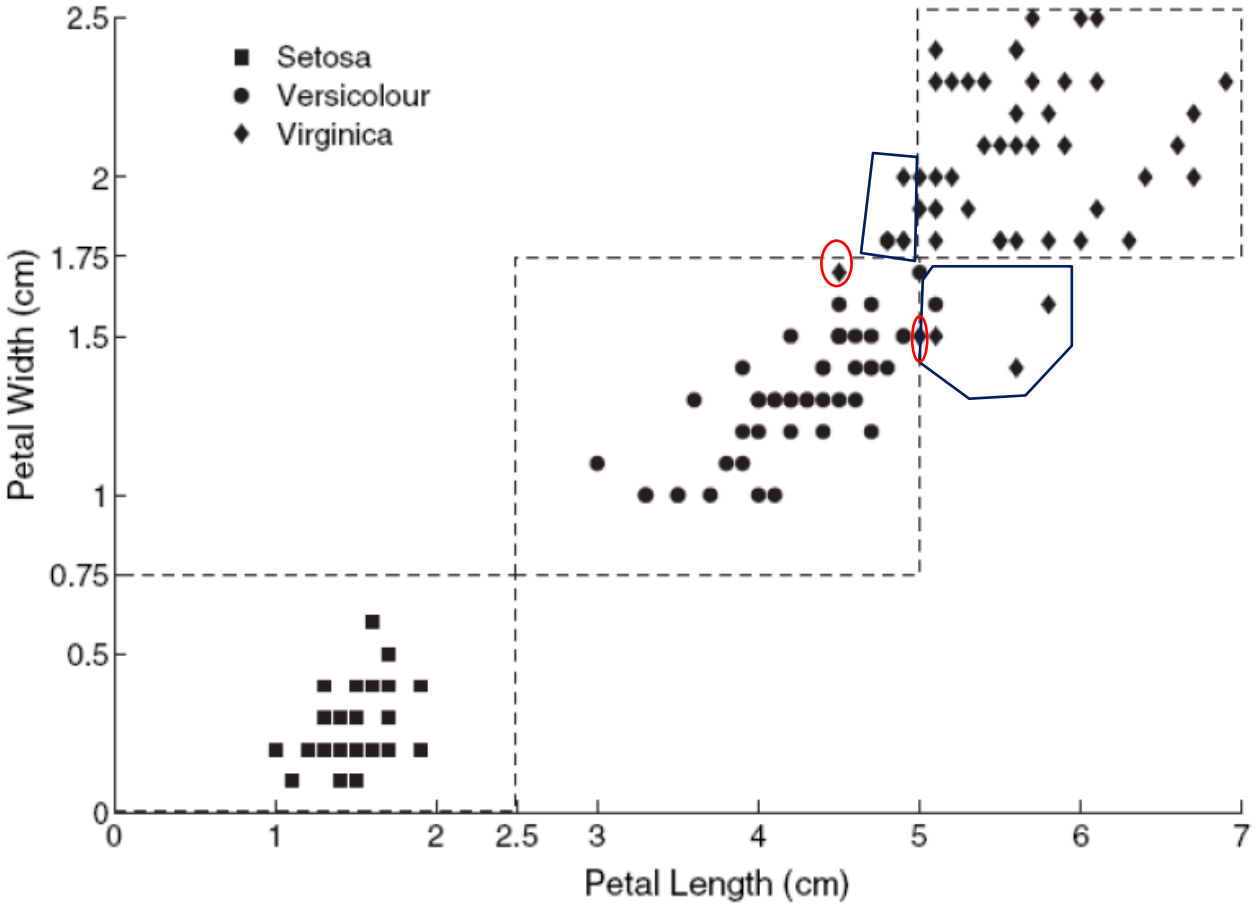
# Classification

- Based on these categories with data, the following rules can be derived:
  - Petal width low and petal length low implies Setosa (山鸢尾).
  - Petal width medium and petal length medium implies Versicolour (变色鸢尾).
  - Petal width high and petal length high implies Virginica (维珍尼亚鸢尾).

# Classification

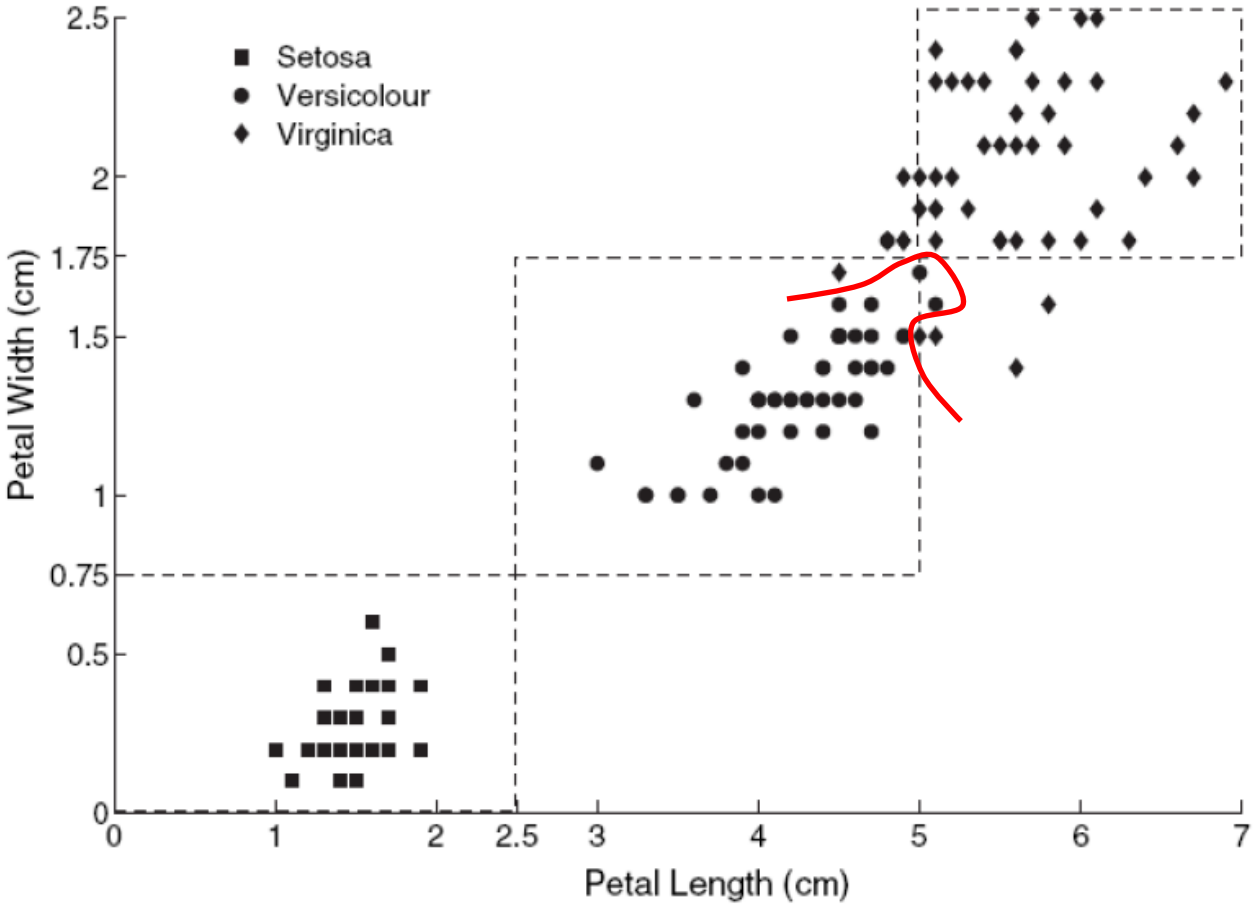
- These rules do not classify all the flowers correctly.
  - Flowers from the Setosa species are well separated from the other two species with respect to petal width and length.
  - However, the Versicolour and Virginica species overlap somewhat with respect to these two attributes.
- Solutions?

# Classification



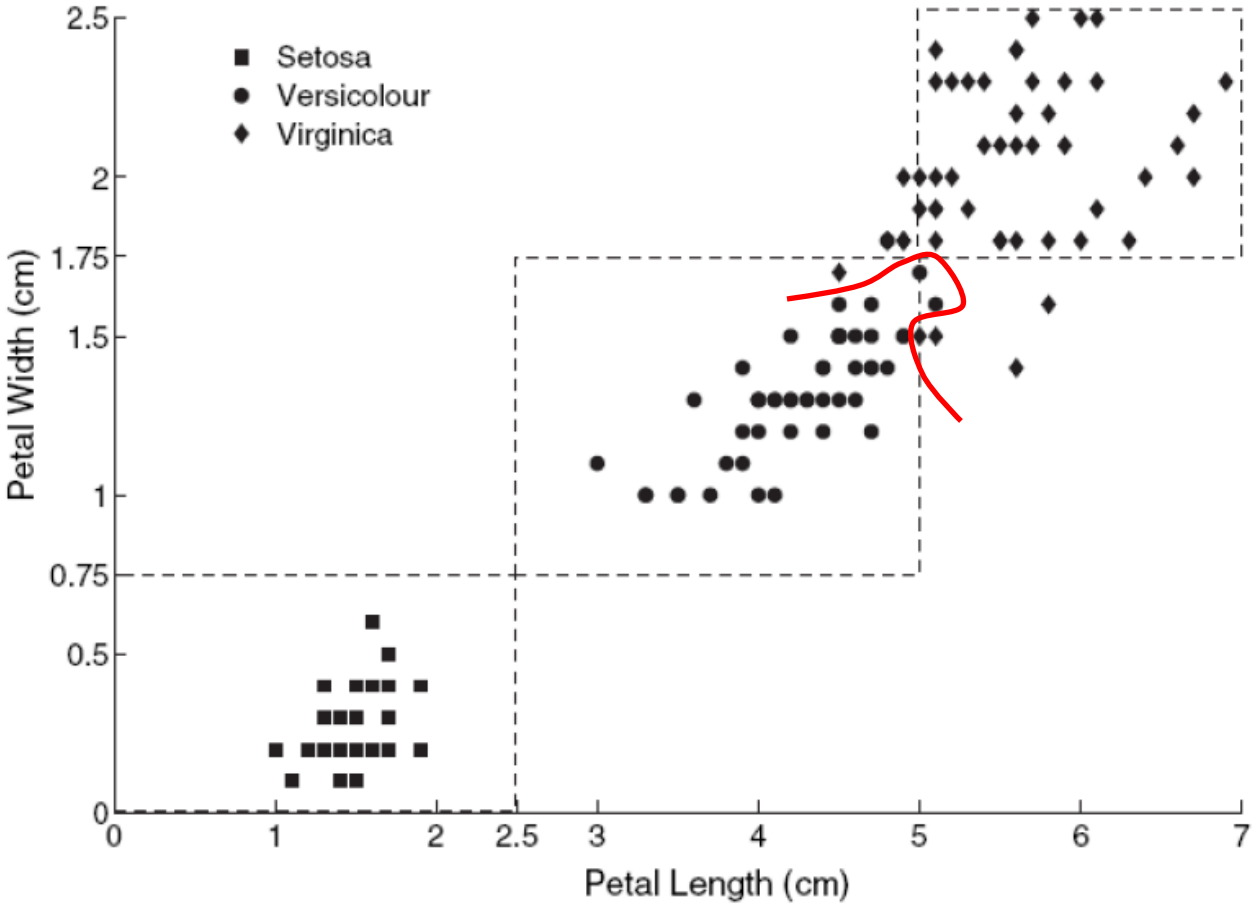

1. **Records surrounded by red line: misclassified**
2. **Records surrounded by blue line: unclassified**

# Classification




1. **A new better classifier model**

# Classification




1. **A new better classifier model**
2. **Add more attributes**
   **(i.e., sepal length and width, and others if possible)**

# What Kinds of Regularities?

- **Regression**
  - Highly related to statistics
  - Many concerned quantitative variables:
    - A person's life expectancy
    - A journal article's citations
    - A city's air temperature next day
    - …
  - Mining the correlation between a series of independent variables ($X$) and dependent variables ($Y$)

# Regression

- Which one of the following is false for building a regression model?

  ($X$: independent variables; $Y$: dependent variables)

  - **1.** $X$ is the working years of an employee, $Y$ is the employee's salary
  - **2.** $X$ is a child's height, $Y$ is the height of the child's father or mother
  - **3.** $X$ is the total production of a product, $Y$ is the total consumption of the product
  - **4.** $X$ is the total consumption of a product, $Y$ is the total production of the product

# Regression

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  - **2.** $X$ is a child's height, $Y$ is the height of the child's father or mother
  - **3.** $X$ is the total production of a product, $Y$ is the total consumption of the product (**iPhone**)
  - **4.** $X$ is the total consumption of a product, $Y$ is the total production of the product

# What Kinds of Regularities?

- Association Rules
  - Detect sets of attributes or items that frequently co-occur in many records
  - On Thursday, during 4-11pm, customers often purchase diapers and beers together

# Association Rules

- Where does the data come from?
  - supermarket transactions, customer complaint calls, discount coupons, etc.
- Cross-marketing analysis
  - purchase recommendation, cross selling
  - what are the subsequent purchases after buying a given product?
- Target-marketing
  - what types of users buy what products
- Catalog design

# What Kinds of Regularities?

- **Clustering**
  - seeks to find groups of closely related records (*e.g.*, users, articles, genes, planets)
  - can be applied to
    - compress data
    - anomaly detection
    - reduce dimensions
    - group sets of related customers/products


# Clustering

- Key steps
  - Feature extraction for each record
    - A user of Amazon
    - An article, *etc*.
  - Weighting for each feature
    - Linear
    - Nonlinear, *etc*.
  - Similarity measurement for *paired* records
    - Euclidean distance
    - Cosine similarity, *etc*.

# Clustering

- How to decide these three articles as two groups/clusters?
  - 1: *I'm involved in the release of apple's iPhone 6.*
  - 2: *Apple's iPhone 6 released on Friday.*
  - 3: *I've eaten an apple this Friday.*