Machine Learning - Deep Learning fundamentals (69152)

Master in Robotics, Graphics and Computer Vision
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Faculty

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Office hours in Google Meet or in person

https://directorio.unizar.es/?#/tutoria?colectivo=PDI&codCentro=110

M - 12.00-14.00h
J - 10.00-14.00h

Please, send me an email to book a slot 24h in advance to confirm and specify if it’s in person or online.

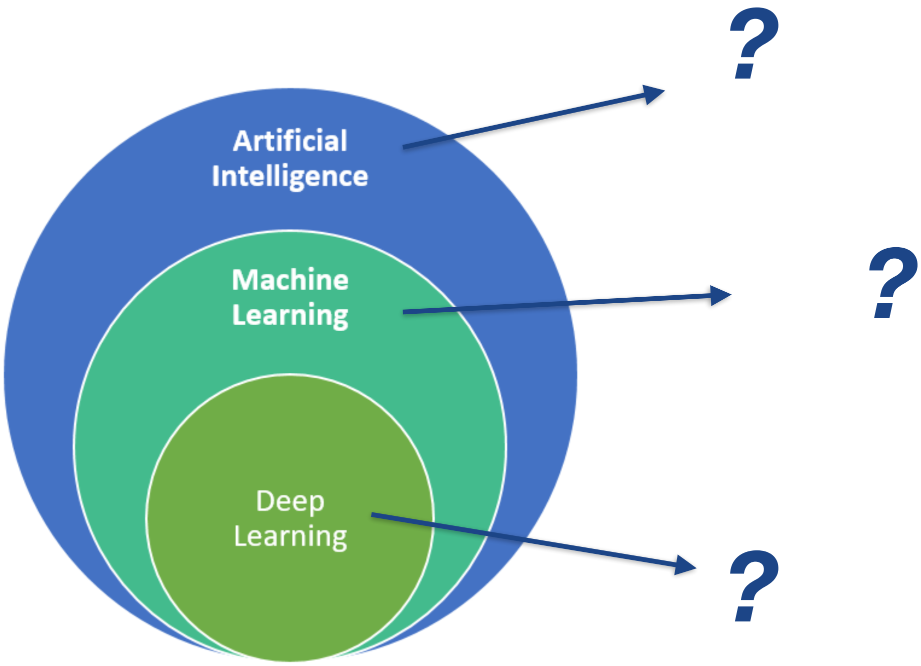
Tentative program for the DL block

Hours	**Day**	***Topic***
		...
M - 13-14h	2-Oct	***Fundamentals of DL***
Tu - 10-12h	3-Oct	***Fundamentals of DL***
M - 13-14h	16-Oct	***CNNs***
Tu - 10-12h	17-Oct	***CNNs***
LAB2	**18-20Oct**	*CNNs - Basics. Clasification. (Detection. Segmentation). Sample CV application.*
M - 13-14h	23-Oct	***Finish CNNs***
...	**...**	****** Bayesian & RL BLOCKS ********
Tu - 10-12h	21-Nov	*DRL*
		Unsupervised
LAB4	**24 & 29 NOV**	*Paper Reading lab*
		Unsupervised. GANs
		RNNs, Transformers
LAB5	13-15 Dec	*More CNNs. Unsupervised. DRL. (GANs). Sample Graphics and Robotics application.*
		More recent DL
		More recent DL

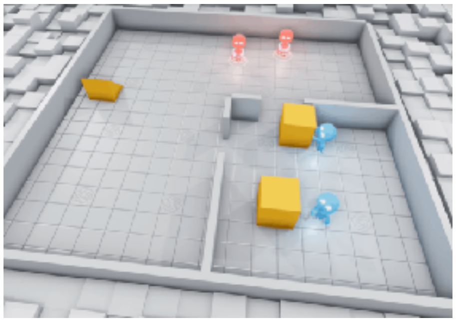
Today's class

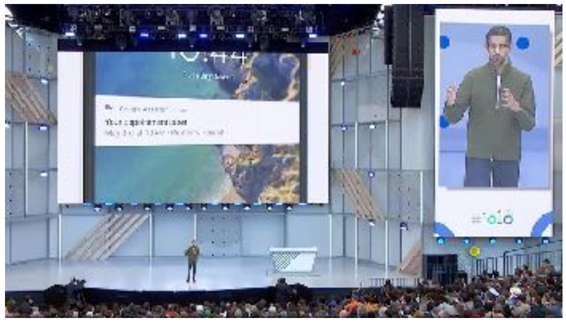
- **What's deep learning?**
  - **Related topics**
  - **DL pipeline**
- Fundamentals of DL
  - Review basic concepts
  - NN and DNN

What’s *deep learning*? (and what’s not …?)



What can we do with deep learning?





Responsible AI

And what not … :-)

What can we do with deep learning?

- Some examples …

Some examples of successful DL applications …

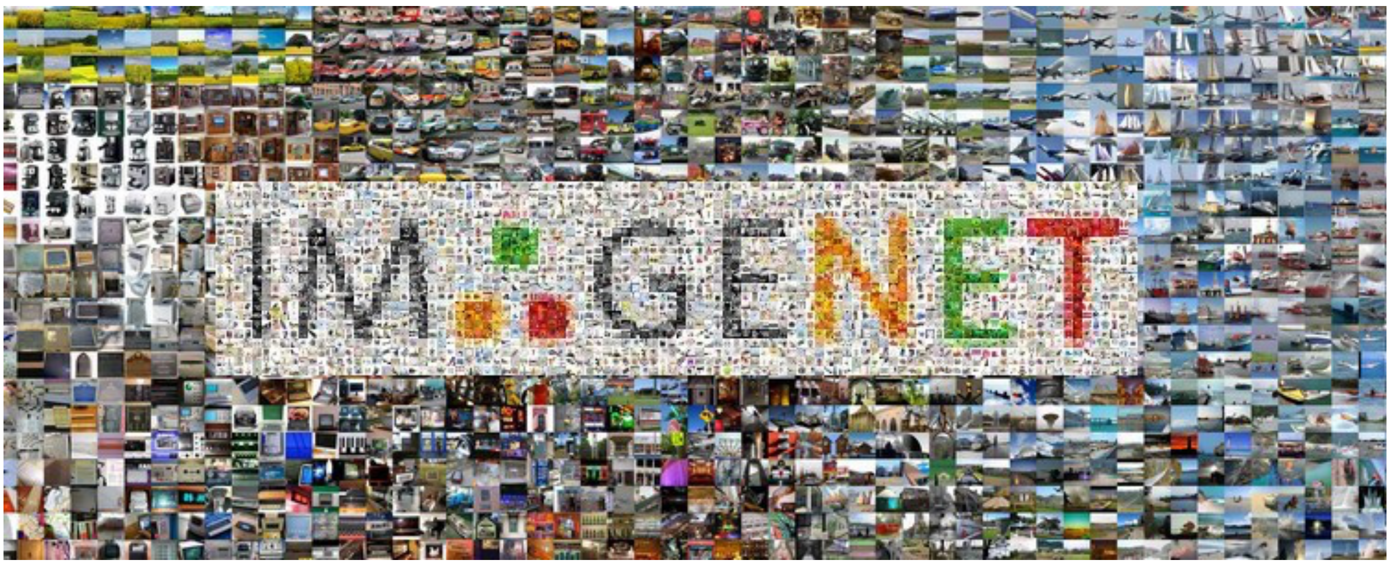
- **Object recognition**

Objects

- AlexNet. Competed in the ImageNet Large Scale Visual Recognition Challenge in 2012

- ImageNet: over <u>10 million</u> annotated images

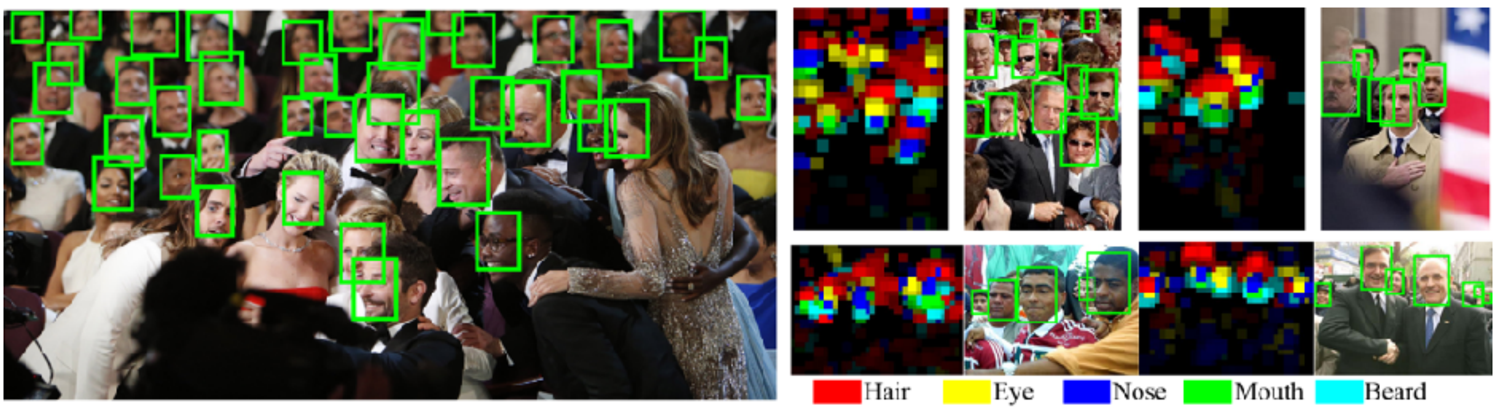
http://image-net.org



Some examples of successful DL applications …

- **Face detection** ***People***

- CelebFaces Attributes Dataset (CelebA). Large-scale face attributes dataset, more than 200K celebrity images



https://www.youtube.com/watch?v=IMPjPQSb9g8&feature=youtu.be

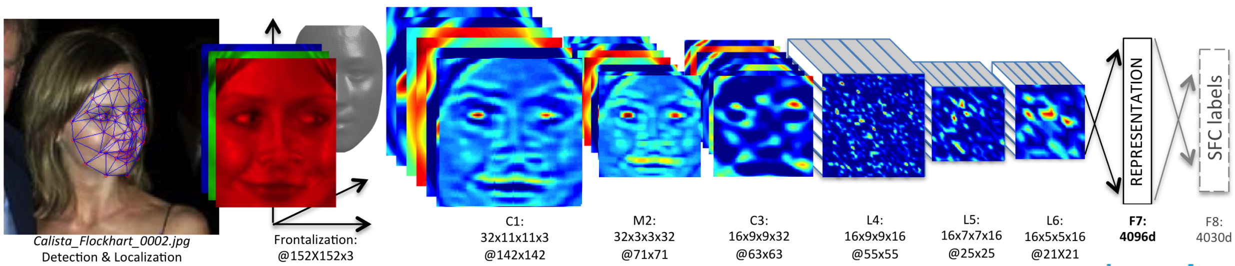
From Facial Parts Responses to Face Detection: A Deep Learning Approach
Shuo Yang Ping Luo Chen Change Loy Xiaoou Tang
International Conference on Computer Vision (ICCV) 2015.

Some examples of successful DL applications …

- **Face recognition**

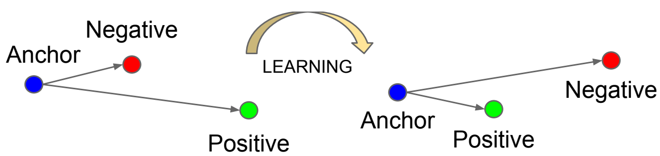
People

- <u>4 million</u> images of 4,000 persons



Human performance!

DeepFace: Closing the Gap to Human-Level Performance in Face Verification.
Yaniv TaigmanMing YangMarc'Aurelio RanzatoLior Wolf. CVPR 2014. Facebook



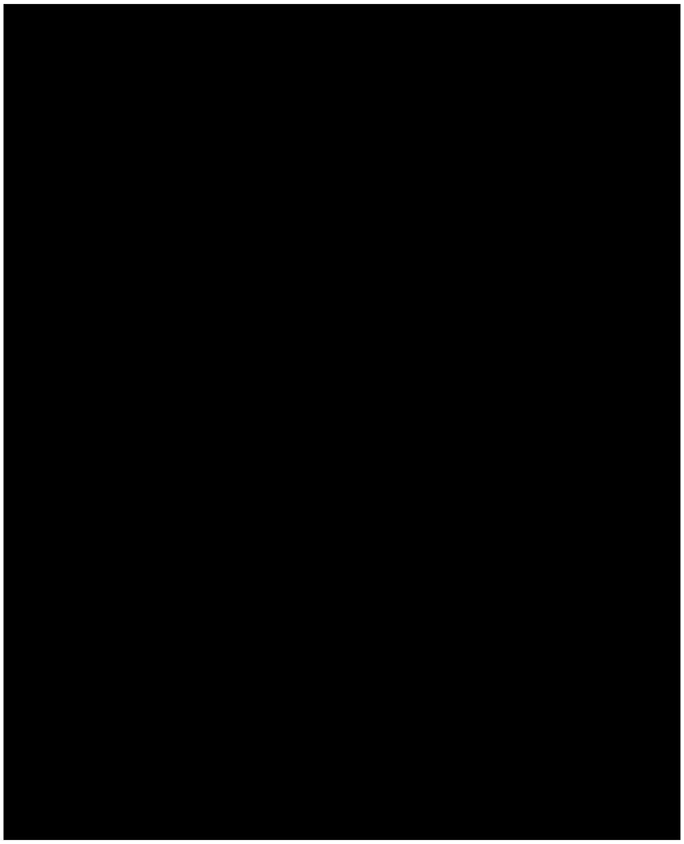
FaceNet: A Unified Embedding for Face Recognition and Clustering.
Florian Schroff, Dmitry Kalenichenko, James Philbin; CVPR 2015. Google

Apple face recognition
wired.com

Some examples of successful DL applications …

- Learn by watching how to play?! —> DRL

Behaviours



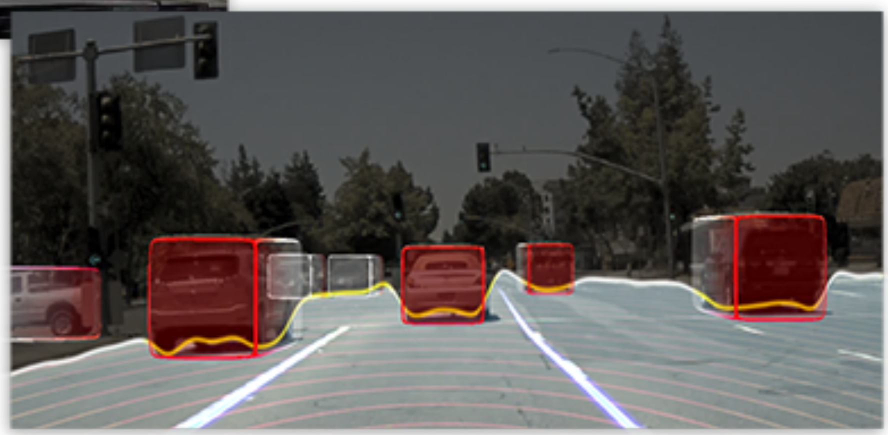
Google's Deep Mind

Some examples of successful DL applications …

- Self-driving car

Behaviours

NVIDIA



Some examples of successful DL applications …

- DeepMind AI

Not only visual tasks …

- Reduces Google Data Centre Cooling Bill by 40%

- "*Using a system of neural networks trained on different operating scenarios and parameters within our data centres, we created a more efficient and adaptive framework to understand data centre dynamics and optimize efficiency*."

Google's Deep Mind

Some examples of successful DL applications …

- **Voice** recognition and
  Natural **Language** Processing

Not only visual tasks …

Hi, how can I help?

ChatGPT

Jeff Bezos: "Alexa, buy me something from Whole Foods."

Alexa: "Sure, Jeff. Buying Whole Foods now."

Jeff Bezos: "WHA- ahh go ahead."

6/16/17, 9:23 AM

Tweet your reply

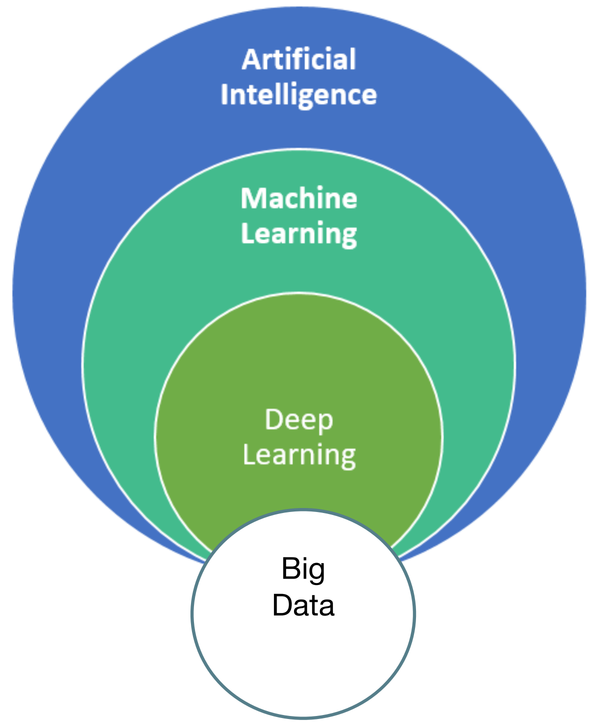
Some examples of successful DL applications …

- **Recommendation** systems

Not only visual tasks …

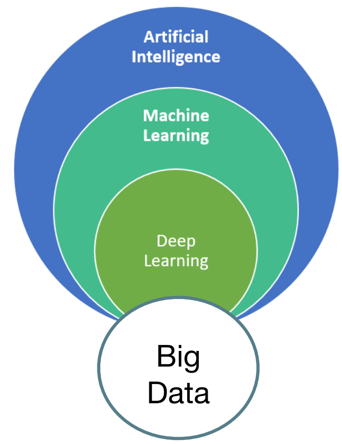
Deep Learning and Big Data

- Related topics to DL
  - Big data
  - Data science
  - Business Intelligence
  - …



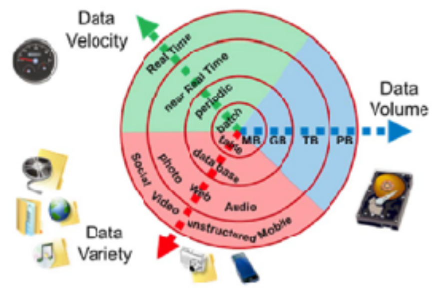
Deep Learning and Big Data

- Related topics to DL
  - ***Big data:*** *"data sets that are so large or complex that traditional data processing application software is inadequate to deal with them"* (Wikipedia)
  - ***Data science***: Scientific field with the aim of extracting knowledge from raw data (usually "big data")
  - ***Business*** *Intelligence*: Set of techniques to extract information from business data, that will be used to improve its performance.
  - *Data mining*: The exploration of raw data in the search for patterns (usually in the context of **databases**).



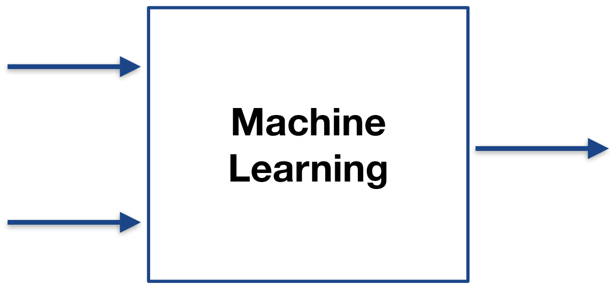
Machine Learning + Big Data

+



- **Cons**:
  - *Torture the numbers, and they'll confess to anything* — Gregg Easterbrook (and probably many others …)
  - *So it's like having billions of monkeys typing. One of them will write Shakespeare*. — Michael Jordan
- **Pros**: New opportunities, challenges, and amazing results and applications!!

Deep Learning vs general ML pipeline



Deep Learning vs general ML pipeline

- Same methodology you saw the first day. Certain steps/ideas get particularly important: data selection, avoid overfitting, …

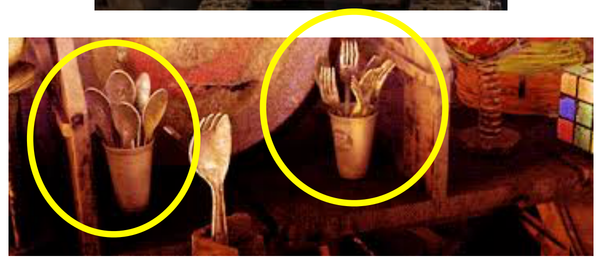
1. Frame problem
2. Get **data**
3. Explore **data**
4. Prepare **data**
5. Explore promising **models**
6. Fine tune the best
7. Present/**analyze** the solution and results

It may sound you just "throw" as much data as you can … but not just that!

expensive!

ML pipeline & DL

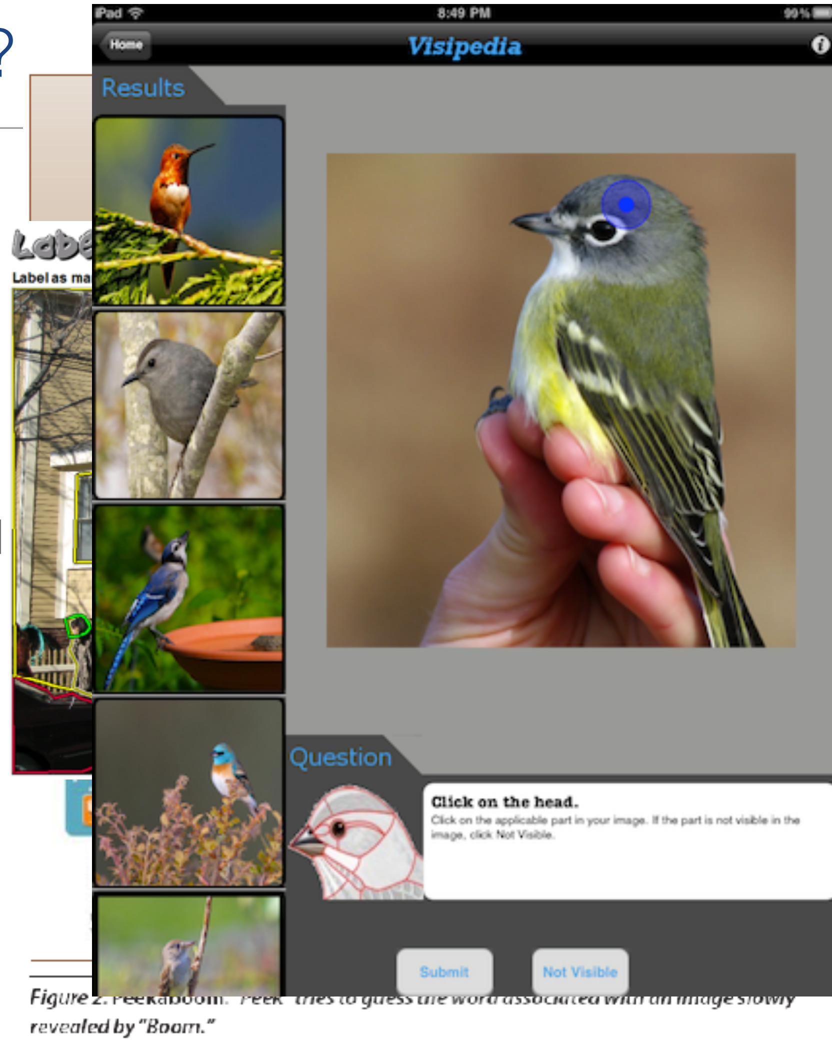
- Collect **data** (labeled?) choose how to **represent** it?
- **Learn**: organize the sample data (training data): fit/learn a **model**
- **Classify**: **evaluate** new data with regard to the model learnt (classify/recognize new content)



How to get training data?

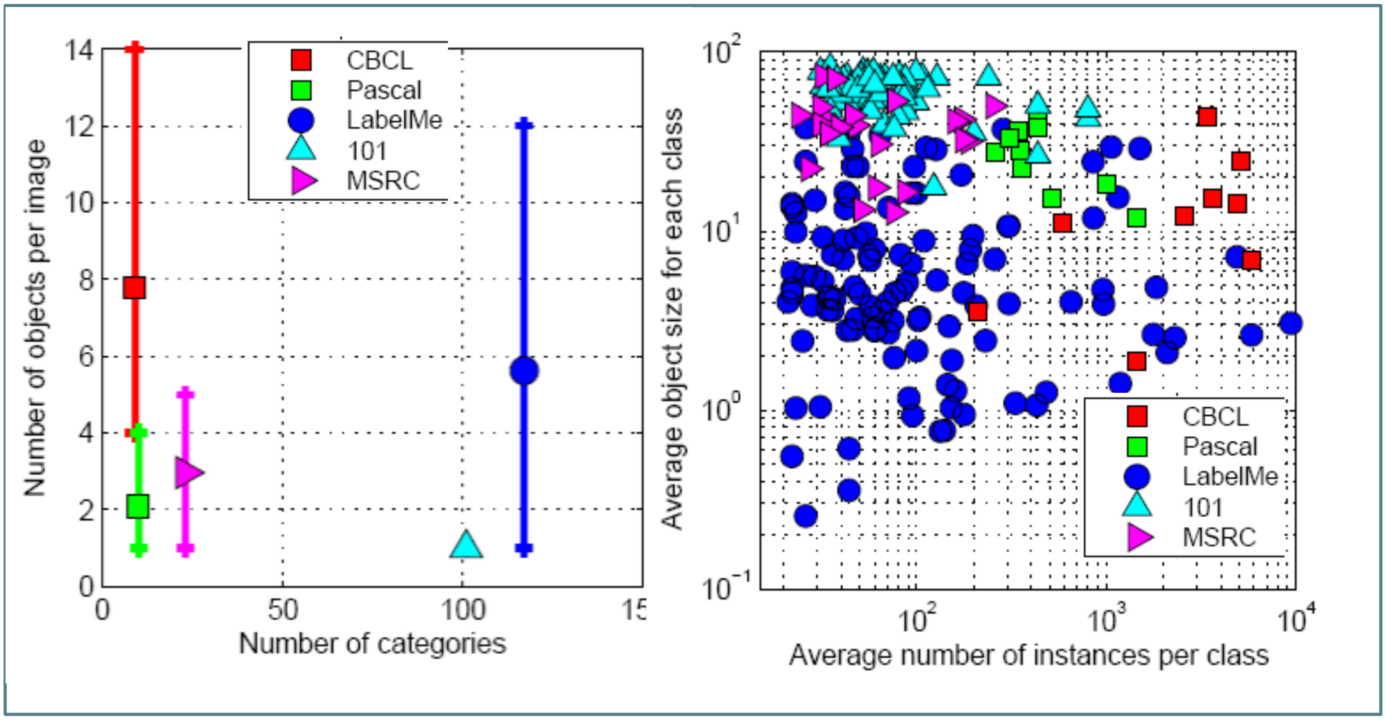
Lots of strategies. Crowdsourcing is a common ingredient lately

- ESP game. Luis Von Ahn and Laura Dabbish 2004
- LabelMe (MIT) - researchers and volunteers Russell, Torralba, Freeman, 2005
- Birds-200-2011 - fans of certain topic. Caltech-UCSD. Wah, Branson, Welinder, Perona, Belongie, 2011



Is my dataset good?

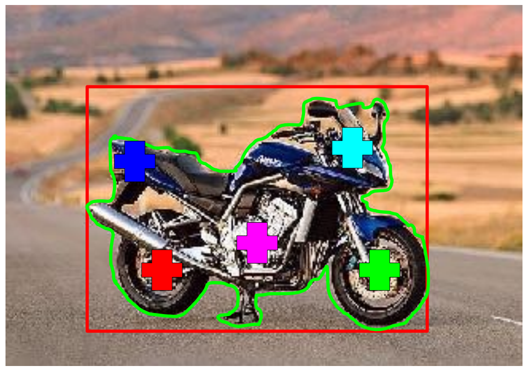
- Enough classes? Enough examples? Enough variability? Good labels?



How to label training data?

- Depends on the application/problem

Contains a motorbike



ML pipeline & DL

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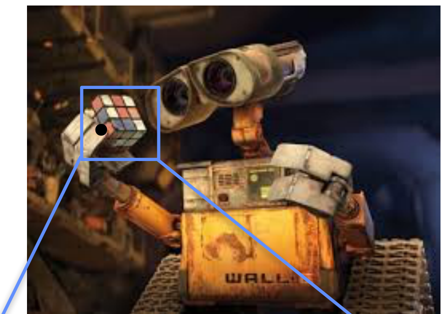
features: VERY complicated and important *design* decision!!



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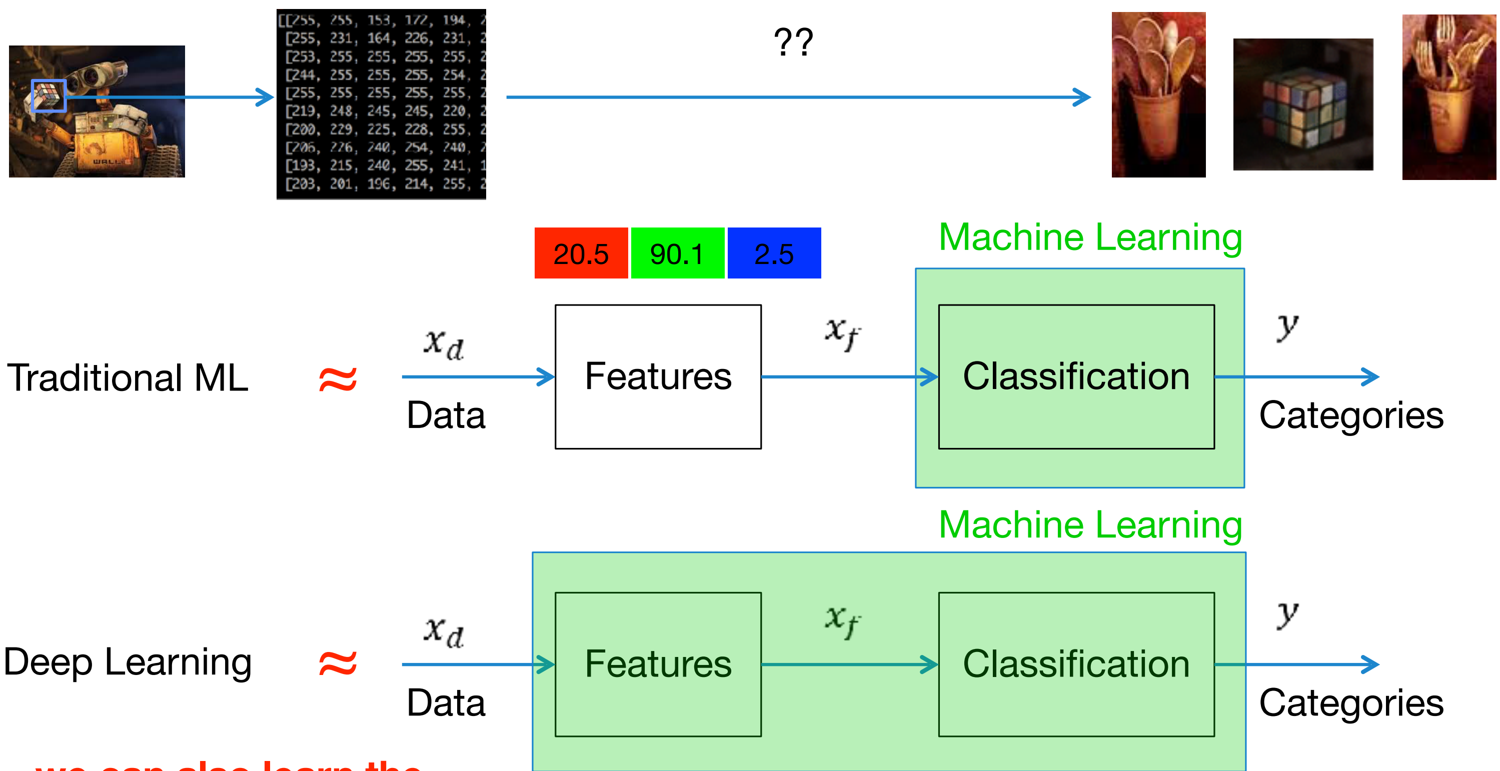
ML pipeline & **DL pipeline**



we can also learn the representations (features)

Next

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    - Related topics
    - DL pipeline
- **Fundamentals of DL**
    - **Review basic concepts**
    - NN and DNN

Bibliography - Resources for some of the materials today

- Stanford classes on deep learning for Computer Vision (http:// cs231n.stanford.edu)

- Ian Goodfellow, Yoshua Bengio, Aaron Courville. ***Deep Learning*.** MIT Press, 2016. http://www.deeplearningbook.org

- Book: ***Computer Vision: Algorithms and Applications*** (http:// szeliski.org/ Book/). Richard Szeliski, Steve Seitz.
  Computer vision course slides. CSE 576 (Graduate Computer Vision) University of Washington (http:// courses.cs.washington.edu/courses/ cse576/08sp/)

- Fei-Fei, Fergus, Torralba: short course “recognising objects” (http:// people.csail.mit.edu/torralba/shortCourseRLOC)