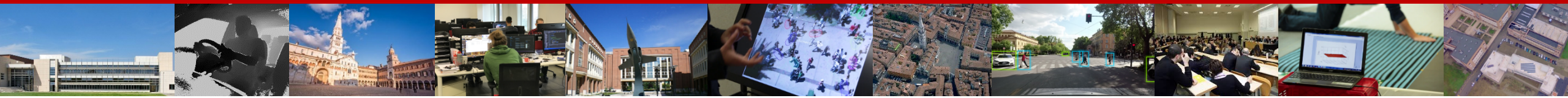
Applicazioni dell'Intelligenza Artificiale: le tecnologie Machine Learning e Deep Learning"



Simone Calderara

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University of Modena and Reggio Emilia, Italy

UNIMORE
UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

AI academy

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A Glossary of Artificial-Intelligence Terms

ARTIFICIAL INTELLIGENCE

AI is the broadest term, applying to any technique that enables computers to mimic human intelligence, using logic, if-then rules, decision trees, and machine learning (including deep learning).

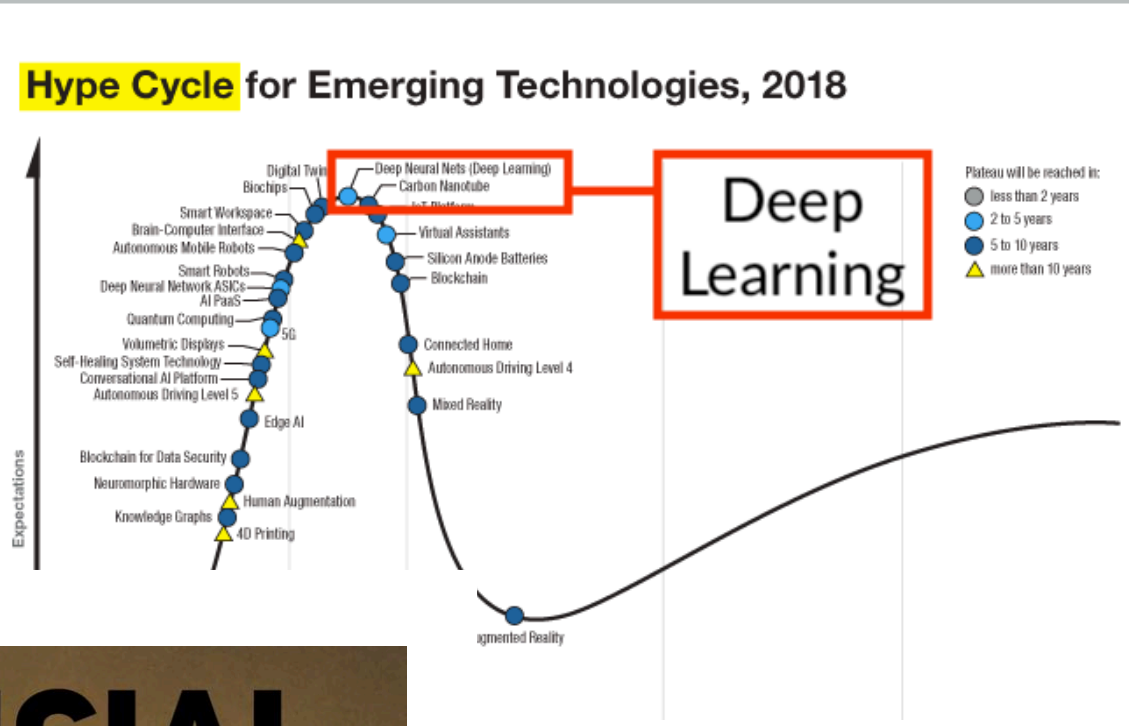
MACHINE LEARNING

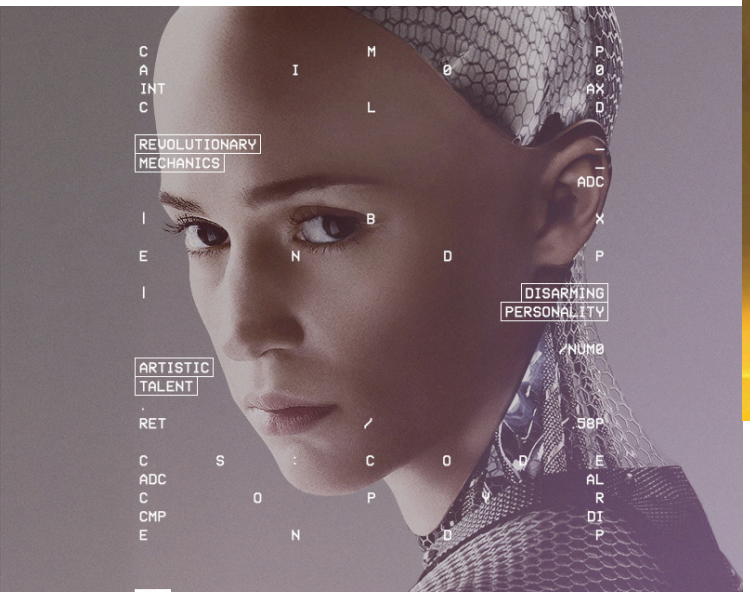
The subset of AI that includes abstruse statistical techniques that enable machines to improve at tasks with experience. The category includes deep learning.

DEEP LEARNING

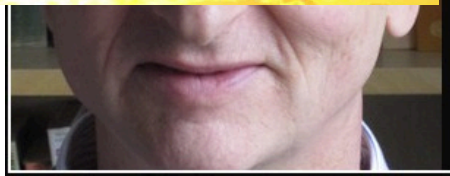
The subset of machine learning composed of algorithms that permit software to train itself to perform tasks, like speech and image recognition, by exposing **multilayered neural networks to vast** amounts of data.

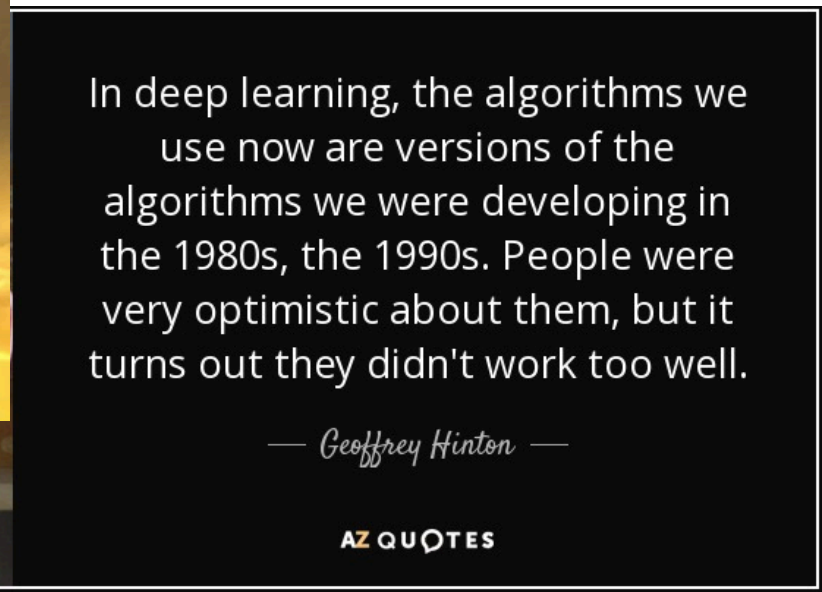

AI is a fundamental risk to the existence of human civilisation.
Elon Musk, CEO of Tesla and SpaceX


Hype Cycle for Emerging Technologies, 2018
Deep Learning
Digital Twin
Biochips
Smart Workspace
Brain-Computer Interface
Autonomous Mobile Robots
Smart Robots
Deep Neural Network ASICs
AI PaaS
Quantum Computing
Volumetric Displays
Self-Healing System Technology
Conversational AI Platform
Autonomous Driving Level 5
Blockchain for Data Security
Neuromorphic Hardware
Knowledge Graphs
Edge AI
Human Augmentation
4D Printing
5G
Deep Neural Nets (Deep Learning)
Carbon Nanotube
Virtual Assistants
Silicon Anode Batteries
Blockchain
Connected Home
Autonomous Driving Level 4
Mixed Reality
Expectations
Plateau will be reached in:
less than 2 years
2 to 5 years
5 to 10 years
more than 10 years

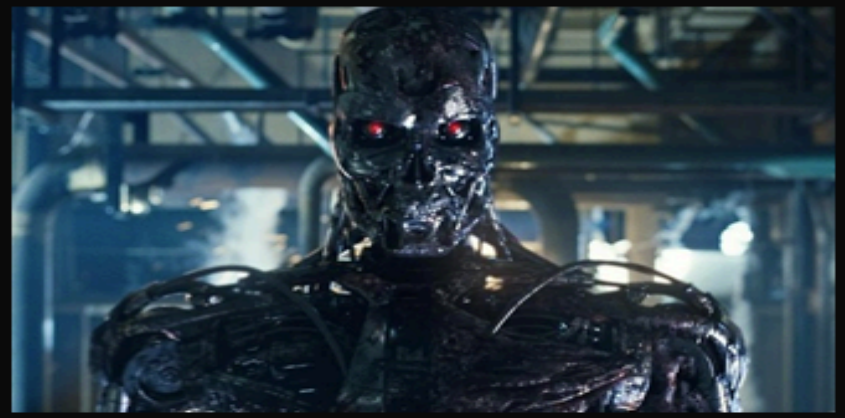

REVOLUTIONARY MECHANICS
DISARMING PERSONALITY
ARTISTIC TALENT


"ARTIFICIAL INTELLIGENCE IS THE NEW ELECTRICITY."
-ANDREW NG

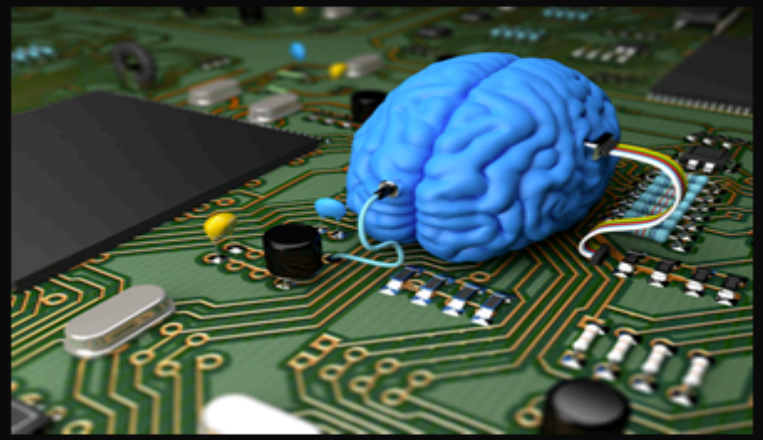



In deep learning, the algorithms we use now are versions of the algorithms we were developing in the 1980s, the 1990s. People were very optimistic about them, but it turns out they didn't work too well.
— Geoffrey Hinton —
AZ QUOTES

Deep Learning

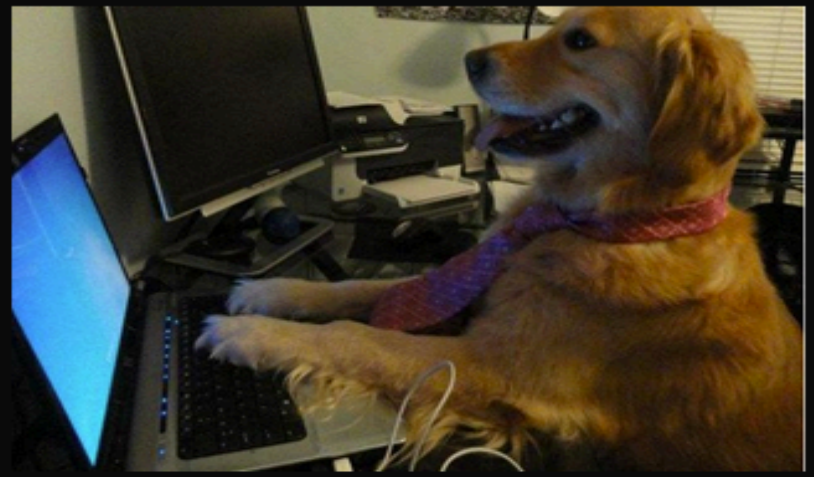


What society thinks I do



What my friends think I do

What other computer scientists think I do



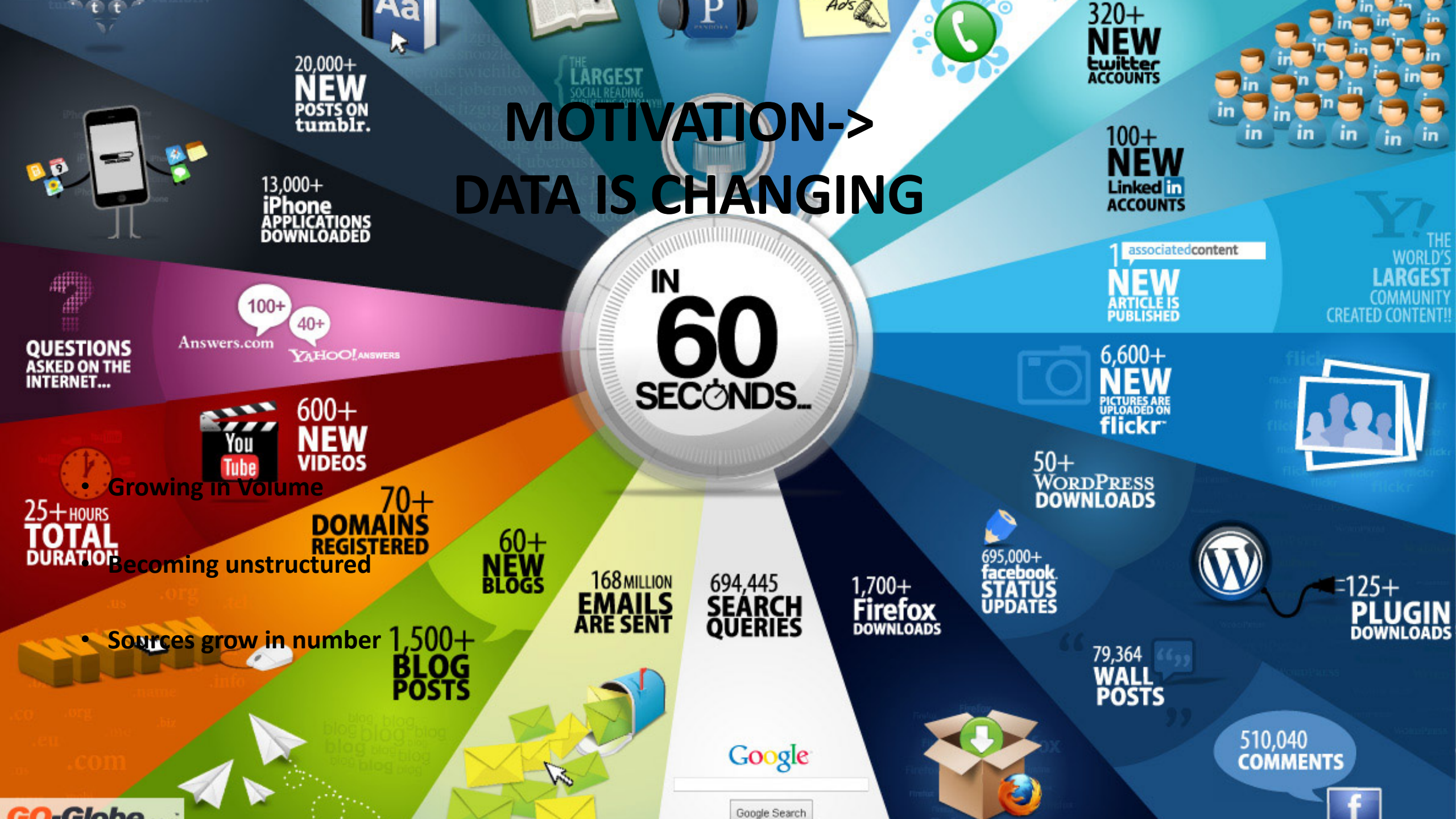
What mathematicians think I do

What I think I do

```
from theano import *
```

What I actually do

MOTIVATION->
DATA IS CHANGING



- Growing in Volume
- Becoming unstructured
- Sources grow in number

New massive applications

Data Security
Malware is a huge — and growing — problem. In 2014, Kaspersky Lab said it had detected 325,000 new malware files *every day*. But, institutional intelligence company Deep Instinct says that each piece of new malware tends to have almost the same code as previous versions — only between 2 and 10% of the files change from iteration to iteration.

Financial Trading
machine learning algorithms are getting closer all the time. Many prestigious trading firms use proprietary systems to predict and execute trades at high speeds and high volume. Many of these rely on probabilities.

Healthcare
Machine learning algorithms can process more information and spot more patterns than their human counterparts.
The more you can understand about your customers, the better you can serve them, and the more you will sell.

Fraud Detection
Machine learning is getting better and better at spotting potential cases of fraud across many different fields. PayPal, for example, is using machine learning to fight money laundering. The company has tools that compare millions of transactions and can precisely distinguish between legitimate and fraudulent transactions between buyers and sellers.

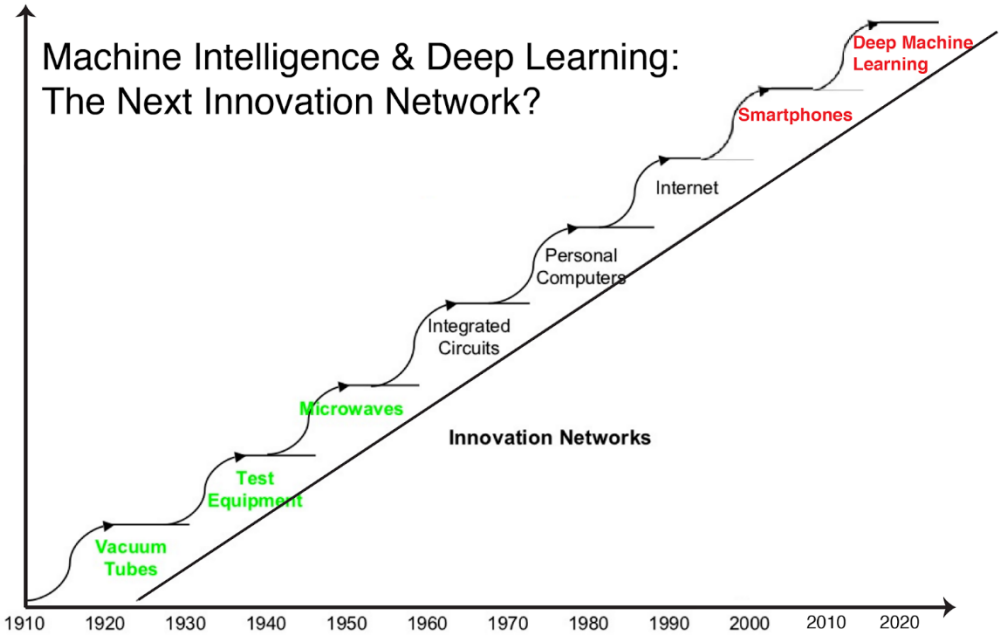
Recommendations
Services like Amazon or Netflix. Intelligent machine learning algorithms analyze your activity and compare it to the millions of other users to determine what you might like to buy or binge watch next.

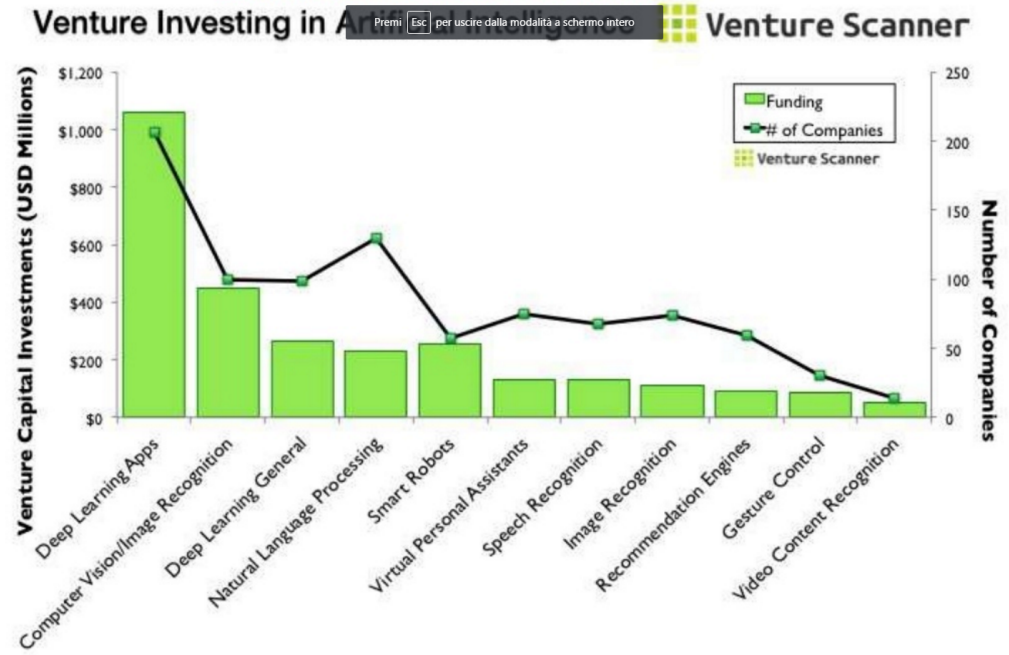
Online Search
Perhaps the most famous use of machine learning, Google and its competitors are constantly improving what the search engine understands.

Natural Language Processing (NLP)
Machine learning algorithms with natural language can stand in for customer service agents and more quickly route customers to the information they need.

Smart Cars
IBM recently surveyed top auto executives, and 74% expected that we would see smart cars on the road by 2025.

Investments in the Deep Learning Trend





From The Futures Agency - Silicon Valley Innovations Timeline

What is Machine Learning?

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Types of Learning

Supervised (inductive) learning

Training data includes desired outputs

Unsupervised learning

Training data does not include desired outputs

Semi-supervised learning

Training data includes a few desired outputs

Reinforcement learning

Rewards from sequence of actions

Supervised vs. unsupervised Learning

Supervised learning: classification is seen as supervised learning from examples.

Supervision: The data (observations, measurements, etc.) are **labeled with pre-defined classes**. It is like that a “teacher” gives the classes (supervision).

Test data are classified into these classes too.

Unsupervised learning (clustering)

Class labels of the data are **unknown**

Given a set of data, the task is to establish the existence of classes or clusters in the data

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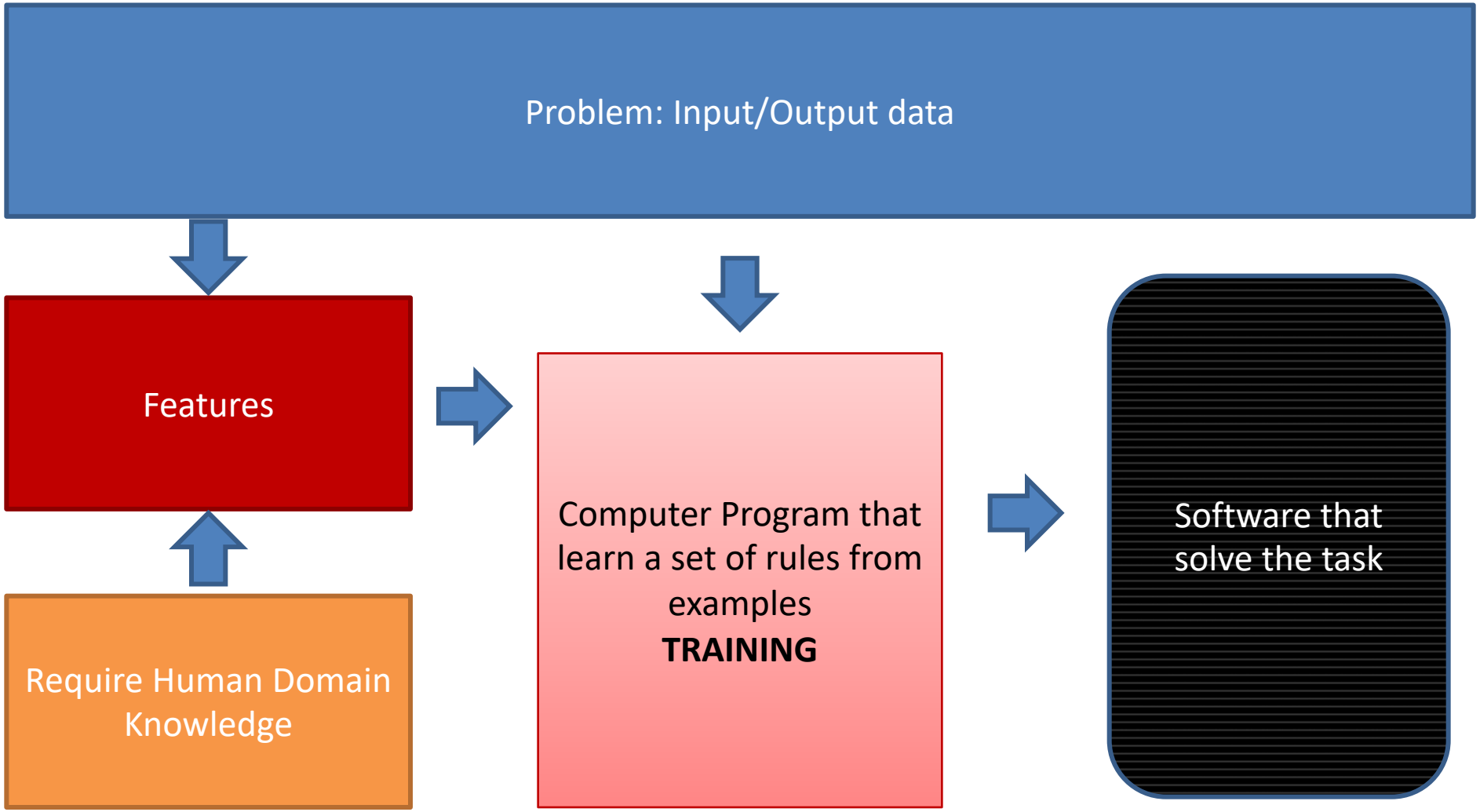
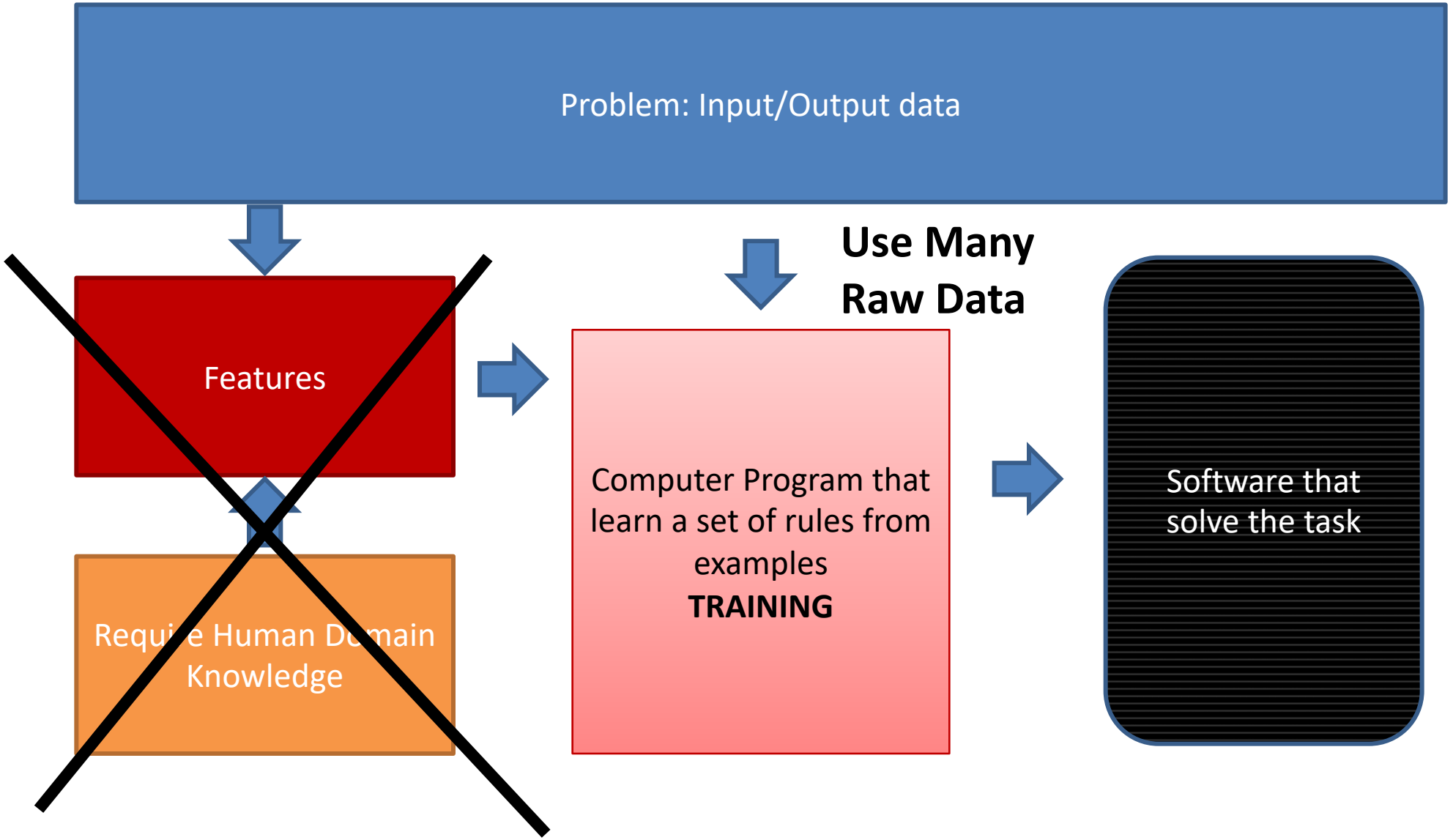
Learning Pipeline



Innovation of Deep Learning



Much more Data are needed: OCR Example

Tesseract Google OCR

- 800 Chars needed for Training
- Avg Trainig Time 10 minutes
- Core i7 PC NO GPU

Deep Neural Network

- 5000 chars needed for Training
- Avg Training time 30 minutes
- Core i7 PC + NVIDIA GPU CARD

Technology	Accuracy
Tesseract eng language	40%
Tesseract trained language	60%
DEEP neural network(NN)	**98%**

DEMO code @
http://christopher5106.github.io/computer/vision/2015/09/14/comparing-tesseract-and-deep-learning-for-ocr-optical-character-recognition.html

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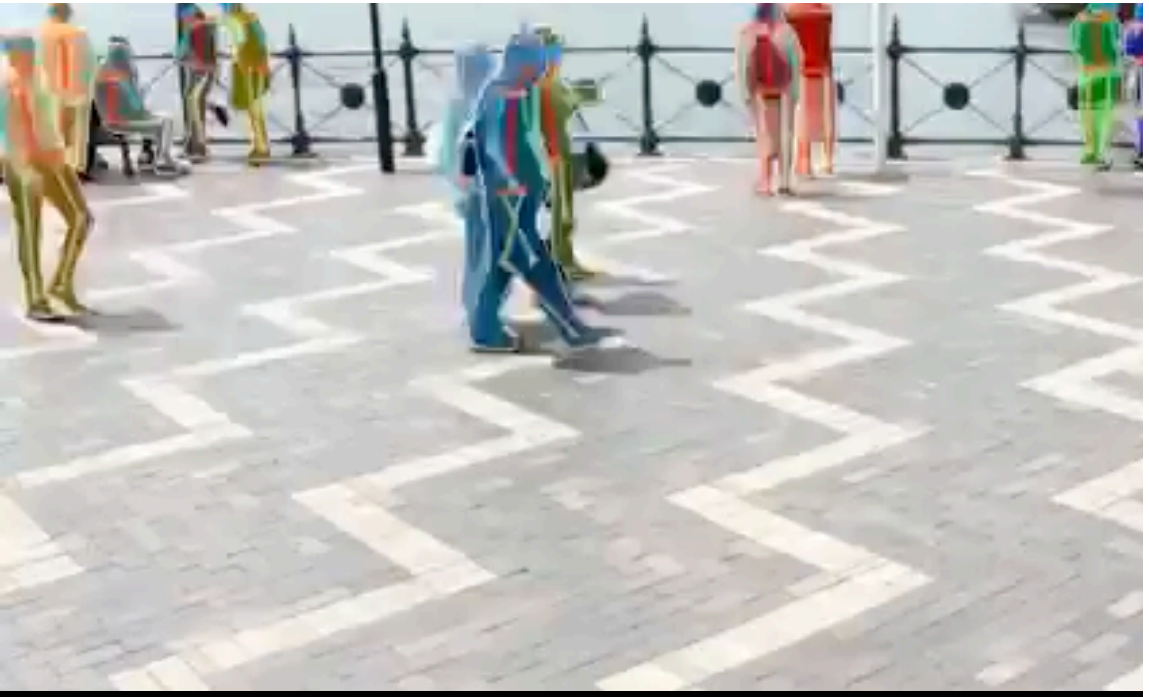
Deep Networks For:

Numerical Data -> Deep Neural Network
Applications: Production management, Prediction, Controls and Robotics

Multimedia Data-> Convolutional Network
Applications: Image and Video classification, Face recognition, Licence Plate Detection, OCRs..

Time series -> Recurrent Neural Network
Applications: Financial Analysis, Audio and Speech analysis, Text analysis and traslation, Forecasting

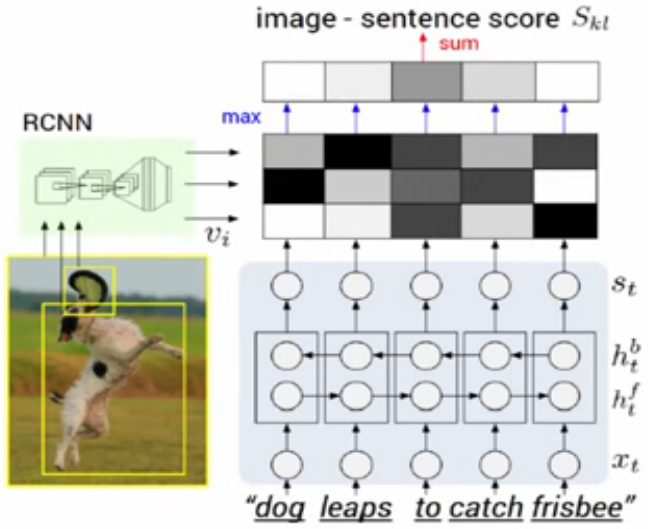
Show time

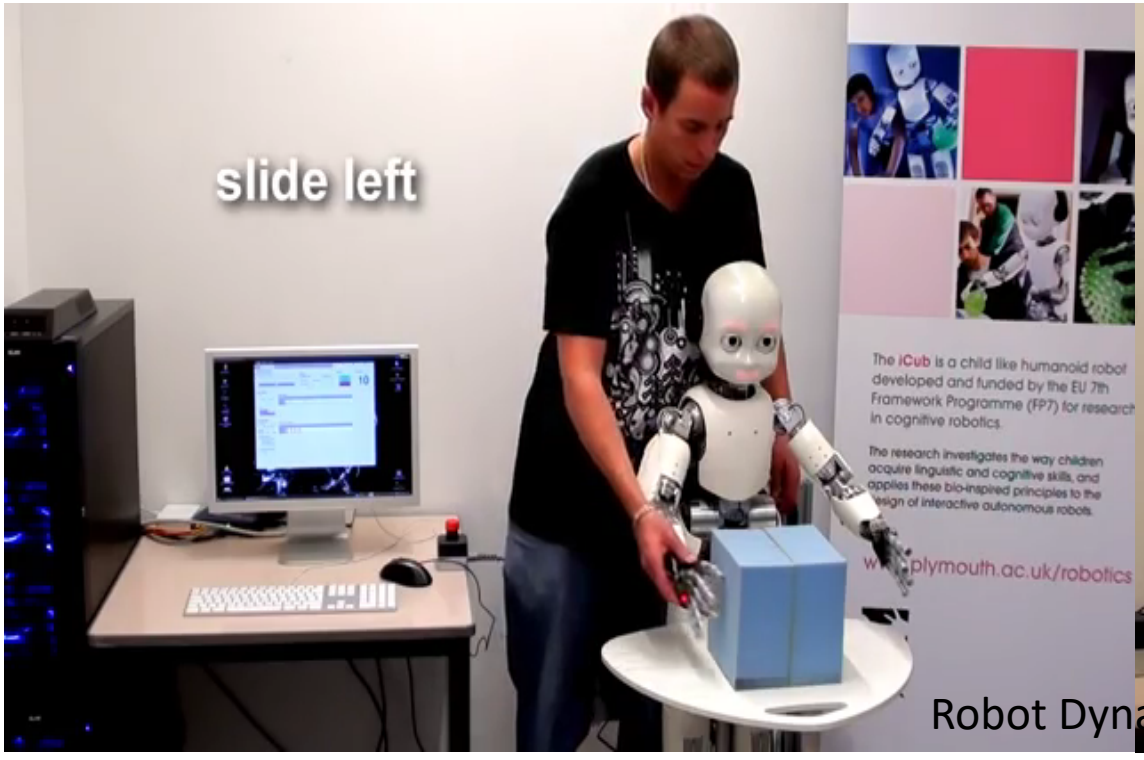



First, the robot arm tries to pick up
iron cylinders at random positions


30
25
20
15
10
5
-10
-5
0
5
10

Source: [Karpathy and Fei-Fei 2015]

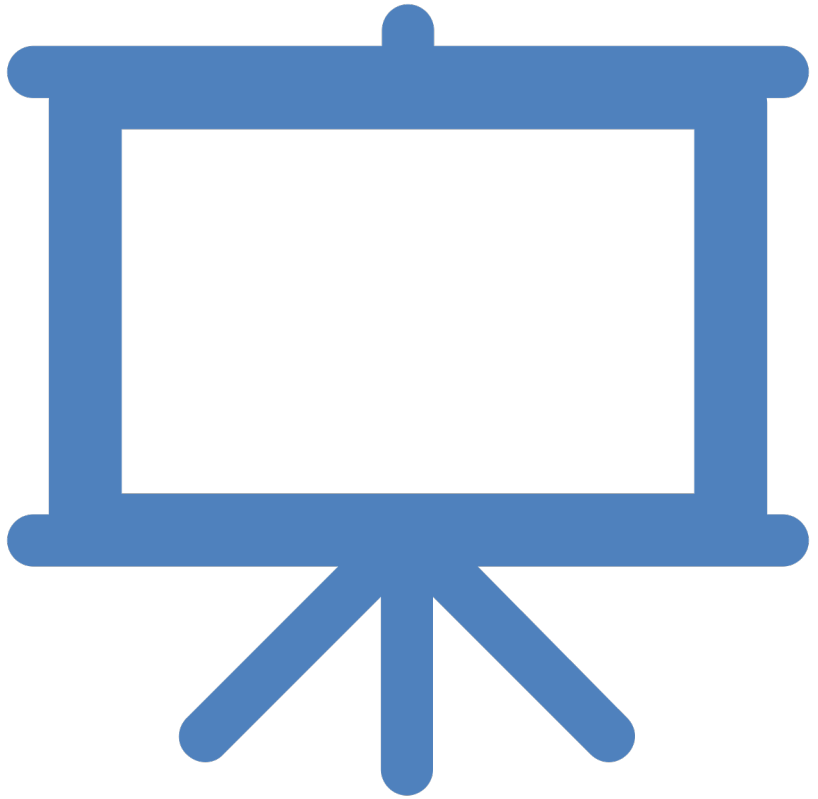




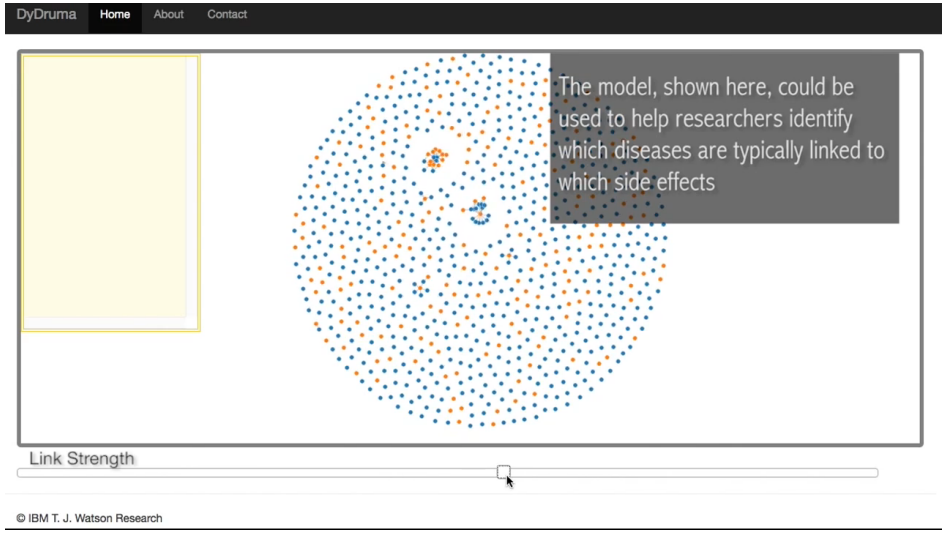
Robot Dynamics Control

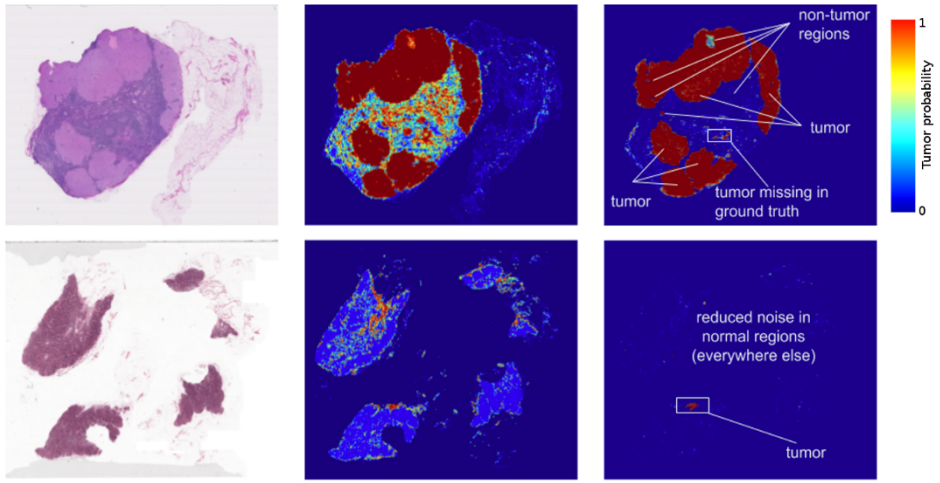

First, the robot arm tries to pick up
iron cylinders at random positions

Case Studies



Machine Learning Applications in Healthcare





Drug Discovery/Manufacturing:

- **Pfizer** is using IBM watson to discover new drugs
- **Huge literature on Generative** models on molecules

Healthcare

- Diagnosis and Medical Imaging analysis (IBM Watson eyes, **Google Breast Cancer** detection 89% accuracy vs 73 human)
- Personalized Treatment and IOT (Microsoft **Azure IoT** system for Healthcare)

Diagnostic Images Analysis

Opportunities:

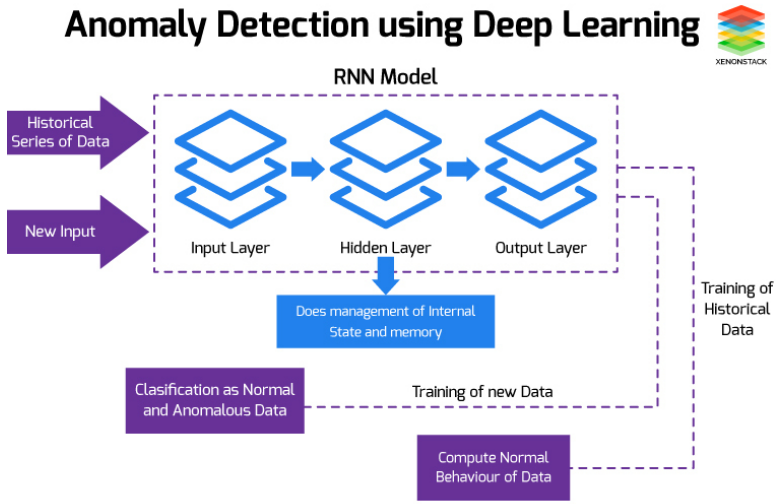
- Speed up the diagnosis times
- Exceed human performances

Difficulties:

- High resolution images
- Huge amount of data
- Unlabeled data

Machine learning has been widely employed in the diagnosis of illness, but usually using aggregated and numerical data. Latest years improvements in the computer vision field have make anlaysis of raw image data feasible. Thus, deep learning techniques could again help reaching top performances in a large set of topics.

Machine Learning Applications in Finance



- Fraud Detection using anomaly detectors on transactions (CityBank and Fetzai Portugal, PayPal)
  - Use of autoencoders and Deep MLP on historical transaction data

AXYON.AI

- Market stock analysis: Use Complex Deep Architecture for stock prediction investments
  - Modena case Axyon.ai

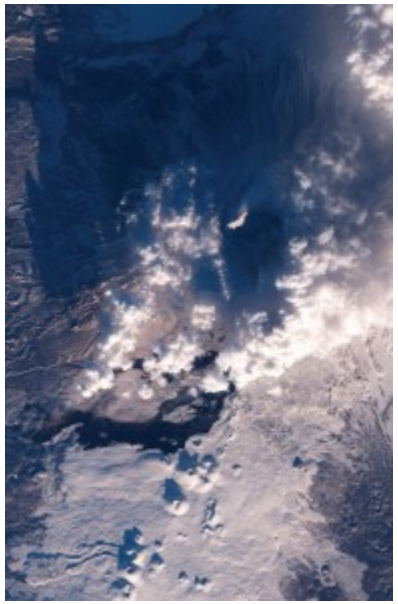
Case study: Satellite Images Analysis

Natural disasters prevention

Deep neural networks could be employed as a probabilistic algorithm to identify possible harm situations for humans, such as **landslides, vulcanic eruptions, tidal waves.**

Some efforts has been tried expecially for the landslide prevention topic:

Pham, Binh Thai, et al. "A comparative study of different machine learning methods for landslide susceptibility assessment: a case study of Uttarakhand area (India)." Environmental Modelling & Software 84 (2016): 240-250.



RGB image

Infrared image

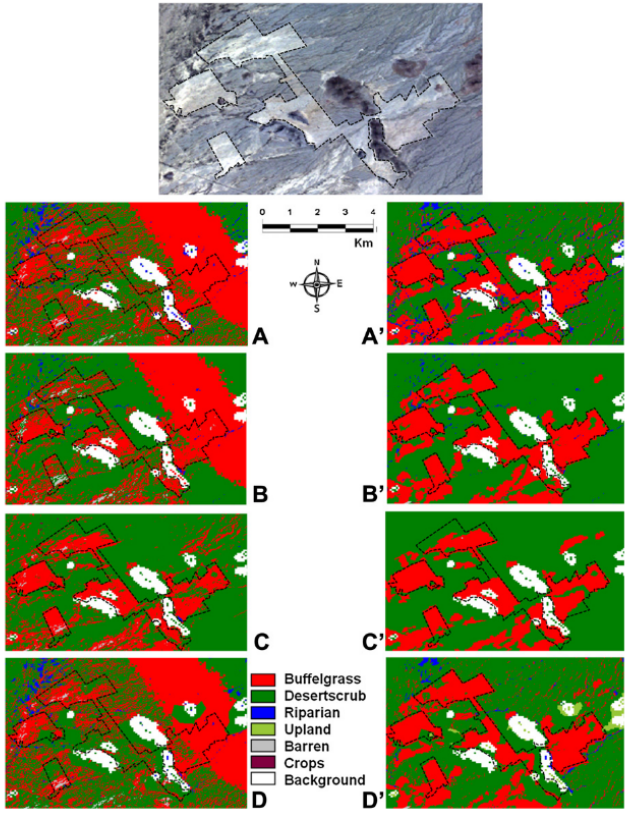
Satellite Images Analysis

Pasture Identification

Light spectre systems images may also be employed to find the best pasture areas, using **deep convolutional neural network** to succesfully segment the earth surface.

Some attempts have been tried in the past using standard machine learning techniques, which do not scale well with the numerous images available today:

Brenner, Jacob C., Zachary Christman, and John Rogan. "Segmentation of Landsat Thematic Mapper imagery improves buffelgrass (Pennisetum ciliare) pasture mapping in the Sonoran Desert of Mexico." Applied Geography 34 (2012): 569-575.



Results of the analysis of an infrared image using a classification tree algorithm

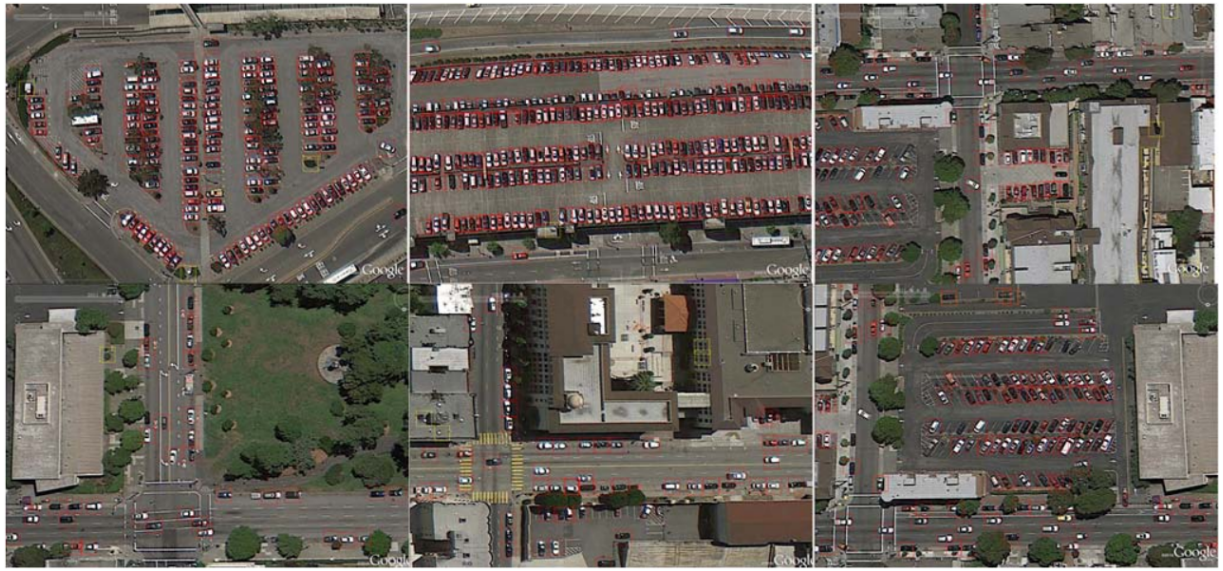
Satellite Images Analysis

Real Time Traffic Control

Thanks to new deep learning architectures able to detect cars and truck even from very far views, traffic monitoring from satellite images could lead to better living conditions in overcrowed cities and highways, providing the right tools for the viability improvement

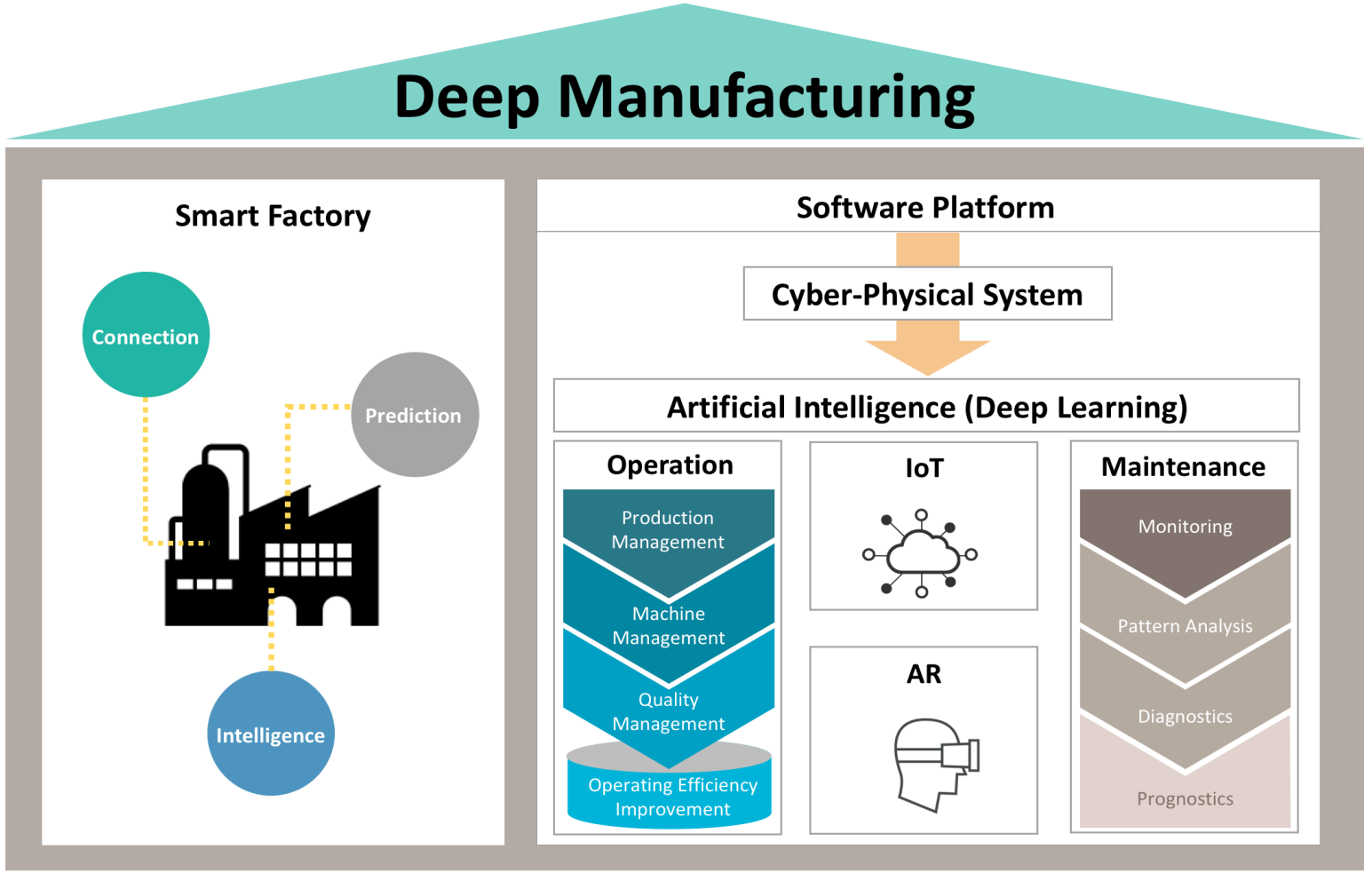
Recent works from the machine learning community prove good detection performances and few false positives even from high altitudes:

Chen, Xueyun, et al. "Vehicle detection in satellite images by hybrid deep convolutional neural networks." IEEE Geoscience and remote sensing letters 11.10 (2014): 1797-1801.



Car detection from Google Street images

Deep Manufacturing



Major Players and Products (Deep learning based)

Holistic product for Plant Management:

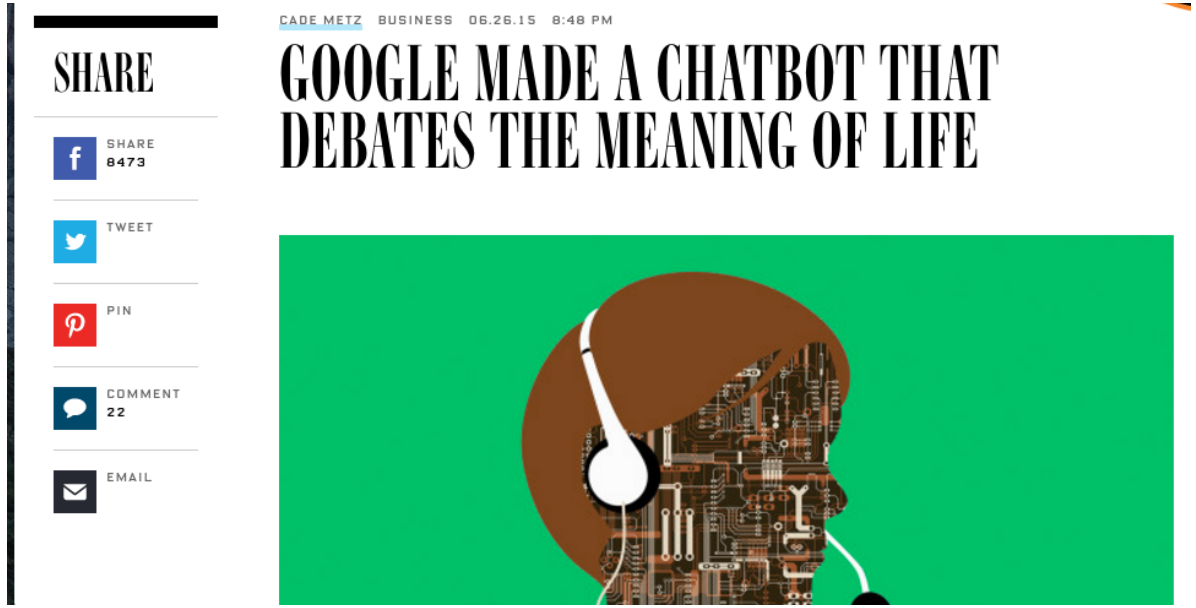
- **Siemens Mindsphere** (AI ecosystem integrated with IBM Watson for plant monitoring and analytics)
- **GE Predix** similar to Mindsphere control the plant and provides optimization to the process.

Robot Vision/Machine Vision

- **Funac** (Japanese Company Partner of NVIDIA) use deep and Reinforcement learnig to train grasping robotic arms
- **KUKA** (Chinese/German Company) Use Reinforcement learning for robot human cooperation
- **Cognex** Deep learning system

Other Applications

- Deep learning for web reputation (Bazoole)
- Deep learning for converstional bot (understanding and generating text) (Conversate) test case at Deloitte Digital
- Deep learning for VQA (Microsoft Azure BoT)



http://neuralconvo.huggingface.co/

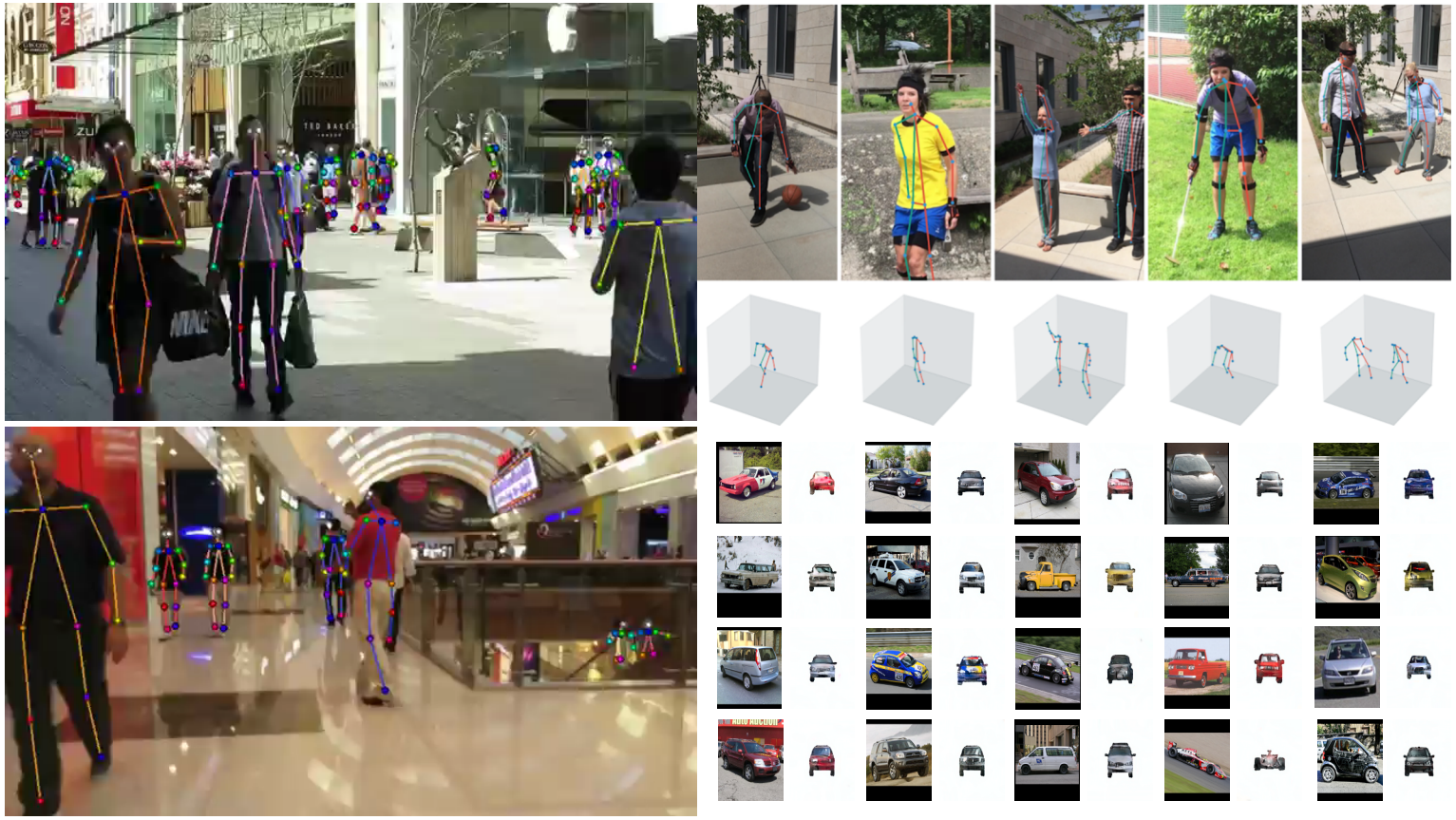
Applications made in ER

https://aimagelab.ing.unimore.it/

ML and CV for People Analysis in Smart Urban Environment

Study Deep Learning techniques for:

- People tracking
- People detection 2D and 3D
- Human Behavior understanding
- Anomaly Detection
- Vehicles-human interaction
- Geometric view synthesis



Conferences and Journals:

CVPR, ICCV, TPAMI, TIP, TMM

Projects and Collaborations:

PRIN COSMOS and PREVUE, EU PRYSTINE, EU ARROWHEADTOOLS, Panasonic Beta LABS, NVIDIA

AImageLab Group: Rita Cucchiara, Roberto Vezzani, Simone Calderara

http://aimagelab.ing.unimore.it

AImage Lab
University of Modena and Reggio Emilia

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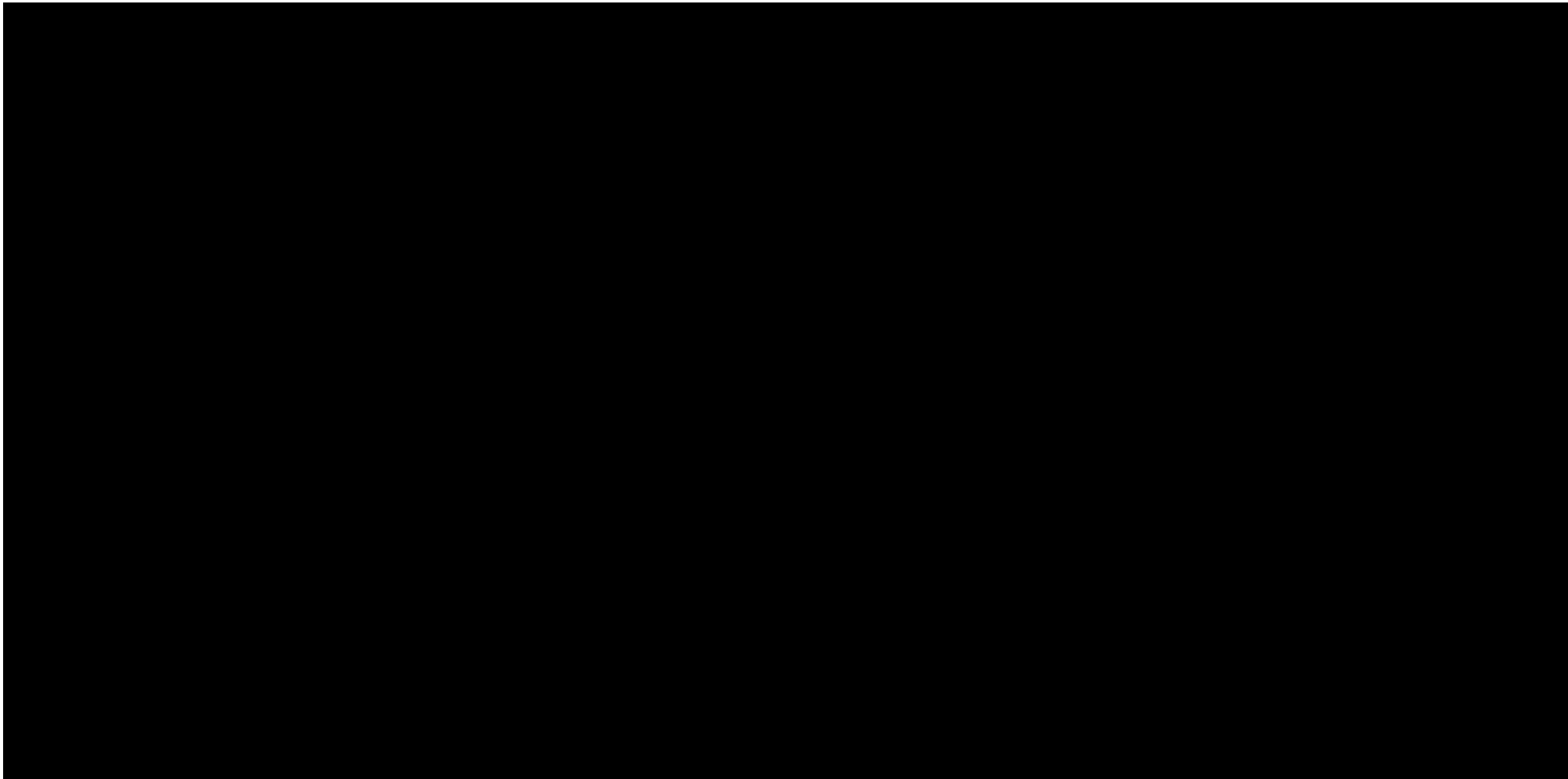
Car perception and analysis



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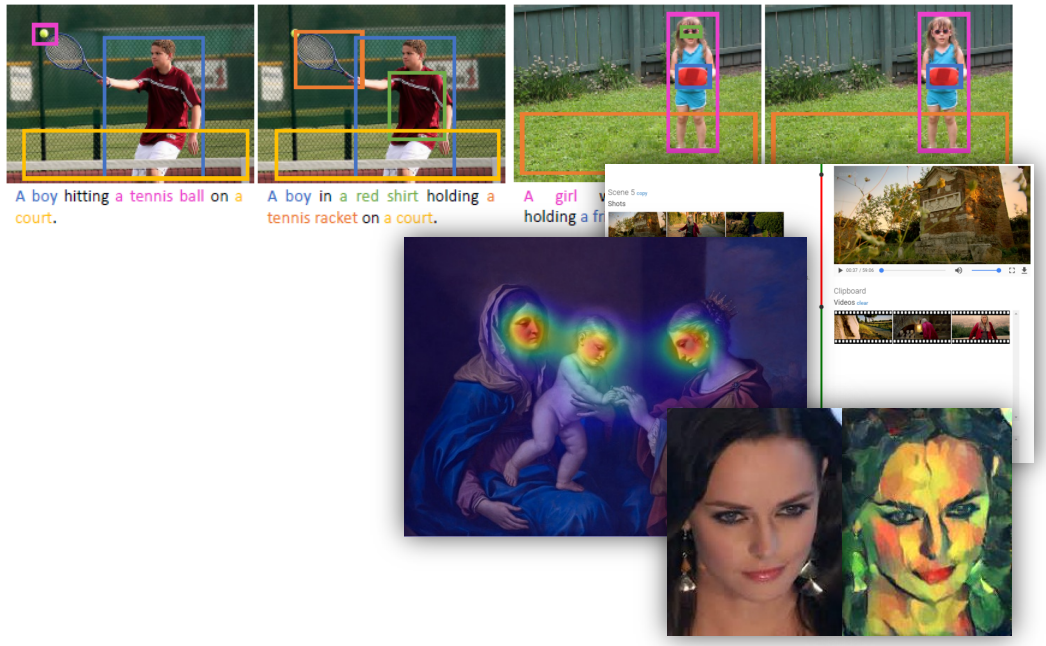
EyeCandy Results

Embodied AI and Digital Humanities

Embodied AI: Integration between Vision, Language and Action

- Automatic description of Images and Video
- Natural Language and multi-modal retrieval
- Vision and Language Navigation
- Navigation of embodied agents in unseen environments

Applications in Cultural Heritage and Digital Humanities



Conferences and Journals:

CVPR, ICCV, TPAMI, TIP, TMM

Projects and Collaborations:

- IDEHA, CULTMEDIA, AI4CH, AI4DH
- Facebook AI Research, NVIDIA, University of Haifa (Israel)

AImageLab Group: Rita Cucchiara, Lorenzo Baraldi, Marcella Cornia

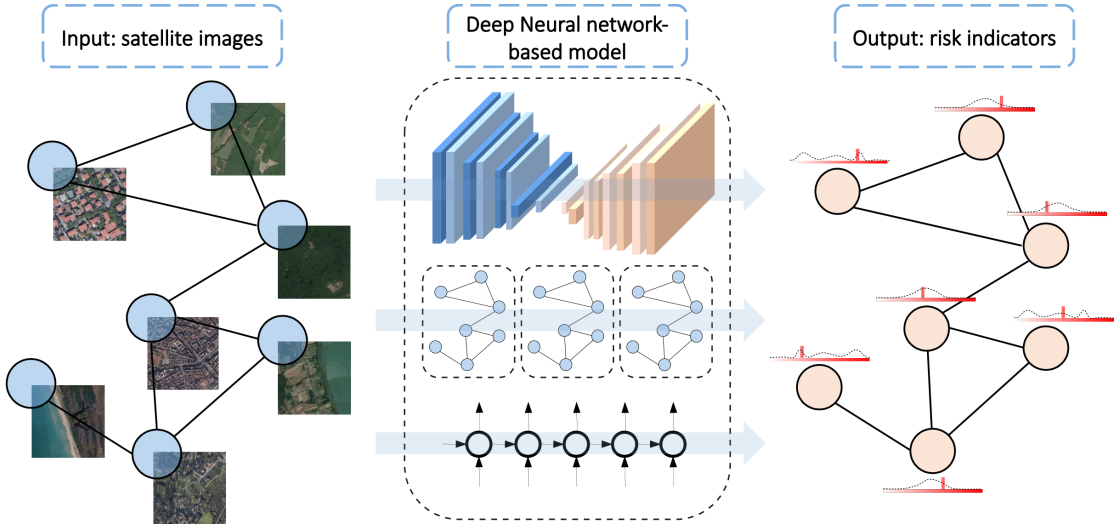
http://aimagelab.ing.unimore.it

AImage Lab
University of Modena and Reggio Emilia

Machine learning for Earth Observation

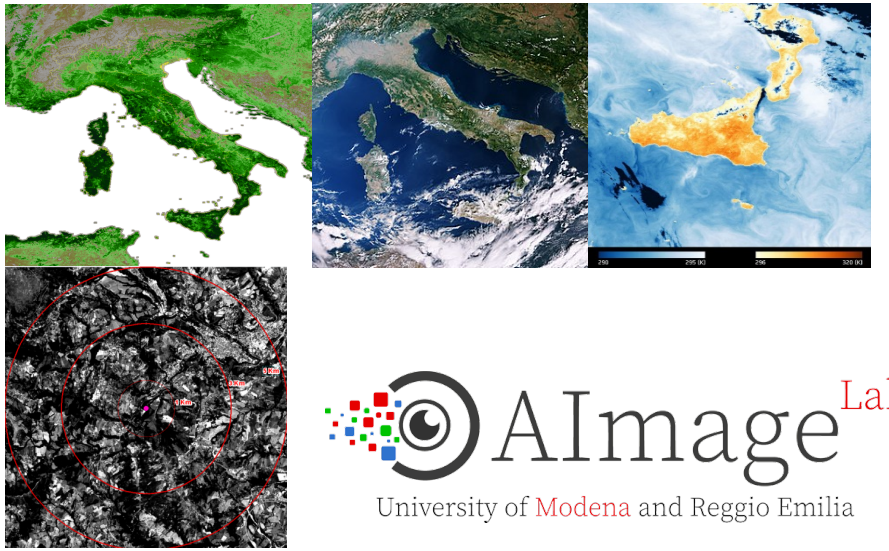
Deep Learning and Graph based analysis for:

- Satellite Images self-supervised feature extraction
- Inference of physical phenomena from EO
- Epidemic and vectors analysis using temporal EO



Projects and Collaborations:

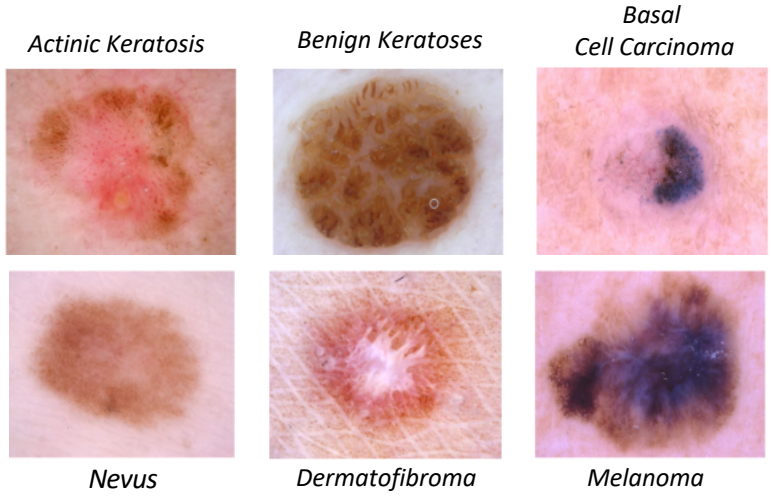
AI4VECT Italian Ministry of Health,
AIDEO European Spatial Agency



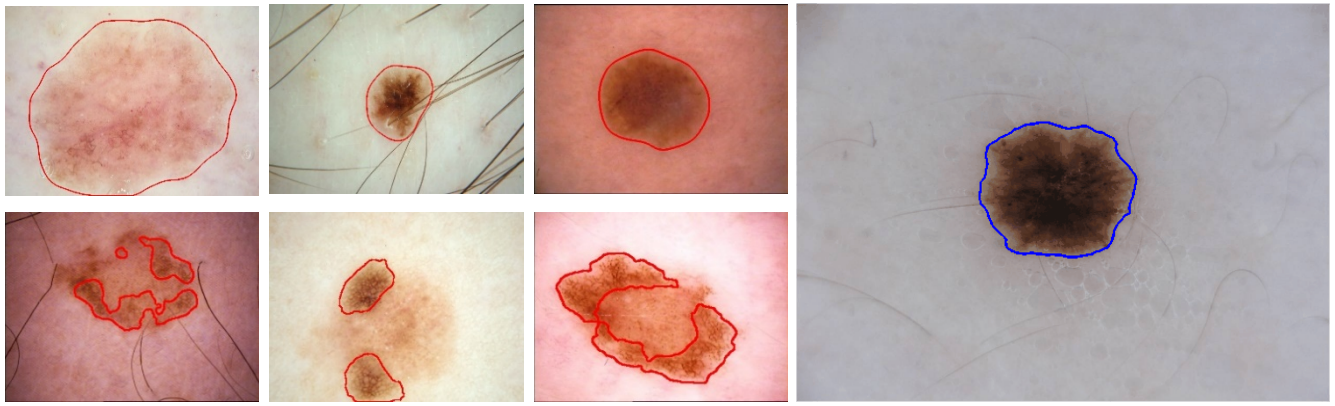
AImageLab Group: Simone Calderara, Angelo Porrello
http://aimagelab.ing.unimore.it

AImage Lab
University of Modena and Reggio Emilia

Medical Imaging

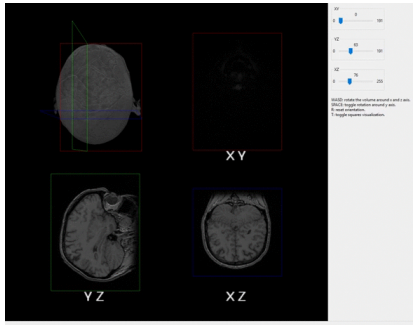


Lesion diagnosis

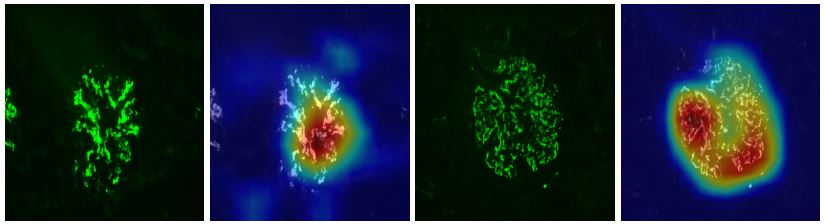


Lesion boundary segmentation and attribute detection

- **Third-place** (out of 64 research groups) at the 2019 **international ISIC challenge** (lesion diagnosis)



- DeepHealth (H2020): Deep-Learning and HPC to Boost Biomedical Applications for Health. **Period:** 2019 - 2021 **Budget:** 14.64 M€



- Intensity, patterns and locations of antibody deposits in immunofluorescence images from renal biopsies

AImageLab Group: Costantino Grana, Federico Bolelli
http://aimagelab.ing.unimore.it

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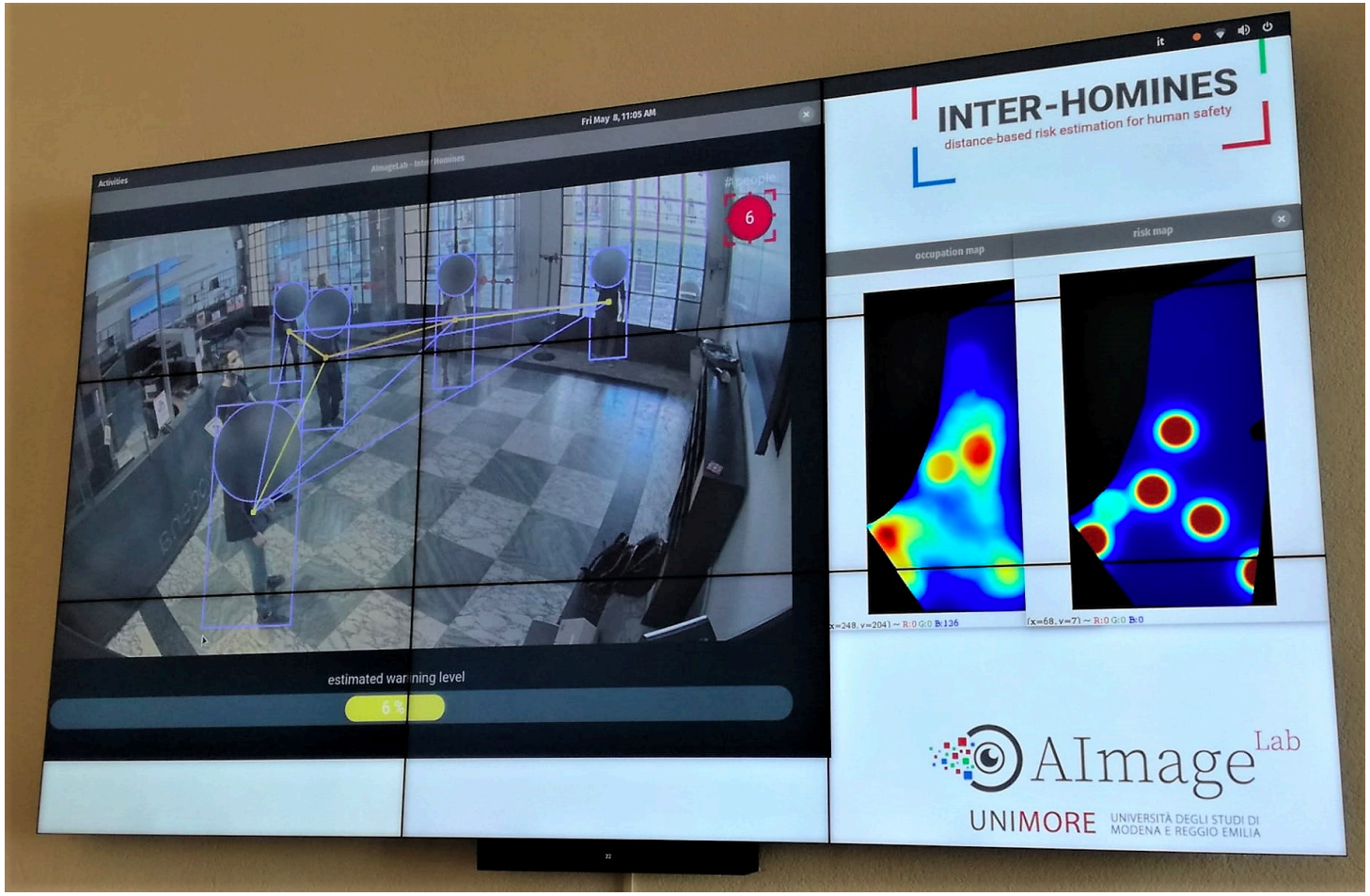
Inter-Homines - Distance-based risk estimation for human safety

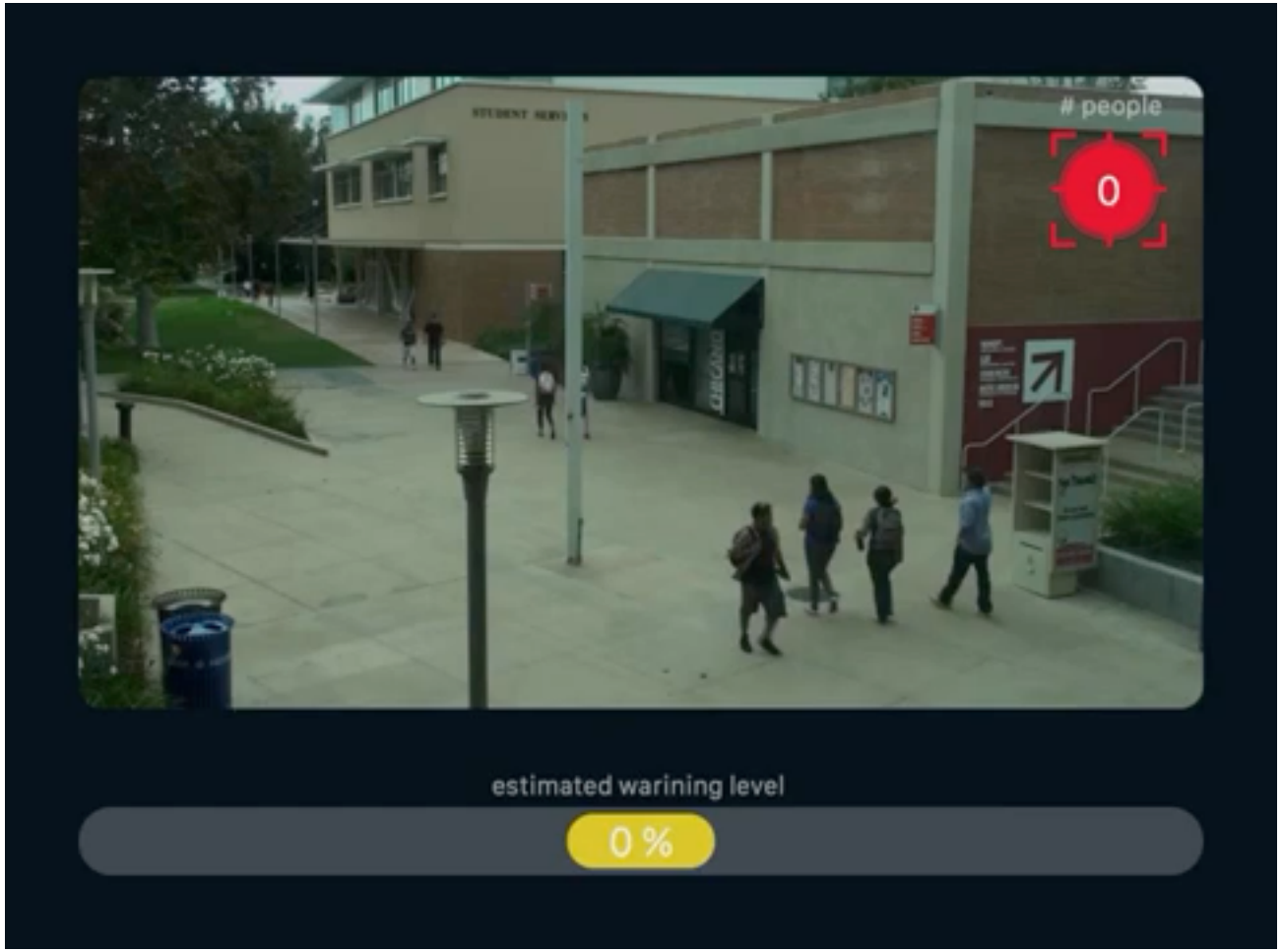
- Using cameras and AI to detect interpersonal distances
- Assess the risk of an area
- Sophisticated behavior analysis models for system robustness and risk evaluation

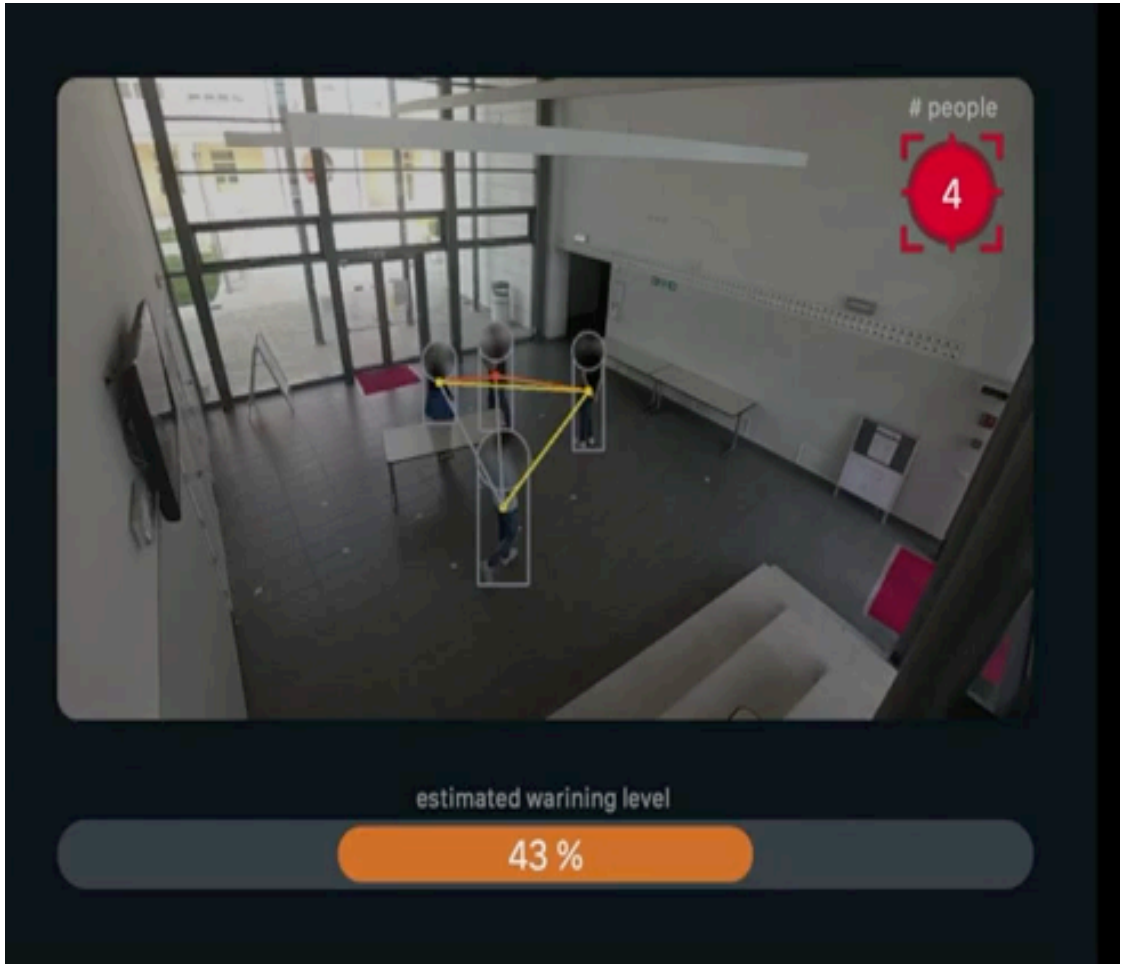


For more info https://aimagelab.ing.unimore.it/imagelab/project.asp?idprogetto=82

Prof. Rita Cucchiara rita.cucchiara@unimore.it Director of the Project

Dr. Matteo Fabbri matteo.fabbri@unimore.it


people
0
estimated warining level
0 %


people
4
estimated warining level
43 %

FUTURE

WE ARE STILL MISSING
ABSTRACTION

WE ARE MISSING
INTERPRETABILITY

WE ARE MISSING
AUTONOMY OF REASONING

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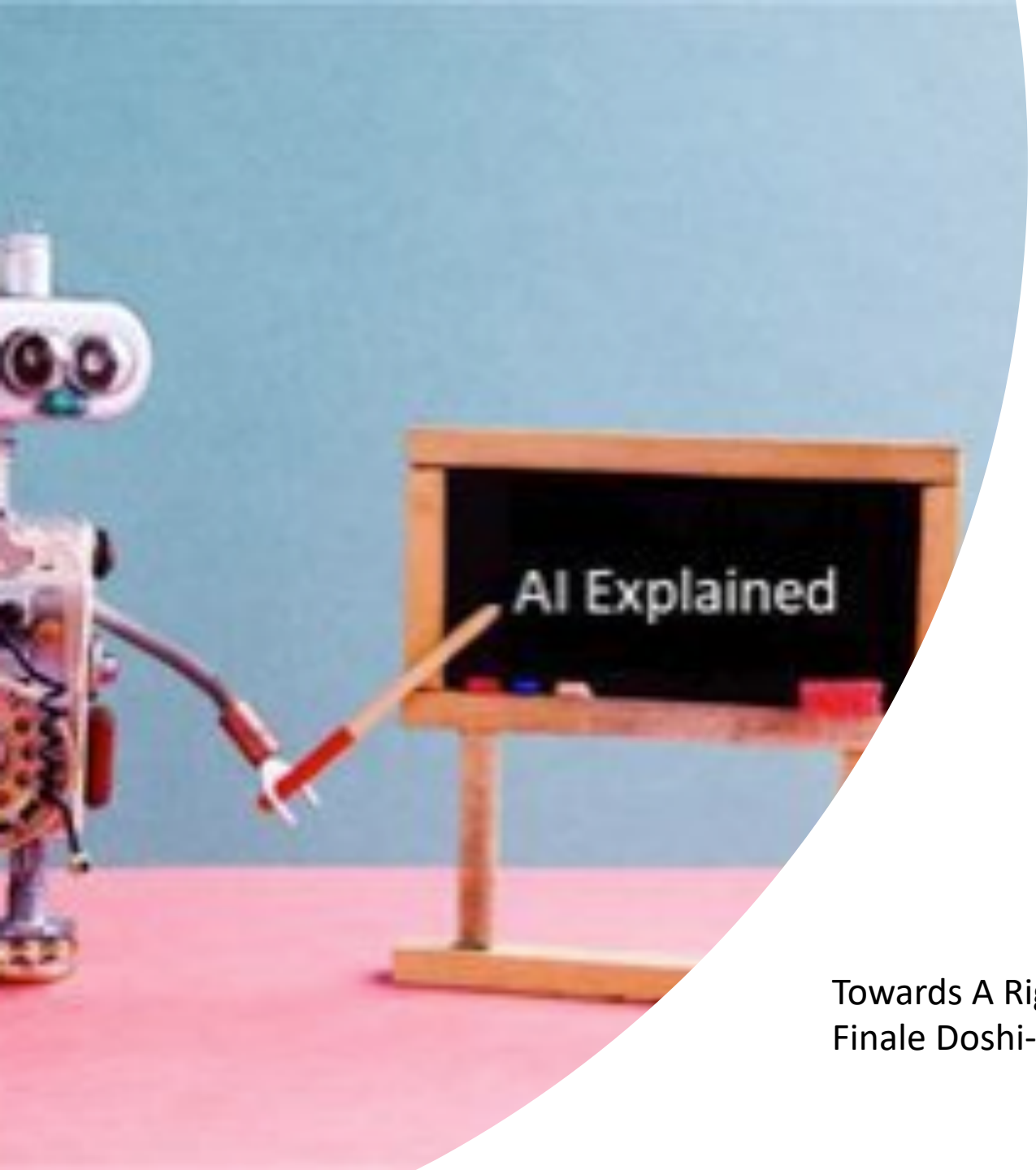
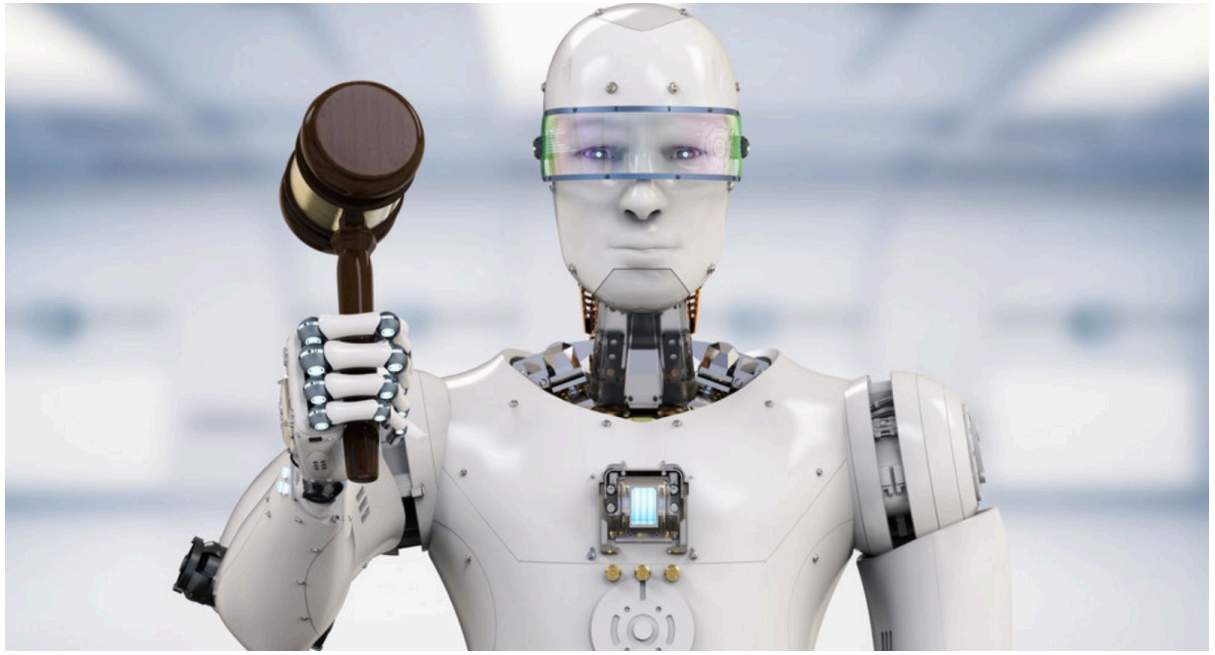


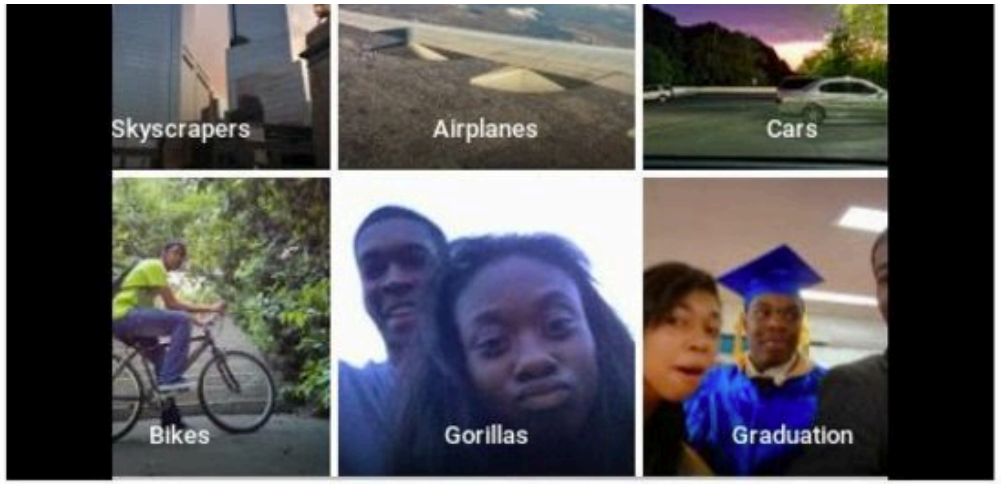
EXPLAINABLE AI

Towards A Rigorous Science of Interpretable Machine Learning
Finale Doshi-Velez, Been Kim

AI academy

WHO DECIDES THAT DEEP LEARNING AND AI OUTCOMES ARE 'RIGHT'?





FAIRNESS AND HUMAN BIAS

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Thank you for your attention

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