



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Introduction

2024/2025 Computer Vision And Image Processing M — University of Bologna (unibo.it)

Corso: Computer Vision and Image Processing M - Image Processing and Computer Vision M | Virtuale (unibo.it)

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

**Department of Computer Science and Engineering (DISI)
University of Bologna, Italy**

Computer Vision vs. Image Processing

Computer Vision deals with extraction of information from images

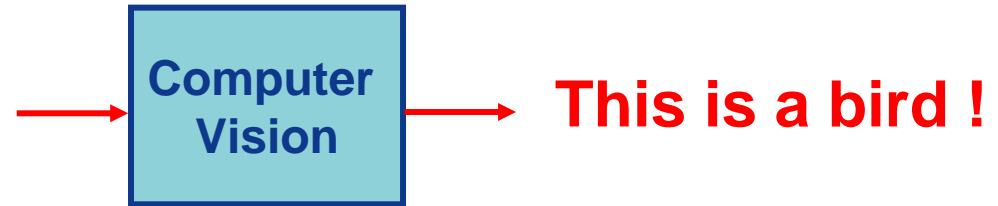
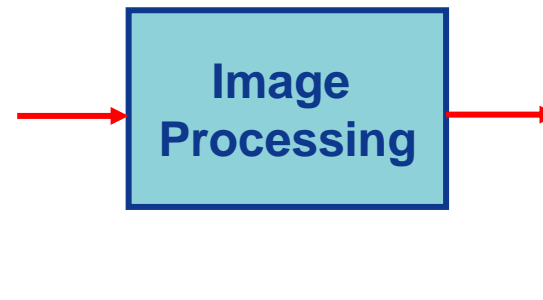
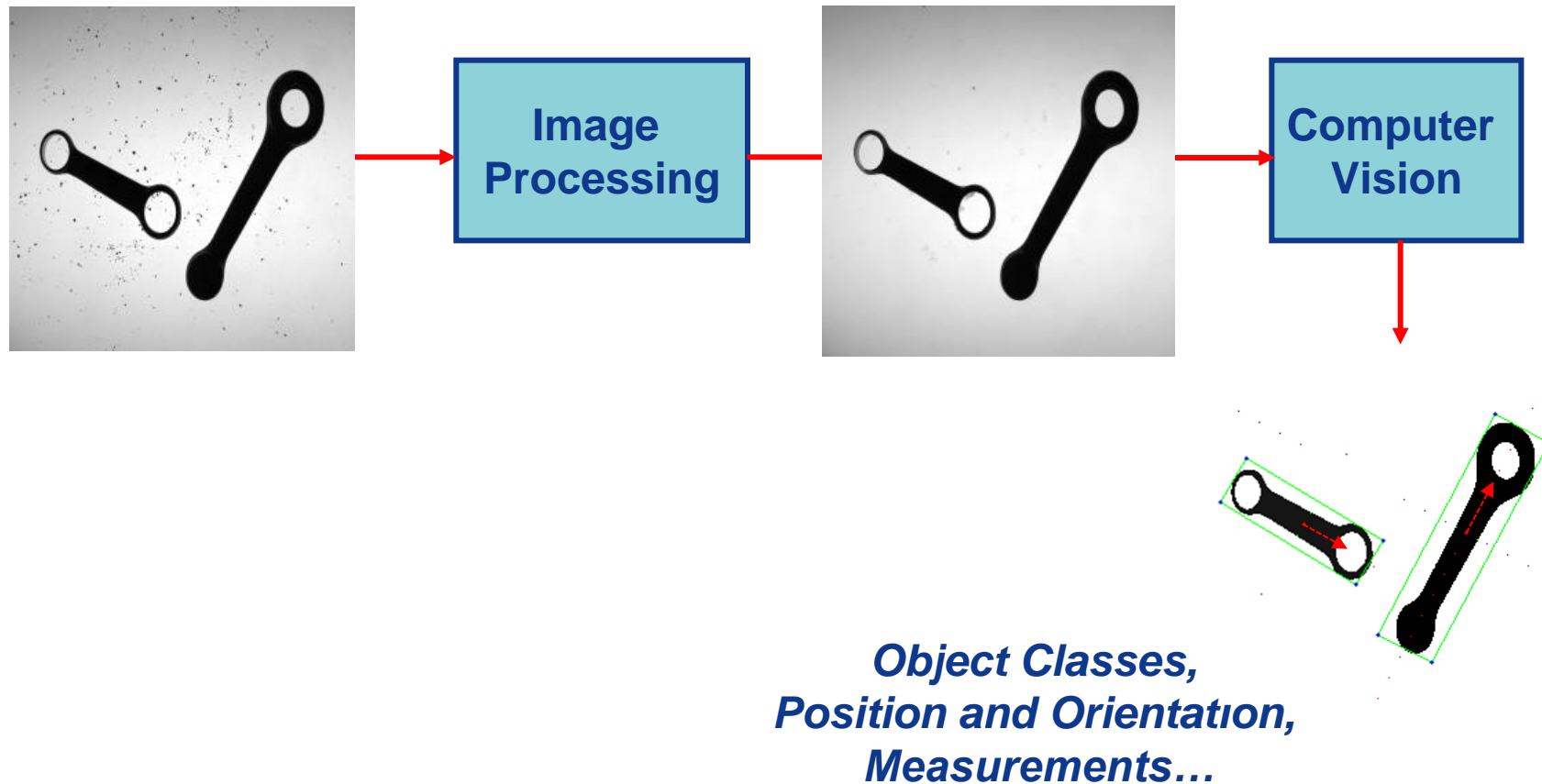


Image Processing aims at improving the quality of images



Computer vision & Image Processing

Quite often Image Processing helps Computer Vision



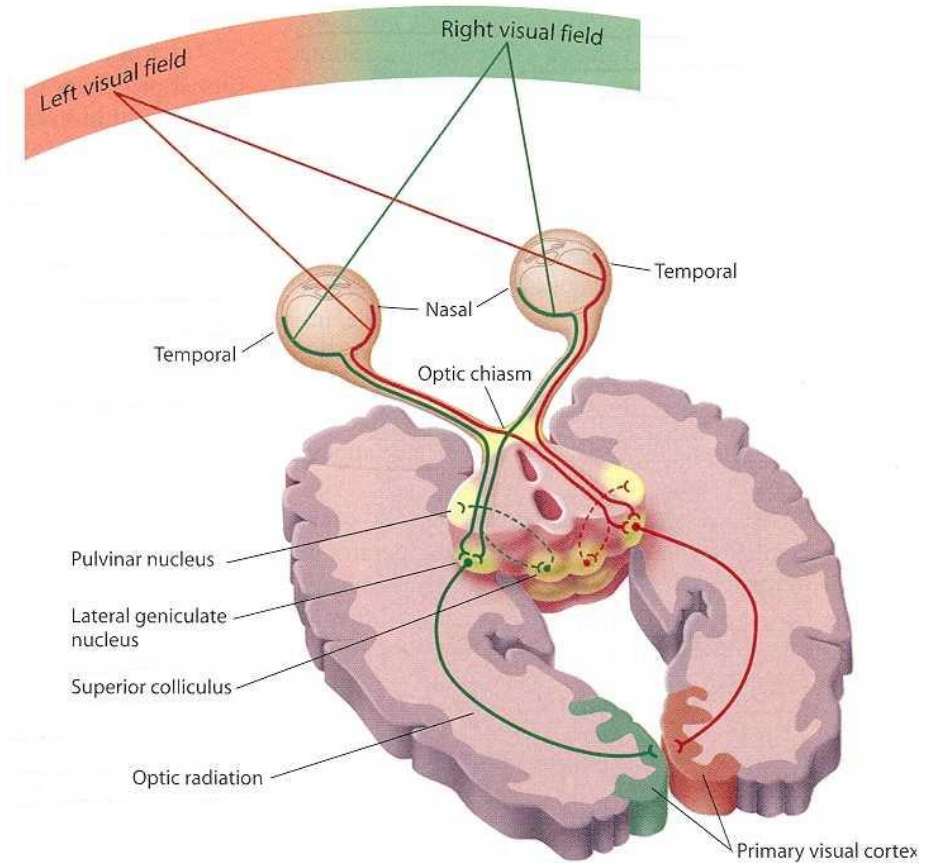
Why studying this stuff ?



Countless applications
in many diverse fields !

ENG

Computer
Vision



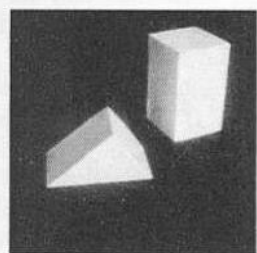
BIO

Quite a successful journey !

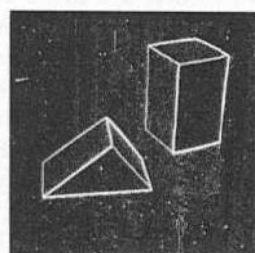
“the block world”



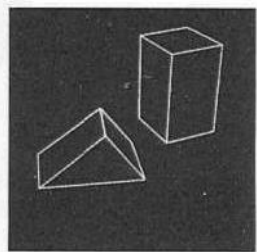
a)



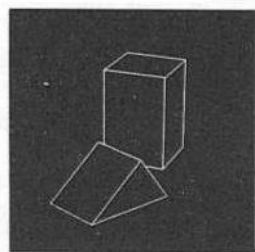
b)



c)



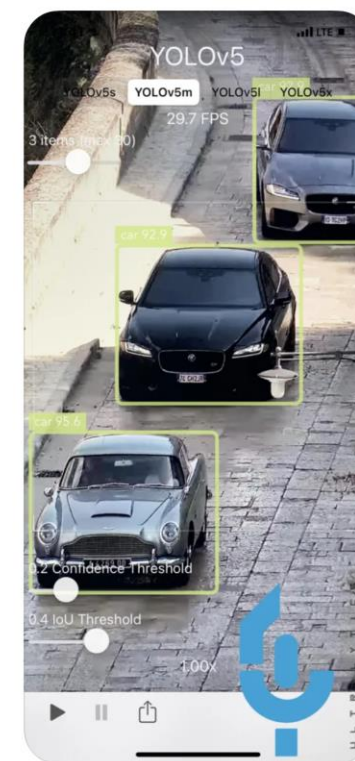
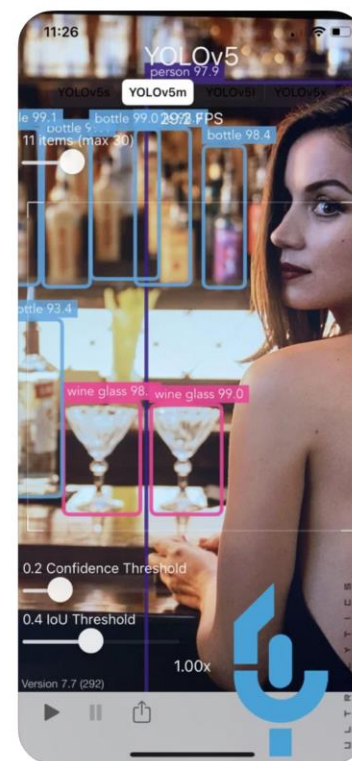
d)



e)

Larry Roberts, PhD thesis,
*Machine perception of three-
dimensional solids*, MIT, 1963.

“anything anywhere”



YOLO - Ultralytics HUB

Massive and highly influential research

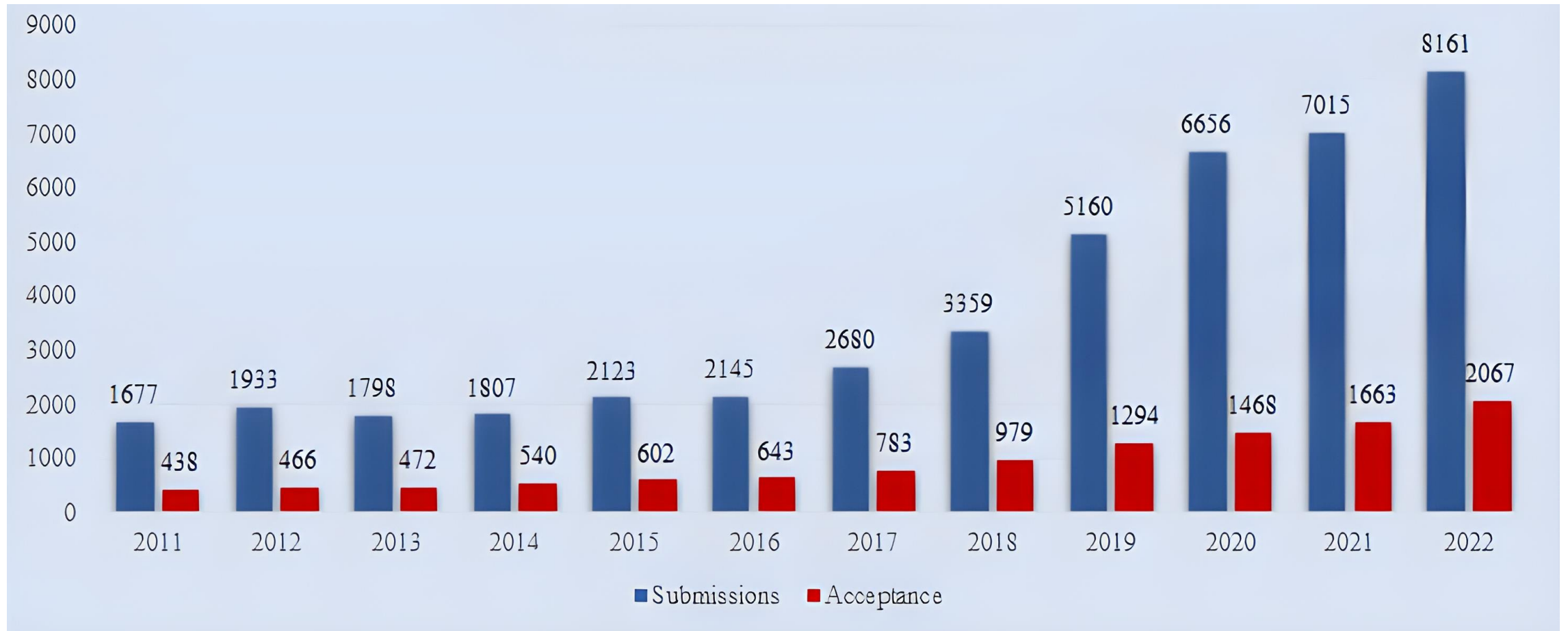


Top publications



	Publication	<u>h5-index</u>	<u>h5-median</u>
1.	Nature	<u>488</u>	745
2.	IEEE/CVF Conference on Computer Vision and Pattern Recognition	<u>440</u>	689
3.	The New England Journal of Medicine	<u>434</u>	897
4.	Science	<u>409</u>	633
5.	Nature Communications	<u>375</u>	492
6.	The Lancet	<u>368</u>	678
7.	Neural Information Processing Systems	<u>337</u>	614
8.	Advanced Materials	<u>327</u>	420
9.	Cell	<u>320</u>	482
10.	International Conference on Learning Representations	<u>304</u>	584

Papers @CVPR since 2011



Key Process Technology in all Industries

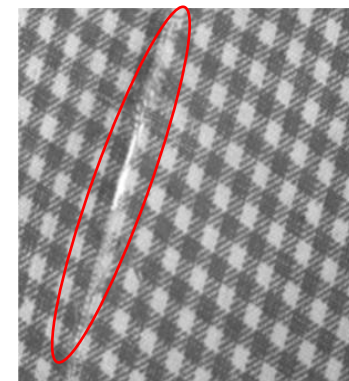


**Cognex DataMan
(1982)**

Automotive



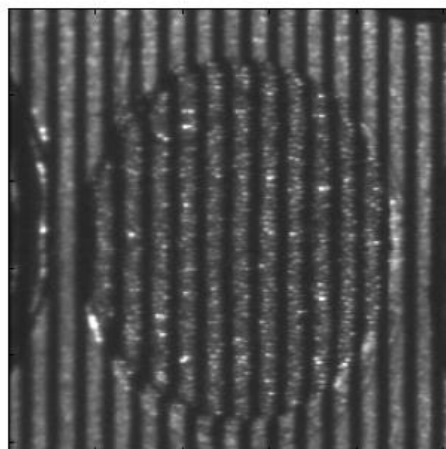
Textile



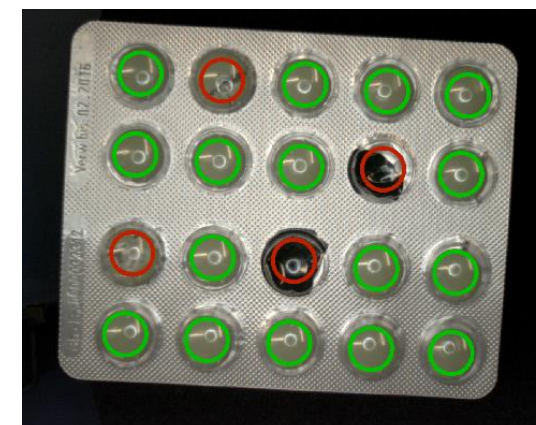
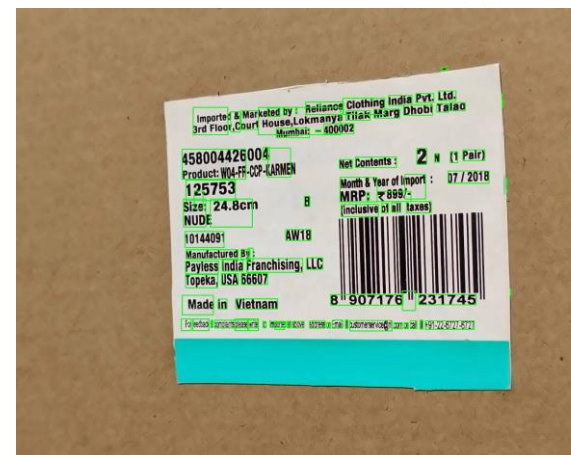
Food&Bevarage



Electronics



Transportation & Logistics



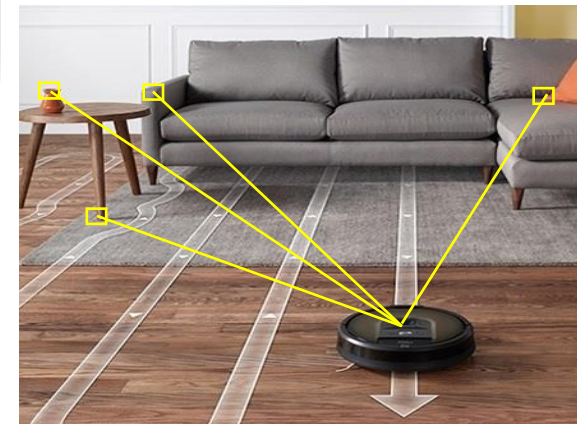
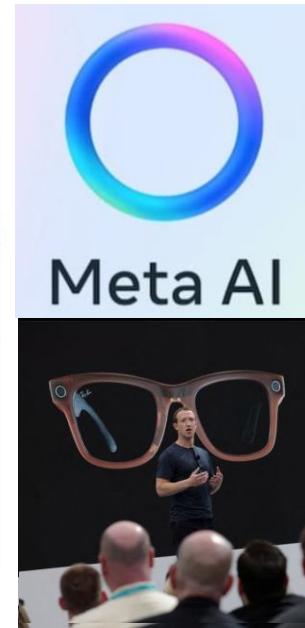
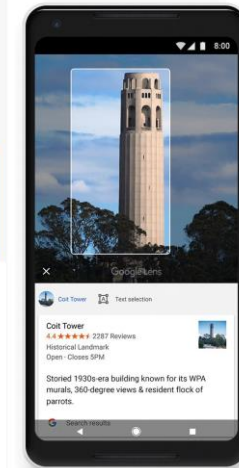
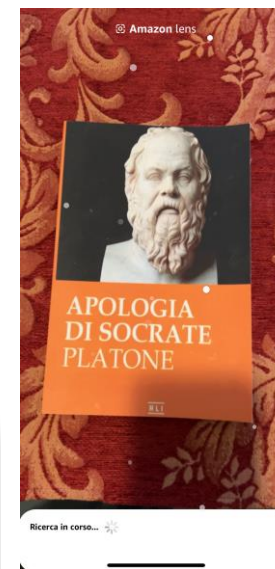
Pharma & Tobacco

**Inspection, Gauging,
Guidance, *Tracing*,
Compliance, Monitoring**

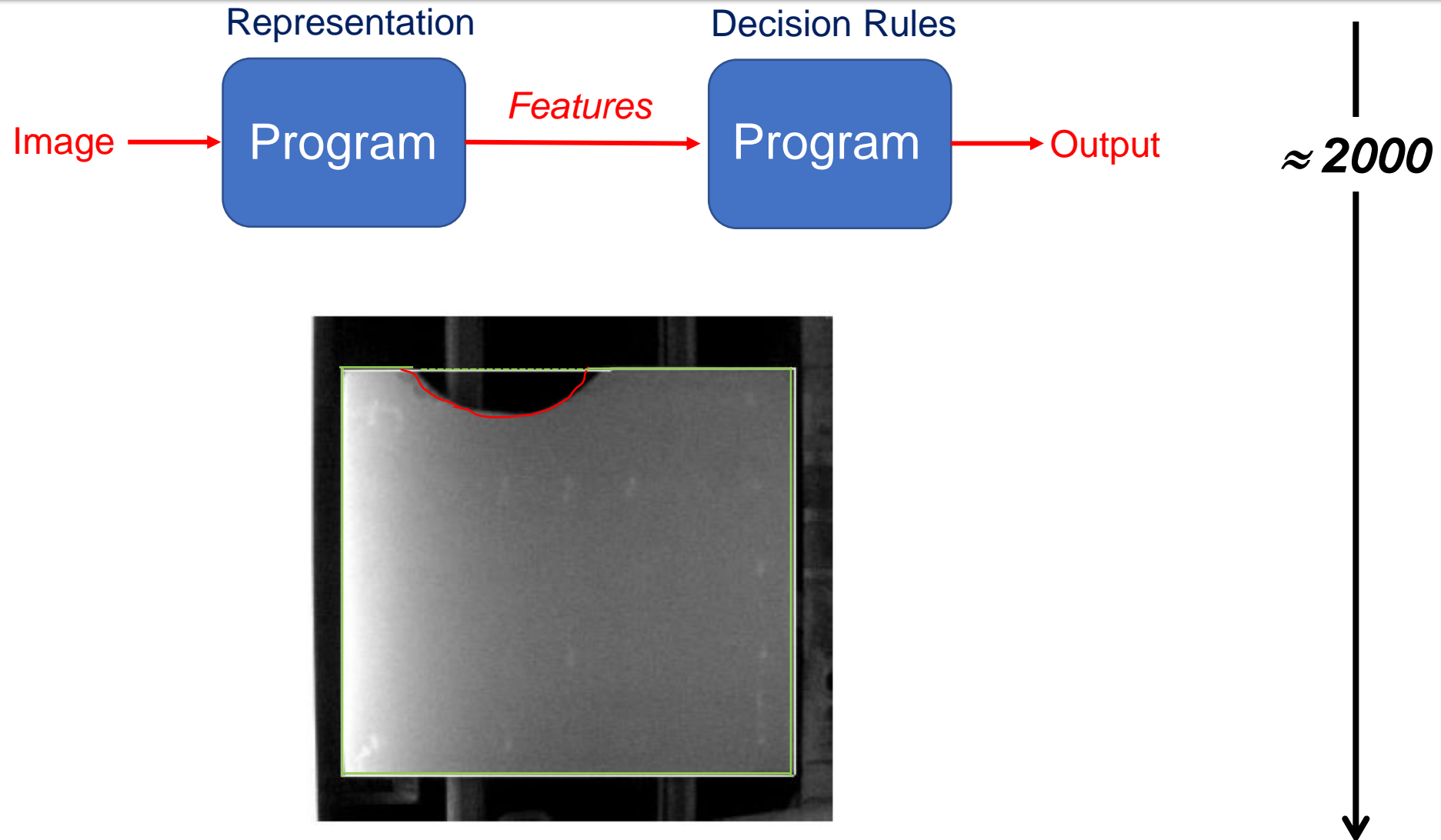


Process Optimization

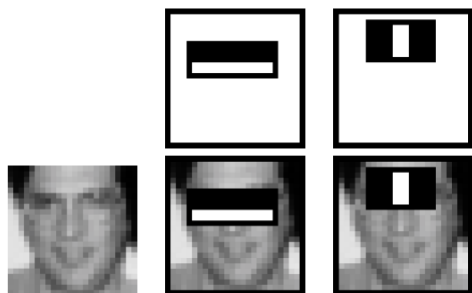
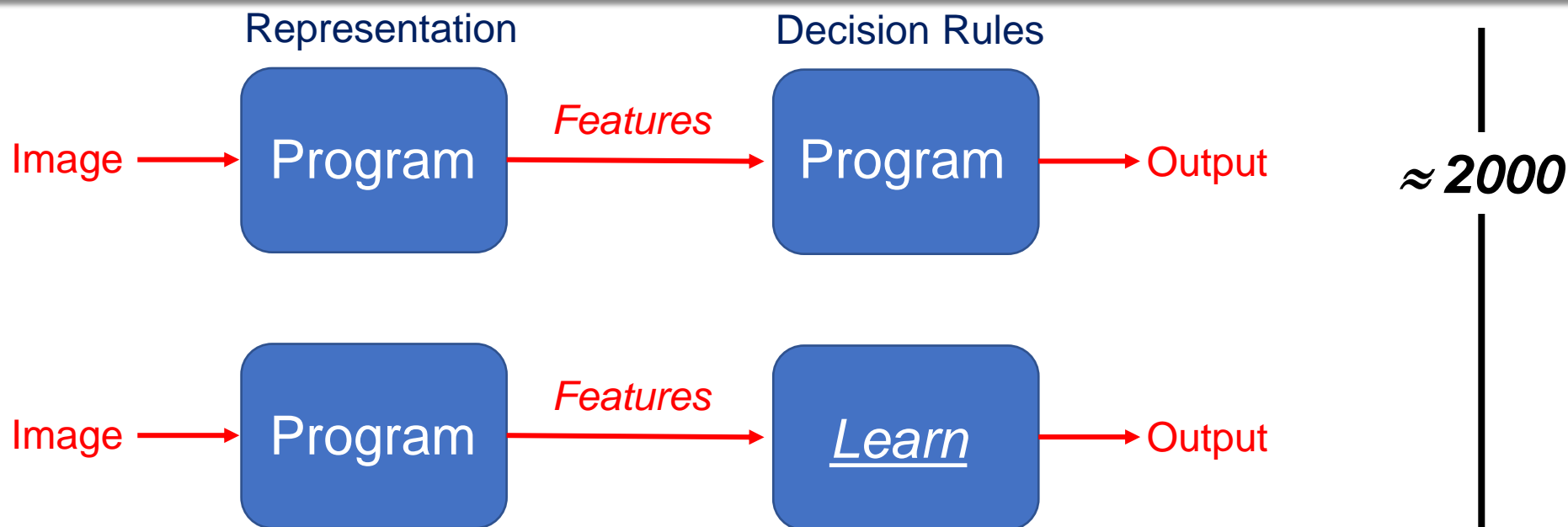
Mass-Market Consumer Products



Paradigms and Timeline



Paradigms and Timeline



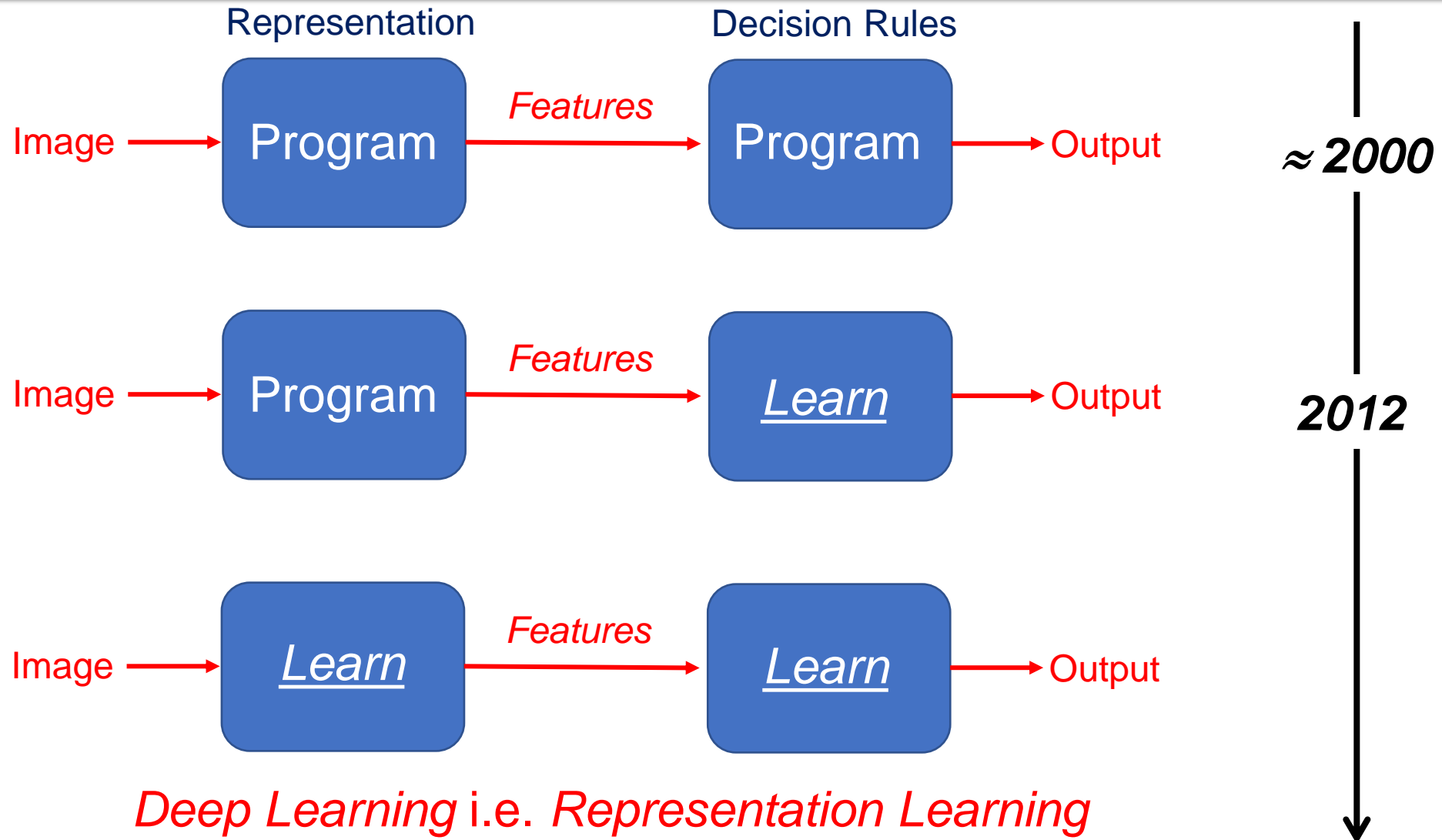
Viola&Jones, Haar Features + Boosting, 2001



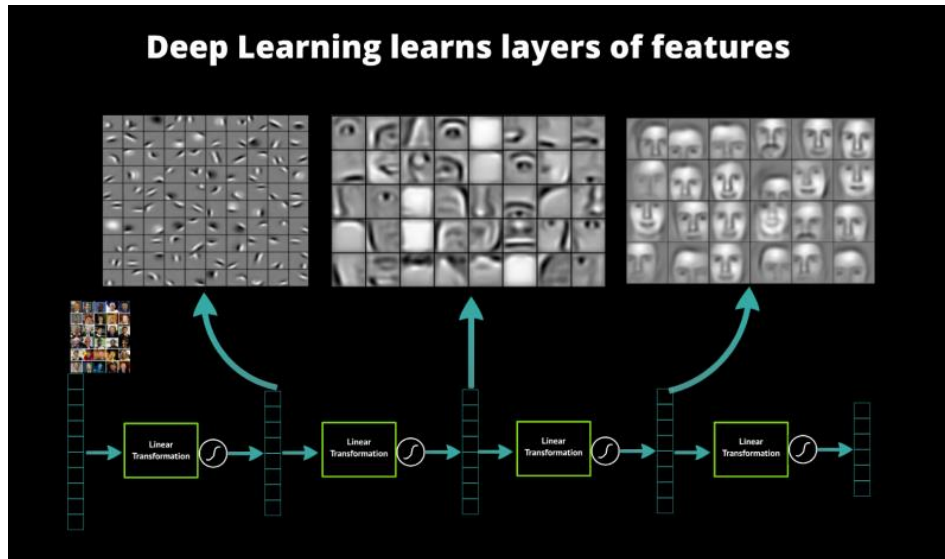
<https://towardsdatascience.com/understanding-face-detection-with-the-viola-jones-object-detection-framework-c55cc2a9da14>



Paradigms and Timeline

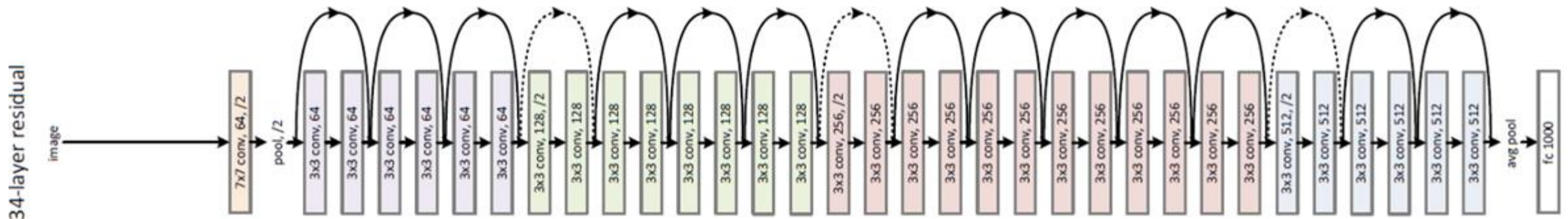


Deep Convolutional Neural Networks...and *beyond*



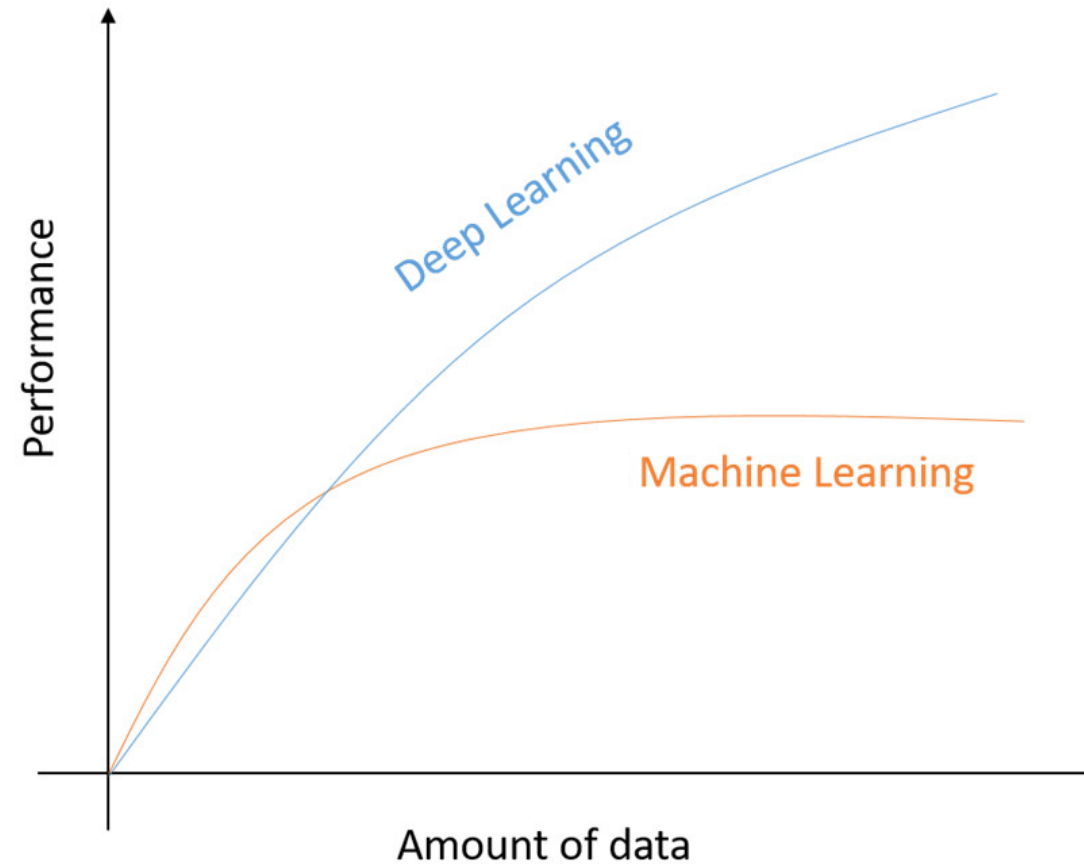
Credits: <https://www.datasciencecentral.com/a-primer-on-deep-learning/>

- Deep CNNs learn hierarchies of features and deploy *inductive biases* dealing with the structure of images.
- Large capacity (i.e. powerful) models requiring vast amounts of training data to prevent overfitting.



Since 2012: AI \approx Deep (Machine) Learning

Deep&Machine Learning vs. Data

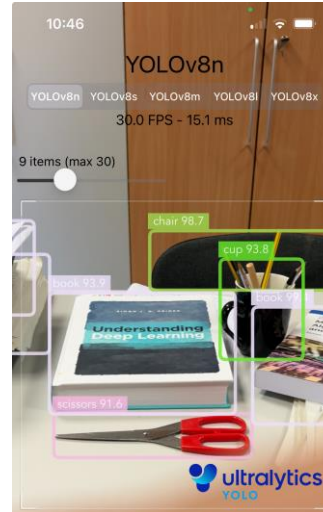


Deep Learning for Computer Vision

Image Classification



Lane Detection



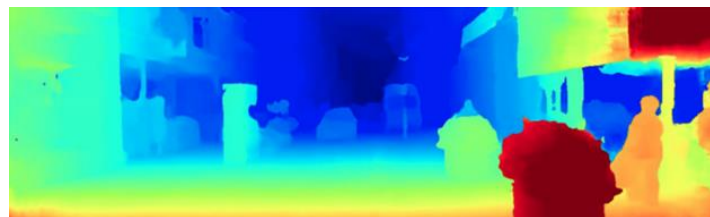
Object Detection and Instance-Part Segmentation



Semantic Segmentation



Depth Estimation (Stereo, Monocular)



Face Recognition



Deep Learning (AI) ?

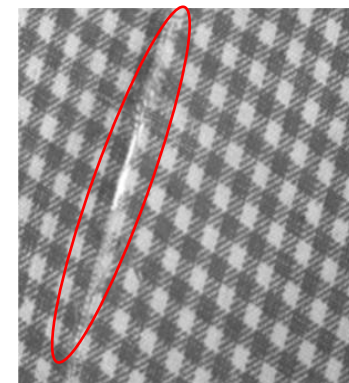


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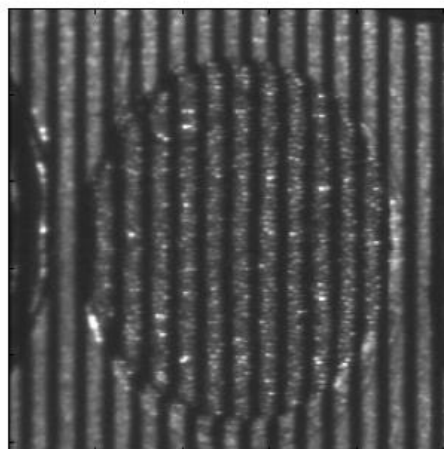
Textile



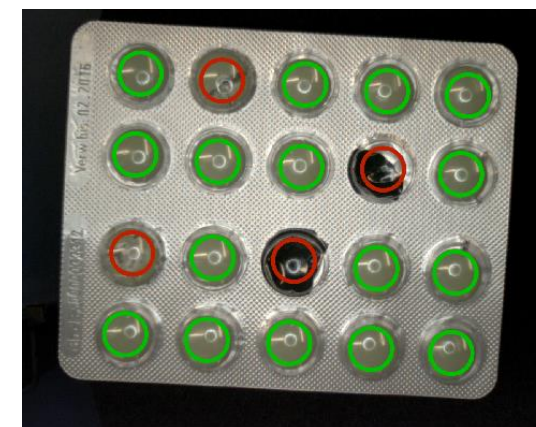
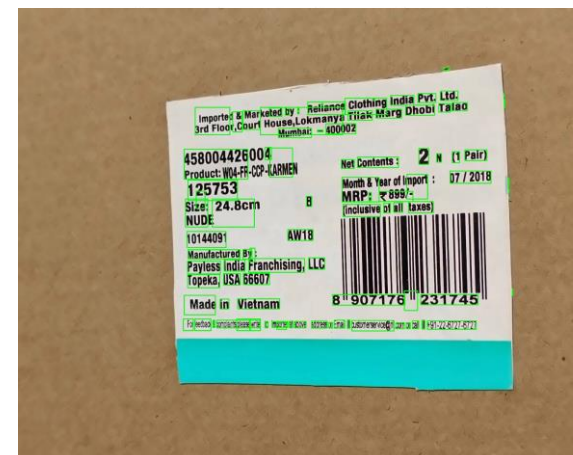
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Transportation & Logistics



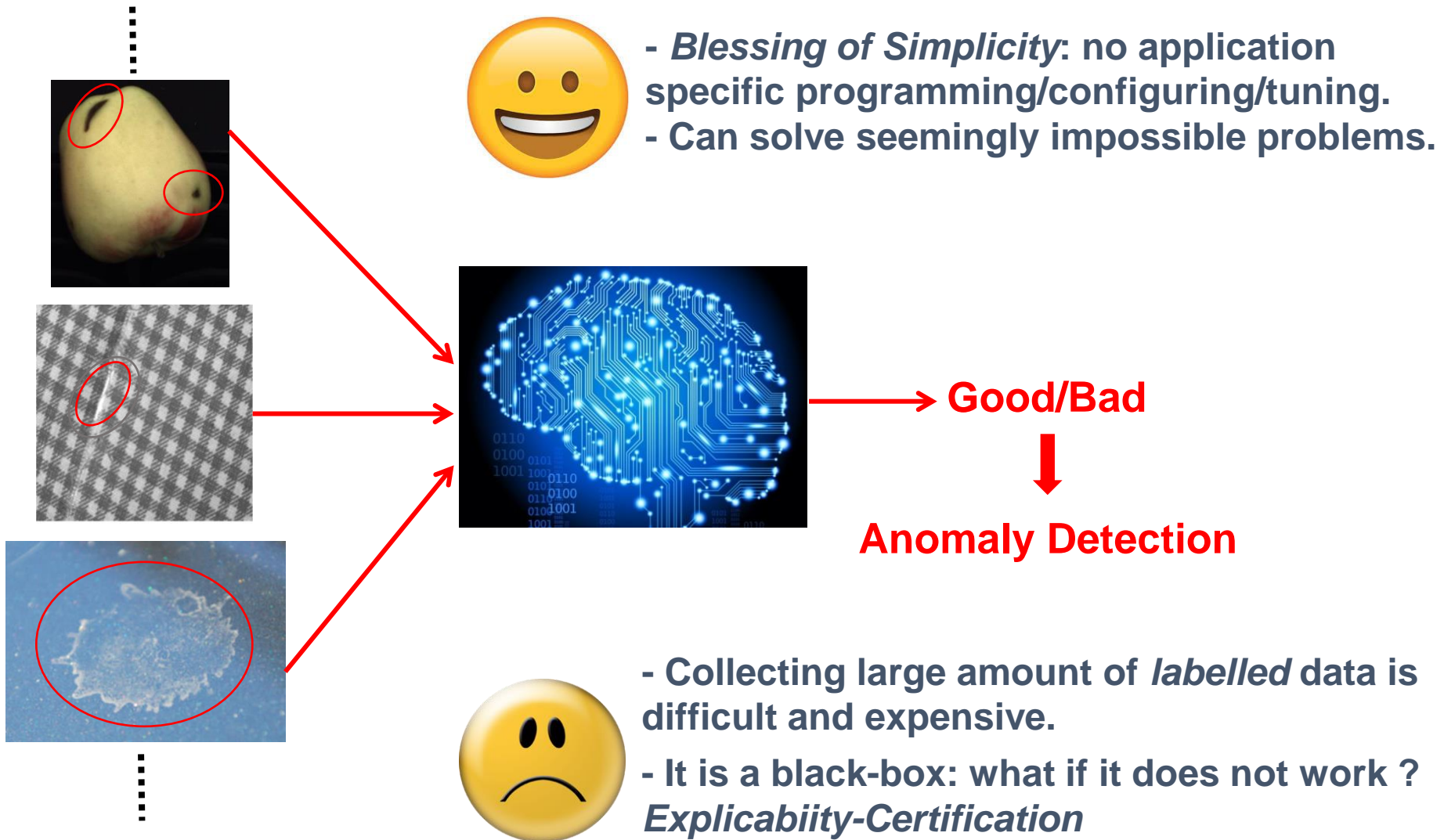
Pharma & Tobacco

**Inspection, Gauging,
Guidance, *Tracing*,
Compliance, Monitoring**



Process Optimization

It's happening

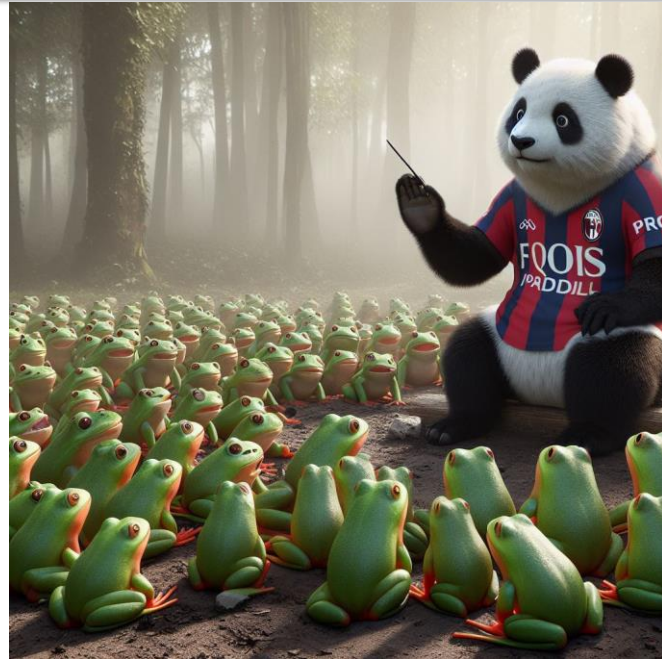


New Generative Tasks

DALL·E 3 (Bing)

DDPM aka Diffusion
Models, 2020

Latent Diffusion Models,
2022 (Stable Diffusion)



**A photorealistic image of a
panda wearing the jersey
of Bologna FC and teaching
to a group of very
interested frogs**



A stylish woman walks down a Tokyo street filled with warm glowing neon and animated city signage. She wears a black leather jacket, a long red dress, and black boots, and carries a black purse. She wears sunglasses and red lipstick. She walks confidently and casually. The street is damp and reflective, creating a mirror effect of the colorful lights. Many pedestrians walk about. *SORA – OpenAI*

Multimodal Large Language Models (MLLMs)

User: What is funny about this image?



GPT-4: The humor in this image comes from the absurdity of plugging a large, outdated VGA connector into a small, modern smartphone charging port.

Visual input example, Extreme Ironing:



LLaVA: Large Language and Vision Assistant

Source: <https://www.barnorama.com/wp-content/uploads/2016/12/03-Confusing-Pictures.jpg>

User
LLaVA

What is unusual about this image?

The unusual aspect of this image is a man ironing clothes on the back of a minivan or van. This is not a typical place to perform this activity, as one would usually iron clothes in a more stationary and safe location, such as a home, using a regular ironing board. The scene depicted in the image is peculiar as it involves a makeshift ironing setup on a vehicle, which can be both unsafe and unconventional. Additionally, it is not clear how the man is able to maintain balance and stability while ironing clothes in such an unstable environment.

User
LLaVA

[Start a new conversation, and clear the history]

What's happening in the scene?

The image depicts a man standing on top of a yellow SUV in a busy city street. He is holding a portable ladder, seemingly ironing clothes while standing on the vehicle. Around the scene, there are other cars, a traffic light, and a fire hydrant. Additionally, there are two other people in the vicinity, one close to the man on the car and another further away. The man on the ladder appears to be attracting attention due to his unconventional choice of ironing his clothes on top of a moving car. The city street around him is bustling with activity, adding to the unique nature of the scene.

User
GPT-4 [32]

What is unusual about this image?

The unusual thing about this image is that a man is ironing clothes on an ironing board attached to the roof of a moving taxi.

User
BLIP-2

Can you explain this meme in detail?
a man is sitting on the back of a yellow cab

User
OpenFlamingo

Can you explain this meme in detail?
The man is drying his clothes on the hood of his car.

Embodied Intelligence

Computer Vision + LLMs + Humanoid Robotics



NVIDIA Isaac Robotics Platform (Computer Vision, GROOT,...), March 2024

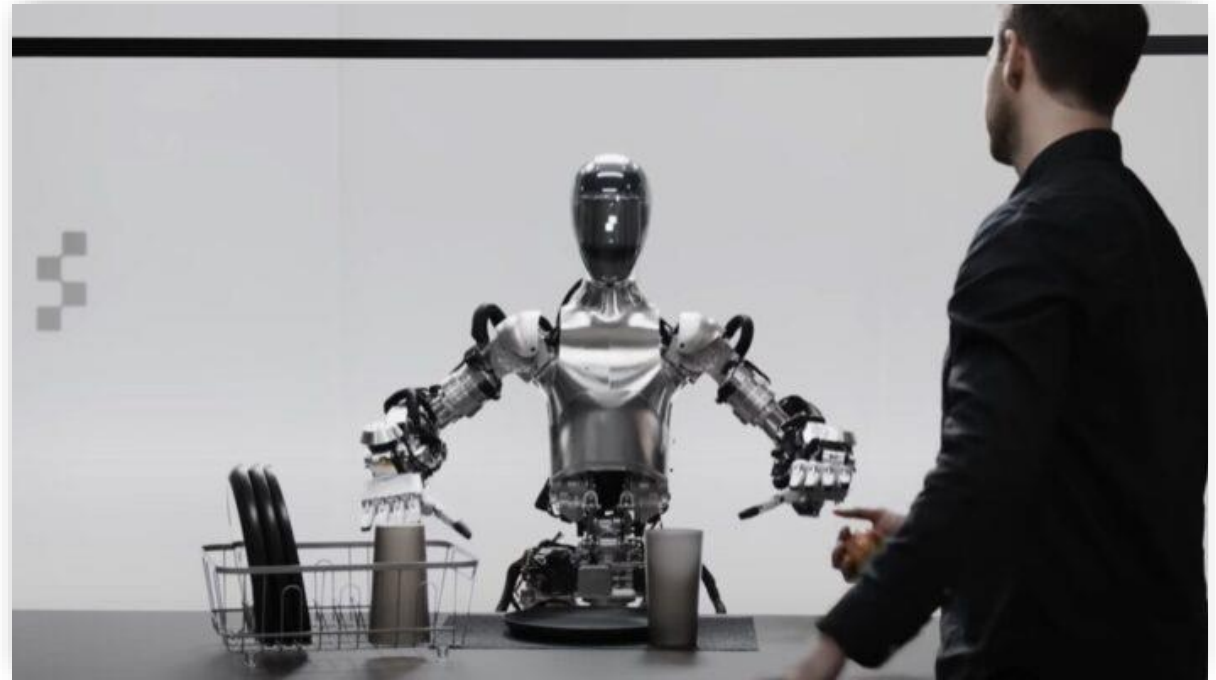


Figure AI + OpenAI
<https://www.figure.ai>