MACHINE LEARNING COMPLETE COURSE

LECTURER: ENG. ABOLFAZL MOHAMMADIJOO
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Course Content

- Chapter 1: Introduction
- Chapter 2: Linear Regression with One Variable
- Chapter 3: Linear Algebra Review
- Chapter 4: Linear Regression with Multiple Variables
- Chapter 5: Octave Tutorial
- Chapter 6: Logistic Regression
- Chapter 7: Regularization
- Chapter 8: Neural Networks Representation

Course Content

- Chapter 9: Neural Networks Learning
- Chapter 10: Advice for Applying Machine Learning
- Chapter 11: Machine Learning System Design
- Chapter 12: Support Vector Machines
- Chapter 13: Clustering
- Chapter 14: Dimensionality Reduction
- Chapter 15: Anomaly Detection
- Chapter 16: Recommender Systems

Course Content

- **Chapter 17: Large Scale Machine Learning**
- **Chapter 18: Application Example Photo OCR**
- **Chapter 19: Conclusion**

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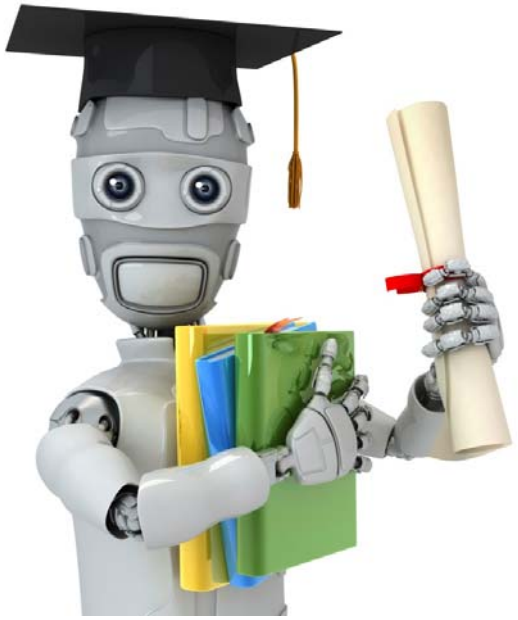

Machine Learning

Chapter 1: Introduction

Welcome

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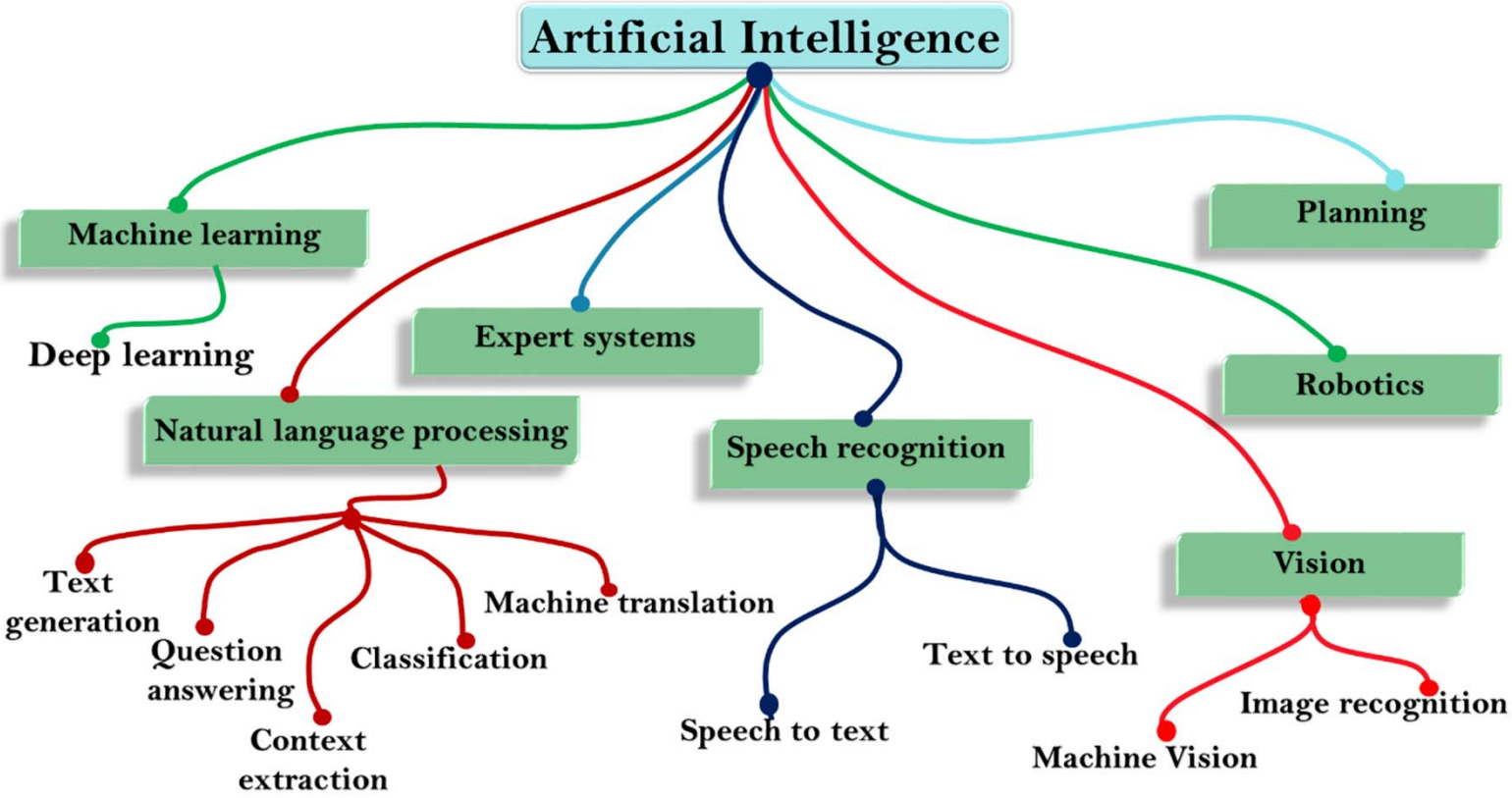
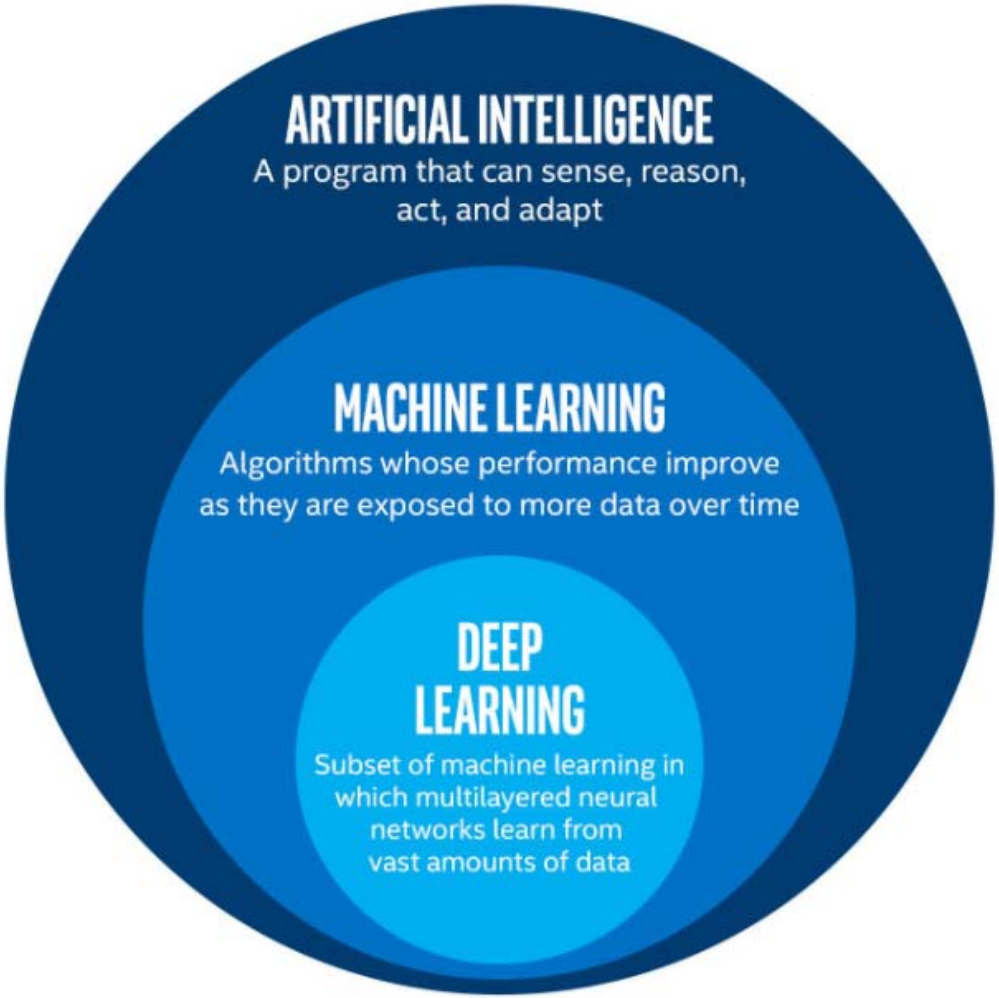

Artificial Intelligence
Machine learning
Deep learning
Expert systems
Natural language processing
Text generation
Question answering
Context extraction
Classification
Machine translation
Speech recognition
Speech to text
Text to speech
Planning
Robotics
Vision
Machine Vision
Image recognition

Question:

How a Machine can learn?!!
(conceptual answer)



Question:

How a Human can learn?!!
(conceptual answer)

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Machine Learning Daily Examples:

- Google Search Engine (to rank pages)
- Finding Spam emails and etc
- Photo Tagging

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

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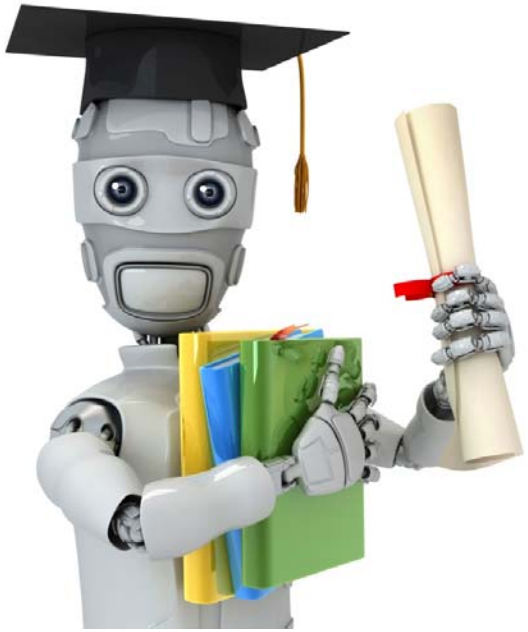

Machine Learning

Introduction

What is machine learning

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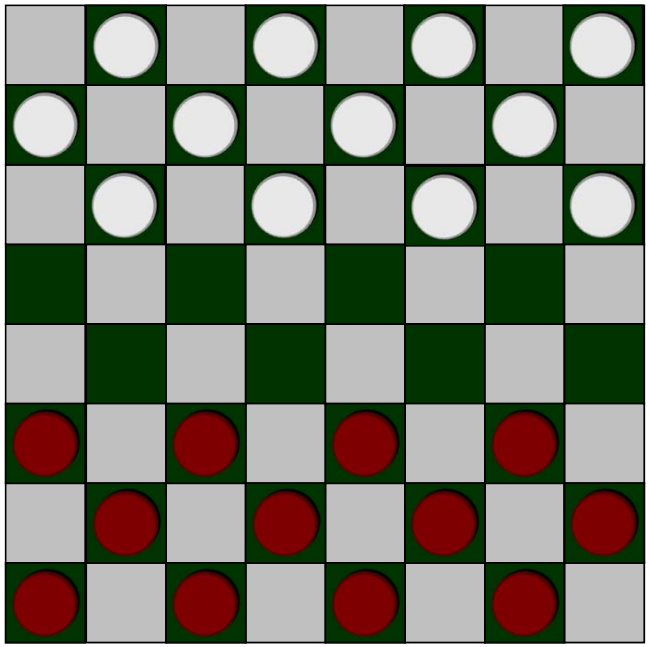
Machine Learning definition

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



Machine Learning definition

- 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.

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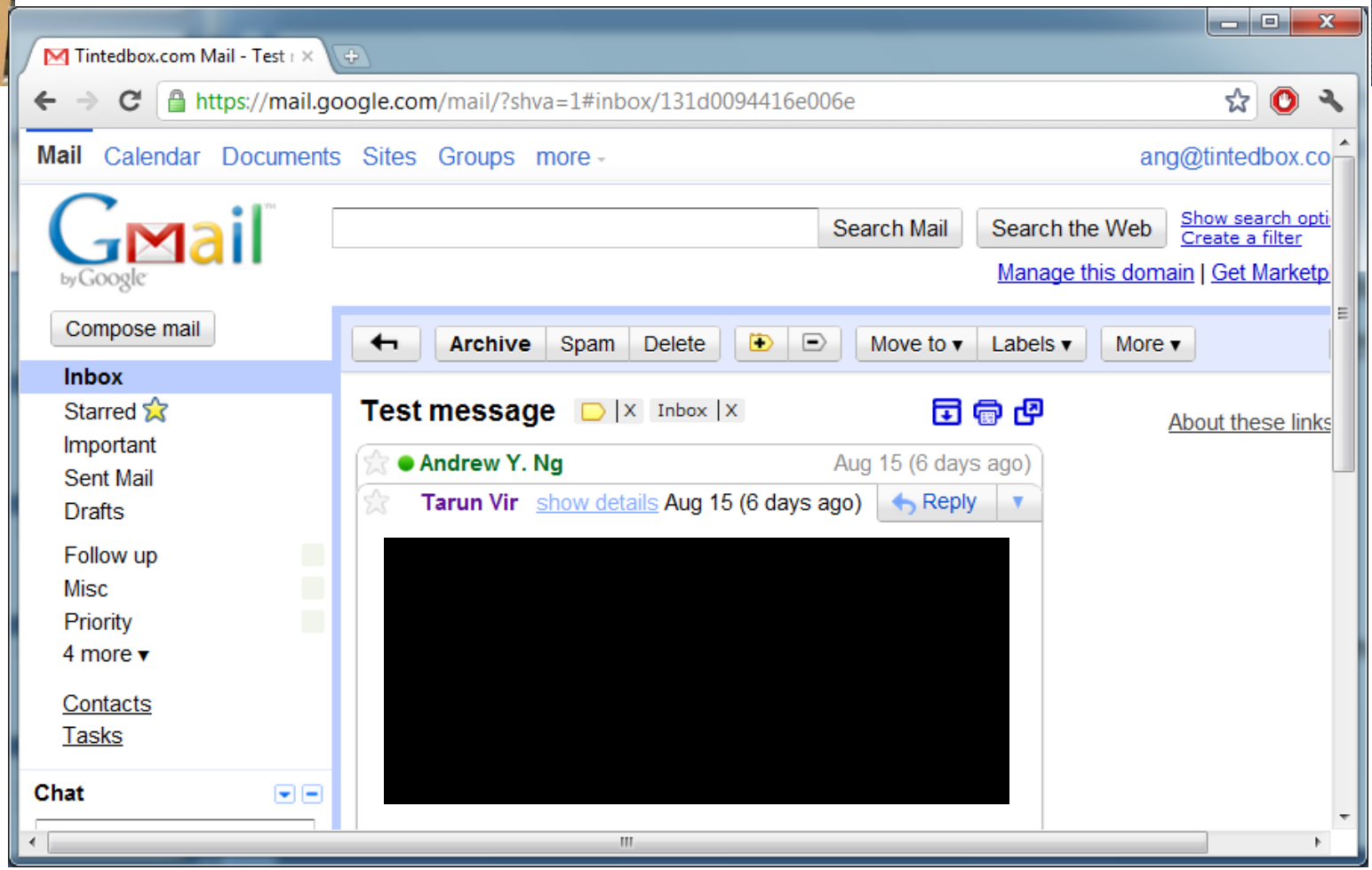

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Machine learning algorithms:

- Supervised learning
- Unsupervised learning

Others: Reinforcement learning, recommender systems.

Also talk about: Practical advice for applying learning algorithms.

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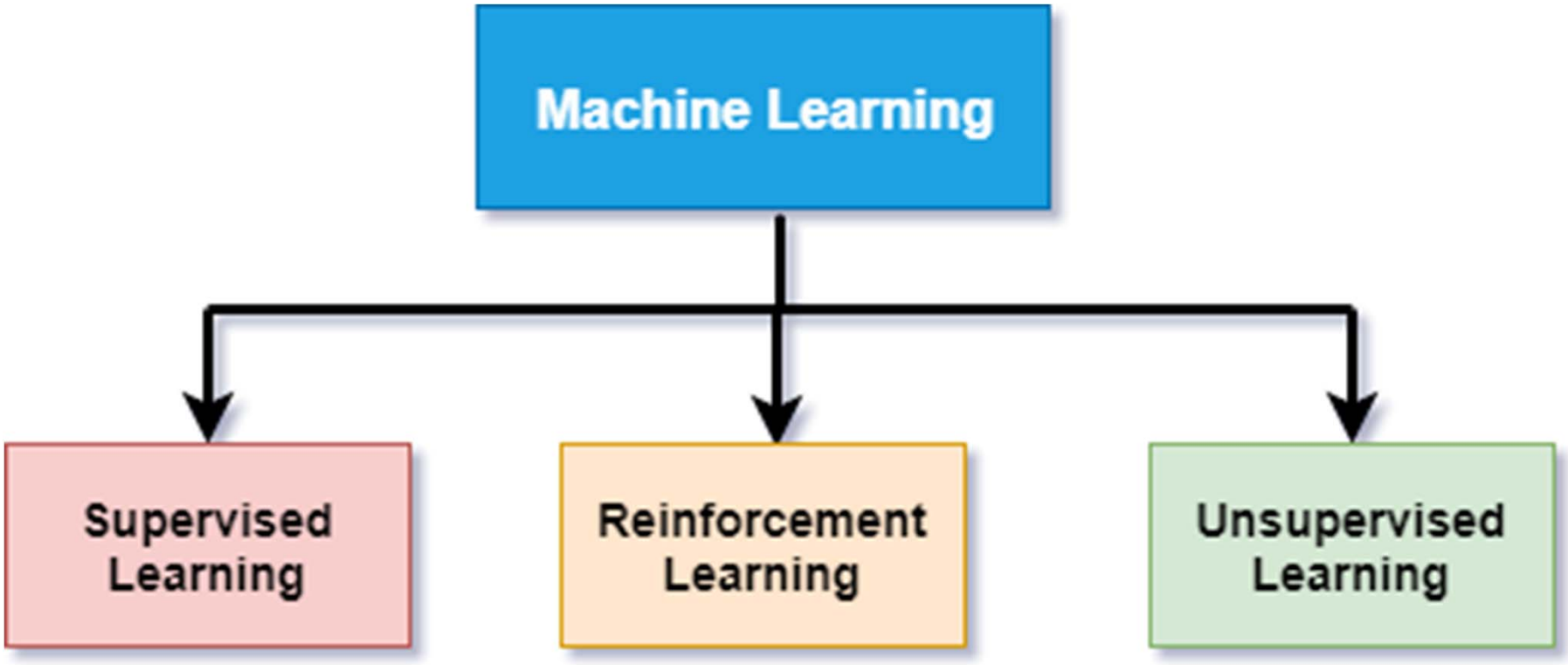

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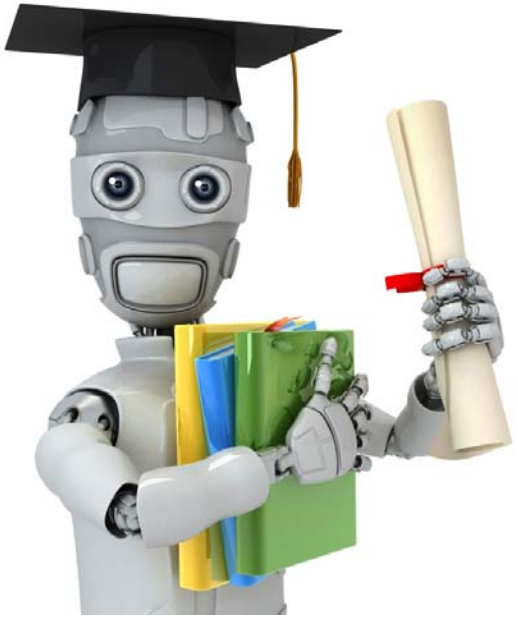

Machine Learning

Introduction

Supervised Learning

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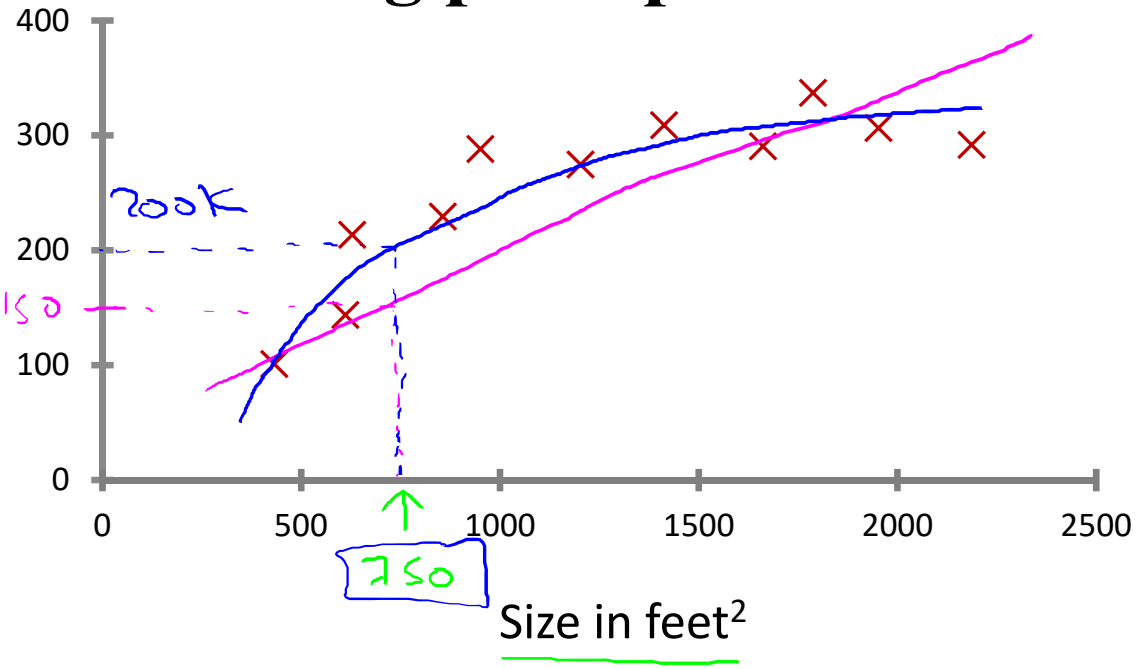
Housing price prediction:

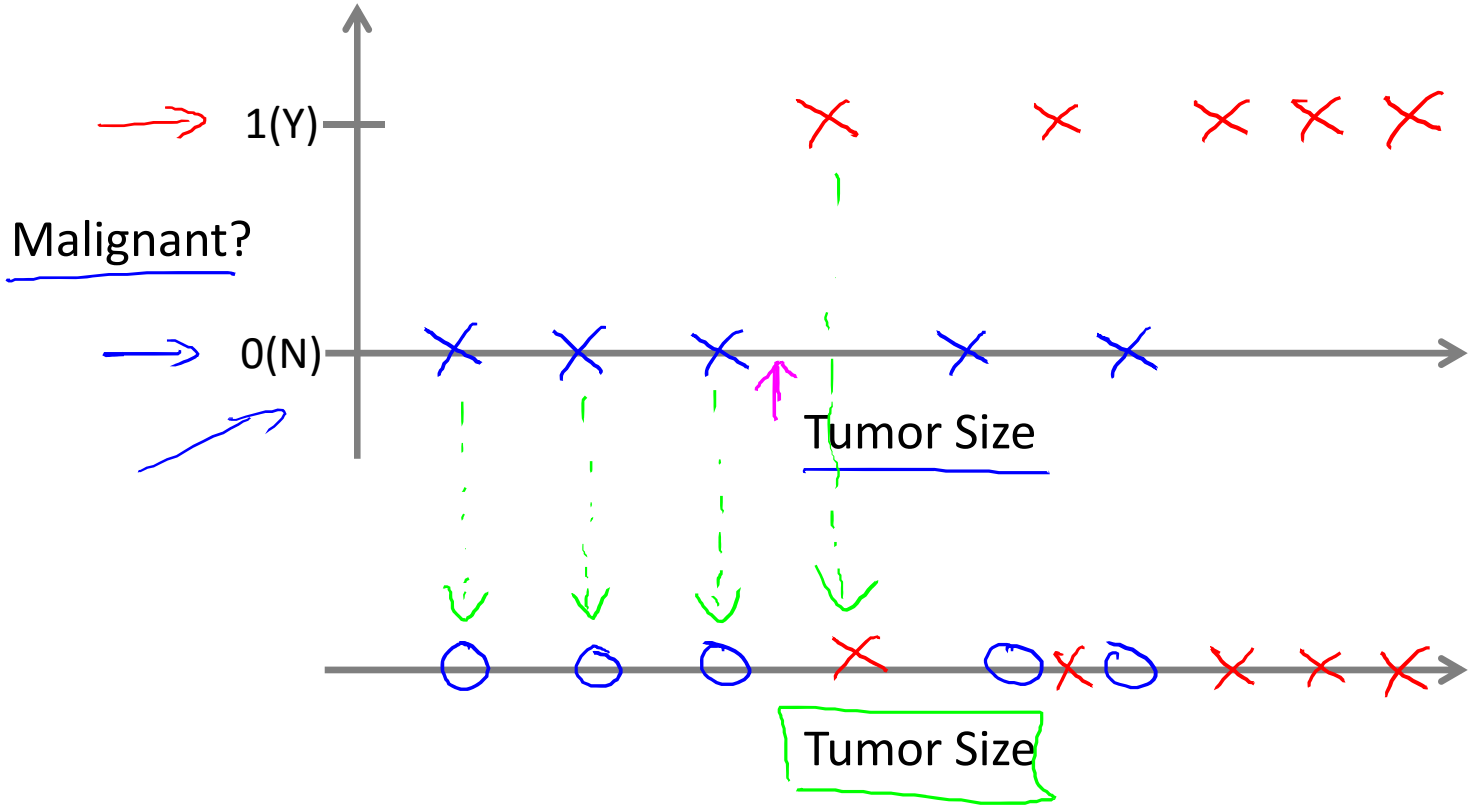


Supervised Learning

"right answers" given

Regression: Predict continuous valued output (price)

Breast cancer (malignant, benign)

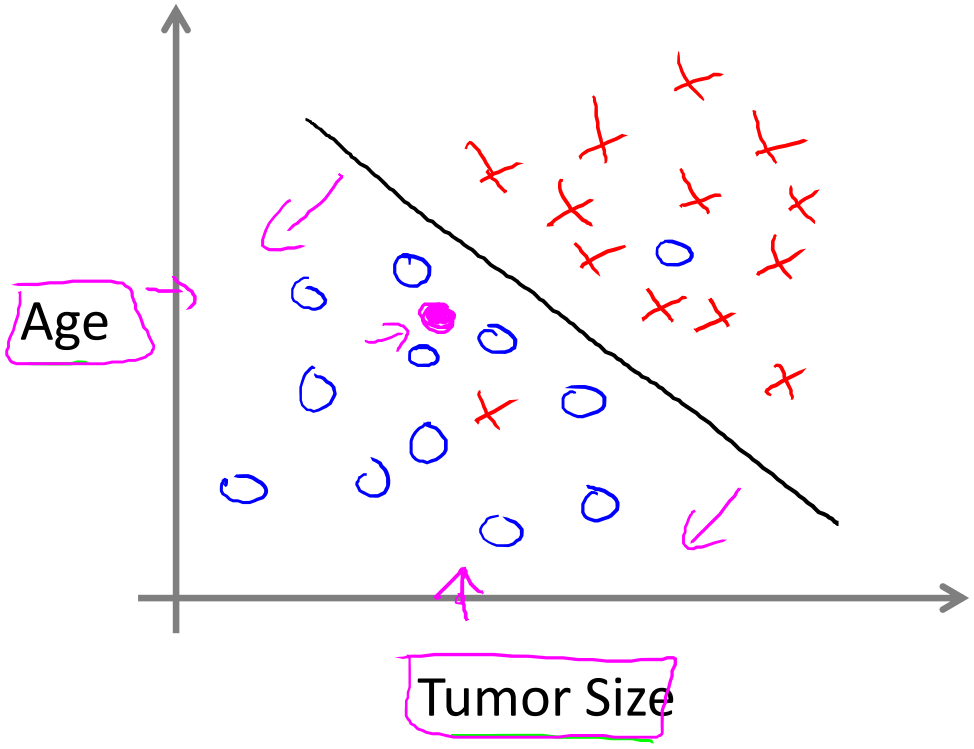


Classification

Discrete valued output (0 or 1)

0, 1, 2, 3

benign type 1 Cancer



- Clump Thickness
- Uniformity of Cell Size
- Uniformity of Cell Shape

...

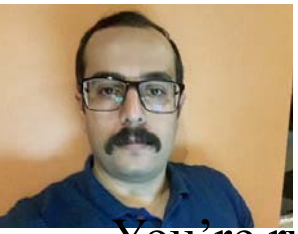
As the factors grow up, we cannot explain the model by a mathematical expression!!!

- ✓ Imagine How a physics formula discovered?!! (for example F=ma)
- ✓ And also imagine how a complex physics formula discovered?!! (Like Navier–Stokes equations of Fluid Mechanics)

Navier–Stokes momentum equation in non-inertial frame

$$\rho\frac{D\mathbf{u}}{Dt} = -\nabla\bar{p} + \mu\nabla^2\mathbf{u} + \tfrac{1}{3}\mu\nabla(\nabla\cdot\mathbf{u}) + \rho\mathbf{g} - \rho\left(2\boldsymbol{\Omega}\times\mathbf{u} + \boldsymbol{\Omega}\times(\boldsymbol{\Omega}\times\mathbf{x}) + \frac{d\mathbf{U}}{dt} + \frac{d\boldsymbol{\Omega}}{dt}\times\mathbf{x}\right).$$

It is almost impossible to derive a explicit mathematical model for a "machine learning model", and that's exactly why we need machine learning.



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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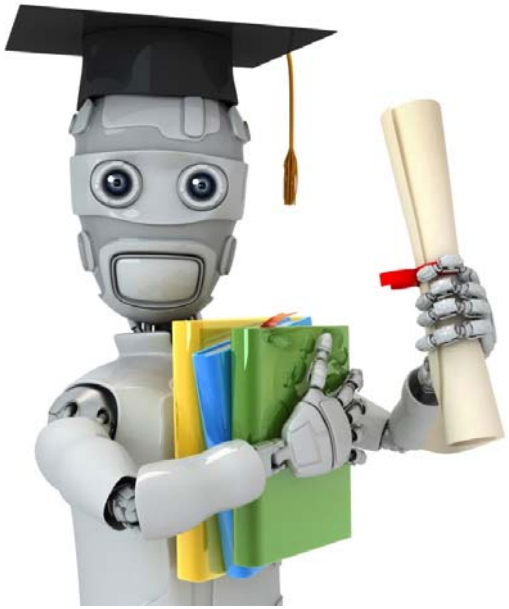

Machine Learning

Introduction

Unsupervised Learning

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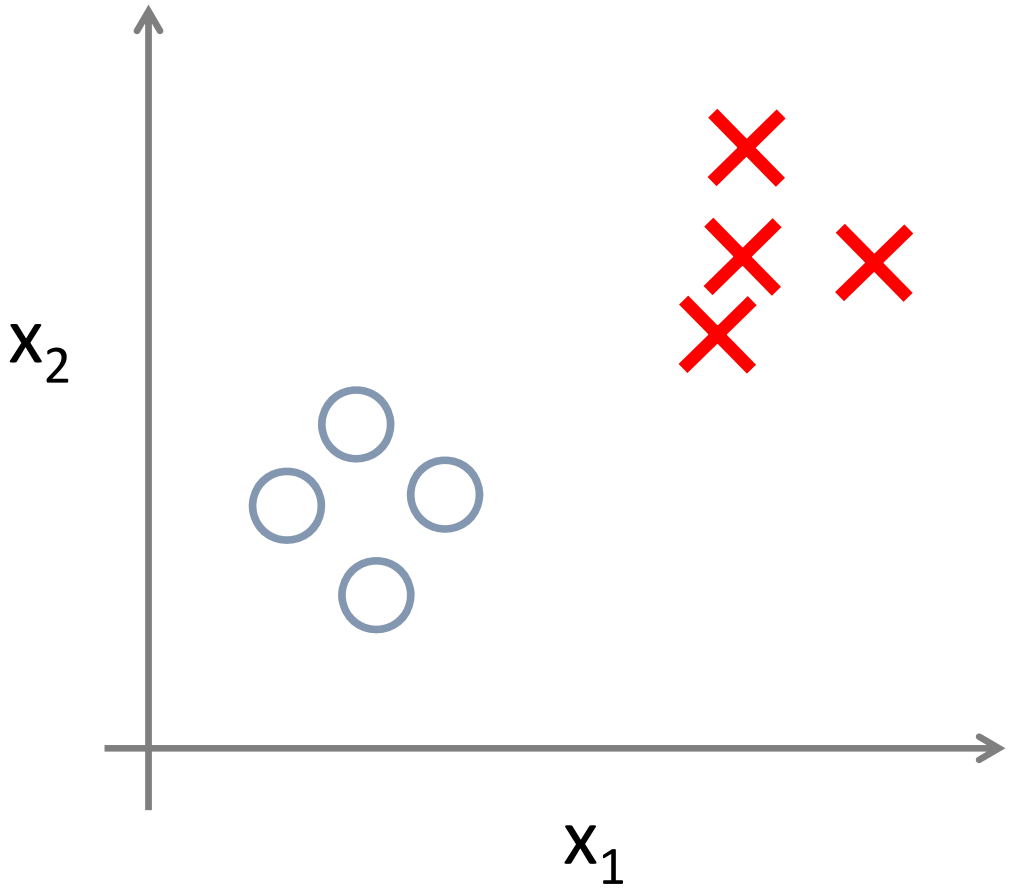
Supervised Learning



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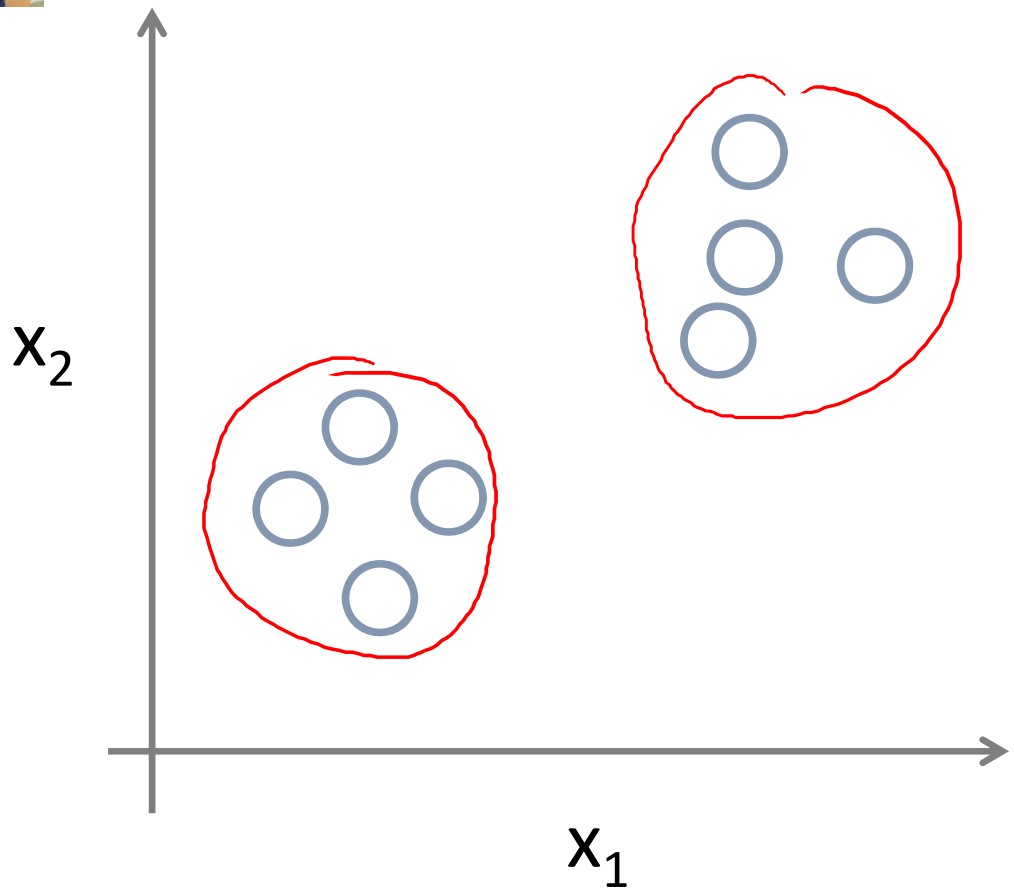
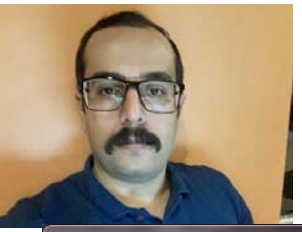
Unsupervised Learning



Clustering Problem:

- For example, if a new data came in (after the model trained), we expect the model tell us, the new data belongs to which cluster?
- Or even tell us new data belongs partially to which cluster?!! For example 40% to first cluster and 60% to second cluster.



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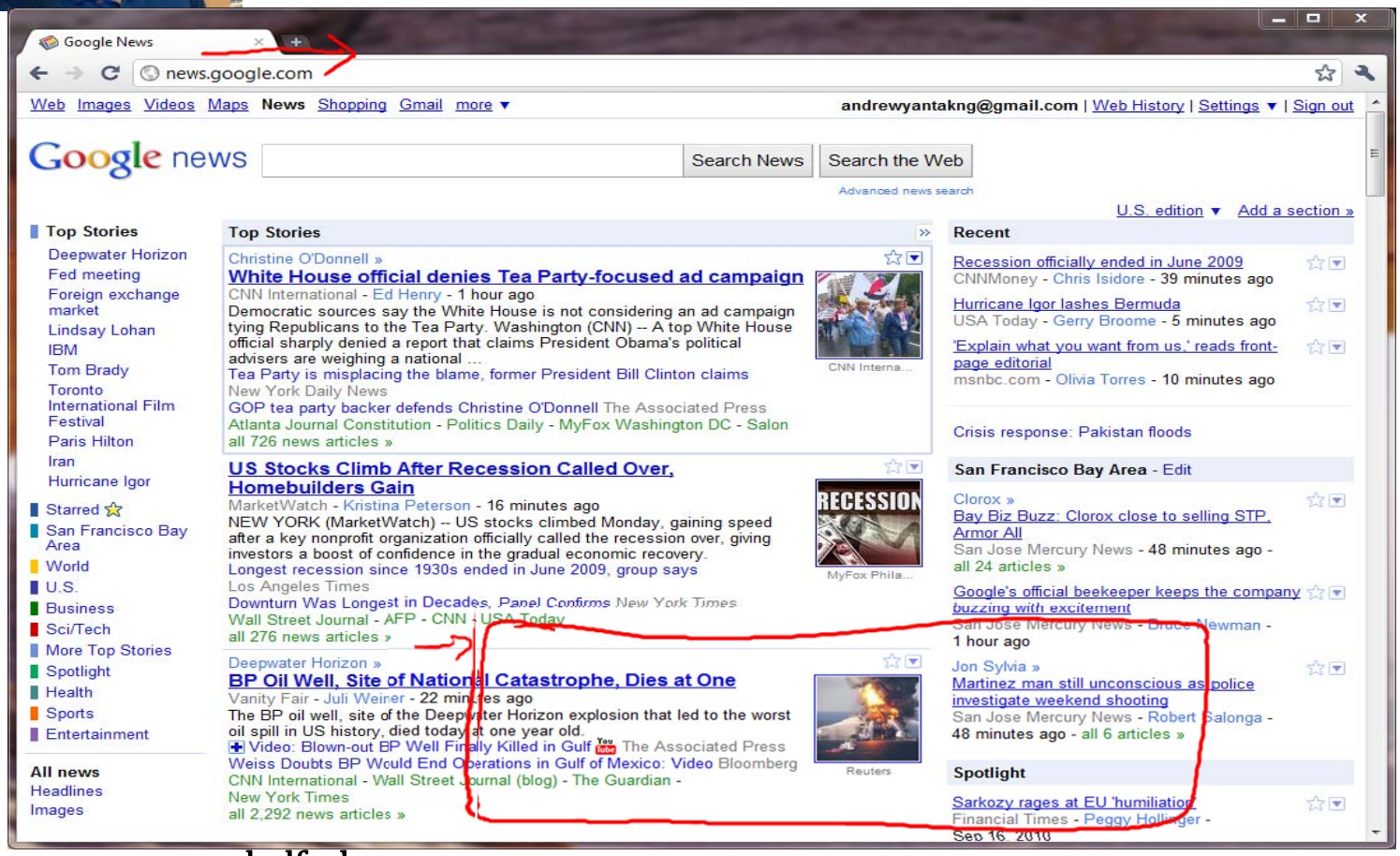

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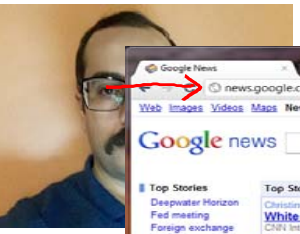
Clustering Example

Like google news, Instagram, Youtube or any other search engine:

When you look for something, it suggests you the things that classified in same cluster.



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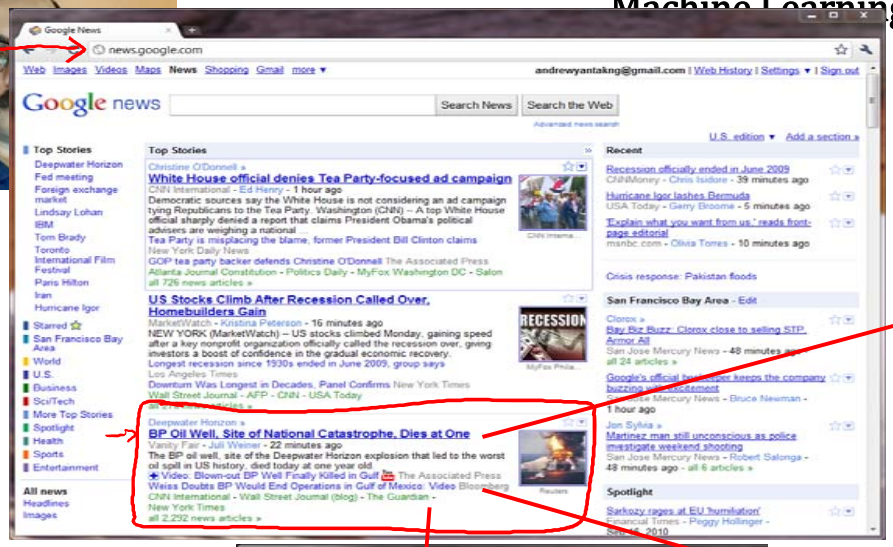

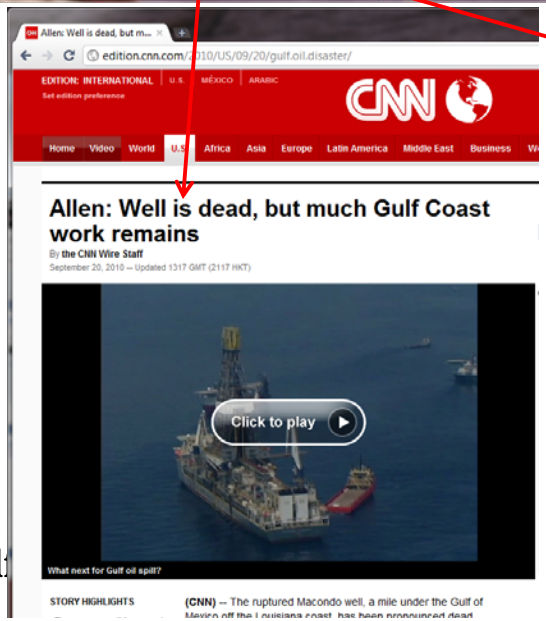

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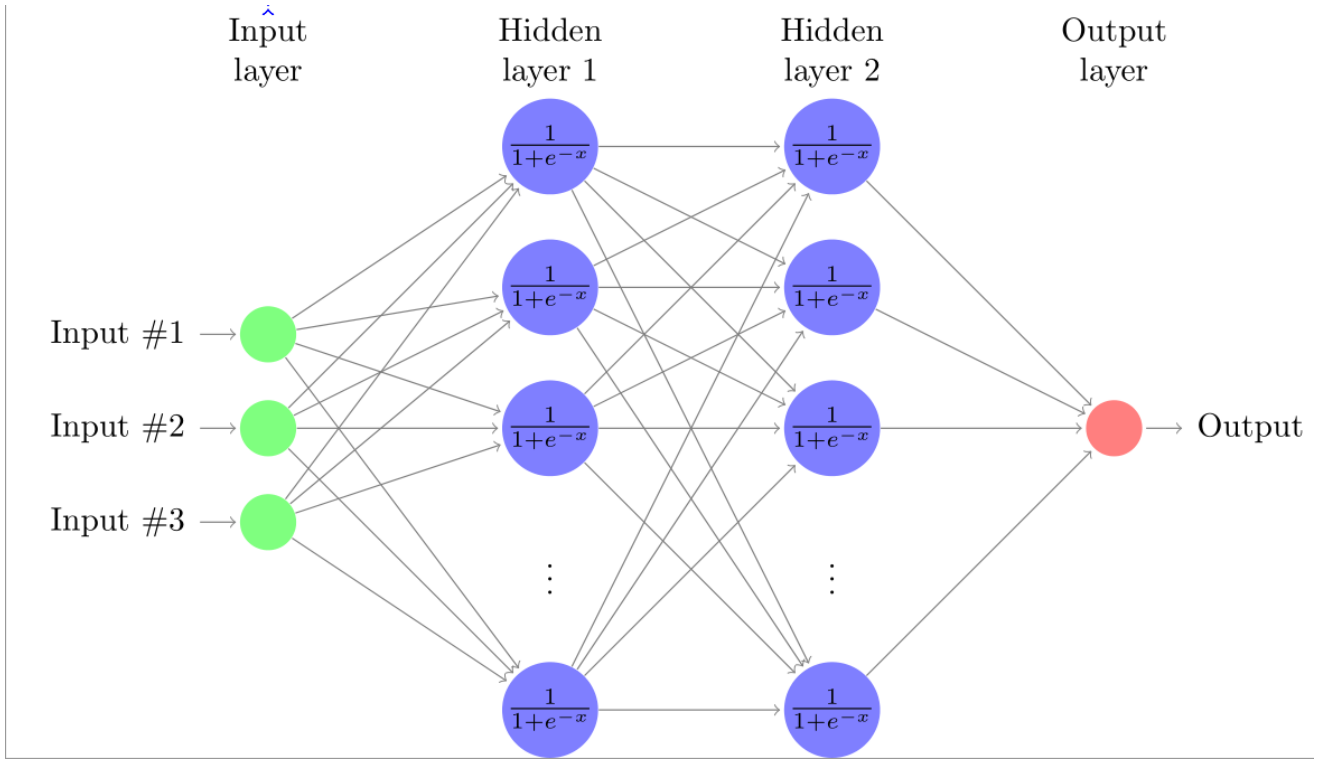
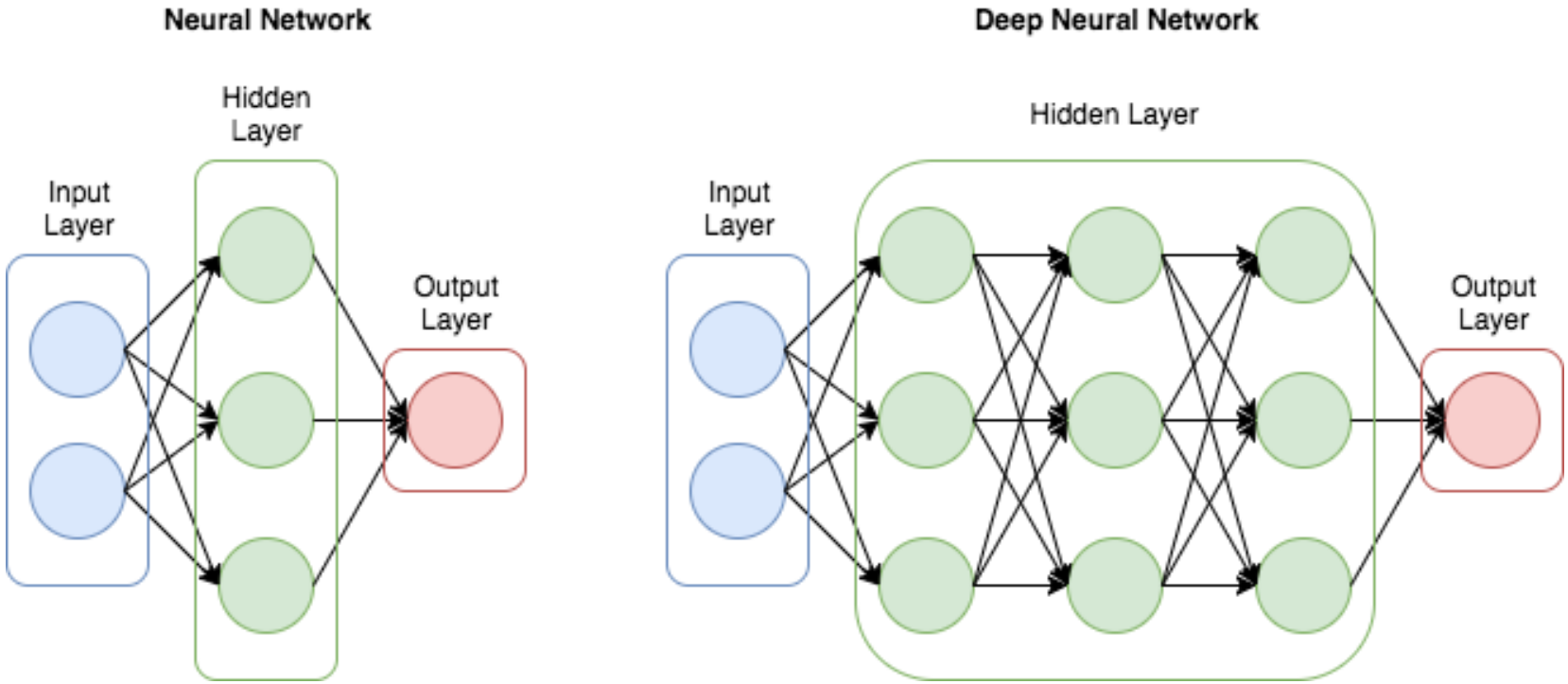
How Neural Network, works?



There is no explicit mathematical model in hidden layers and the weight of neurons will update in each training process.

How Neural Network, works?



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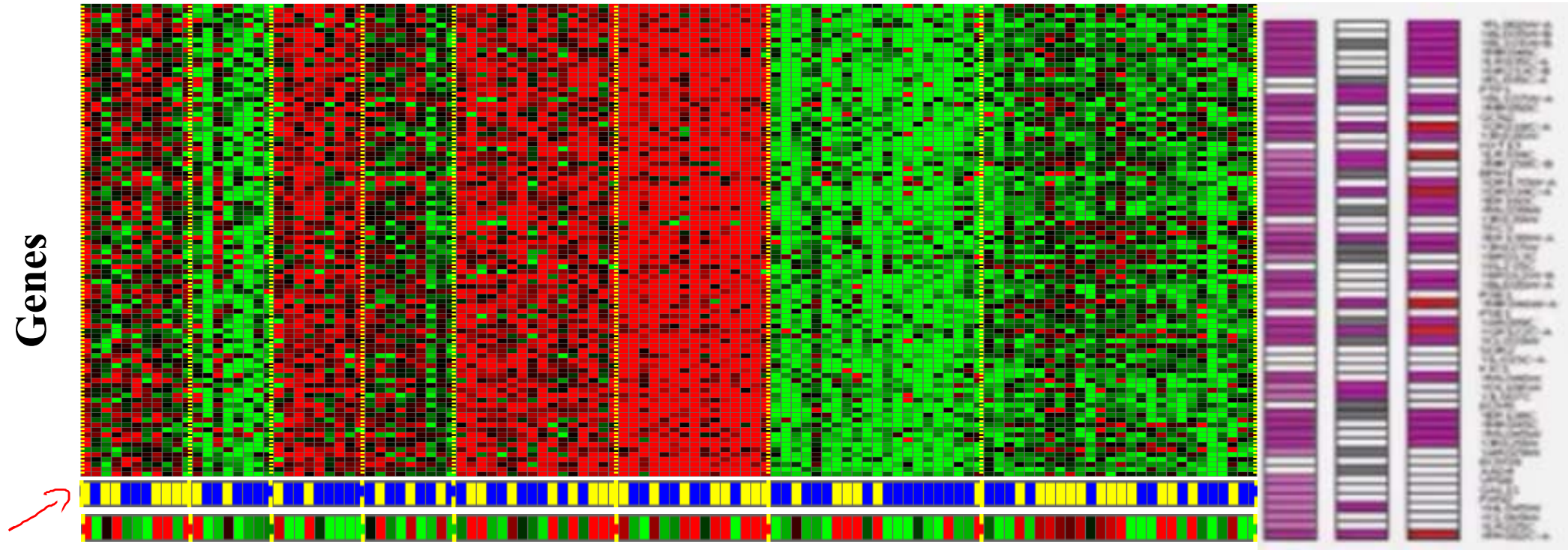

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[Source: Daphne Koller]

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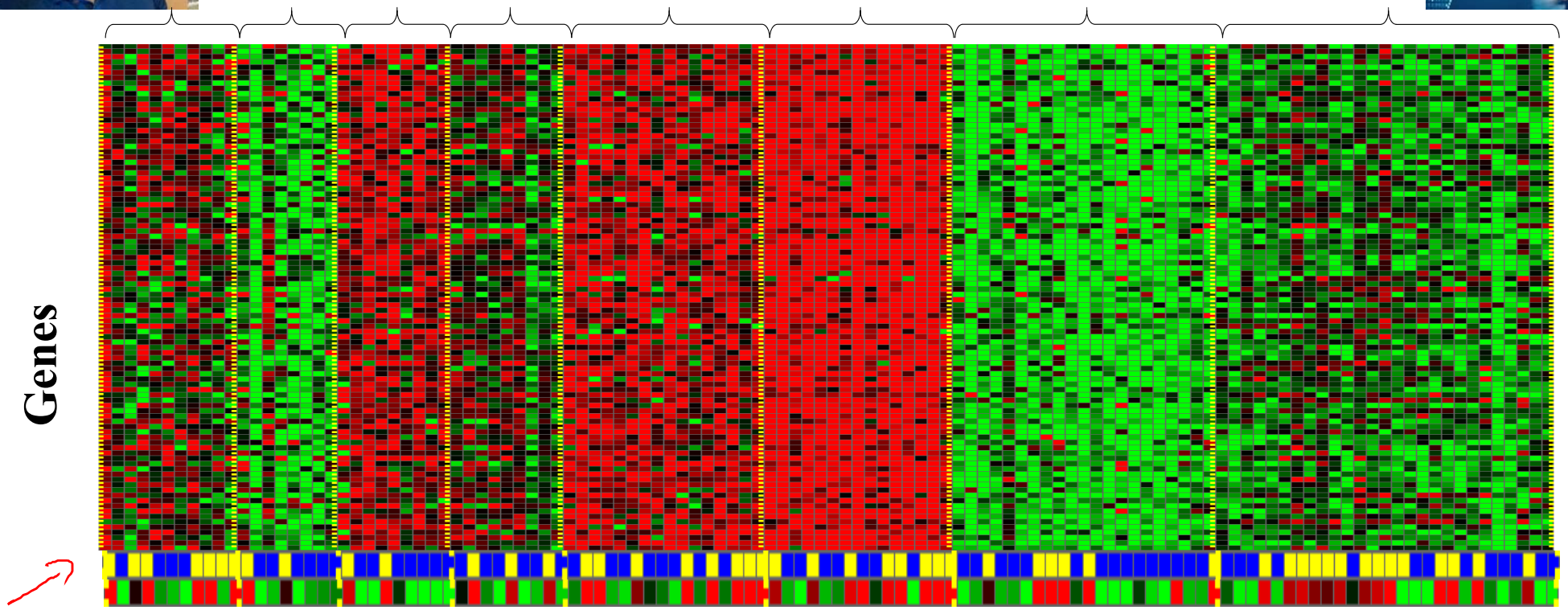
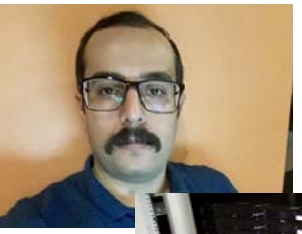


[Source: Daphne Koller]



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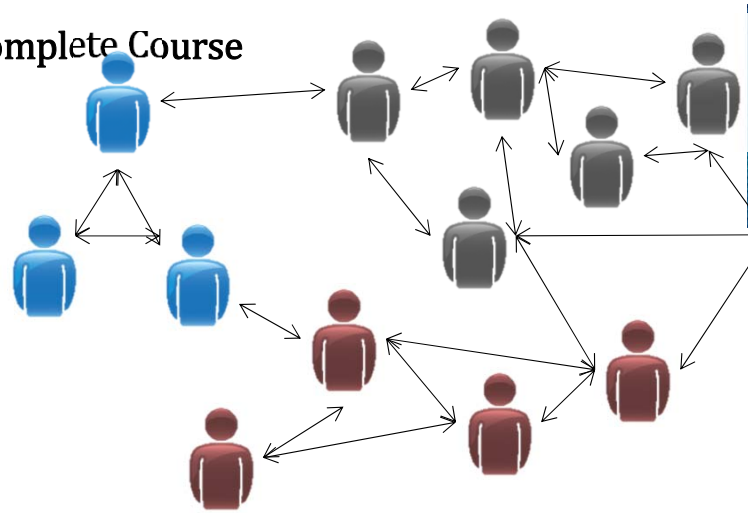
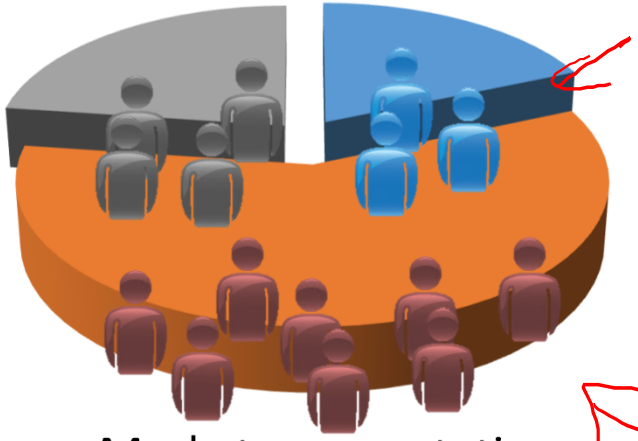
Organize computing clusters



Social network analysis



Market segmentation

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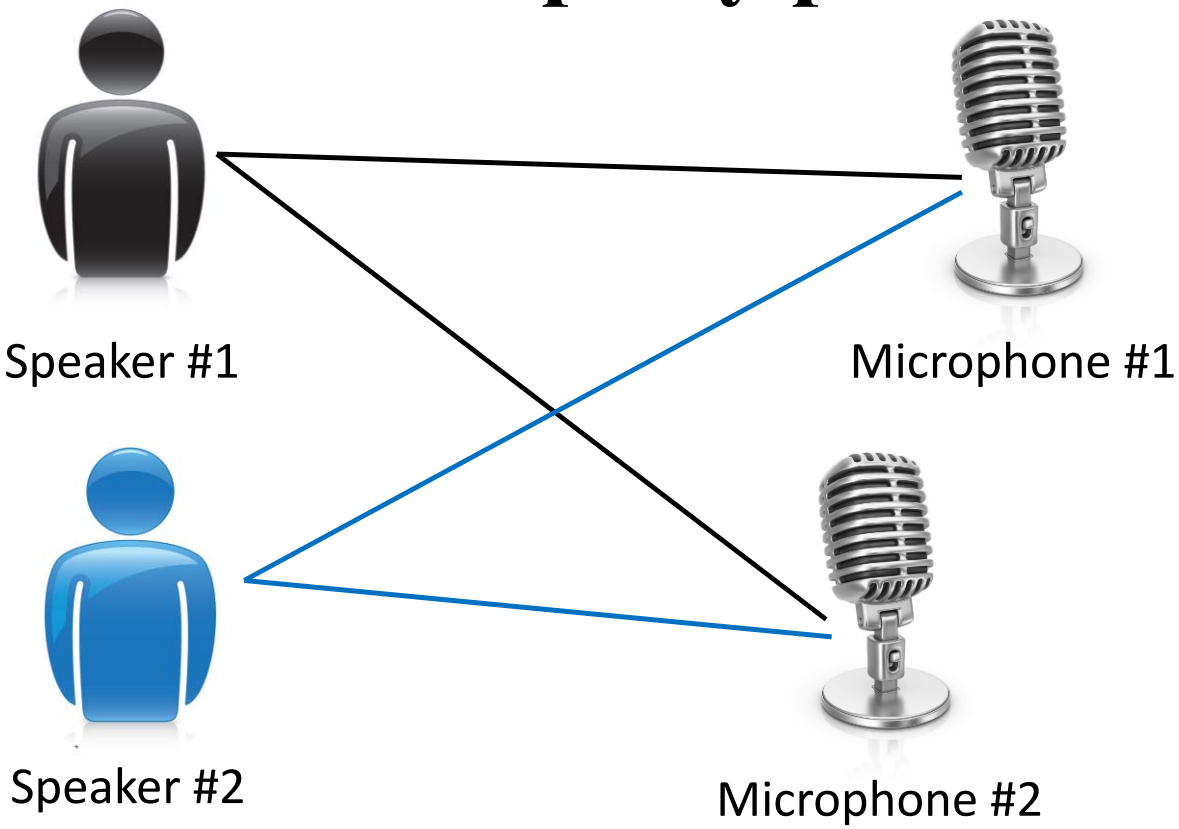
Astronomical data analysis

Cocktail party problem



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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 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.

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THANK YOU FOR YOUR ATTENTION!

You can keep in touch with me for any other possible helps or workshops, via:

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