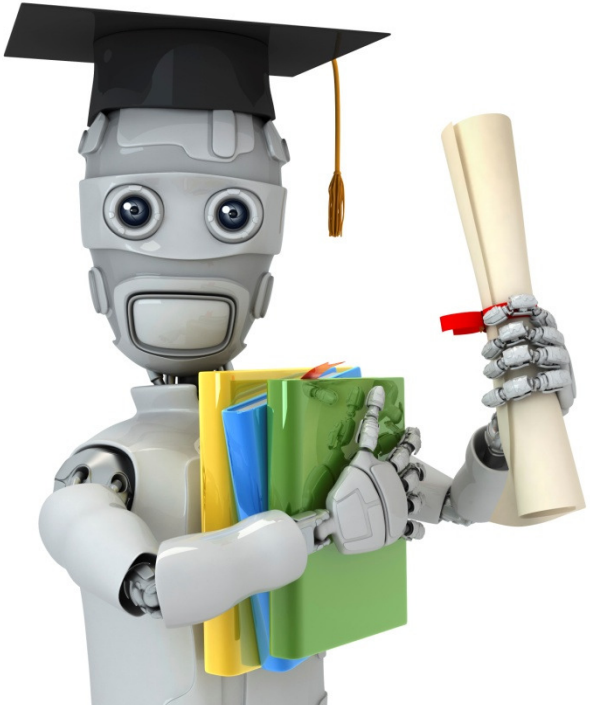

Machine Learning

Introduction

Welcome

What is machine learning? You probably use it dozens of times a day without even knowing it. Each time you do a web search on Google or Bing, that works so well because their machine learning software has figured out how to rank what pages. When Facebook or Apple's photo application recognizes your friends in your pictures, that's also machine learning. Each time you read your email and a spam filter saves you from having to wade through tons of spam, again, that's because your computer has learned to distinguish spam from non-spam email. So, that's machine learning. There's a science of getting computers to learn without being explicitly programmed.

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iPod
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iPhoto
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Upgrade Now
iPhoto '11
From your Facebook Wall to your coffee table to your best friend's inbox (or mailbox). Do more with your photos than you ever thought possible. And do it all in one place. iPhoto.
Watch the iPhoto video
MacBook Pro
What's New in iPhoto
What is iPhoto?

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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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- Self-customizing programs

  E.g., Amazon, Netflix product recommendations

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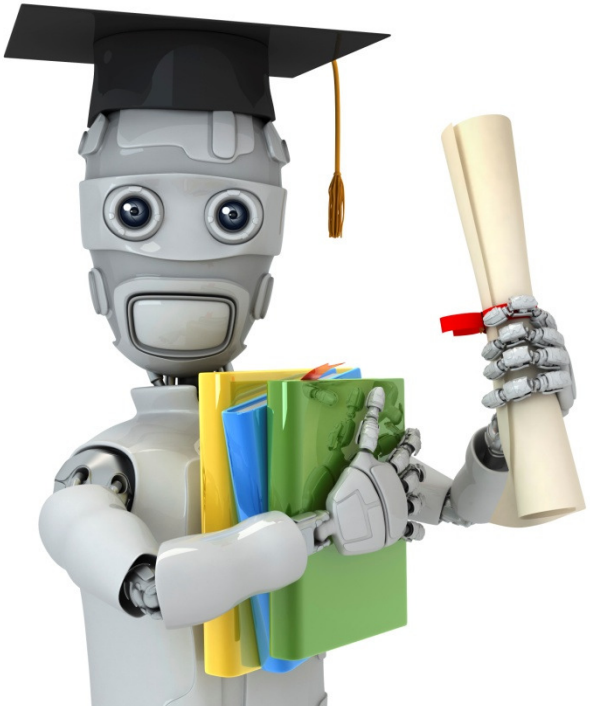
- Self-customizing programs

  E.g., Amazon, Netflix product recommendations

- Understanding human learning (brain, real AI).



Machine Learning

Introduction

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.

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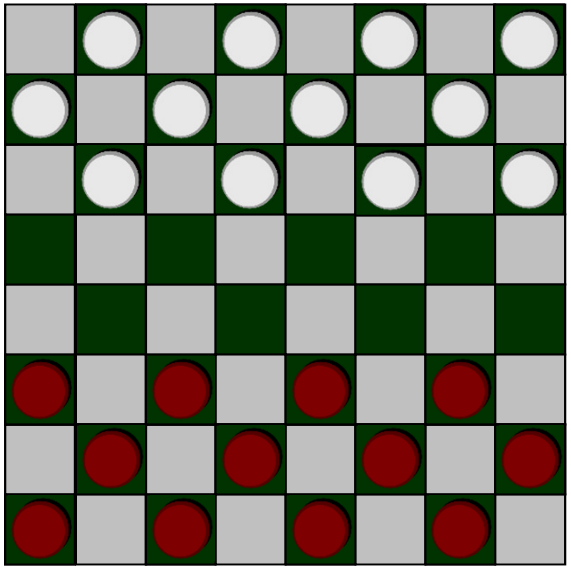


Machine Learning definition

- 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.

"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."

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

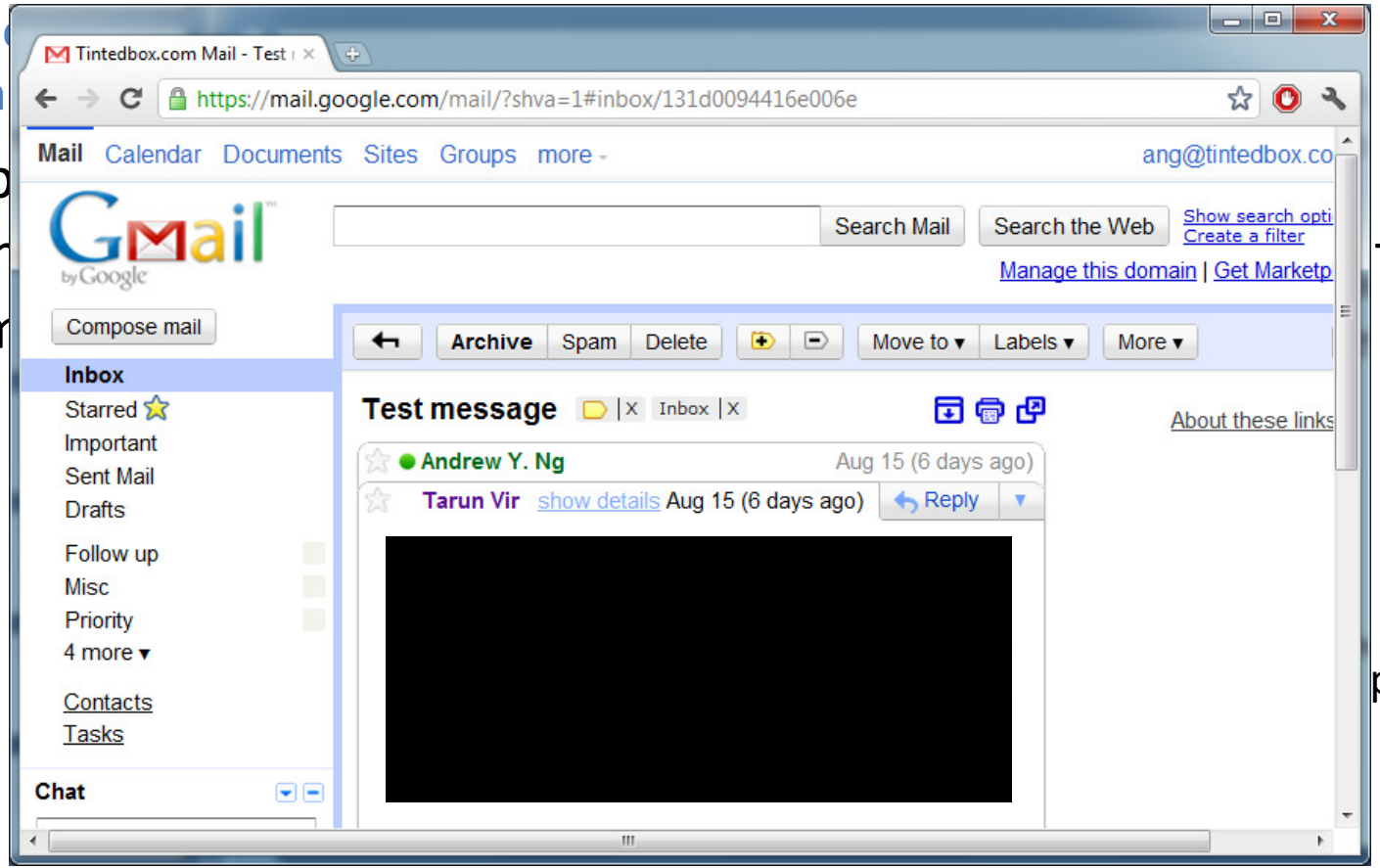
T ←

E ←

P ←

"A computer program is said to *learn* from experience E with respect to s on T, a

Supp or do not r filter spam



pam.

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E ←

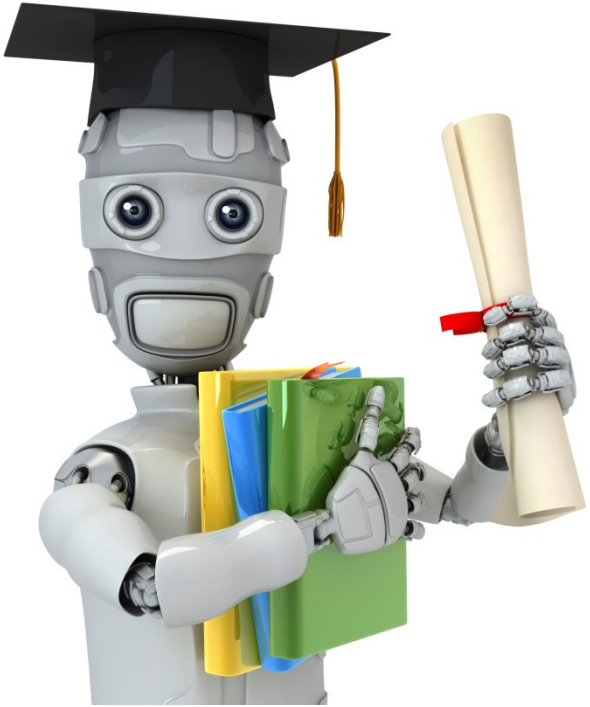
P ←

Machine learning algorithms:

- Supervised learning
- Unsupervised learning

Others: Reinforcement learning, recommender systems.

Also talk about: Practical advice for applying learning algorithms.

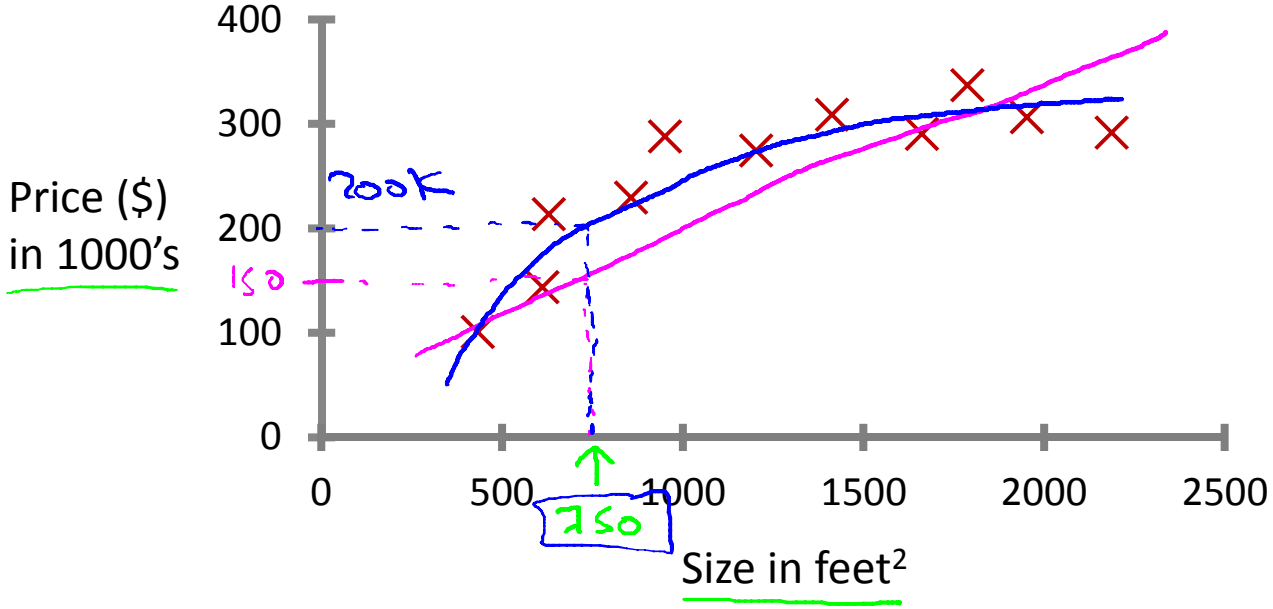


Machine Learning

Introduction

Supervised Learning

Housing price prediction.

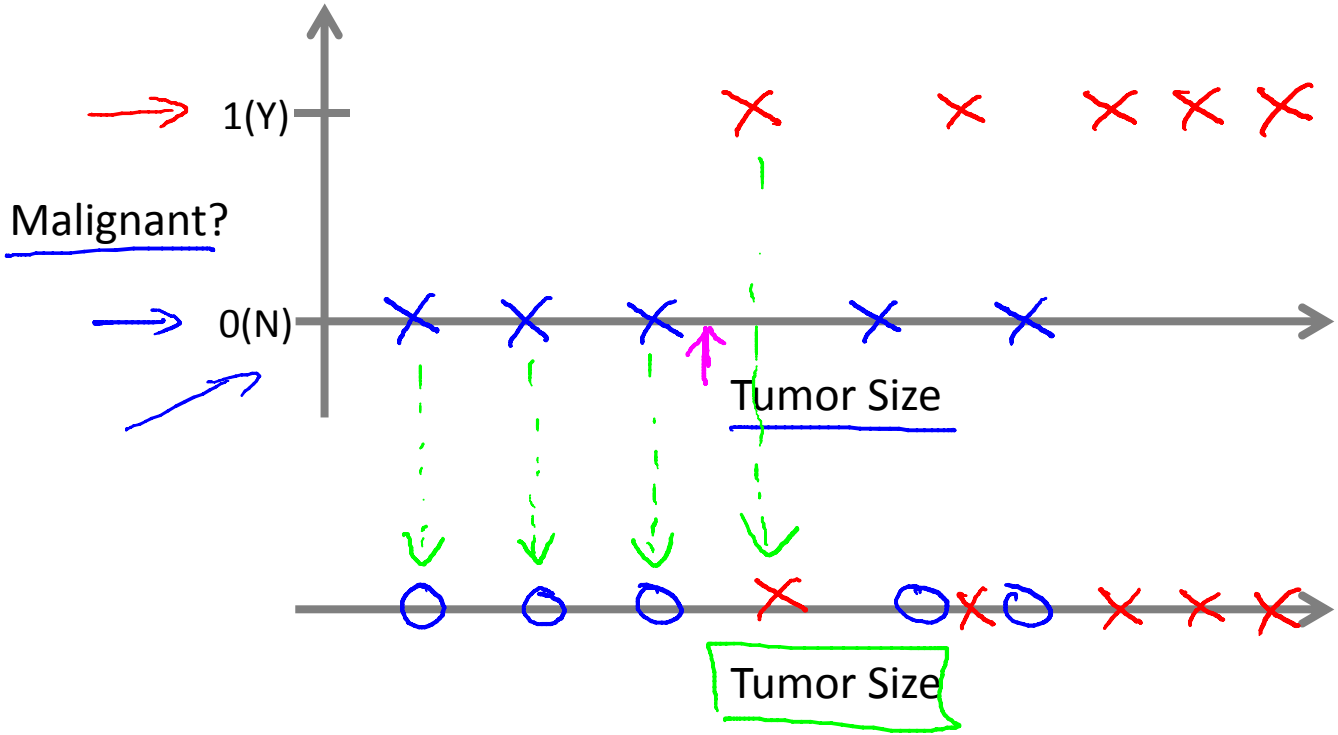


Supervised Learning

"right answers" given

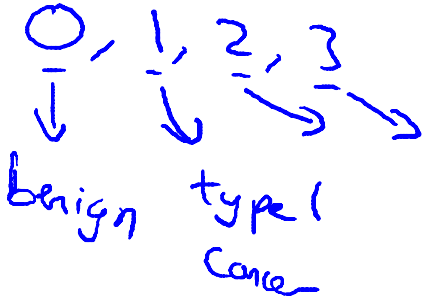
Regression: Predict continuous valued output (price)

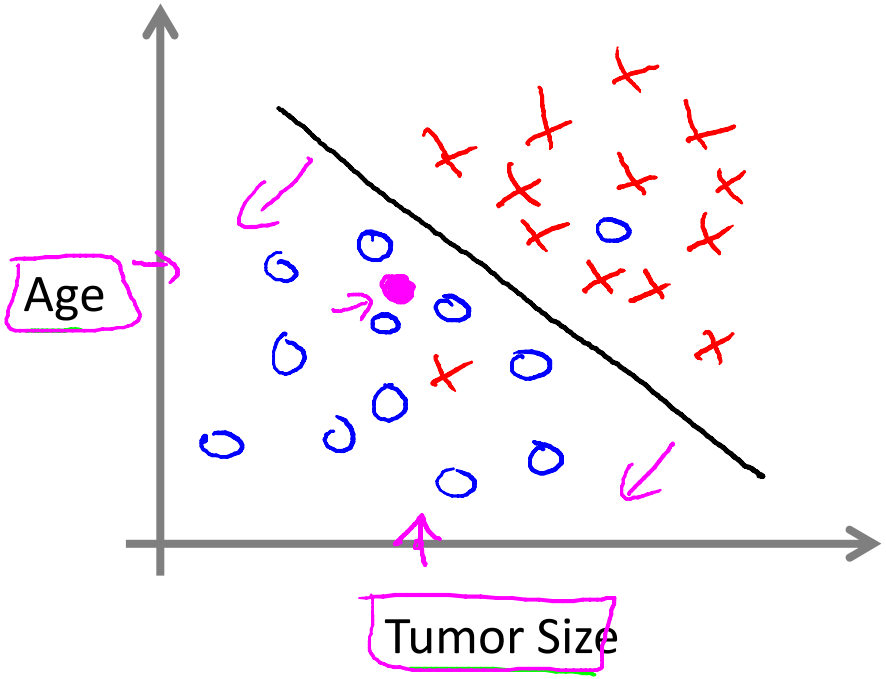
Breast cancer (malignant, benign)



Classification

Discrete valued output (0 or 1)





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

...

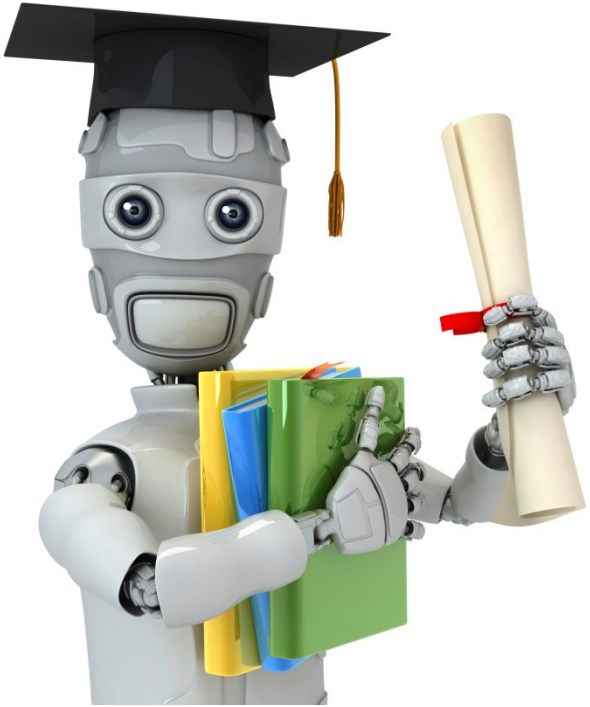
You're running a company, and you want to develop learning algorithms to address each of two problems.

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.

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.

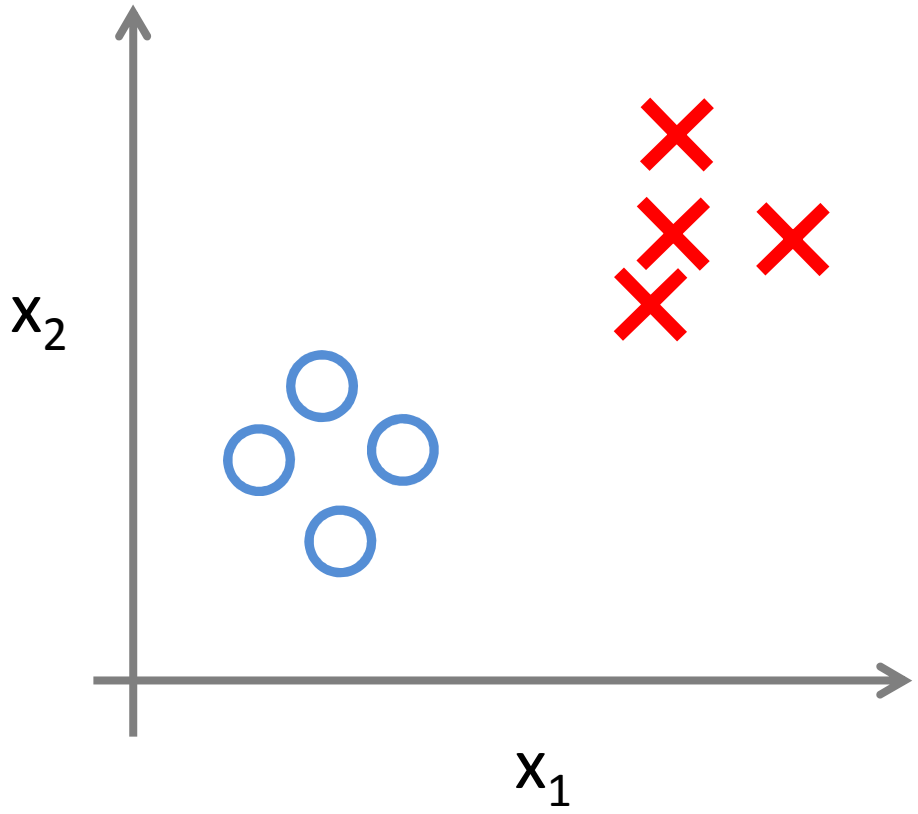


Machine Learning

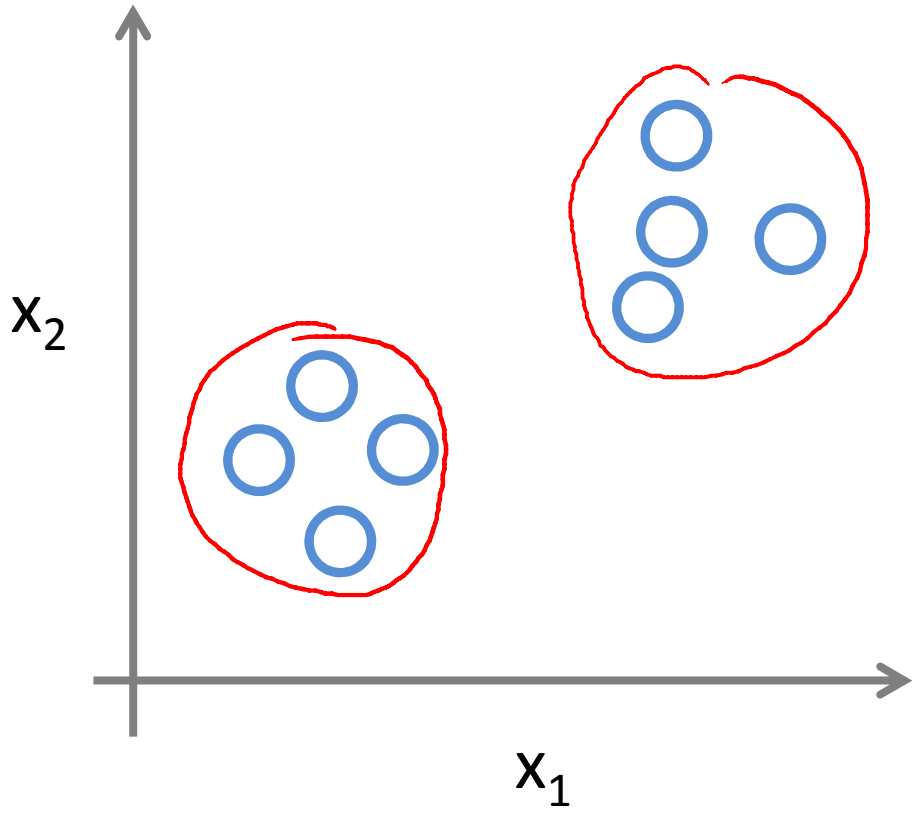
Introduction

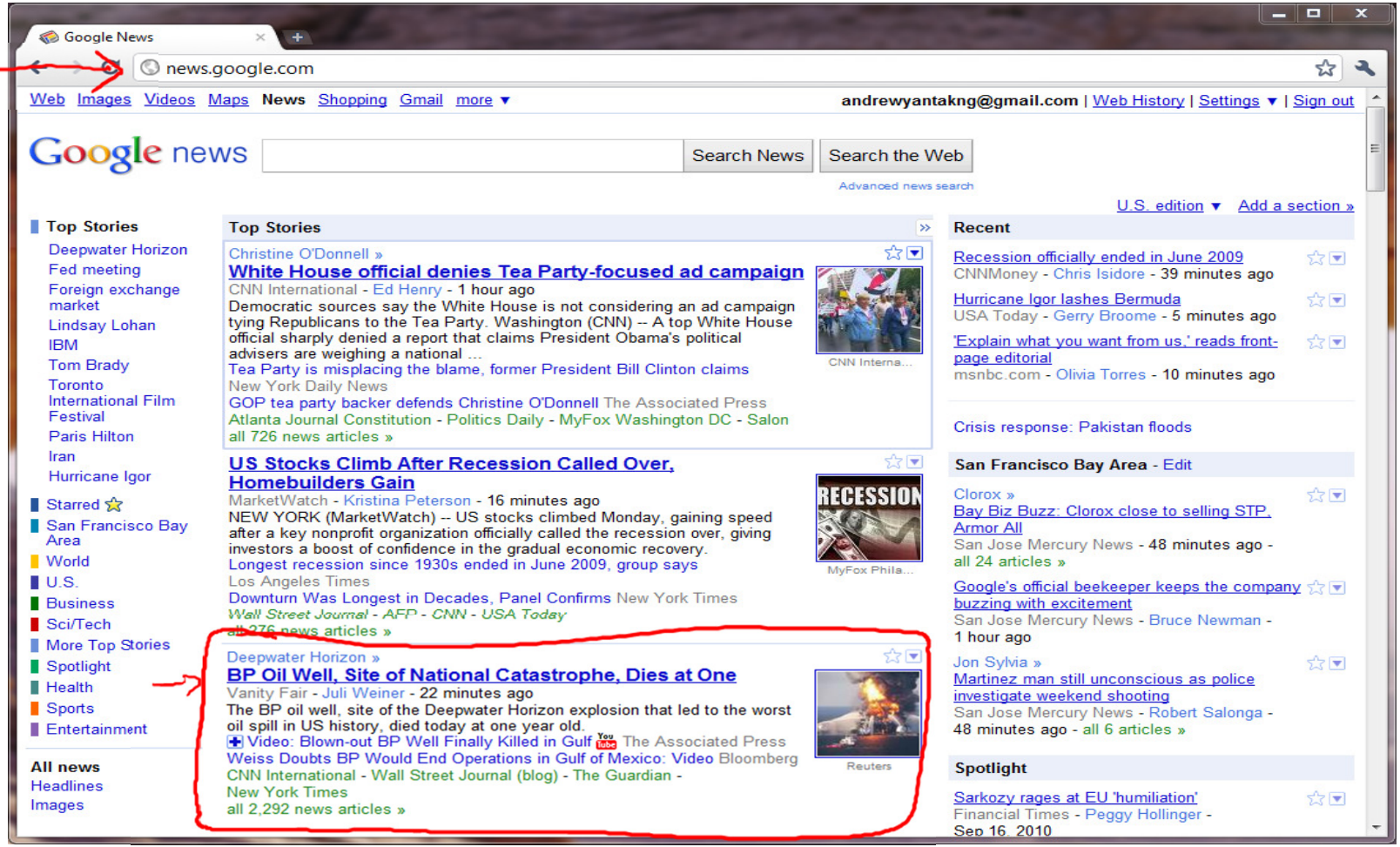
Unsupervised Learning

Supervised Learning



Unsupervised Learning

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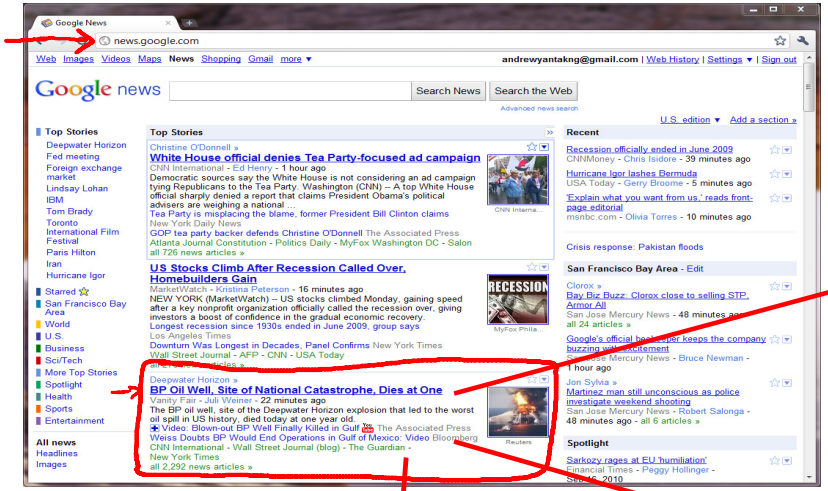
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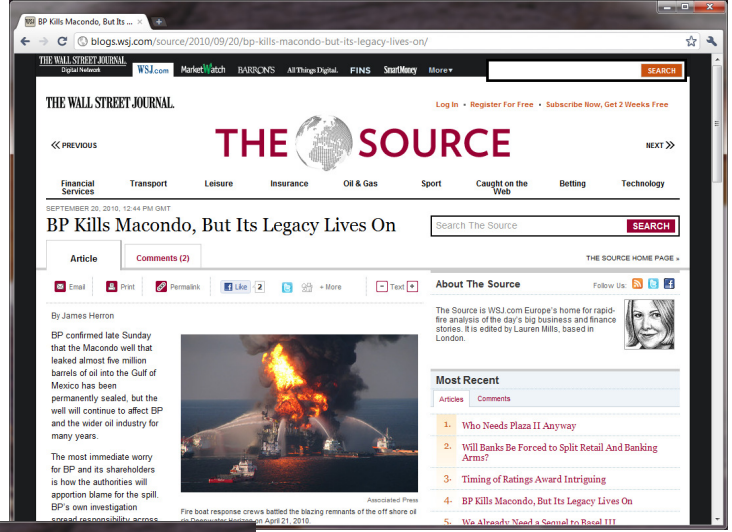
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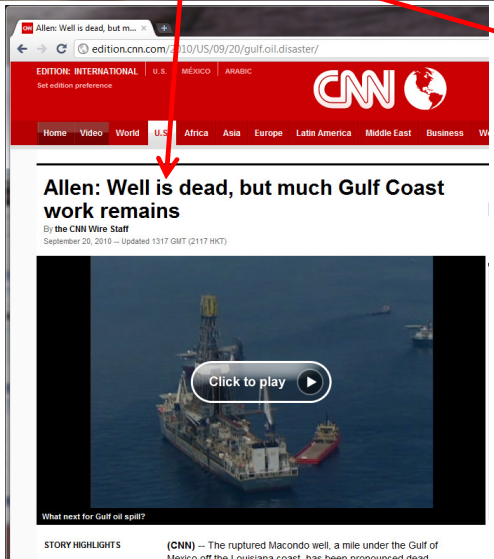
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By the CNN Wire Staff
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Business : BP
BP oil spill cost hits nearly $10bn
BP has set up a $20bn compensation fund after the Deepwater Horizon disaster, which has so far paid out 19,000 claims totalling more than $240m
Julia Kollewe
guardian.co.uk, Monday 20 September 2010 08.33 BST
Article history
BP's costs for the Deepwater Horizon disaster have hit $10bn. Photograph: Hoi/Reuters

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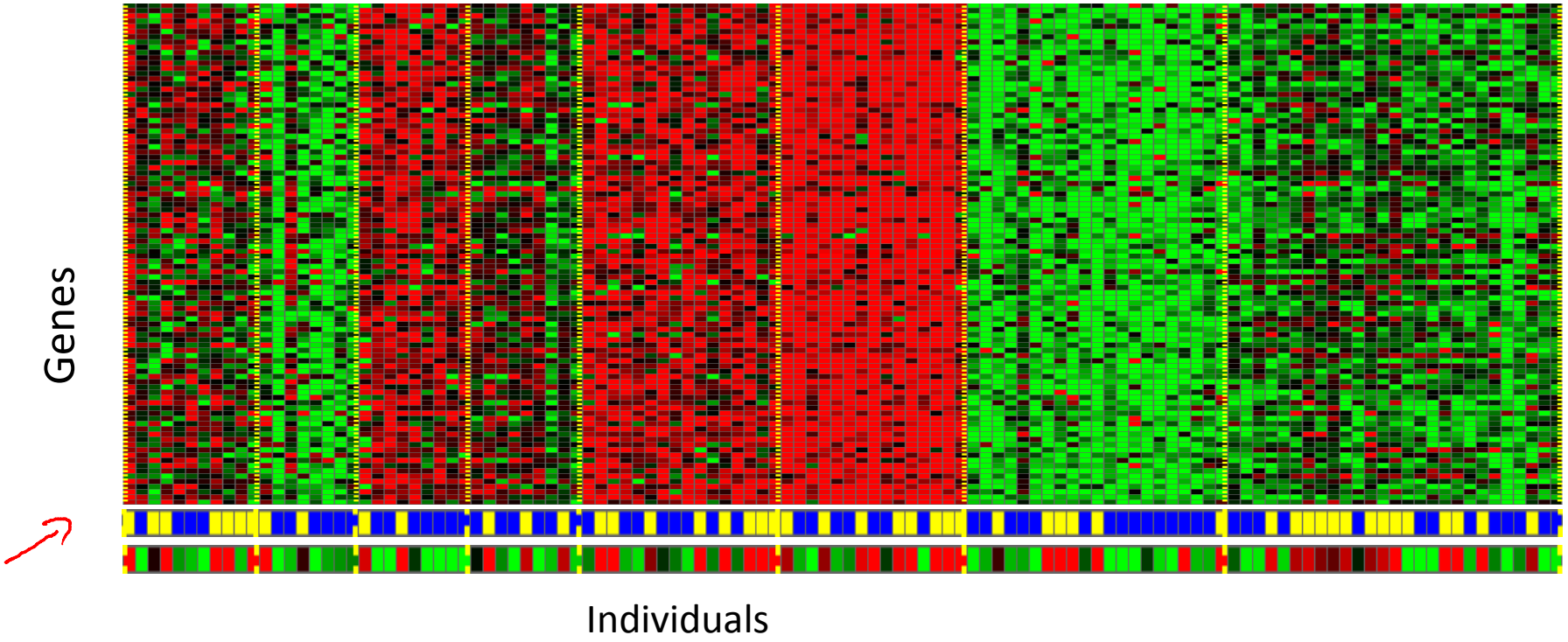
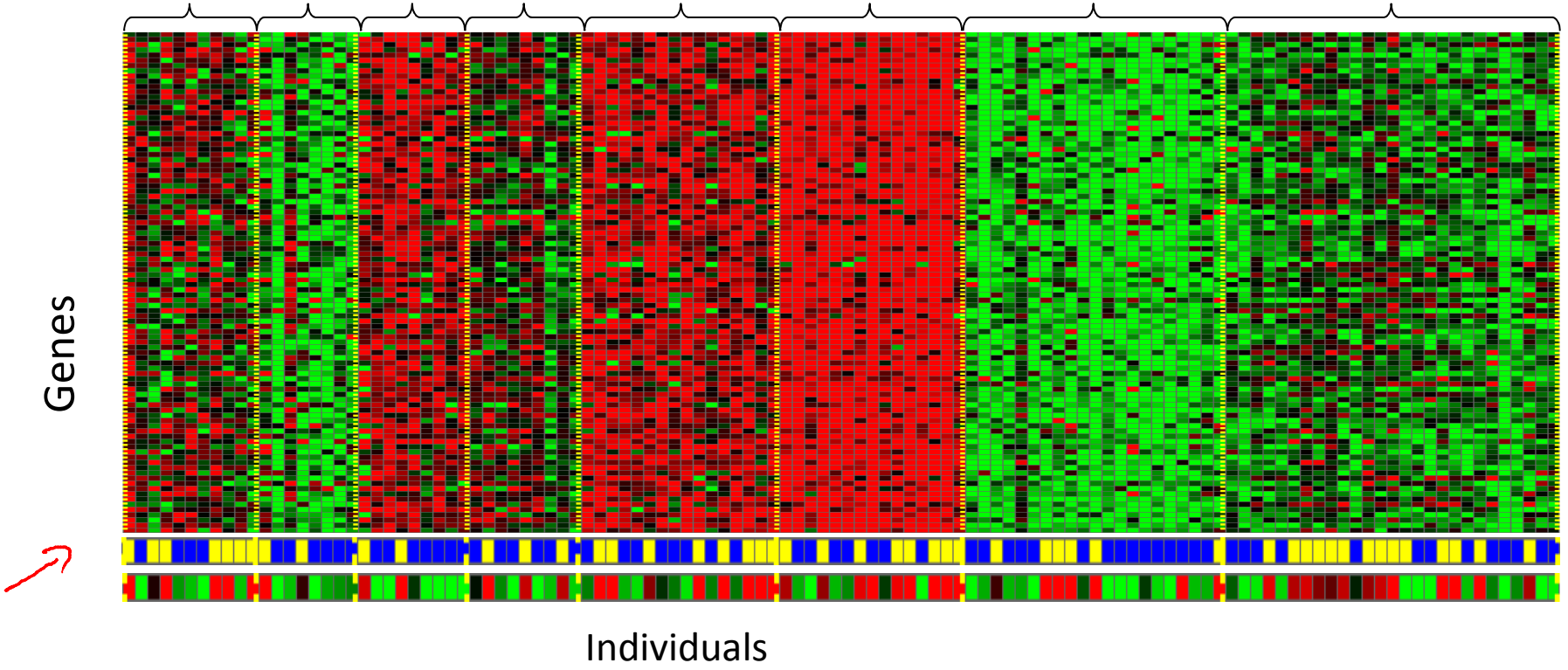


[Source: Daphne Koller]



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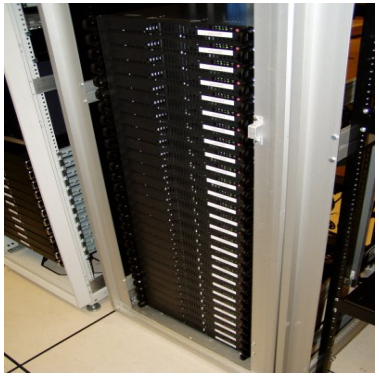
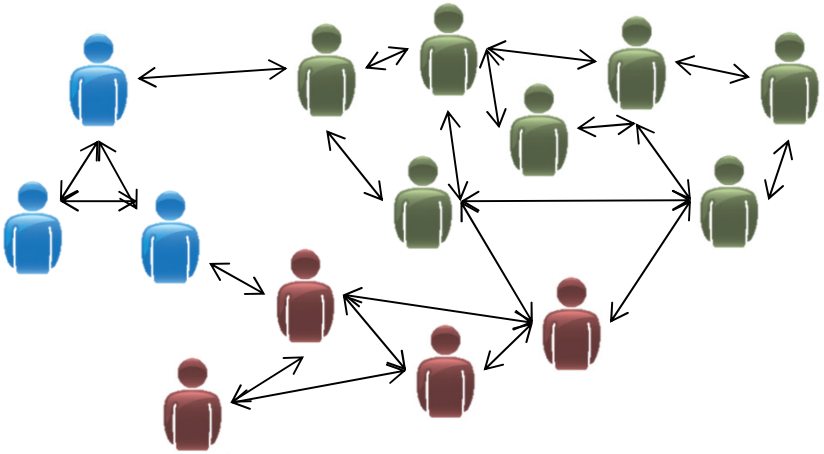
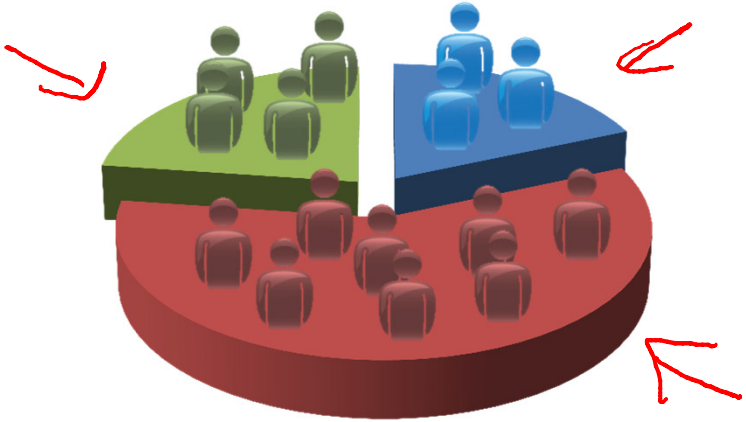


Organize computing clusters



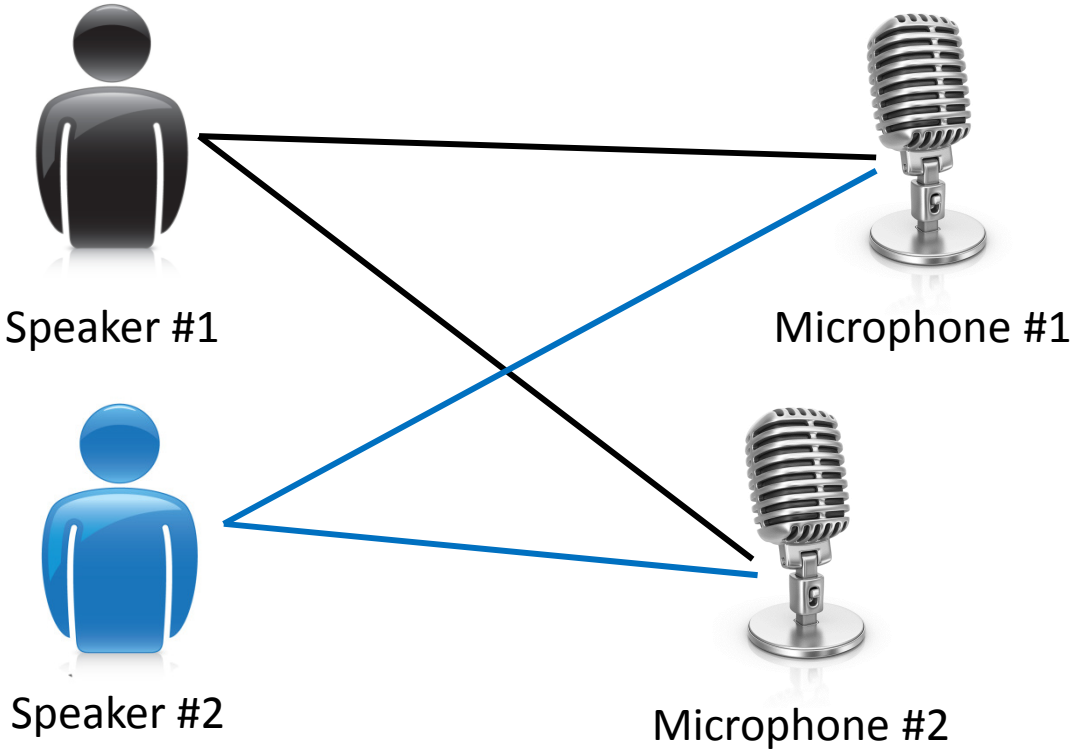
Social network analysis



Market segmentation

Astronomical data analysis

Cocktail party problem



Microphone #1:

Output #1:

Microphone #2:

Output #2:

Microphone #1:

Output #1:

Microphone #2:

Output #2:

[Audio clips courtesy of Te-Won Lee.]

Cocktail party problem algorithm

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

we're going to use the Octave programming environment.

[Source: Sam Roweis, Yair Weiss & Eero Simoncelli]

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.
- [ ] 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.