

INTRODUCTION

SOME PRELIMINARY NOTES

I AM NOT A MACHINE LEARNING RESEARCHER

SOME PRELIMINARY NOTES

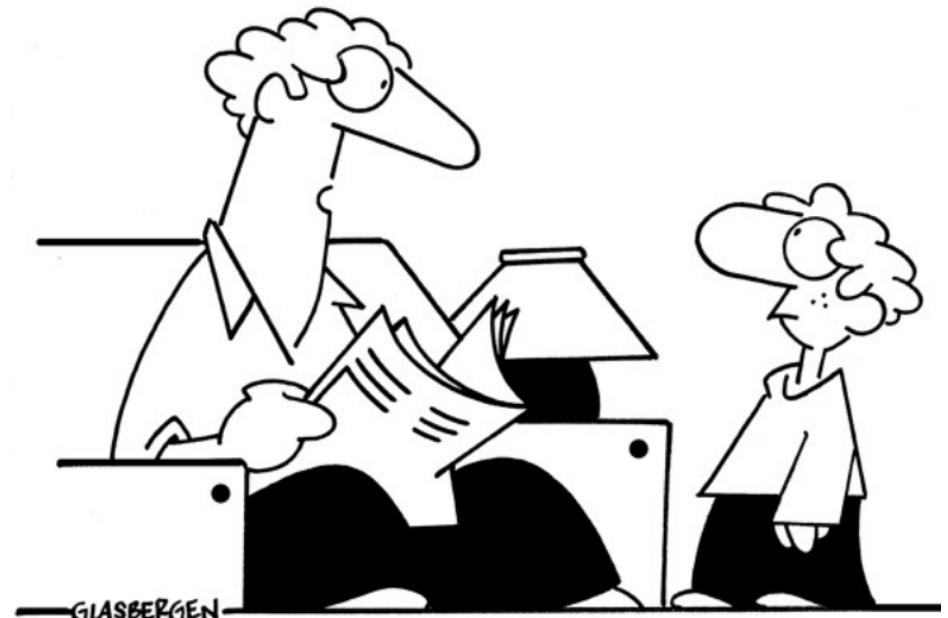
I AM NOT A MACHINE LEARNING RESEARCHER

ONLY AN ASTRONOMER WHO HAS BEEN USING MACHINE
LEARNING FOR THE LAST ~13 YEARS FOR MY RESEARCH

THIS COURSE IS INTENDED TO PROVIDE A GLOBAL
UNDERSTANDING OF HOW AI TECHNIQUES WORK AND
ESPECIALLY HOW TO USE THEM FOR YOUR RESEARCH

WHAT ARE WE GOING TO LEARN?

data-science
pattern-recognition
artificial-intelligence
database
data
big-data machine
data-mining
learning
clustering



*"Artificial intelligence is when you get a college degree,
but you're still stupid when you graduate."*

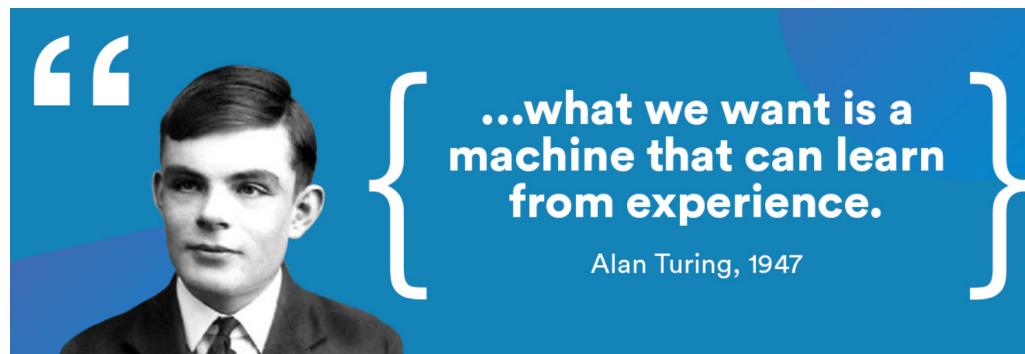
WHAT ARE WE GOING TO LEARN?

data-science
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learning
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A BUNCH OF
SOMETIMES
CONFUSING
TERMS...

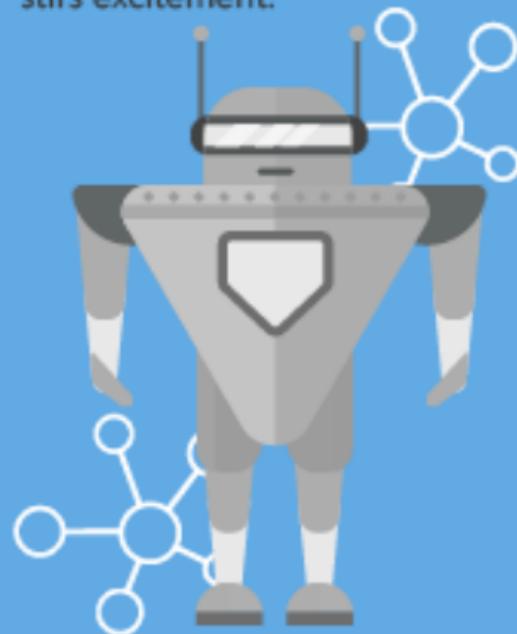


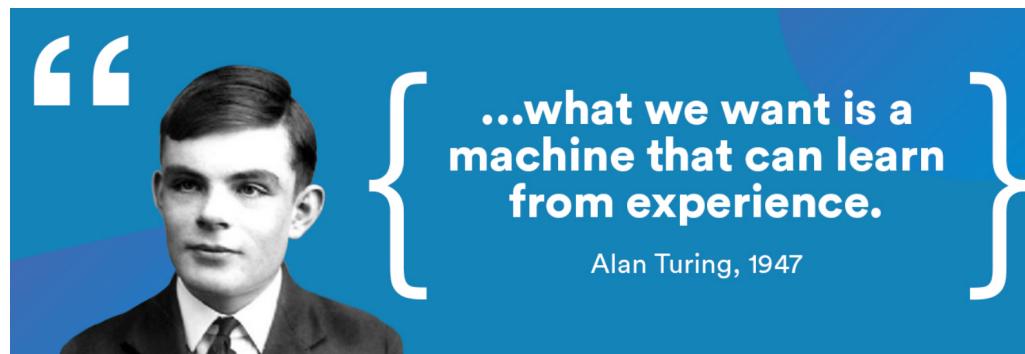
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ARTIFICIAL INTELLIGENCE

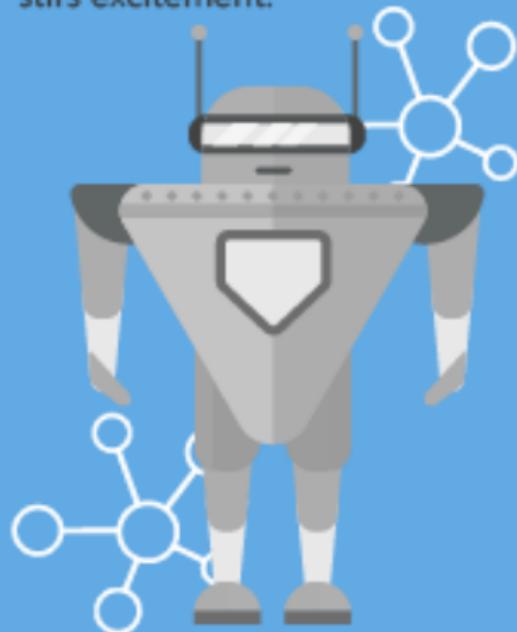
Early artificial intelligence stirs excitement.





ARTIFICIAL INTELLIGENCE

Early artificial intelligence stirs excitement.



1950's

1960's

1970's

1980's

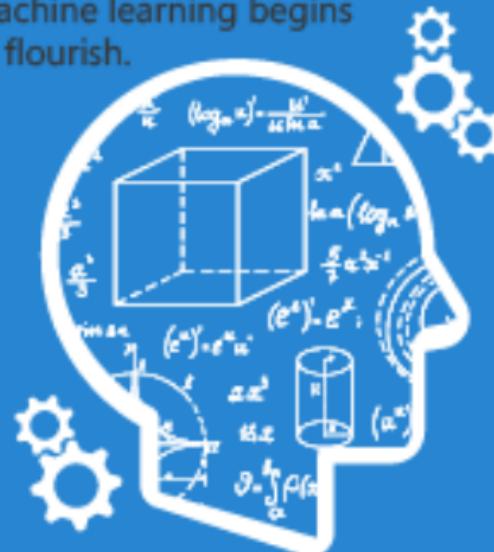
1990's

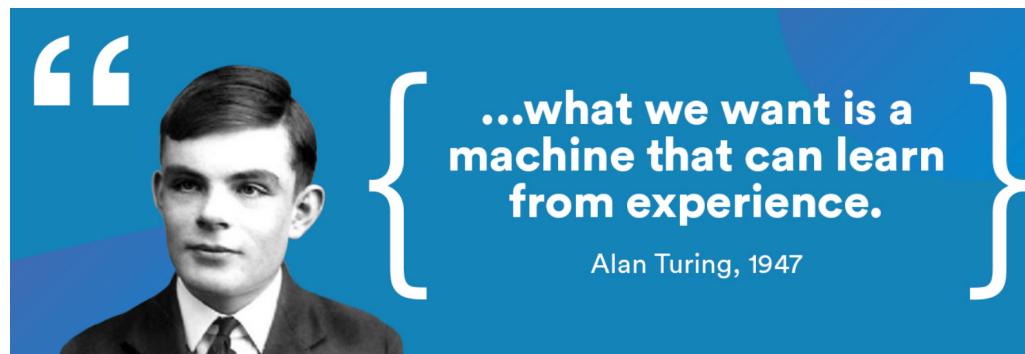
2000's

2010's

MACHINE LEARNING

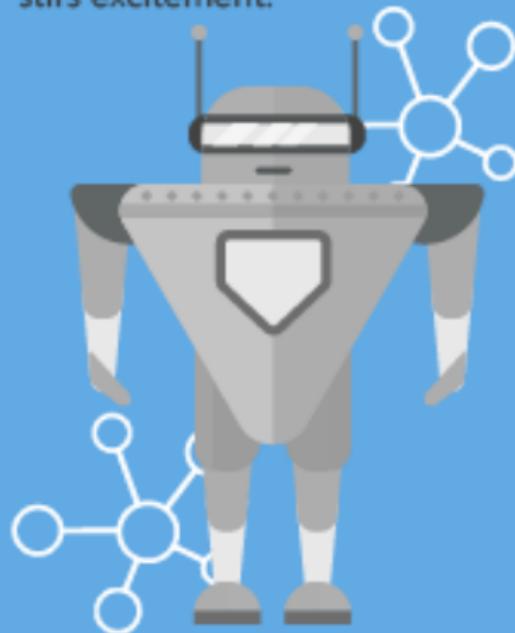
Machine learning begins to flourish.





ARTIFICIAL INTELLIGENCE

Early artificial intelligence stirs excitement.



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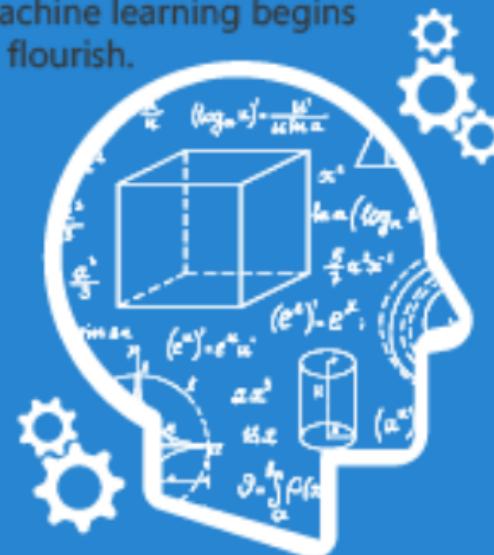
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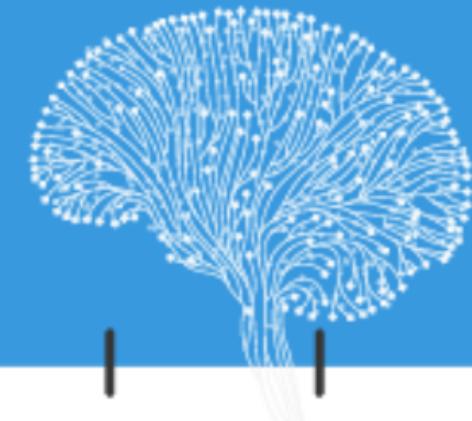
MACHINE LEARNING

Machine learning begins to flourish.

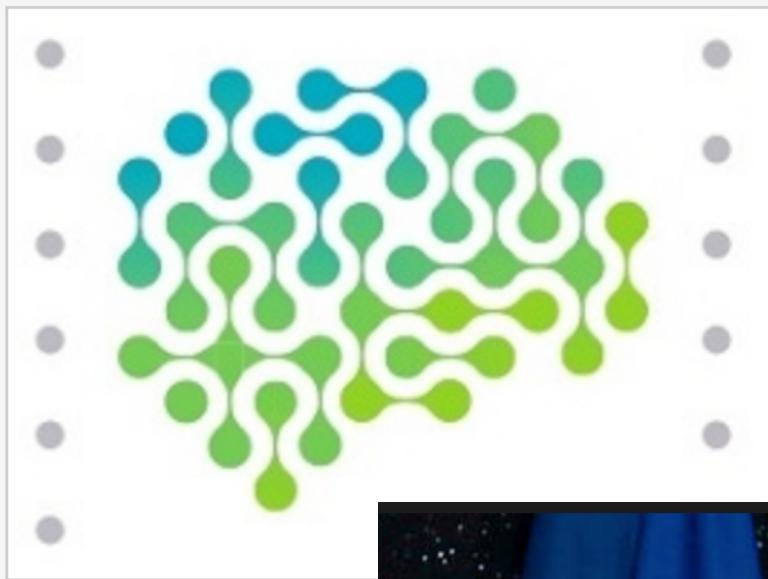


DEEP LEARNING

Deep learning breakthroughs drive AI boom.



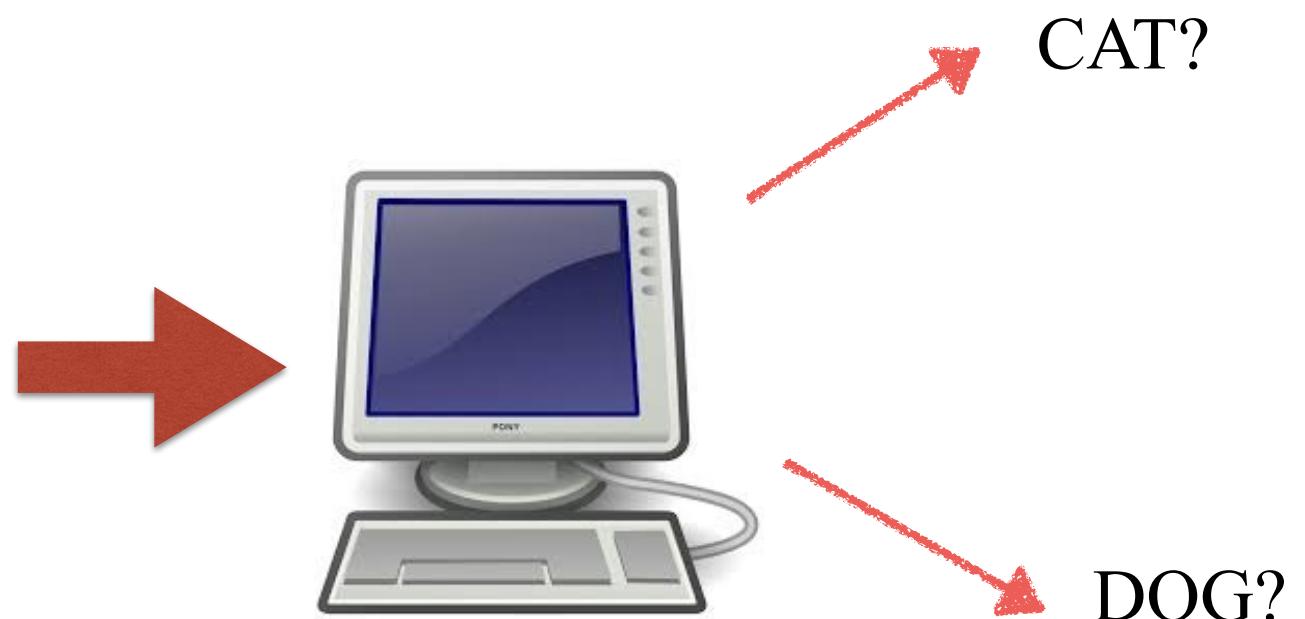
AN AMAZING MEDIA ATTENTION



Le CNRS, Inria, l'université PSL et les entreprises Amazon, Criteo, Facebook, Faurecia, Google, Microsoft, NAVER LABS, Nokia Bell Labs, le Groupe PSA, SUEZ et Valeo font converger intérêts académiques et industriels et s'unissent pour créer, à Paris, l'Institut PRAIRIE dont l'objectif est de devenir une référence internationale de l'intelligence artificielle.

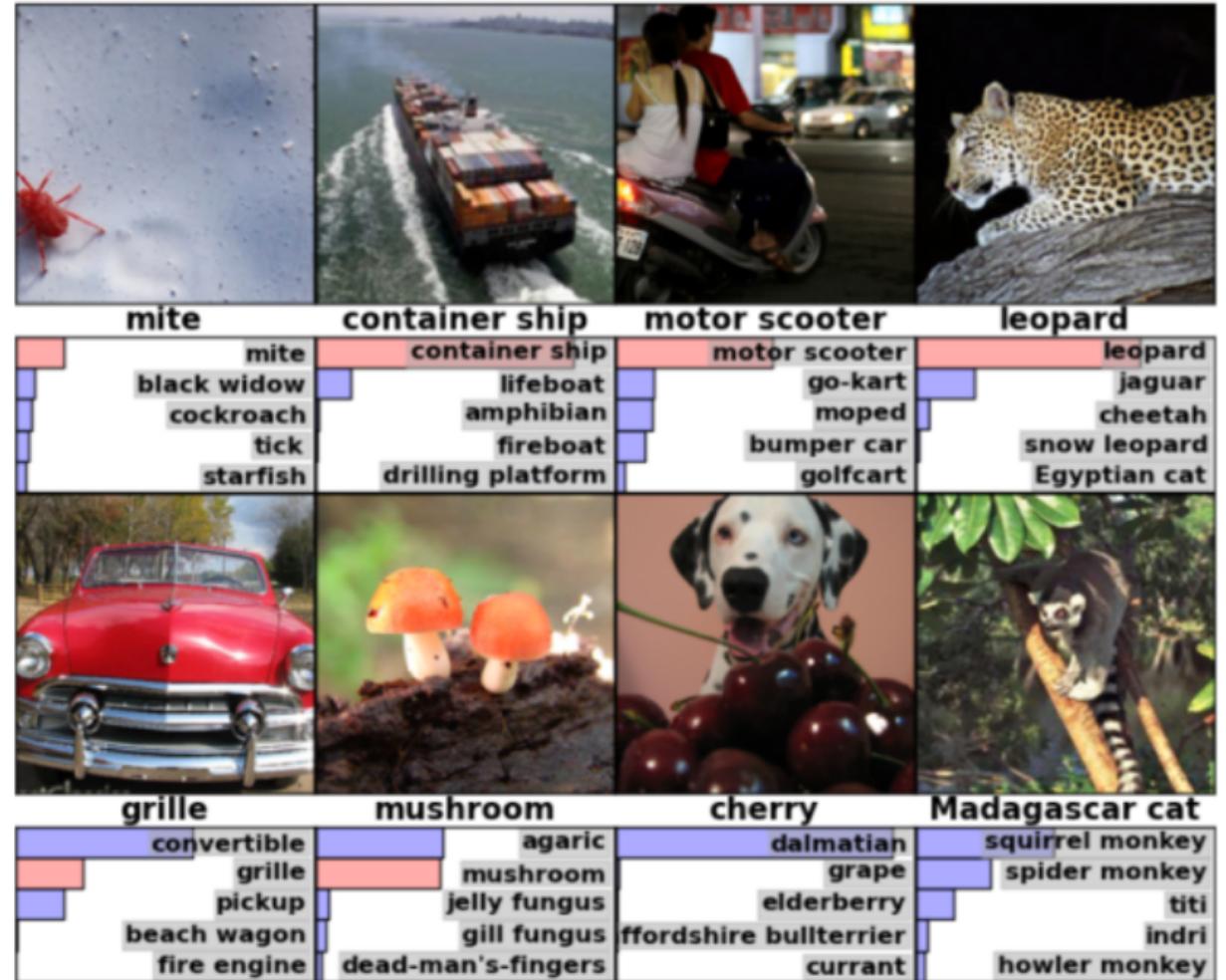
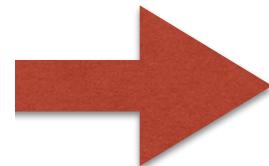


UNTIL 2012....



**TRIVIAL HUMAN TASKS REMAINED
CHALLENGING FOR COMPUTERS**

SINCE 2012



IT HAS BECOME TRIVIAL....

ONE OF THE MAIN REASONS OF THIS
BREAKTHROUGH IS THE AVAILABILITY OF VERY
LARGE DATASETS TO LEARN

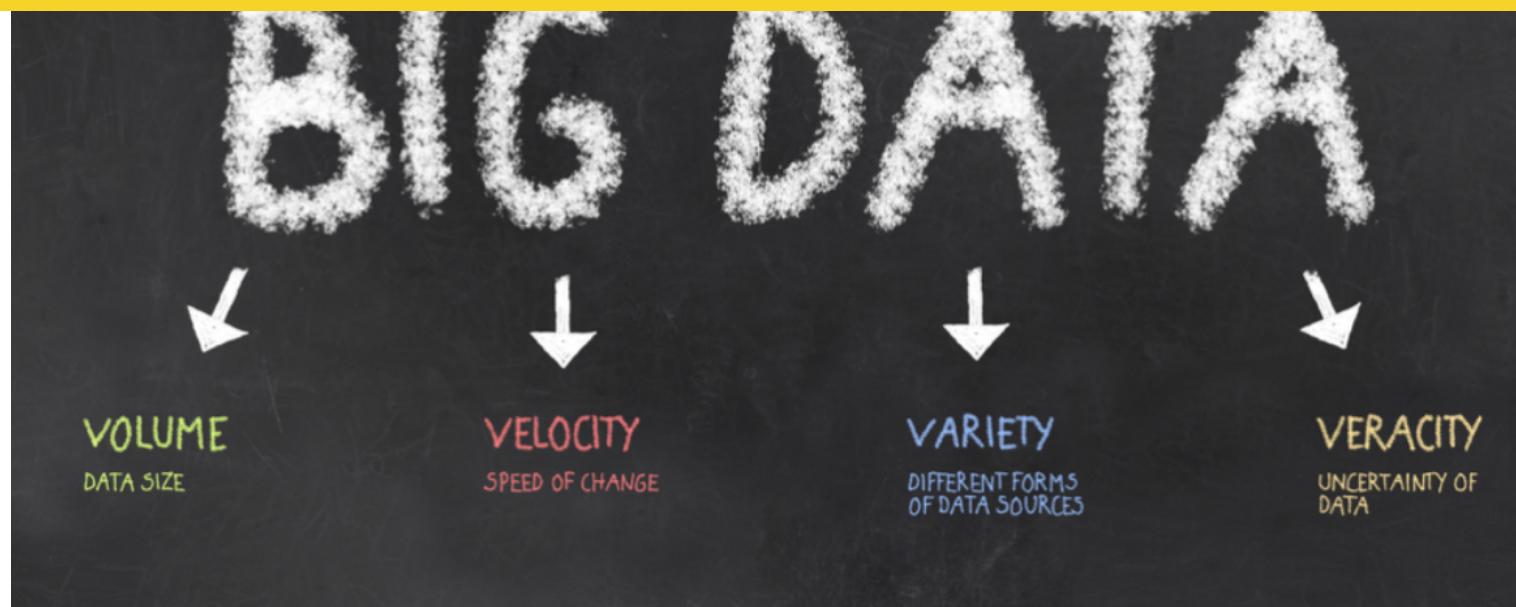


COMBINED WITH THE TECHNOLOGY TO
PROCESS ALL THIS DATA



ONE OF THE MAIN REASONS OF THIS
BREAKTHROUGH IS THE AVAILABILITY OF VERY
LARGE DATASETS TO LEARN

HOWEVER THERE HAS NOT BEEN A MAJOR
REVOLUTIONARY IDEA



BASICS OF CLASSICAL MACHINE LEARNING

BASICS OF DEEP LEARNING

HOPING THAT THIS WOULD BE USEFUL FOR YOUR
RESEARCH!

(Apologies in advance for biases on Extra-Galactic Science +
imaging)

PROGRAM FOR THE WEEK

1. THEORY

- **AN INTRODUCTION TO ‘CLASSICAL’ MACHINE LEARNING**
 - UNSUPERVISED / SUPERVISED
 - GENERAL STEPS TO “TEACH A MACHINE”
 - SUPERVISED ALGORITHMS [CARTS, RF, SVMS, NN]
 - EVALUATION OF RESULTS [ROC, P-C..]
 - WHAT DATA TO TRAIN?

PROGRAM FOR THE WEEK

1. THEORY

- **FOCUS ON ‘SHALLOW’ NEURAL NETWORKS**
 - PERCEPTRON, NEURON DEFINITION
 - LAYER OF NEURONS, HIDDEN LAYERS
 - ACTIVATION FUNCTIONS
 - OPTIMIZATION [GRADIENT DESCENT]
 - BACKPROPAGATION

PROGRAM FOR THE WEEK

1. THEORY

- **CONVOLUTIONAL NEURAL NETWORKS**

- CONVOLUTIONS AS NEURONS
- CNNs [POOLING, DROPOUT]
- VANISHING GRADIENT / BATCH NORMALIZATION
- DATA AUGMENTATION
- TRANSFER LEARNING
- CNN AS FEATURE EXTRACTOR FOR ASTRONOMY
- OPTIMIZING YOUR NET: HYPER PARAMETER SEARCH
- VISUALIZING CNNs [DECONVNETS, INCEPTIONISM, INTEGRATED GRADIENTS]

PROGRAM FOR THE WEEK

1. THEORY

- CONVOLUTIONAL NEURAL NETWORKS AS IMAGE GENERATORS [E. DECENCIÈRE]
 - SEGMENTATION
 - U-NETS
 - BULGE-DISC DECOMPOSITIONS

PROGRAM FOR THE WEEK

1. THEORY

- CONVOLUTIONAL NEURAL NETWORKS AS IMAGE GENERATORS [S. VELASCO-FORERO]
 - AUTO-ENCODERS
 - ANOMALY DETECTION
 - AN INTRODUCTION TO GENERATIVE ADVERSARIAL NETWORKS

PROGRAM FOR THE WEEK

2. PRACTICE

- **P1** [Monday]: MORPHOLOGY OF GALAXIES WITH CLASSICAL MACHINE LEARNING
- **P2** [Tuesday]: MORPHOLOGY OF GALAXIES WITH DEEP LEARNING
- **P3** [Wednesday-Friday]: SOURCE DEBLENDING WITH DEEP LEARNING

PROGRAM FOR THE WEEK

2. PRACTICE

- P1 [Monday]: MORPHOLOGY OF GALAXIES WITH CLASSICAL MACHINE LEARNING
- P2 [Tuesday]: MORPHOLOGY OF GALAXIES WITH DEEP LEARNING



THIS WILL BE DONE WITH YOUR LAPTOP

PROGRAM FOR THE WEEK

2. PRACTICE

- P3 [Wednesday-Friday]: SOURCE DEBLENDING WITH DEEP LEARNING



THIS WILL BE ORGANIZED AS A CHALLENGE [RAMP]

YOU WILL SUBMIT JOBS TO THE GPU SERVER @ CCIN2P3
SERVER AND RECOVER RESULTS

PROGRAM FOR THE WEEK

2. PRACTICE

- P3 [Wednesday-Friday]: SOURCE DEBLENDING WITH DEEP LEARNING



WE WILL KEEP A “LEADER BOARD” RANKING THE
DIFFERENT SOLUTIONS

A DEBRIEFING WILL BE DONE ON FIRDAY AFTERNOON

PROGRAM FOR THE WEEK

2. PRACTICE

- P3 [Wednesday, Friday]: SOURCE DEBLENDING WITH DEEP LEARNING

**MORE INFO ON TUESDAY -
TALK BY ALEX BOUCAUD
FROM CDS-SACLAY**



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PROGRAM FOR THE WEEK

2. PRACTICE

LET'S TRY TO DISCUSS AS MUCH AS POSSIBLE!

AT THE END OF EVERY PRACTICE YOU WILL BE ASKED TO
DO SHORT PRESENTATIONS EXPLAINING THE SOLUTIONS
FOUND

PROGRAM FOR THE WEEK

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[THIS MEANS: L, M, F]

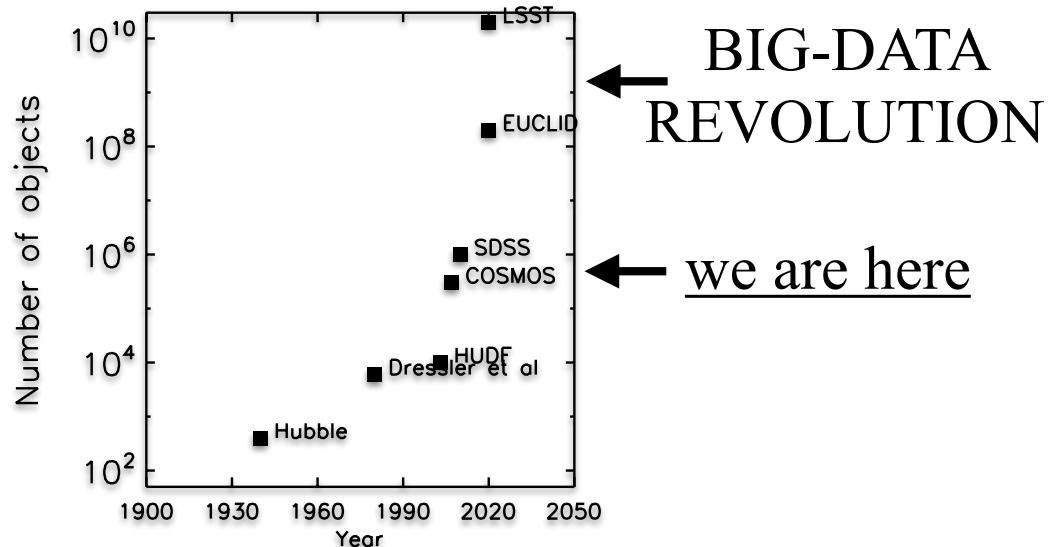
SOFTWARE REQUIREMENTS

- PYTHON 3 OR GREATER
- TENSORFLOW FOR DEEP LEARNING
- KERAS - HIGH LEVEL LIBRARY WHICH MAKES GPU CODING TRANSPARENT - SIMPLIFIES THINGS A LOT AND MOST OF THE TIME ENOUGH FOR OUR APPLICATIONS

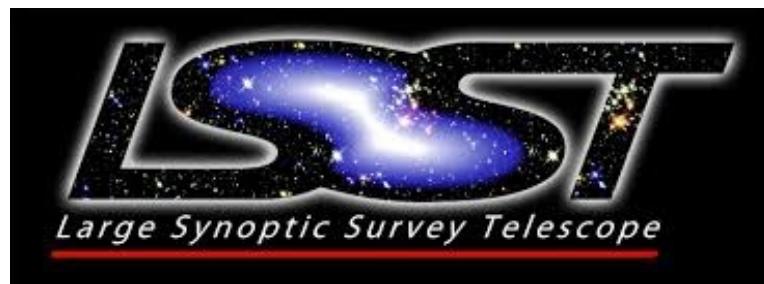
WHY DO WE NEED THESE TOOLS IN ASTRONOMY?

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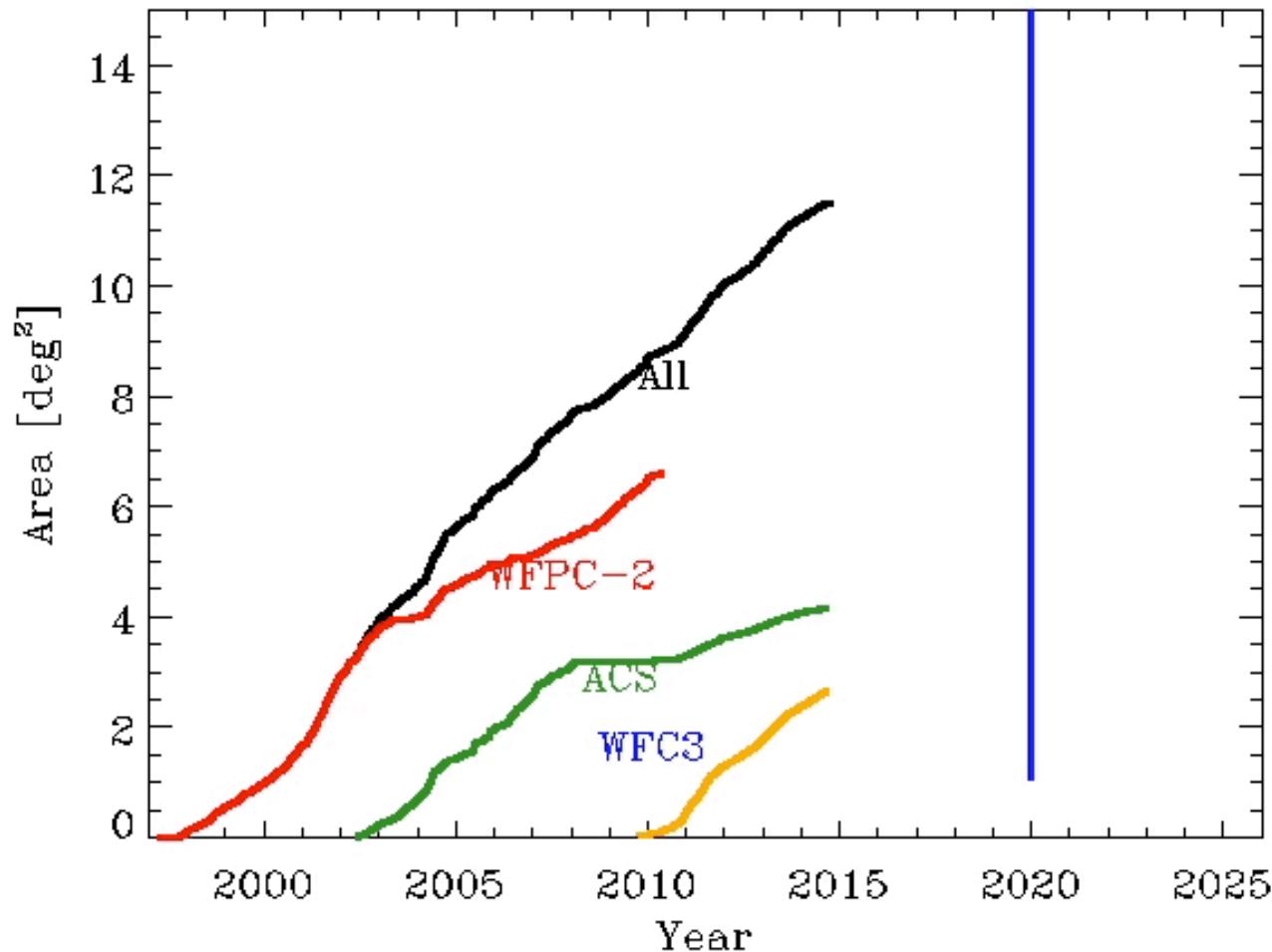
AS IN MANY OTHER DISCIPLINES THE BIG-DATA REVOLUTION HAS ARRIVED TO ASTRONOMY TOO



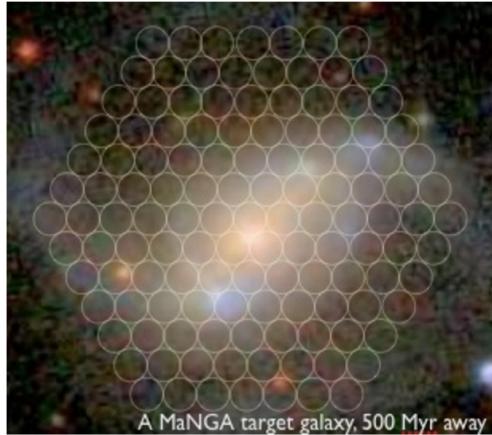
EXTREMELY LARGE
IMAGING SURVEYS
DELIVERING BILLIONS
OF OBJECTS IN 2-5 YEARS



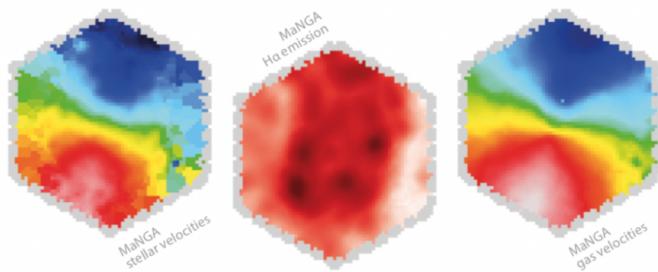
LSST simulation



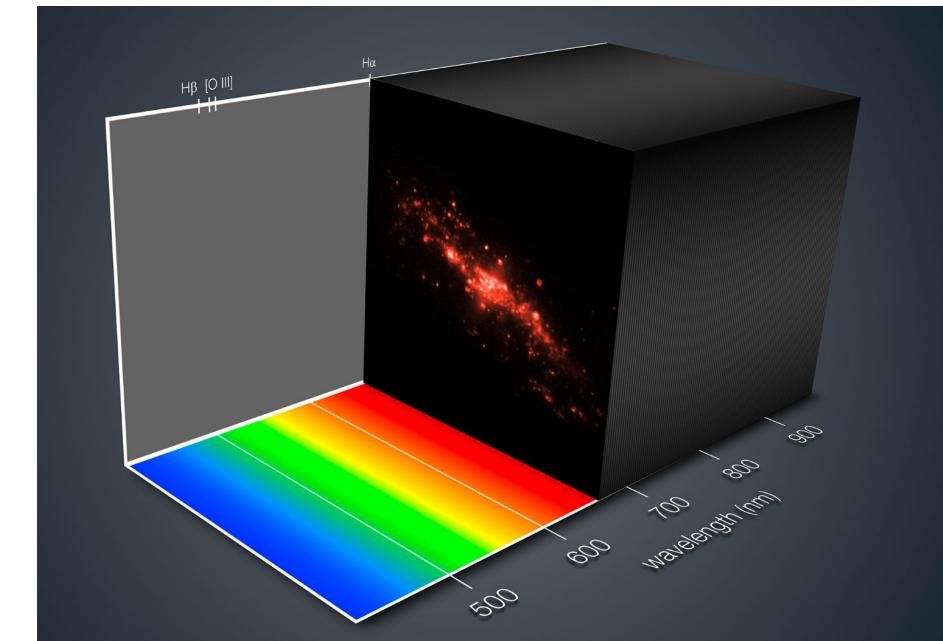
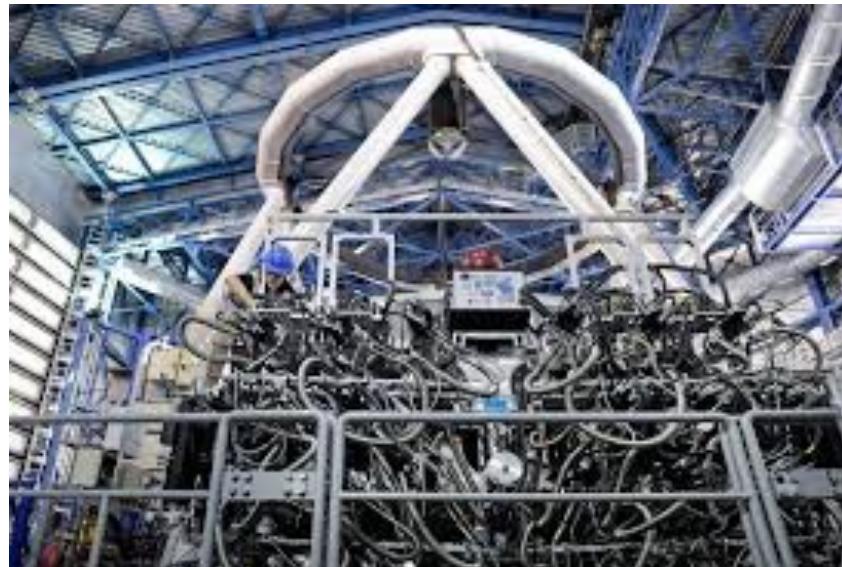
(Thanks to J. Brinchmann)



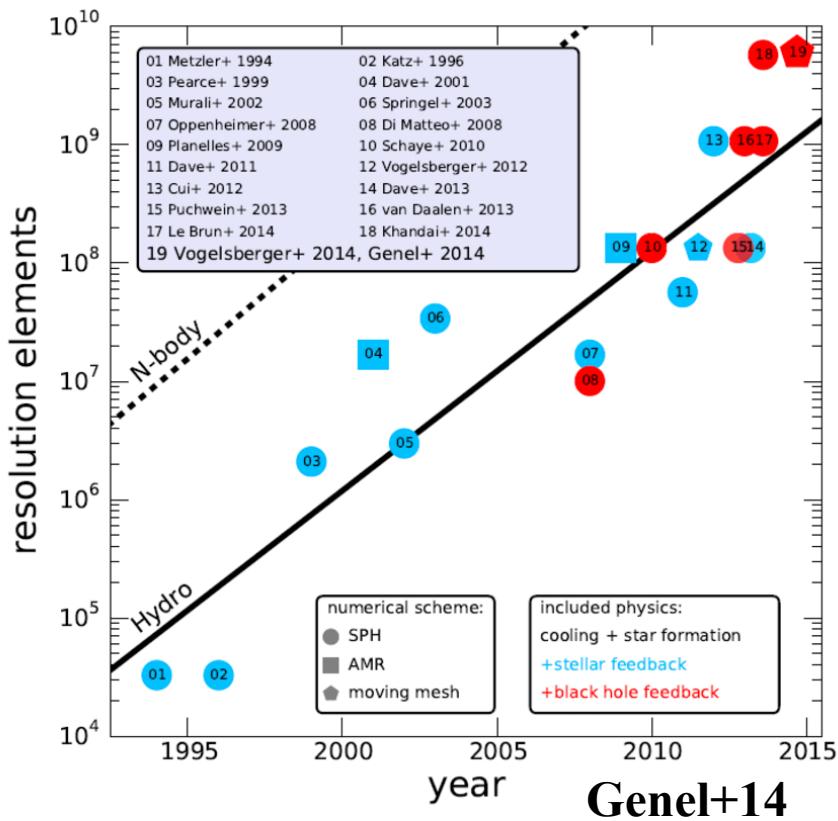
NOT ONLY VOLUME: AN INCREASING COMPLEXITY OF DATA



MANGA Survey



MUSE@VLT



AND ALSO SIMULATIONS!

