



ALMA MATER STUDIORUM  
UNIVERSITÀ DI BOLOGNA

# Introduction

2025/2026 Computer Vision And Image Processing M — University of Bologna

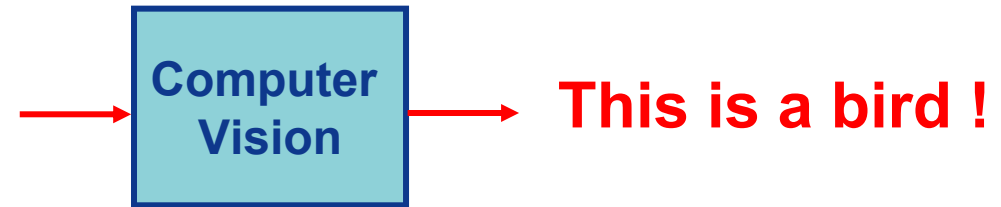
Corso: Computer Vision and Image Processing M - Image Processing and Computer Vision M | Virtuale)

**Luigi Di Stefano ([luigi.distefano@unibo.it](mailto:luigi.distefano@unibo.it))**

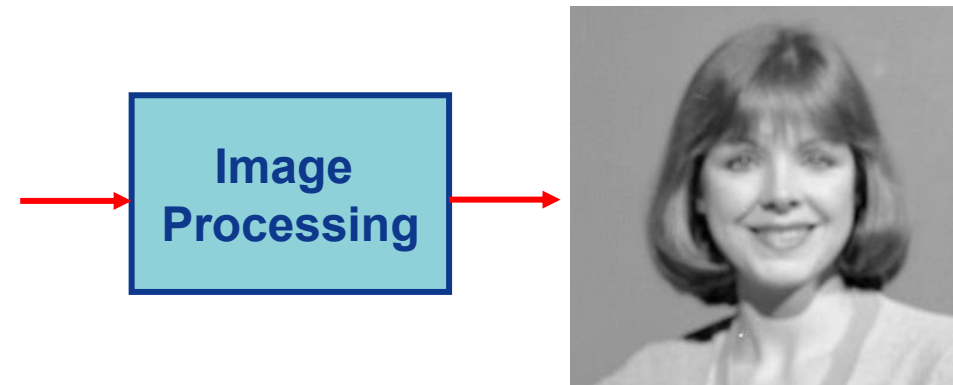
**Department of Computer Science and Engineering (DISI)  
University of Bologna, Italy**

# Computer Vision vs. Image Processing

**Computer Vision** deals with extraction of information from images

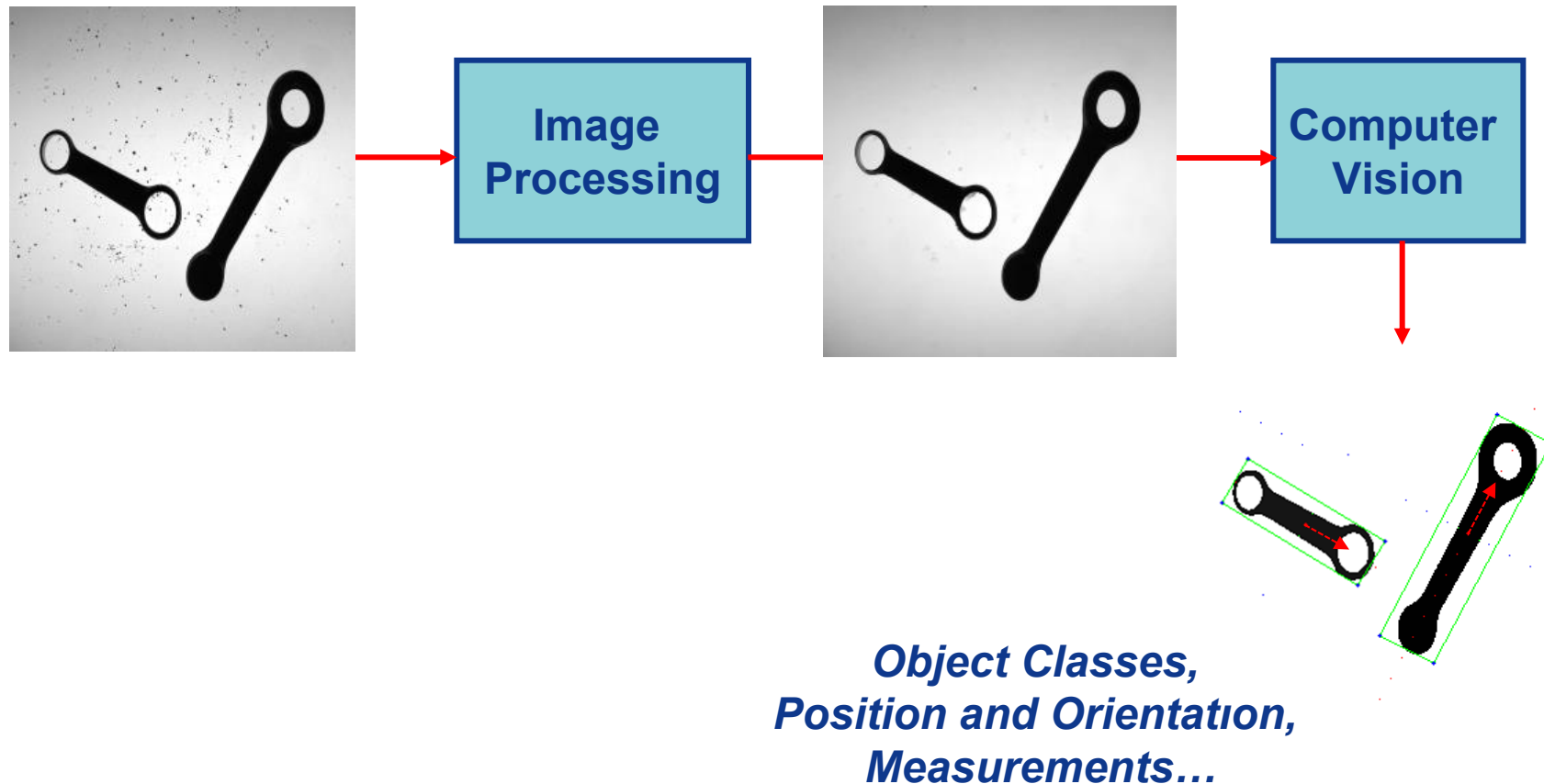


**Image Processing** aims at improving the quality of images



# Computer vision & Image Processing

Quite often Image Processing helps Computer Vision



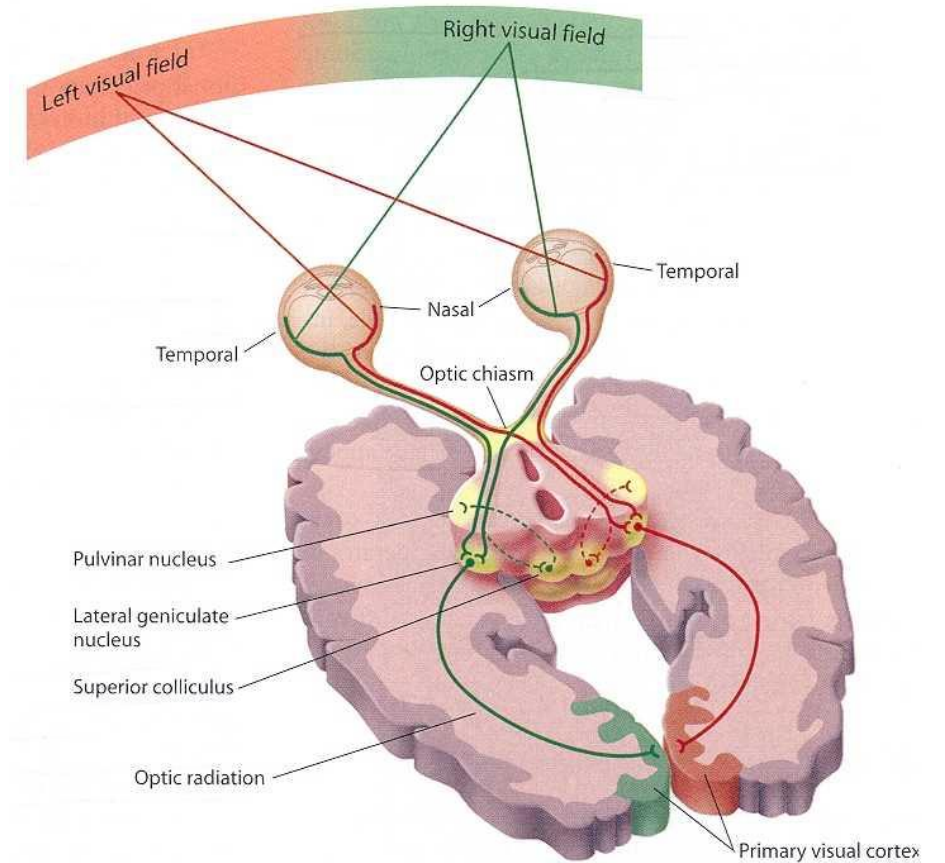
# Why studying this stuff ?



**Countless applications  
in many diverse fields !**

**ENG**

**Computer  
Vision**



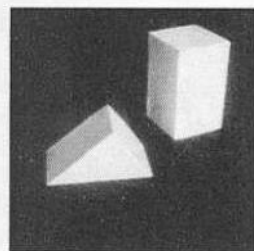
**BIO**

# Quite a successful journey !

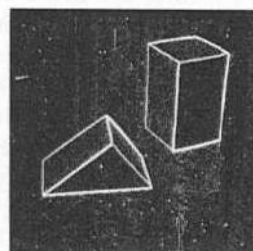
*“the block world”*



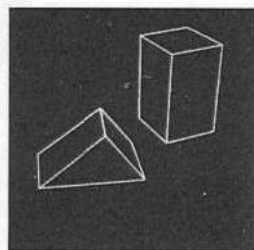
a)



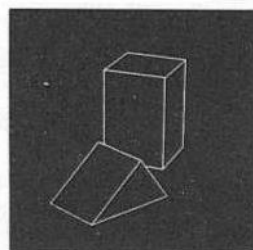
b)



c)



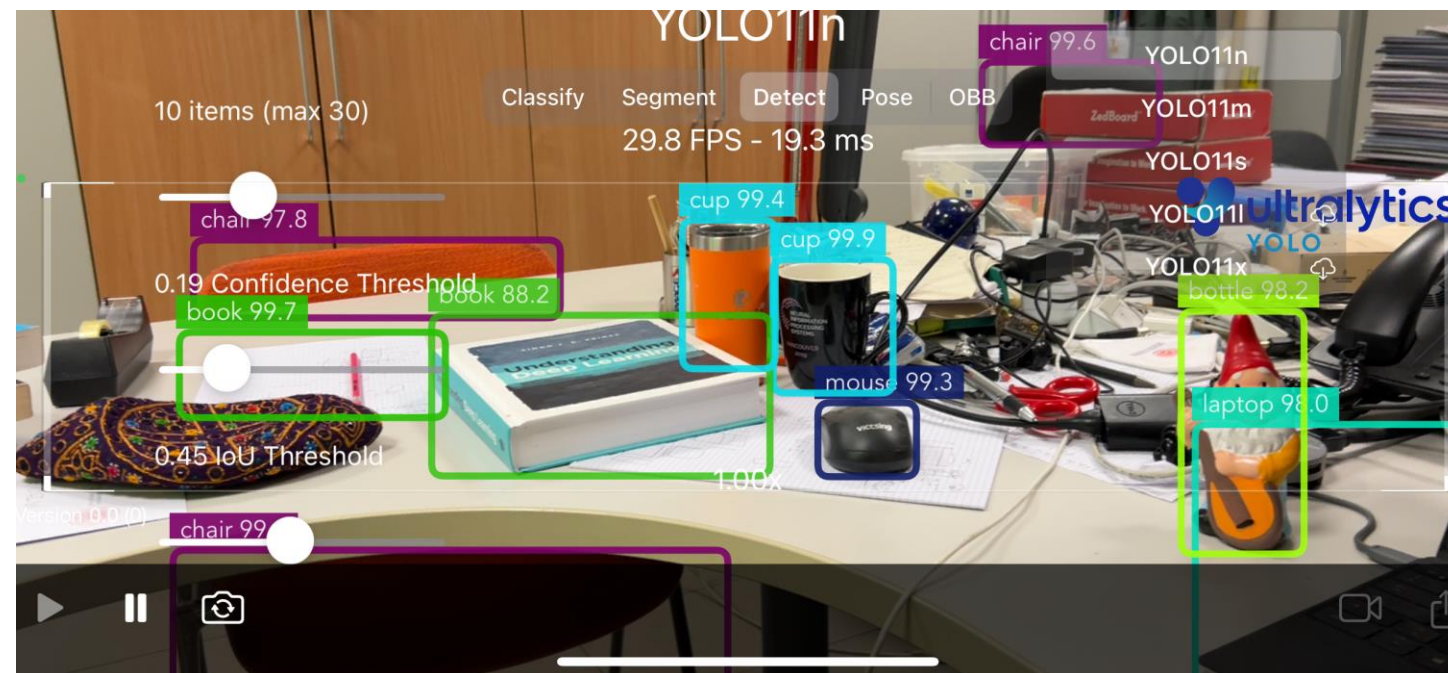
d)



e)

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

*“anything anywhere”*



Ultralytics Hub - YOLO11 (App Store, Google Play)



# Massive and highly influential research



## ★ Top publications

Top cited publications over the last five years



Publication	h5-index	h5-median
1. Nature	490	784
2. IEEE/CVF Conference on Computer Vision and Pattern Recognition	450	702
3. The New England Journal of Medicine	441	854
4. Science	415	653
5. Nature Communications	399	509
6. The Lancet	375	712
7. Neural Information Processing Systems	371	637
8. International Conference on Learning Representations	362	652
9. Advanced Materials	330	440
10. Cell	317	528

# Key Process Technology in all Industries

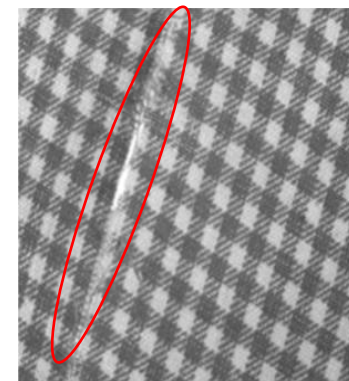


**Cognex DataMan  
(1982)**

**Automotive**



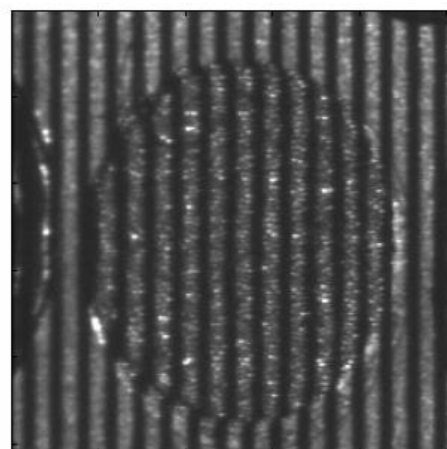
**Textile**



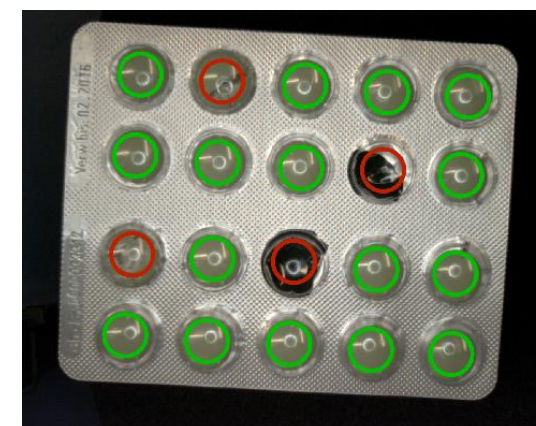
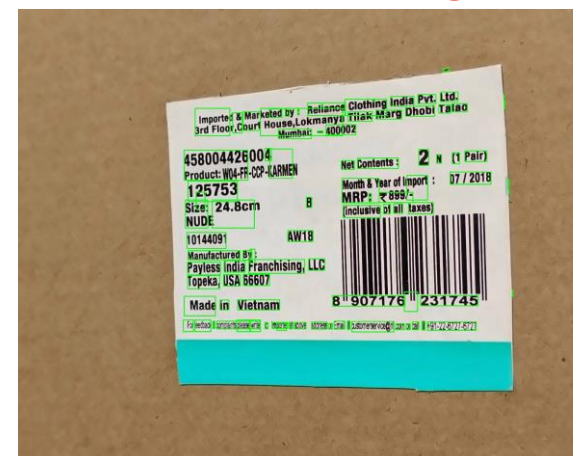
**Food&Bevarage**



**Electronics**



**Transportation & Logistics**



**Pharma & Tobacco**

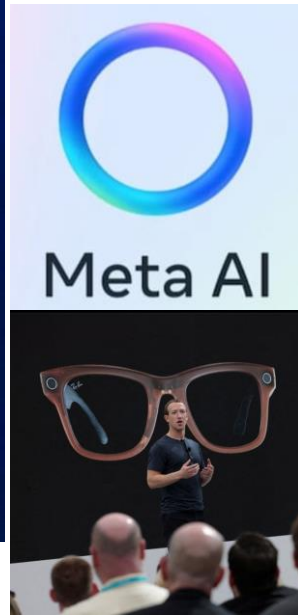
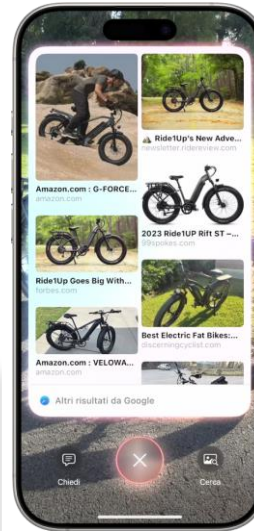
Inspection, Gauging,  
Guidance, *Tracing*,  
*Compliance*, *Monitoring*



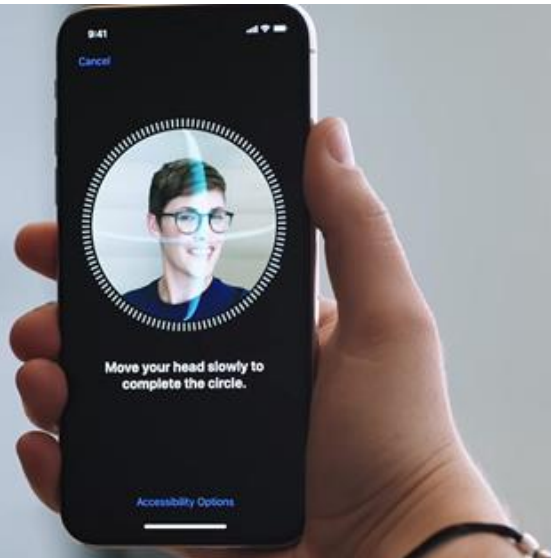
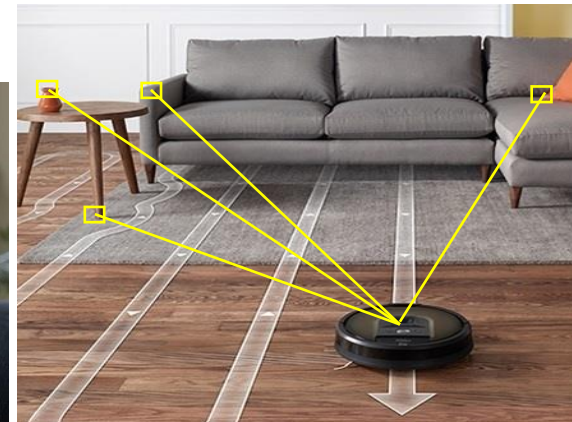
Process Optimization



# Mass-Market Consumer Products



Google





# Key Process Technology in all Industries

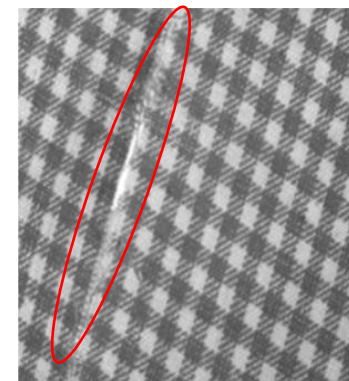


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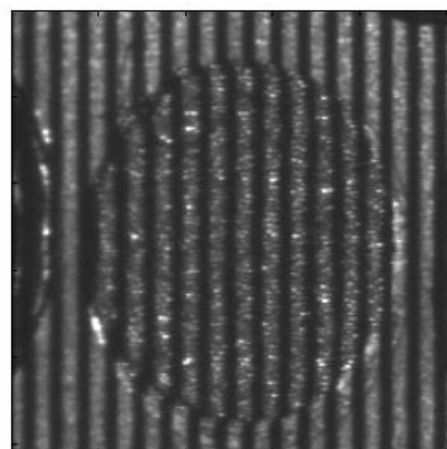
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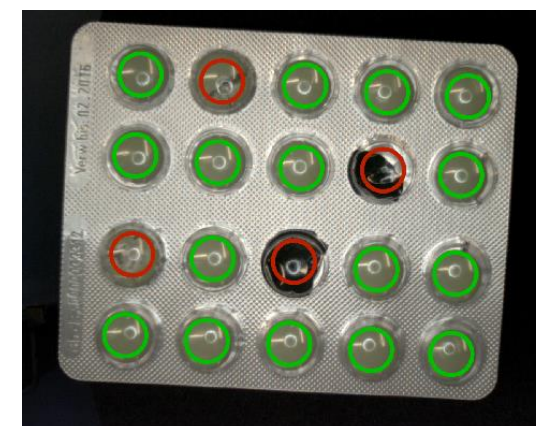
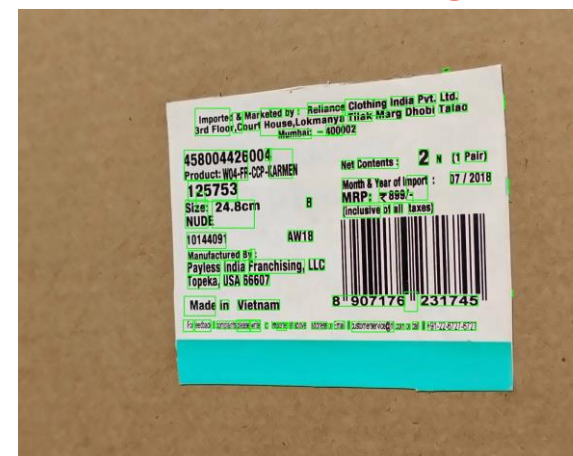
**Food&Bevarage**



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**Transportation & Logistics**



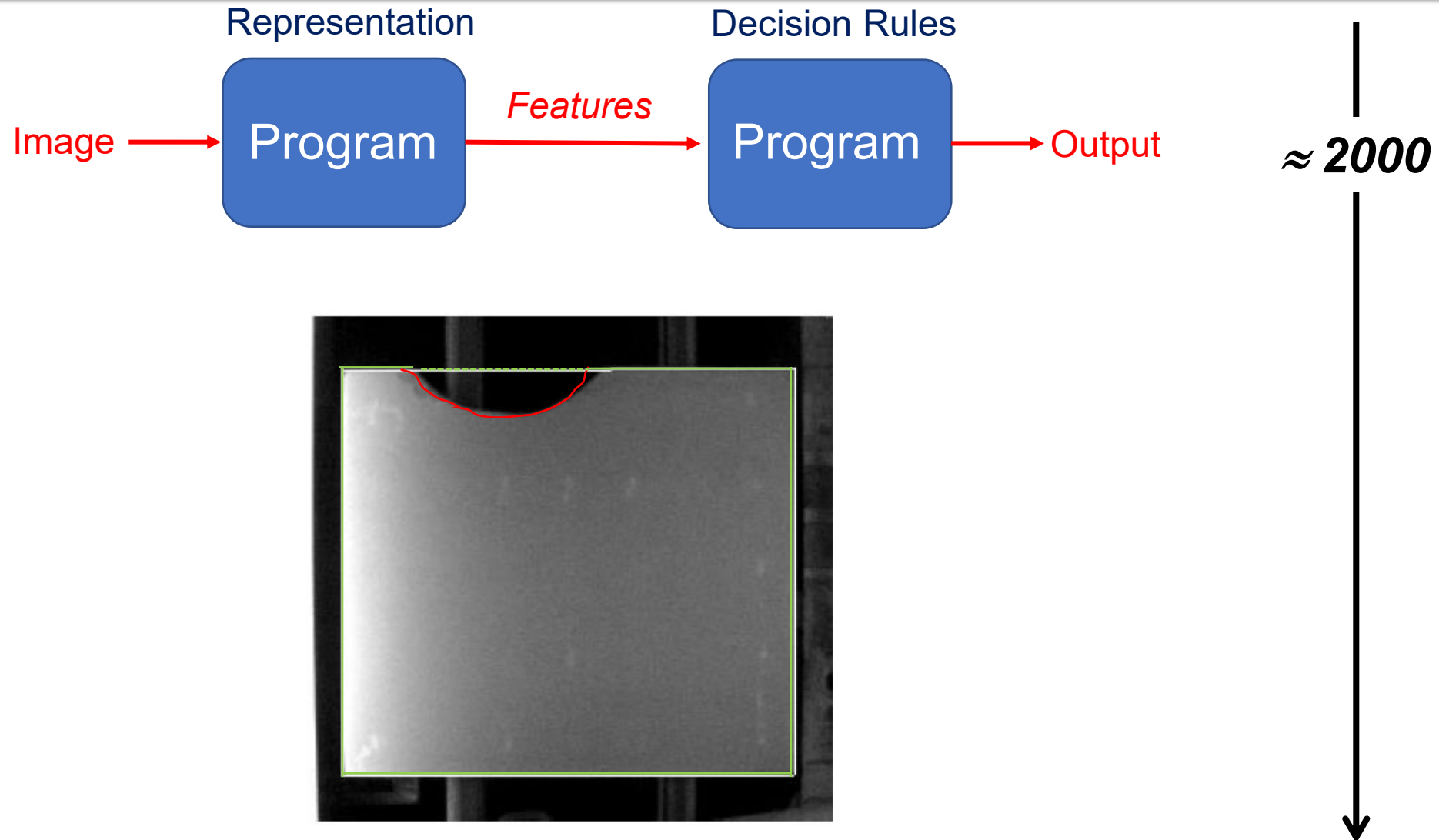
**Pharma & Tobacco**

Inspection, Gauging,  
Guidance, *Tracing*,  
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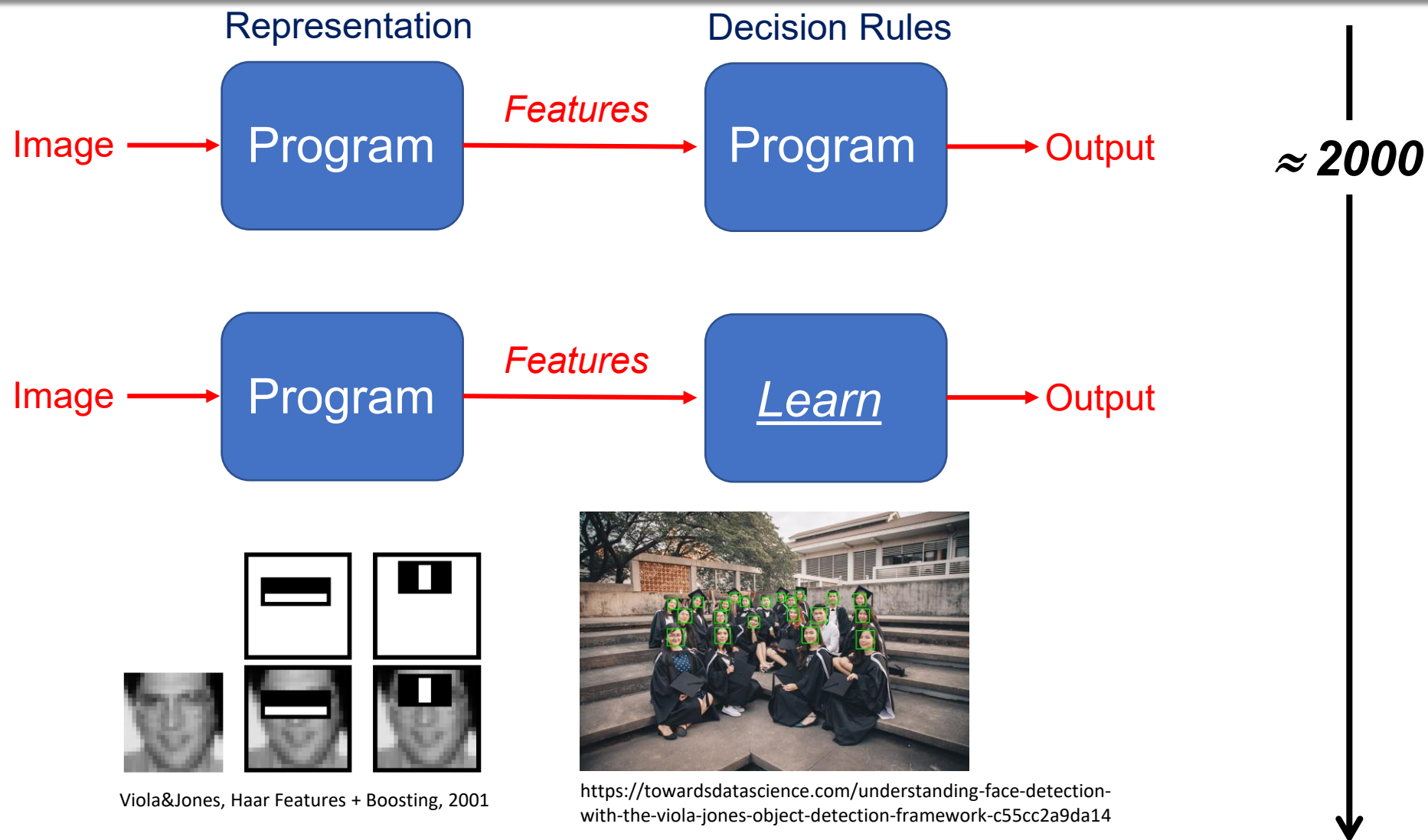


Process Optimization

# Paradigms and Timeline

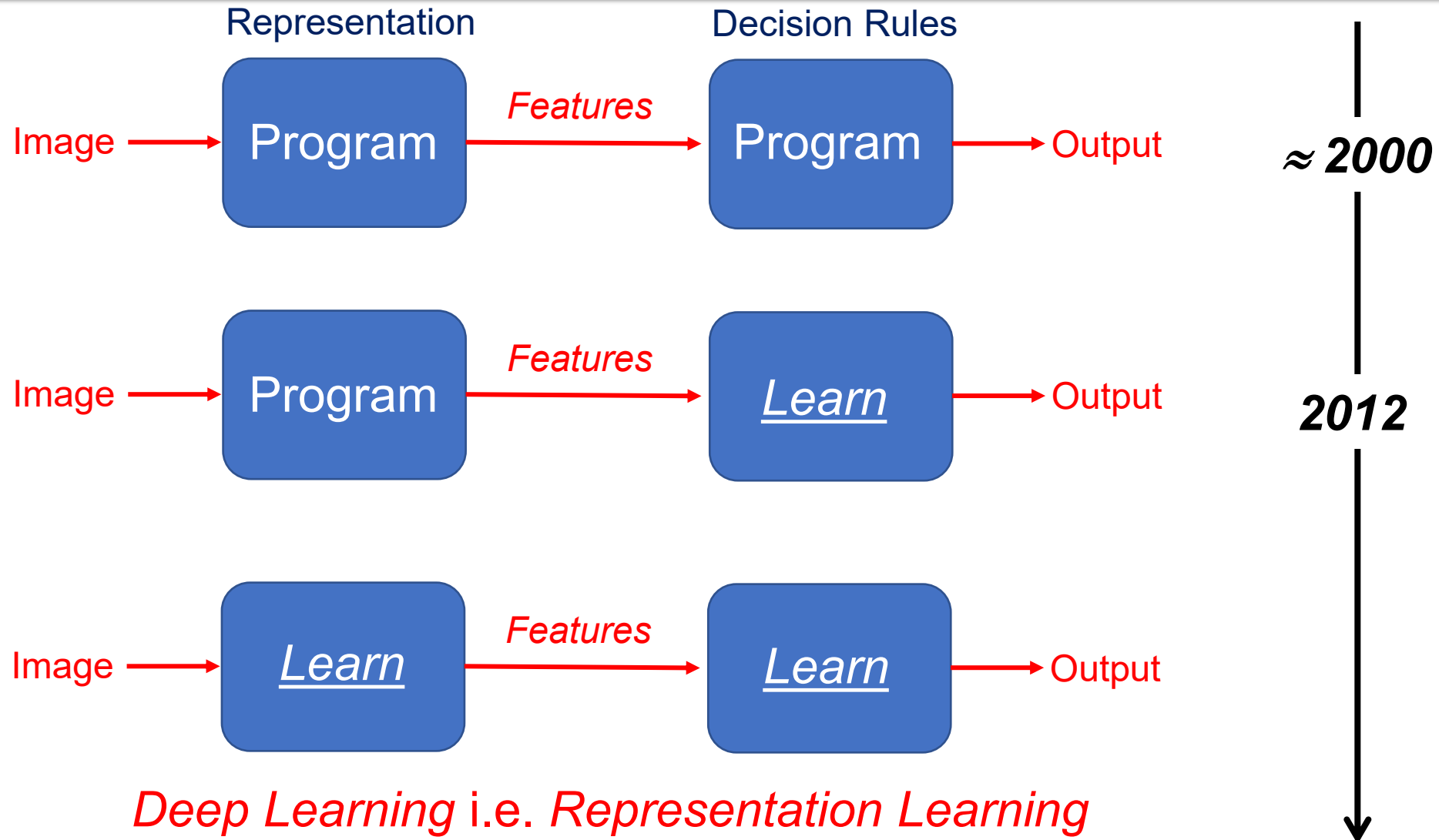


# Paradigms and Timeline

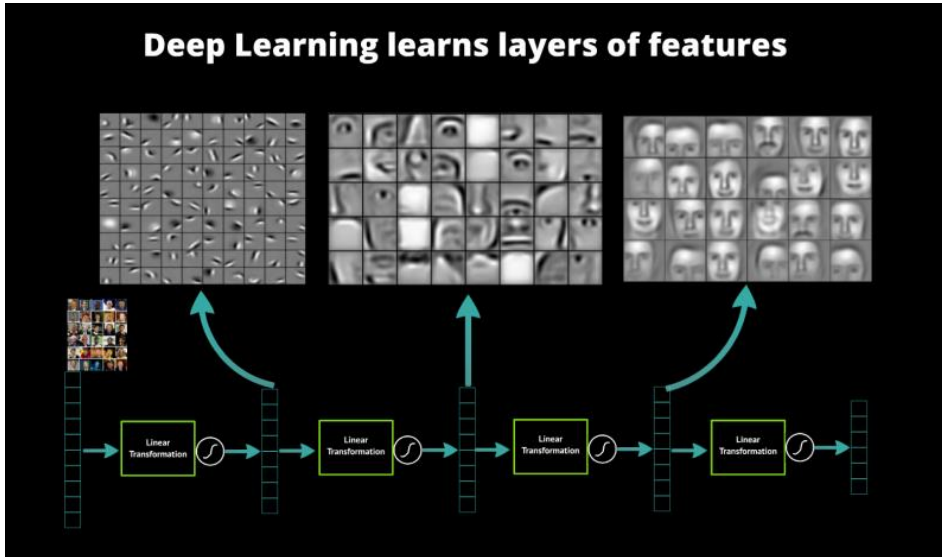




# Paradigms and Timeline

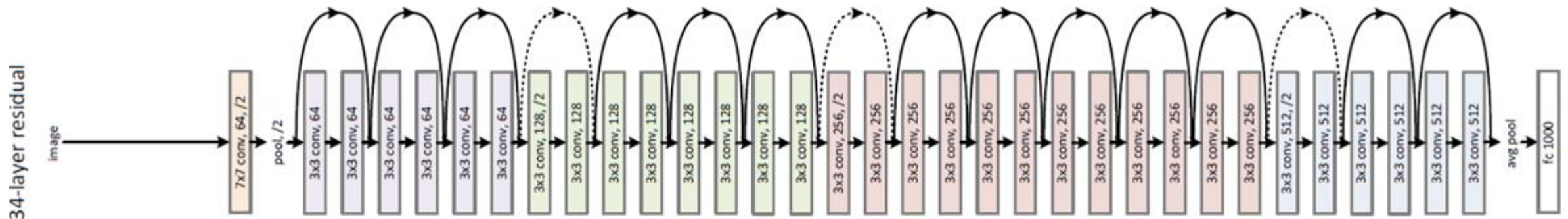


# Deep Convolutional Neural Networks...and *beyond*



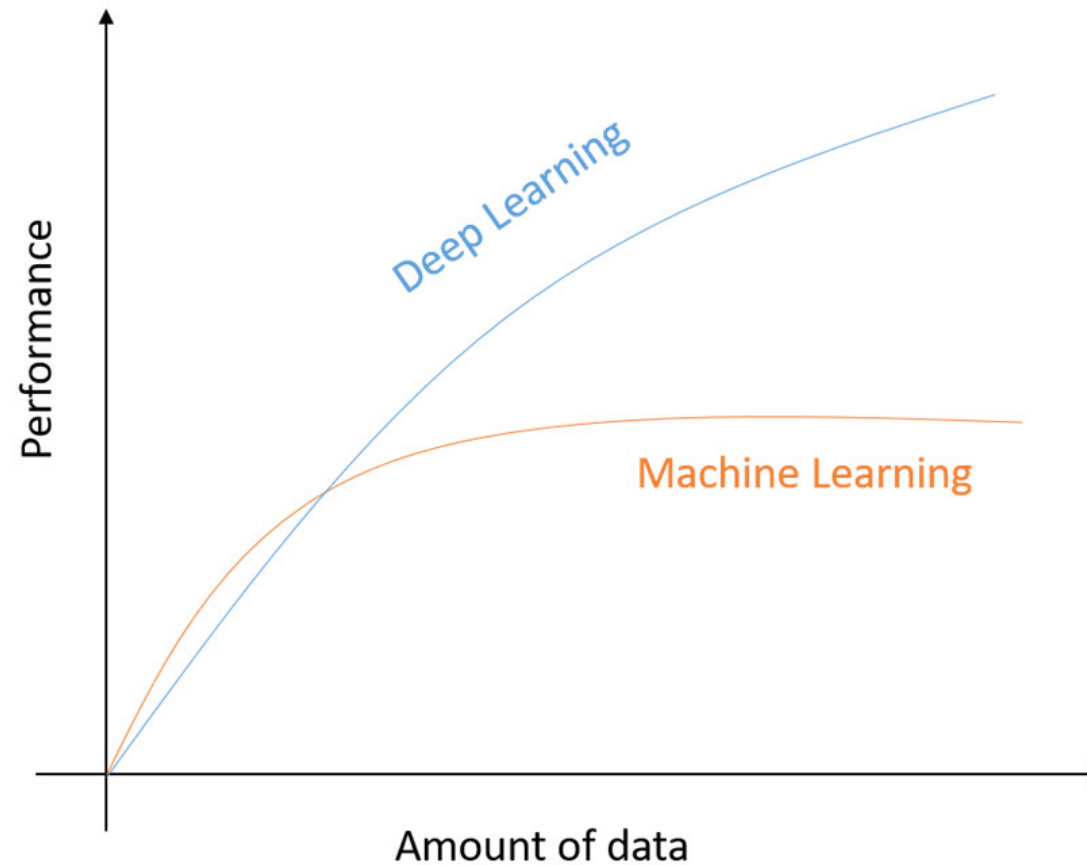
Credits: <https://www.datasciencecentral.com/a-primer-on-deep-learning/>

- 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



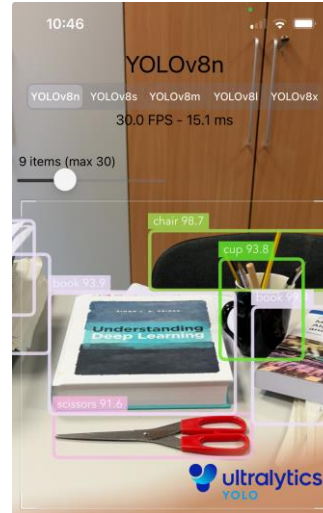


# Deep Learning for Computer Vision

## Image Classification



## Lane Detection



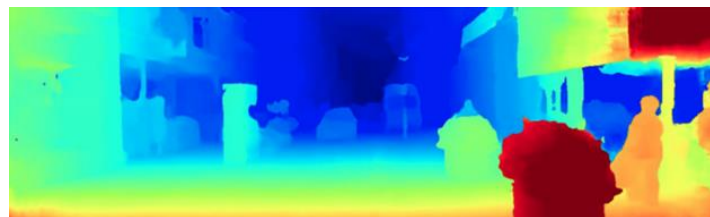
## Object Detection and Instance-Part Segmentation



## Semantic Segmentation



## Depth Estimation (Stereo, Monocular)



## Face Recognition





# Deep Learning (AI) ?

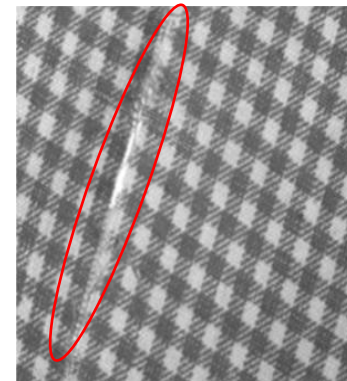


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(1982)**

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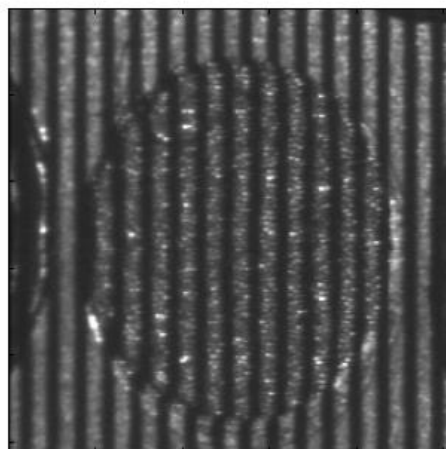
**Textile**



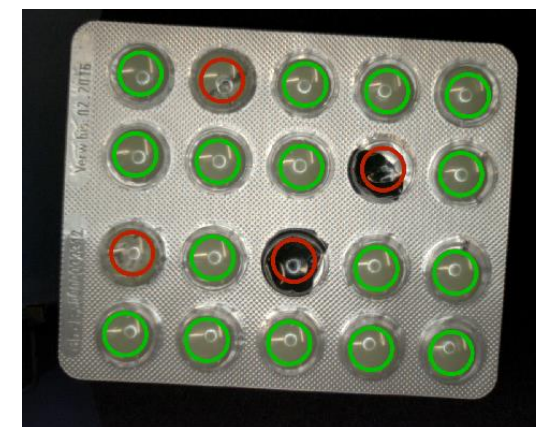
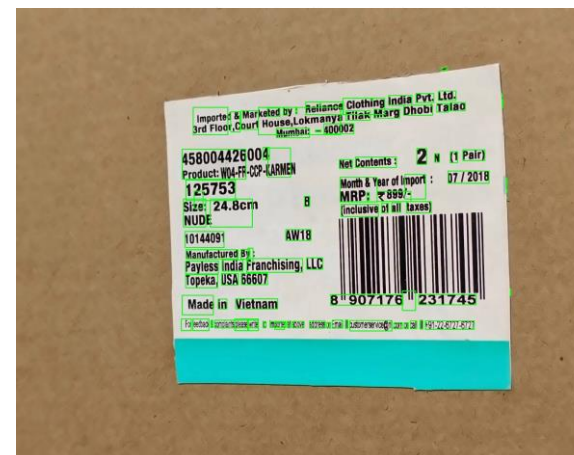
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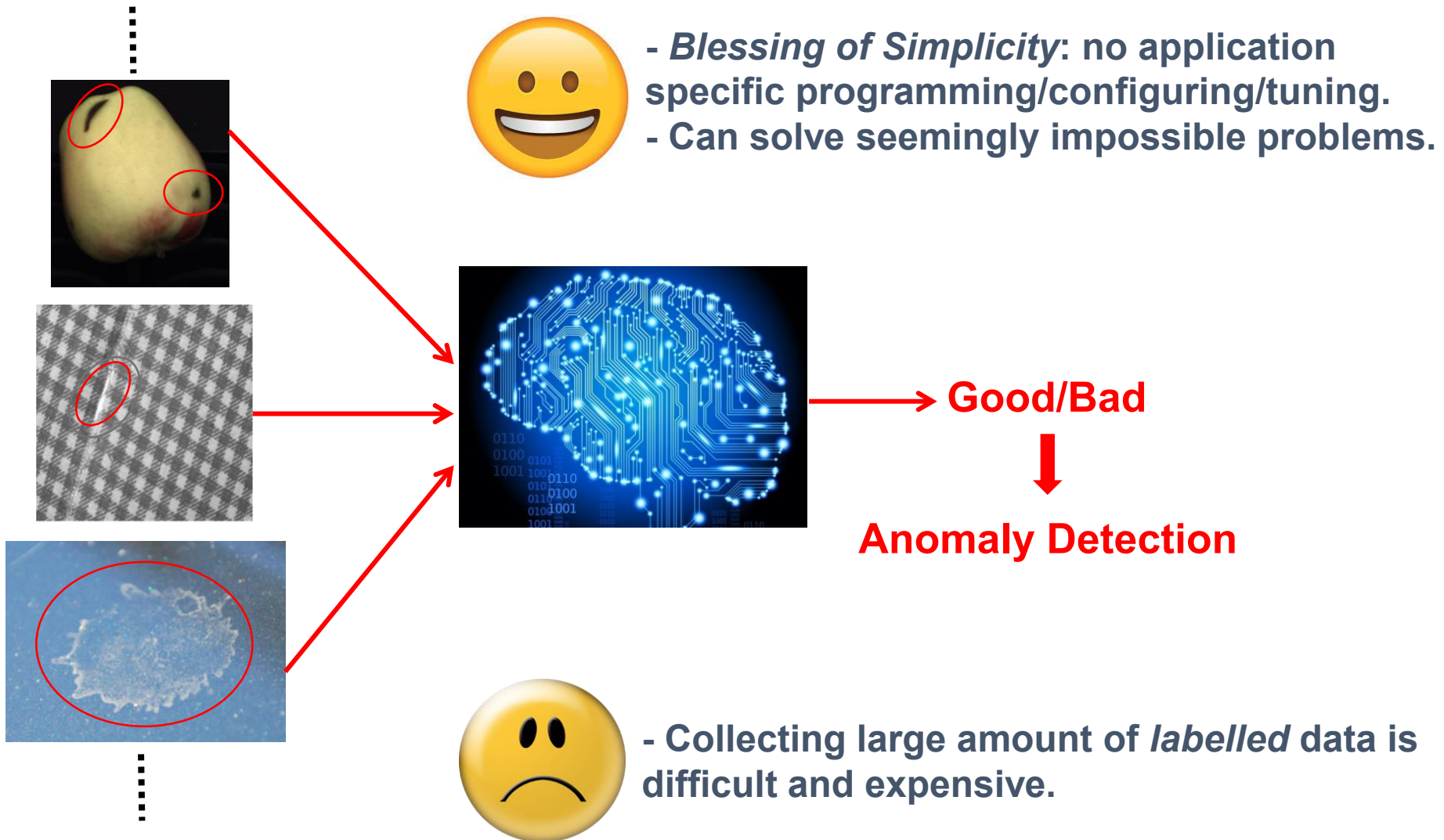
**Pharma & Tobacco**

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



**Process Optimization**

# It's happening



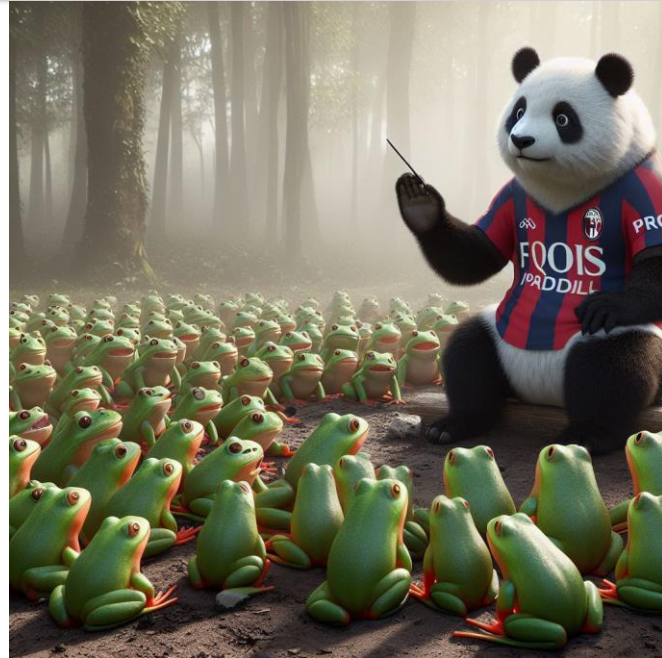


# New Generative Tasks

*DALL·E 3 (Bing)*

DDPM aka Diffusion  
Models, 2020

Latent Diffusion Models,  
2022 (Stable Diffusion)



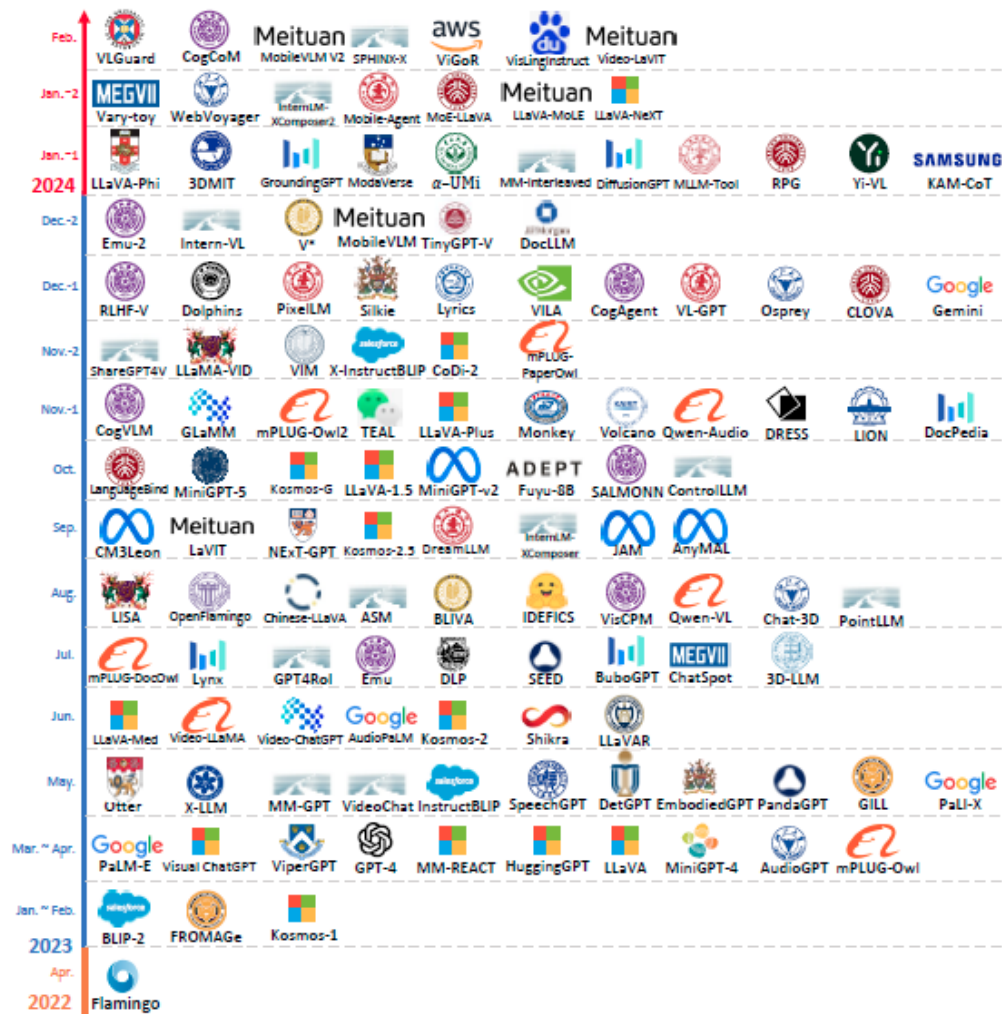
**A photorealistic image of a panda wearing the jersey of Bologna FC and teaching to a group of very interested frogs**



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***



# MLLMs (Multimodal Large Language Models)



Timeline of MLLMs

(<https://arxiv.org/pdf/2401.13601>)

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.

[Start a new conversation, and clear the history]

User  
LLaVA

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

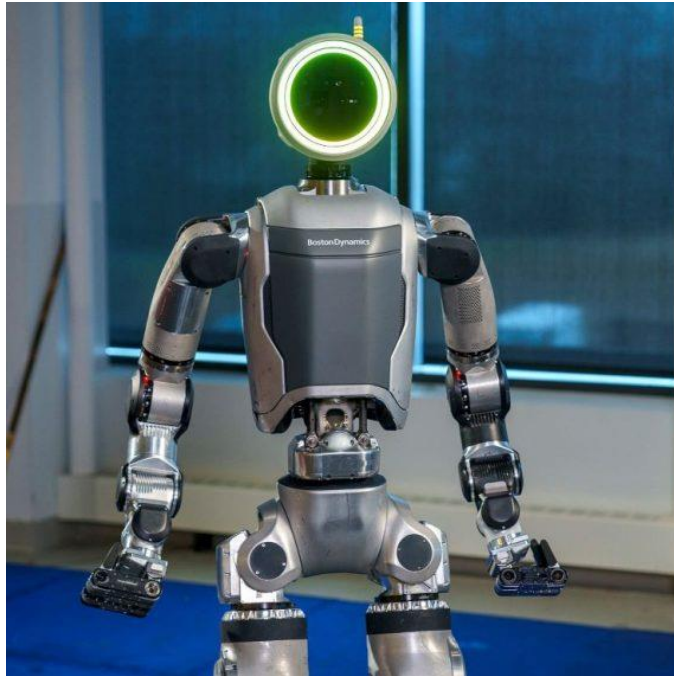
User  
OpenFlamingo

Can you explain this meme in detail?

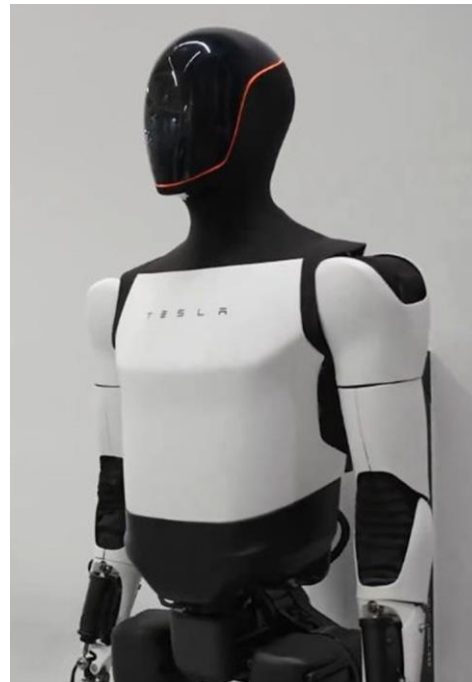
The man is drying his clothes on the hood of his car.

# Embodied Intelligence

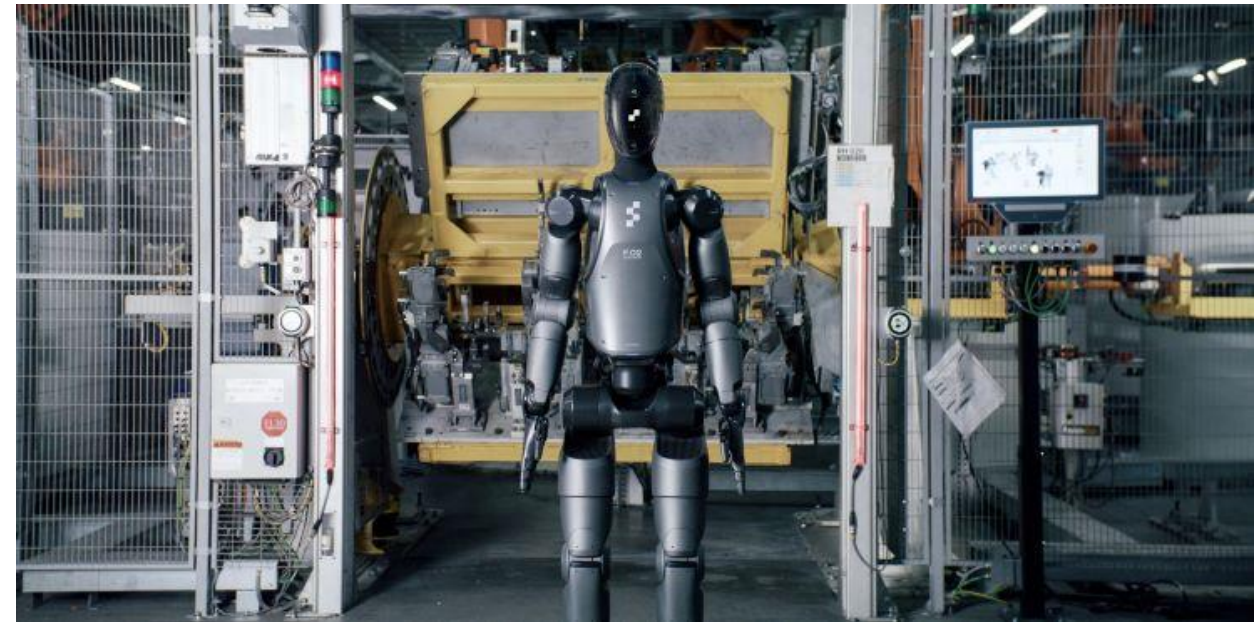
## Computer Vision + LLMs + Humanoid Robotics



**Electric Atlas**  
**Boston Dynamics**



**Optimus Gen 2**  
**Tesla**



**Figure 02 – Figure AI**  
<https://www.figure.ai>