



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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 - 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

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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.”

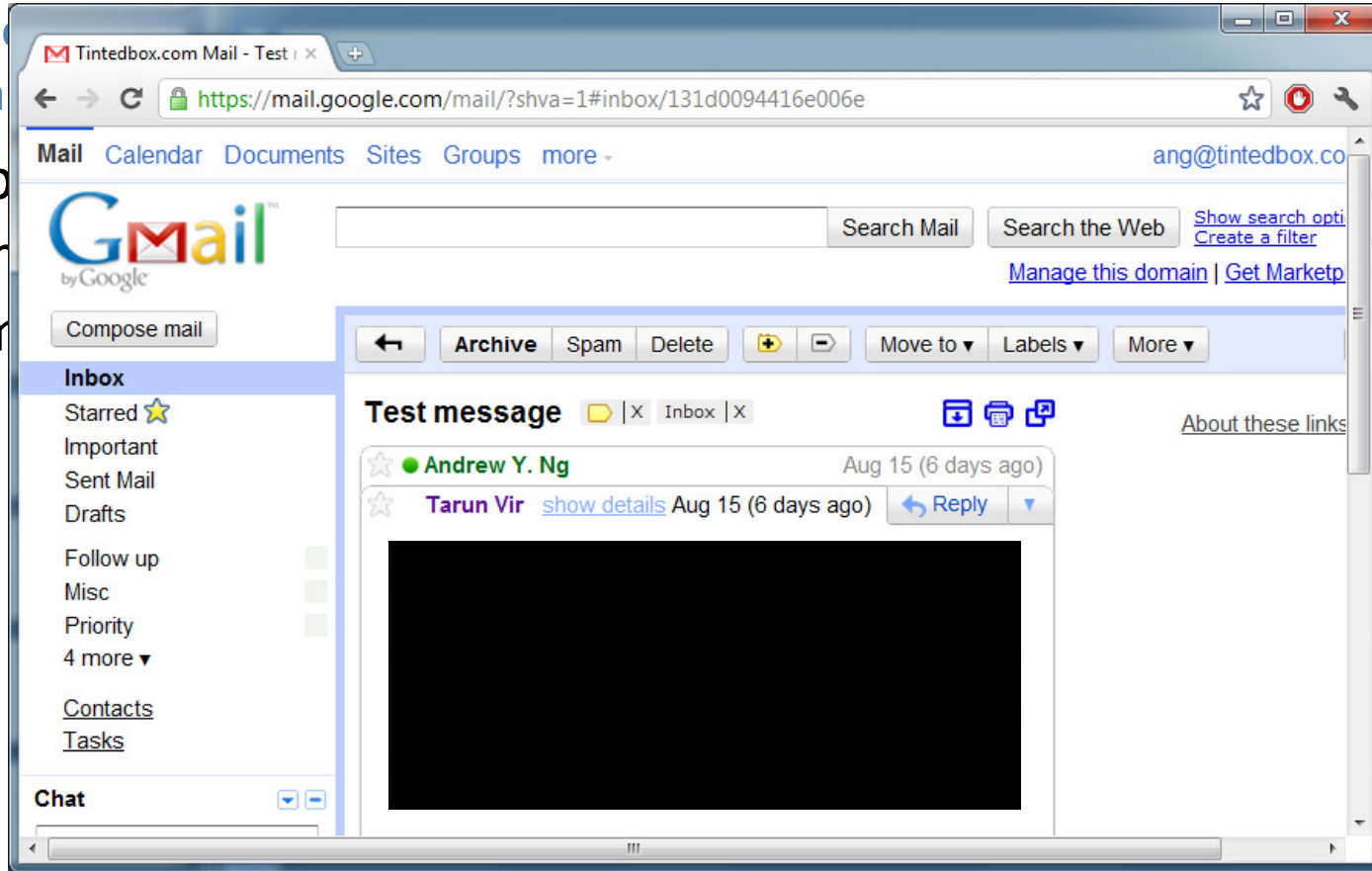
Suppose your email program watches which emails you do or do not mark as spam, and based on that learns how to better filter spam. What is the task T in this setting?

- ☒ 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. $P \leftarrow$

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Support
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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

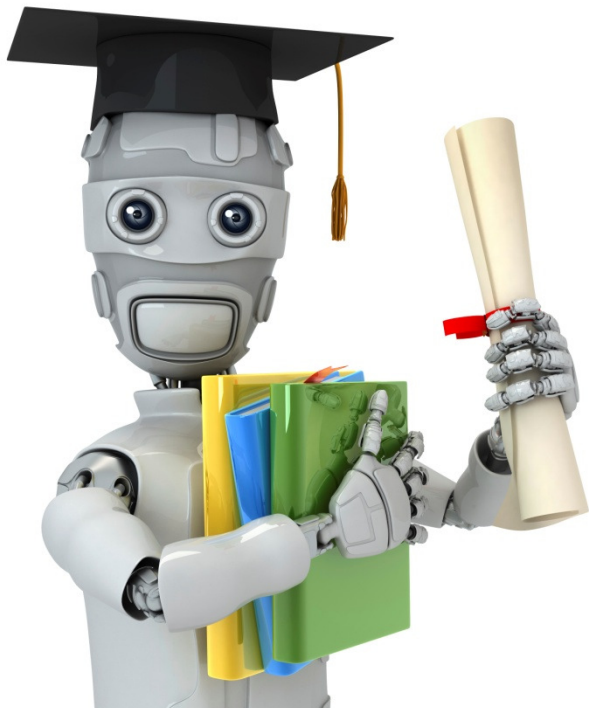
let the computer to learn by itself

other types of machine learning algorithms (later)

Others: Reinforcement learning, recommender systems.

important!

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



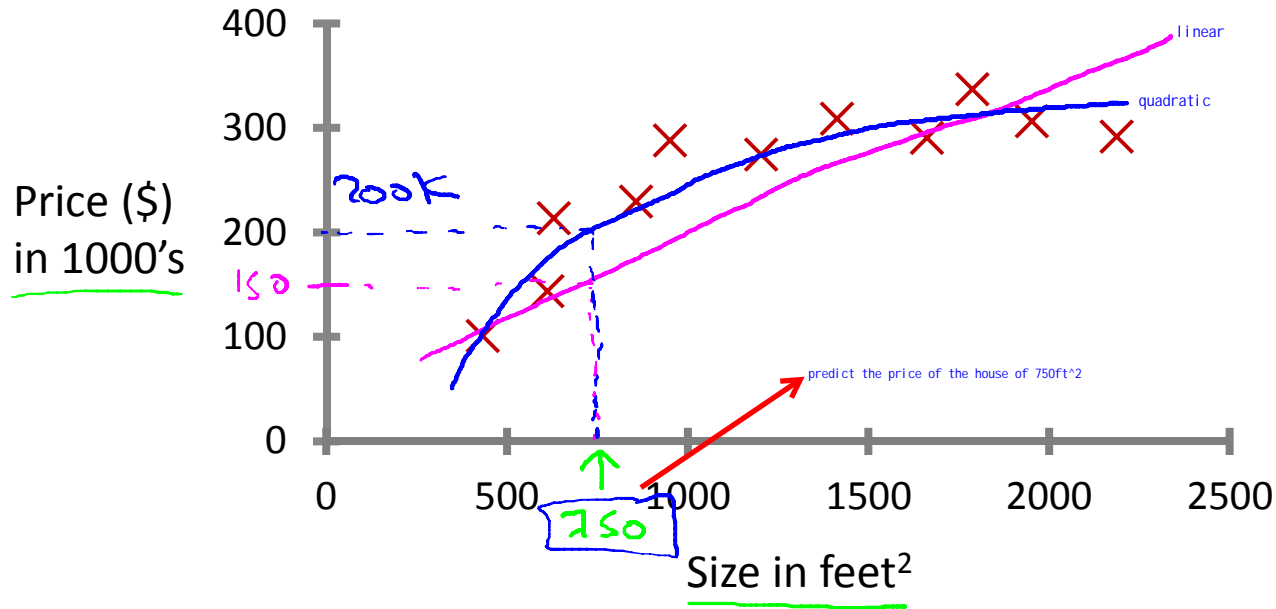
Machine Learning

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

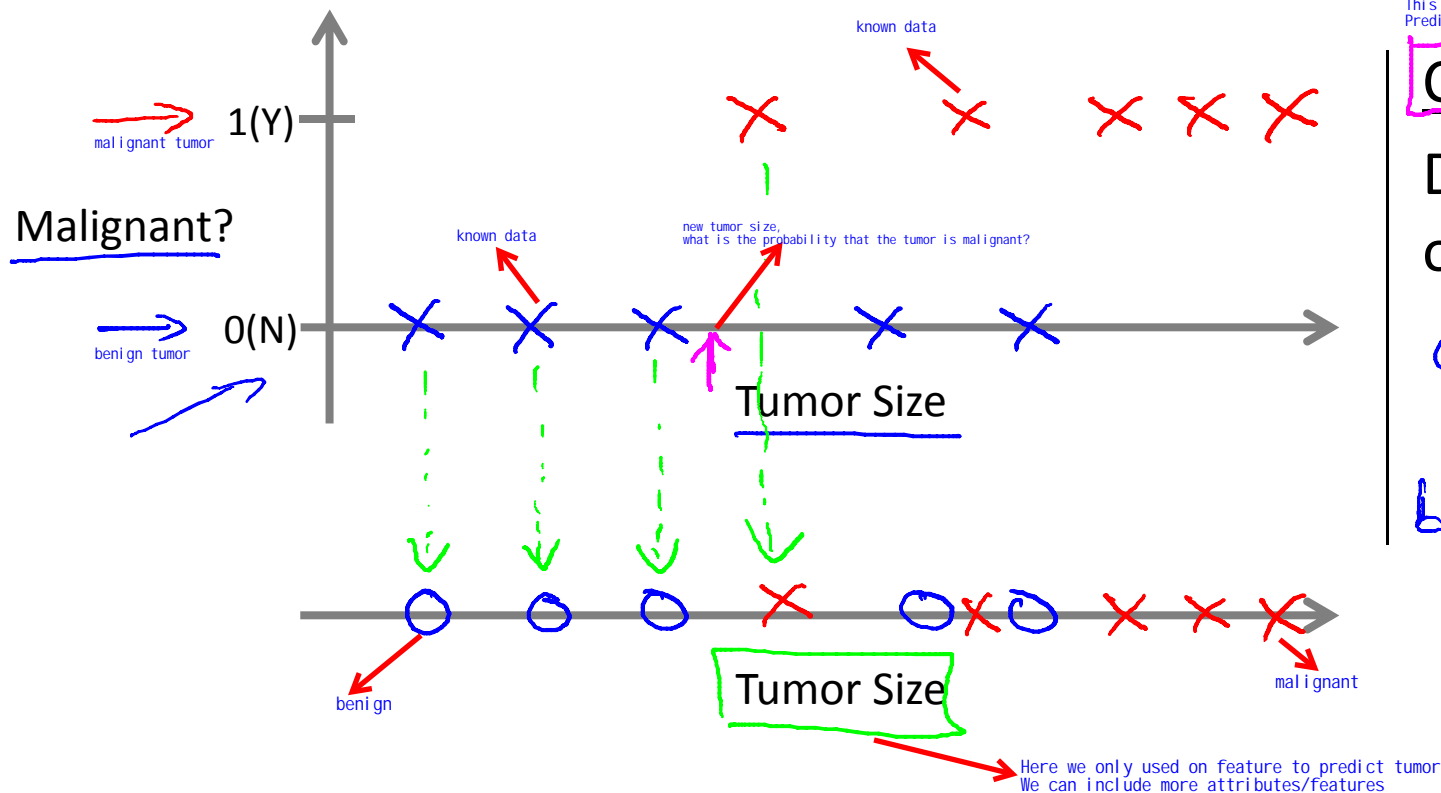
"right answers" given

Also called

Predict continuous output

Regression: Predict continuous
valued output (price)

Breast cancer (malignant, benign)



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

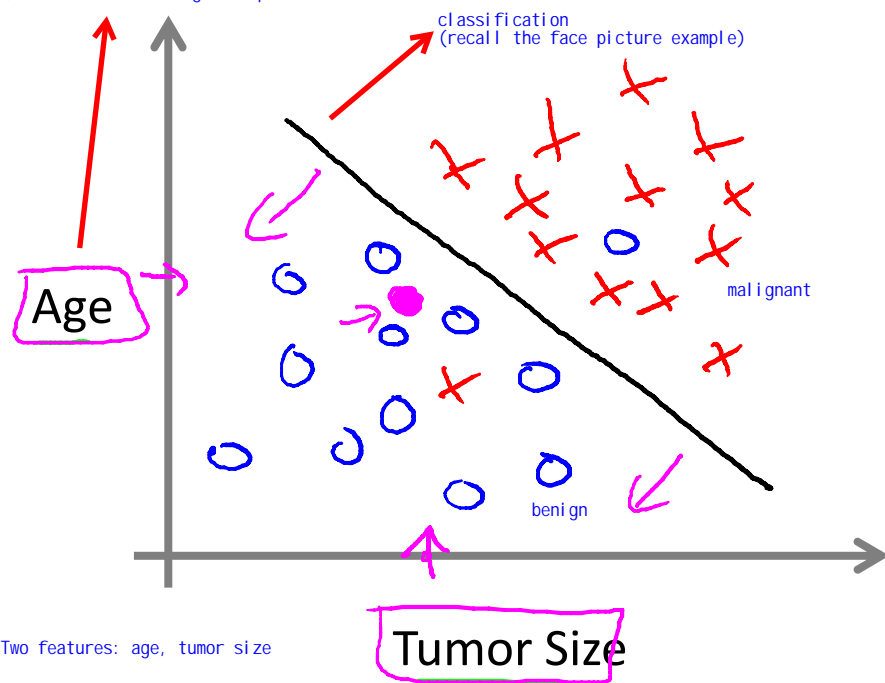
Classification

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.

just treat as continuous value

(0, 1) discrete output values

☐ Treat both as regression problems.



Machine Learning

Introduction

Unsupervised Learning

Supervised Learning



Unsupervised Learning



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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 assign responsibility across

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

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By the CNN Wire Staff

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BP oil spill cost hits nearly \$10bn

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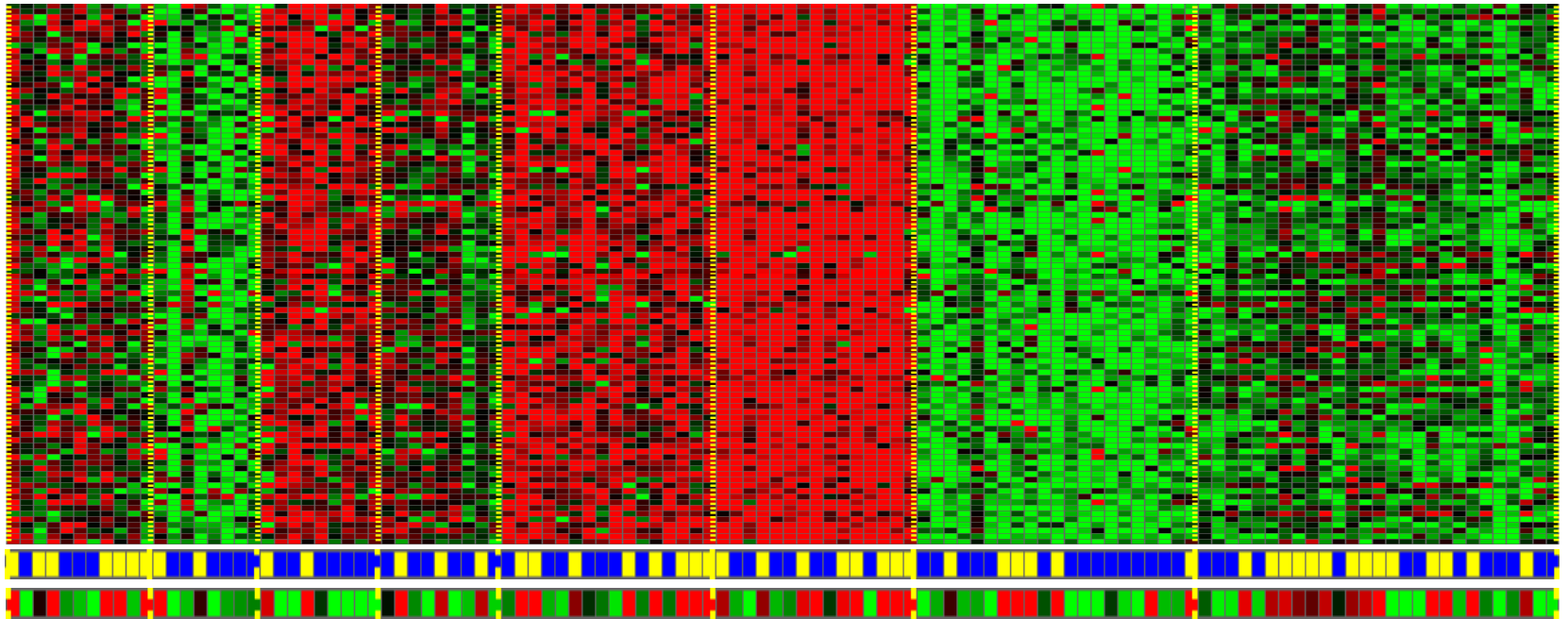
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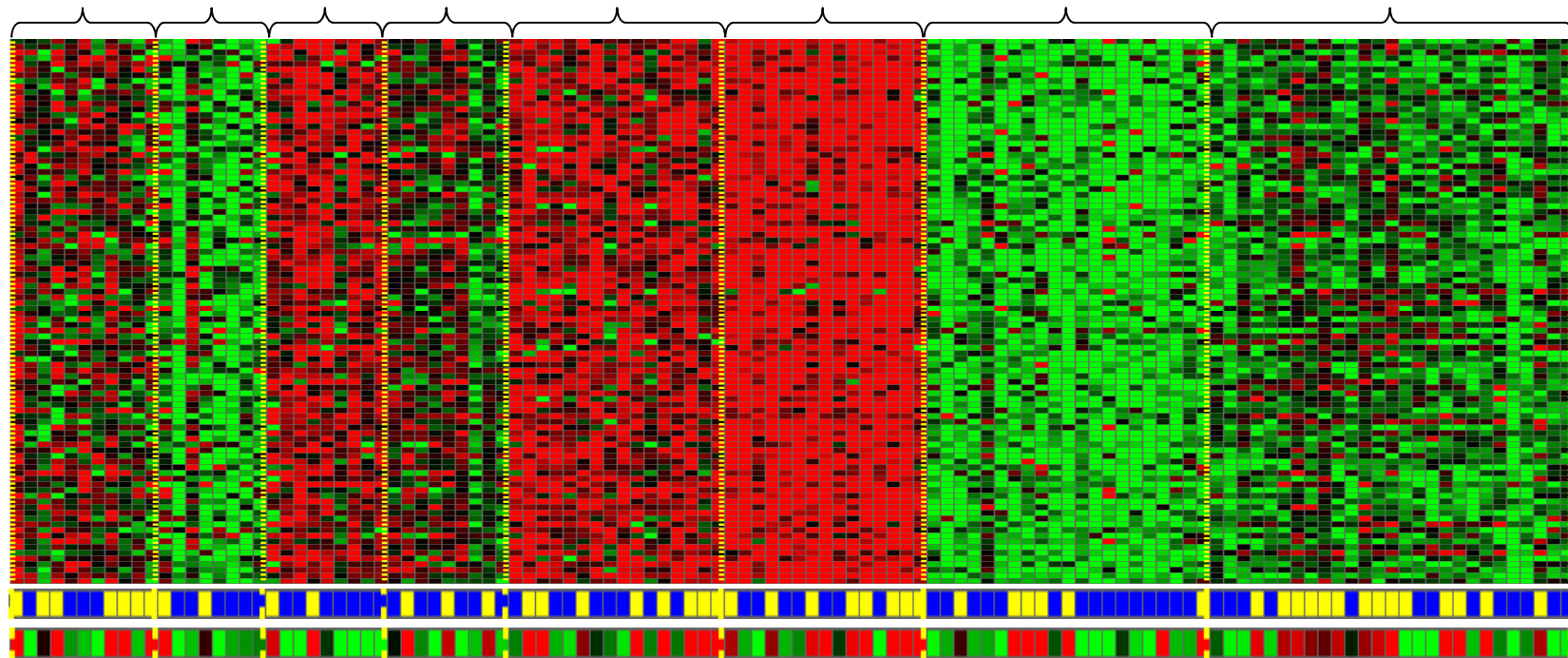
BP's costs for the Deepwater Horizon disaster have hit \$10bn. Photograph: Ho/Reuters

Genes



Individuals

Genes



Individuals



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.

