



Machine Learning

Introduction

Welcome





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.

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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.”

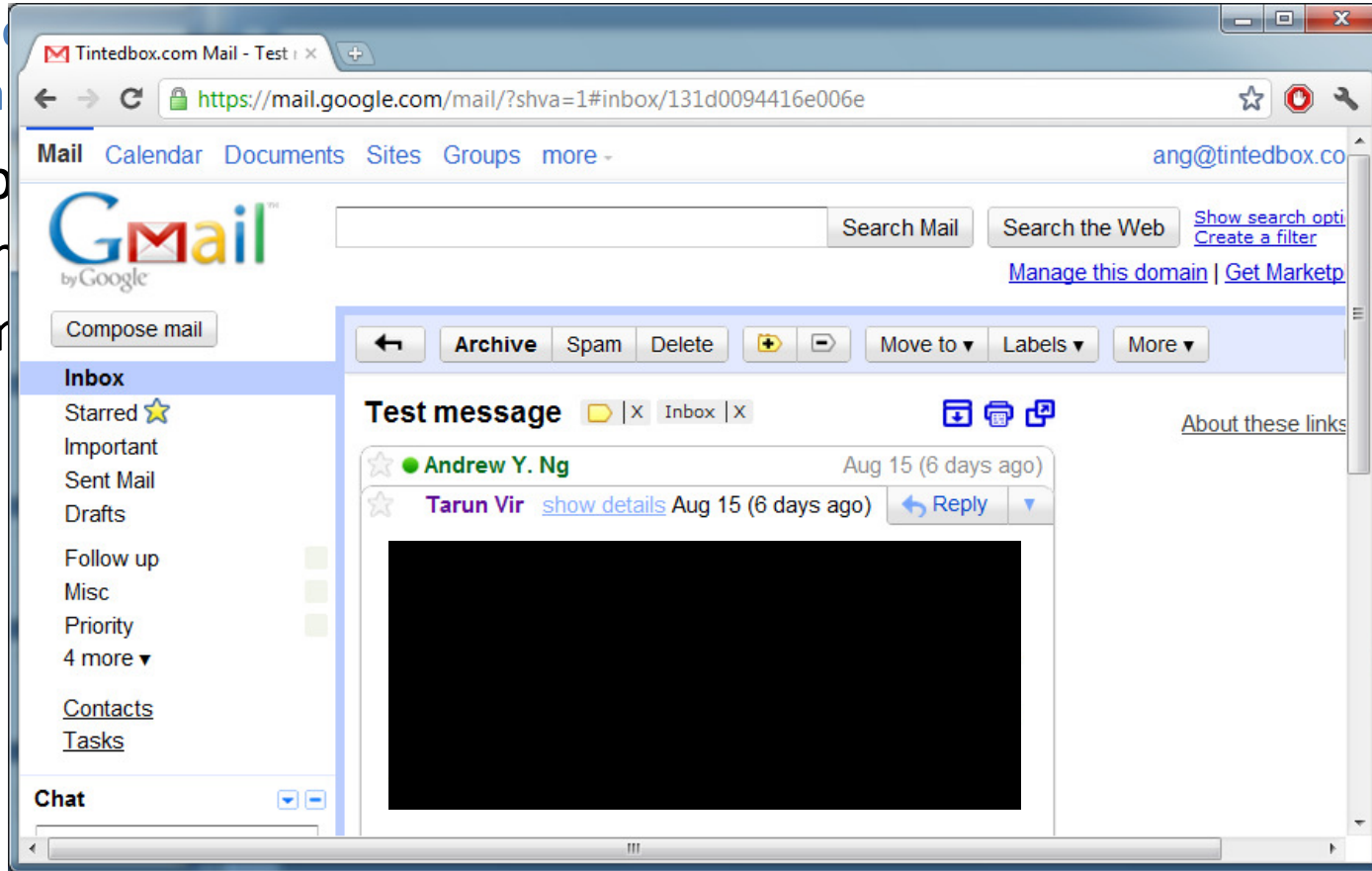
Suppose your email program watches which emails you do or do not mark as spam, and based on that learns how to better filter spam. What is the task T in this setting?

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

“A computer program is said to *learn* from experience E with respect to τ on T ,

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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.



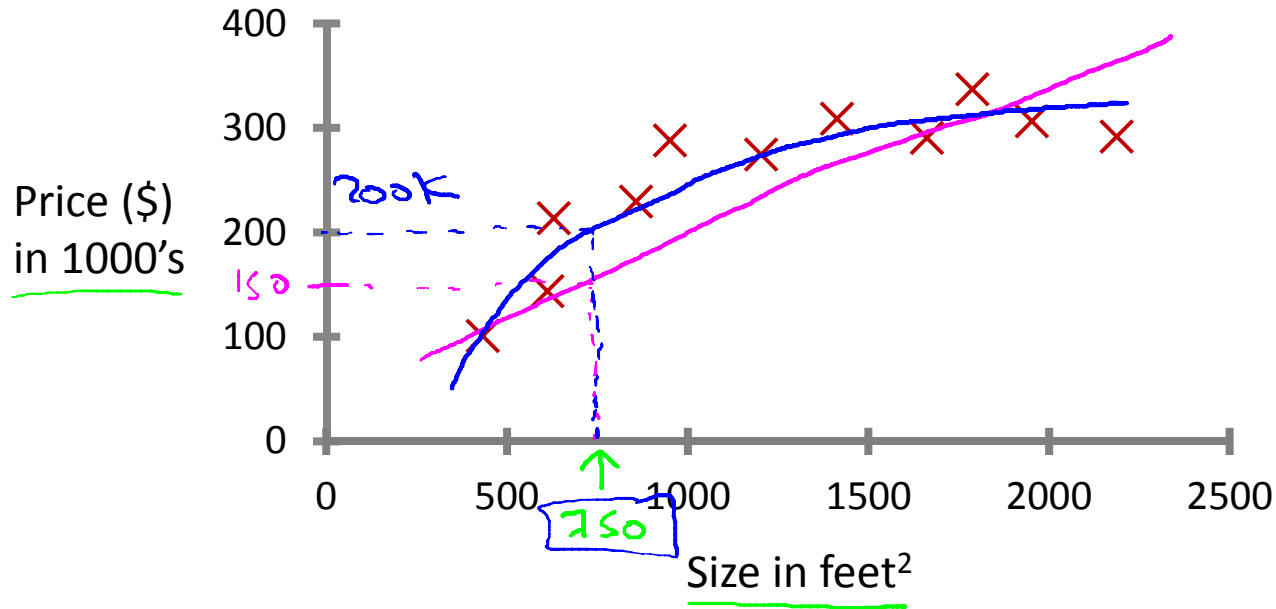


Machine Learning

Introduction

Supervised Learning

Housing price prediction.

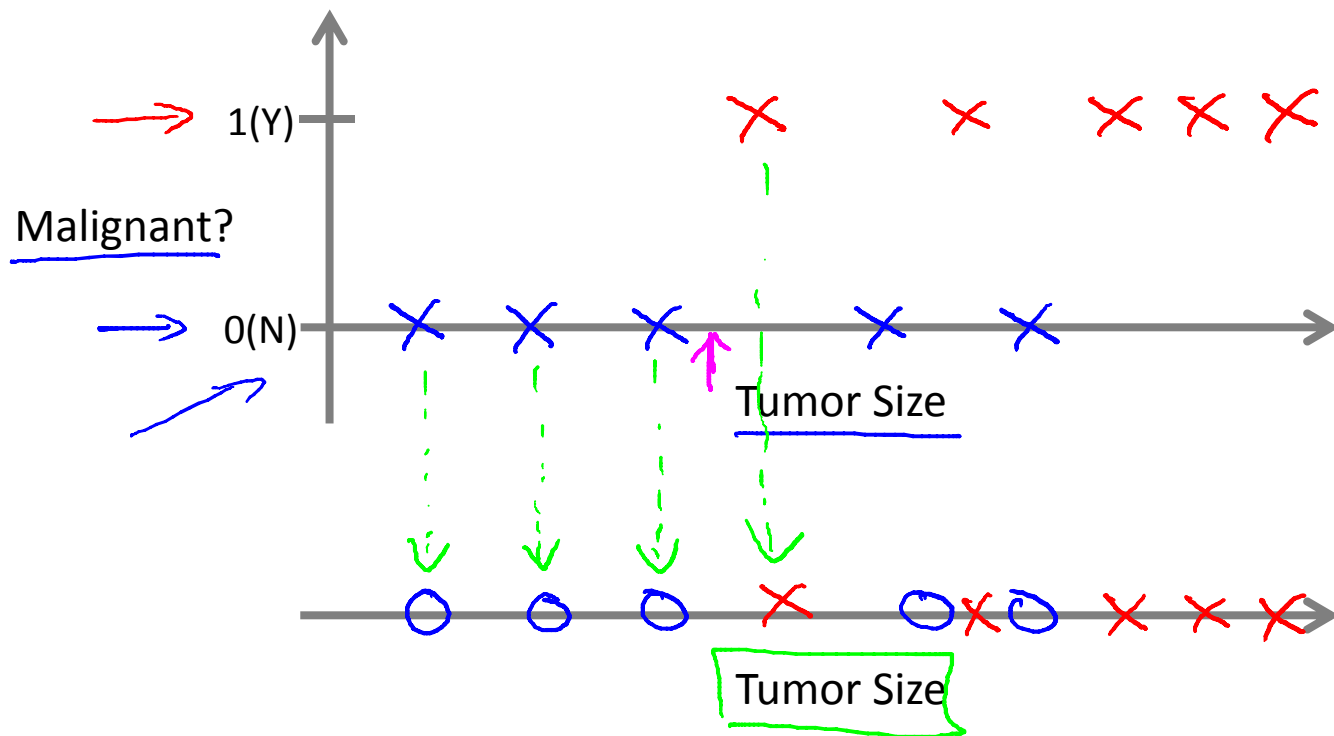


Supervised Learning

"right answers" given

Regression: Predict continuous
valued output (price)

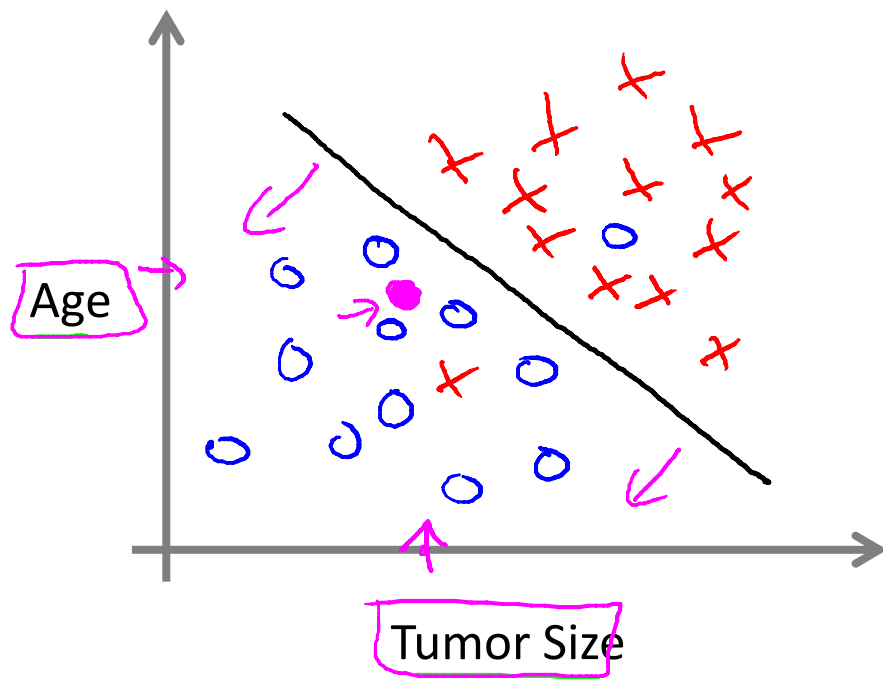
Breast cancer (malignant, benign)



Classification

Discrete valued
output (0 or 1)

0, 1, 2, 3
↓ ↓ ↓ ↓
benign type 1
cancer



- 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

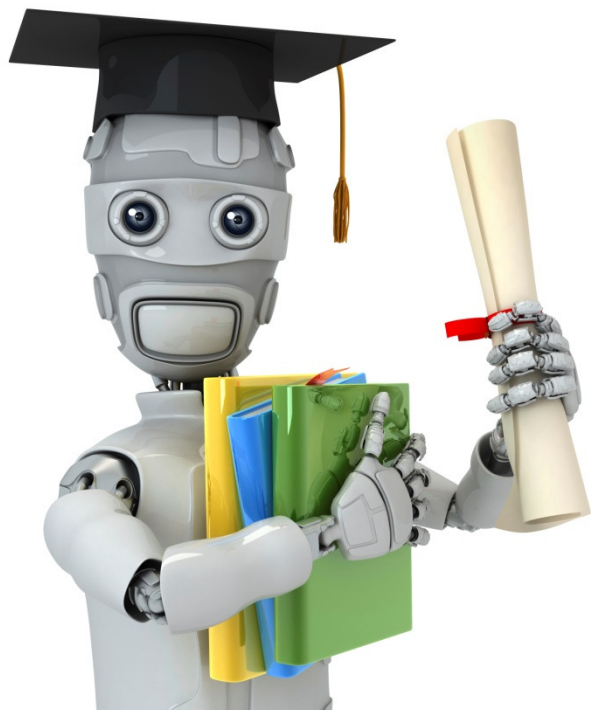
↗ Problem 1: You have a large inventory of identical items. You want to predict how many of these items will sell over the next 3 months.

↗ 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.

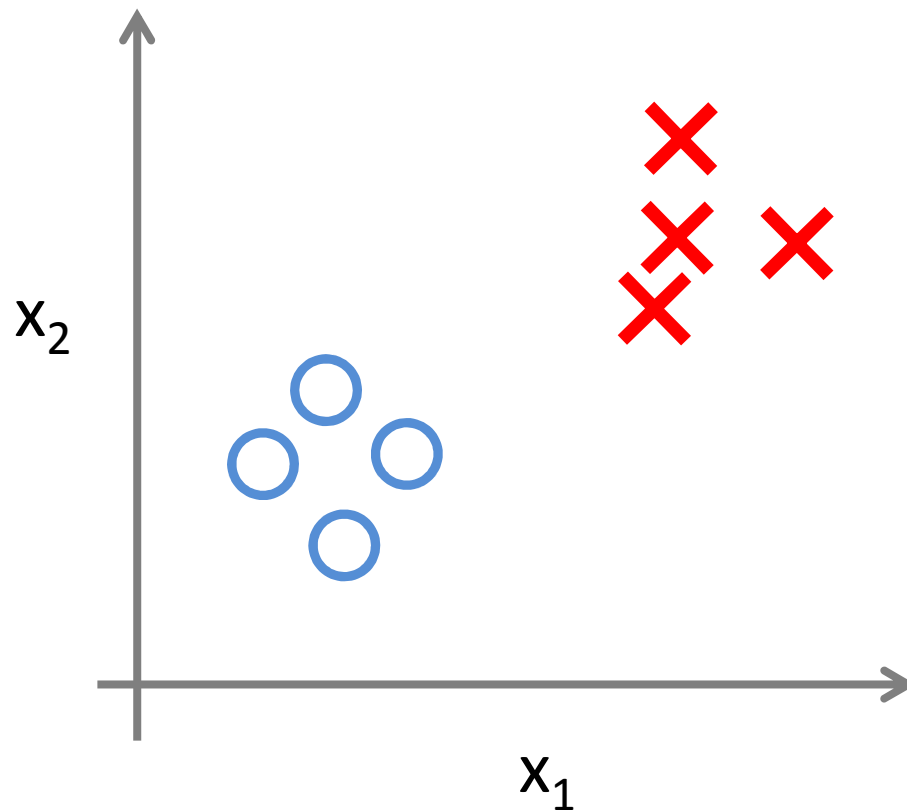


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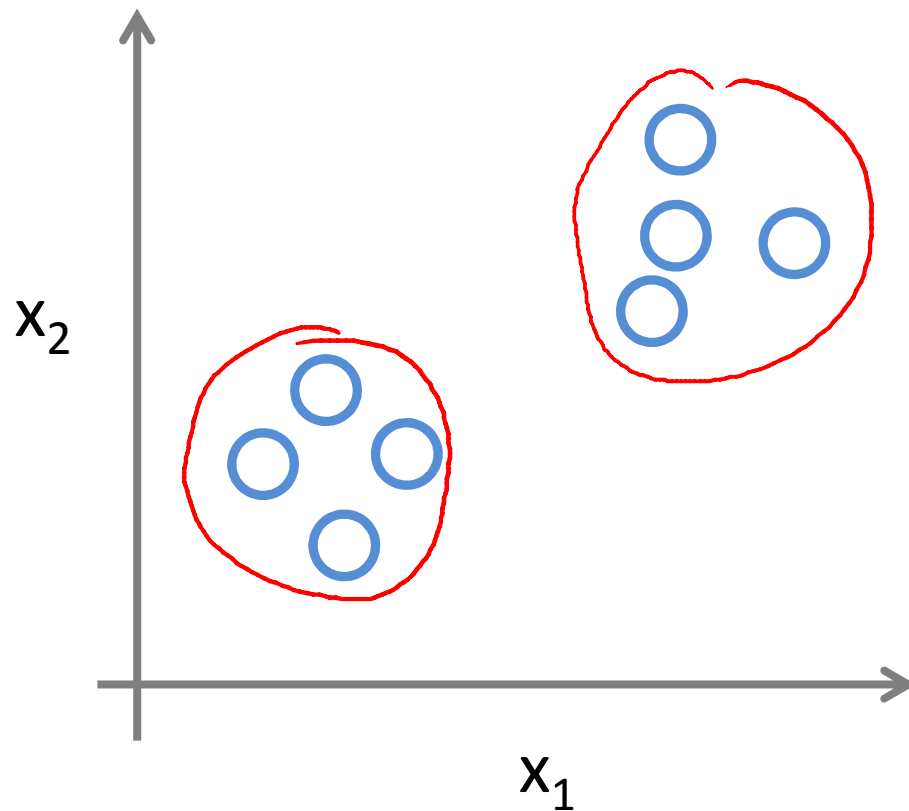
Introduction

Unsupervised Learning

Supervised Learning



Unsupervised Learning



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Tea Party is replacing the blame, former President Bill Clinton claims
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GOP tea party backer defends Christine O'Donnell The Associated Press
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Google's official browser keeps the company buzzing
San Jose Mercury News - Bruce Newman - 1 hour ago

Spotlight

Sarkozy rages at EU 'humiliation'
Financial Times - Peggy Hollinger - 10 minutes ago

BP Oil Well, Site of National Catastrophe, Dies at One
Variety Fair - Juli Weiner - 22 minutes ago
The BP oil well, site of the Deepwater Horizon explosion that led to the worst oil spill in US history, died today at one year old.
Video: Blow-out BP Well Finally Killed in Gulf
The Associated Press
Weiss Doubts BP Would End Operations in Gulf of Mexico: Video Blogging
CNN International - Wall Street Journal (blog) - The Guardian - New York Times
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BP Kills Macondo, But Its Legacy Lives On

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BP Kills Macondo, But Its Legacy Lives On

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By James Heron

BP confirmed late Sunday that the Macondo well that leaked almost five million barrels of oil into the Gulf of Mexico has been permanently sealed, but the well will continue to affect BP and the wider oil industry for many years.

The most immediate worry for BP and its shareholders is how the authorities will apportion blame for the spill. BP's own investigation could apportion responsibility across

Fire boat response crews battled the blazing remnants of the off shore oil rig on April 21, 2010.

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The Source is WSJ.com Europe's home for rapid-fire analysis of the day's big business and finance stories. It is edited by Lauren Mills, based in London.

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By the CNN Wire Staff

September 20, 2010 - Updated 1317 GMT (2117 HKT)

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BP oil spill cost hits nearly \$10bn

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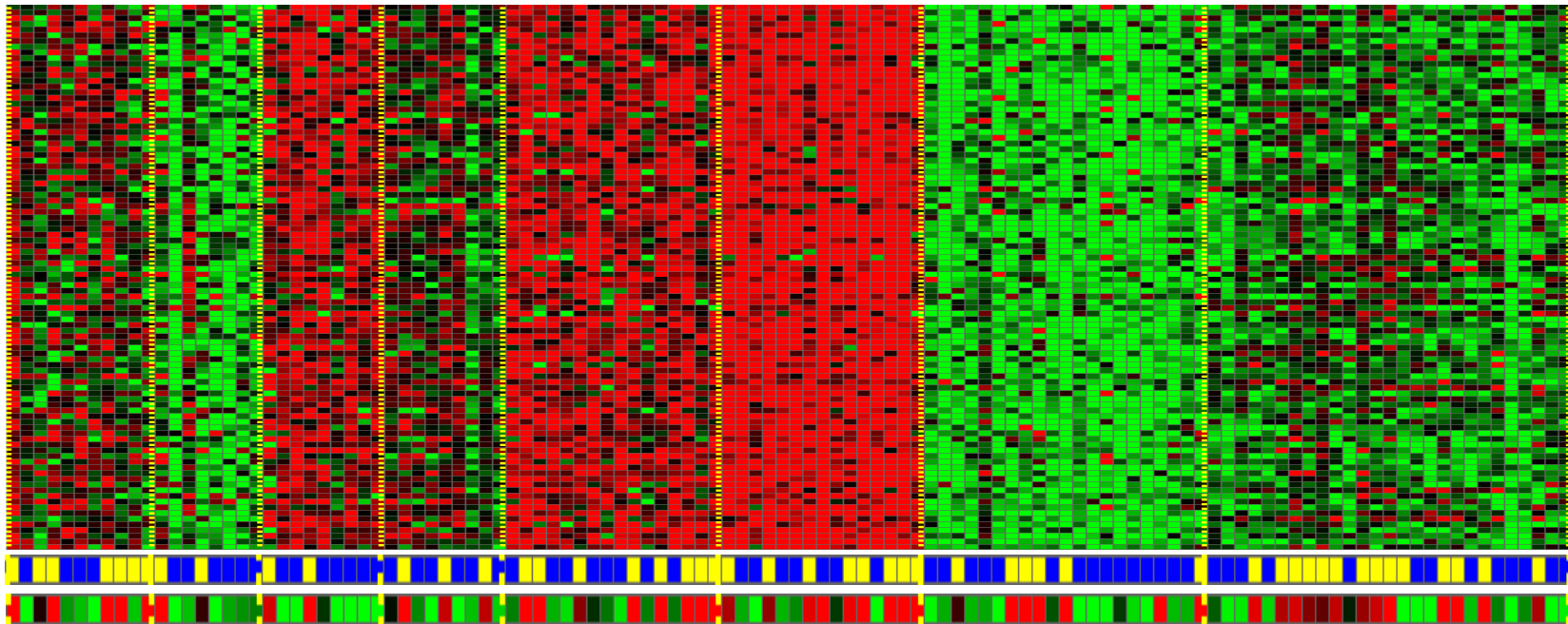
BP oil spill cost hits nearly \$10bn

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

Julia Kollewe
guardian.co.uk, Monday 20 September 2010 08:33 BST
Article history

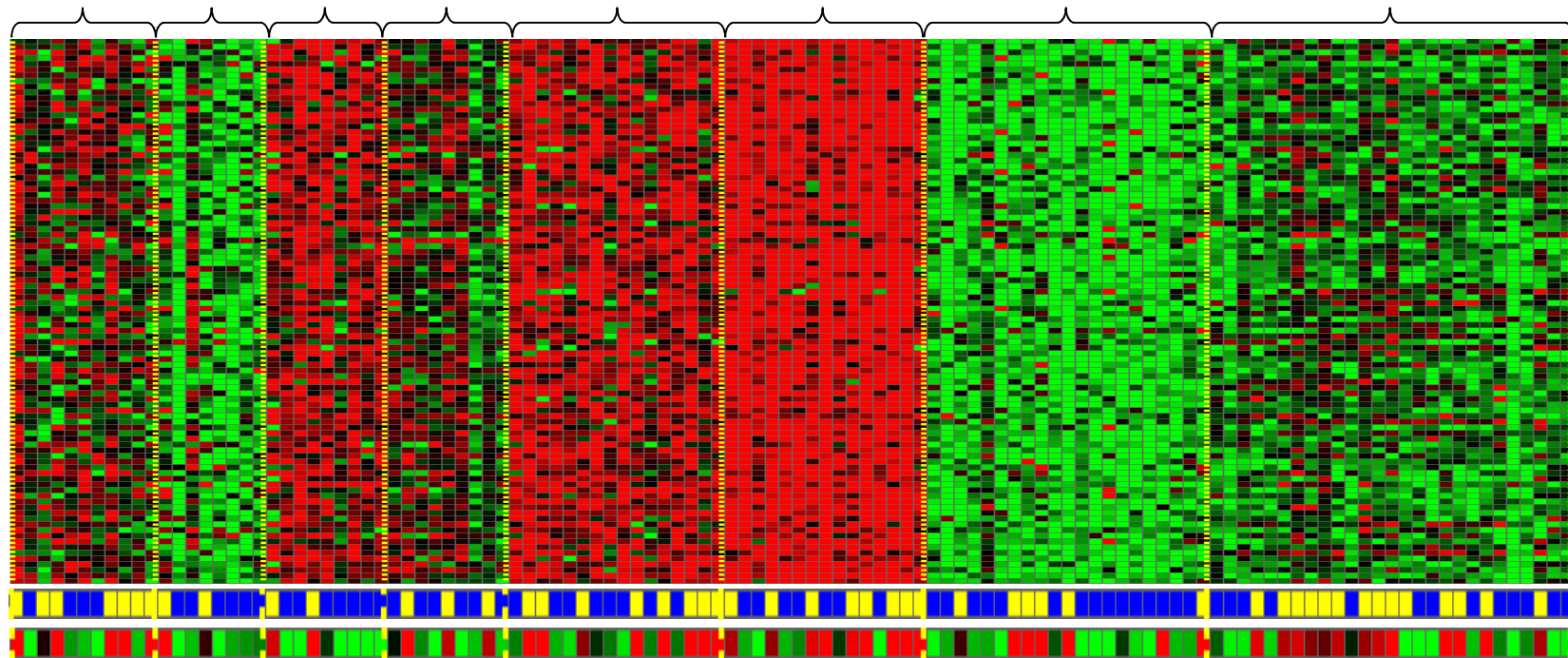
BP's costs for the Deepwater Horizon disaster have hit \$10bn. Photograph: Ho/Reuters

Genes

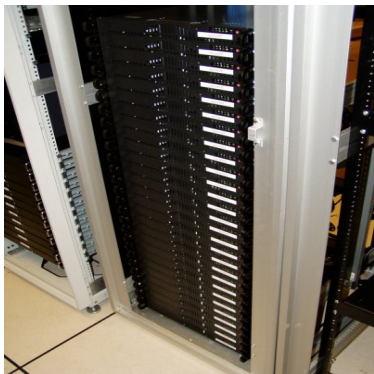


Individuals

Genes



Individuals



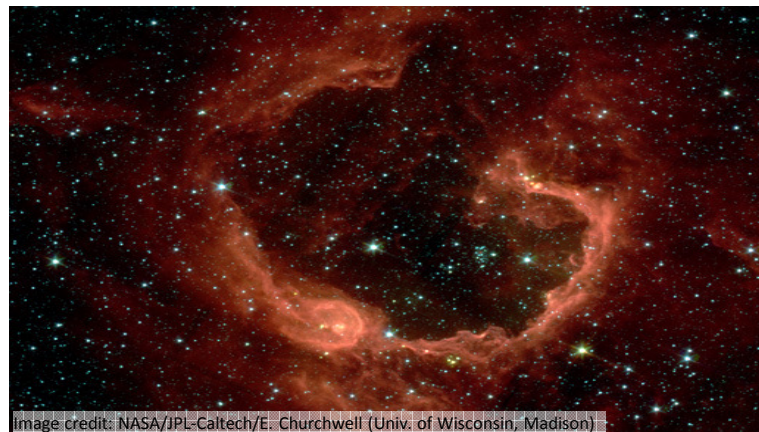
Organize computing clusters



Social network analysis

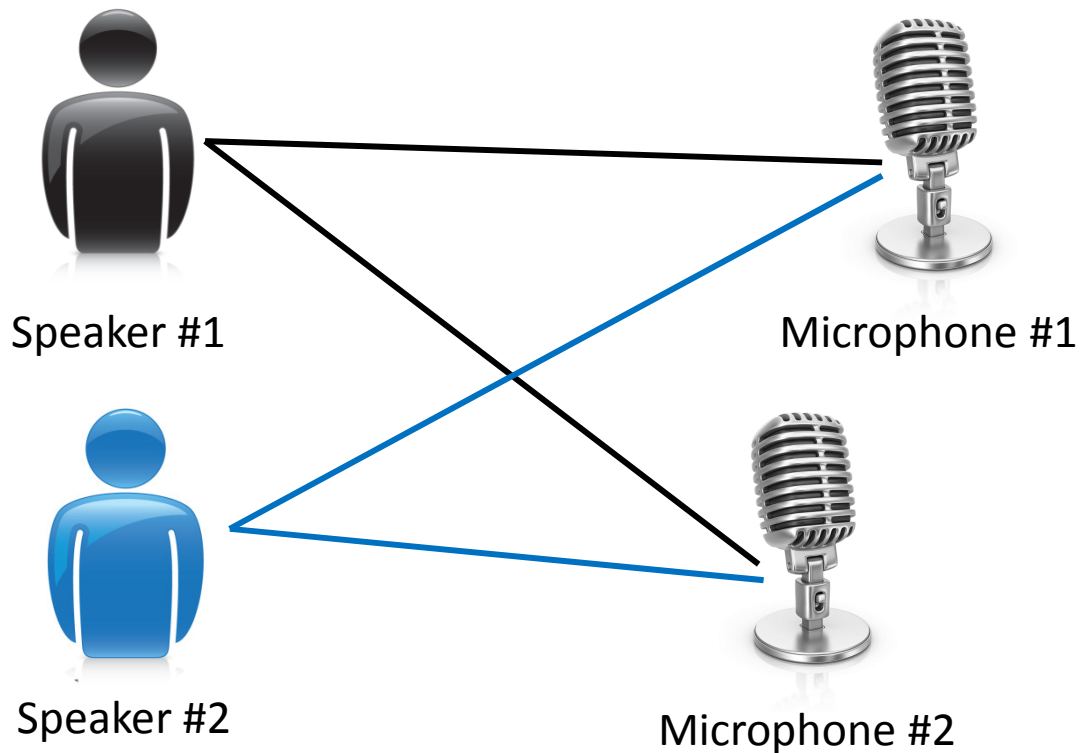


Market segmentation



Astronomical data analysis

Cocktail party problem



Microphone #1: 🗣️

Output #1: 🗣️

Microphone #2: 🗣️

Output #2: 🗣️

Microphone #1: 🗣️

Output #1: 🗣️

Microphone #2: 🗣️

Output #2: 🗣️

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.
- ☐ 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.

