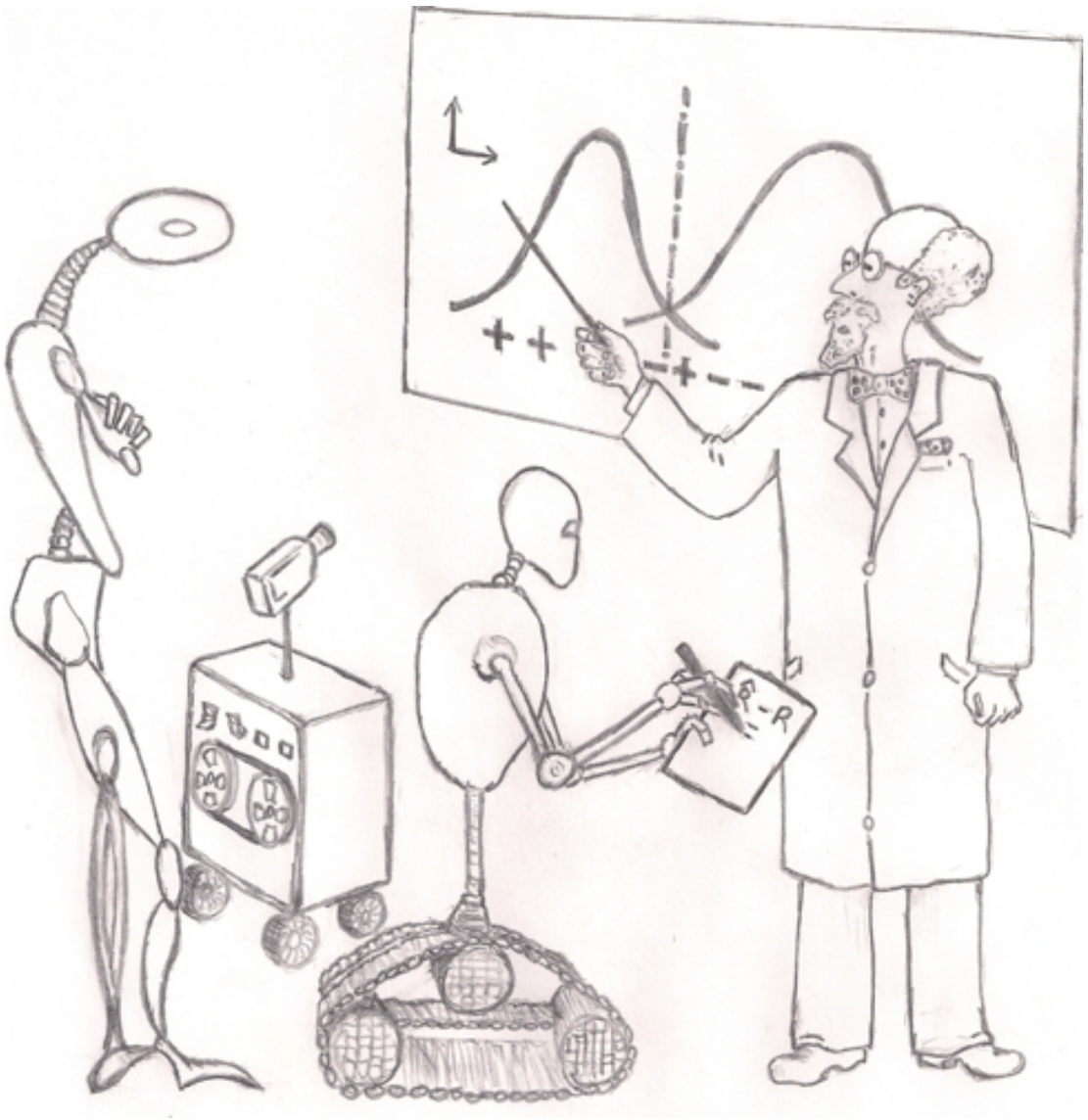
Introduction To Machine Learning



Shai Shalev-Shwartz

The Hebrew University of Jerusalem
האוניברסיטה העברית בירושלים
Est. 1925

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

Example – OrCam

OrCam developed glasses for the visually impaired

http://www.youtube.com/watch?v=k_C1iKIqi_o

Example - Pedestrian Detection

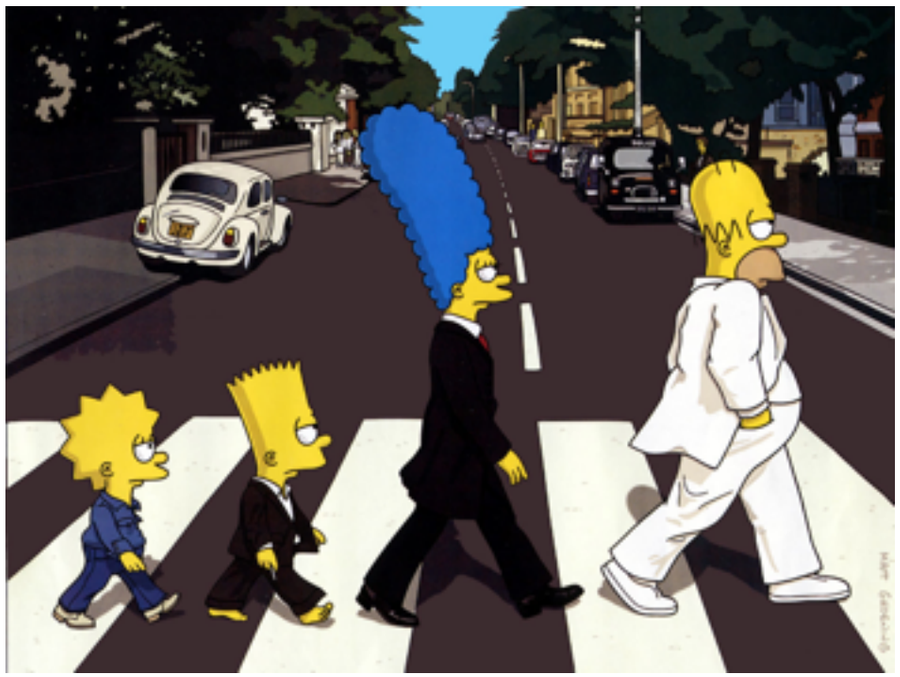
Example - Pedestrian Detection

Difficulty

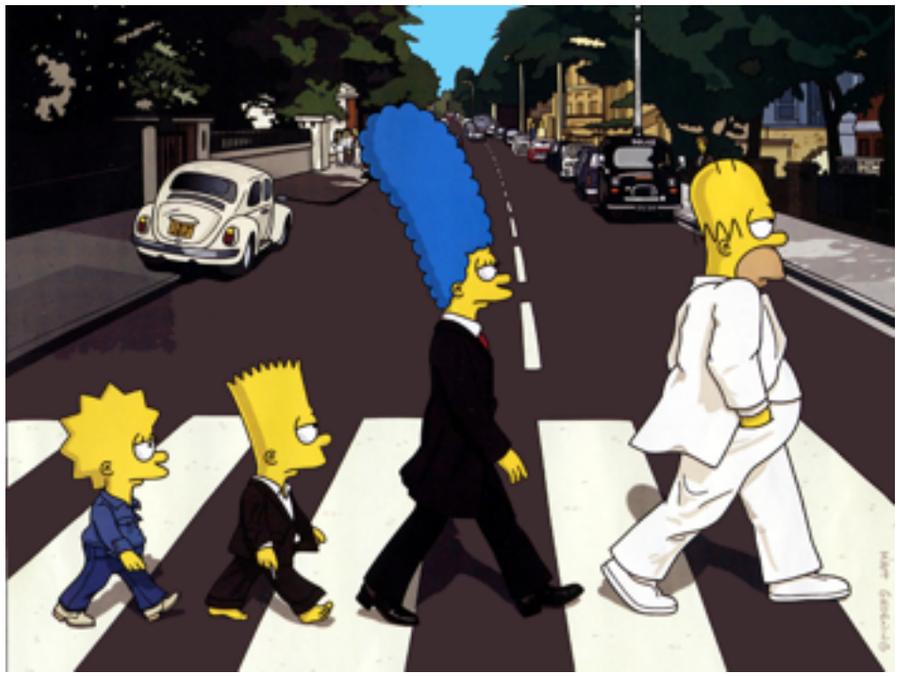
Difficulty

Difficulty

Difficulty



Difficulty



What is Learning ?

אבות פרק ה

(טו)
ארבע מדות ביושבים לפני חכמים.
ספוג, ומשפך, משמרת, ונפה.
ספוג, שהוא סופג את הכל.
משפך, שמכניס בזו ומוציא בזו.
משמרת, שמוציאה את היין וקולטת את השמרים.
ונפה, שמוציאה את הקמח וקולטת את הסלת.

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

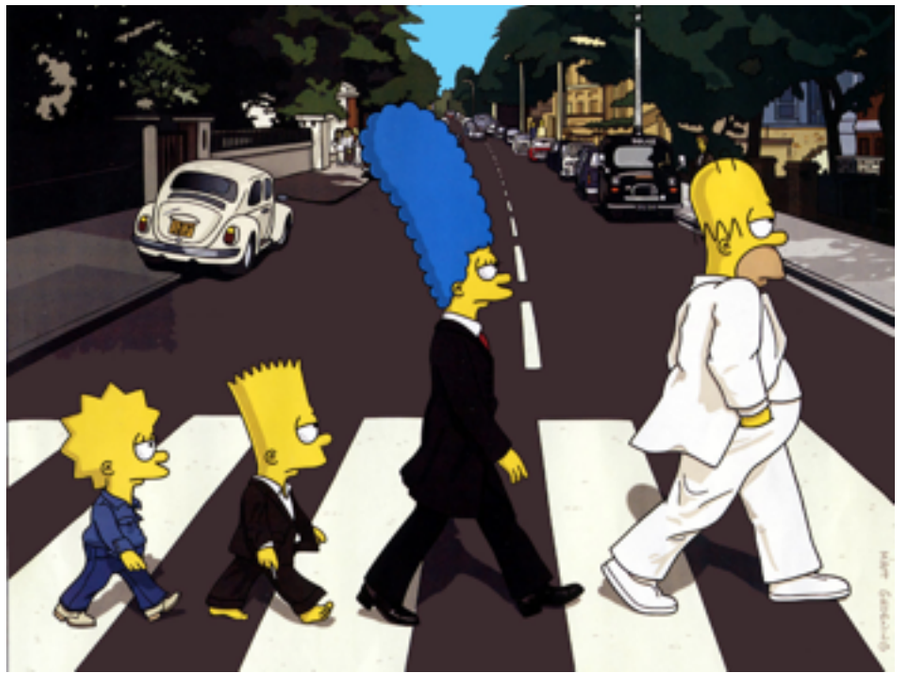
A computer can be an excellent "sponge" learner

The "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

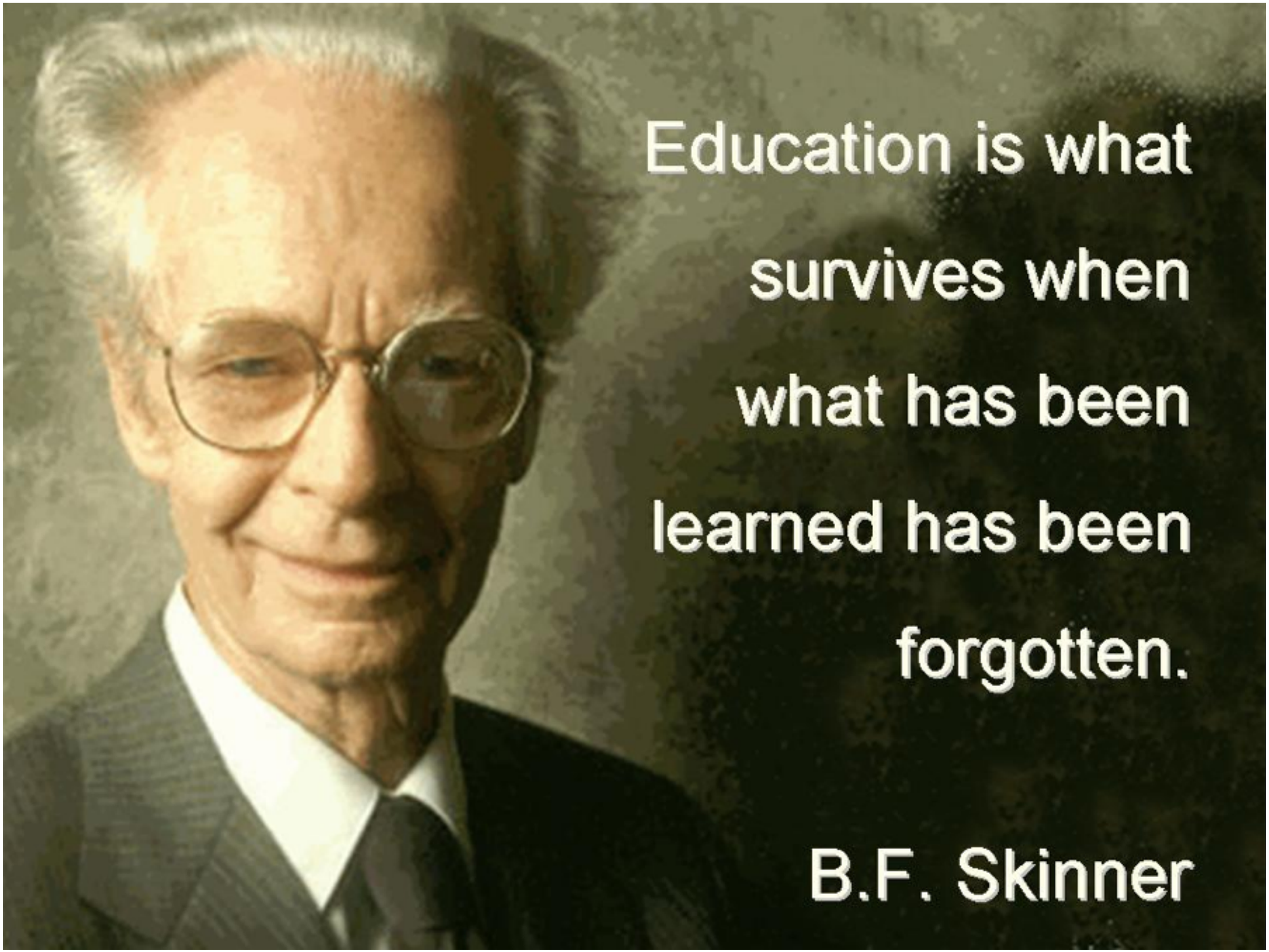
How to learn? What is learnable ?

How can we know that what we learned is true?

Pigeon Learning

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


HOW TO SHIT ON
PEDESTRIANS
IN ONLY 12
LESSONS

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

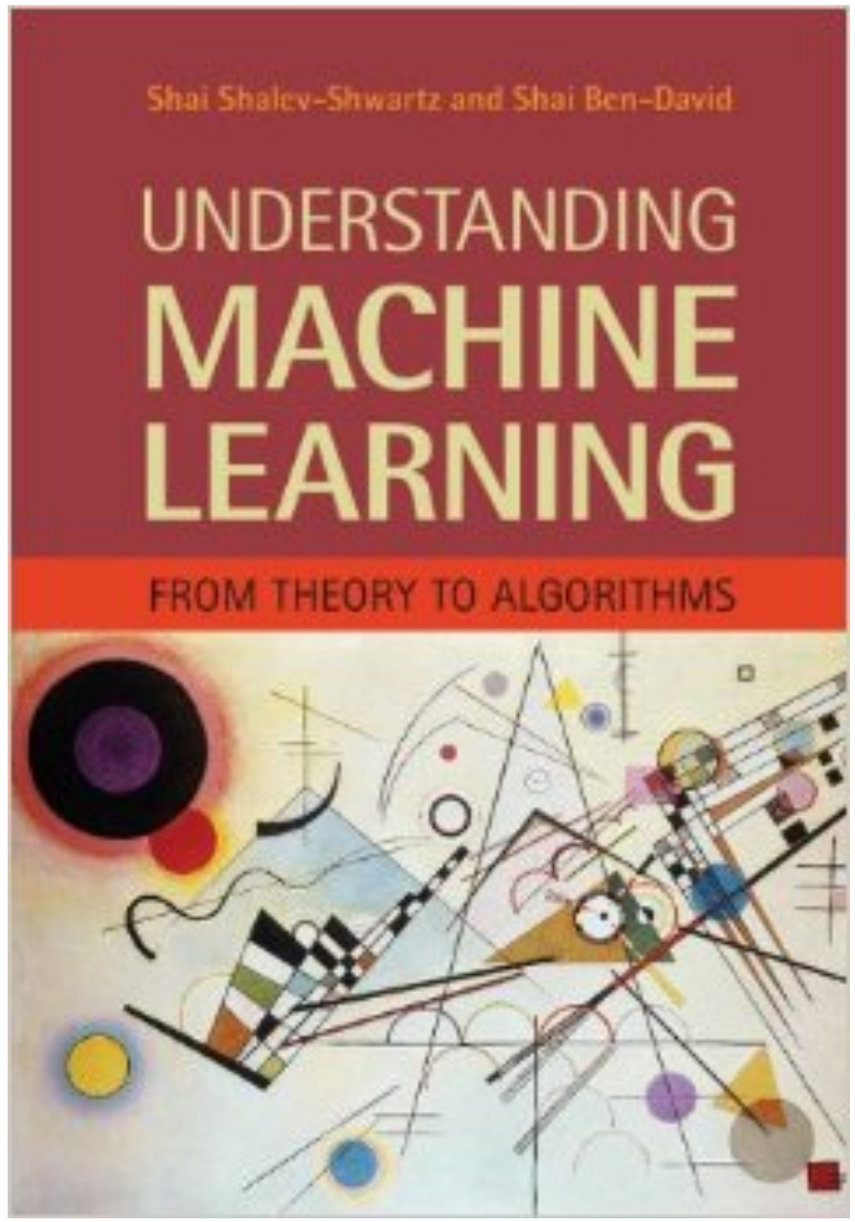
"When solving a problem of interest, do not solve a more general problem as an intermediate step"

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:



Example

You've just arrived in some small pacific island

Example

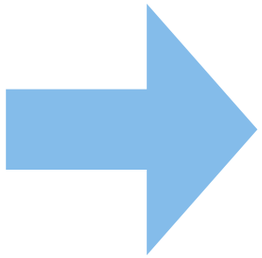
You soon find that papayas are a significant ingredient in the local diet

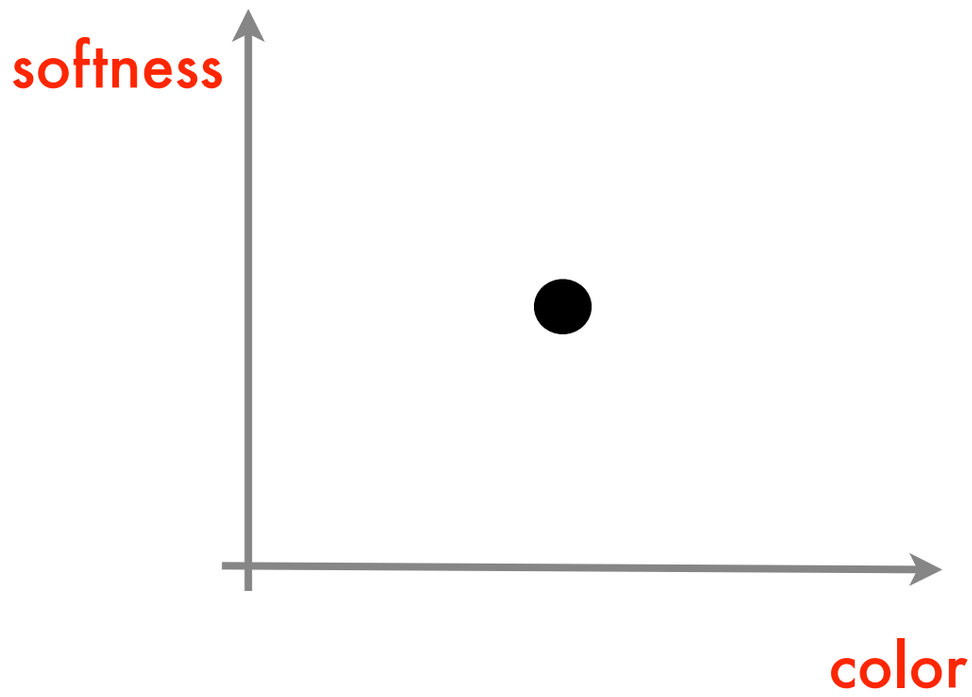
Example

How can you know if a papaya is tasty?

Example

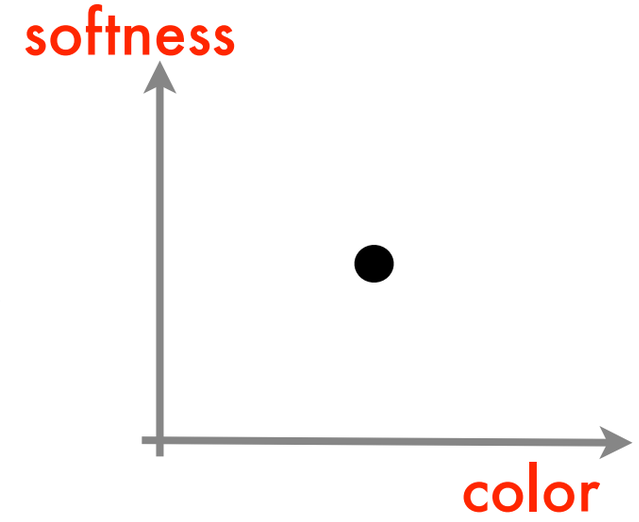
Based on previous experience with other fruits, you decide to use two features:

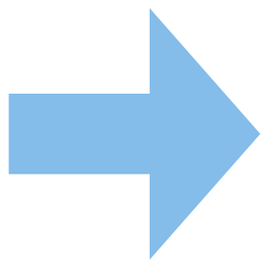




Example

Your goal is to find a prediction rule:





{Tasty/Not tasty}