Introduction to Machine Learning

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Objective

Objective

Define machine learning

Objective

Illustrate key elements of machine learning

What is Machine Learning?

- **Many different definitions for "machine learning"**
  - All involve *learning* by a machine (computer)
- **Definition of *learning* in a typical dictionary: "the acquisition of knowledge or skills through experience, study, or by being taught"**
  - Can machines be enabled to learn, without being explicitly programed?
- **Learning and adaption**

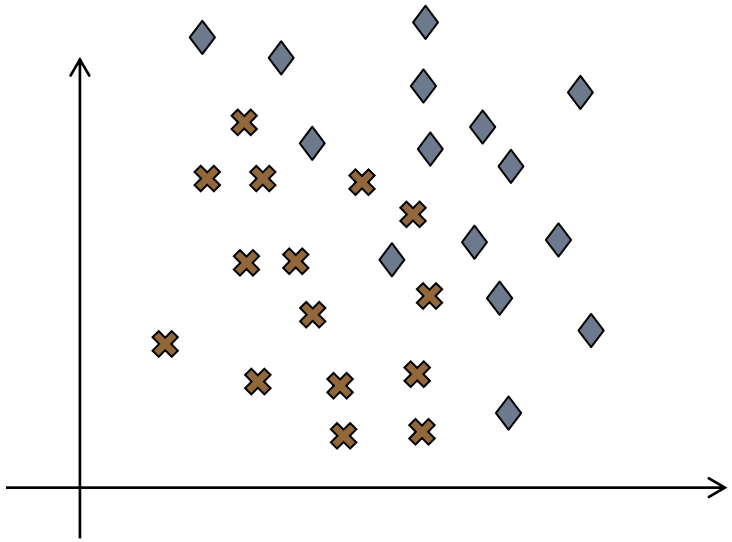
An Illustrative Example

Given some example pictures, how a computer can learn to differentiate dogs from cats?

Data Representation – Feature Extraction

Raw data: Images

Features



Different Types of Data Representation

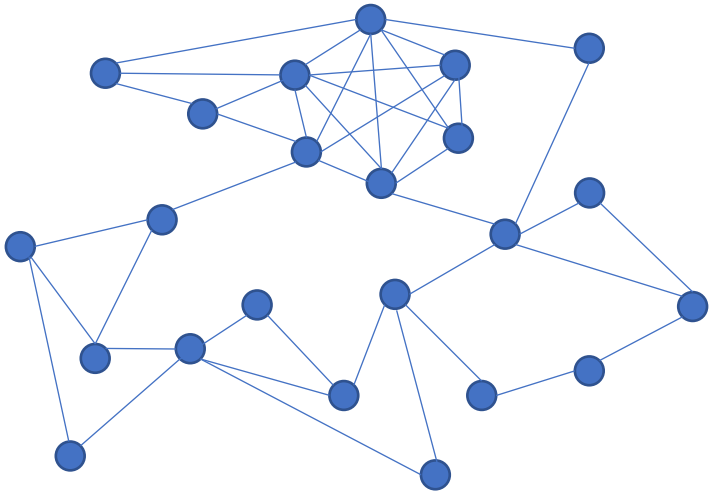
Numerical; Categorical; Ordinal

- Univariate or multivariate

  ➔ All could be represented by numbers.

Graphical representations in terms of nodes & edges

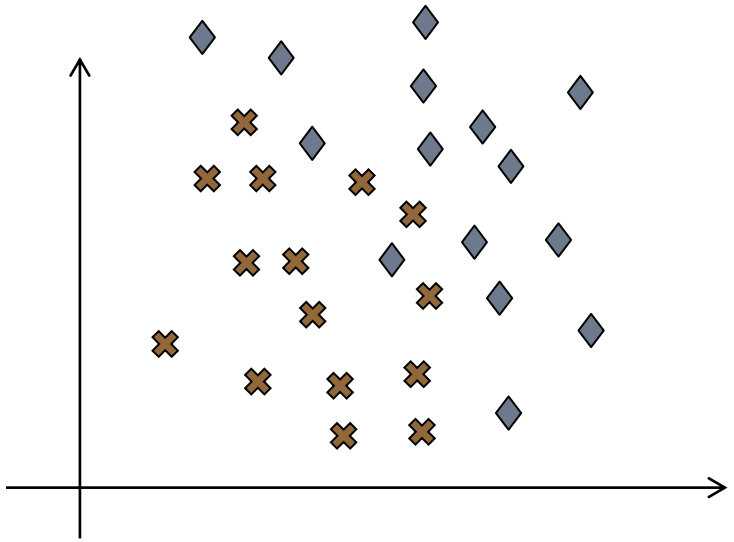
- E.g., Social network analysis



Preprocessing for Feature Extraction

- **Segmentation**
- **Filtering**
- **Various transformations**
  - ➔ All intended for facilitating feature extraction
- **Good features should be *invariant* in some sense.**

Mathematical Models for Classification



Importance of Statistical Modeling

- **Why we often reply on statistical methods in machine learning?**
- **Data is noisy (measurement noise) ➔ Features are often represented random variables/vectors.**
- **Inaccuracy of the assumed model**
- **Inherent ambiguity of many real-world problems**

Basic Machine Learning Paradigms

Supervised learning:

- the training samples have labels.

Unsupervised learning:

- the training set is not labeled.

Reinforcement learning:

- Learning to take actions to maximize some notion of *reward*.

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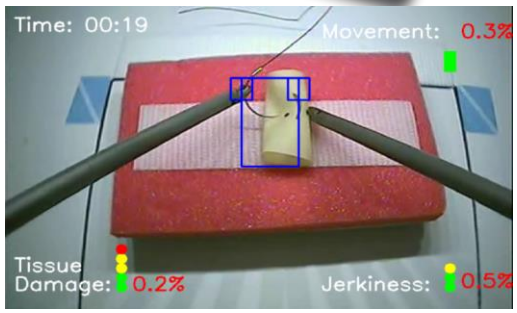
Illustrate specific machine learning examples

Objective

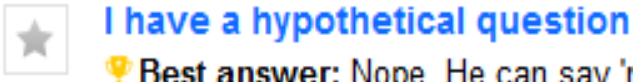
Describe broad machine learning applications

A Few Examples of Machine Learning (1/3)

Learning to assess skills in simulation-based laparoscopic surgery training

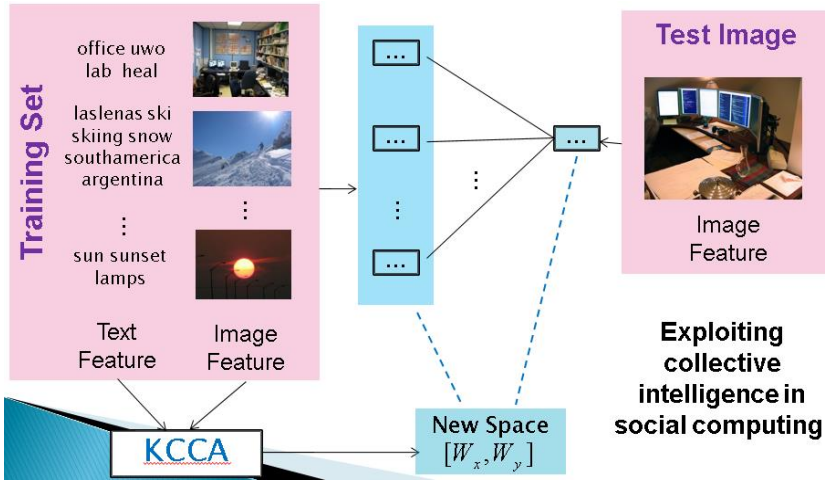


Learning to predict best answers in community Q & A



A Few Examples of Machine Learning (2/3)

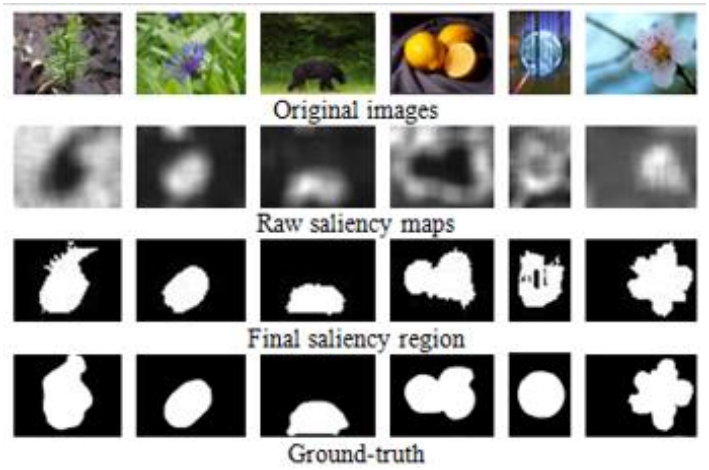
Tag prediction/recommendation



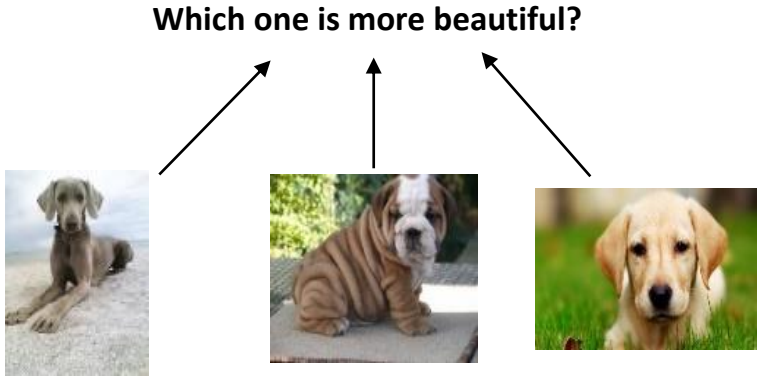
Diabetic retinopathy detection

A Few Examples of Machine Learning (3/3)

Visual saliency detection



Computational visual aesthetics



Broad Applications of Machine Learning

- Computer vision
- Speech recognition; natural language processing
- Medical informatics
- Robotics
- Computational biology
- Information technology
- Finance

Information Technology

- Spam detection
- Web image search
- Recommendation
- Information filtering
- Community detection
- Adaptive advertisement
- Sentiment analysis

Finance

- Credit risk assessment
- Fraud detection
- Stock market prediction
- Algorithmic trading
- Return forecasting