



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.

Machine Learning

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- |

Exam

- |

- |



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most of

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

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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

old

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

new

- 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.”

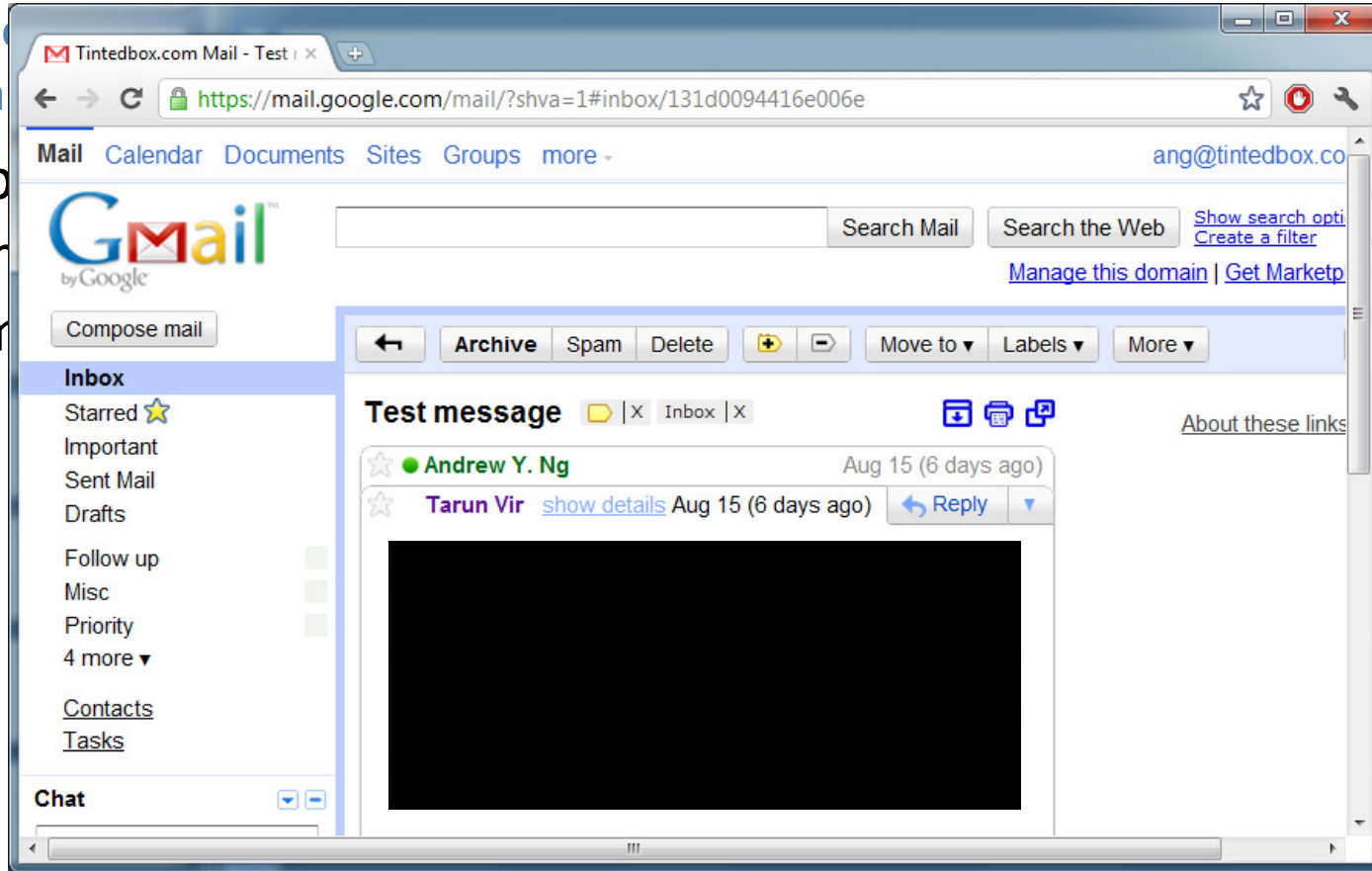
Suppose your email program watches which emails you do or do not mark as spam, and based on that learns how to better filter spam. What is the task T in this setting?

- ☒ 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 T ,

Support
not r
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filter



spam.

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Machine learning algorithms:

two most popular machine learning algorithms

- Supervised learning
- Unsupervised learning

teach the computer to how to do sth

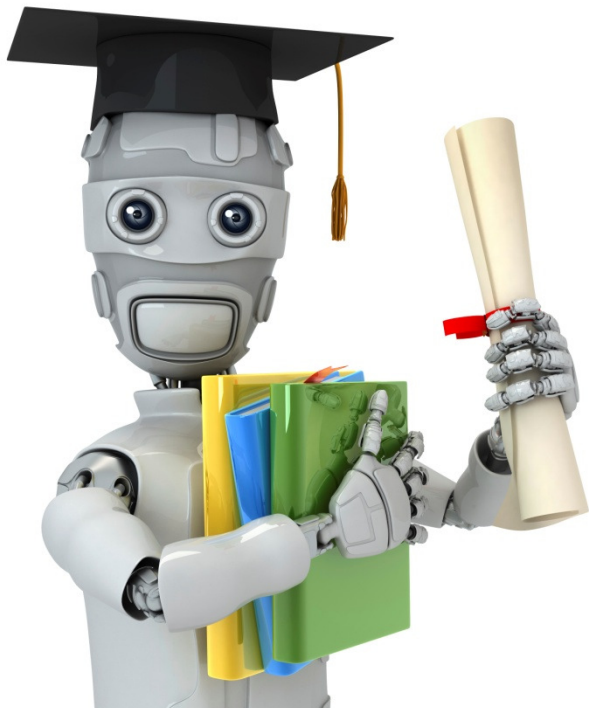
let the computer to learn by itself

other types of machine learning algorithms (later)

Others: Reinforcement learning, recommender systems.

important!

Also talk about: **Practical advice** for applying learning algorithms.



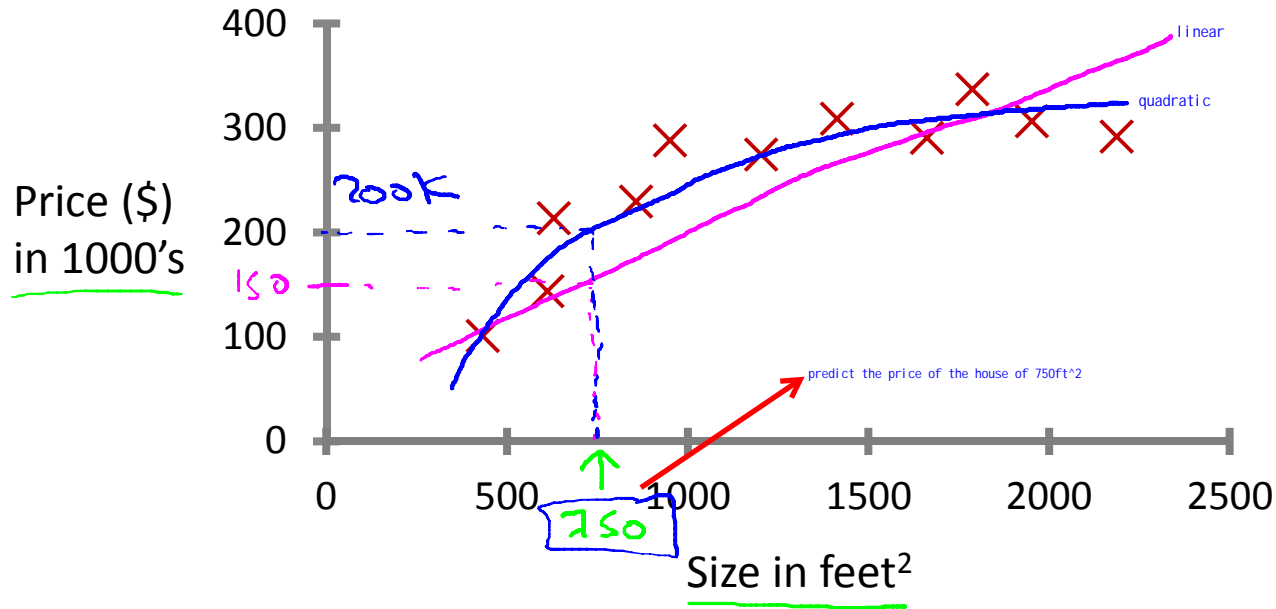
Machine Learning

Introduction

Probably the most popular ML

Supervised Learning

Housing price prediction.



For each house, the exact price (right answer)
The task to predict the price for a new house.

Supervised Learning

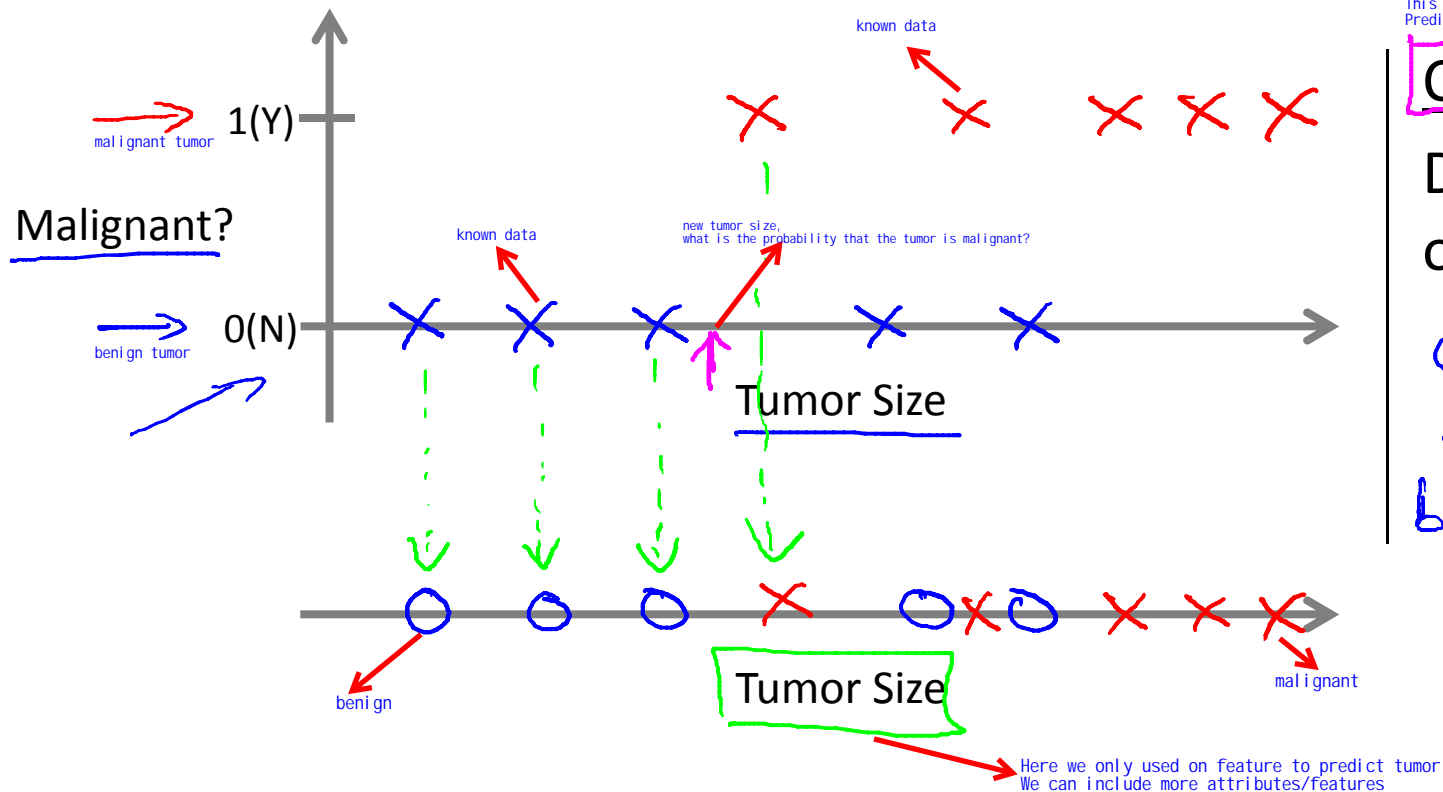
"right answers" given

Also called

Predict continuous output

Regression: Predict continuous
valued output (price)

Breast cancer (malignant, benign)



This kind problem is a classification problem (0,1)
Predict discrete valued output

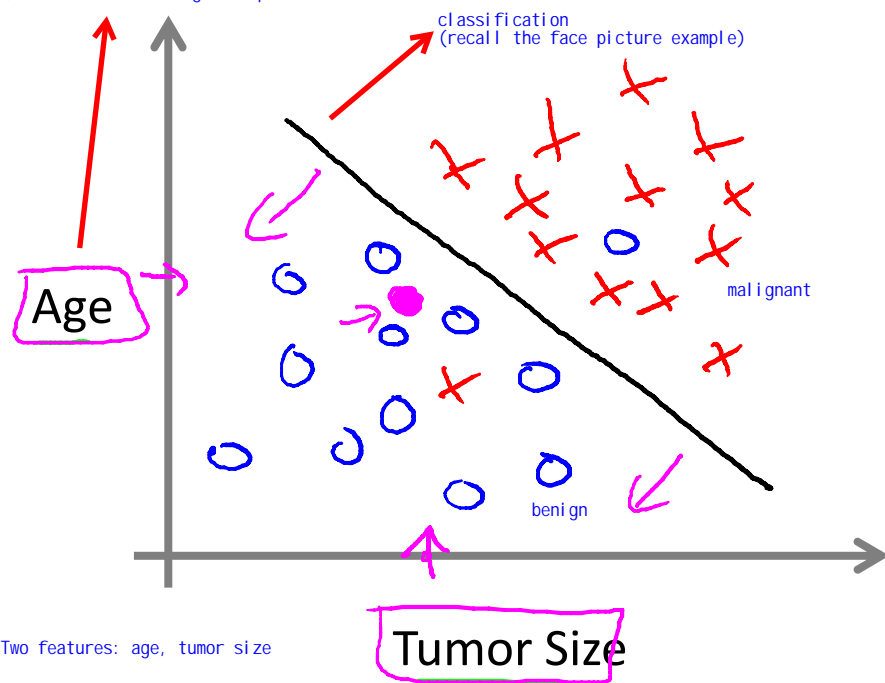
Classification

Discrete valued
output (0 or 1)

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

sometimes, we can have more than 2 outputs

Here, we also know the ages of patients



We can also include many other features.
Some learning algorithms use infinite number of features (computer limited memory).
(support vector machine allows the computer to deal with infinite features)

- 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.

compromised account (受波及的账户)

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.

just treat as continuous value

(0, 1) discrete output values

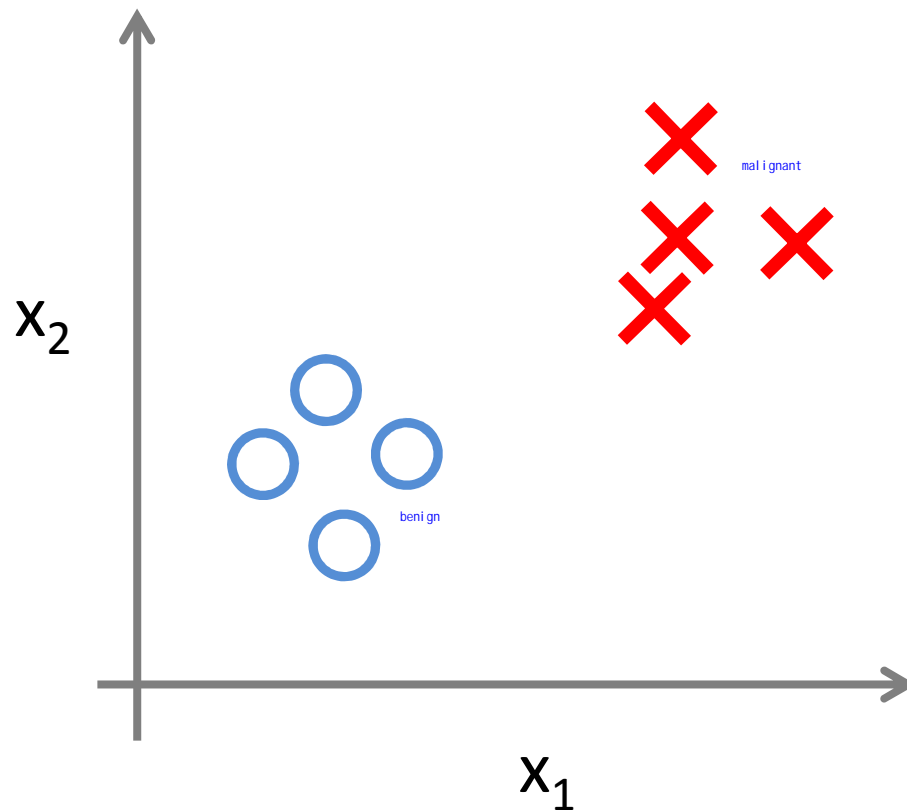


Machine Learning

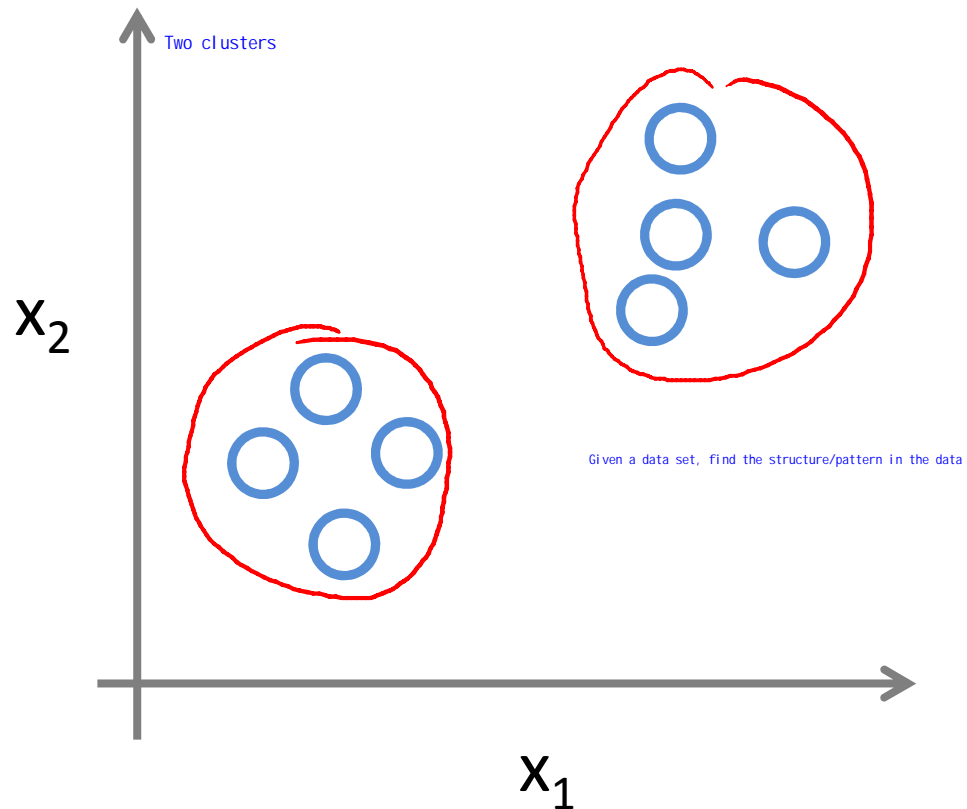
Introduction

Unsupervised Learning

Supervised Learning



Unsupervised Learning



Clustering Algorithm
used by Google news

Google News

news.google.com

Web Images Videos Maps News Shopping Gmail more

andrewyantakng@gmail.com | Web History | Settings | Sign out

Google news

Search News Search the Web

Advanced news search

U.S. edition Add a section

Top Stories

Deepwater Horizon
Fed meeting
Foreign exchange market
Lindsay Lohan
IBM
Tom Brady
Toronto International Film Festival
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Iran
Hurricane Igor

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Christine O'Donnell »
White House official denies Tea Party-focused ad campaign
CNN International - Ed Henry - 1 hour ago
Democratic sources say the White House is not considering an ad campaign tying Republicans to the Tea Party. Washington (CNN) -- A top White House official sharply denied a report that claims President Obama's political advisers are weighing a national ...
Tea Party is misplacing the blame, former President Bill Clinton claims
New York Daily News
GOP tea party backer defends Christine O'Donnell The Associated Press
Atlanta Journal Constitution - Politics Daily - MyFox Washington DC - Salon all 726 news articles »


CNN Interna...


US Stocks Climb After Recession Called Over, Homebuilders Gain

MarketWatch - Kristina Peterson - 16 minutes ago
NEW YORK (MarketWatch) -- US stocks climbed Monday, gaining speed after a key nonprofit organization officially called the recession over, giving investors a boost of confidence in the gradual economic recovery.
Longest recession since 1930s ended in June 2009, group says
Los Angeles Times
Downturn Was Longest in Decades, Panel Confirms New York Times
Wall Street Journal - AFP - CNN - USA Today all 276 news articles »


MyFox Phila...

Deepwater Horizon »

BP Oil Well, Site of National Catastrophe, Dies at One
Vanity 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: 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 all 2,292 news articles »


Reuters

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Recession officially ended in June 2009
CNMMoney - Chris Isidore - 39 minutes ago

Hurricane Igor lashes Bermuda
USA Today - Gerry Broome - 5 minutes ago

'Explain what you want from us.' reads front-page editorial
msnbc.com - Olivia Torres - 10 minutes ago

Crisis response: Pakistan floods

San Francisco Bay Area - Edit

Clorox »
Bay Biz Buzz: Clorox close to selling STP, Armor All
San Jose Mercury News - 48 minutes ago - all 24 articles »

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San Jose Mercury News - Bruce Newman - 1 hour ago

Jon Sylvia »
Martinez man still unconscious as police investigate weekend shooting
San Jose Mercury News - Robert Salonga - 48 minutes ago - all 6 articles »

Spotlight

Sarkozy rages at EU 'humiliation'
Financial Times - Peggy Hollinger - Sep 16, 2010

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More Top Stories
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Christine O'Donnell
White House official denies Tea Party-focused ad campaign
CNN International - Ed Henry - 1 hour ago
Democratic sources say the White House is not considering an ad campaign tying Republicans to the Tea Party. Washington (CNN) - A top White House official sharply denied a report that claims President Obama's political advisers are weighing a national...
Tea Party is replacing the blame, former President Bill Clinton claims
New York Daily News
GOP tea party backer defends Christine O'Donnell The Associated Press
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San Francisco Bay Area - Edit

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all 24 articles
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Weiss Doubts BP Would End Operations in Gulf of Mexico Video Bloomberg
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BP Kills Macondo, But Its...

blogs.wsj.com/source/2010/09/20/bp-kills-macondo-but-its-legacy-lives-on/

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September 20, 2010, 12:44 PM GMT

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.

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.

About The Source

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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Allen: Well is dead, but m...

edition.cnn.com/2010/09/20/gulf.oil.disaster/

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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 permanently sealed.

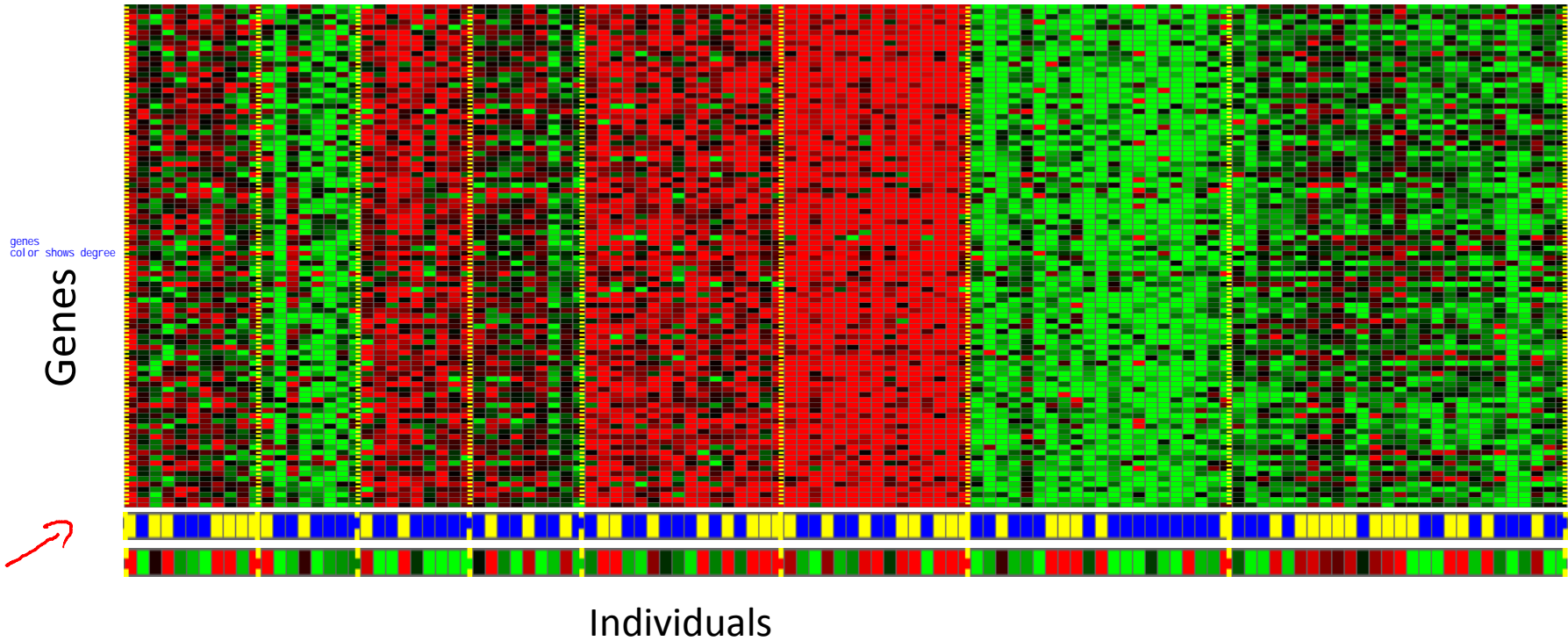
BP oil spill cost hits nearly \$10bn

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

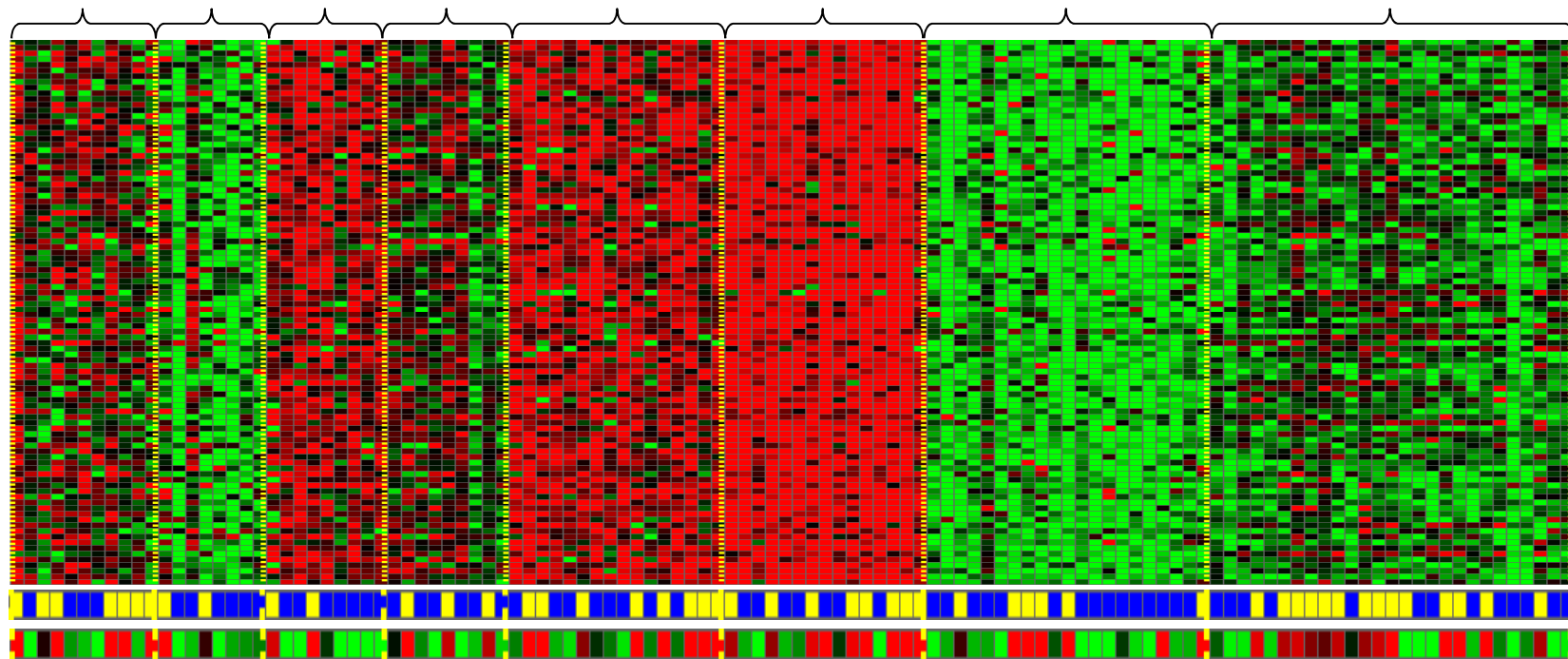
Julia Kollewe
guardian.co.uk, Monday 20 September 2010 08:33 BST
Article history

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

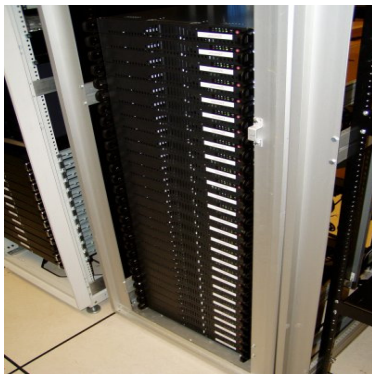
Different stories on the same topic been clustered together



Genes

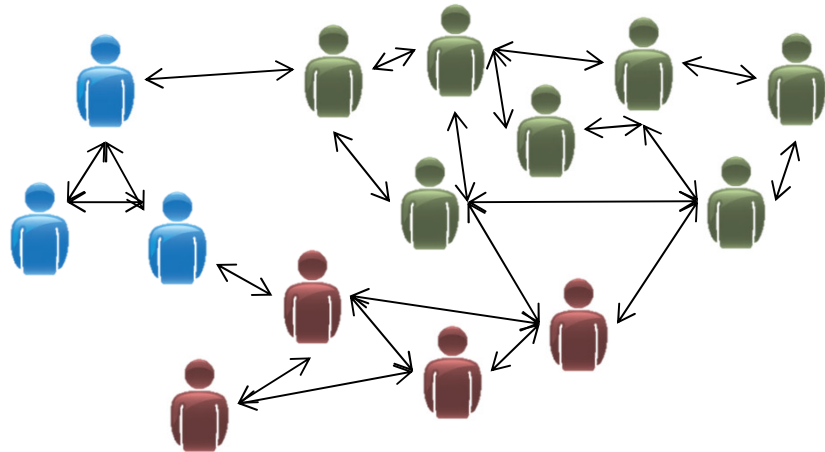


Individuals



Organize computing clusters

clustering: one type of unsupervised-learning
look at the data set
and automatically clustering



Social network analysis



Market segmentation

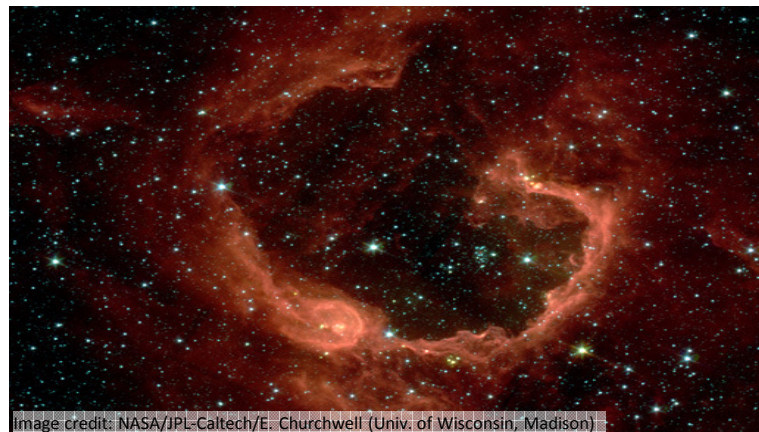
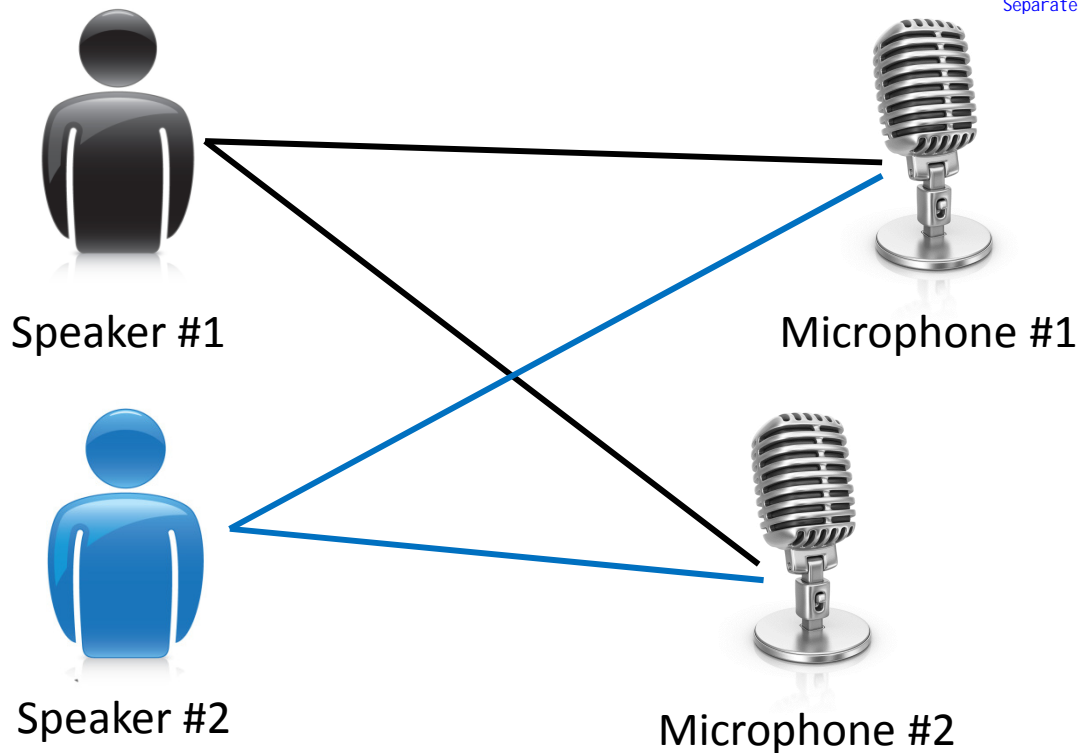


Image credit: NASA/JPL-Caltech/E. Churchwell (Univ. of Wisconsin, Madison)

Astronomical data analysis

Cocktail party problem

Another type of unsupervised-learning
Separate the overlapped recording



1st recording

Microphone #1: 📢

Output #1: 📢

separate the overlapped algorithm
(filtering, filter the audio?)

Microphone #2: 📢

Output #2: 📢

2nd recording

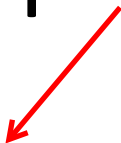
Microphone #1: 📢

Output #1: 📢

Microphone #2: 📢

Output #2: 📢


Cocktail party problem algorithm



- 1. Can be solved with one line in MATLAB/Octave
- 2. C++/Python will be much complicated. e.g. svd
- 3. Company in silicon valley: prototype in Octave then migrate your code to c++ once you have good results

```
[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. unsupervised?
 - ☒ 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. supervised

