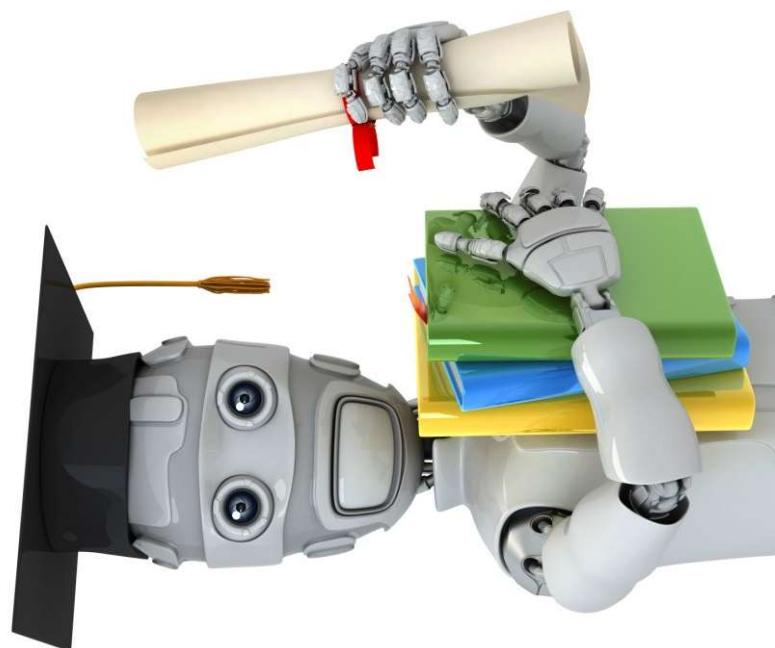


Introduction

Welcome



Machine Learning

The screenshot shows the official Apple website for iLife '11. The URL in the address bar is www.apple.com/ilife/iphoto/. The main content area features a large image of two people smiling, one wearing a helmet, displayed on a tablet screen. Below this image is the title "iPhoto '11". A paragraph of text describes the software's features, mentioning integration with Facebook, email, and the ability to store more photos than ever. To the right of the main image, there are two call-to-action buttons: "What's New in iPhoto" and "What is iPhoto?". At the bottom left, there is a thumbnail for a video titled "Watch the iPhoto video ▶". The navigation menu at the top includes links for Store, Mac, iPod, iPhone, iPad, iTunes, Support, Resources, GarageBand, Video Showcase, and Upgrade Now.



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

- Grew out of work in AI

- |

Exam

- |

- ,

lost of

lg



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E.g., Amazon, Netflix product recommendations

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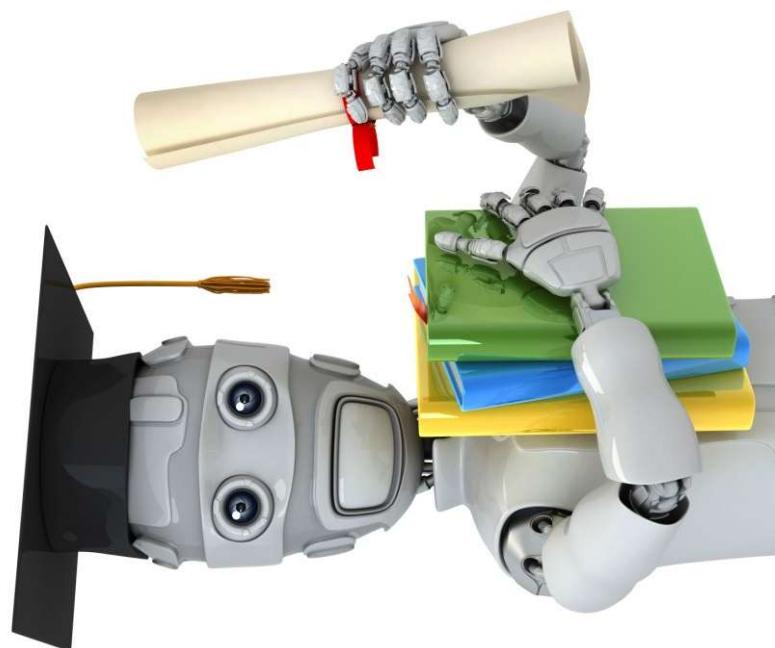
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 - E.g., Autonomous helicopter, handwriting recognition, most of Natural Language Processing (NLP), Computer Vision.
 - Self-customizing programs
 - E.g., Amazon, Netflix product recommendations
 - Understanding human learning (brain, real AI).

Introduction

What is machine learning



Machine Learning

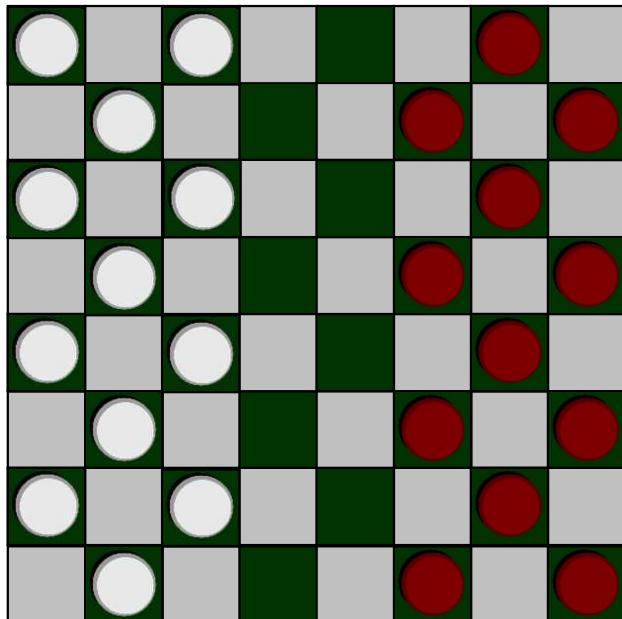
Machine Learning definition

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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

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- 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?

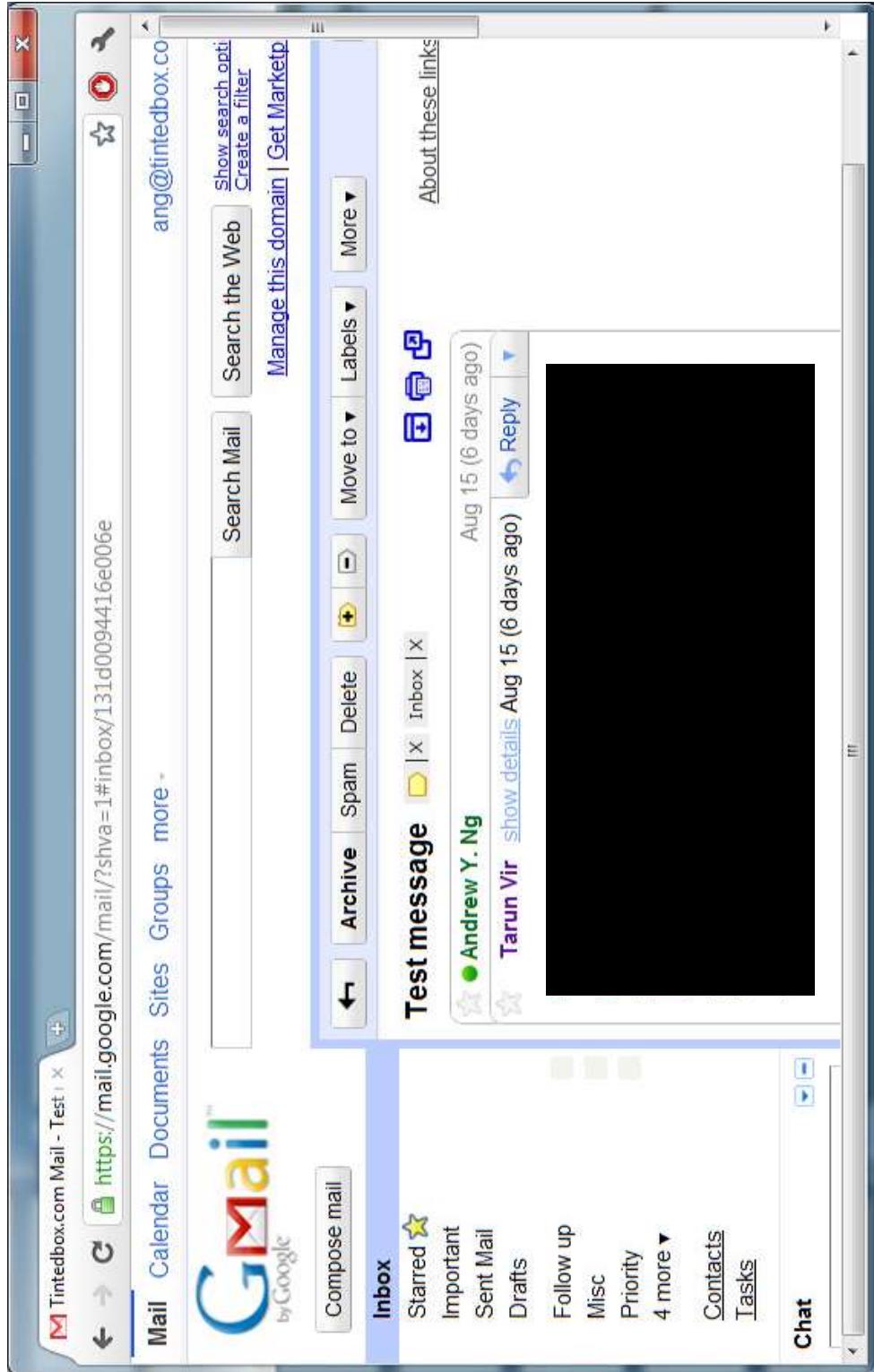
- Classifying emails as spam or not spam. $\rightarrow T \leftarrow$
- Watching you label emails as spam or not spam. $E \leftarrow$
- The number (or fraction) of emails correctly classified as spam/not spam. $P \leftarrow$
- None of the above—this is not a machine learning problem.

"A computer program is said to learn from experience E with respect to

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*or do
filter*



pam.

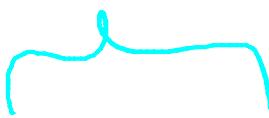
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Machine learning algorithms:

- Supervised learning
- Unsupervised learning



Others: Reinforcement learning, recommender systems.

Also talk about: Practical advice for applying learning algorithms.

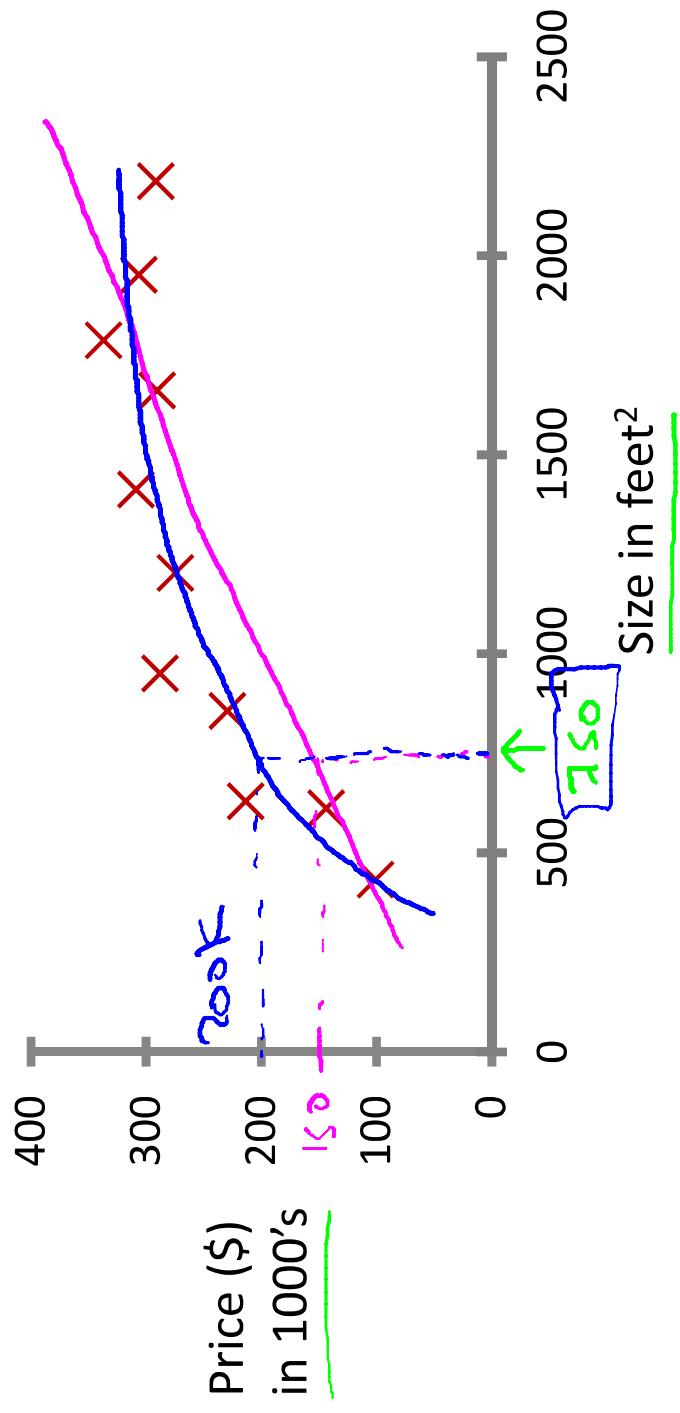


Introduction Supervised Learning



Machine Learning

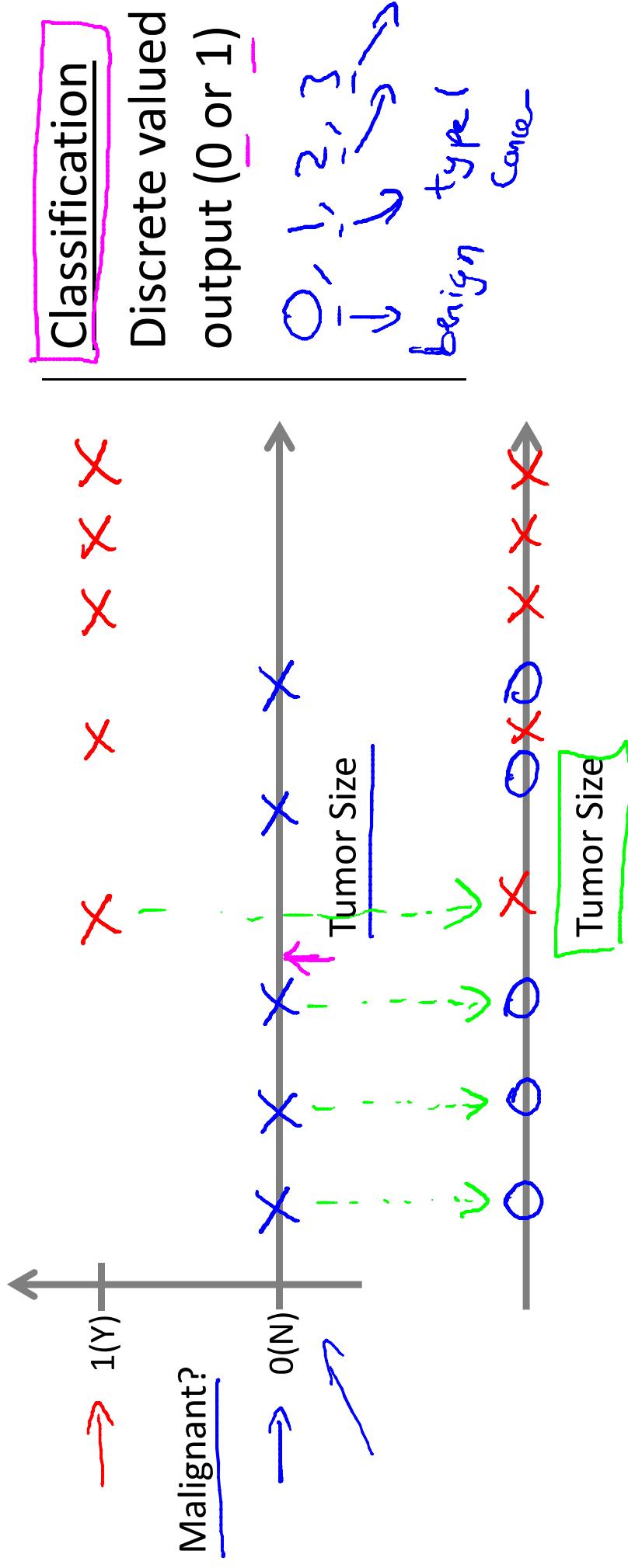
Housing price prediction.



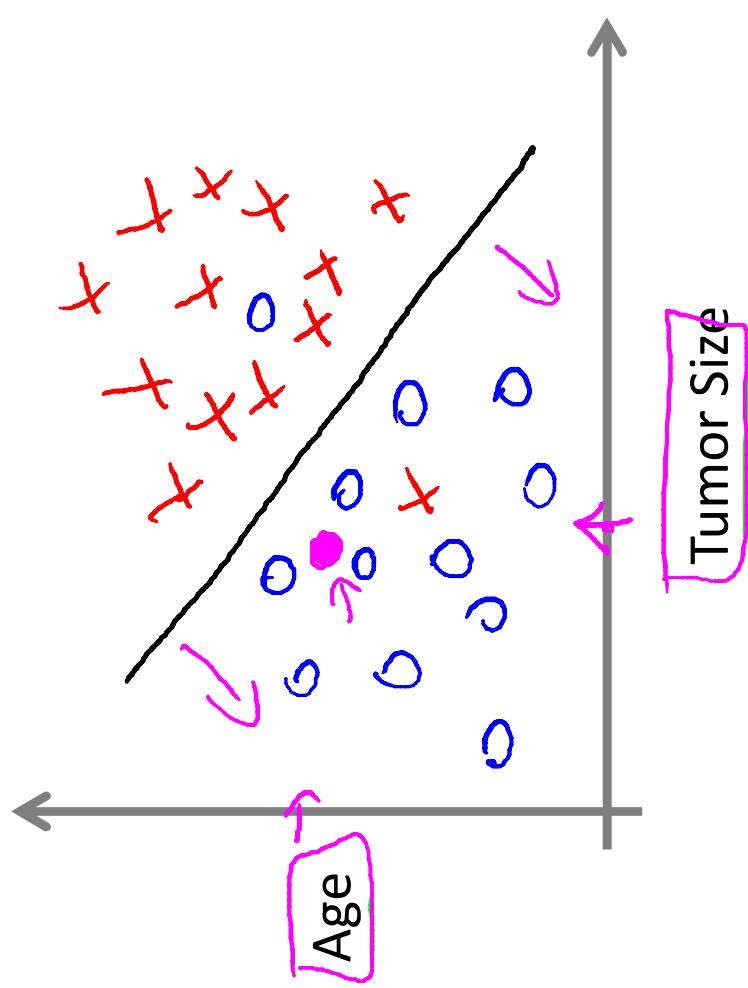
Supervised Learning
given
'right answers'

Regression: Predict continuous
valued output (price)

Breast cancer (malignant, benign)



- 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.

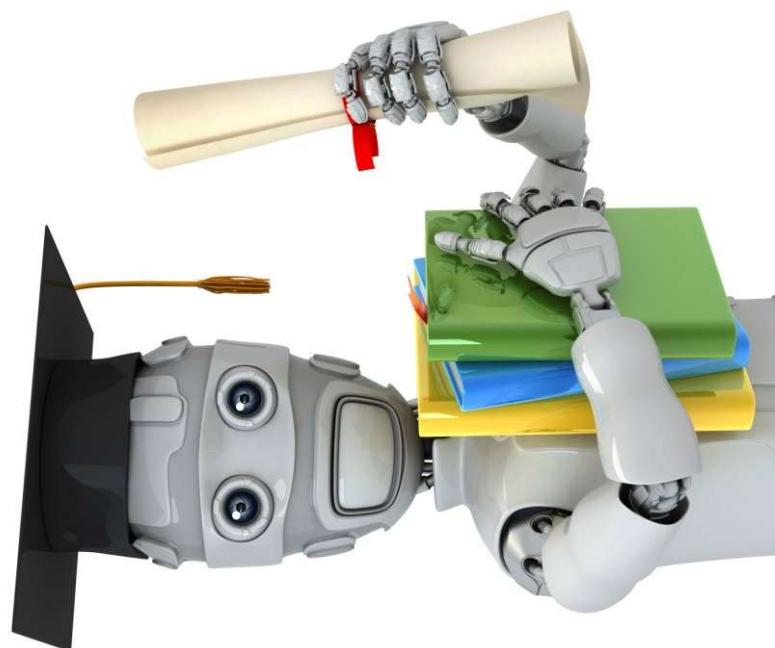
1000's

- 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. → $0 - \text{not hacked}$
→ $1 - \text{hacked}$

Should you treat these as classification or as regression problems?

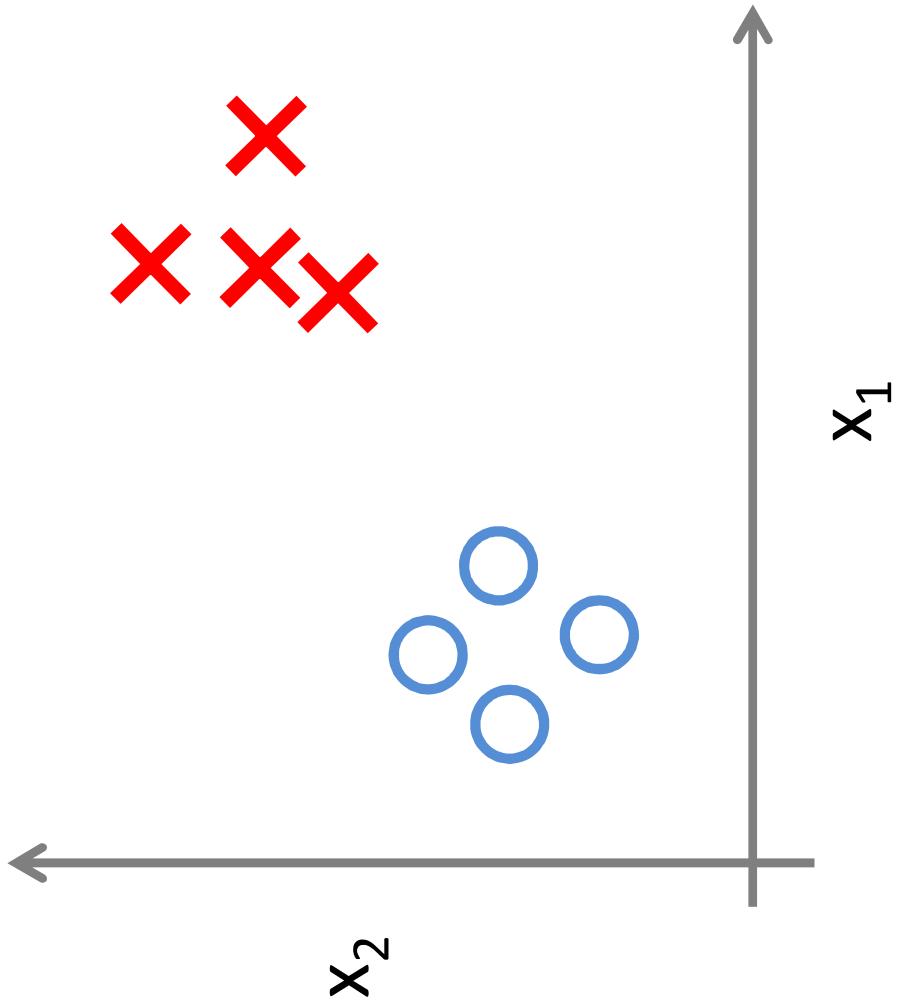
- Treat both as classification problems.
- Treat problem 1 as a classification problem, problem 2 as a regression problem.
- Treat problem 1 as a regression problem, problem 2 as a classification problem.
- Treat both as regression problems.

Introduction to Unsupervised Learning

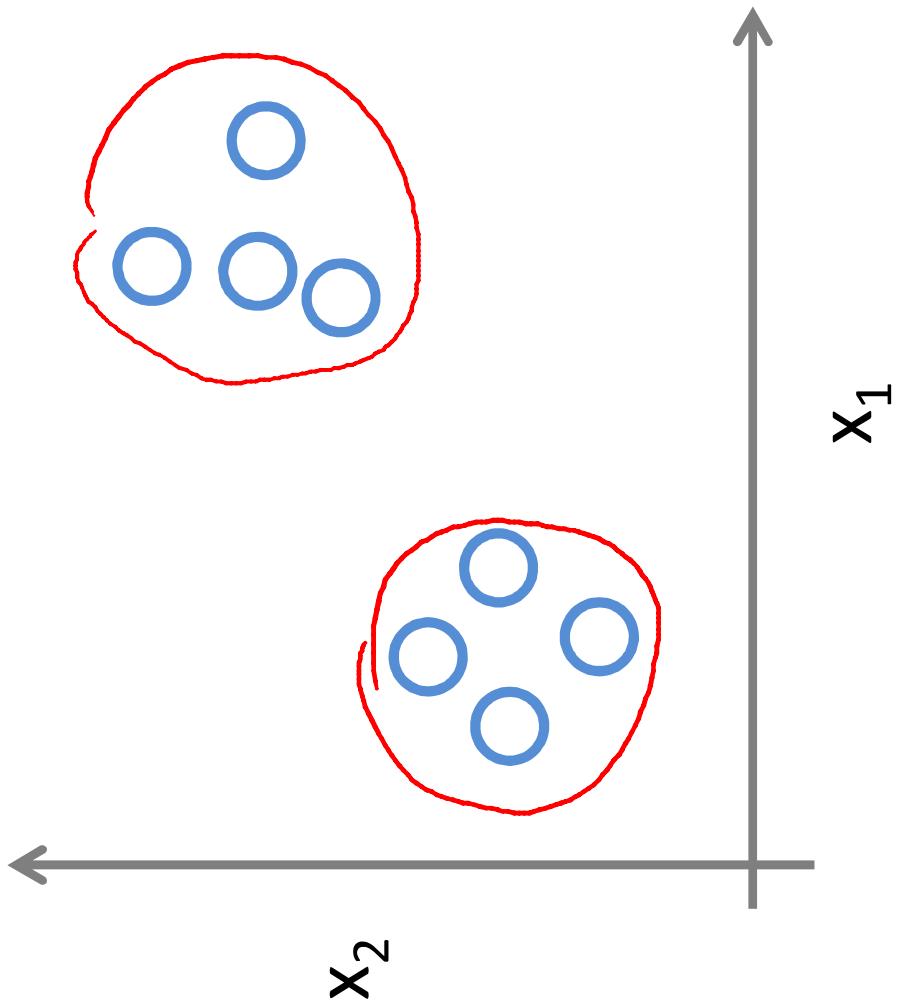


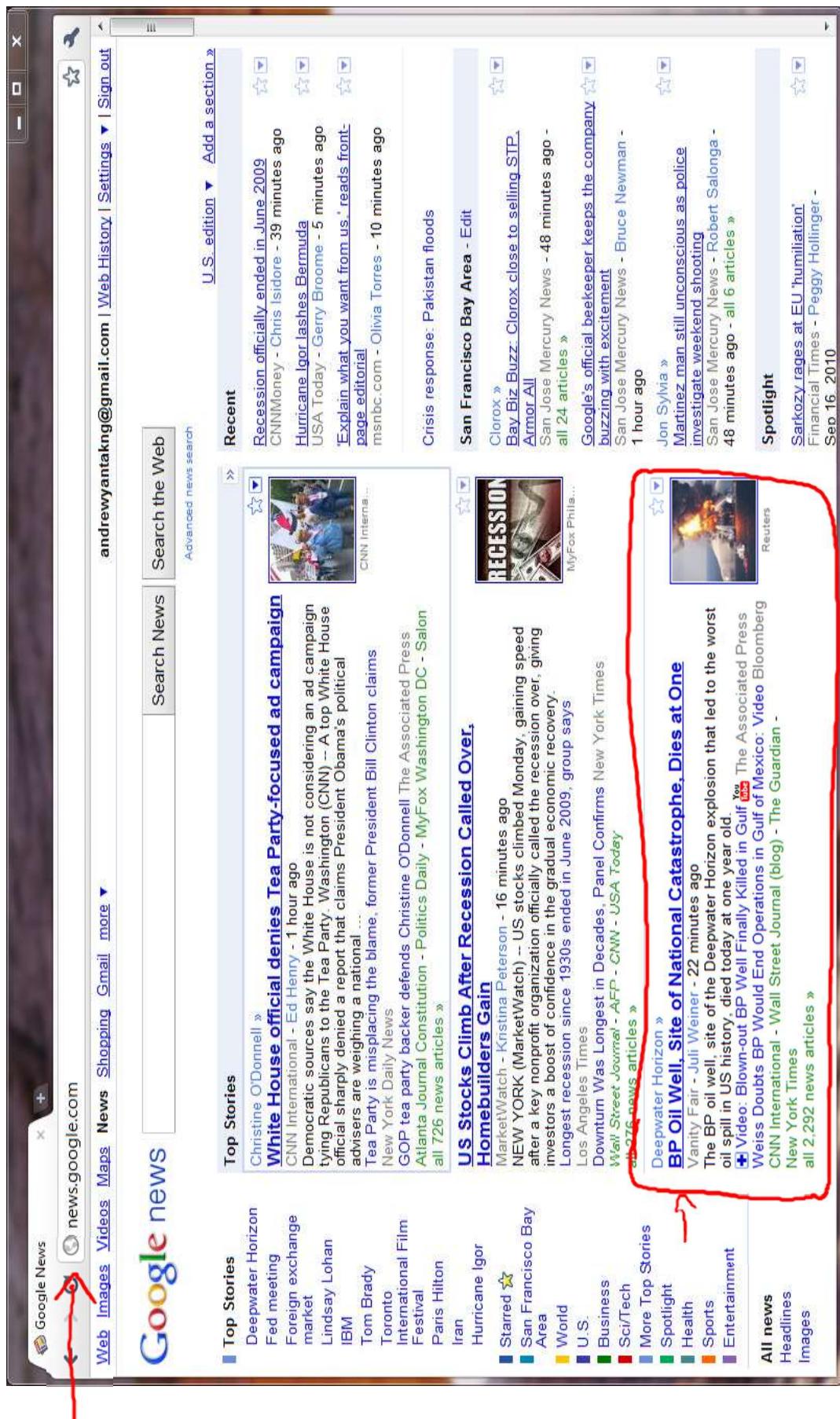
Machine Learning

Supervised Learning

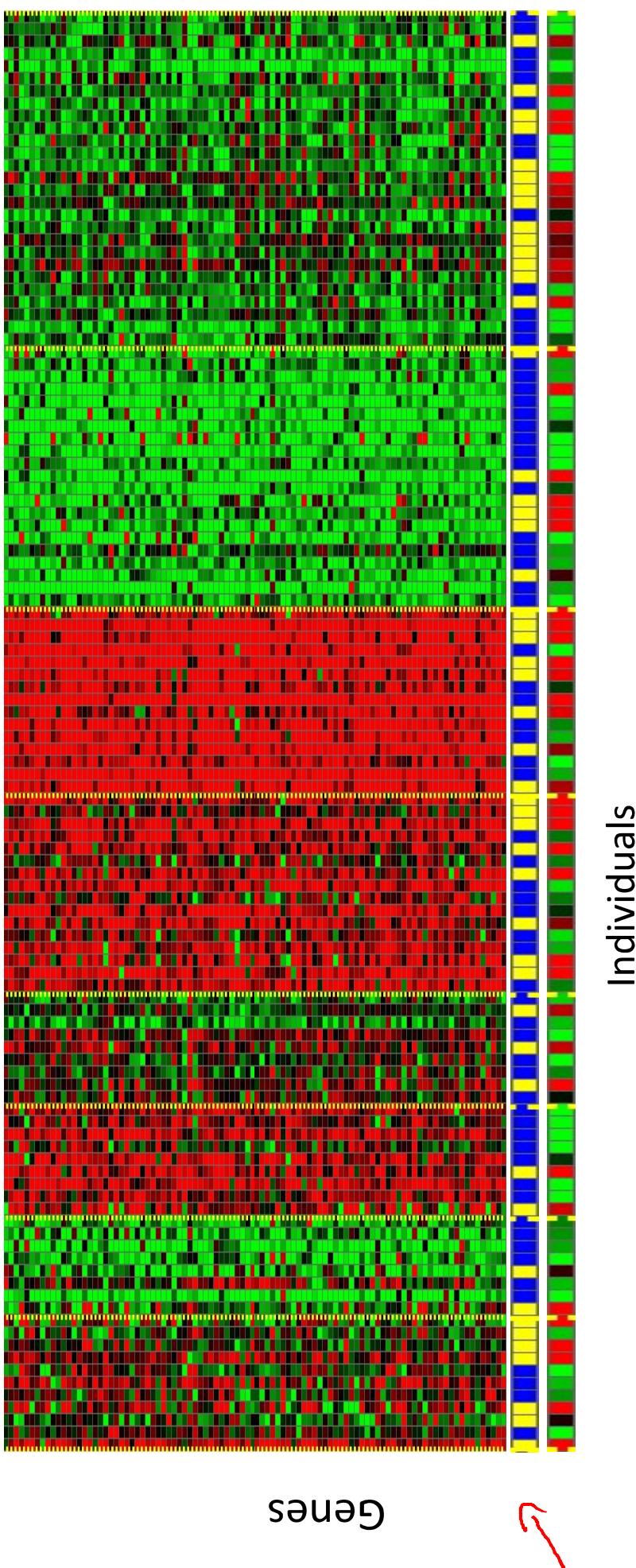


Unsupervised Learning

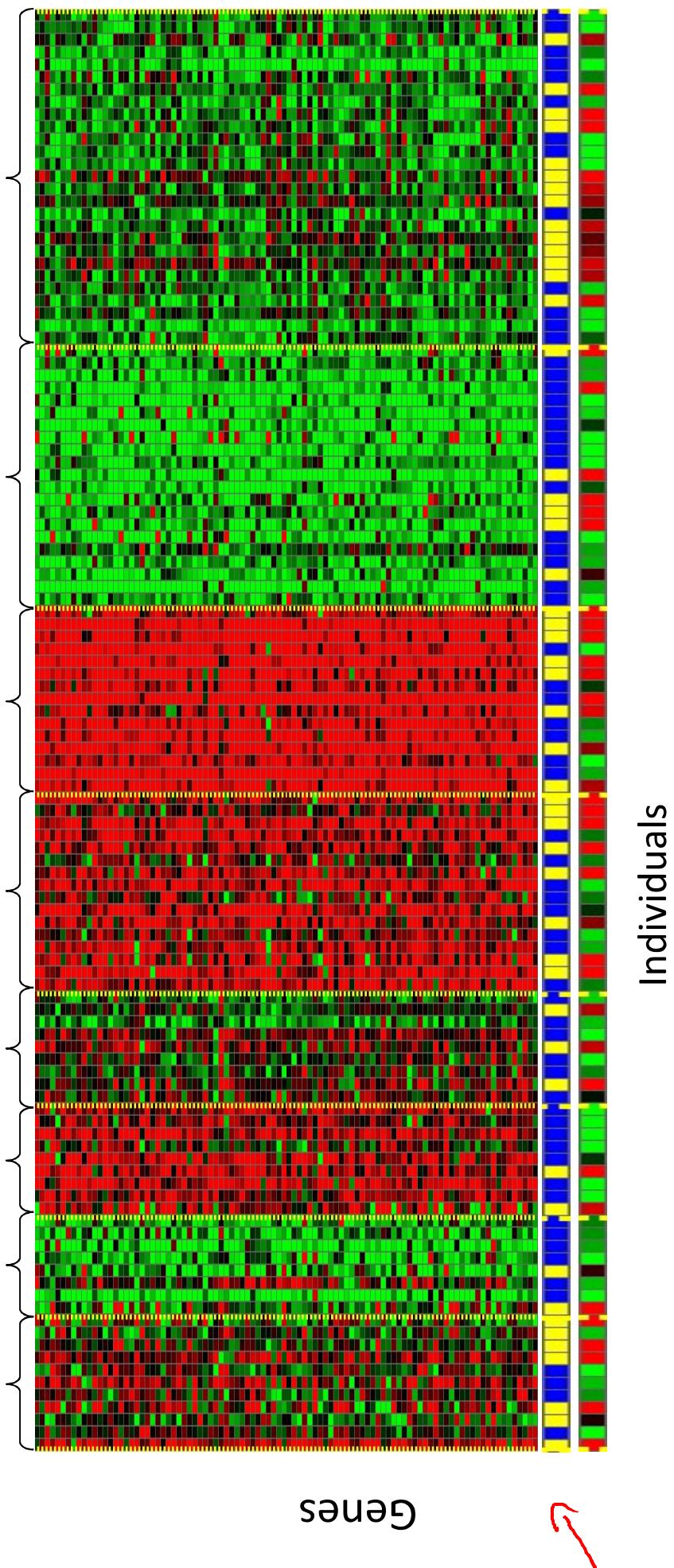




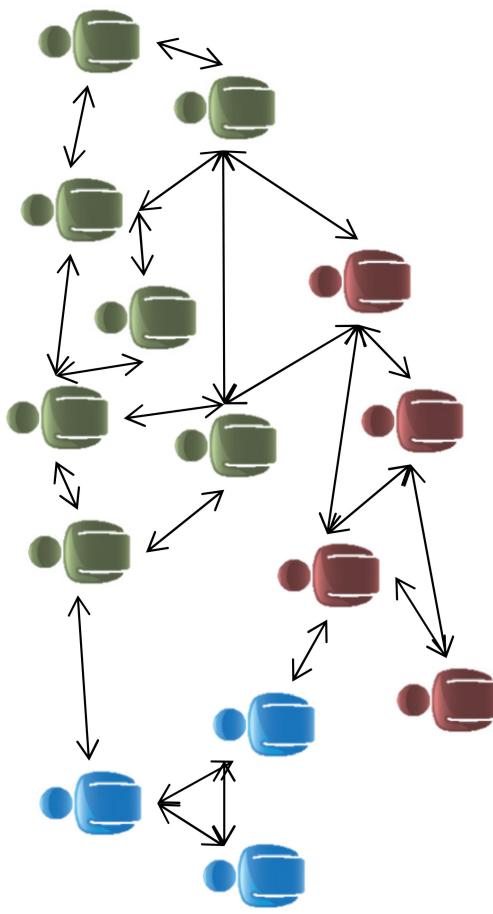
The screenshot shows a Google search results page for "Google news". The top navigation bar includes links for "Google News", "Web Images", "Videos", "Maps", "News", "Shopping", "Gmail", and "more". Below the search bar, there are sections for "Top Stories" and "Recent". The "Top Stories" section features headlines like "Christine O'Donnell » White House official denies Tea Party-focused ad campaign", "US Stocks Climb After Recessions Called Over", and "Hurricane Igor". The "Recent" section shows news items such as "Bacardi CEO ends 16-month run" and "Bacardi CEO ends 16-month run". A red arrow points from the "Top Stories" section towards the right side of the page. The right side of the page contains a CNN news card with the headline "Allen: Well is dead, but much Gulf Coast work remains" and a video thumbnail showing an oil rig. A red arrow also points from the CNN card towards the right edge of the screen.



[Source: Daphne Koller]



[Source: Daphne Koller]



Social network analysis

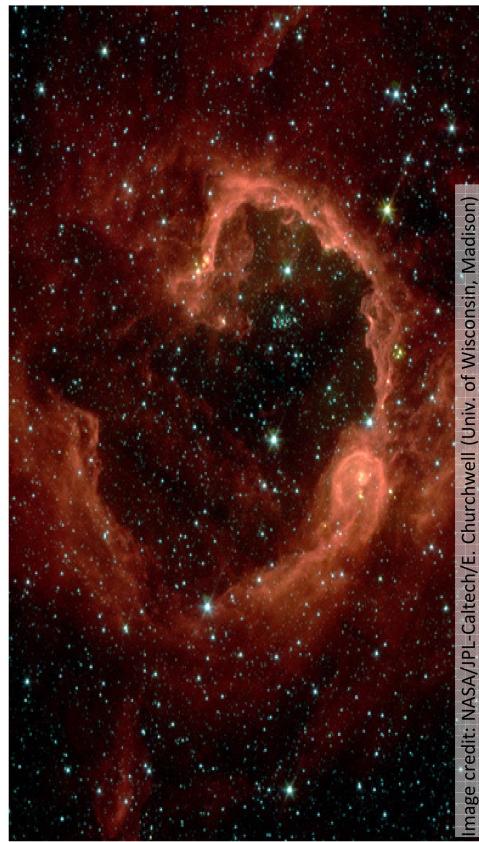
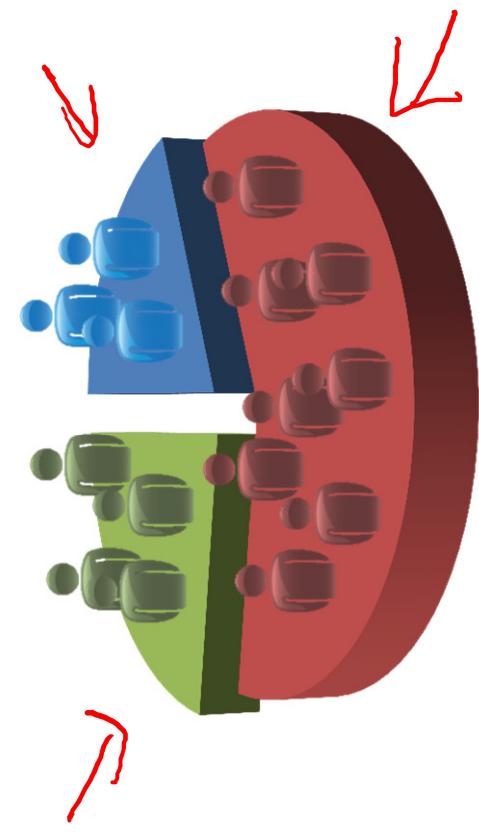


Image credit: NASA/JPL-Caltech/E. Churchwell (Univ. of Wisconsin, Madison)

Astronomical data analysis

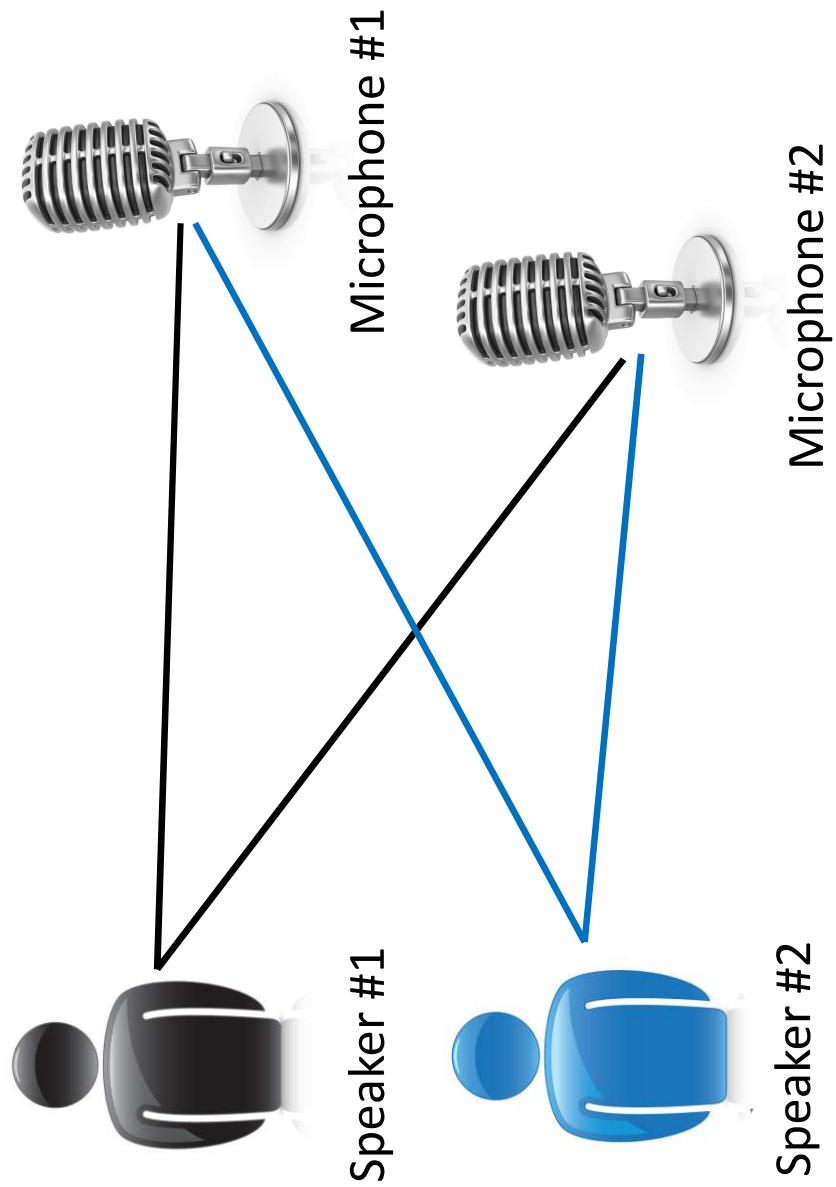


Organize computing clusters



Market segmentation

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');
```

[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 a 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.

