

Machine Learning

# Introduction

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Andrew Ng



# Machine Learning

- Grew out of work in AI
- New capability for computers

## Examples:

- Database mining

Large datasets from growth of automation/web.

E.g., Web click data, medical records, biology, engineering

- Applications can't program by hand.

E.g., Autonomous helicopter, handwriting recognition, most of Natural Language Processing (NLP), Computer Vision.

# Machine Learning

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- Examples

- Examples



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- Self-customizing programs

E.g., Amazon, Netflix product recommendations

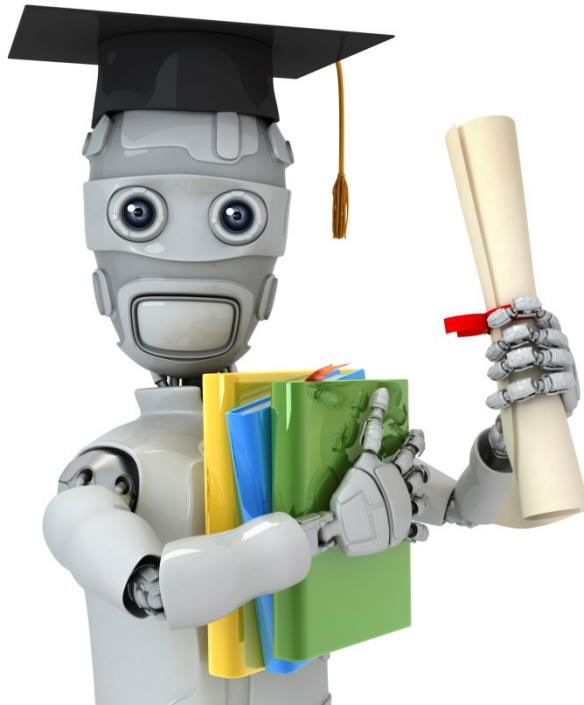
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  - E.g., Autonomous helicopter, handwriting recognition, most of Natural Language Processing (NLP), Computer Vision.
- Self-customizing programs
  - E.g., Amazon, Netflix product recommendations
- Understanding human learning (brain, real AI).





Machine Learning

# Introduction

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# What is machine learning

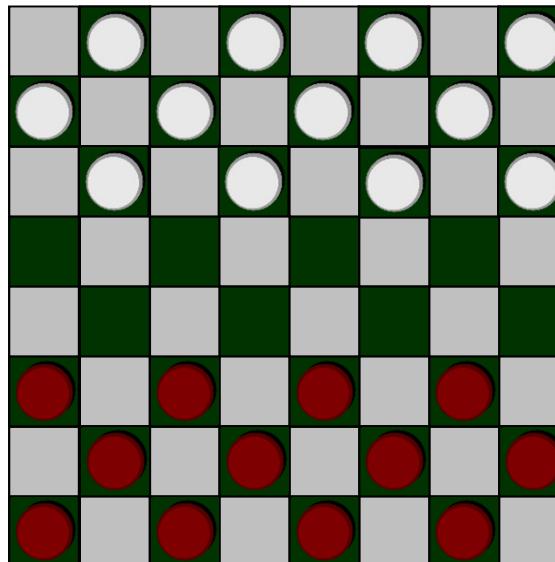
# Machine Learning definition

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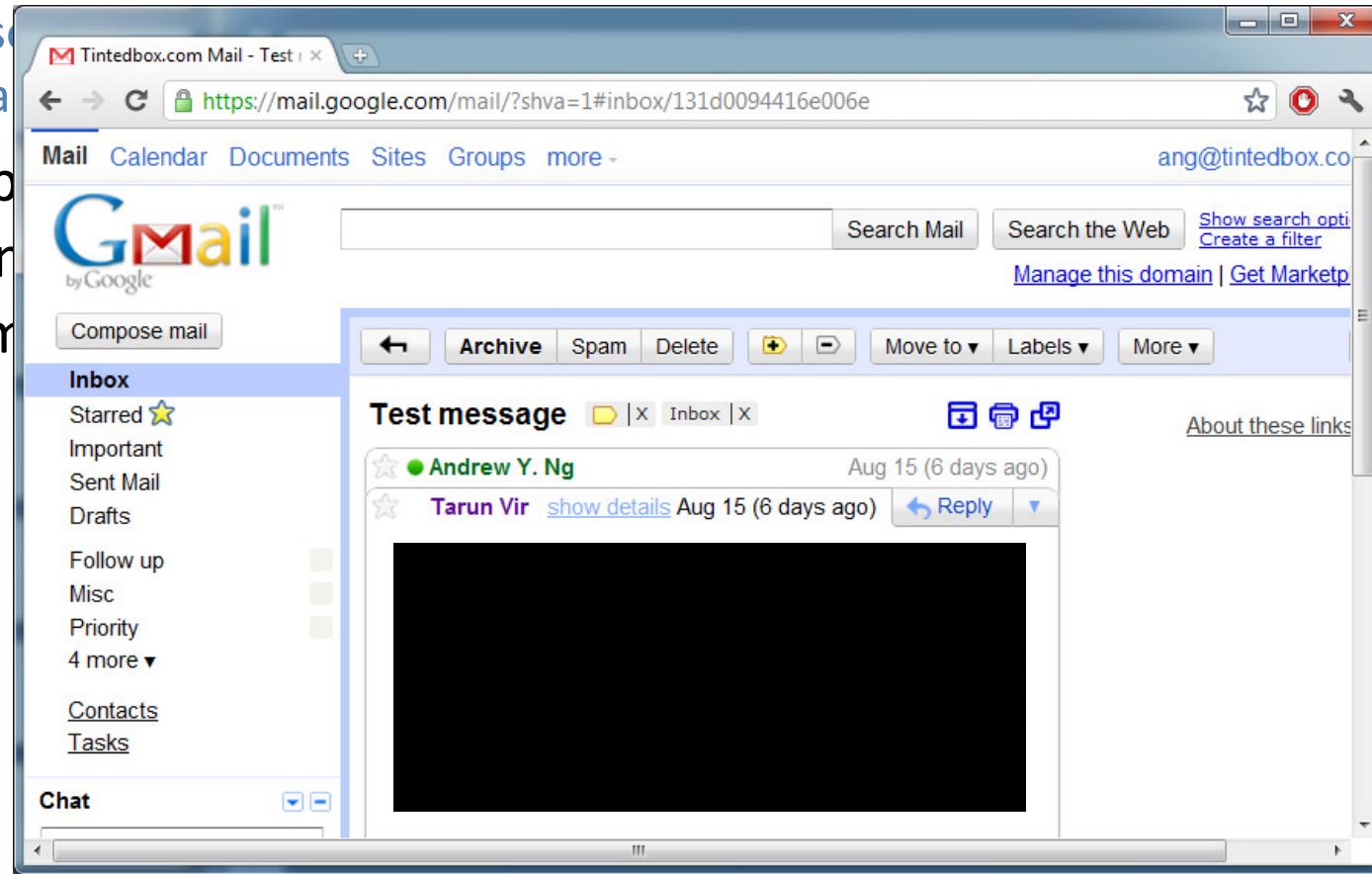
- Arthur Samuel (1959). Machine Learning: Field of study that gives computers the ability to learn without being explicitly programmed.
- Tom Mitchell (1998) Well-posed Learning Problem: A computer program is said to *learn* from experience E with respect to some task T and some performance measure P, if its performance on T, as measured by P, improves with experience E.

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Suppose your email program watches which emails you do or do not mark as spam, and based on that learns how to better filter spam. What is the task T in this setting?

- Classifying emails as spam or not spam. *T ↙*
- Watching you label emails as spam or not spam. *E ↙*
- The number (or fraction) of emails correctly classified as spam/not spam. *P ↙*
- None of the above—this is not a machine learning problem.

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# Machine learning algorithms:

- Supervised learning
- Unsupervised learning

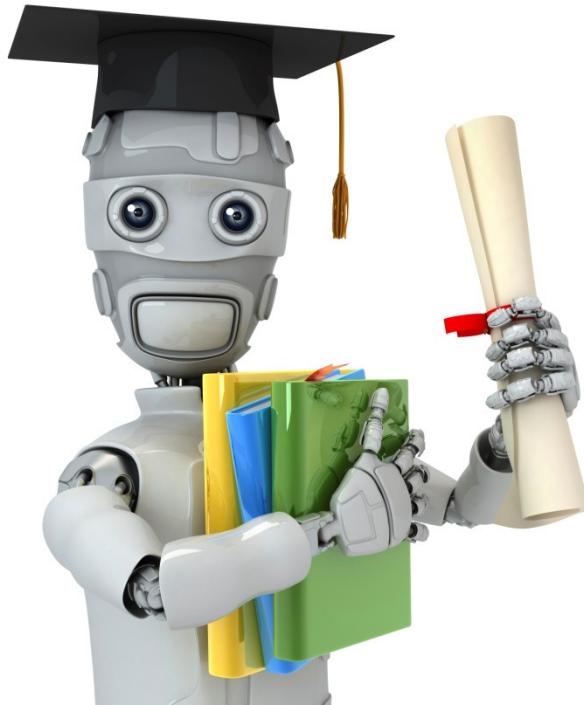


Others: Reinforcement learning, recommender systems.

Also talk about: Practical advice for applying learning algorithms.





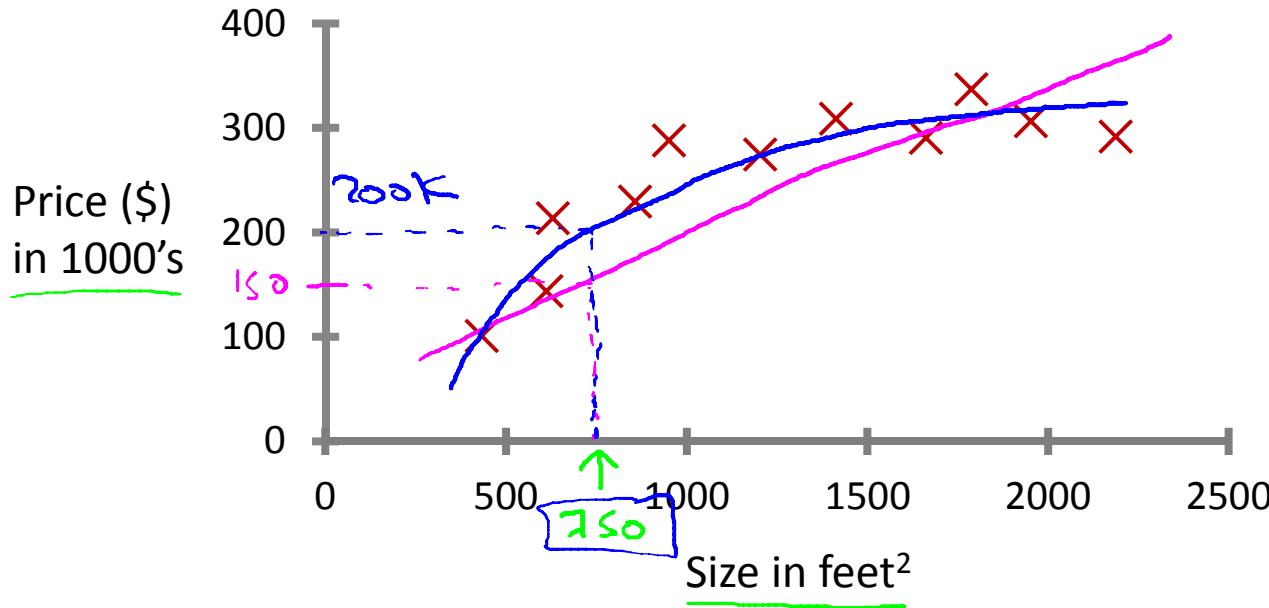


Machine Learning

# Introduction Supervised Learning

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# Housing price prediction.

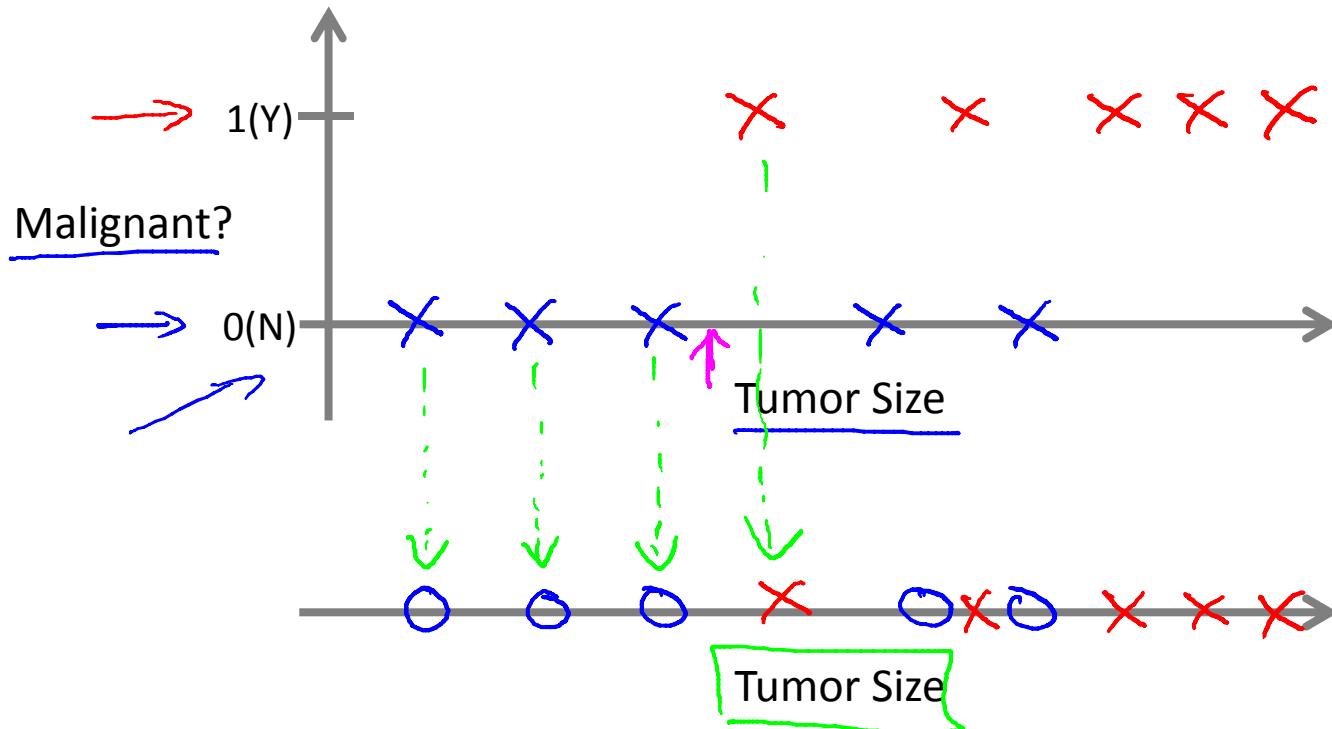


Supervised Learning

'right answers' given

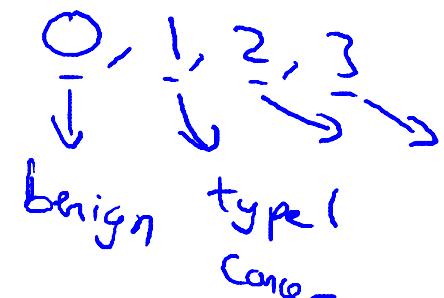
Regression: Predict continuous valued output (price)

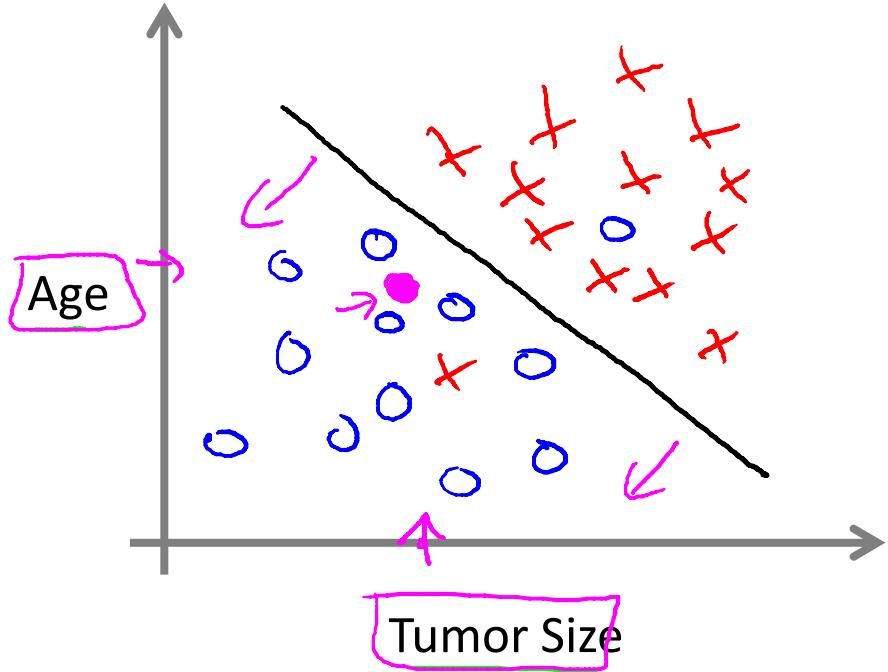
# Breast cancer (malignant, benign)



## Classification

Discrete valued output (0 or 1)





- Clump Thickness
- Uniformity of Cell Size
- Uniformity of Cell Shape
- ...

You're running a company, and you want to develop learning algorithms to address each of two problems.

1000's

→ Problem 1: You have a large inventory of identical items. You want to predict how many of these items will sell over the next 3 months.

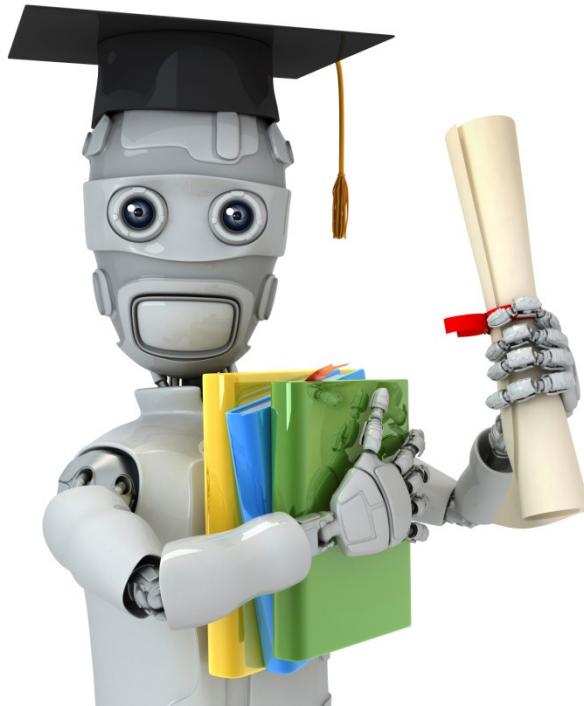
→ Problem 2: You'd like software to examine individual customer accounts, and for each account decide if it has been hacked/compromised.

→ 0 - not hacked  
→ 1 - hacked

Should you treat these as classification or as regression problems?

- Treat both as classification problems.
- Treat problem 1 as a classification problem, problem 2 as a regression problem.
- Treat problem 1 as a regression problem, problem 2 as a classification problem.
- Treat both as regression problems.





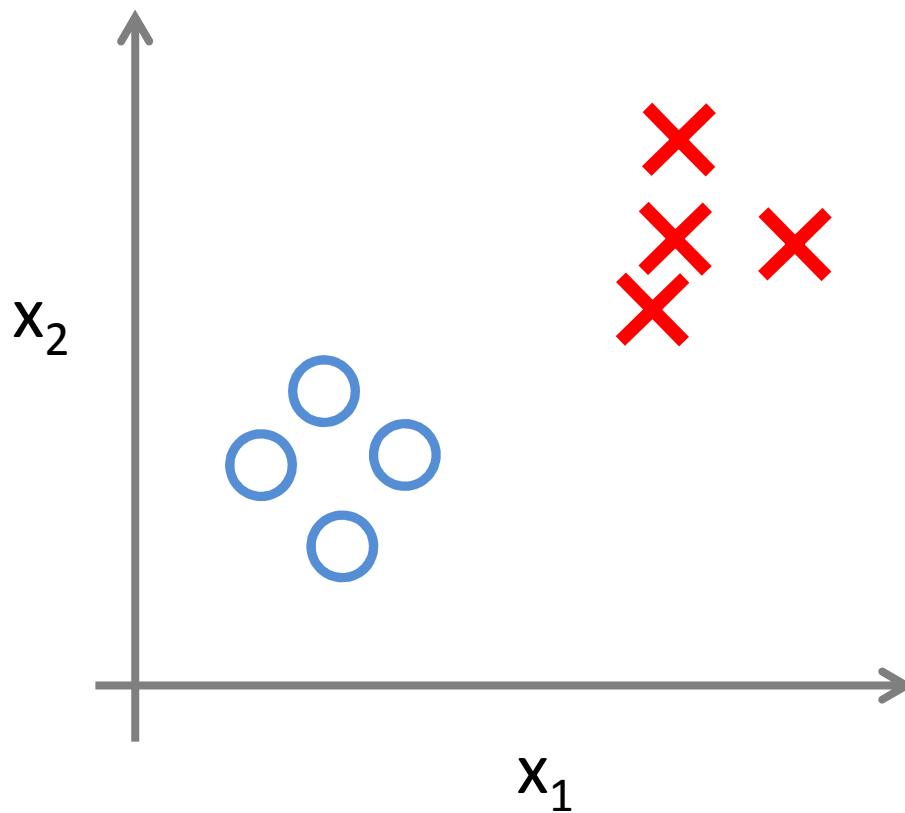
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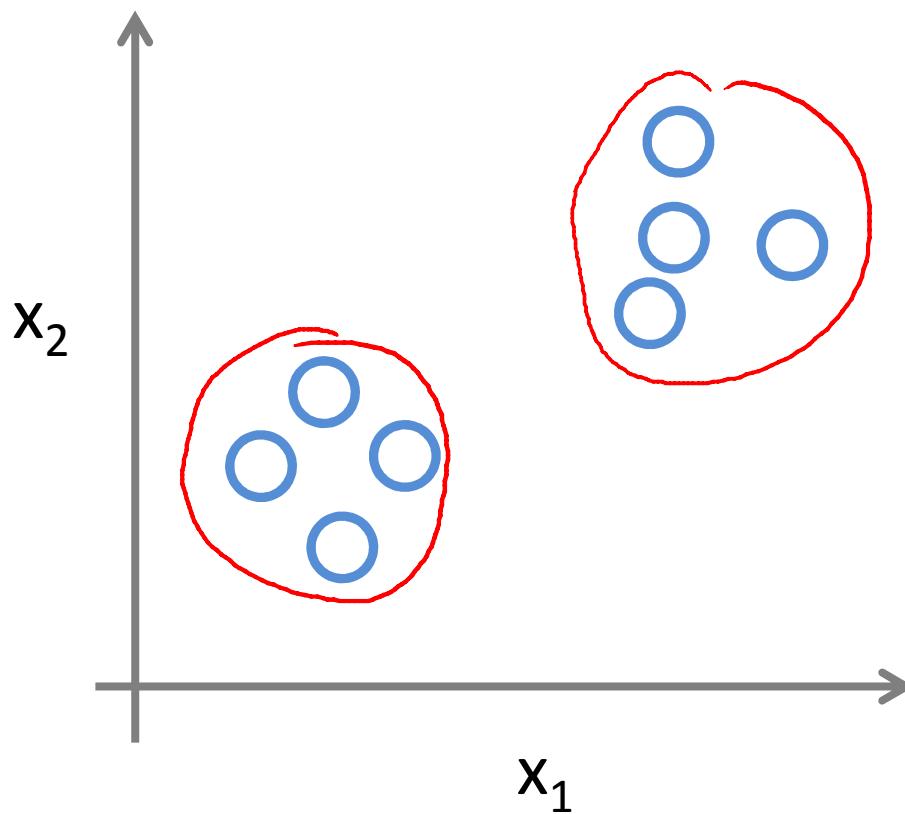
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# Unsupervised Learning

# Supervised Learning



# Unsupervised Learning



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A screenshot of a CNN news article. The URL in the browser bar is edition.cnn.com/2010/09/20/gulf.oil.disaster/. The page header includes "EDITION: INTERNATIONAL" and links for "U.S.", "MÉXICO", and "ARABIC". Below the header are navigation links for Home, Video, World, U.S., Africa, Asia, Europe, Latin America, Middle East, Business, and Weather. A large red arrow points from the left margin down to the headline of the story. The main headline reads "Allen: Well is dead, but much Gulf Coast work remains". Sub-headlines include "By the CNN Wire Staff" and the date "September 20, 2010 — Updated 1317 GMT (2117 HKT)". Below the headline is a large video thumbnail showing an offshore oil rig at sea, with a "Click to play" button overlaid. At the bottom of the page, there is a "STORY HIGHLIGHTS" section and a quote from CNN stating: "(CNN) -- The ruptured Macondo well, a mile under the Gulf of Mexico, has been sealed off by BP and its partners, but the cleanup operation is far from over." The overall background of the page is white.

BP Kills Macondo, But Its Legacy Lives On

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# BP oil spill cost hits nearly \$10bn

BP has set up a \$20bn compensation fund after the Deepwater Horizon disaster, which has so far paid out 19,000 claims totalling more than \$240m

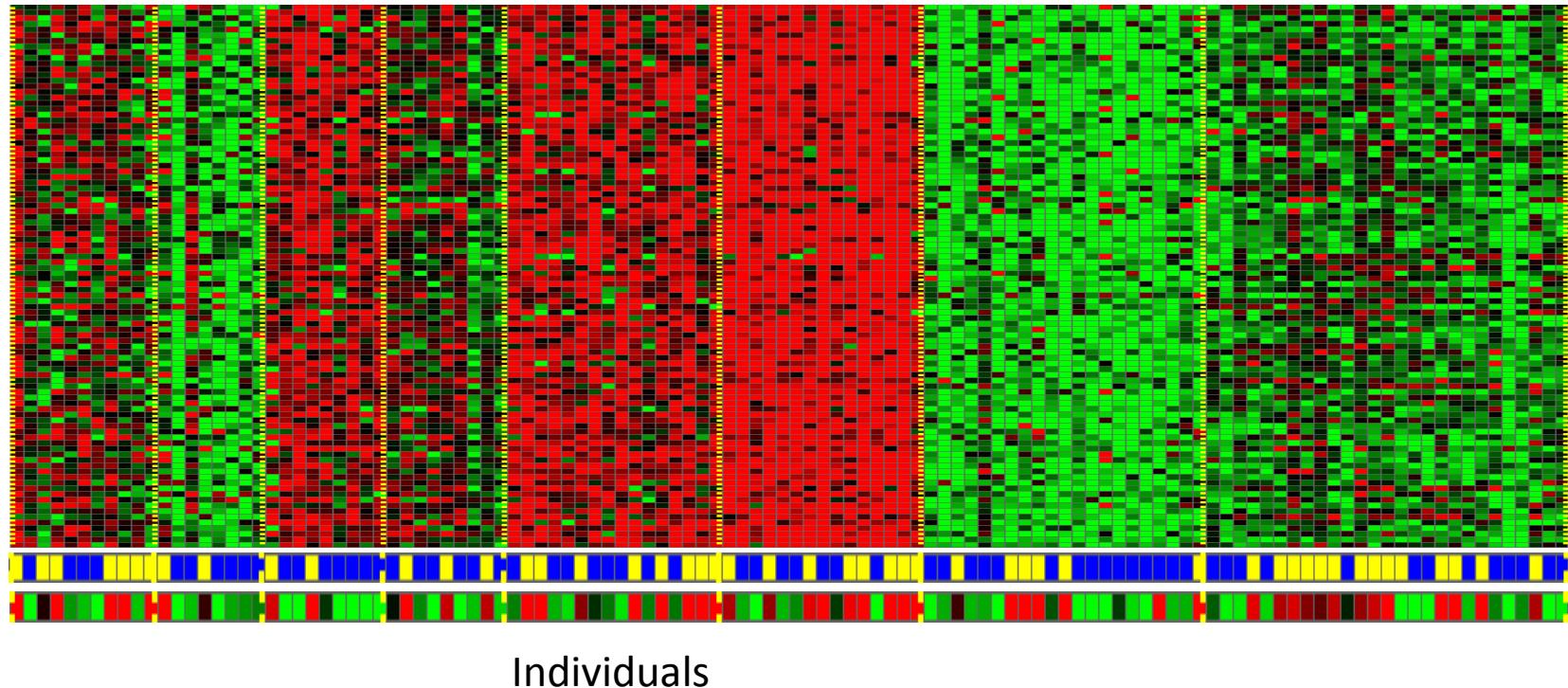
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**Julia Kollewe**  
guardian.co.uk, Monday 20 September 2010 08.33 BST  
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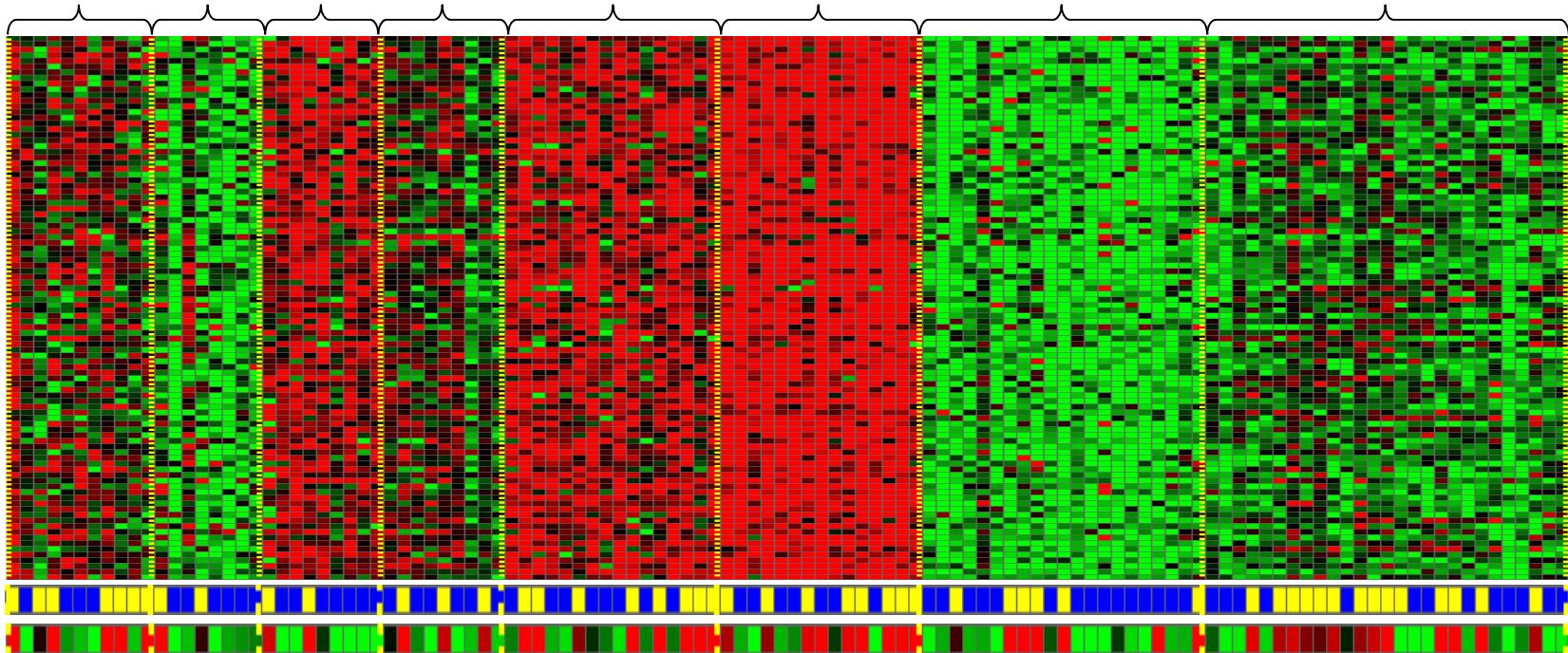
BP's costs for the Deepwater Horizon disaster have hit \$10bn. Photograph: Ho/Reuters



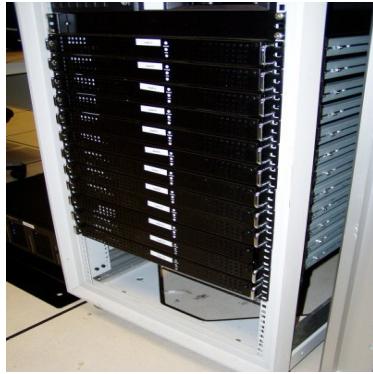
[Source: Daphne Koller]

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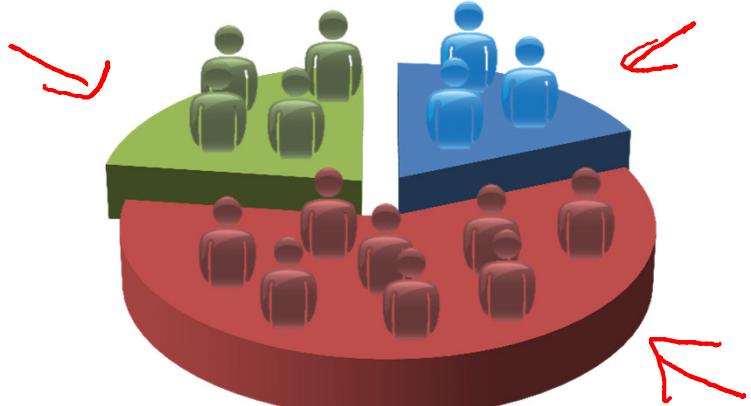
Genes



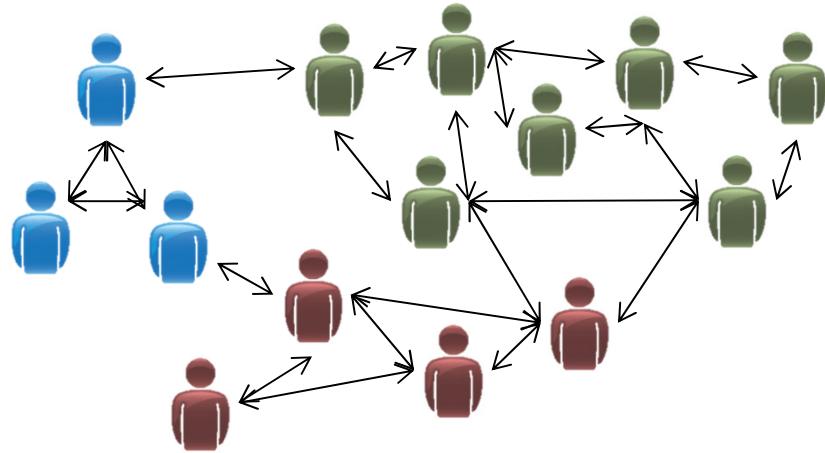
Individuals



Organize computing clusters



Market segmentation



Social network analysis

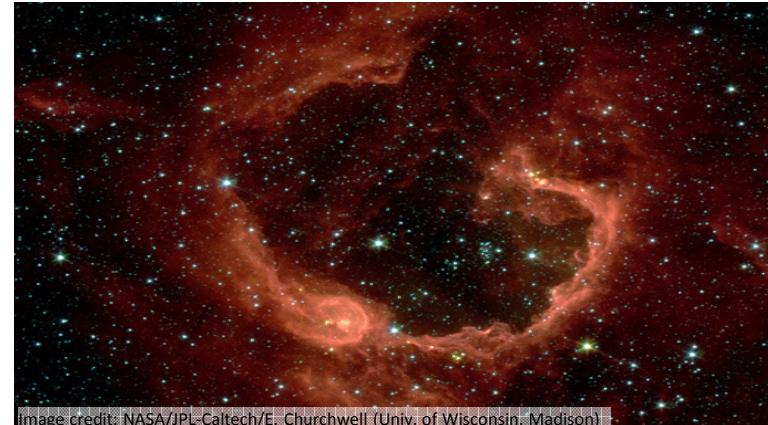
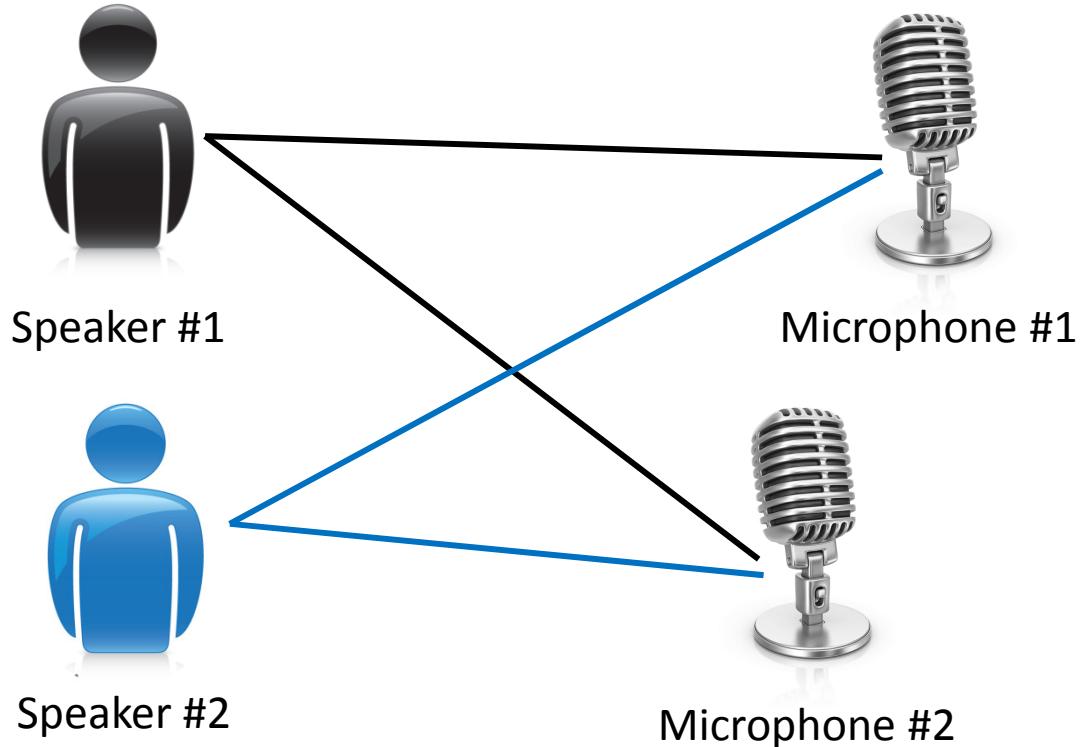


Image credit: NASA/JPL-Caltech/E. Churchwell (Univ. of Wisconsin, Madison)

Astronomical data analysis

Andrew Ng

# Cocktail party problem



Microphone #1: 

Output #1: 

Microphone #2: 

Output #2: 

---

Microphone #1: 

Output #1: 

Microphone #2: 

Output #2: 

# Cocktail party problem algorithm

```
[W,s,v] = svd((repmat(sum(x.*x,1),size(x,1),1).*x)*x');
```

Of the following examples, which would you address using an unsupervised learning algorithm? (Check all that apply.)

- Given email labeled as spam/not spam, learn a spam filter.  
spam/not spam
- Given a set of news articles found on the web, group them into set of articles about the same story.
- Given a database of customer data, automatically discover market segments and group customers into different market segments.
- Given a dataset of patients diagnosed as either having diabetes or not, learn to classify new patients as having diabetes or not.

