What is Learning?

Using Experience to gain Expertise
Why do we need Machine Learning?

- Tasks that are too complex to program
- Computer vision: we know to detect objects but have no idea how we do it
- Search engines: a human can’t read the entire internet
- Adaptivity and speed of development
OrCam developed glasses for the visually impaired

http://www.youtube.com/watch?v=k_C1iKIqi_o
Example - Pedestrian Detection
Example - Pedestrian Detection
Difficulty
Difficulty
Difficulty
Difficulty
Difficulty
What is Learning?

אבות פרק ה

(ס)
ארבע מדרת ביוושבים לפןיה האיתנים.
ספג, ומישר, שמור, ומנה.
ספג, בשאר סופר את כל
משר, שמוכנים בו ומזינים בדו.
משר, שמוכנים את כל הקולים ואת השמשים.
מנה, שמוציאה את כל הקלה ואת הכלים
מנה, שמוציאה את כל הקהל ואת הכלים.
What is Learning?

The Mishna (Jewish oral tradition), “Book of Principles”, Chapter 5

There are 4 type of learners:

1. A **sponge**, which absorbs everything

2. A **funnel**, that lets in at one end and discharges at the other

3. A **sieve**, that forgets the essential but retains the unimportant

4. A **strainer**, that memorises the good and rejects the worthless
The “Sponge” Learner

A computer can be an excellent “sponge” learner
A computer can be an excellent "sponge" learner.
The “Sponge” Learner

A computer can be an excellent “sponge” learner
Memorising the Good

Inductive inference and generalisation
Should be able to predict on unseen examples

Fundamental Questions

How to learn? What is learnable?
How can we know that what we learned is true?
B.F. Skinner teaches pigeons to turn around
http://www.youtube.com/watch?v=TtfQlkGwE2U
Education is what survives when what has been learned has been forgotten.

B.F. Skinner
Pigeon Superstitious

http://www.youtube.com/watch?v=8uPmeWiFTIw
N-Rays

- Discovered by Rene Blondlot (1903)
- In 3 years, 300 papers by 120 scientists
N-Rays

• Discovered by Rene Blondlot (1903)
• In 3 years, 300 papers by 120 scientists
• But,
  • Experiments were not easily duplicated
  • or even duplicated at all...
N-Rays

- Discovered by Rene Blondlot (1903)
- In 3 years, 300 papers by 120 scientists
- But,
  - Experiments were not easily duplicated
  - or even duplicated at all...

Robert Wood (Nature 1904):
- Self-induced visual hallucination
- Simple black-box experiment can resolve doubt
Black-Box Approach

Even if we don’t understand how it works, we can easily check if it works...
Metaphysical Crystals

James Randi tests crystal power and applied Kinesiology

http://www.youtube.com/watch?v=p_MzP2MZaOo
Occam’s Razor

“A short explanation tends to be more valid than a long explanation”

William of Ockham, a 14th-century English logician
No Free Lunch

No learning is possible without some prior knowledge
Vapnik’s Principle

“When solving a problem of interest, do not solve a more general problem as an intermediate step”
Many applications

- **AI**: Object recognition, face detection, autonomous driving, text categorization, speech-to-text, voice recognition, ...
- **Science**: Gene expression, drug design, medical imaging, climate, astronomy, ...
- **Web applications**: Search engines, spam detection, machine translation ...
- **Economy**: E-commerce, trades, ...
Course Info

- Course site on moodle (syllabus, exercises ...)
- Course TA: Alon Gonen
- Videos of lectures will be available on YouTube
- Course textbook:
You’ve just arrived in some small Pacific island.
You soon find that papayas are a significant ingredient in the local diet.
How can you know if a papaya is tasty?
Based on previous experience with other fruits, you decide to use two features:
Your goal is to find a prediction rule:

\{\text{Tasty}/\text{Not tasty}\}