



Machine Learning

# Introduction

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# 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.

# Machine Learning

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- Self-customizing programs
  - E.g., Amazon, Netflix product recommendations

# Machine Learning

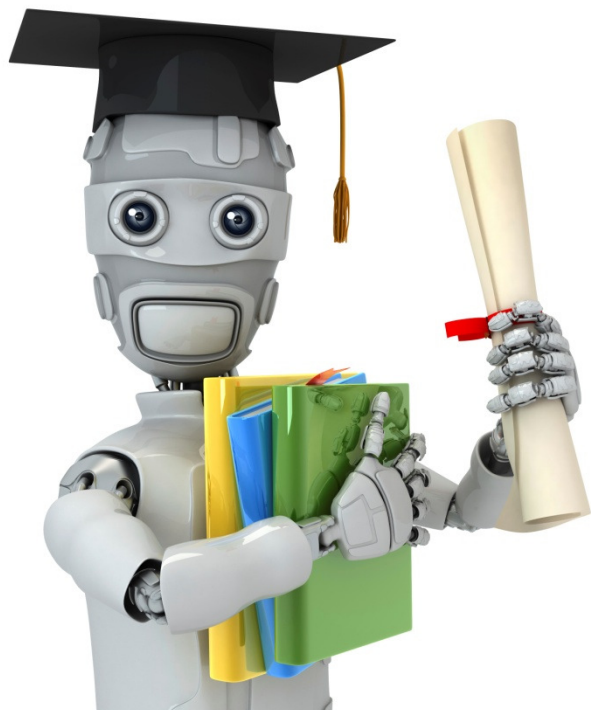
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- Self-customizing programs
  - E.g., Amazon, Netflix product recommendations
- Understanding human learning (brain, real AI).







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## What is machine learning

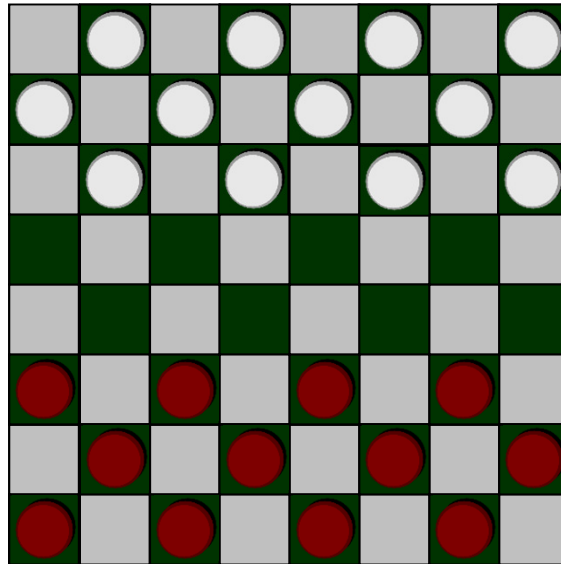
# Machine Learning definition

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- Arthur Samuel (1959). Machine Learning: Field of study that gives computers the ability to learn without being explicitly programmed.

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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  $E$ .

“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.”

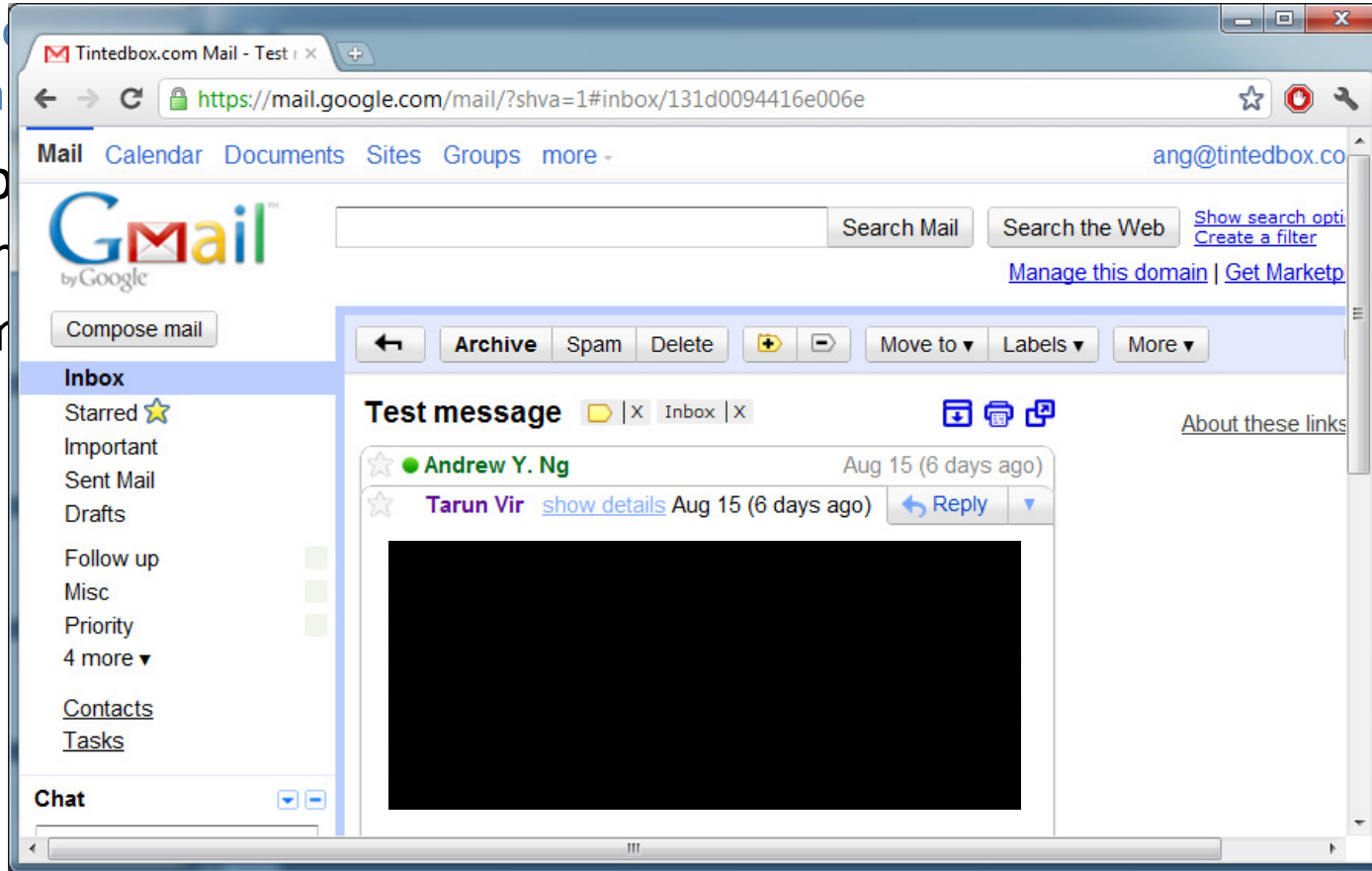
Suppose your email program watches which emails you do or do not mark as spam, and based on that learns how to better filter spam. What is the task T in this setting?

- ☒ 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.  $P \leftarrow$

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spam

or do  
filter



spam.



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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.







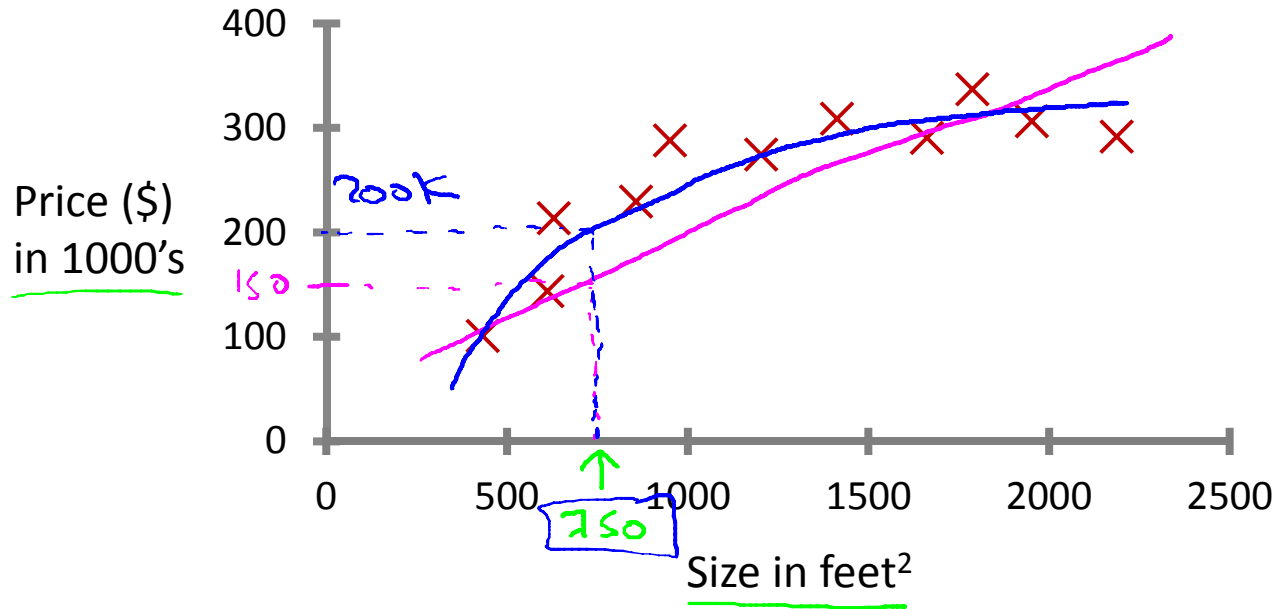
Machine Learning

# Introduction

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# Supervised Learning

# Housing price prediction.

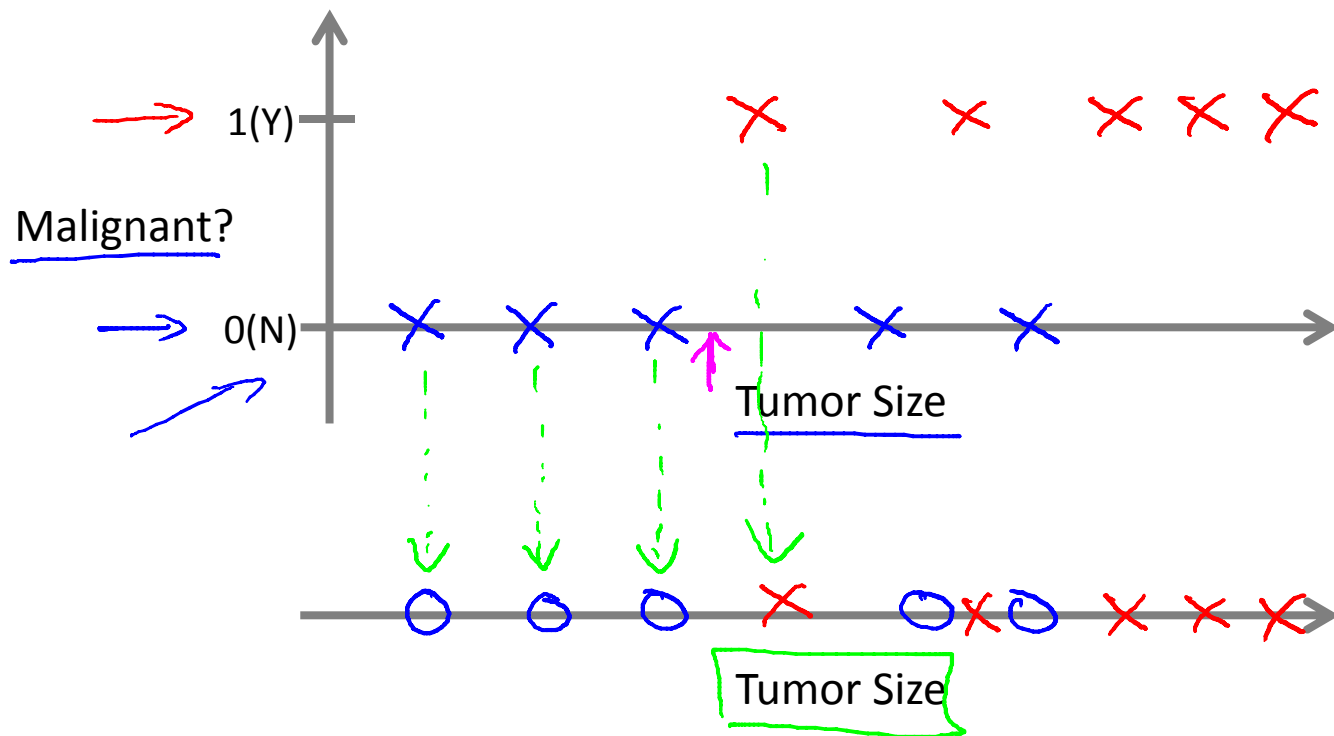


Supervised Learning

"right answers" given

Regression: Predict continuous  
valued output (price)

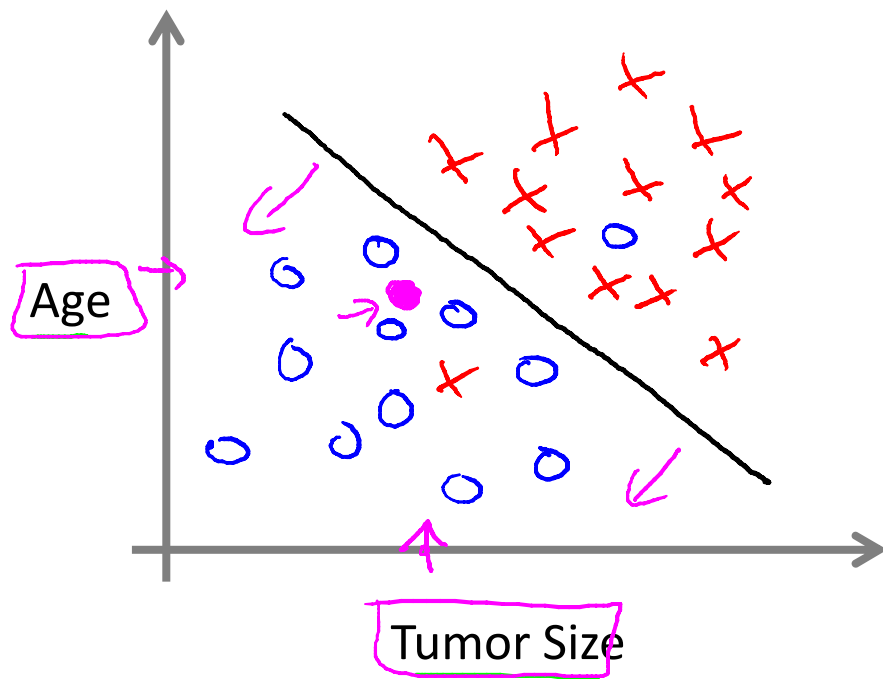
# Breast cancer (malignant, benign)



## 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.

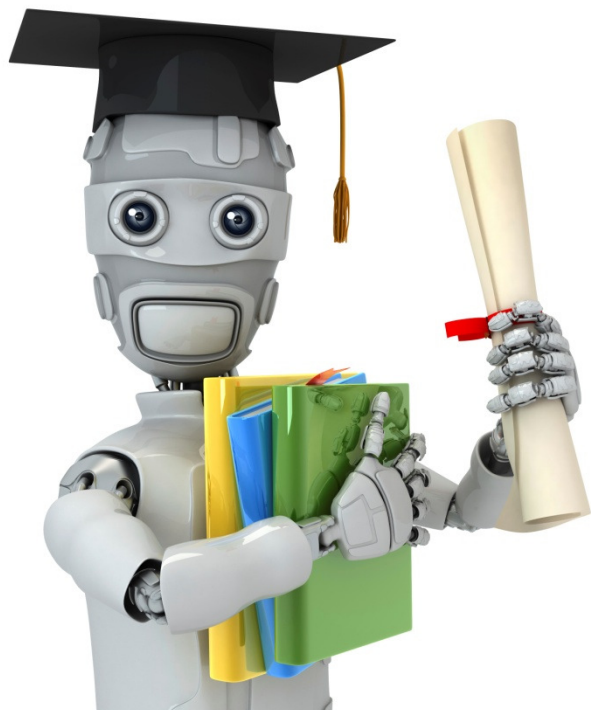
↗ 0 - not hacked  
↗ 1 - hacked

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.







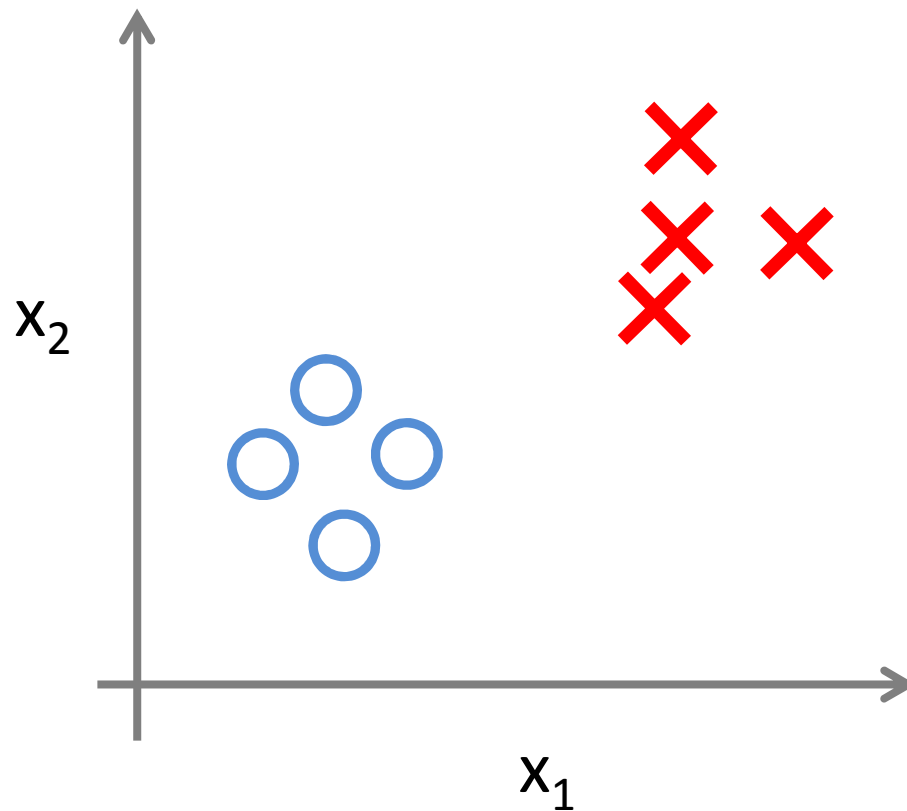
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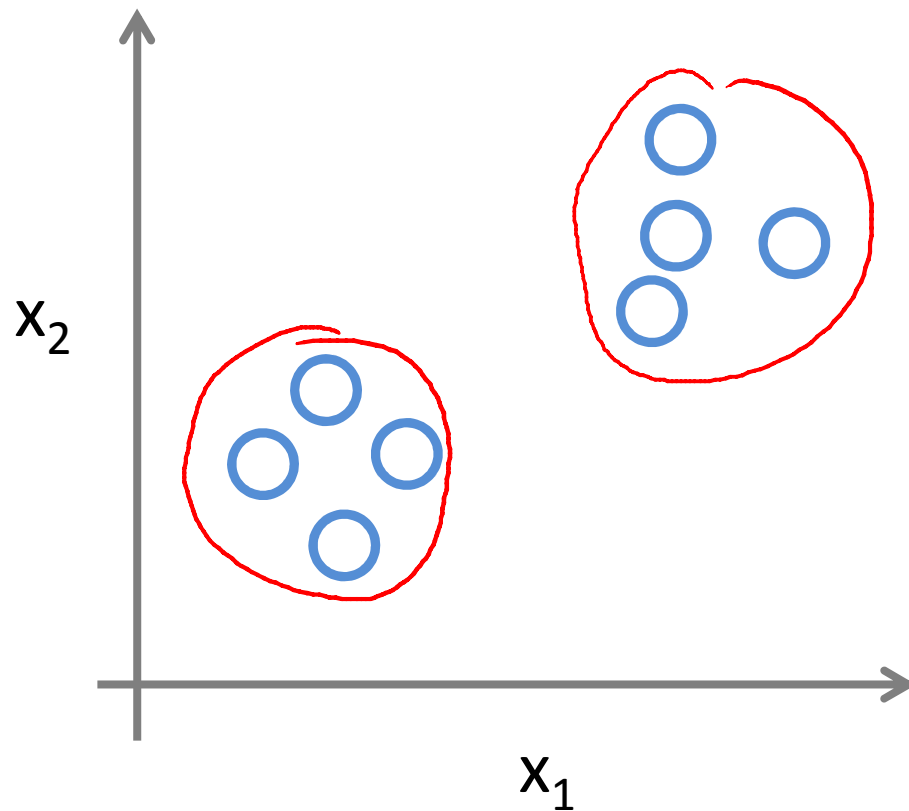
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# Unsupervised Learning

# Supervised Learning



# Unsupervised Learning



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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.  
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- Video: Blown-out BP Well Finally Killed in Gulf The Associated Press
- Weiss Doubts BP Would End Operations in Gulf of Mexico Video Bloomberg
- CNN International - Wall Street Journal (blog) - The Guardian - New York Times
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**Spotlight**

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**Allen: Well is dead, but much Gulf Coast work remains**

By the CNN Wire Staff

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

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What next for Gulf oil spill?

STORY HIGHLIGHTS

(CNN) - The ruptured Macondo well, a mile under the Gulf of Mexico off the Louisiana coast, has been pronounced dead.

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**BP Kills Macondo, But Its Legacy Lives On**

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By James Herron

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.

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

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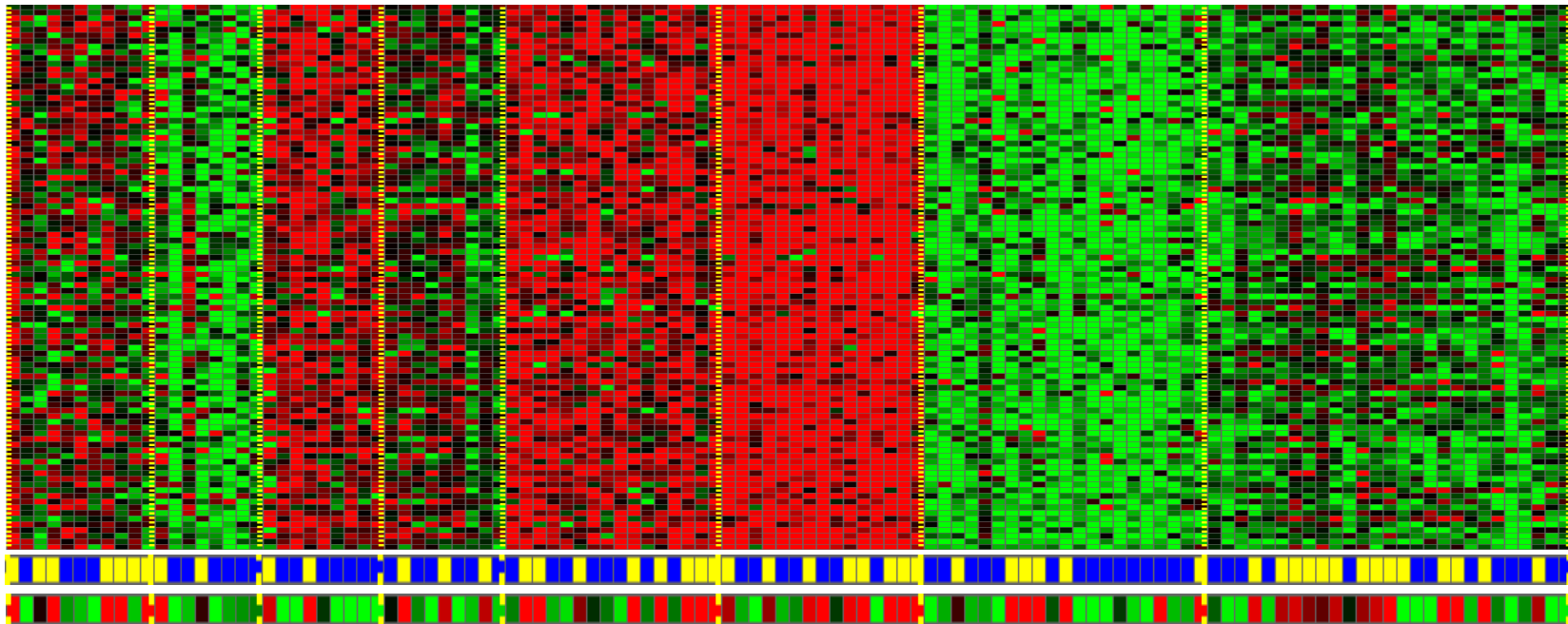
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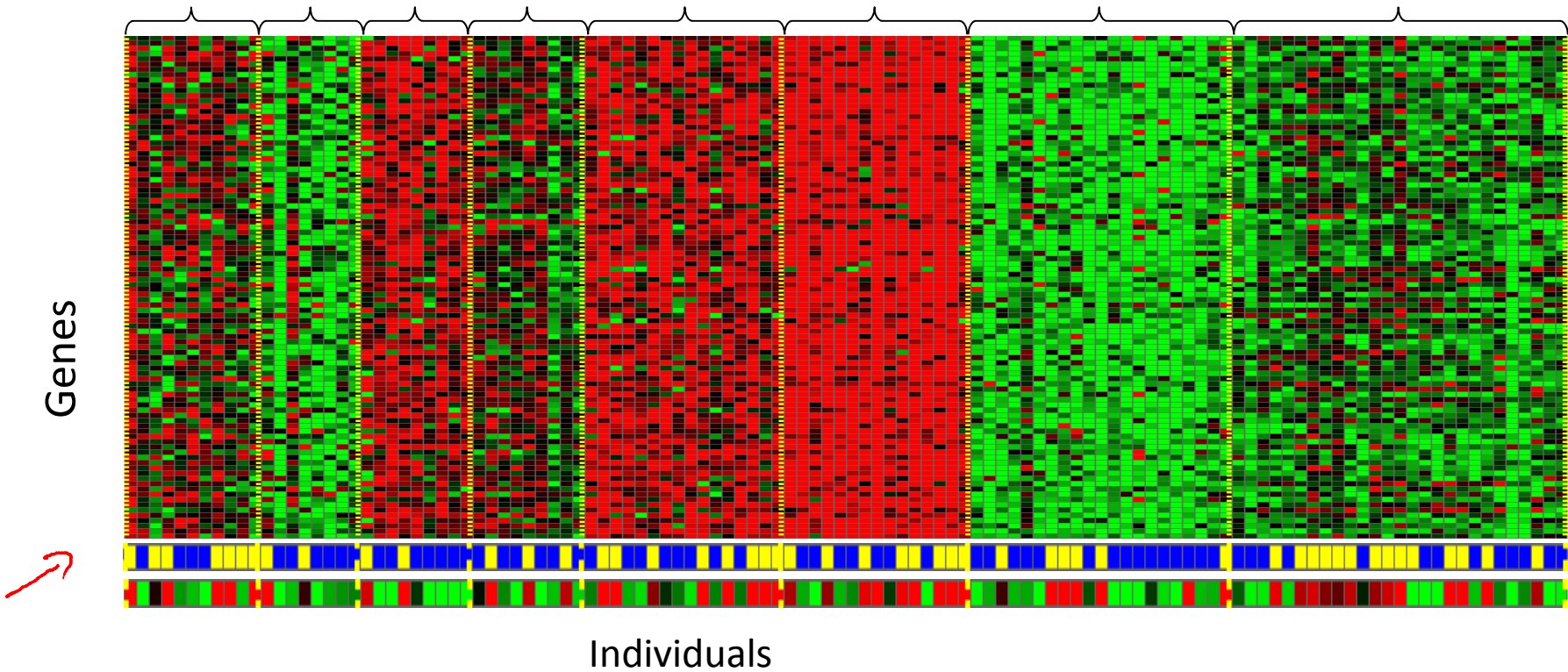
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BP's costs for the Deepwater Horizon disaster have hit \$10bn. Photograph: Ho/Reuters

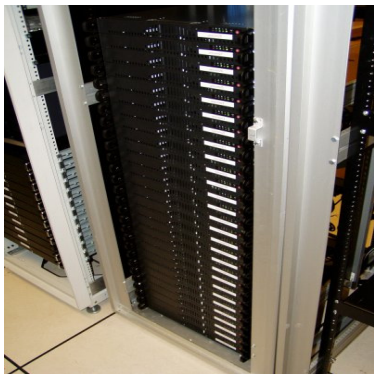
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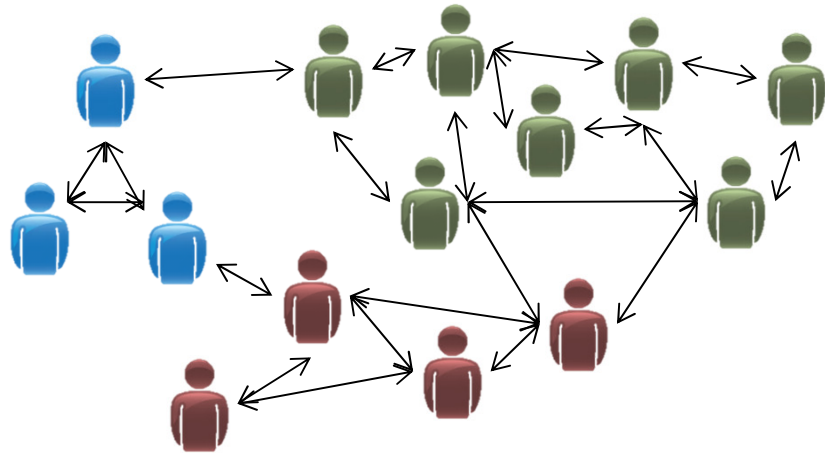
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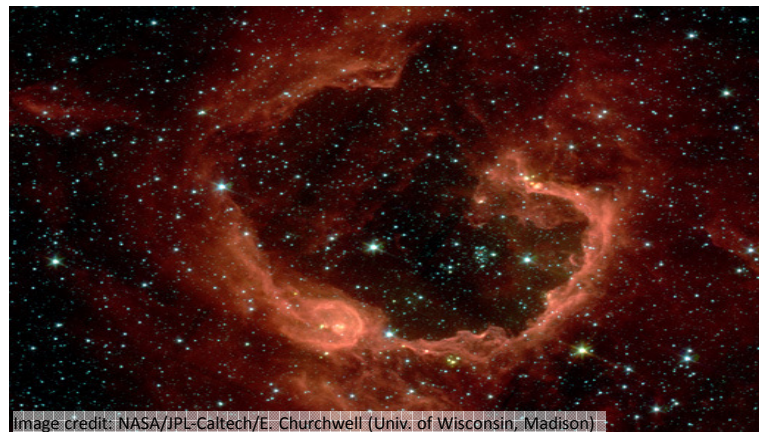
Organize computing clusters



Social network analysis

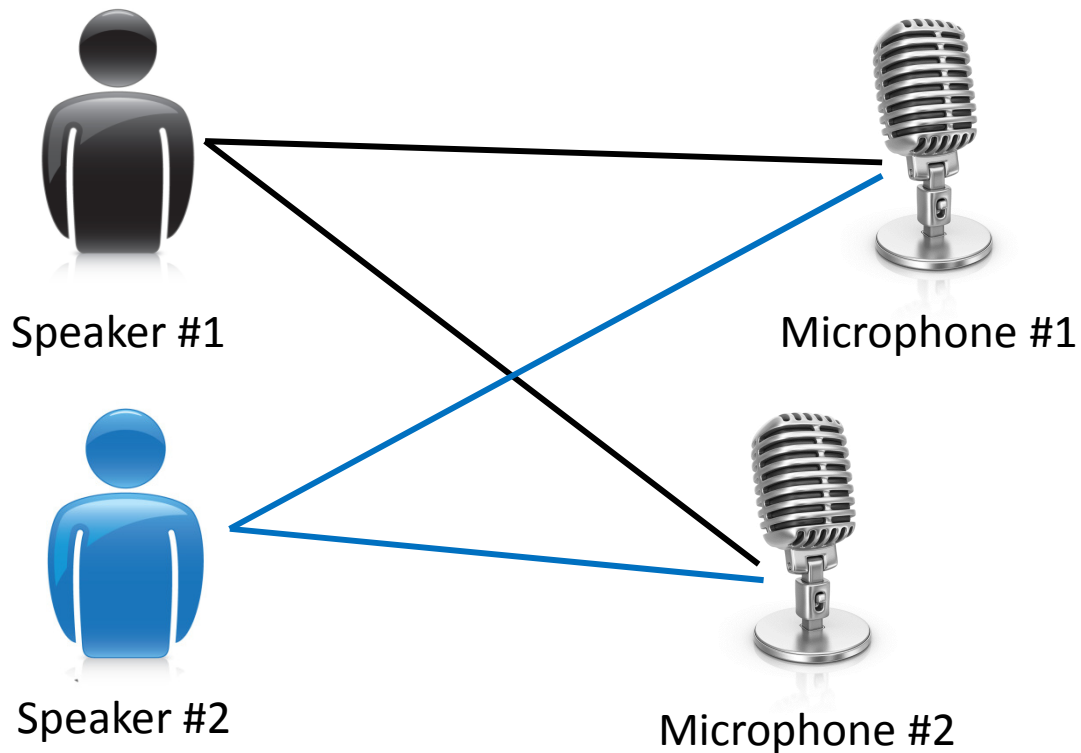


Market segmentation



Astronomical data analysis

# Cocktail party problem



Microphone #1: 📢

Output #1: 📢

Microphone #2: 📢

Output #2: 📢

---

Microphone #1: 📢

Output #1: 📢

Microphone #2: 📢

Output #2: 📢

# 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.