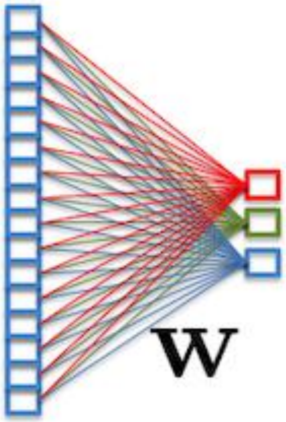
AI and Data Analysis



Christian Wolf

The speaker

2000	Dipl.Ing. TU Vienna, Austria	
2003	PhD in Computer Science INSA-Lyon	Teaching, academic resea
2004	MCF Télécom Physique Strasbourg	
2005	MCF INSA-Lyon	
2022-now	Principal Scientist, Team Lead AI for Robotics	Research in a private laboratory

NAVER is a global ICT company with technology leadership in various fields of business

[Global Search Engine Market Share]

NAVER

No.1 Search Engine in South Korea

Global Daily Active Users
2021.12
34 Million

NAVER Shopping

No.1 E-commerce Platform in South Korea

Annual Transaction Amount (USD)
2021.12
1.5 Billion

WEBTOON

Global Digital Comics Platform

Global Monthly Active Users
2022.01
82 Million

ZEPETO

Asia's No.1 Metaverse Platform

Global Accumulated Subscribers
2022.03
300 Million

LINE

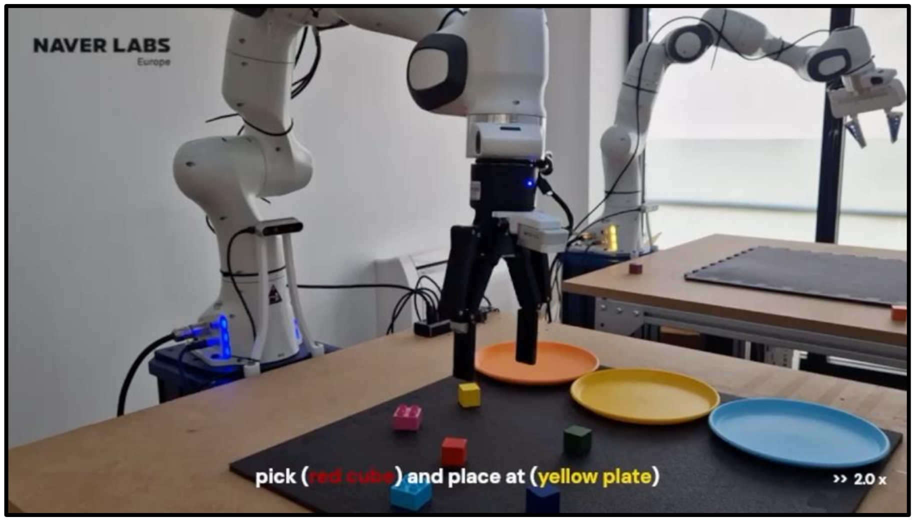
Global Mobile Messenger & Portal

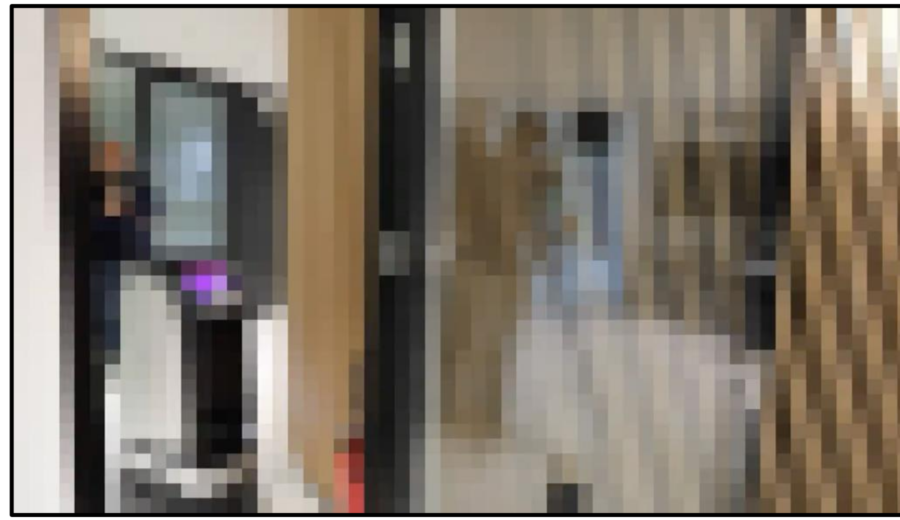
Global Monthly Active Users
2021.04
186 Million


Seoul city 3D reconstruction
LOTTE WORLD
LOTTE WORLD


NAVER
NAVER

AI for Robotics





1.1 Introduction

1 Introduction

1 Introduction: machine learning, a couple of applications [47]
2 A short history of deep learning [10]
3 The basics of machine learning: fitting and generalization [16]

2 Neural networks and PyTorch

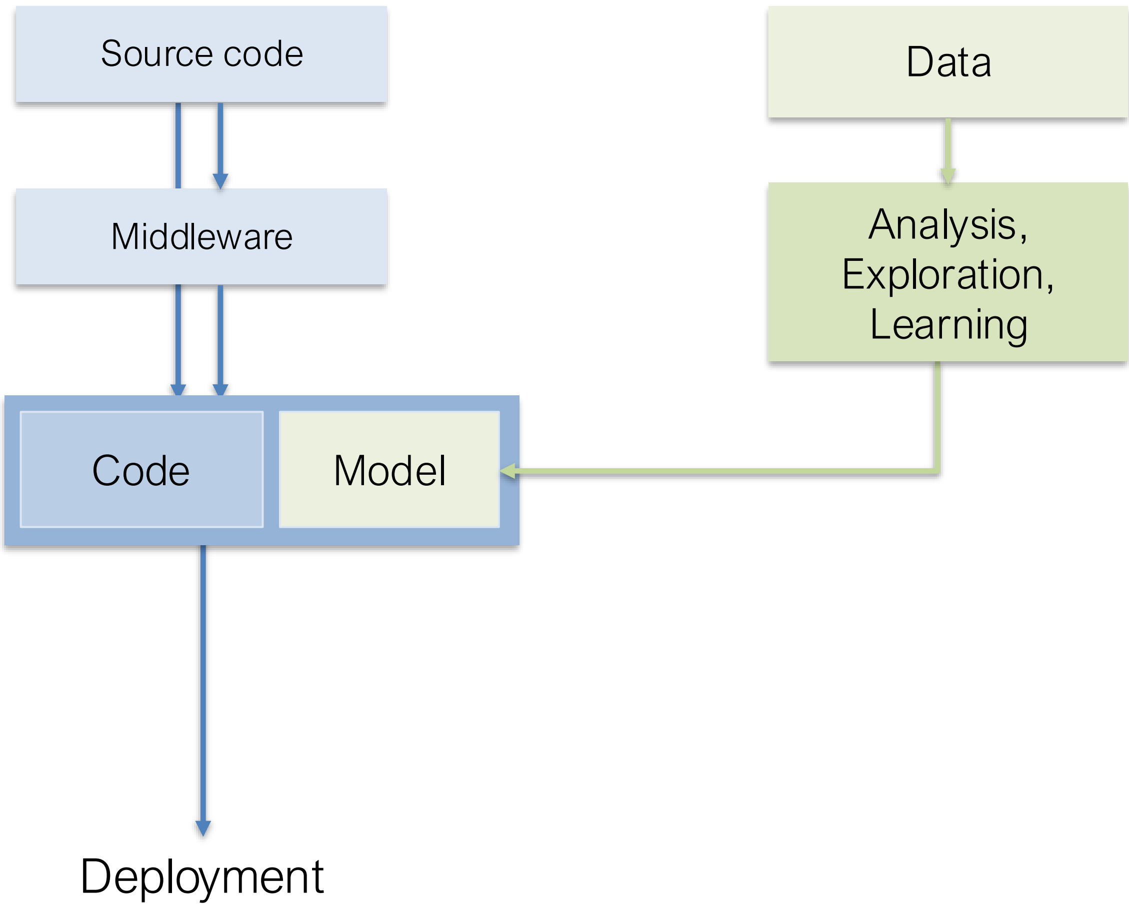
1 Frameworks and Tensors *{+PyTorch}* [24]
2 Simple models (linear regression, logistic regression) *{+PyTorch}* [32]
3 Multi layer models + universal approximation theorem *{+PyTorch}* [32]
4 Train/Validation/Test split; Tensorboard *{+PyTorch}* [14]
5 Gradient Backpropagation and Autograd *{+PyTorch}* [17]
6 Stochastic Gradient Descent and Variants (Adam, RMSProp) [15]
7 Shift invariance and Convolutions *{+PyTorch}* [38]

3 Scaling up: vision, transfer, visualization

1 Computer Vision [39]
2 Semi-supervised, Self-supervised learning [8]
5 GPUs – Software *{+CUDA, +PyTorch}* [14]

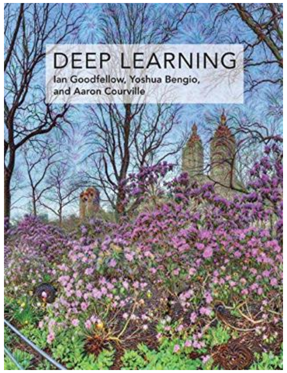
(…)

Software development … and data



Approximation
Simplification
Handling Uncertainty
Modelling

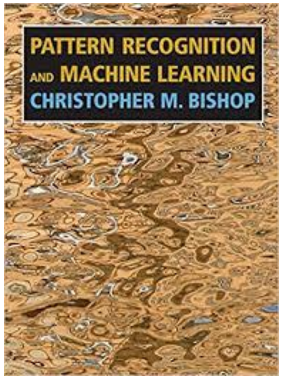
To go deeper



Ian Goodfellow, Yoshua Bengio, Aaron Courville, « Deep Learning », MIT Press

PyTorch online tutorials

https://pytorch.org/



Christopher Bishop, « Pattern Recognition and Machine Learning », 2006 (*Pre-deeplearning area, but a very pedagogical book on machine learning)*

Learn Python!

For example: https://learnxinyminutes.com/docs/python/

Learn X in Y minutes

Share this page

Select theme: light dark

Where X=python

Get the code: learnpython.py

Python was created by Guido Van Rossum in the early 90s. It is now one of the most popular languages in existence. I fell in love with Python for its syntactic clarity. It's basically executable pseudocode.

Feedback would be highly appreciated! You can reach me at @louiedinh or louiedinh [at] [google's email service]

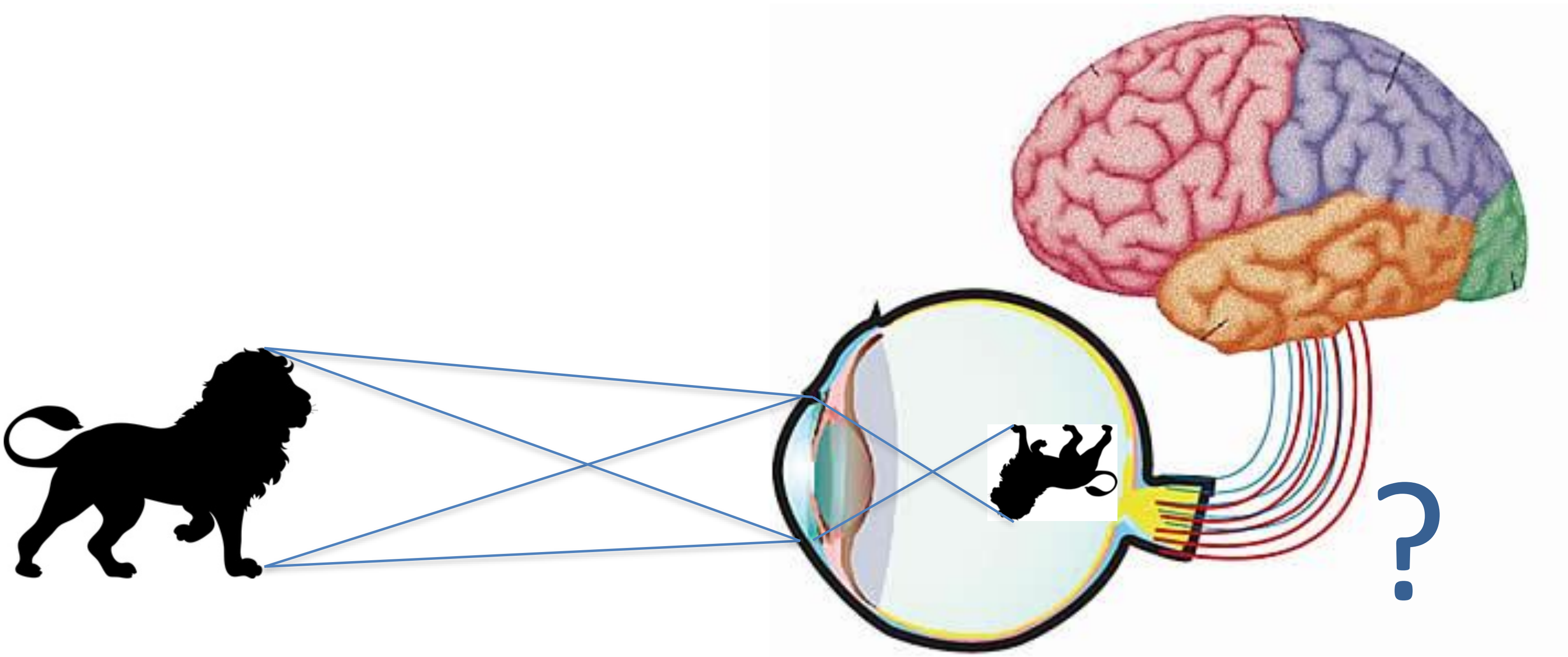
Note: This article applies to Python 2.7 specifically, but should be applicable to Python 2.x. Python 2.7 is reaching end of life and will stop being maintained in 2020, it is though recommended to start learning Python with Python 3. For Python 3.x, take a look at the Python 3 tutorial.

It is also possible to write Python code which is compatible with Python 2.7 and 3.x at the same time, using Python `__future__` imports. `__future__` imports allow you to write Python 3 code that will run on Python 2, so check out the Python 3 tutorial.

```
# Single line comments start with a number symbol.

""" Multiline strings can be written
    using three "s, and are often used
    as comments
"""
```

Why do we need learning?



The human visual system


LANGERS

Interpretation

174	191	199	199	202	203	200	200	202	201	201	201	201	201	201	201	201	201	201	201	201	201	201	200	200	200	200	200	200	200	201	202	202	201	201	201	201
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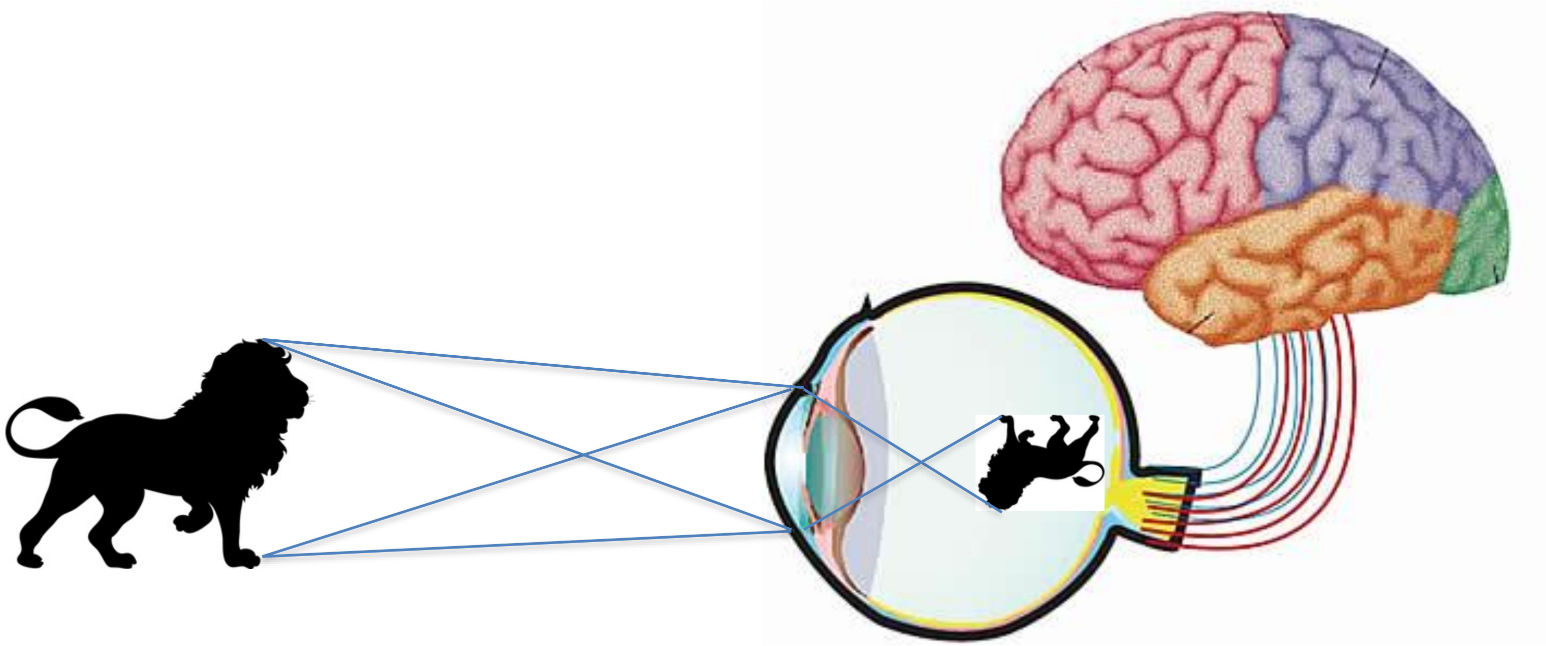
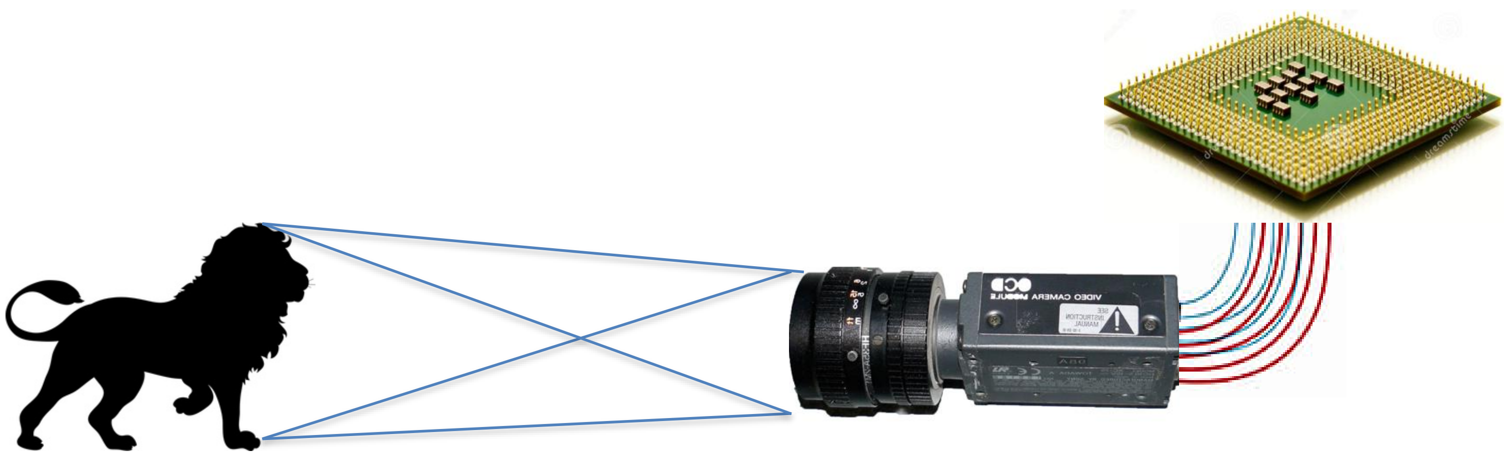
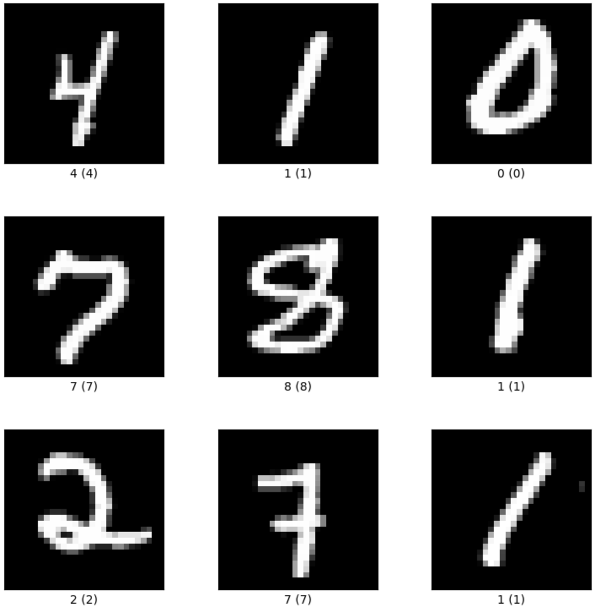




Interpretation



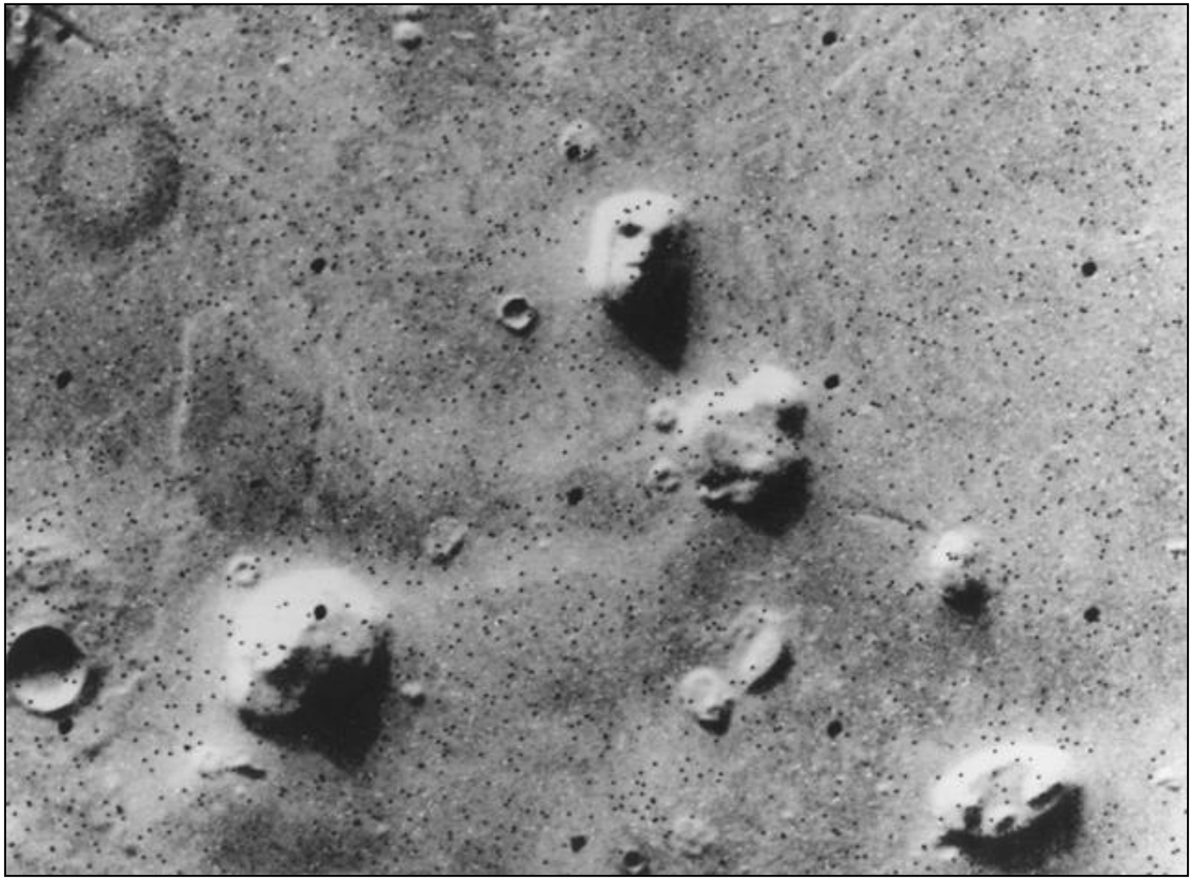
Human/hand-crafted recognition ("Rule-based") is possible when the data regularities are simple.

Here: straight lines, some curves and junctions.

[redacted]

Friend or foe?
Smile or run?

The brain specializes on faces



« compagnon » robot

Figure : Figure-AI "Neo"

Navigation : where am I?
« Visual Landmarks »

Robot navigation

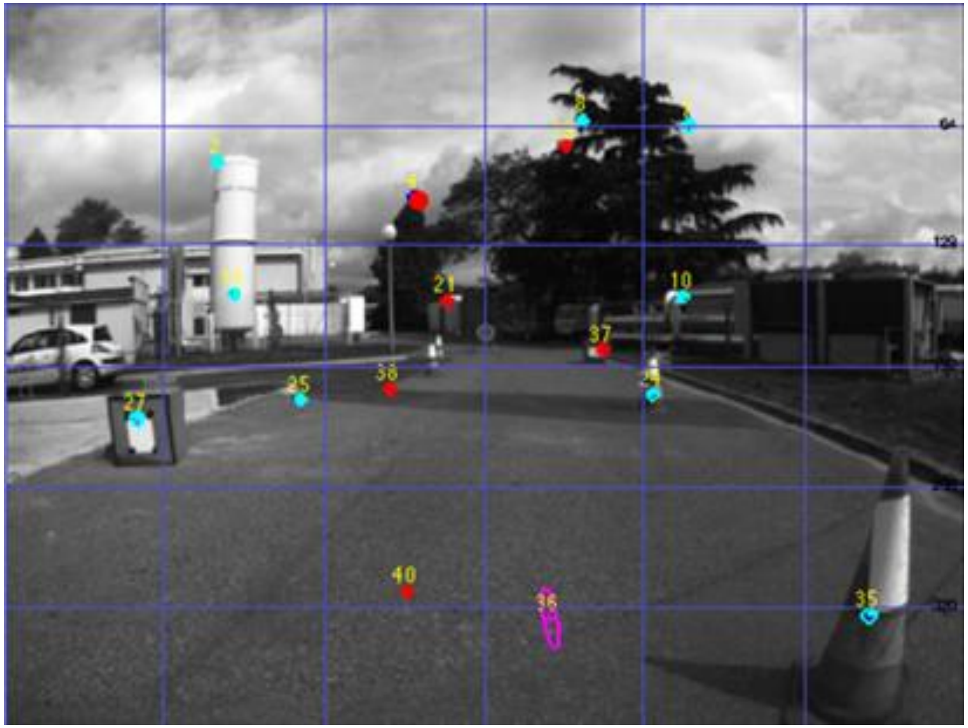


Figure : LAAS-CNRS, Toulouse

Visual SLAM using landmarks

Support for tools (motor control)

Visual servoeing

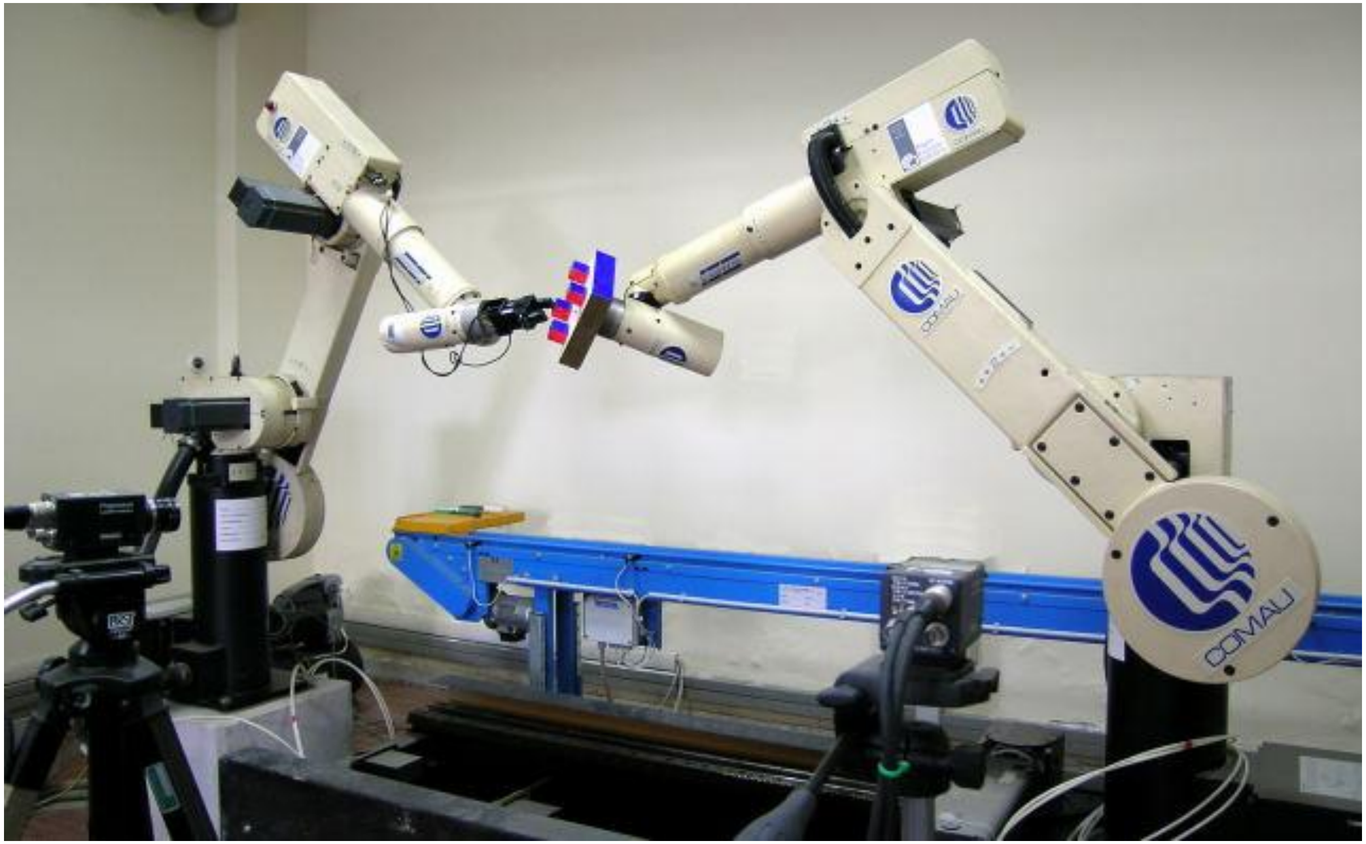
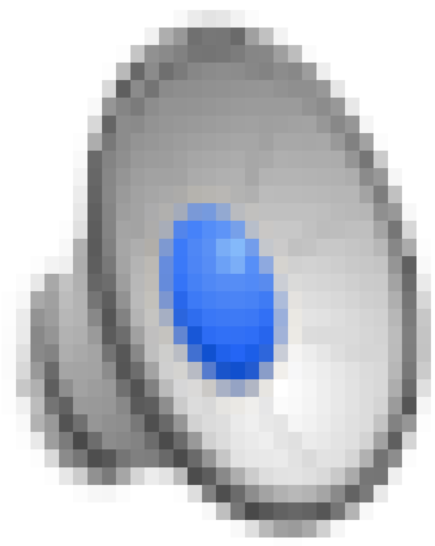


Figure : PRISMA Lab, Université de Naples

Some applications of Deep Learning

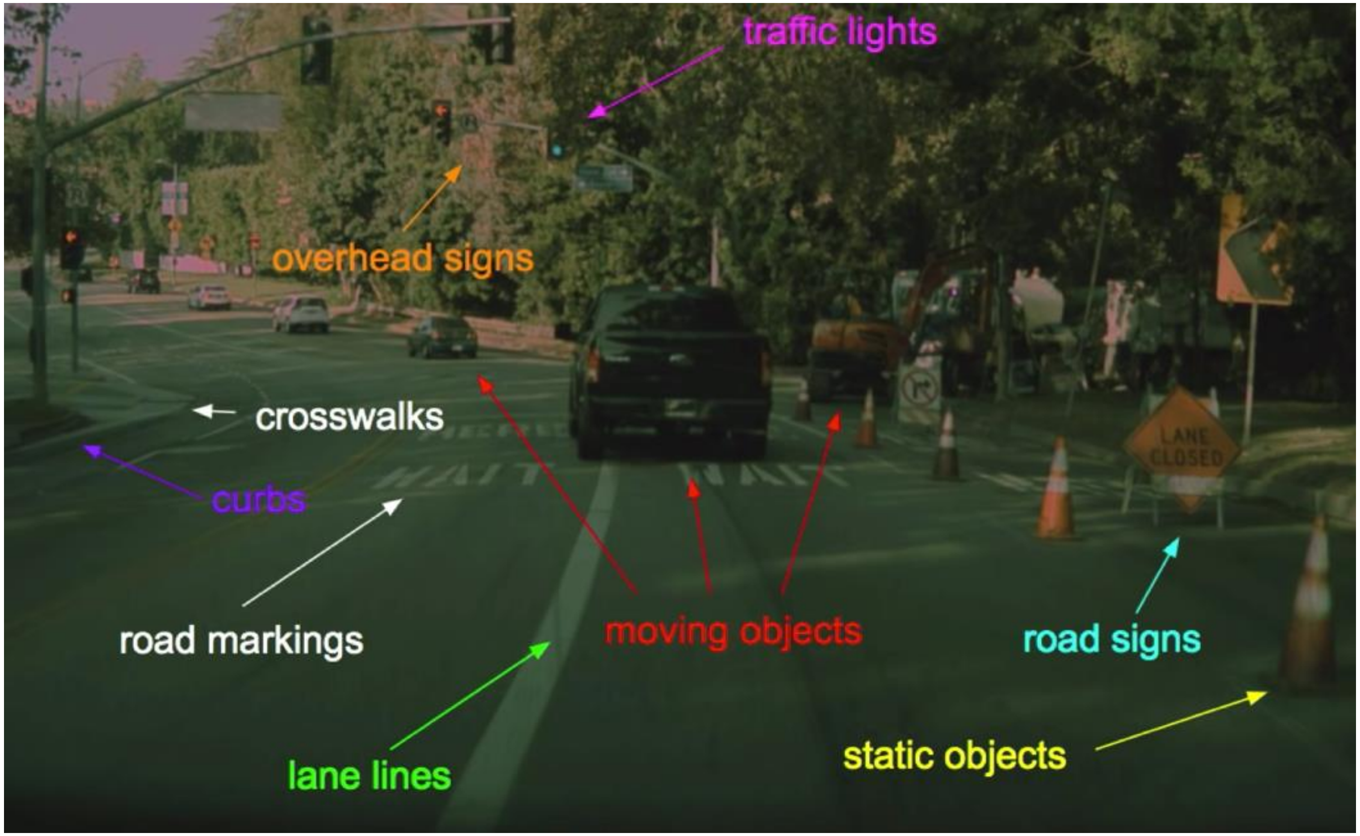
Semantic Segmentation



[Fourure, Emonet, Fromont, Muselet, Tremeau, Wolf, BMVC 2017]

PyTorch + computer vision @Tesla

https://www.youtube.com/watch?v=oBklltKXtDE

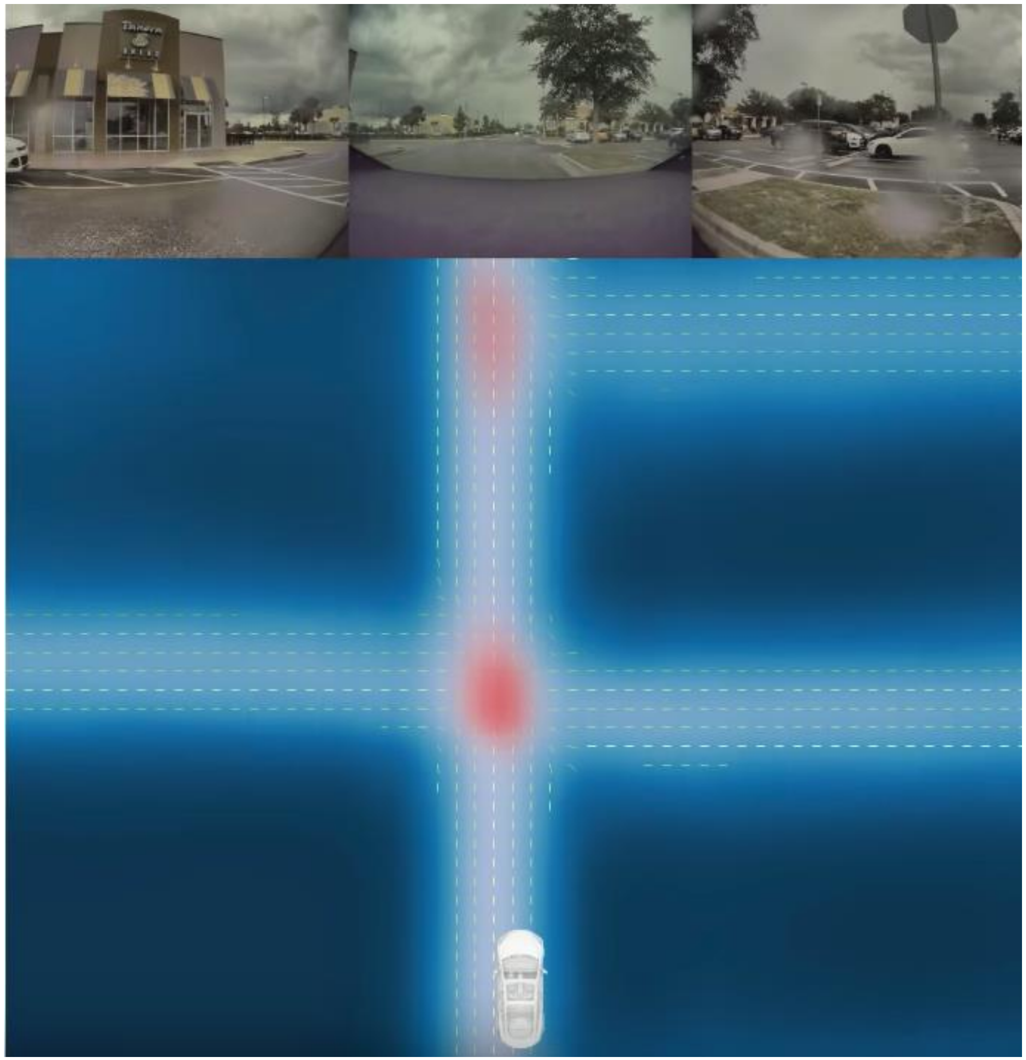


https://www.youtube.com/watch?v=oBklltKXtDE

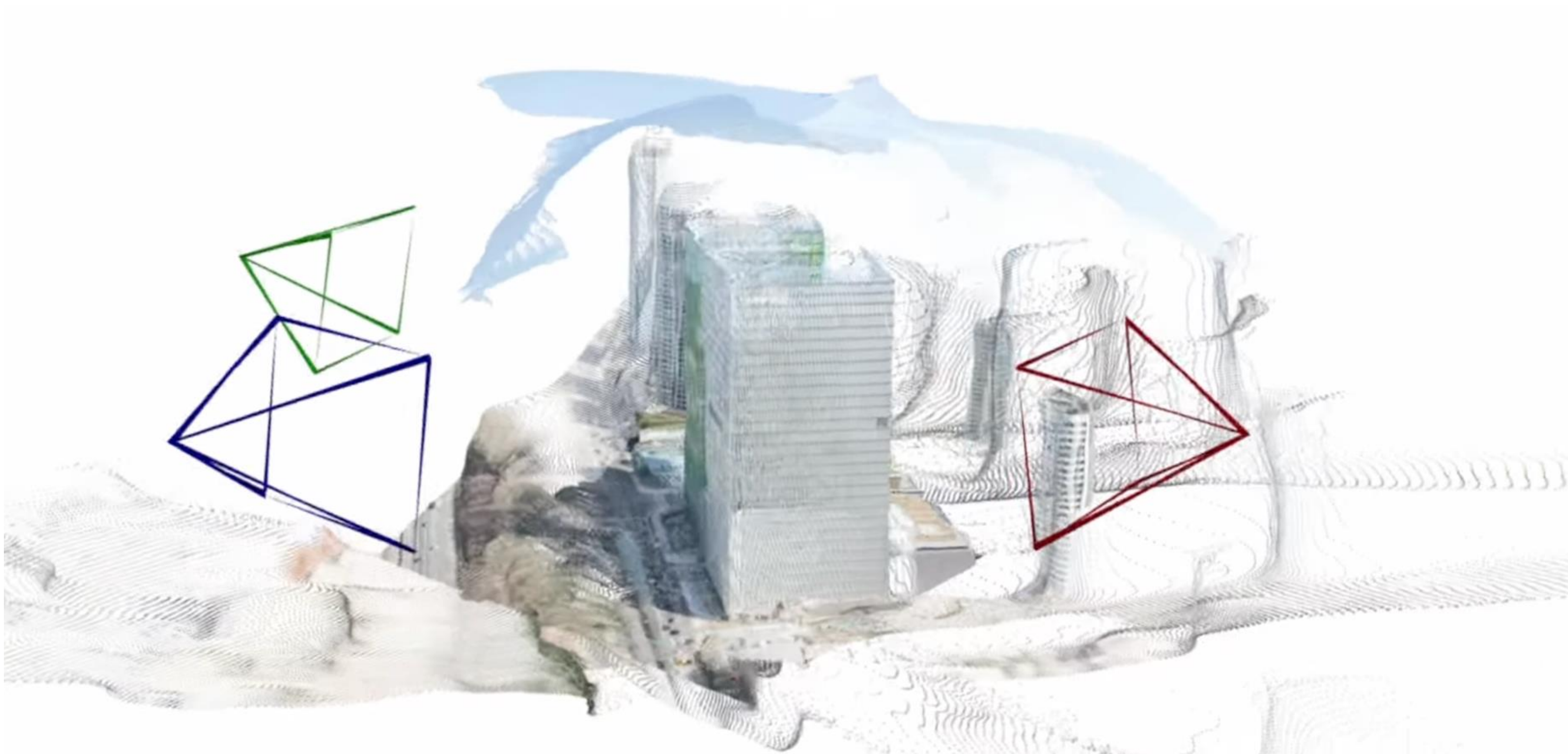
- (3, 960, 1280) input images
- “ResNet-50 like” dilated backbones
- FPN / DeepLabV3 / UNet -like heads
- ~15 tasks => “prototypes framework”

PyTorch + computer vision @Tesla

https://www.youtube.com/watch?v=oBklltKXtDE



3D reconstruction: DUSt3R



https://www.youtube.com/watch?v=kI7wCEAFFb0

[Shuzhe Wang, Vincent Leroy, Yohann Cabon, Boris Chidlovskii, Jerome Revaud, 2023]

Human pose estimation: Anny

https://www.youtube.com/watch?v=vpAZQrty45Y

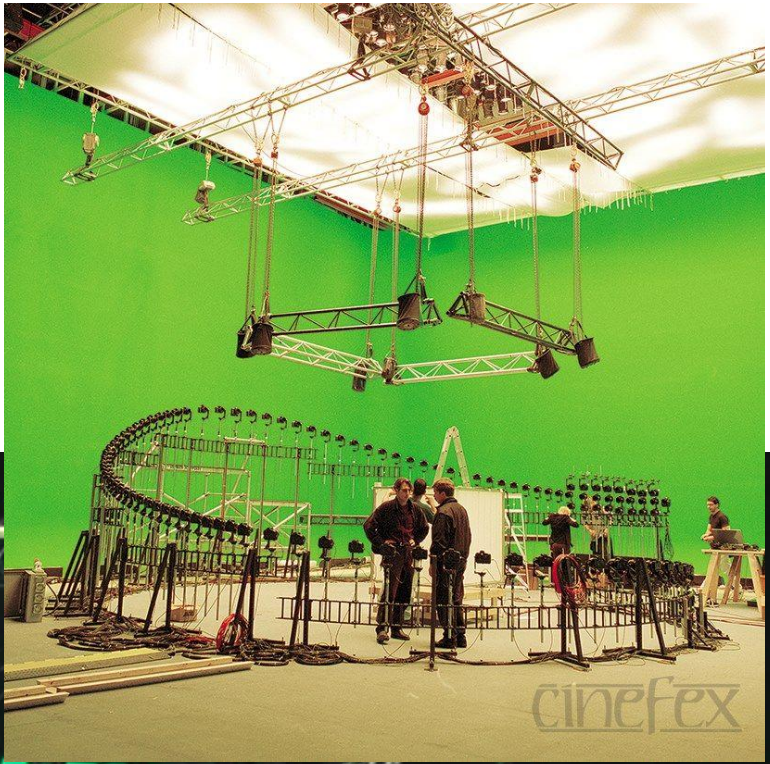
[Romain Brégier, Guénolé Fiche, Laura Bravo-Sánchez, Thomas Lucas, Matthieu Armando, Philippe Weinzaepfel, Gregory Rogez, Fabien Baradel, 2025]

Bullet time

https://free-view-video.github.io/

[C. Gao, A. Saraf, J. Kopf, J.-B. Huang, Dynamic View Synthesis from Dynamic Monocular Video, ICCV 2021]

Bullet time in 1999 (Matrix)



Learning inverse problems

Learning is particularly useful in applications, where

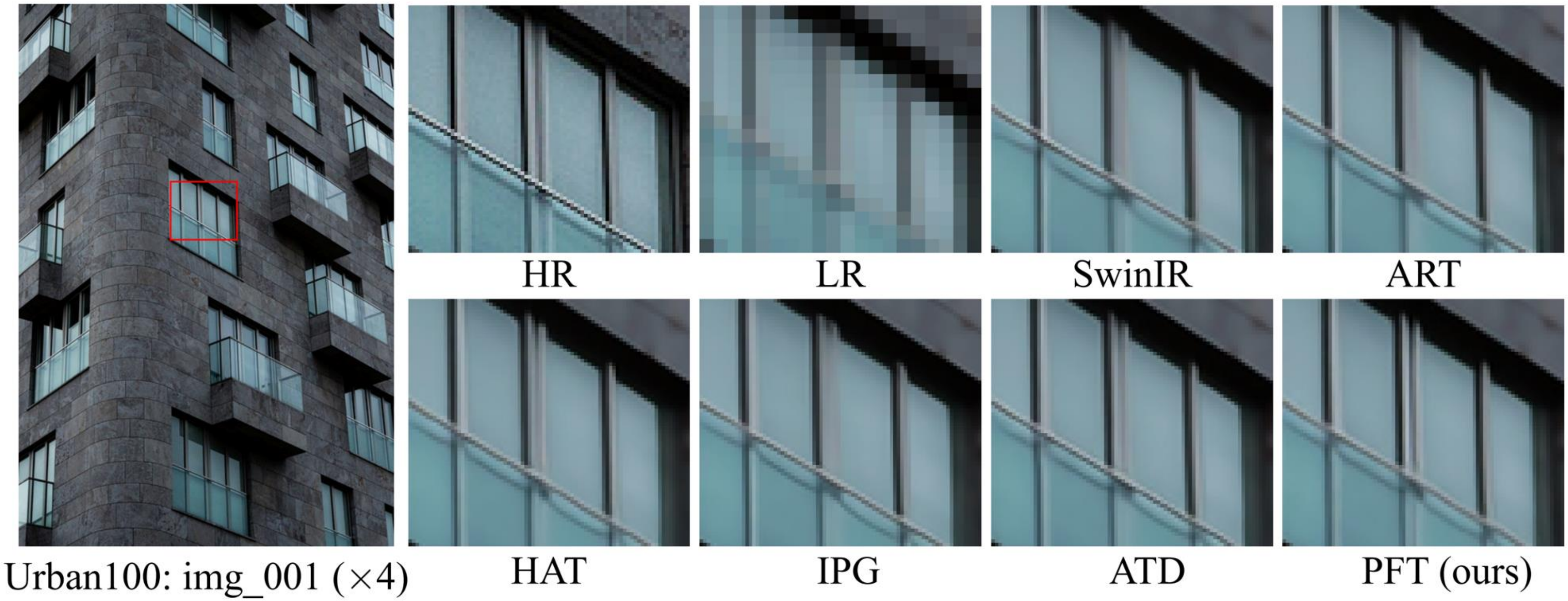
1. a forward function is known and easy, but its inverse is difficult and needs to be learned, and
2. Data can be found / generated easily

$$\begin{tikzcd} x \arrow[r, bend left, "f"] & y \arrow[l, bend left, "f^{-1}"] \end{tikzcd}$$

Generate

Learn, use x as target!

Super-resolution



[Wei Long, Xingyu Zhou, Leheng Zhang , Shuhang Gu, CVPR 2026]

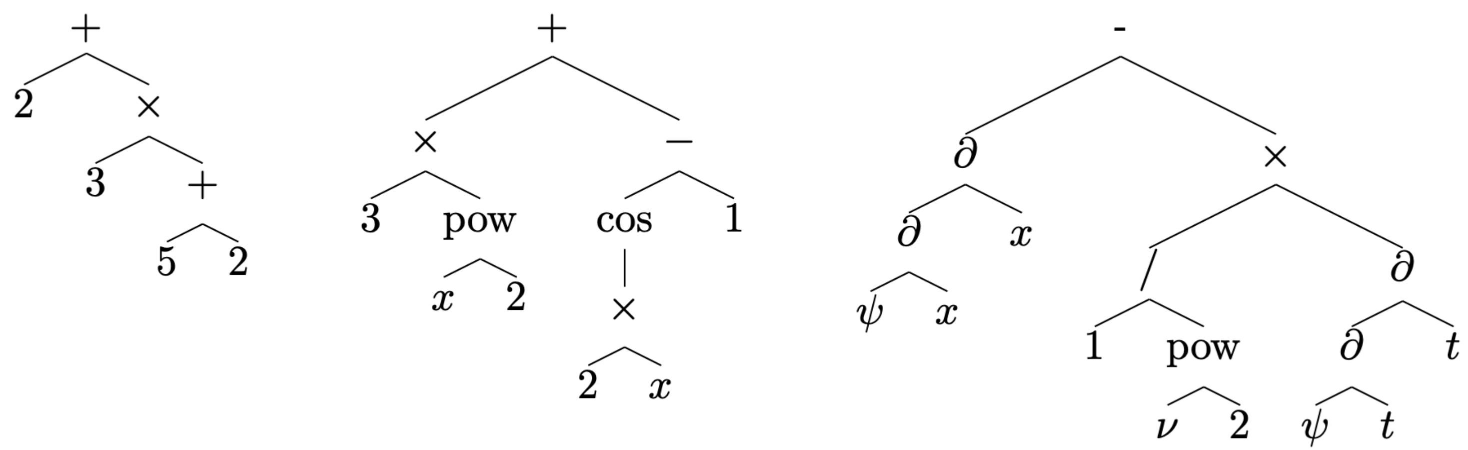
De-Oldify

https://github.com/jantic/DeOldify

Symbolic mathematics

It is easy to: generate random expressions, and derive them.
It is hard to: integrate them
Learn it!

$2 + 3 \times (5 + 2)$, $3x^2 + \cos(2x) - 1$, and $\frac{\partial^2 \psi}{\partial x^2} - \frac{1}{\nu^2}\frac{\partial^2 \psi}{\partial t^2}$:



[Guillaume Lample, François Charton, ICLR 2020]

Learning to control

Task: design a controller for a system.

1. We know the system (equations!):

   Solution: design the controller with control theory.

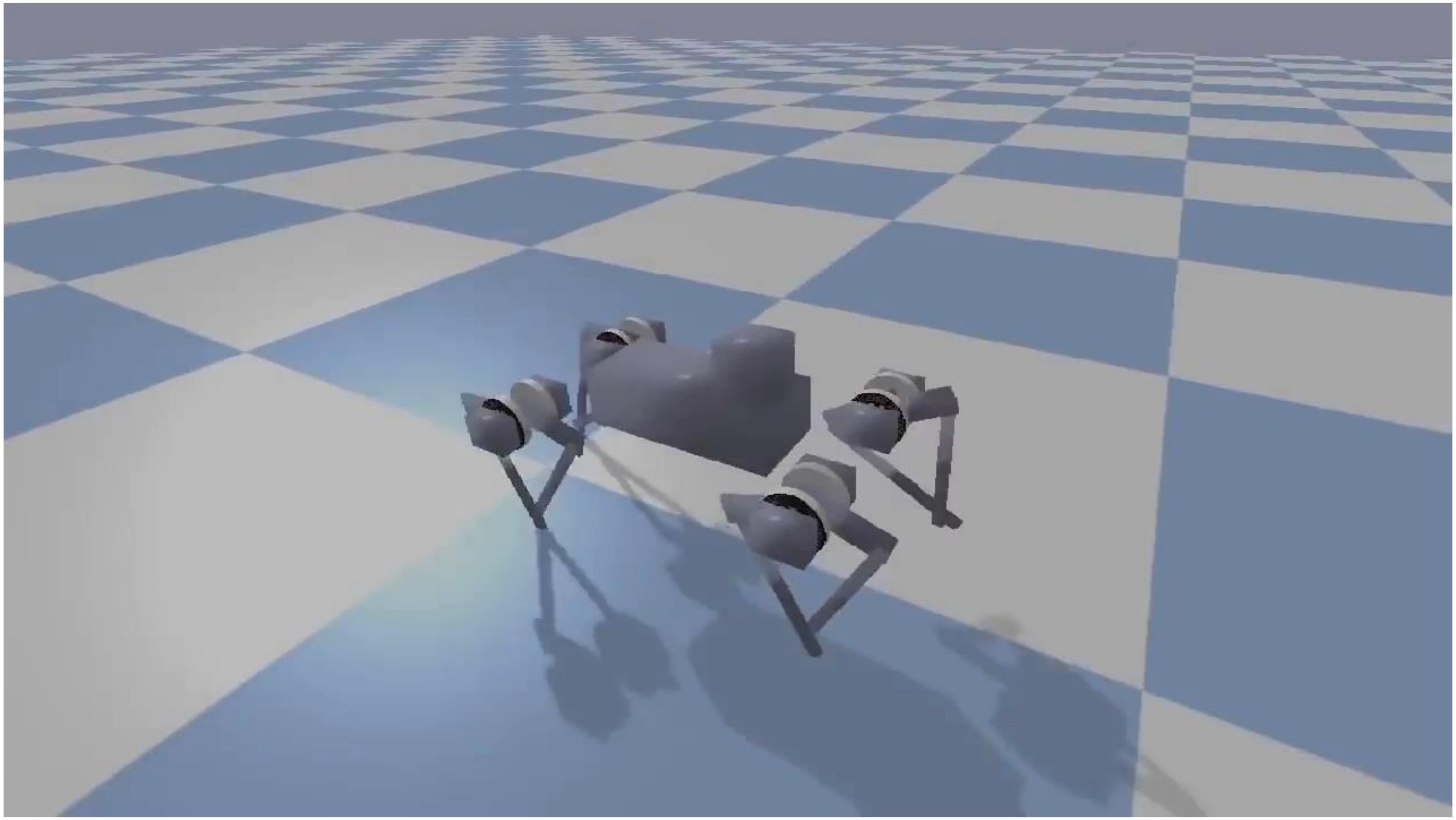
2. We do not know the system but we have expert trajectories (inputs and outputs):

   Solution: use Supervised Learning.

3. We know the system (equations!): and do not have any expert trajectories. But given a trajectory, we can know whether the control decisions were satisfactory or not.

   Solution: use Reinforcement Learning.

Learning to control



[Tan, Zhang, Coumans, Iscen, Bai, Hafner, Bohez, Vanhouke, RSS 2018]

Learning to control

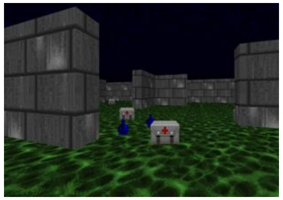
https://www.youtube.com/watch?v=I44_zbEwz_w

[Boston Dynamics Atlas, 2025]

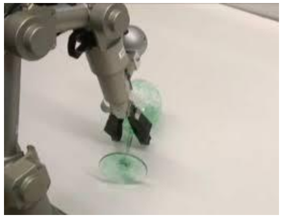
Taking decisions

{dog, **cat**, avocado, chair, …}

{0, 1, … 26, 27, **28**…, 98, 99, …}



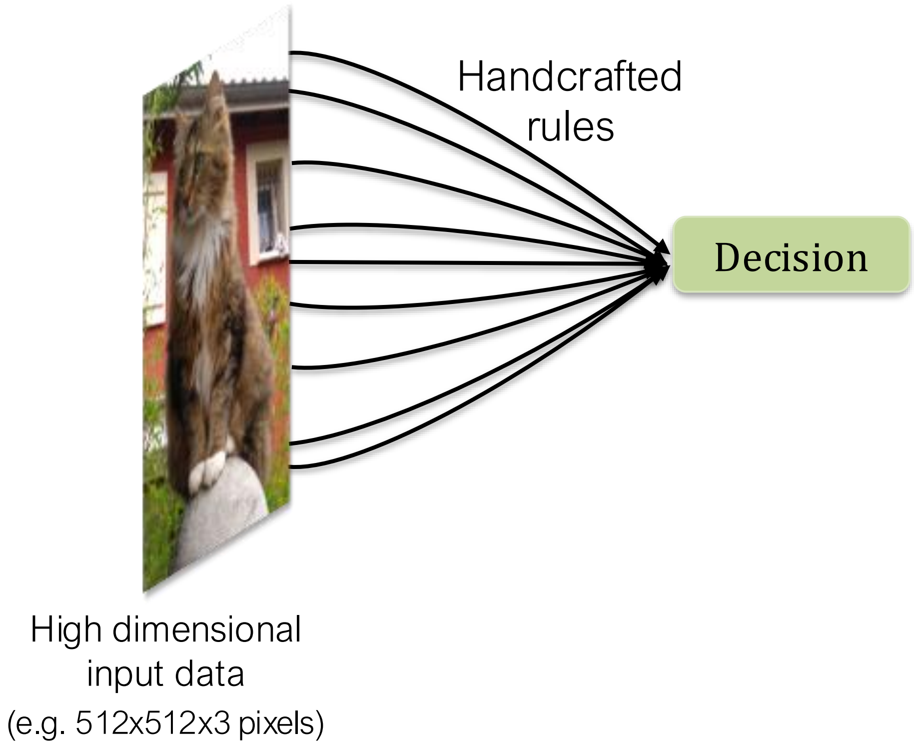
{Left, right, forward, backward, …}



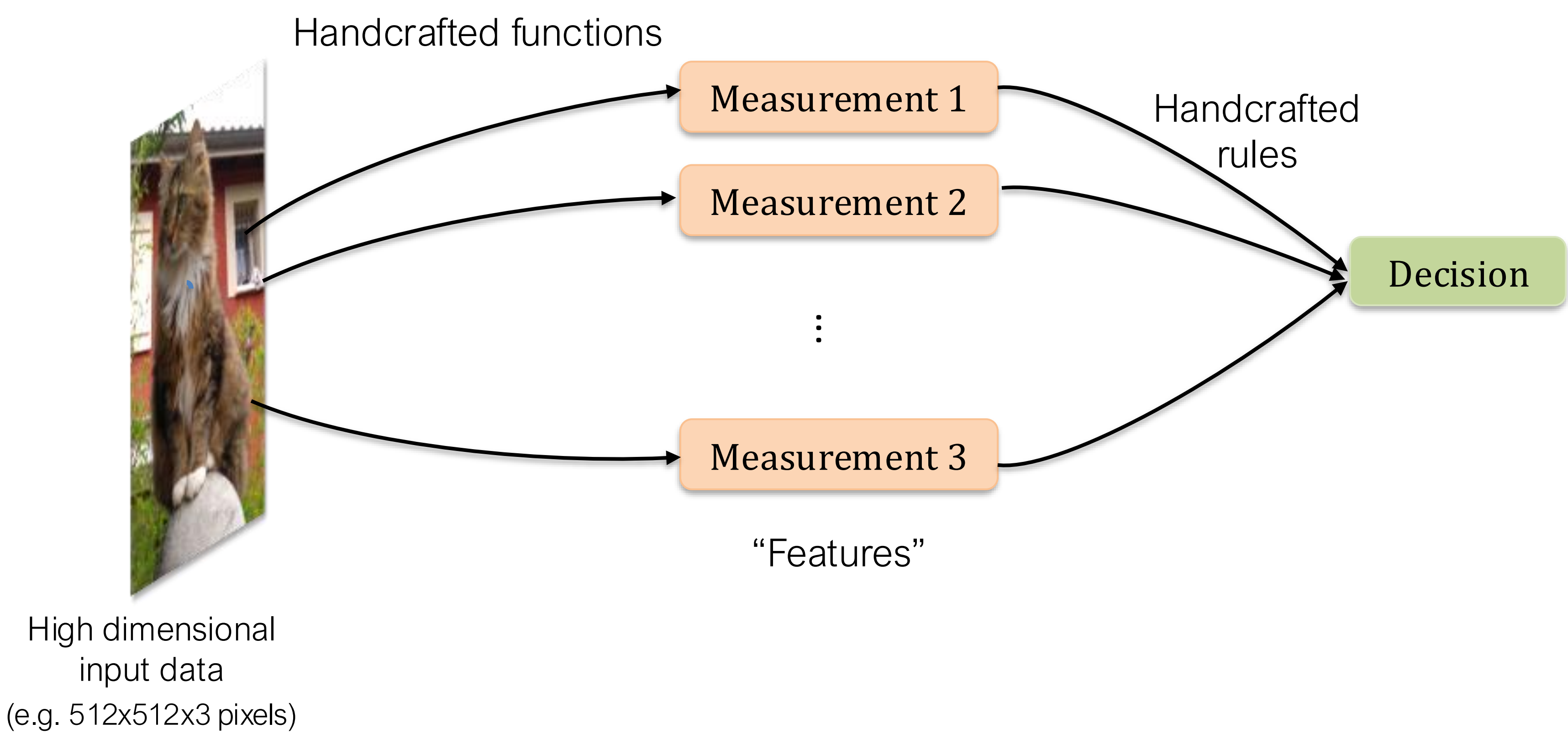
Motor control

"A blue parrot with a yellow belly sitting on a branch in a forest"

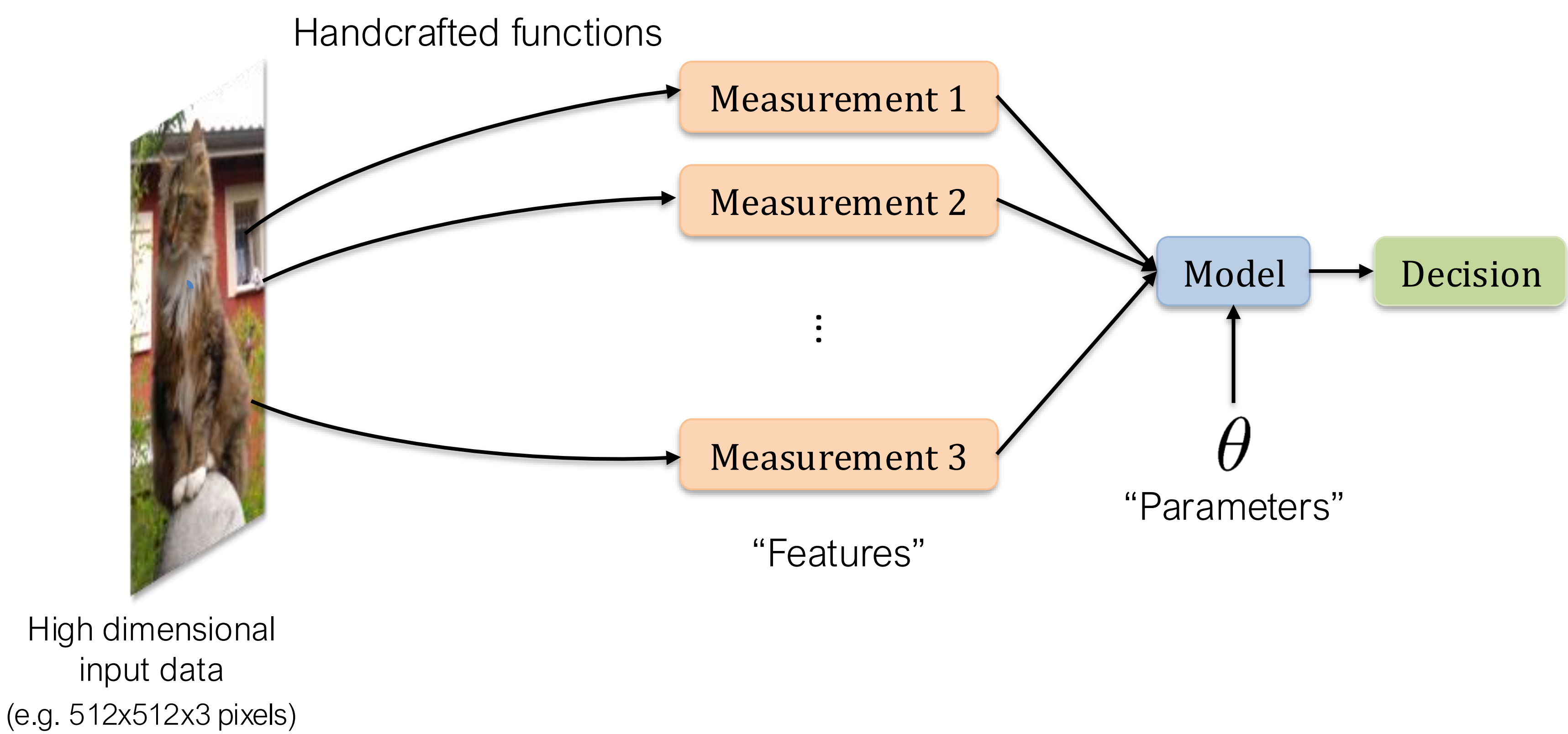
Decision taking



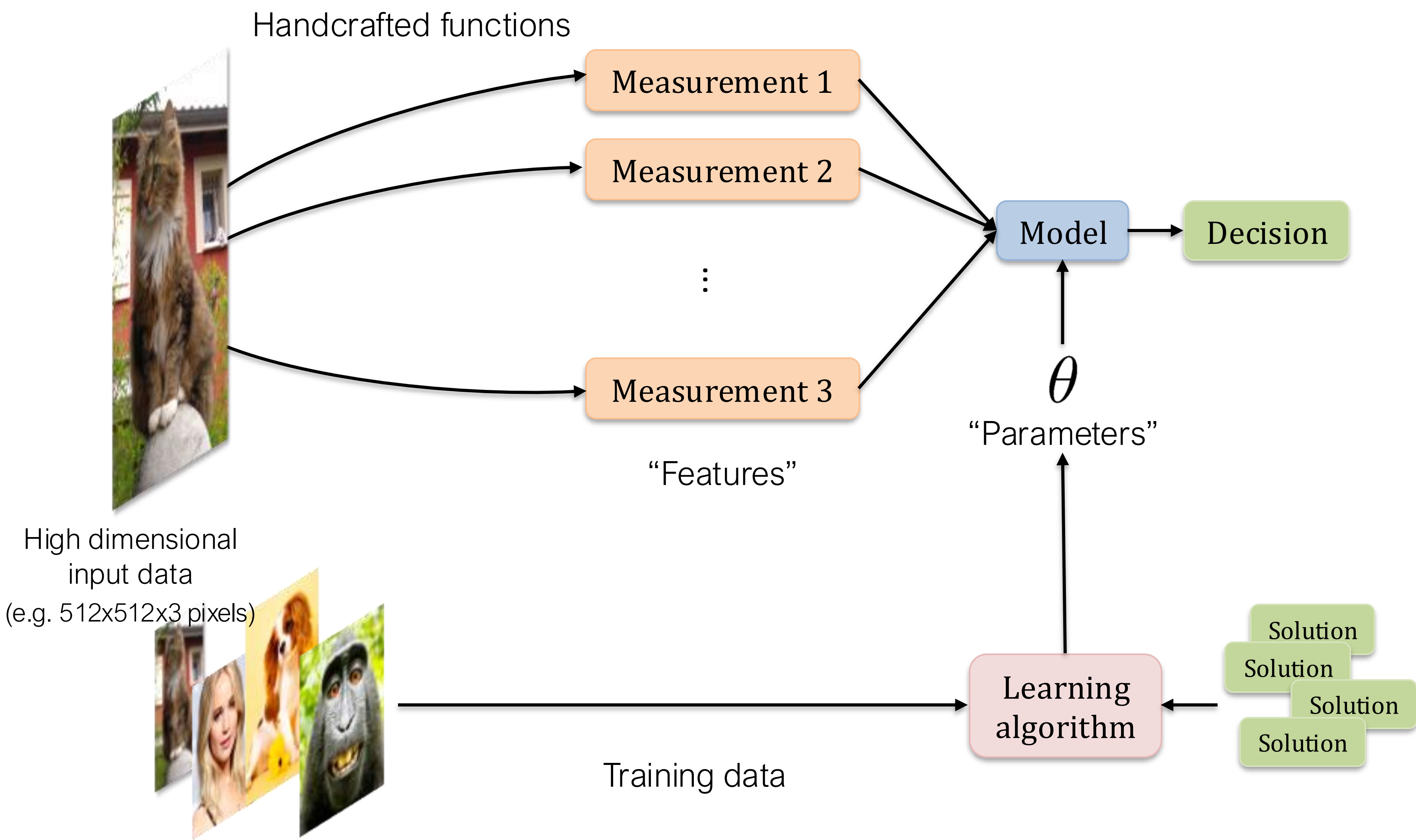
Decision taking: expert knowledge



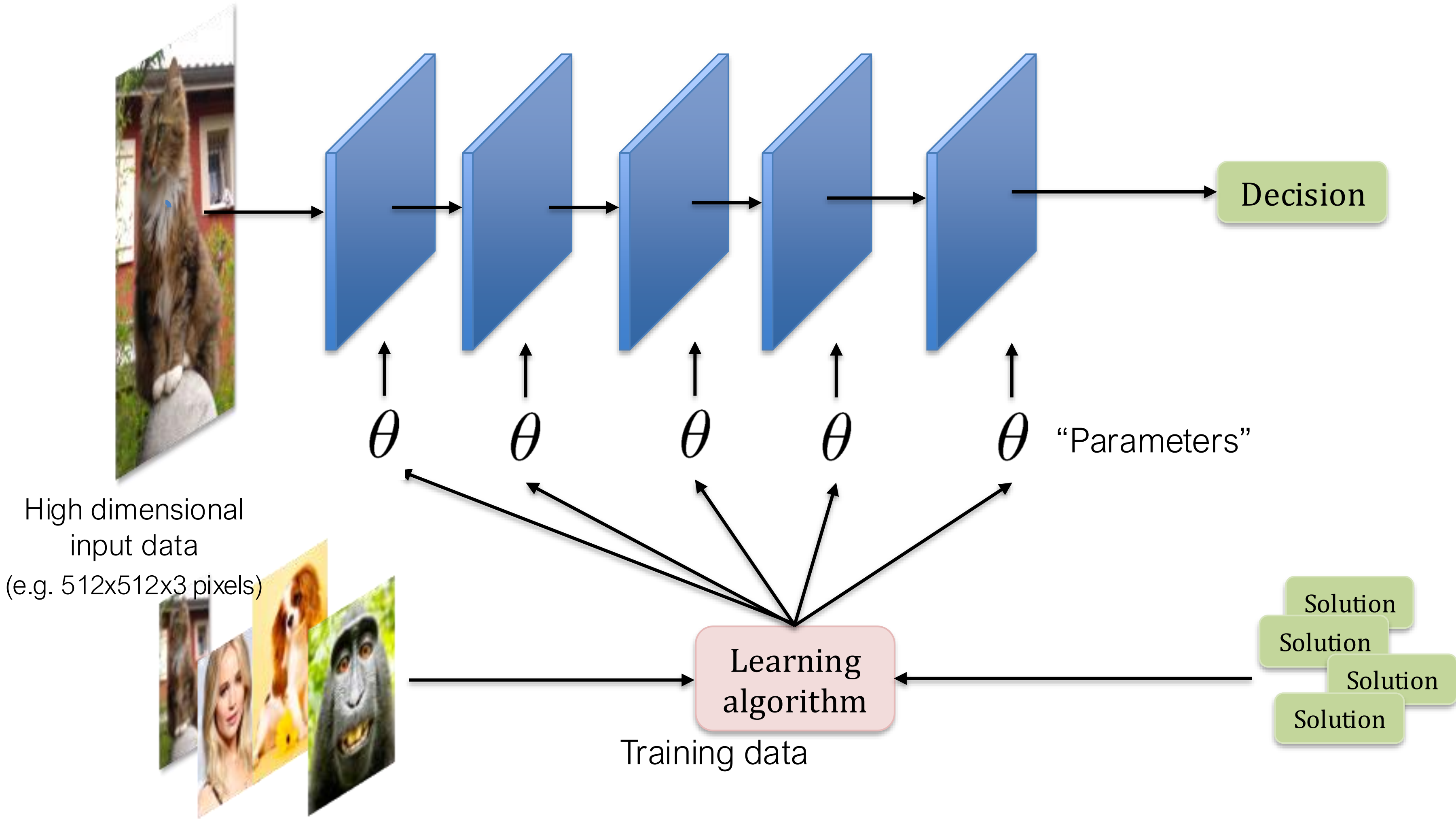
Decision taking: adding learning



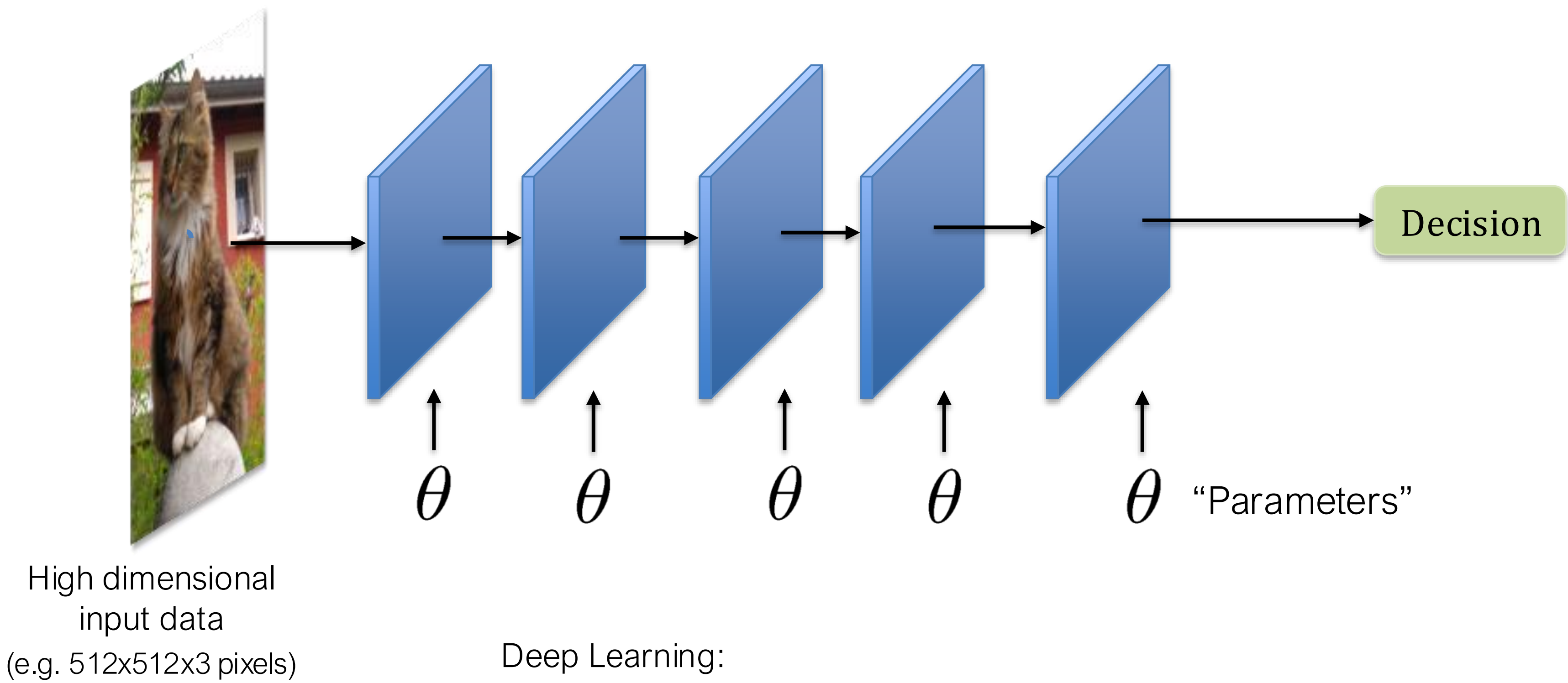
Adding machine learning



Decision taking: deep learning



Decision taking: deep learning



Deep Learning:

- Learning from <u>raw signals</u>
- Hierarchical, layered representation
- Different levels of abstraction
- Learning from <u>massive amounts of data</u>, requiring massive compute