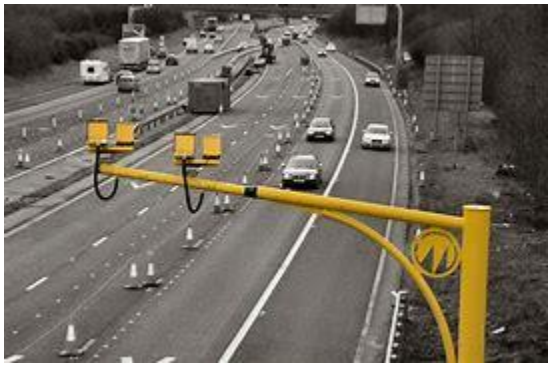
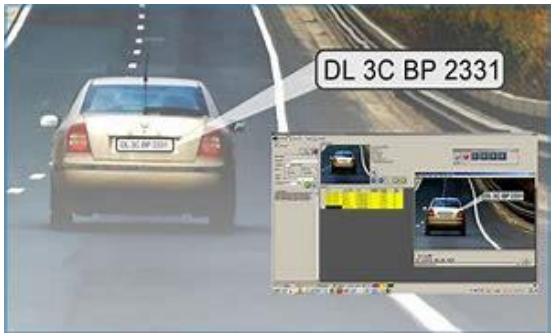
Introduction to Machine Learning


SPAM

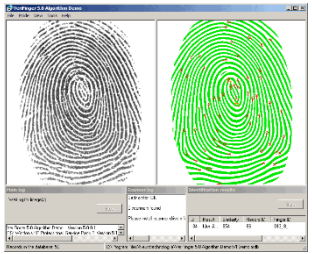
Images to Text

- Reading license plates, zip codes, checks





Biometrics



Fingerprint scanners on many new laptops, other devices

Face recognition systems now beginning to appear more widely
http://www.sensiblevision.com/

Source: S. Seitz

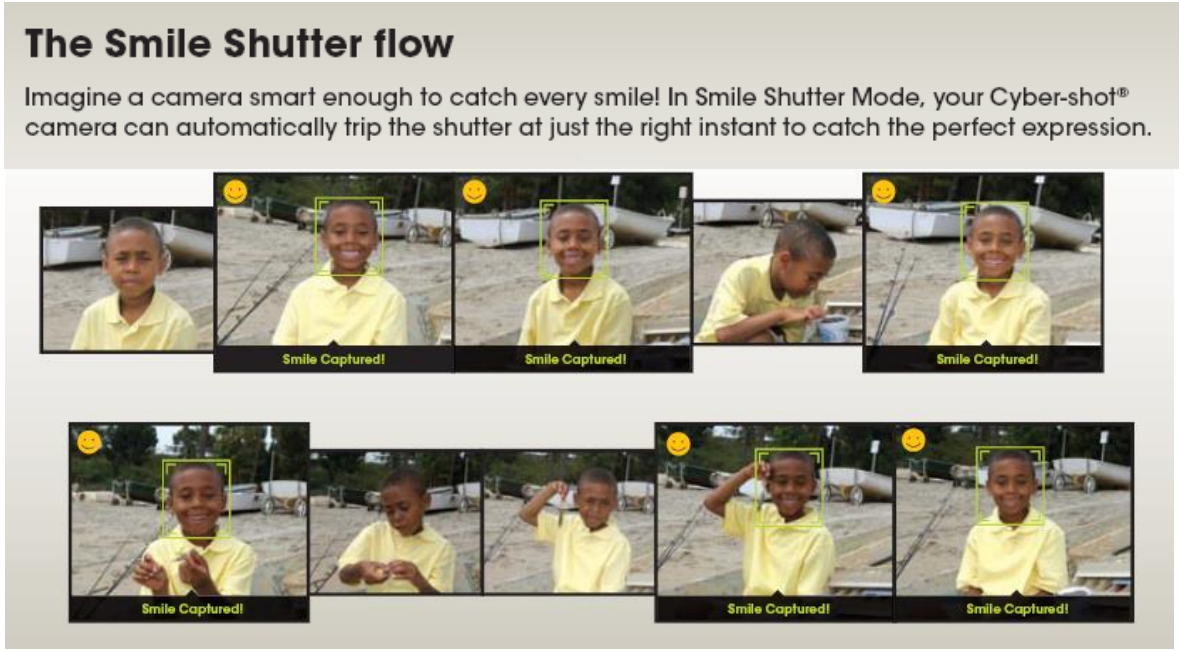
Face detection

- Many new digital cameras now detect faces
  - Canon, Sony, Fuji, …

Source: S. Seitz

Face recognition: Apple iPhoto, Facebook, Google, etc

Smile detection



Sony Cyber-shot® T70 Digital Still Camera

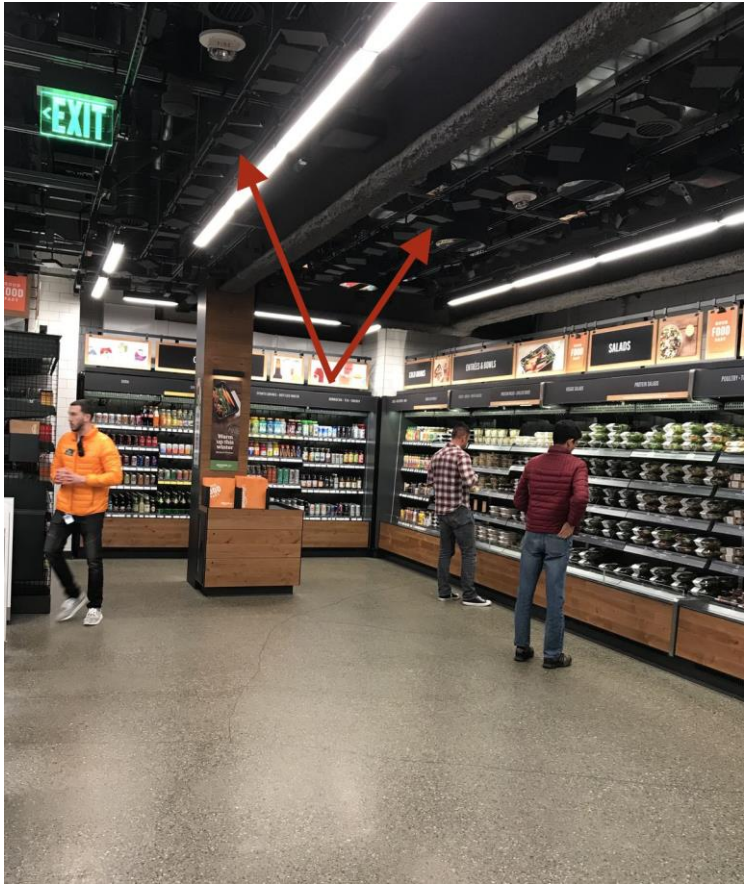
Source: S. Seitz

Amazon Go


NO LINES. NO CHECKOUT.
(NO, SERIOUSLY.)
JUST WALK OUT SHOPPING
amazon go


amazon go
NO LINES

Amazon Go

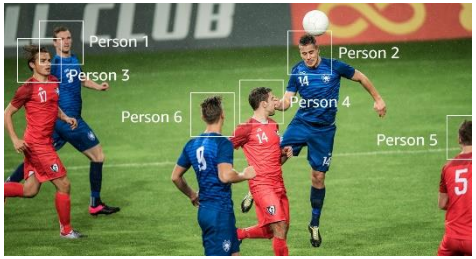


Amazon Rokognition (AWS)

Object Detection

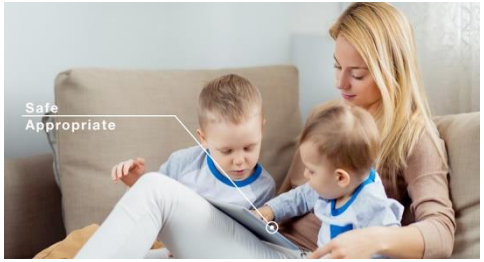
Facial Recognition

Facial Analysis



Pathing

Celebrity Recognition



Unsafe Content Detection

Text in images

Google cars

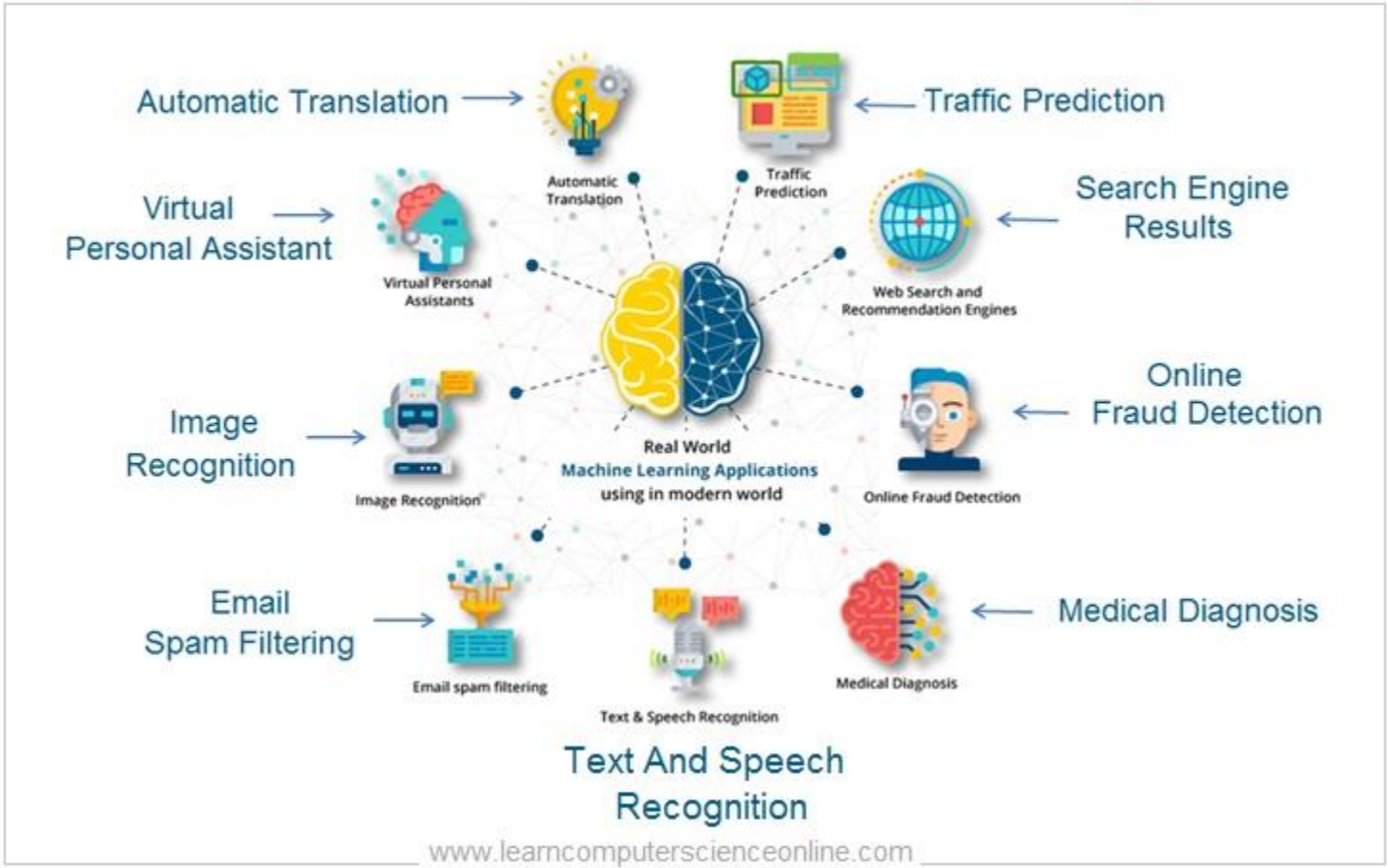
Oct 9, 2010. "Google Cars Drive Themselves, in Traffic". *The New York Times*. John Markoff
June 24, 2011. "Nevada state law paves the way for driverless cars". *Financial Post*. Christine Dobby
Aug 9, 2011, "Human error blamed after Google's driverless car sparks five-vehicle crash". *The Star* (Toronto)

WAYMO LLC

WAYMO Self Driving Car

Tesla Auto Pilot

Real World Applications Of Machine Learning



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., Handwriting recognition, most of Natural Language Processing (NLP), Computer Vision.

Machine Learning

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Examples:

- Database mining

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  E.g., Web click data, medical records, biology, engineering
- Applications can’t program by hand.

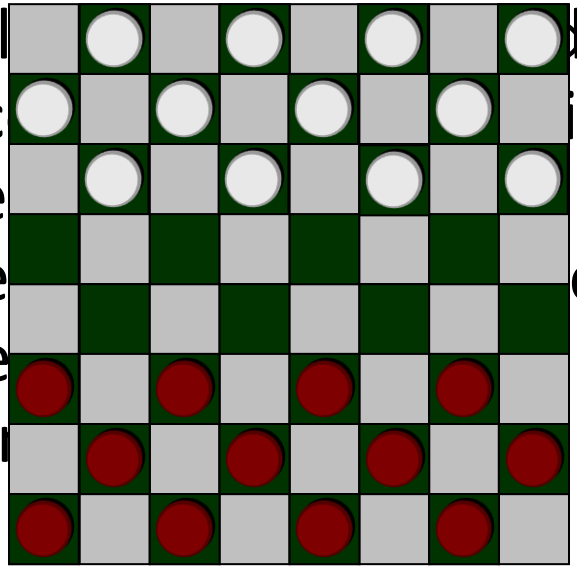
  E.g., Handwriting recognition, most of Natural Language Processing (NLP), Computer Vision.
- Self-customizing programs

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

What is machine learning?

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.

Machine learning algorithms:

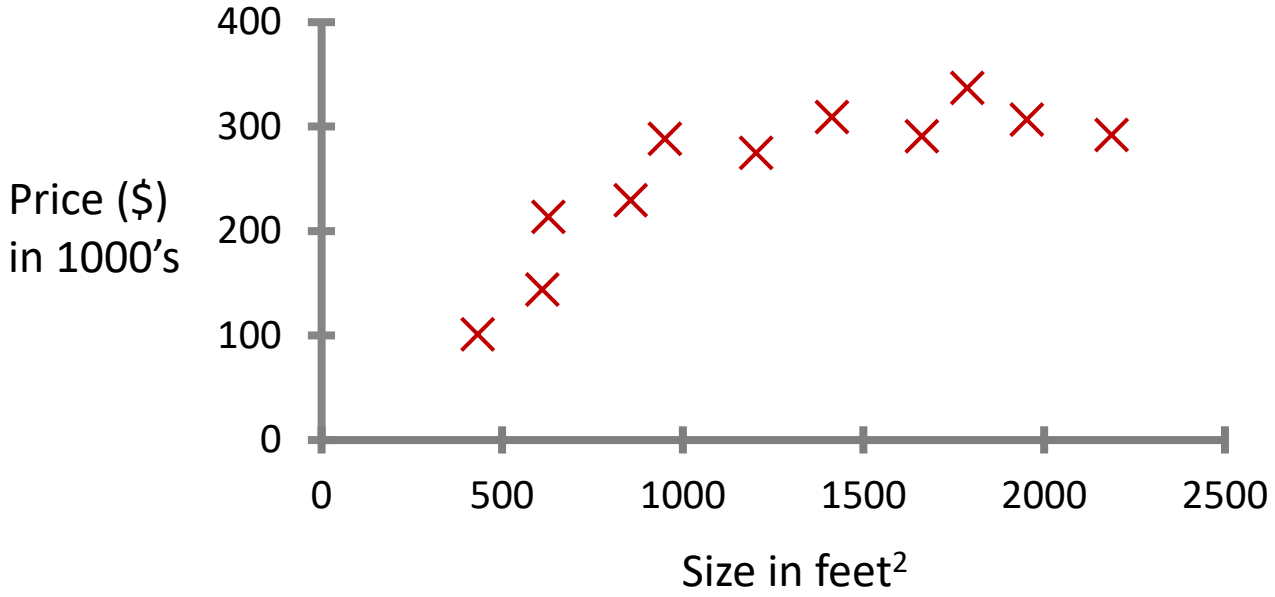
- Supervised learning
- Unsupervised learning

Others: Reinforcement learning, recommender systems.

Also talk about: Practical advice for applying learning algorithms.

Supervised Learning

Housing price prediction.

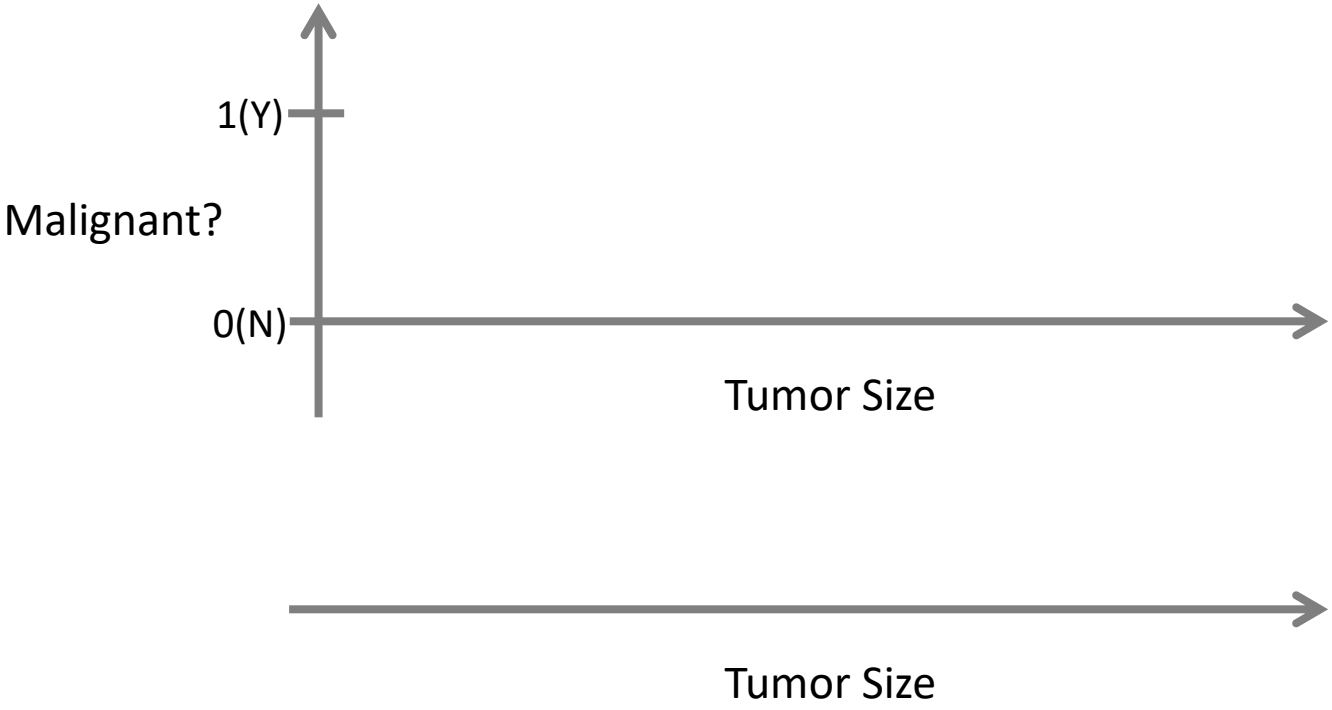


Supervised Learning

"right answers" given

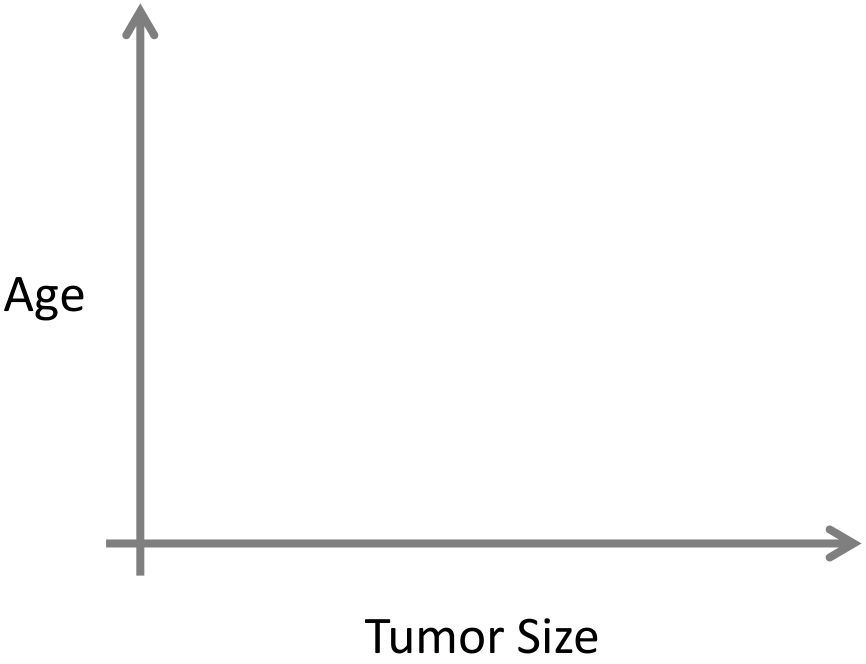
Regression: Predict continuous valued output (price)

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.

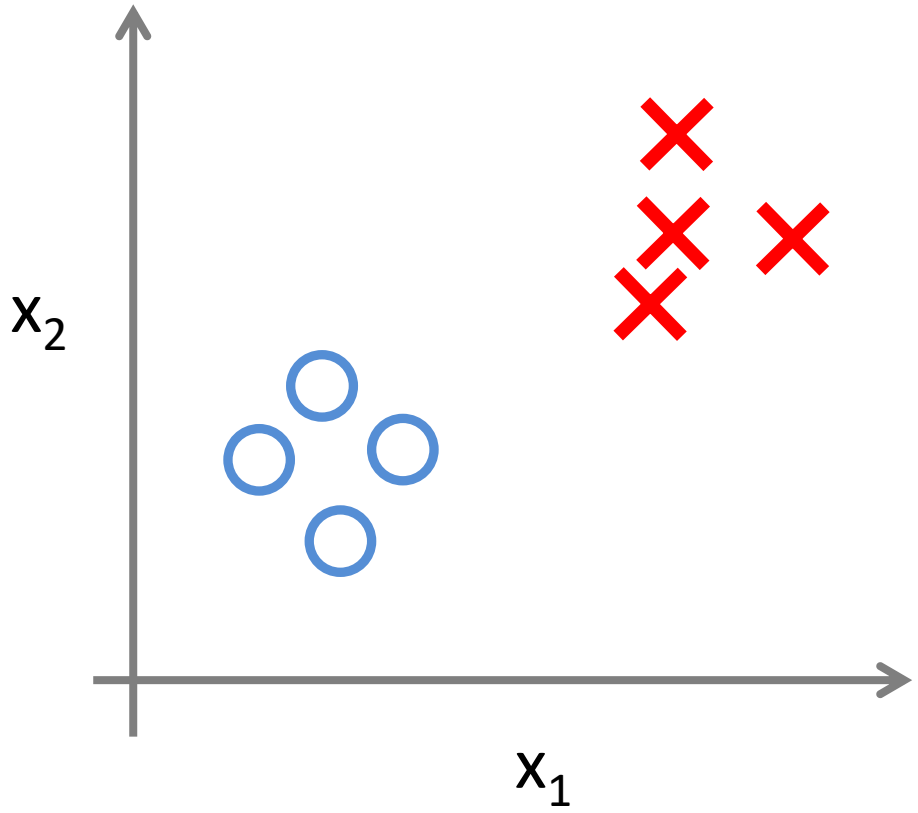
Treat problem 1 as a classification problem, problem 2 as a regression problem.

Treat problem 1 as a regression problem, problem 2 as a classification problem.

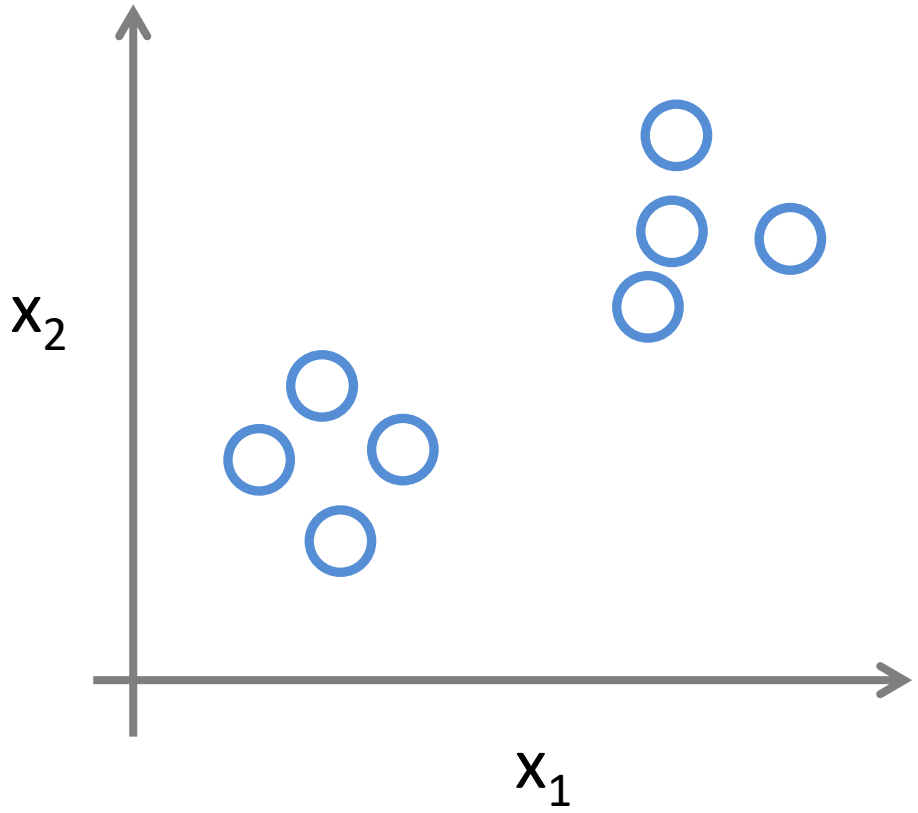
Treat both as regression problems.

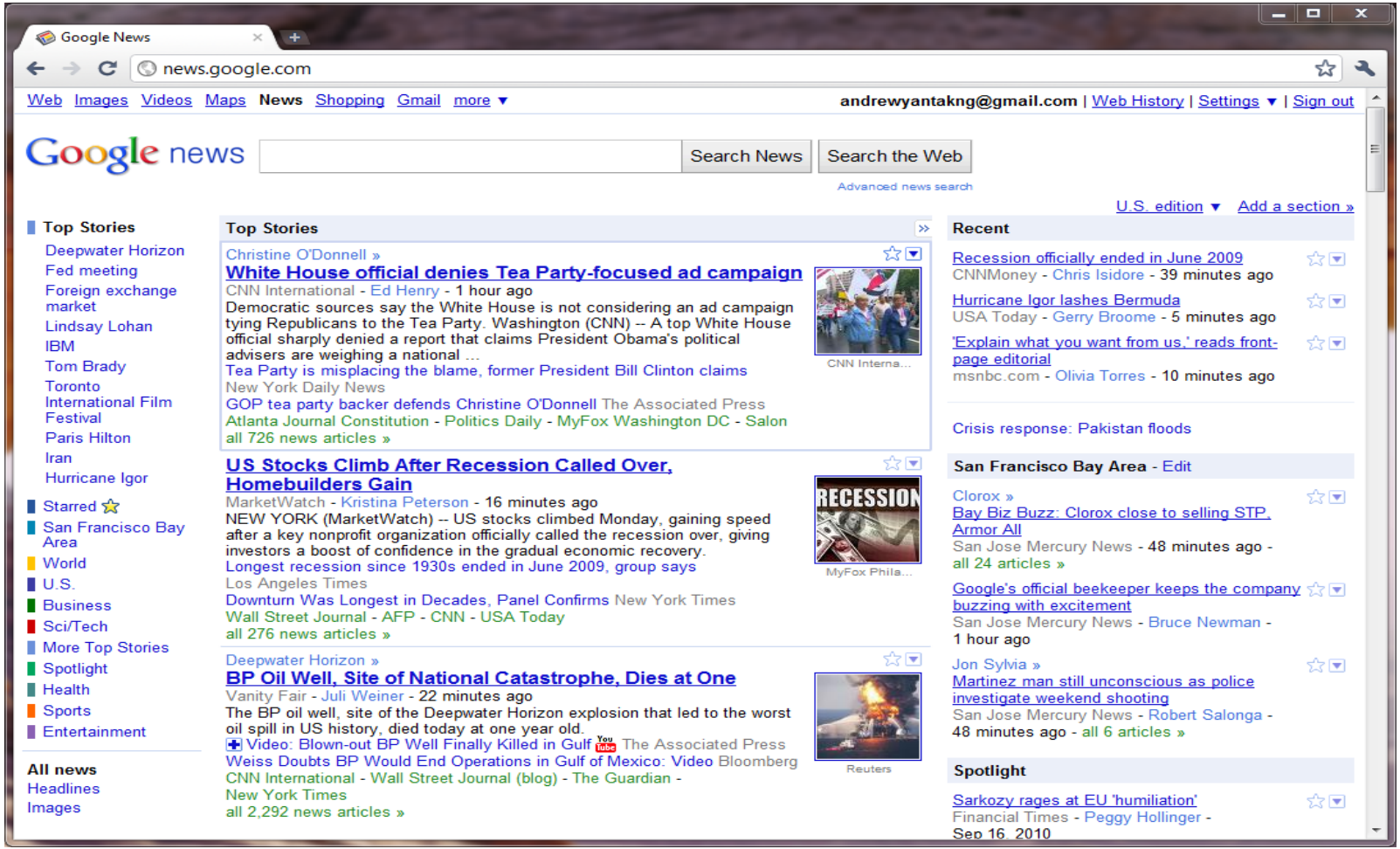
Unsupervised Learning

Supervised Learning



Unsupervised Learning

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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
Paris Hilton
Iran
Hurricane Igor
Starred
San Francisco Bay Area
World
U.S.
Business
Sci/Tech
More Top Stories
Spotlight
Health
Sports
Entertainment
All news
Headlines
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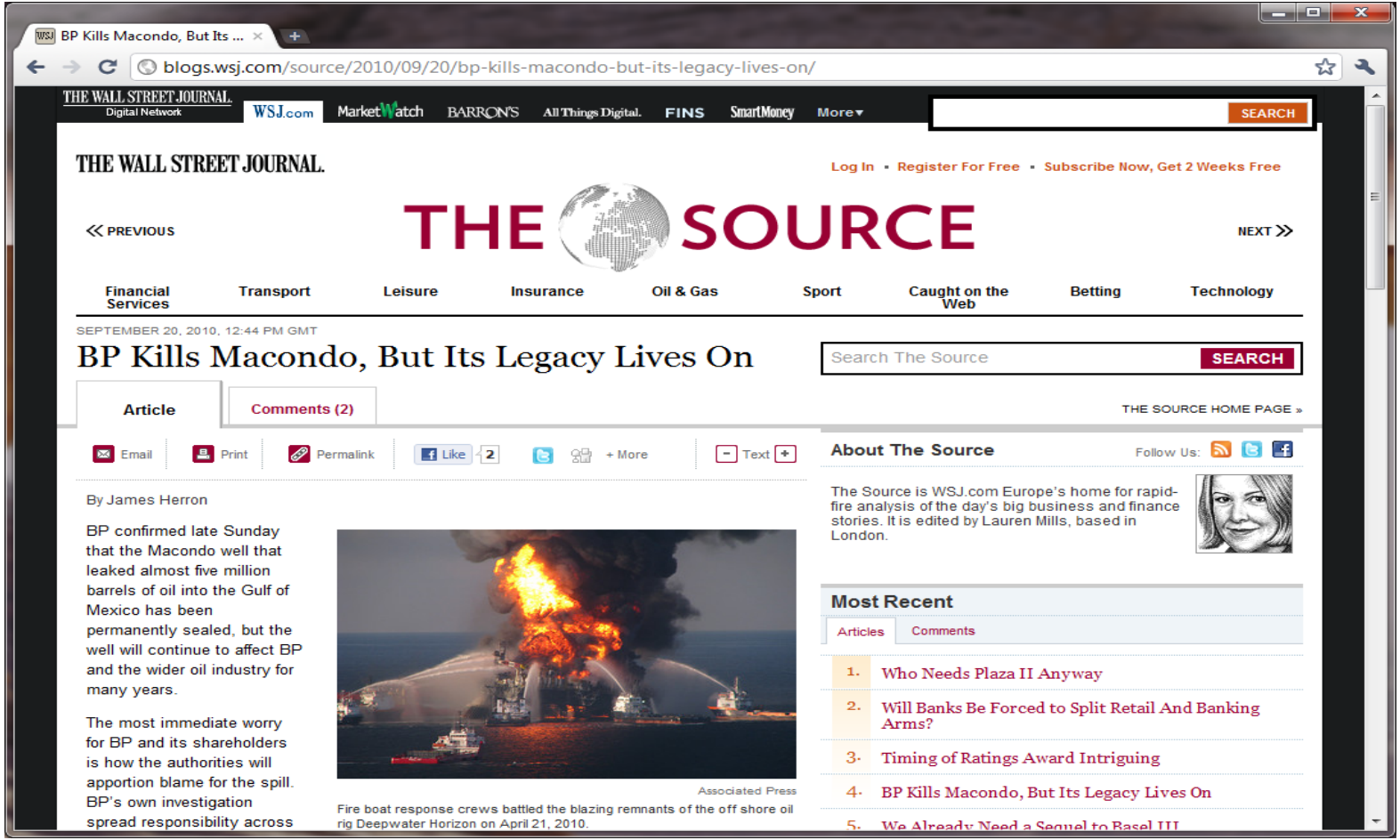
Top Stories
Christine O'Donnell »
White House official denies Tea Party-focused ad campaign
CNN International - Ed Henry - 1 hour ago
Democratic sources say the White House is not considering an ad campaign tying Republicans to the Tea Party. Washington (CNN) -- A top White House official sharply denied 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 »
RECESSION
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
Recent
Recession officially ended in June 2009
CNNMoney - 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 »
Google's official beekeeper keeps the company buzzing with excitement
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


BP Kills Macondo, But Its ...
blogs.wsj.com/source/2010/09/20/bp-kills-macondo-but-its-legacy-lives-on/
THE WALL STREET JOURNAL. Digital Network
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SEPTEMBER 20, 2010, 12:44 PM GMT
BP Kills Macondo, But Its Legacy Lives On
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Email Print Permalink Like 2 + More Text
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 spread responsibility across
Associated Press
Fire boat response crews battled the blazing remnants of the off shore oil rig Deepwater Horizon on April 21, 2010.
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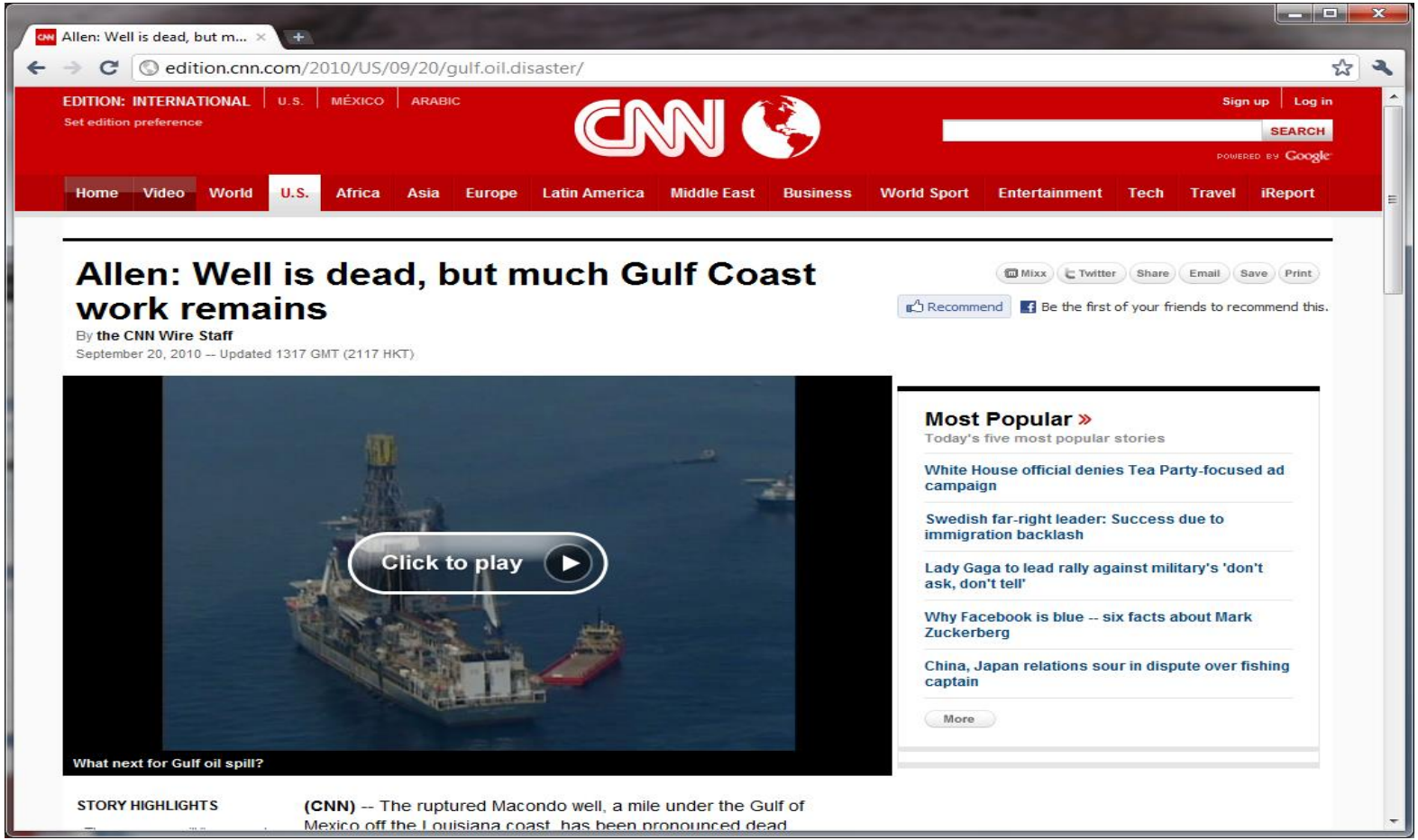
3. Timing of Ratings Award Intriguing
4. BP Kills Macondo, But Its Legacy Lives On
5. We Already Need a Sequel to Basel III


Allen: Well is dead, but m...
edition.cnn.com/2010/US/09/20/gulf.oil.disaster/
EDITION: INTERNATIONAL
U.S.
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ARABIC
Set edition preference
CNN
Sign up
Log in
SEARCH
POWERED BY Google
Home
Video
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U.S.
Africa
Asia
Europe
Latin America
Middle East
Business
World Sport
Entertainment
Tech
Travel
iReport
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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(CNN) -- The ruptured Macondo well, a mile under the Gulf of Mexico off the Louisiana coast, has been pronounced dead

BP oil spill cost hits nearl...

www.guardian.co.uk/environment/2010/sep/20/bp-oil-spill-deepwater-horizon-costs-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

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US government declares wall 'dead'

BP oil spill news on Twitter

Latest news on the BP oil spill in the Gulf of Mexico

BP_America: Find fact sheets, open house info and e-mail alert sign-ups at @EPAgov's oil spill community page: http://bit.ly/diuHoH
about 3 weeks ago

guardianeco: UN report on Nigeria oil spills relies too much on data from Shell | Nnimmo Bassey http://bit.ly/dBd7Ru
about 3 weeks, 5 days ago

BP_America: Newly discovered microbe thriving from consumption of #oil in the #Gulf of Mexico: http://bit.ly/9kQYwa
about 3 weeks, 5 days ago

- Archive page: read more BP oil spill tweets
- Follow BP oil spill news with our Twitter list
- Full BP oil spill coverage from guardian.co.uk

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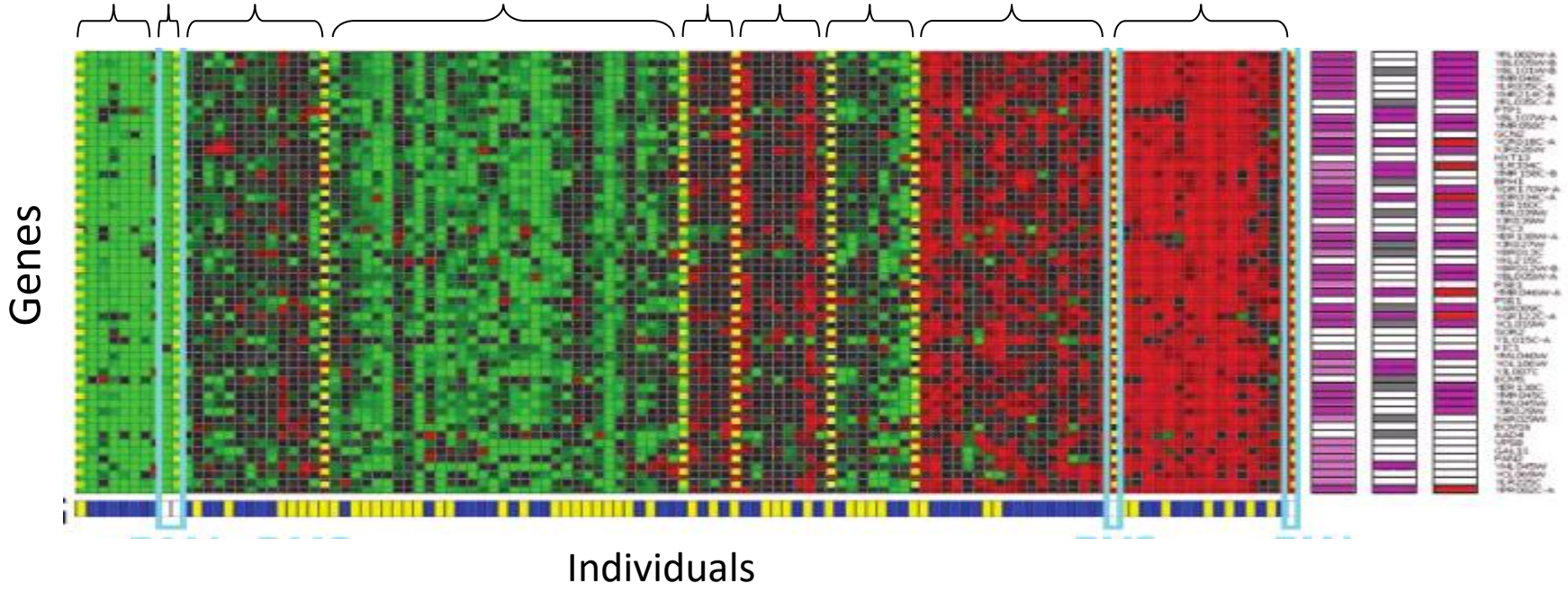
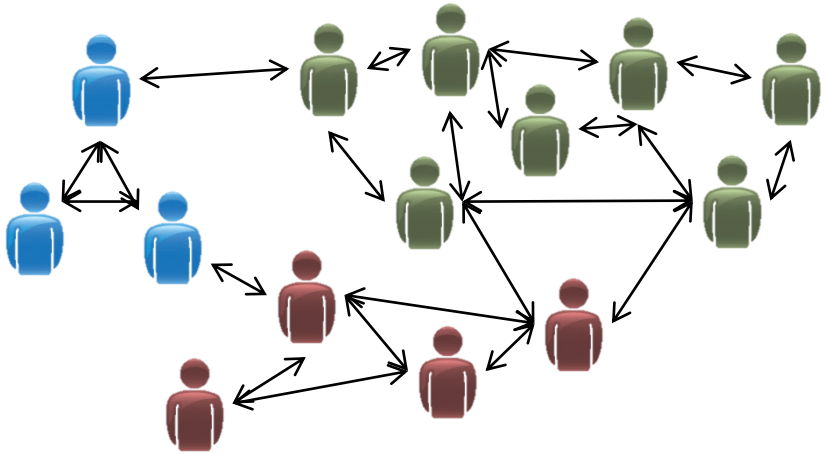
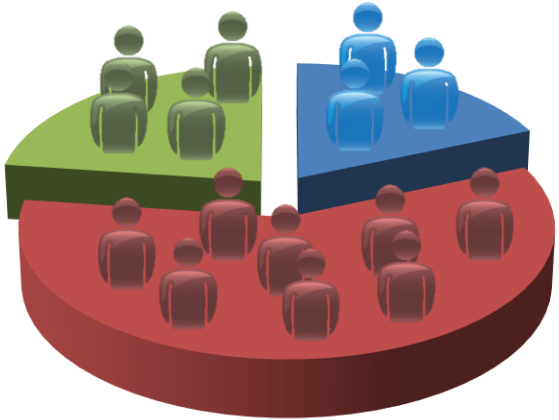


[Source: Su-In Lee, Dana Pe'er, Aimee Dudley, George Church, Daphne Koller]

Organize computing clusters



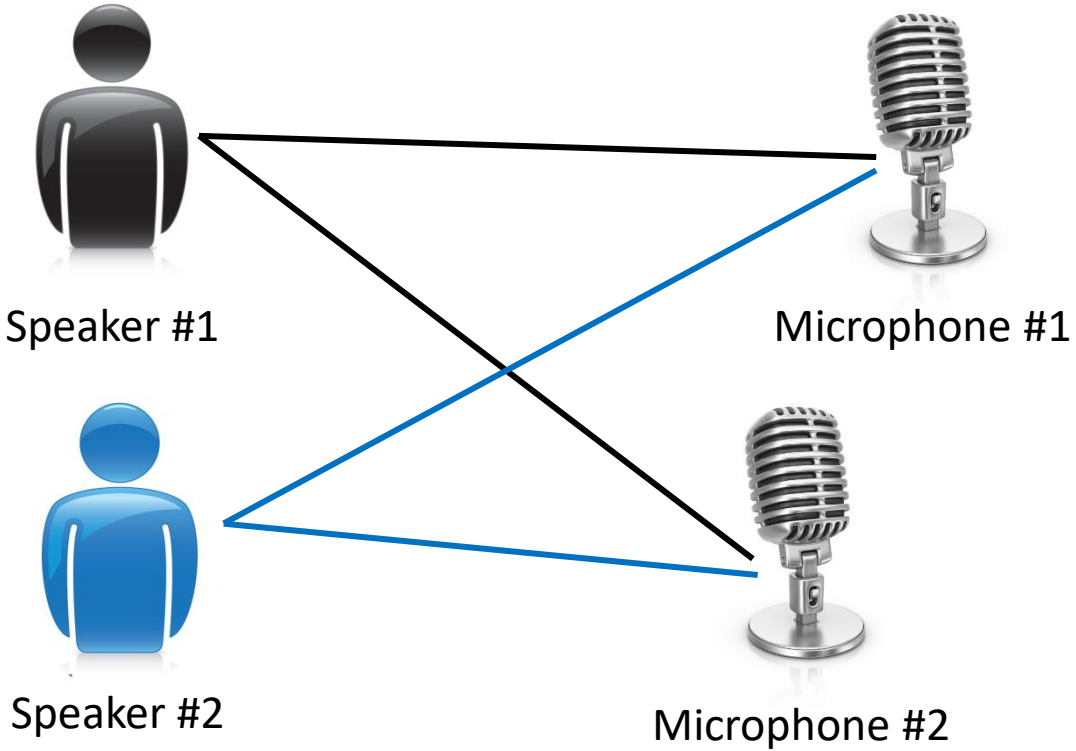
Social network analysis



Market segmentation

Astronomical data analysis

Cocktail party problem



Cocktail party problem algorithm

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

[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.