

IME/USP – 2021

MAC 0460 / 5832
Introduction to Machine Learning

Course page: edisciplinas.usp.br



Nina Hirata (nina@ime.usp.br)

Mondays: 2pm

Wednesdays: 4pm

google meet: meet.google.com/kek-rsgn-csu

- will be recorded
- please use your USP account

What is Machine Learning (ML) ?

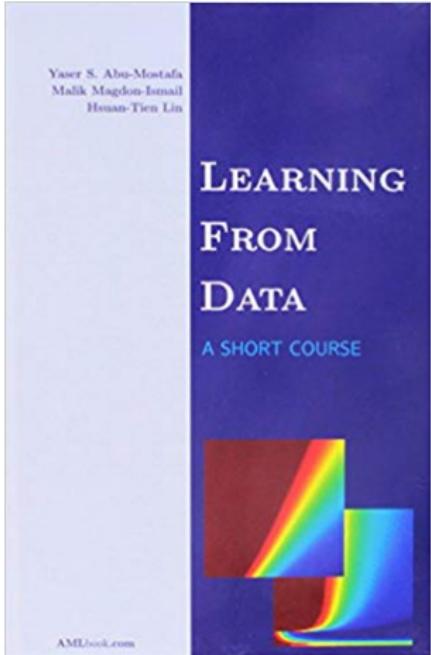
How do we do ML ?

How do we do ML well ?

Concepts

Theory

Practice



Caltech course

Video (lectures)

Slides

Exercises



Prof. Abu-Mostafa

Implement or experiment algorithms/methods

Python notebooks (mostly)

Important: Numpy

Later: libraries such as scikit-learn and Tensorflow/Keras

It will based on

- EP (algorithm implementation or testing)
- Written exercises
- Quick tasks

Details will be in the course site (edisciplinas)

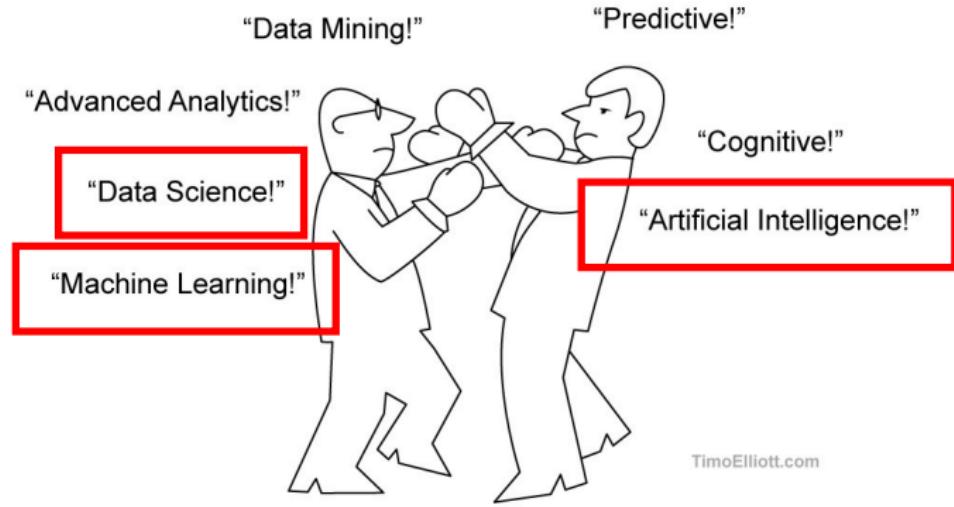
Let's start !

What is Machine Learning ?

Machine learning is related to computational intelligence

Computational intelligence is a field under development.

Several areas



- AI ↵ intelligent machines/agents, able to reason
- Idea present in fiction since long ago (robots, androids)
(https://en.wikipedia.org/wiki/List_of_artificial_intelligence_films)
- What changed since 1956 ?
(The term was coined in 1956 by John McCarthy at the Massachusetts Institute of Technology)



Deep Blue vs. Kasparov



Deep Blue
IBM chess computer



Garry Kasparov
World Chess Champion

First match

- February 10, 1996: took place in Philadelphia, Pennsylvania
- Result: **Kasparov**-Deep Blue (4-2)
- Record set: First computer program to defeat a world champion in a *classical* game under tournament regulations

Second match (rematch)

- May 11, 1997: held in New York City, New York
- Result: Deep Blue-Kasparov (3½-2½)
- Record set: First computer program to defeat a world champion in a *match* under tournament regulations

(wikipedia)

AI: Where is it working?



(AlphaGo. Google DeepMind)

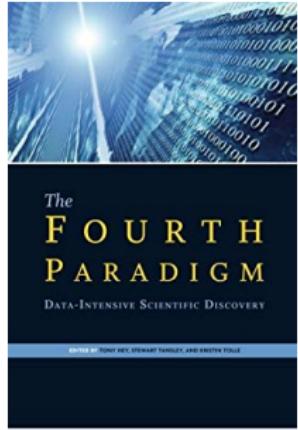
AI: Where is it working? Self-driving cars



AI: Where is it working? Digital assistants

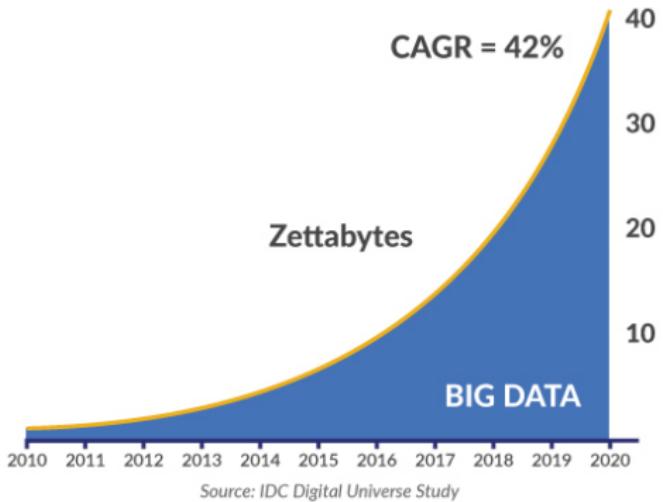


'This Is So Sad Alexa Play Despacito is a catchphrase and phrasal template of a mock conversation between a user and their Alexa digital assistant"



- Big data
5V (Volume, Velocity, Variety, Veracity, Value)
- Cloud computing
- GPU
- Deep learning

Data growth



zettabyte - one sextillion (10^{21}) ou 2^{70} bytes

1 The accelerating pace of change ...



2 ... and exponential growth in computing power ...

Computer technology, shown here climbing dramatically by powers of 10, is now progressing more each hour than it did in its entire first 90 years

COMPUTER RANKINGS

By calculations per second per \$1,000



At a price of \$1,298,
the compact
machine was one of
the first massively
popular personal
computers

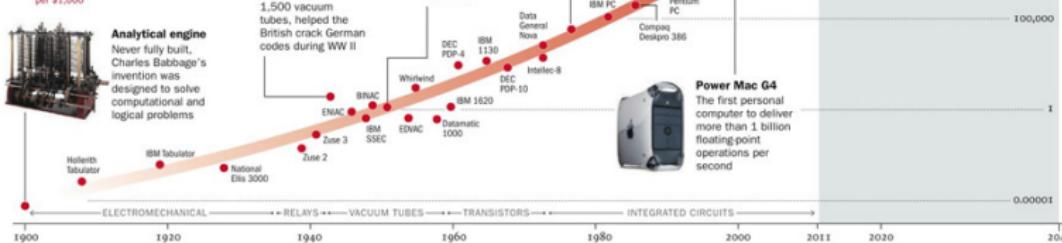


At a price of \$1,298,
the compact
machine was one of
the first massively
popular personal
computers

3 ... will lead to the Singularity

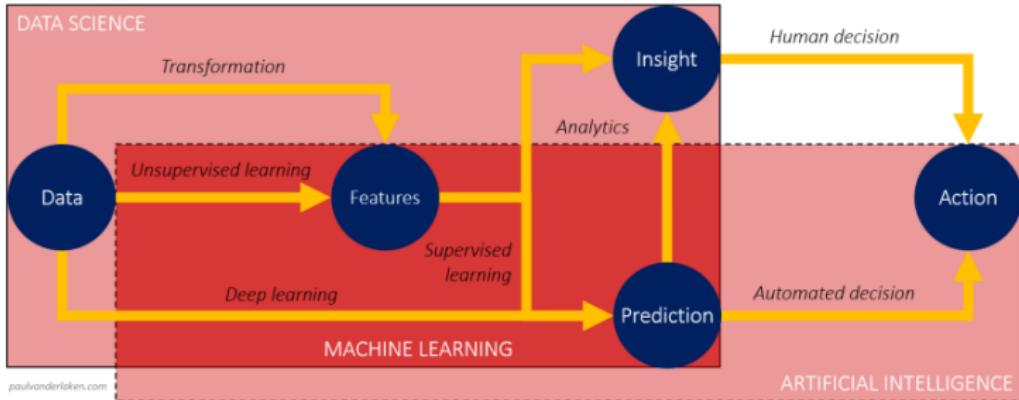
Surpasses
brainpower
equivalent
to that of
all human
brains
combined

Surpasses
brainpower
of human
in 2023



(Time)

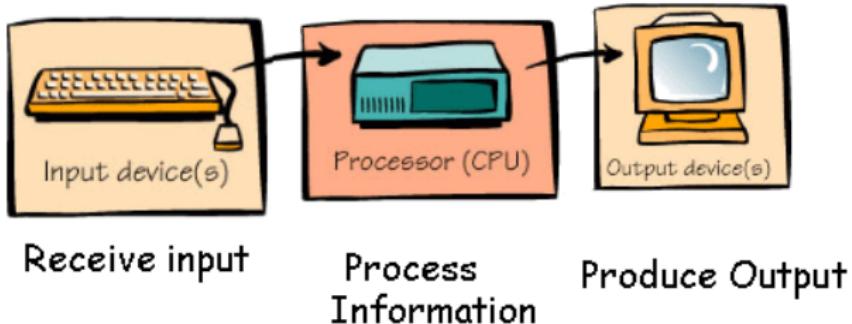
Machine learning (Today's view ?)



(Author: Paul van der Laken)

→ *Machine Learning is part of AI and Data Science*

A computational perspective



<http://gebar.weebly.com/inputoutput-devices.html>

Computers process data according to an **algorithm**

Algorithms are solutions for **computational problems**

An example

Problem Given a list of numbers, compute their sum

Examples of input and output instances of the problem

Input \Rightarrow Output

3, 1, 7 \Rightarrow 11

0.25, 0.75, 0.5, 0.1 \Rightarrow 1.6

1, 3, 5, 7, 9 \Rightarrow 25

Algorithm

Input: a list with the number to be summed
Output: the sum of the numbers in the list

SUM = 0

While the list of number is not empty

 Move the next number in the list to NUM

 SUM = SUM + NUM

Return SUM

Problems characterized by input-output examples

Input	\Rightarrow	Output
9, 2, 0, -1, 7, 4	\Rightarrow	-1, 0, 2, 4, 7, 9
'x', 'a', 'm', 'b'	\Rightarrow	'a', 'b', 'm', 'x'

What problem do they correspond to?

Problems characterized by input-output examples

Input	⇒	Output
9, 2, 0, -1, 7, 4	⇒	-1, 0, 2, 4, 7, 9
'x', 'a', 'm', 'b'	⇒	'a', 'b', 'm', 'x'

What problem do they correspond to?

Sorting! and we know several algorithms:

- selection sort • insertion sort • bubble sort •
- merge sort • quick sort • etc •

Another input-output example

a \Rightarrow 'a'

X \Rightarrow 'X'

A \Rightarrow 'A'

d \Rightarrow 'd'

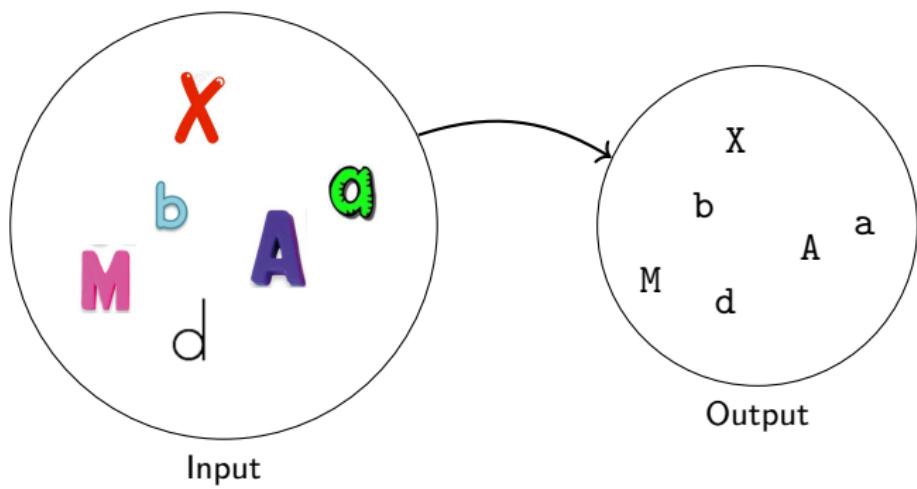
b \Rightarrow 'b'

M \Rightarrow 'M'

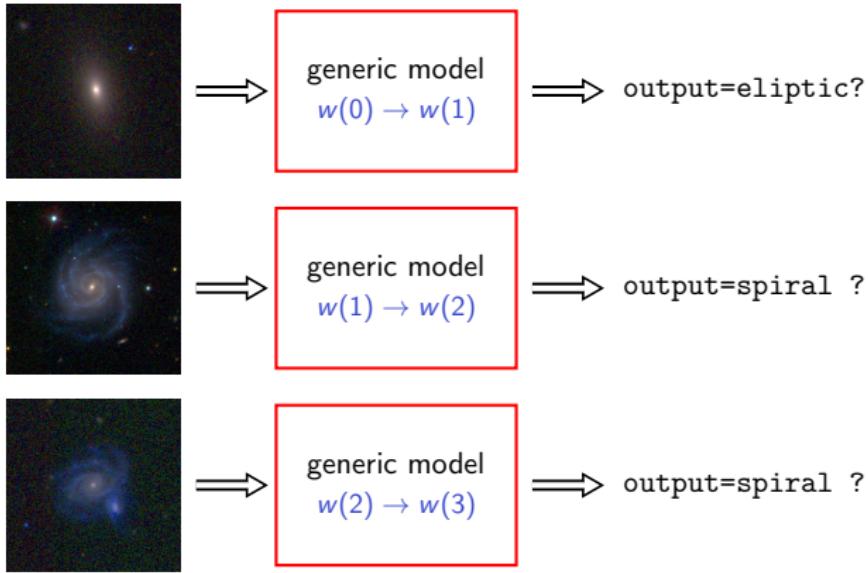
- Can you give me an algorithm that solves this problem ? •

Input-output relation

- Complex data; ambiguous cases; frequently changing data
- Hard to design an algorithm, but often easy to list **input-output** pairs



Rather than writing a specific code, let us consider a **generic input-to-output mapping model**, and adjust its parameters from available training data



From a purely computational point of view, ML is a meta-programming approach

Just let the computer generate the processing code !!

What about **learning** ??

Today's tasks – see Task section (moodle)

- QT1 (quick task 1) – google form (data collection)
====> This is for tonight!
- QT2 – Self-presentation
(a short video or a pdf document, with a picture if possible)

QT1 – collection of data

- Sex
- Age
- Height
- Weight
- Shoe number
- Trouser (pants) number

We will use this data to answer some questions:

- Given Height, can we guess Weight accurately ?
- Given Height, can we guess Sex ?
- Does other information help ?