Artificial Intelligence
——Introduction

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Announcement of lab course

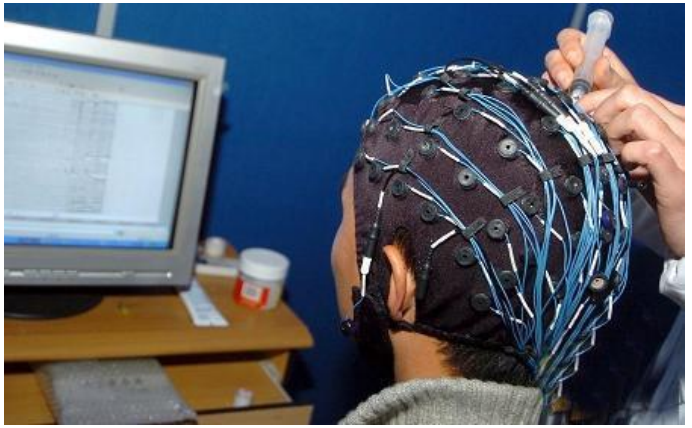
- Will start in the Third Week (实B201)
- Five or six experiments
- A final project
- All the subjects will be carefully redesign (different from last year's subjects)
- Strictly prohibited for plagiaristic activities (严禁抄袭)

Background

- **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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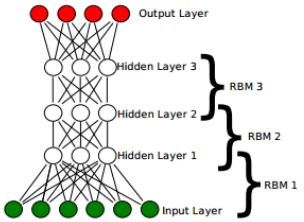
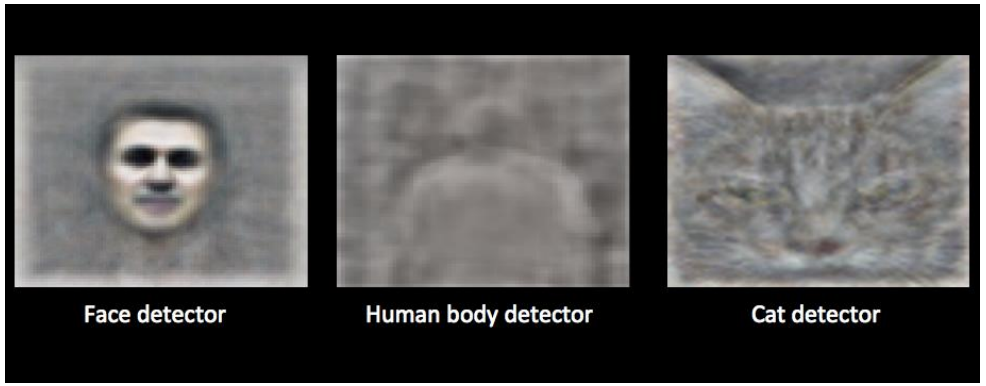


- face detector
- human body detector
- cat detector
- …



History of AI

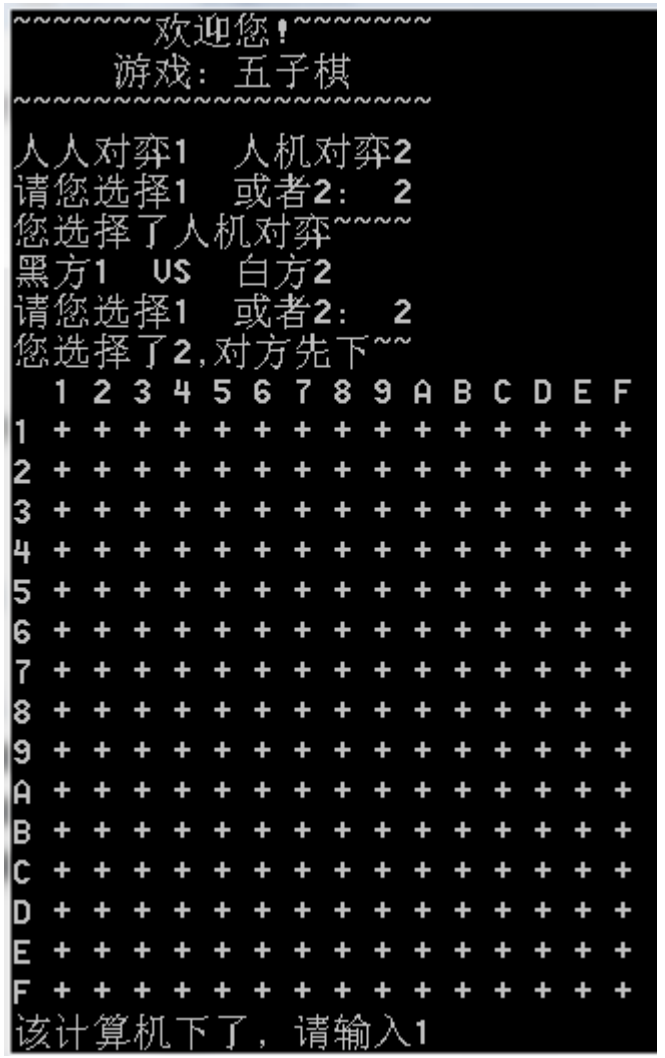
- Turing Test, proposed by A.M. Turing in 1950
- Loebner Prize, pledged by Hugh Loebner in 1990
  - "Question Answering"/Chat robots
  - http://www.loebner.net/Prizef/loebner-prize.html
  - 1991, Joseph Weintraub
    - If you say "I need my Mommy", ELIZA will say "Tell me why you need your Mommy?"
    - It employs AI sentence parsing and knowledgebase technology, plus a 70,000 word vocabulary.
  - …

History of AI

- 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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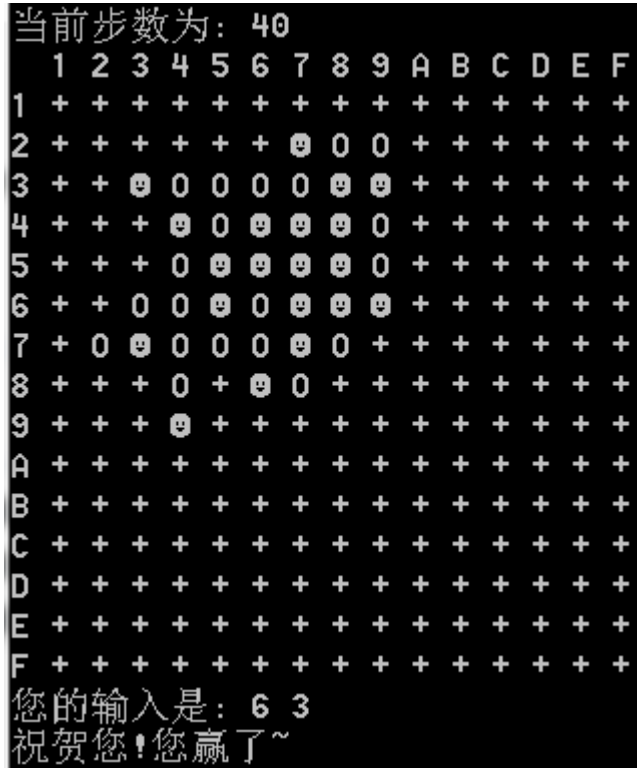

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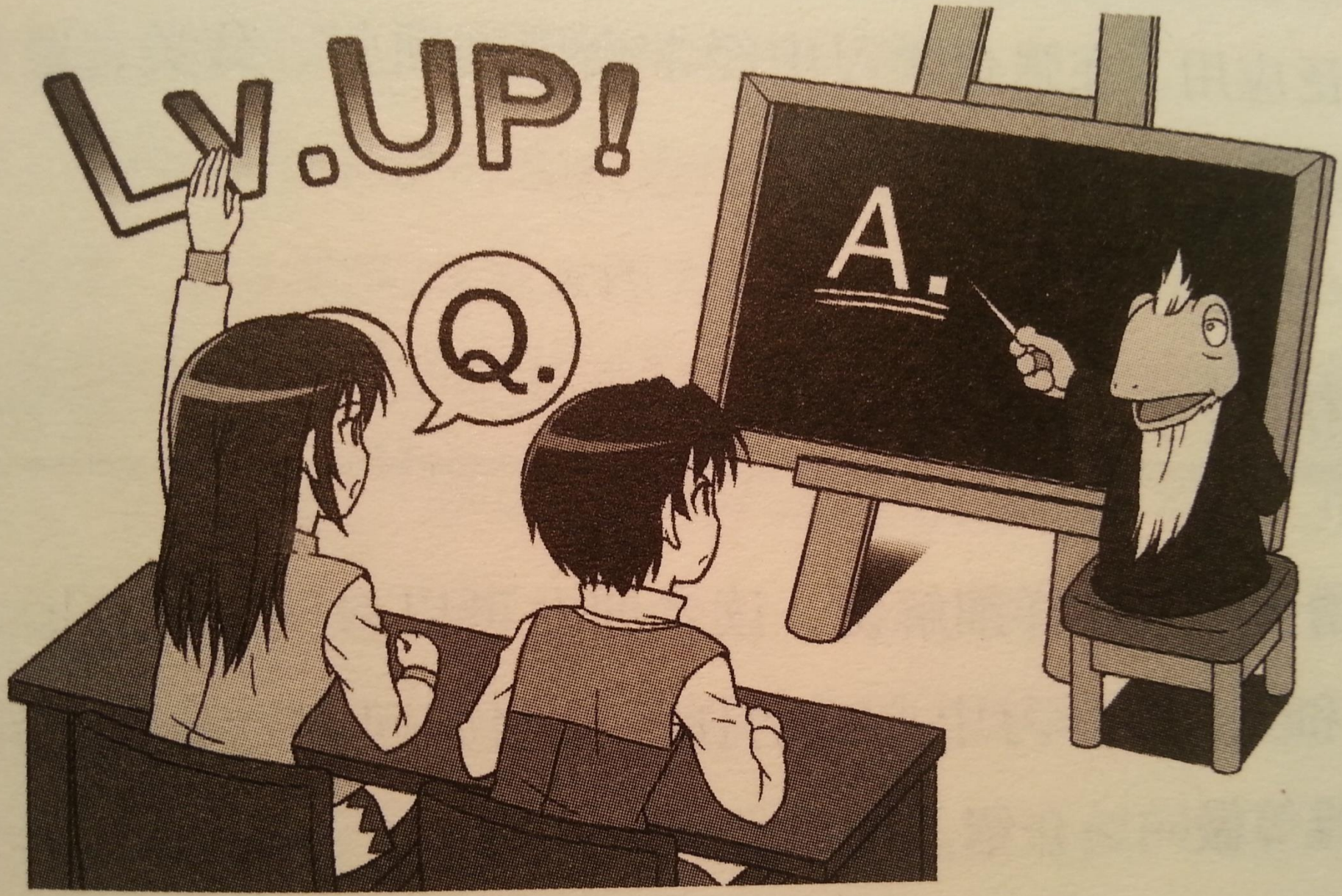
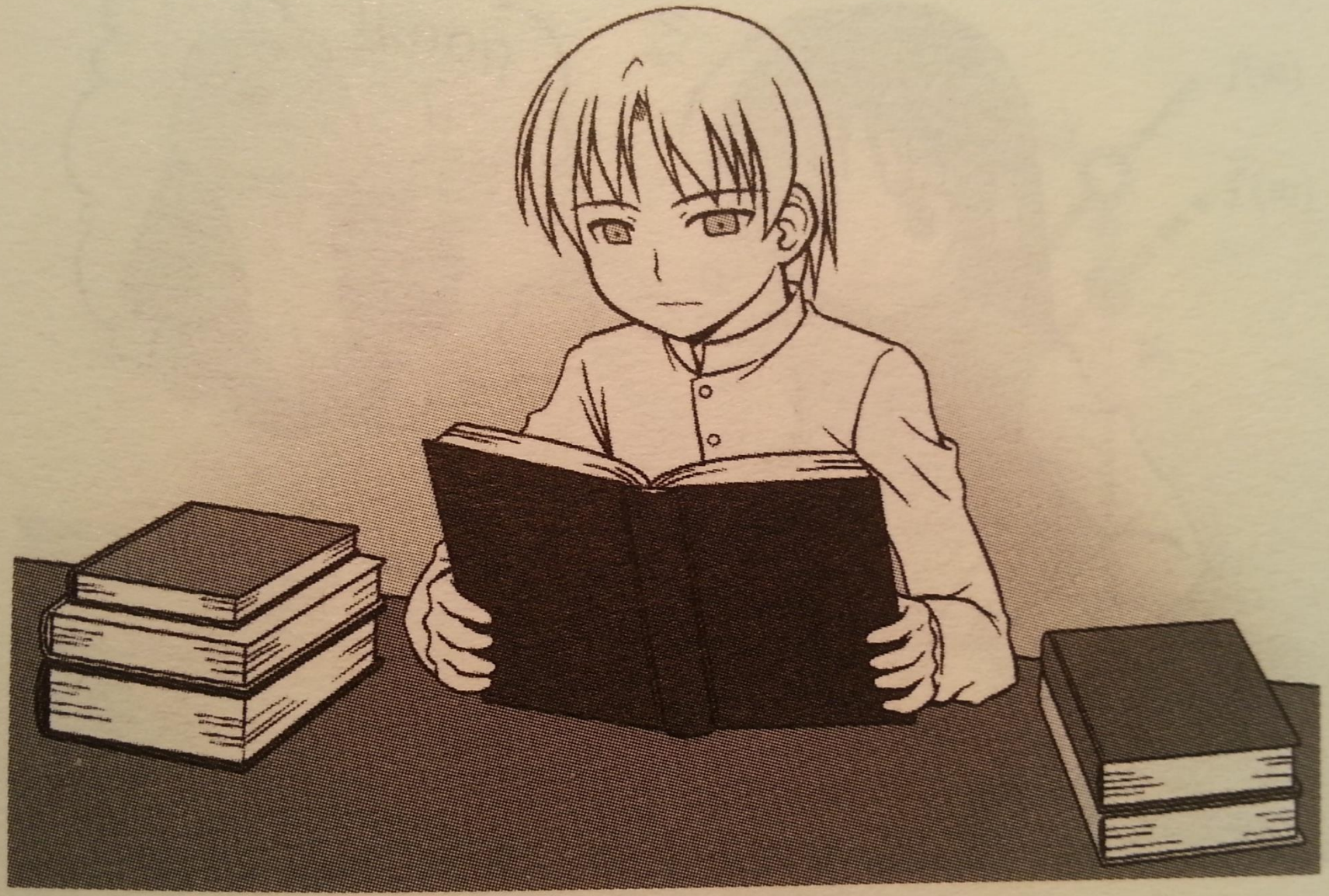
- Machine Learning, 1990~
  - "Knowledge" is learnt by computers primarily
  - *supervised* learning (监督学习): classification…
  - *unsupervised* learning (无监督学习) : clustering, density estimation…
  - *reinforcement* learning (强化/增强学习)



监督学习

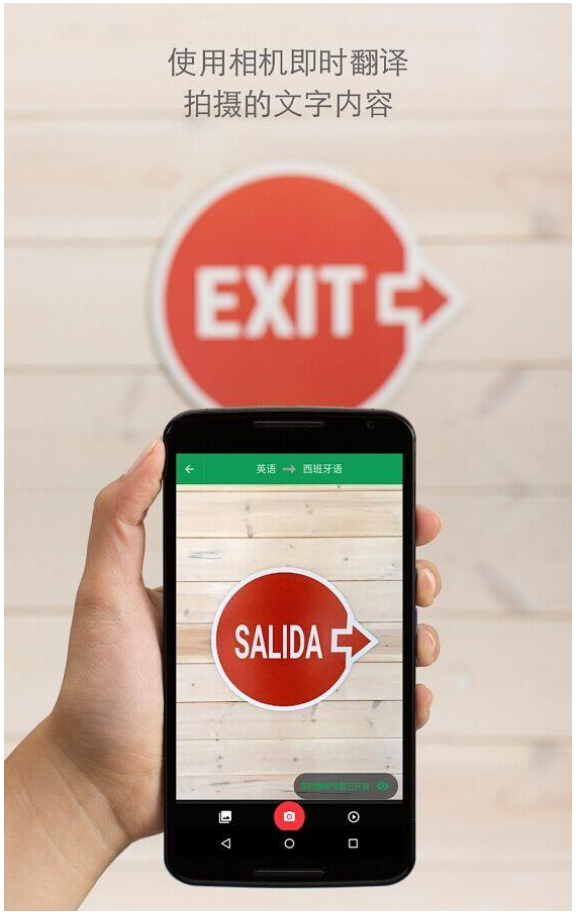


无监督学习

强化学习

What is Artificial Intelligence

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



What is Artificial Intelligence

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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：

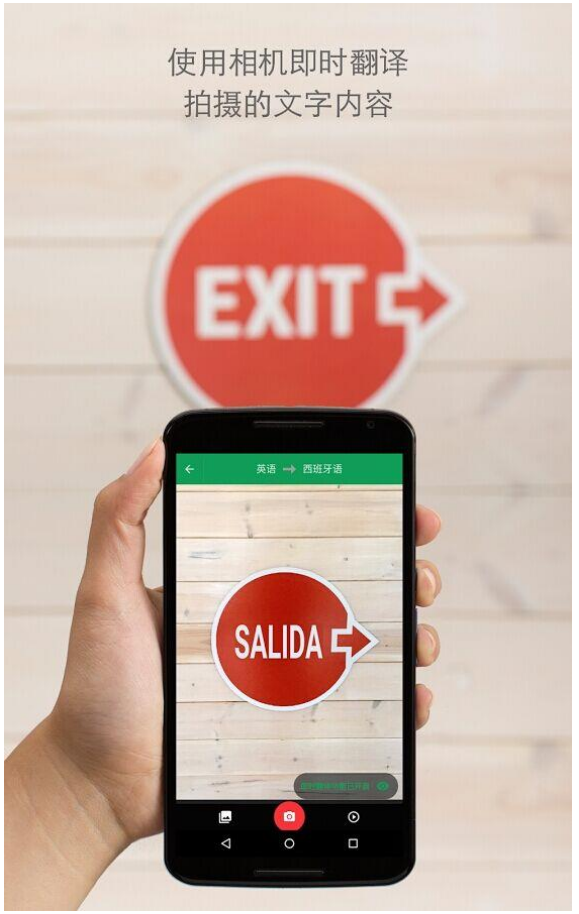
……

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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  - Input vectors: height, weight, has a tail? (yes or no)
  - Target vectors: human or monkey

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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
  - 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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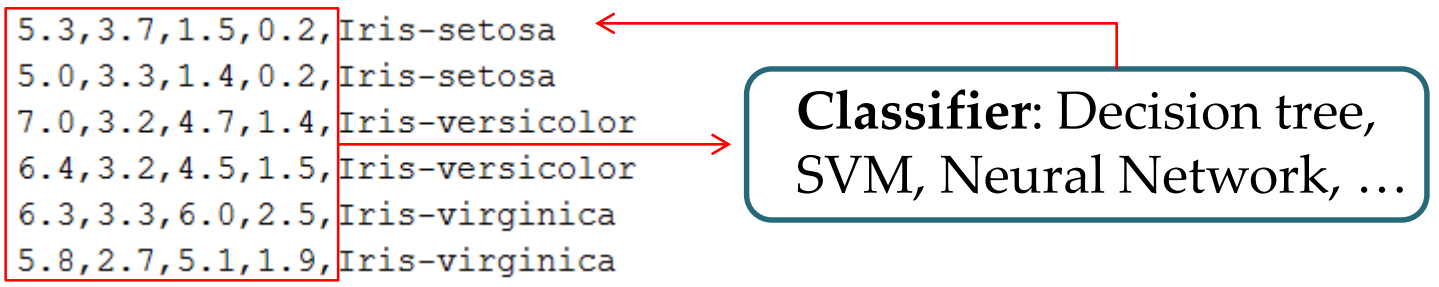
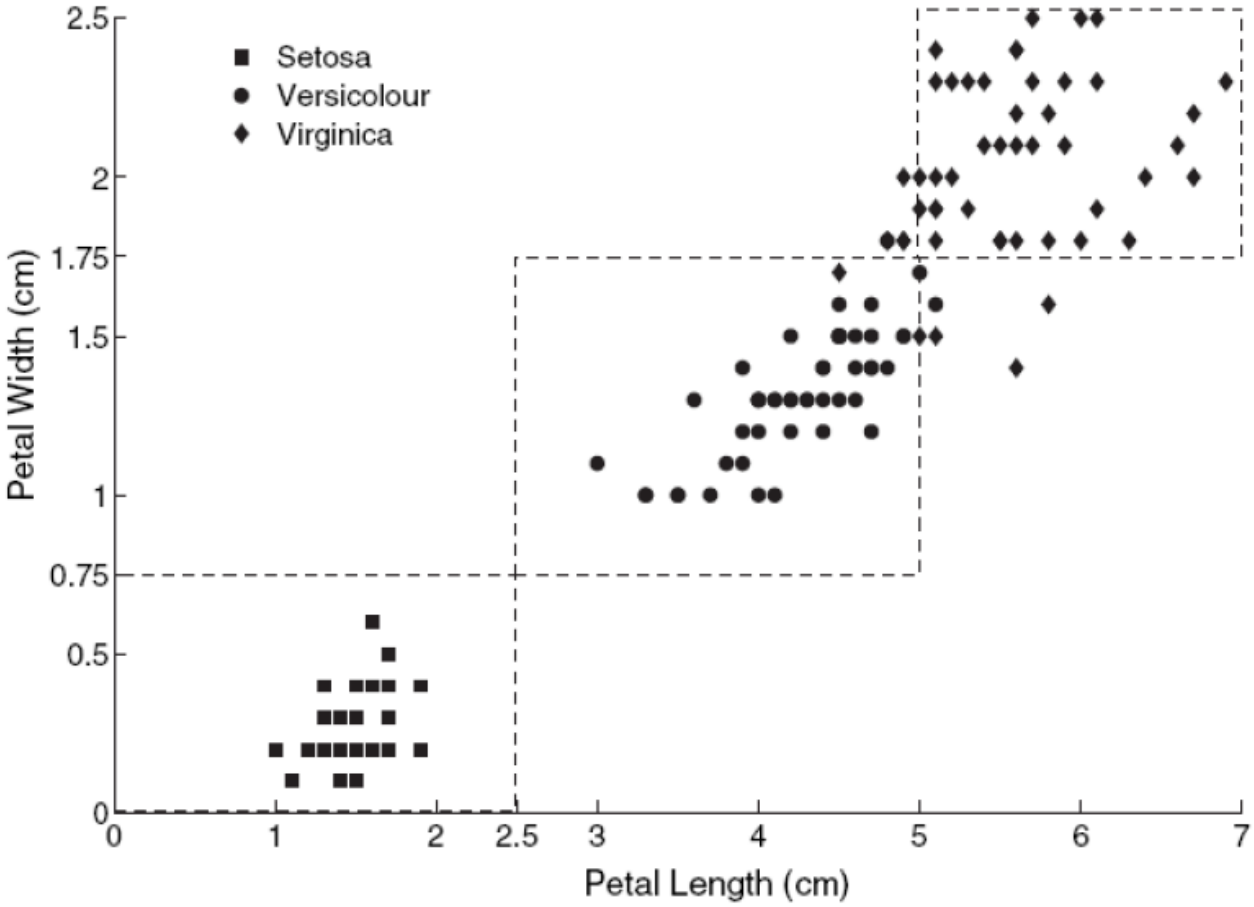


Classification

- Plot using petal length and width



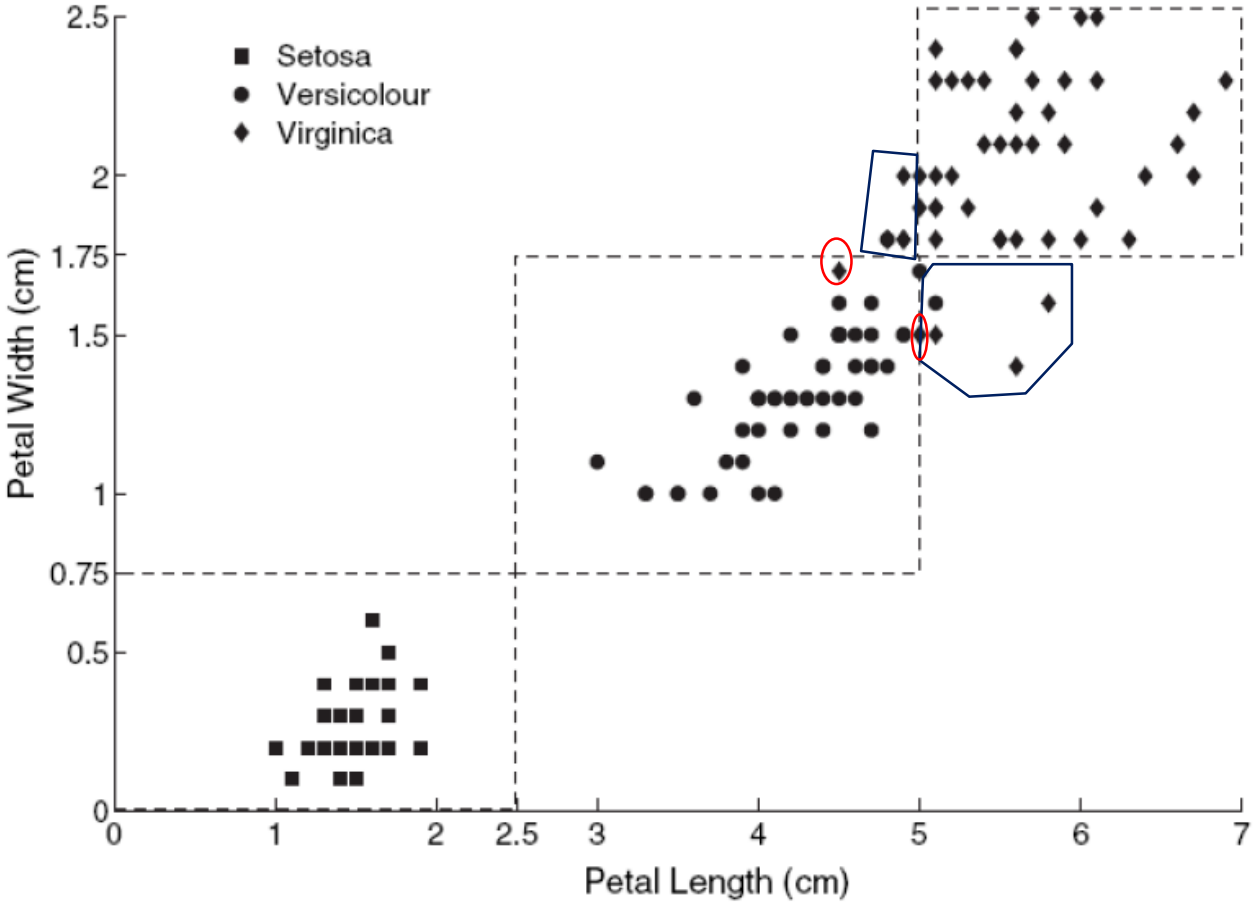
Classification

- 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

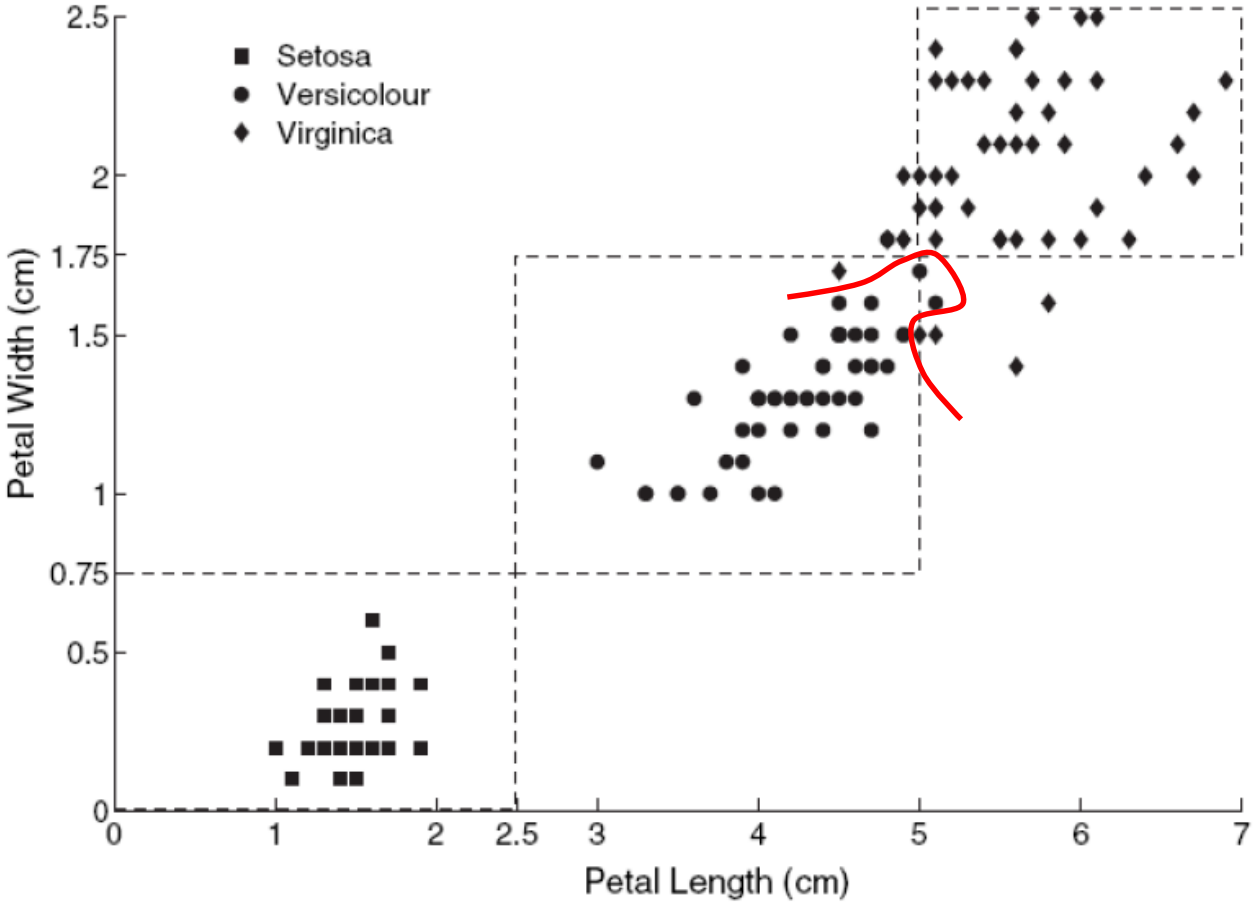
- These rules do not classify all the flowers correctly.
  - Flowers from the Setosa species are well separated from the other two species with respect to petal width and length.
  - However, the Versicolour and Virginica species overlap somewhat with respect to these two attributes.
- Solutions?

Classification



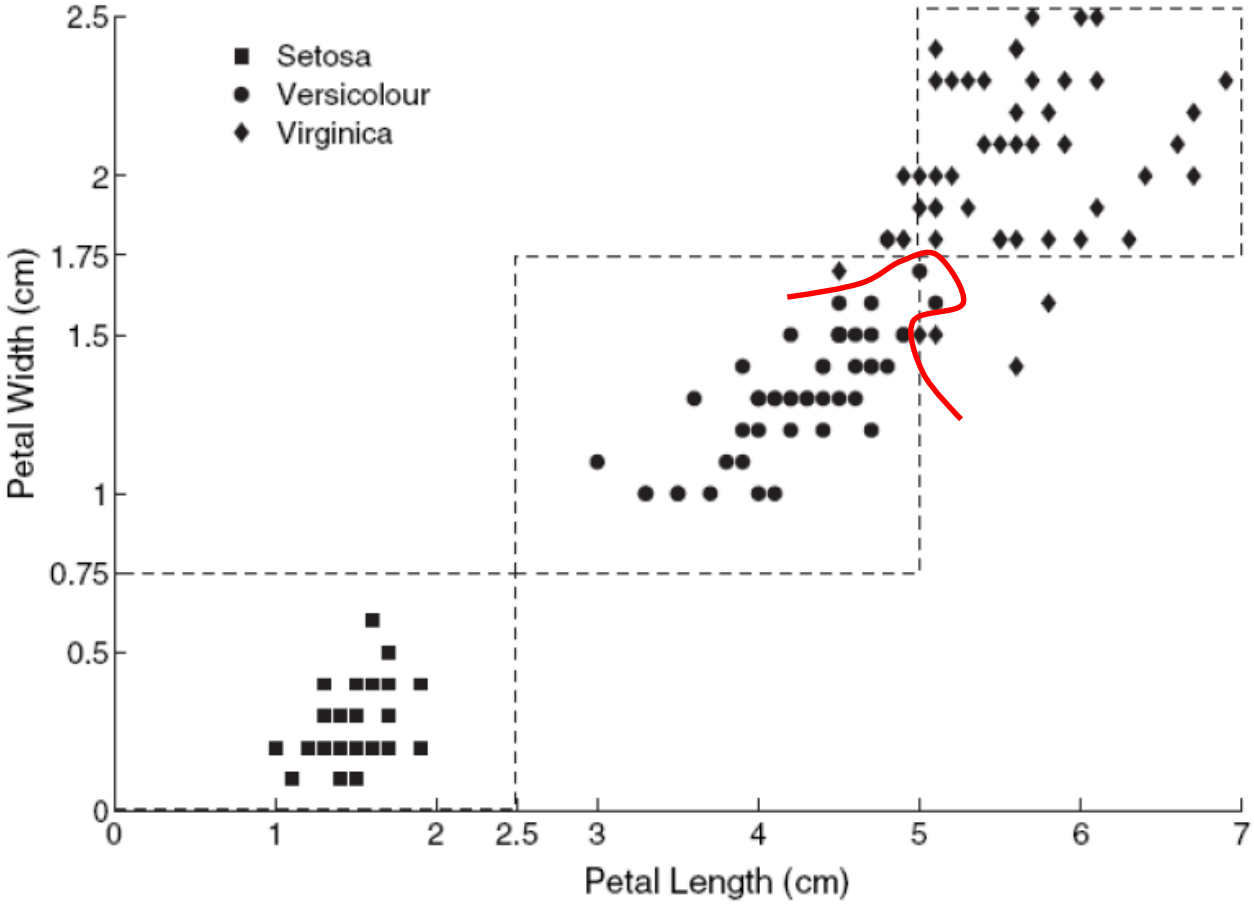
1. **Records surrounded by red line: misclassified**
2. **Records surrounded by blue line: unclassified**

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.*