

Department of Computer Science and
Engineering - University of Bologna



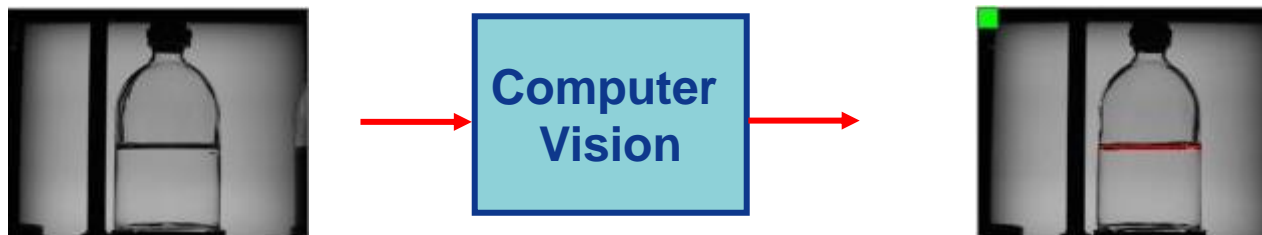
Introduction

[Computer Vision And Image Processing M 2021/2022 — University of Bologna \(unibo.it\)](https://www.unibo.it)

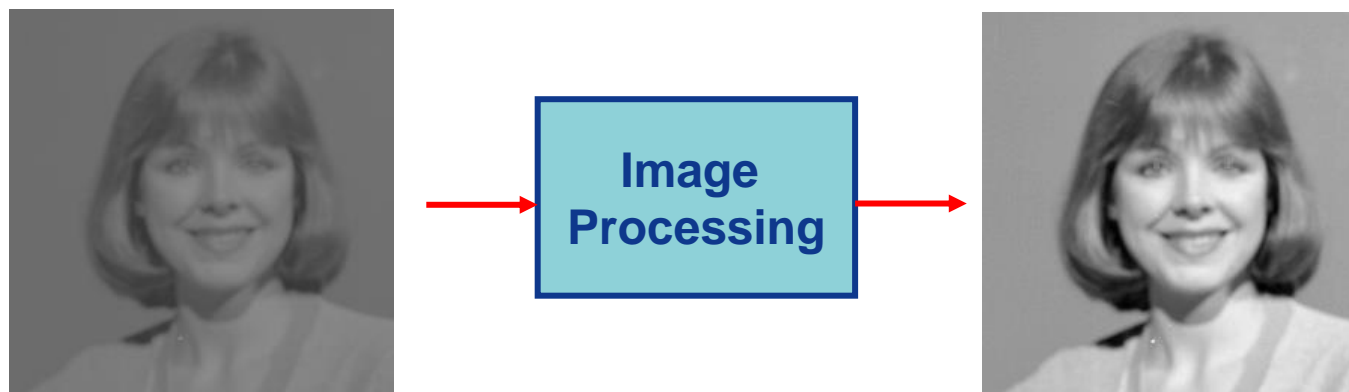
Luigi Di Stefano (luigi.distefano@unibo.it)

What is Computer Vision ?

Computer Vision deals with extraction of information from images

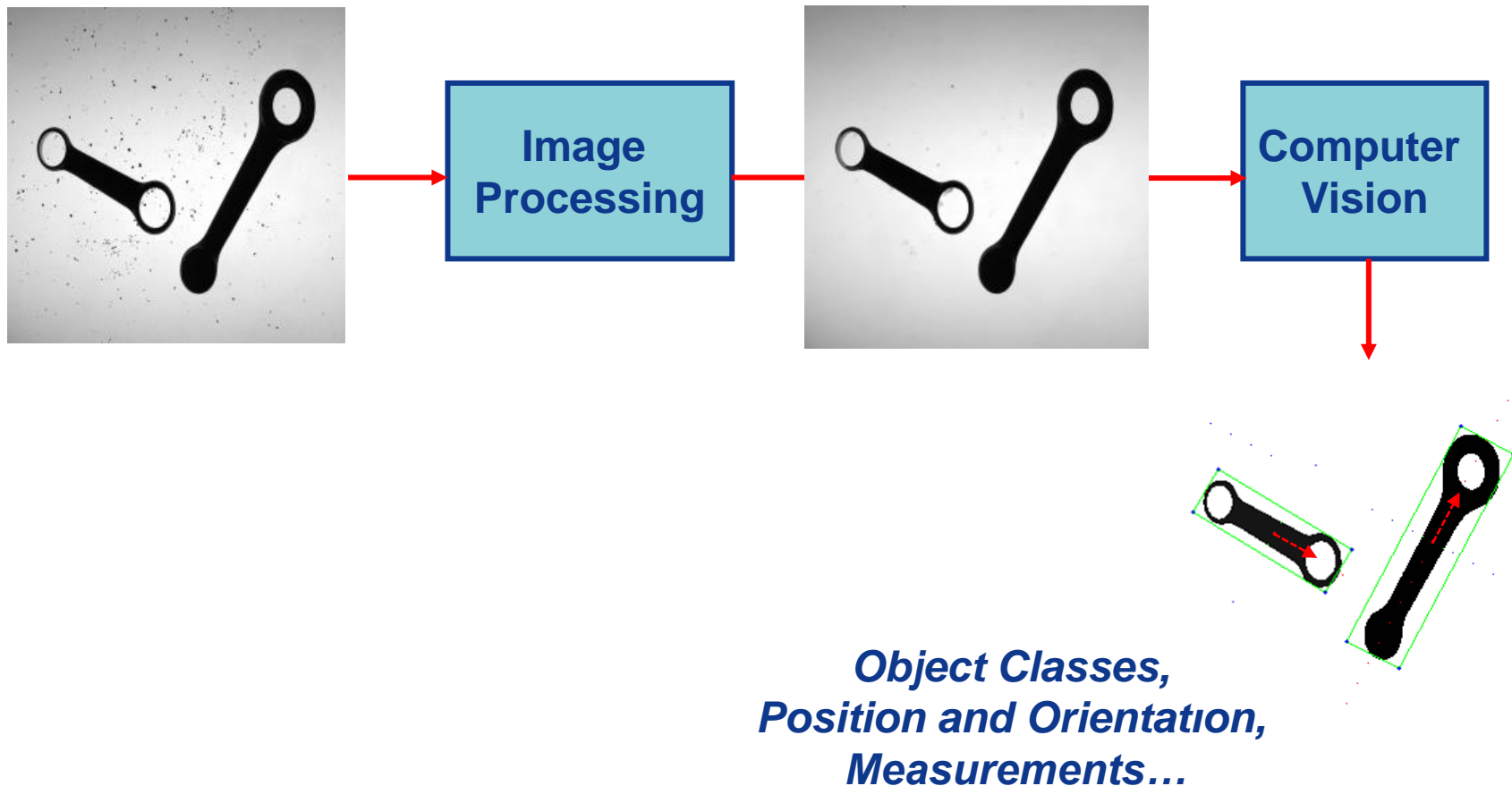


and is therefore different from Image Processing.....



Computer Vision & Image Processing

quite often, though, Image Processing helps Computer Vision:



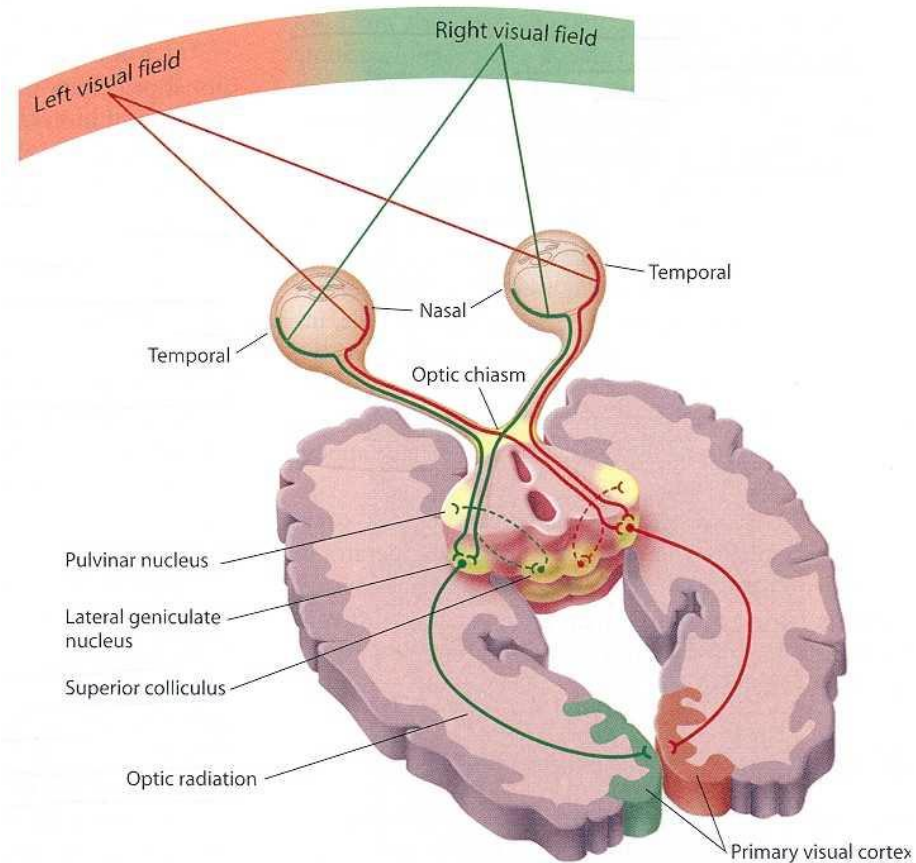
Why studying this stuff ?



**Countless applications
in many diverse fields !**

**Computer
Vision**

ENG



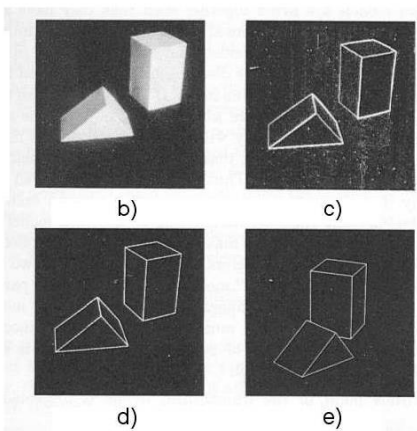
BIO

Quite a successful journey.....

“the block world”, Roberts, MIT, 1965



a)



.....from labs to the
factory



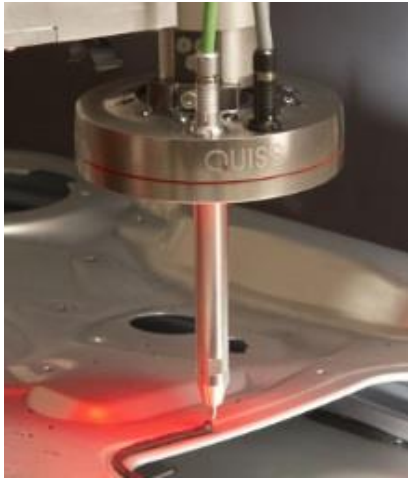
*Cognex DataMan, 1982
first industrial OCR system*



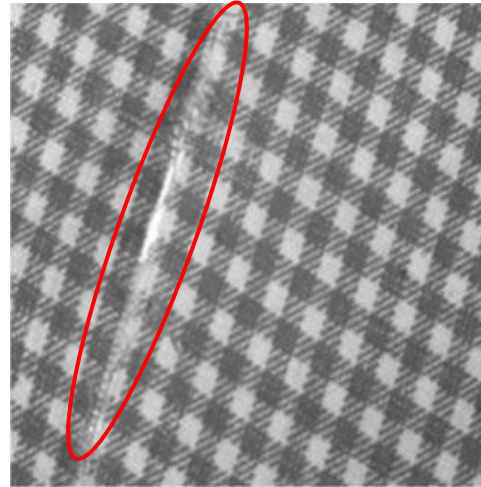
Through successes and failures, computer vision has eventually reached maturity. Computer vision is now a key process technology deployed throughout almost all industries.

Process Technology: Inspection and Gauging

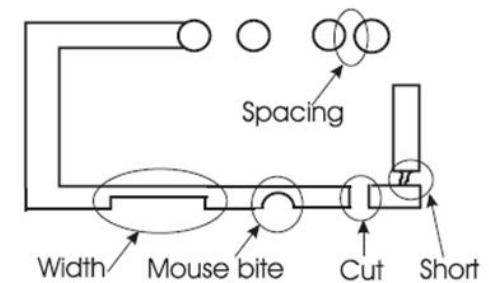
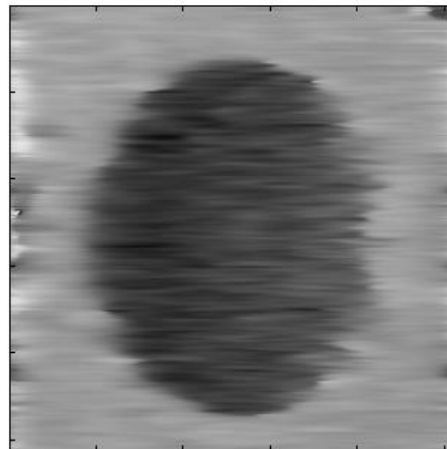
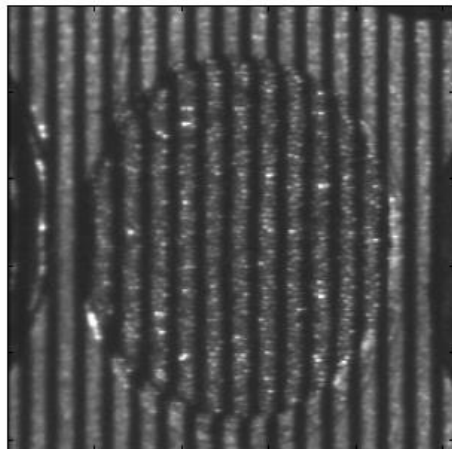
Automotive



Textile

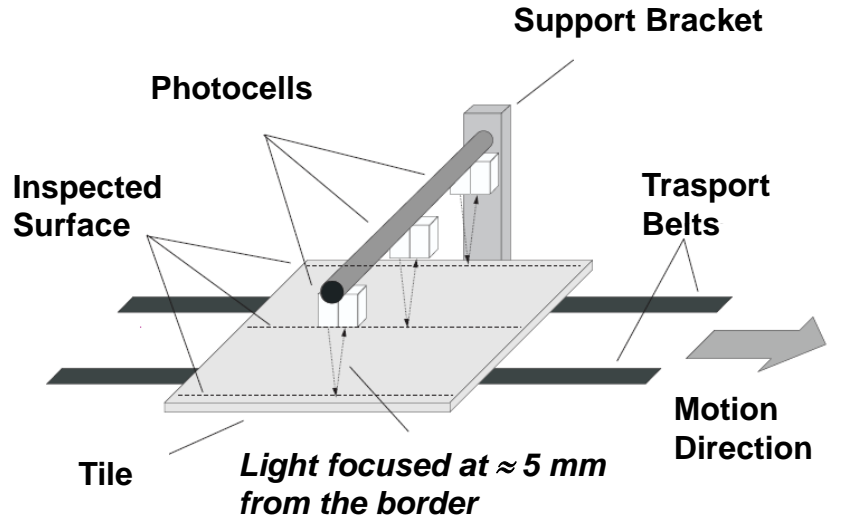


Food



Electronics (PCB)

A case study: tile inspection

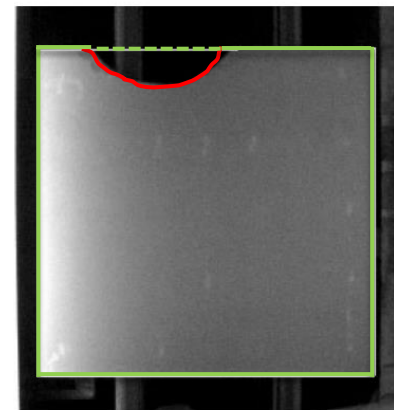
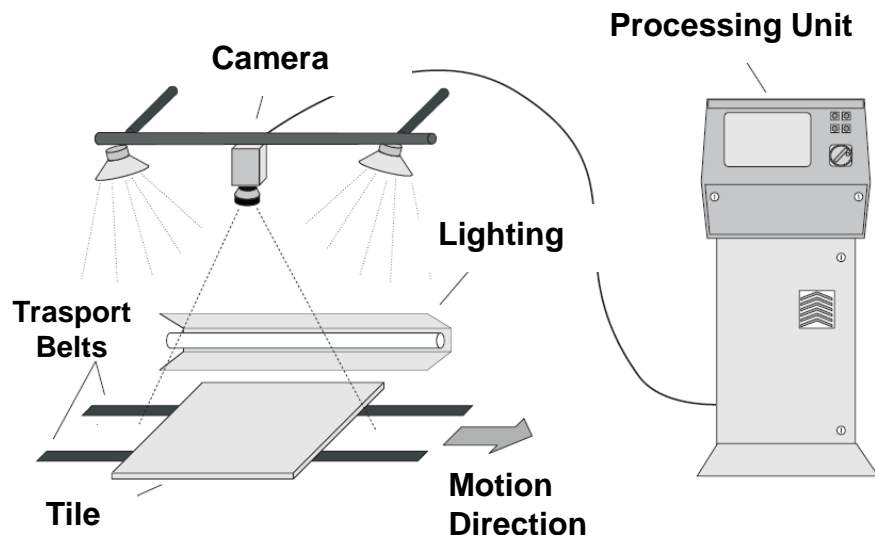


“Old” systems for detecting broken tiles were mostly based on photocells.



- The two borders orthogonal to the motion direction cannot be inspected.
- Small rotations can yield false positives.
- **Poor flexibility.**

A computer vision approach turns out significantly more effective !



Process Technology: Robot Guidance



Computer vision is key to endow industrial robots with an otherwise unattainable degree of flexibility.

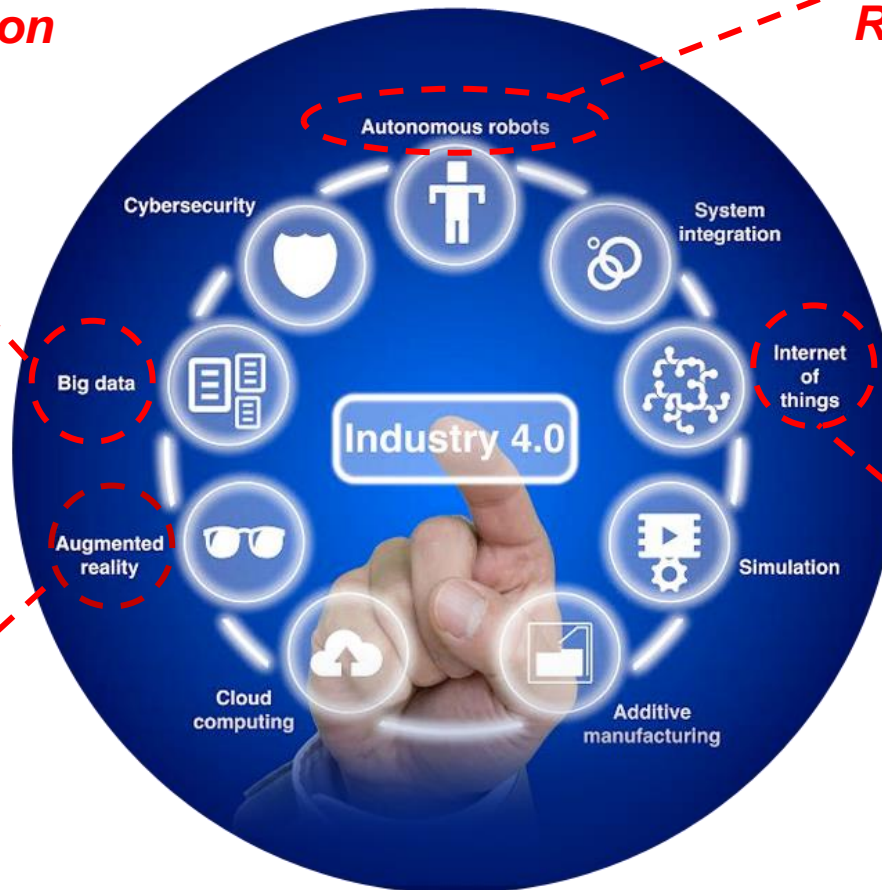


The ability to detect and localize a few objects allows the robot to adapt its operation to a wide range of unknown arrangements (i.e. type of objects as well as their positions and poses).

Computer Vision & Industry 4.0

**Quality & Process
Data from Vision
Systems**

**Vision for Advanced
Robotics**



Smart AR

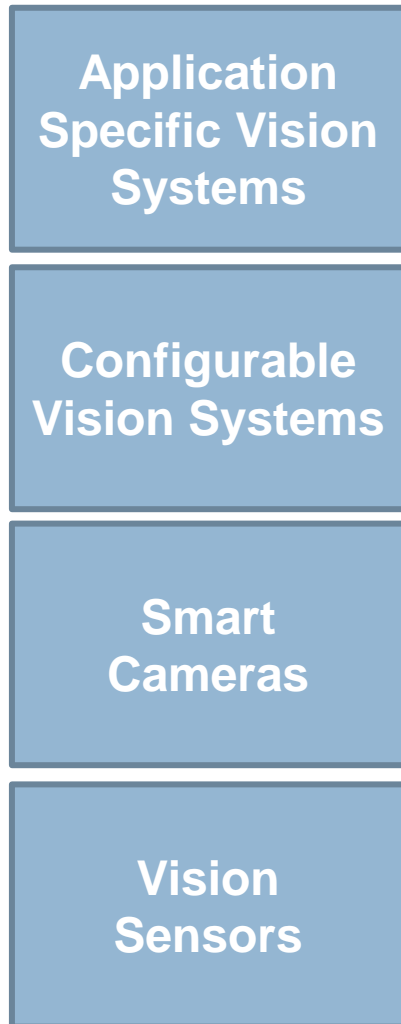
**Vision Systems &
Sensors**

"From inspection to optimization" - VDMA, Machine Vision 2017/18

Machine Vision Systems in the Market



Complexity & Cost



Turnkey systems designed for a specific application, which is either widespread throughout the industry or used in a particular sector.



The user can configure the system without writing or changing the source code. Typically PC-based, flexible multi-camera support.



Cameras with embedded computational intelligence (e.g. a CPU,DSP or FPGA), which can be programmed or configured.

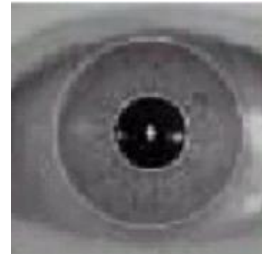


Turnkey products combining a sensor and a processor. Equipped with specific application software geared at a widespread use (e.g. presence/absence, code reading)

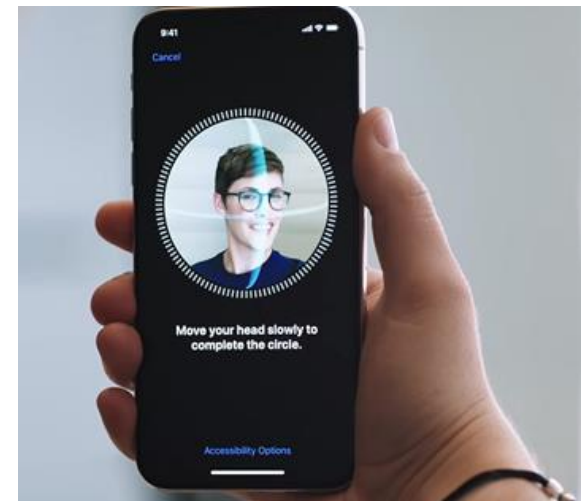
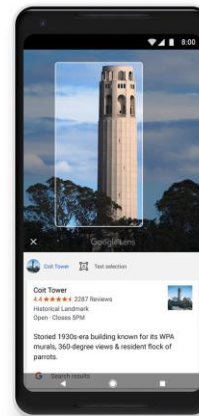
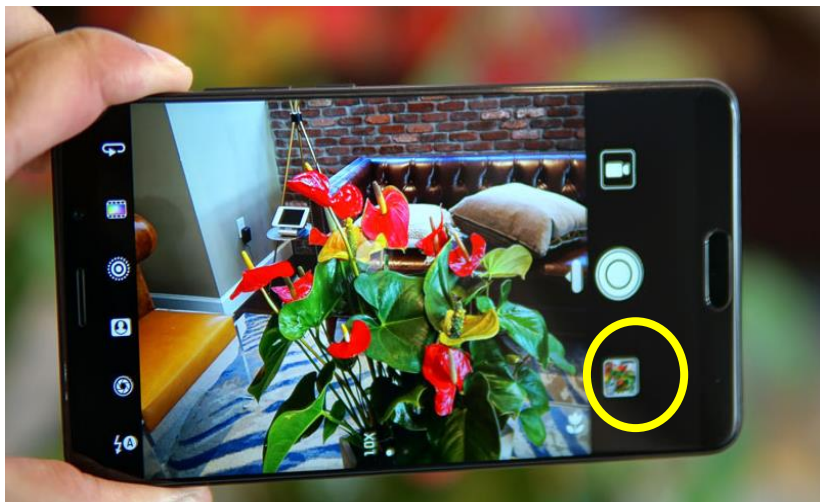
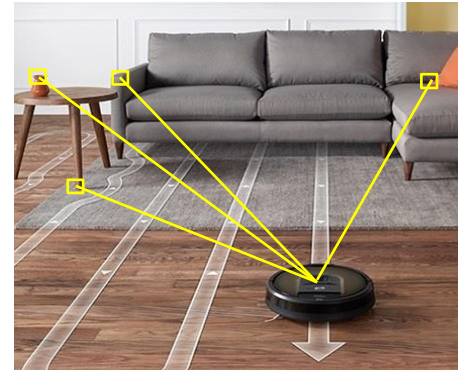
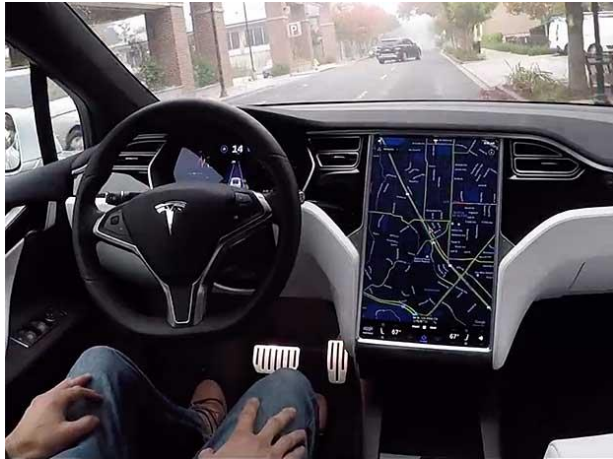


Curse of diversity - Highly fragmented market - Bigs are small !

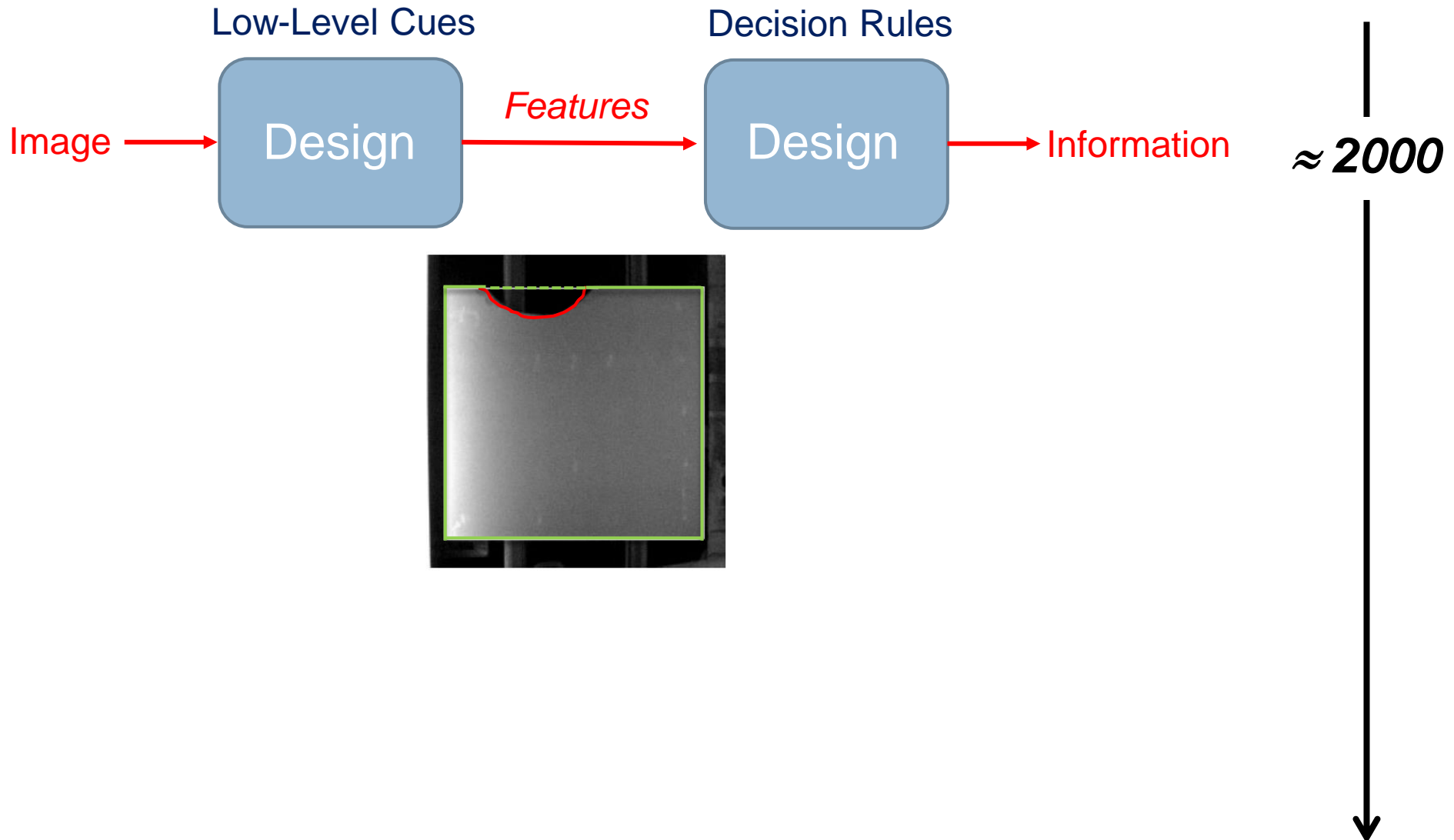
Increasingly a Product Technology



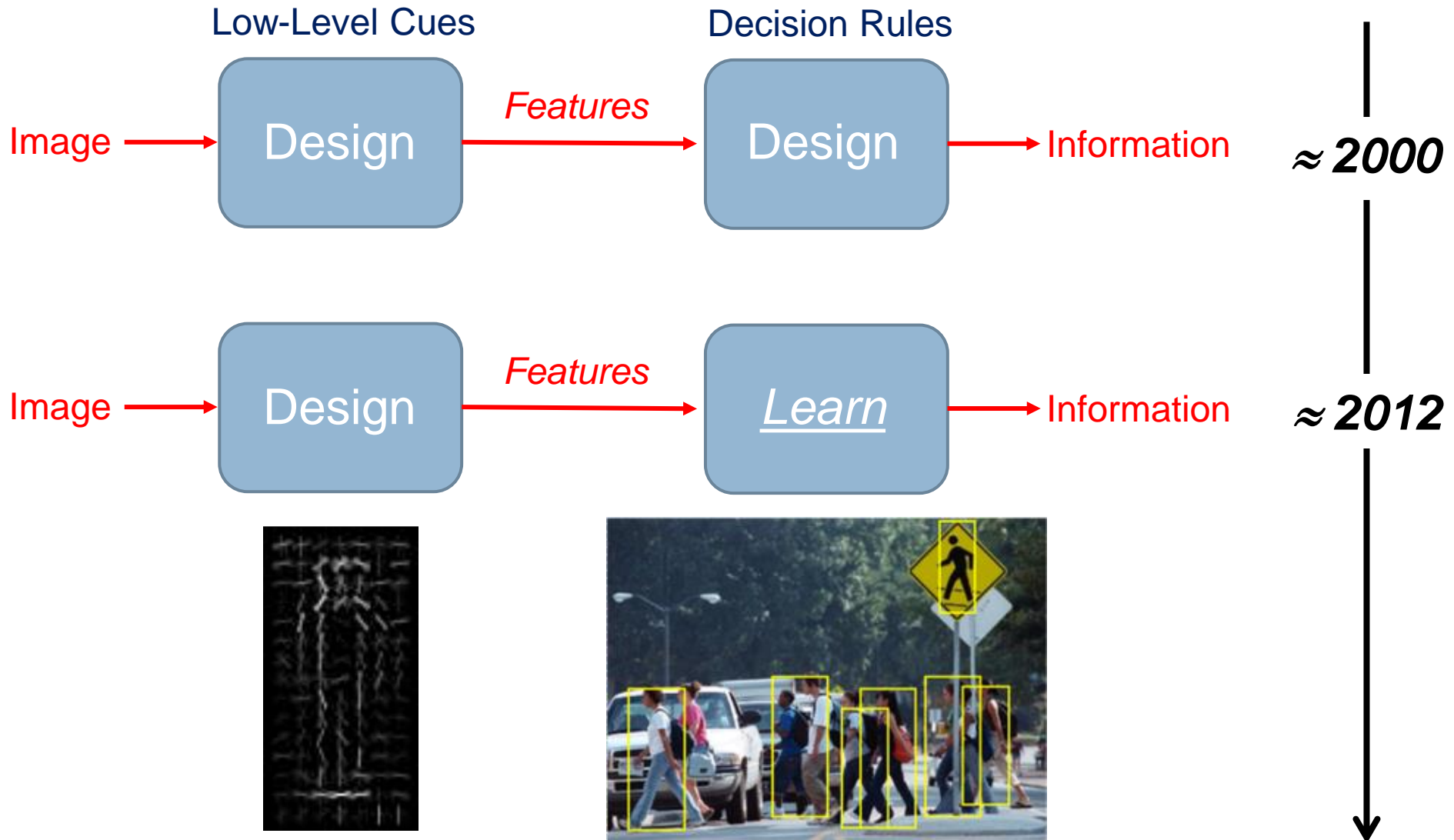
Mass-Market Consumer Products !



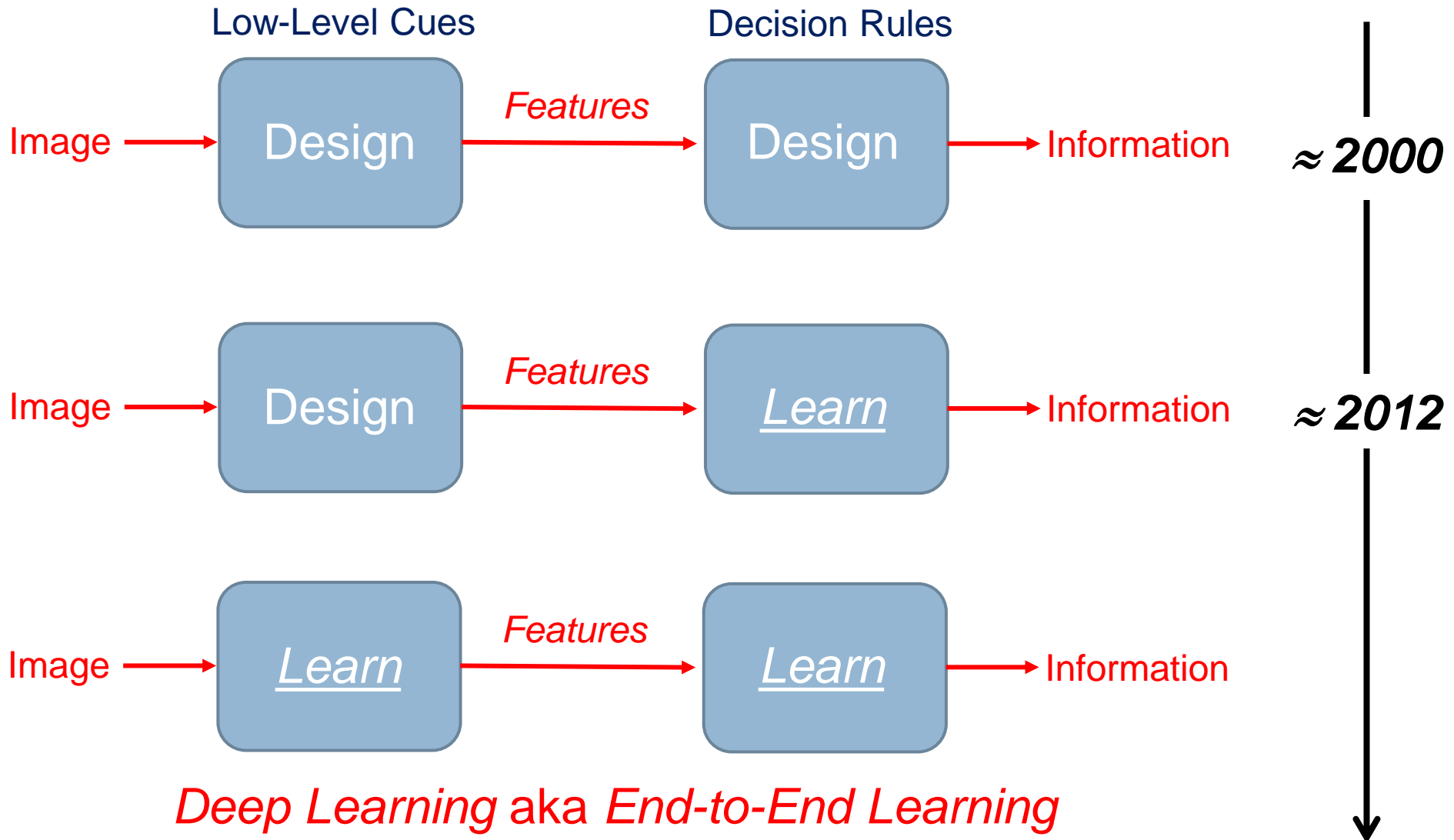
Timeline of the Computational Workflow



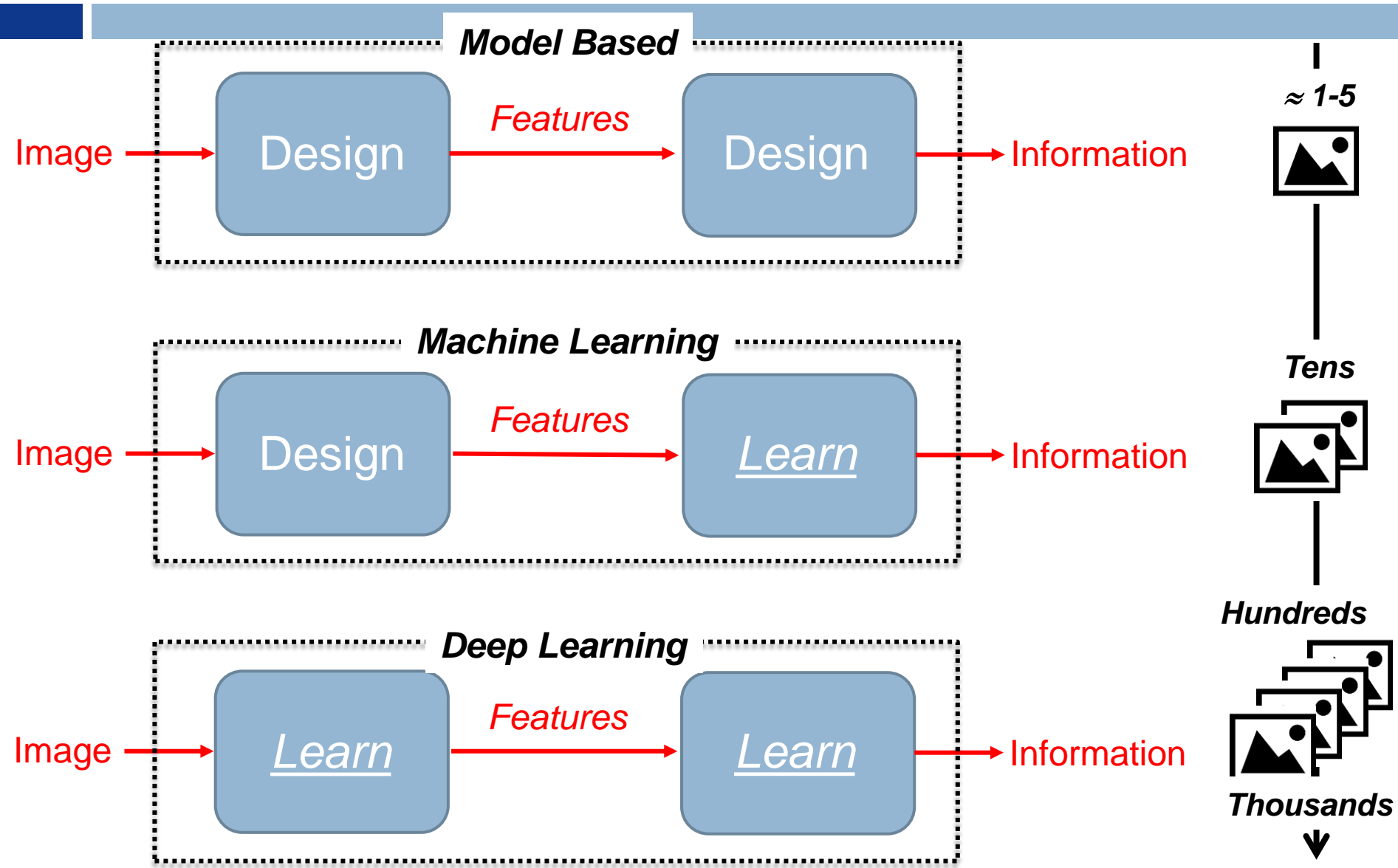
Timeline of the Computational Workflow



Timeline of the Computational Workflow



Dataline of the Computational Workflow



Computer Vision & AI



Artificial Intelligence (AI)

Machine Learning

Computer Vision

Deep Learning

AI: any technique that enables computers to mimic human intelligence

Machine Learning: computers learn from examples rather than being explicitly programmed

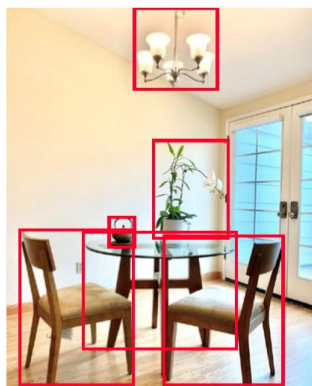
Deep Learning: Machine Learning realized through Deep Neural Networks

Deep Learning for Computer Vision



*Novel View Sythesis
(NERF, 2020)*

Universal Product Recognition from photos by FAIR (GrokNet)



Antique
Bronze
Pendant



Cast
Iron
Teapot



Walnut
Dining
Table

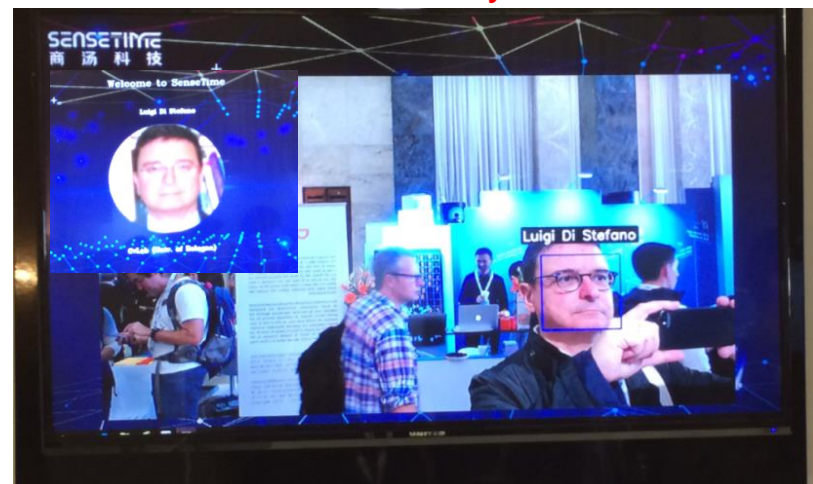


Walnut
Dining
Chair

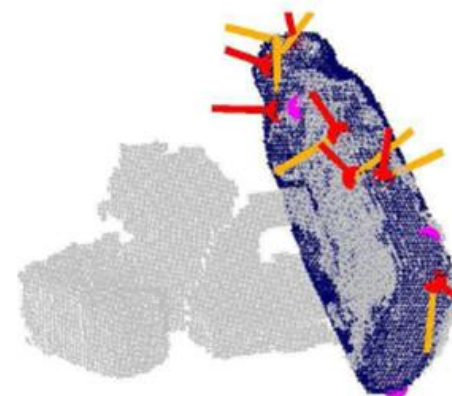
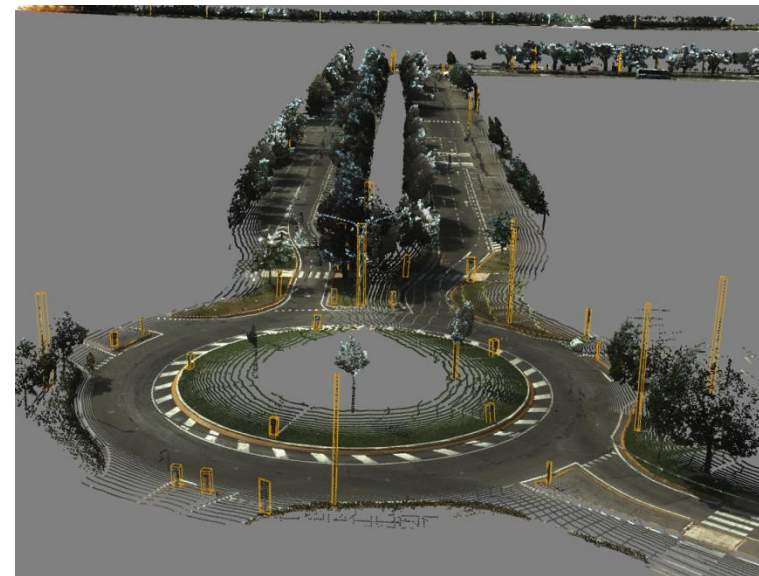


*Face Synthesis by
NVIDIA (StyleGAN)*

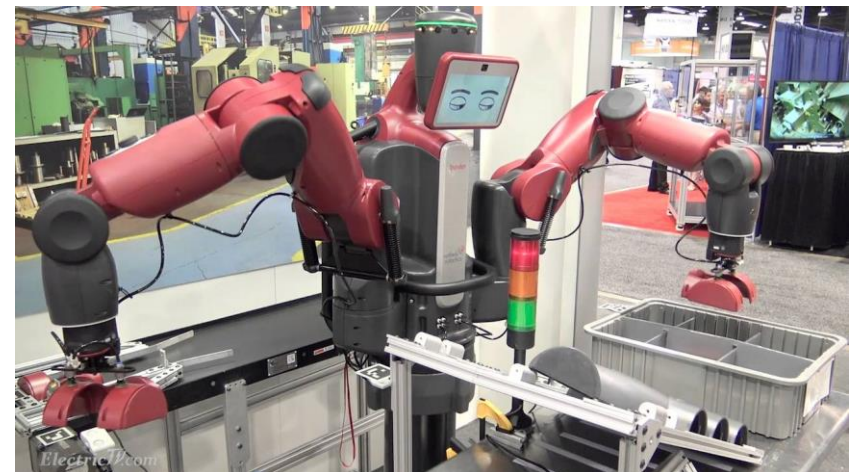
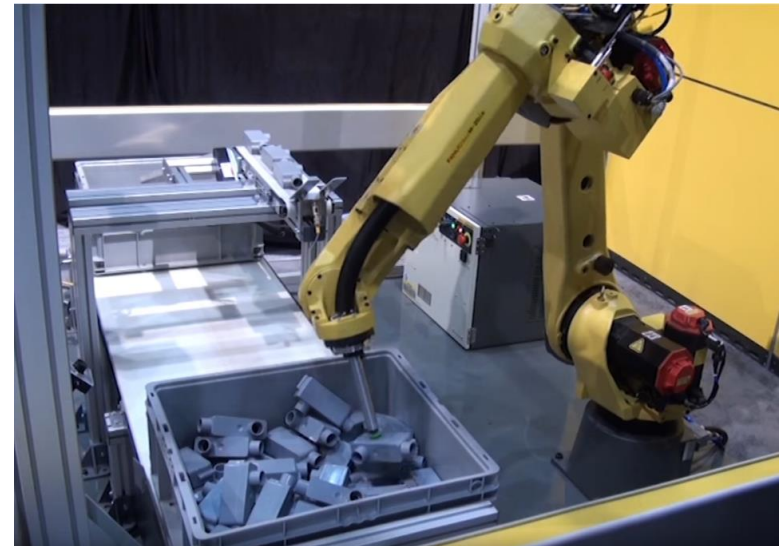
*Face Recognition
by SENSETIME*



Future... more and more 3D !



Future...3D will foster robotics



Future...Linked/Augmented Life



Devices based on geo-localization, inertial sensors and computer vision may link seamlessly digital content to physical objects

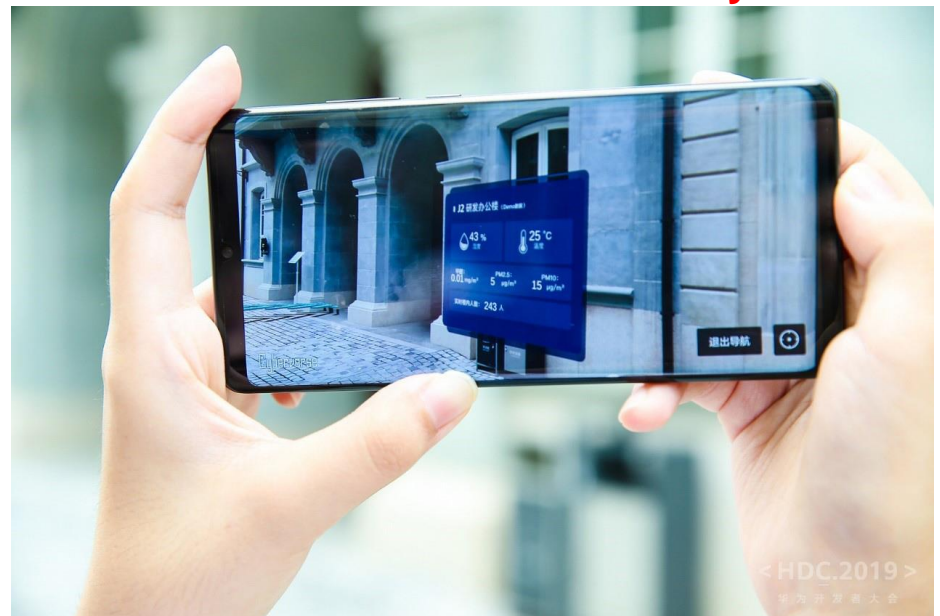
Microsoft HoloLens



Huawei Cyberverse



Magic Leap 1



<https://www.youtube.com/watch?v=KNKtkRMb0yw>