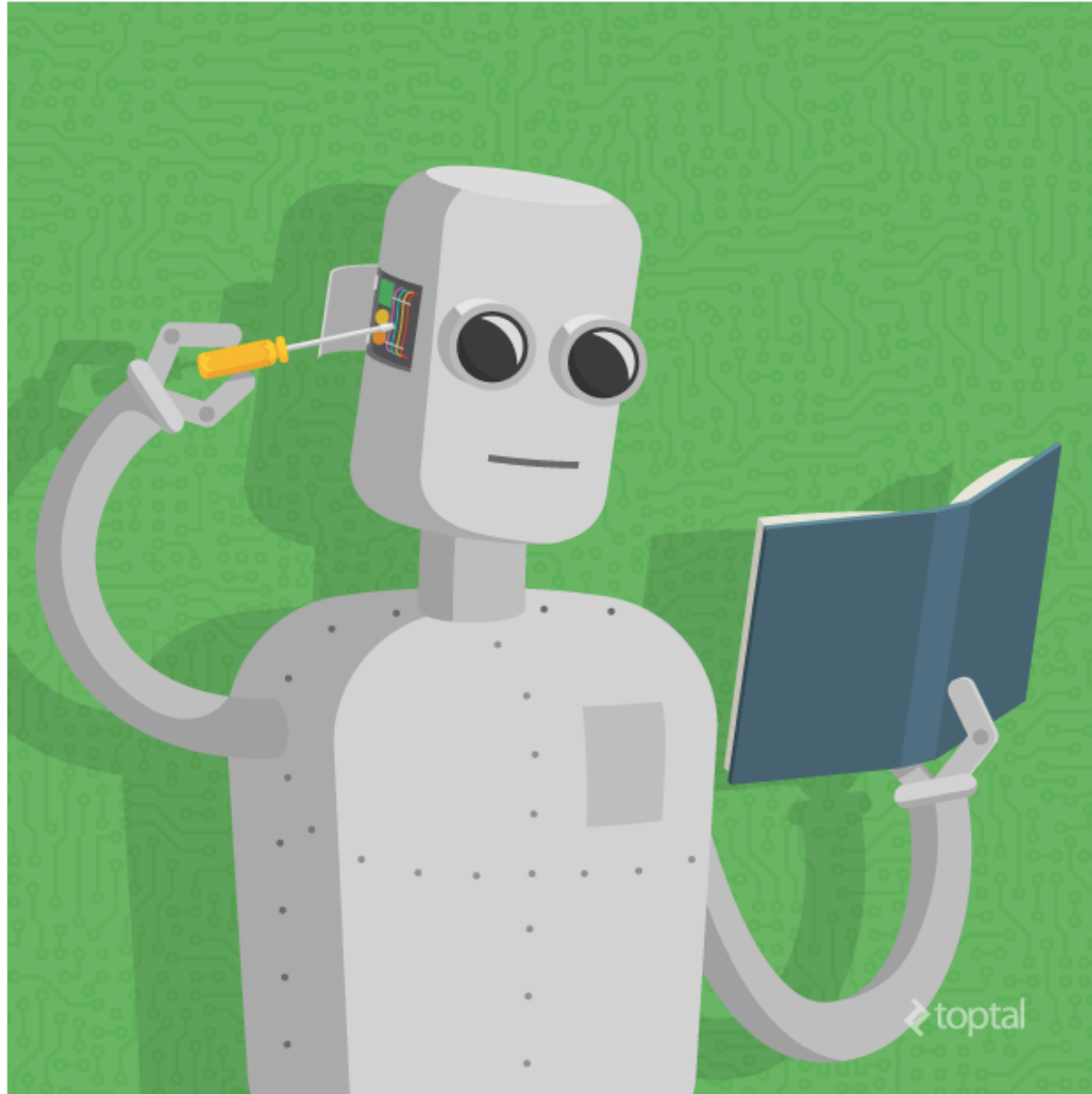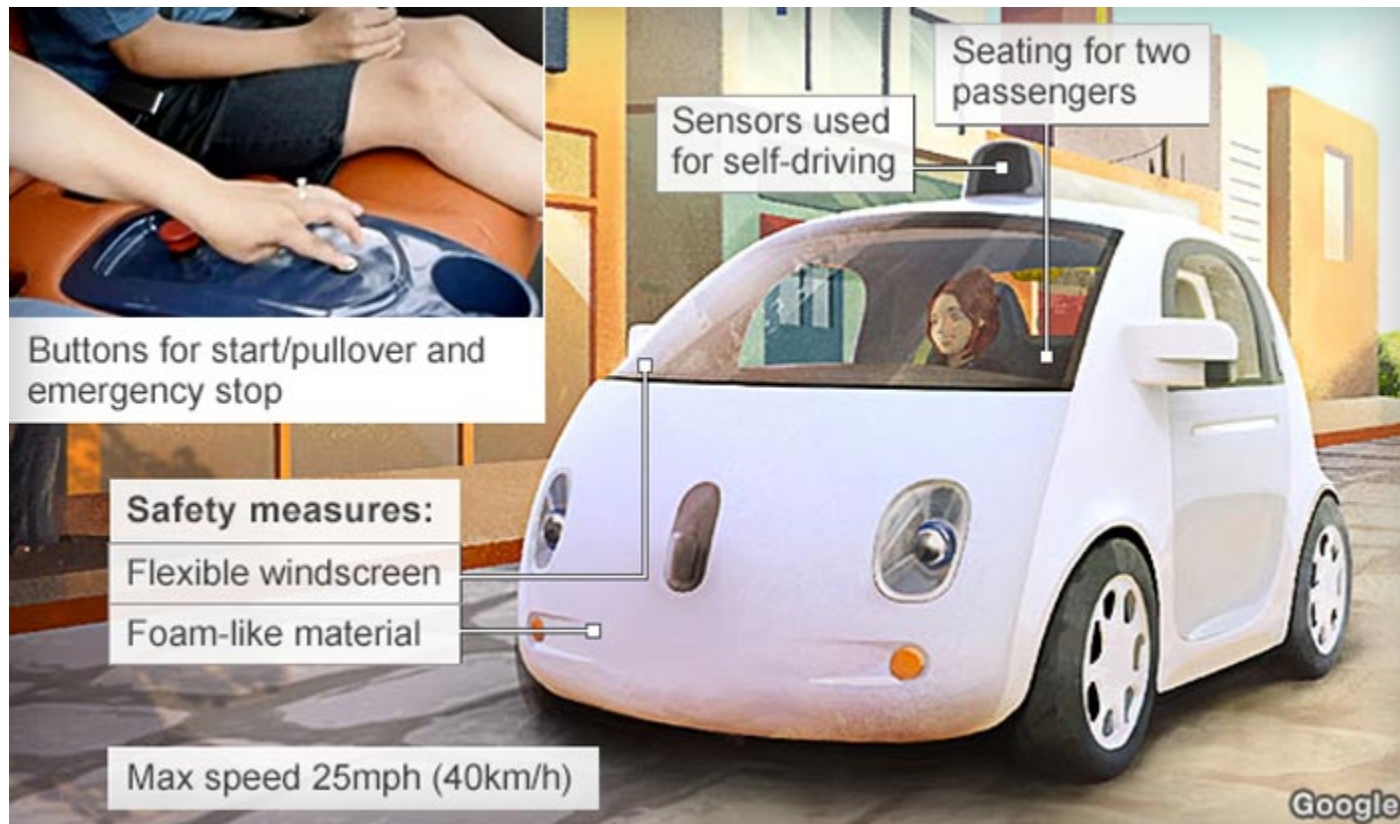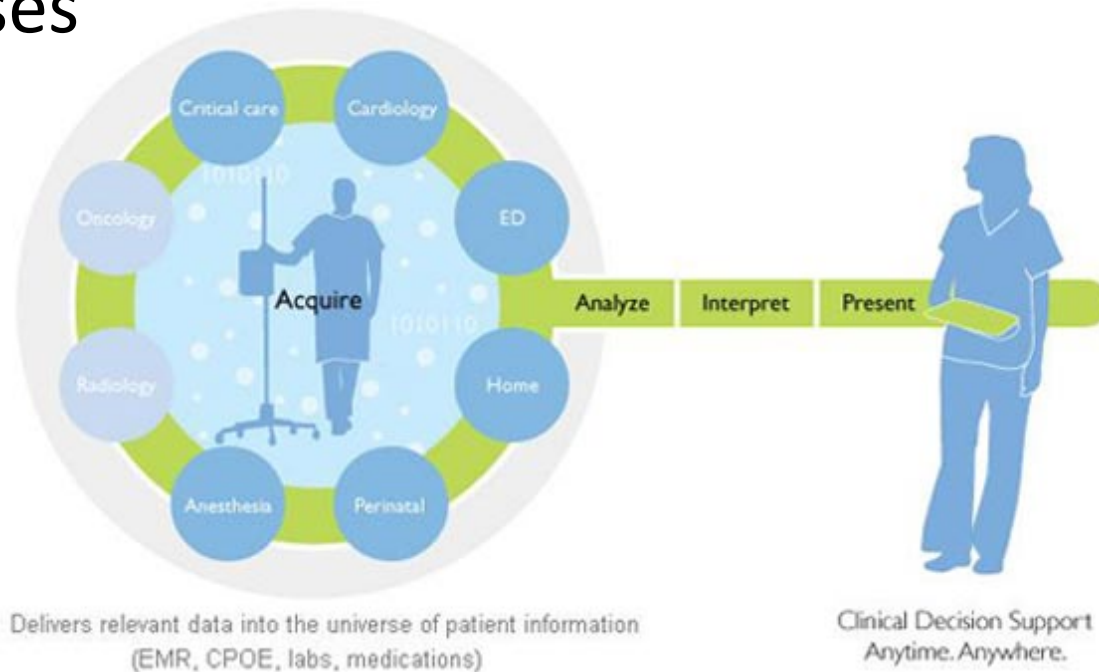# Machine Learning

# Machine Learning in Action

# Machine Learning in Action

# Machine Learning in Action

- Computers learning from medical records which treatments are most effective for new diseases



Delivers relevant data into the universe of patient information
(EMR, CPOE, labs, medications)

Clinical Decision Support
Anytime. Anywhere.

http://www.healthcare.philips.com/main/products/hi_pm/products/clinical_support.wpd

# Machine Learning in Action

- Houses learning from experience to optimize energy costs based on the particular usage patterns of their occupants

# Machine Learning in Action

- Helicopters can learn aerial tricks by watching other helicopters perform the stunts first

# Machine Learning in Action

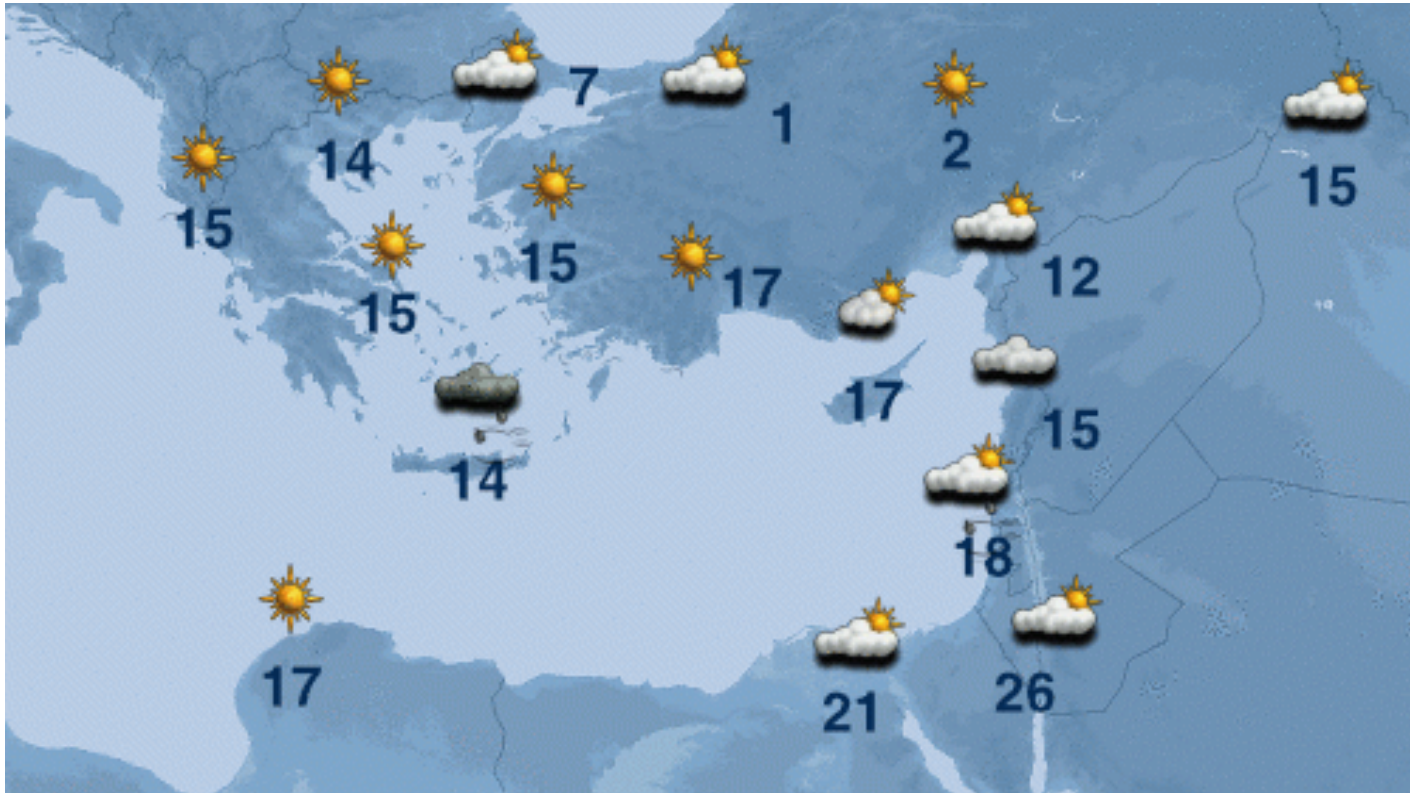- Document Classification

# Machine Learning in Action

- Stock Market Prediction

# Machine Learning in Action

- Weather Prediction

# Machine Learning in Action

- Many, many more…
  - Speech recognition, Natural language processing
  - Computer vision
  - Sensor networks
  - Social networks
  - …

# Formal Definition

- Definition: "A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E"

  Tom M. Mitchel

# Well-defined Learning Problem

- Identify three features
  - Class of tasks
  - Measure of performance to be improved
  - Source of experience

# Predicting Traffic Patterns

- **Task T:** predicting traffic patterns at a busy street

- **Performance measure P:** accuracy of the predicted future traffic patterns

- **Training experience E:** data about past traffic patterns

# A checkers learning problem

- **Task T:** playing checkers
- **Performance measure P:** percent of games won against opponents
- **Training experience E:** playing practice games against itself

# A robot driving learning problem

- **Task T:** driving on public four-lane highways using vision sensors

- **Performance measure P:** average distance traveled before an error (as judged by human overseer)

- **Training experience E:** a sequence of images and steering commands recorded while observing a human driver

# Handwriting Recognition

- **Task T:** ?
- **Performance measure P:** ?
- **Training experience E:** ?

# Text Classification Problem

- **Task T:** ?
- **Performance measure P:** ?
- **Training experience E:** ?

# Some disciplines that influence ML

- Artificial intelligence
- Bayesian methods
- Computational complexity theory
- Control theory
- Information theory
- Philosophy
- Psychology and neurobiology
- Statistics

# Designing a Learning System

- **Choosing the Training Experience**
  - Direct or Indirect
  - Distribution of examples
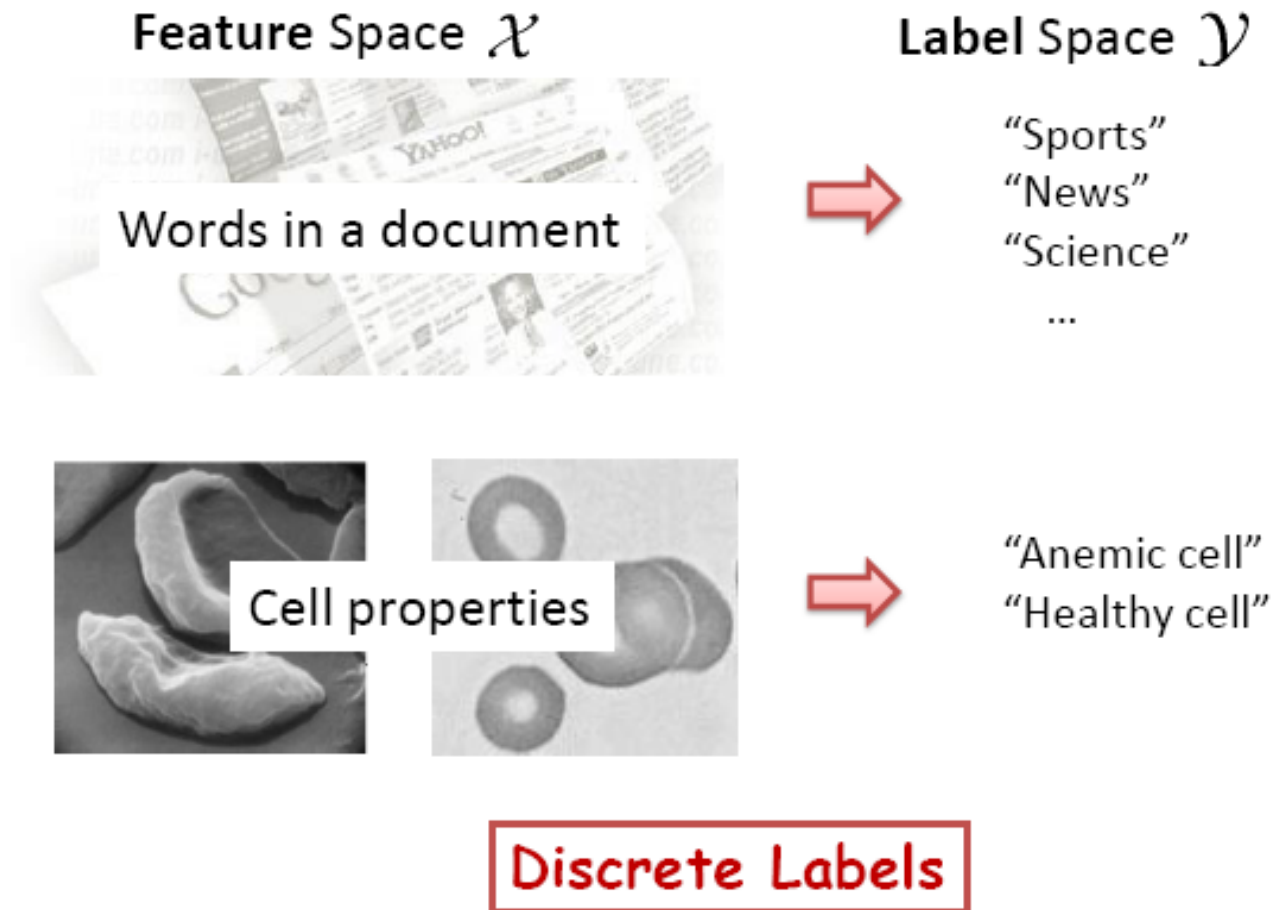
# Designing a Learning System

- **Choosing the Target Function**
  - The next design choice is to determine exactly what type of knowledge will be learned and how this will be used by the performance program.

- **Choosing a Representation for the Target Function**
  - Now that we have specified the ideal target function, we must choose a representation that the learning program will use to describe the function that it will learn.

- **Choosing a Learning Algorithm**
  - Mechanism to learn from the experiences.

# Types of Machine Learning

- **Supervised learning**
  - Where we get a set of training inputs and outputs. The correct output for the training samples is available

- **Unsupervised learning**
  - No specific output values are supplied with the learning patterns

- **Semi-supervised learning**
  - Where we get a small amount of labeled data with a large amount of unlabeled data
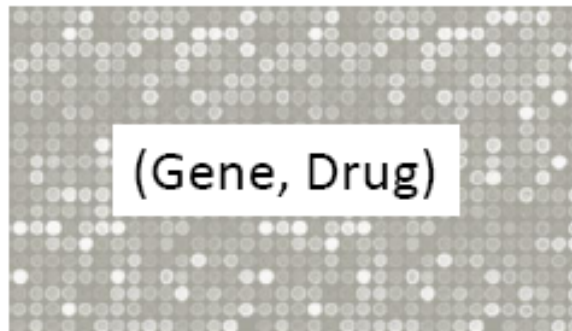
# Supervised Learning - Classification

**Feature** Space $\mathcal{X}$

Words in a document

**Label** Space $\mathcal{Y}$

➡ "Sports"
"News"
"Science"
…

Cell properties

➡ "Anemic cell"
"Healthy cell"

**Discrete Labels**

# Supervised Learning - Regression

**Feature** Space $\mathcal{X}$             **Label** Space $\mathcal{Y}$



Market information up to time t

⇒ Share Price "$ 24.50"

(Gene, Drug)

⇒ Expression level "0.01"

**Continuous Labels**