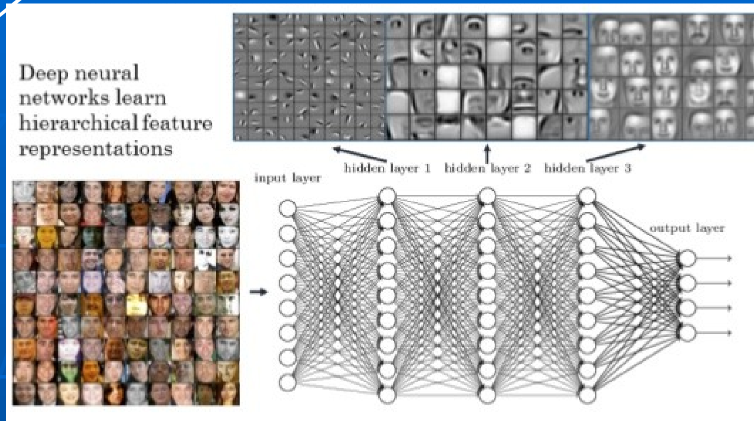


Artificial Intelligence - 65th Jubilee - Some Examples and Opportunities

- IEEE student branch UFCB - July, 22th, 2021

Prof. Adolfo Bauchspiess

LARA - Laboratório de Automação e Robótica
Departamento de Engenharia Elétrica
Universidade de Brasília - Brazil

Summary

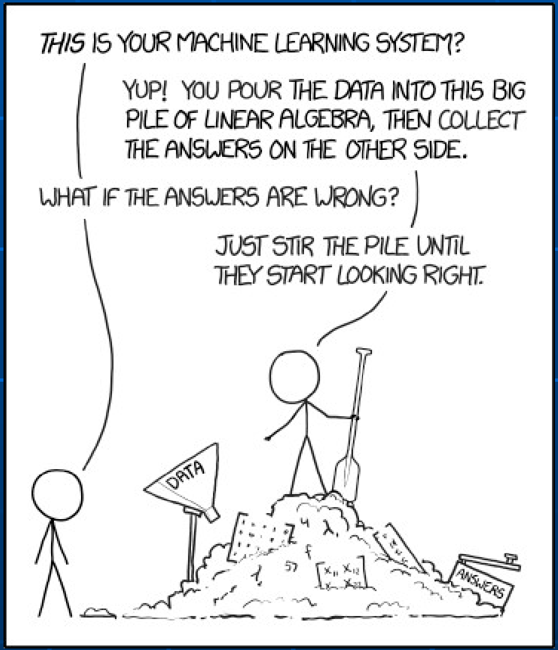
Background:

- Smart Cities
- IoT
- Machine Learning

Examples

- UAV/Drone Examples
- Self-Driving Car
- …

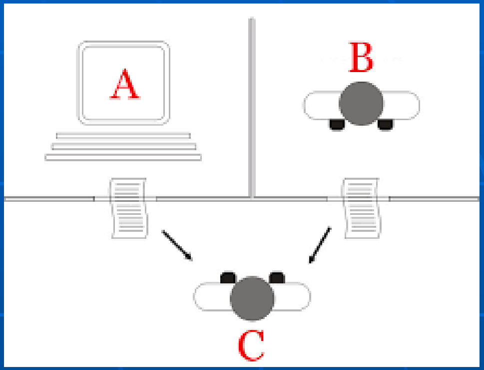
Perspectives



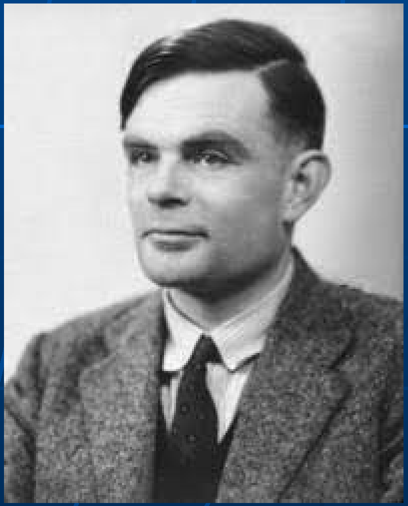
Background

I PROPOSE to consider the question, **'Can machines think?'**
This should begin with definitions of the meaning of the terms 'machine' and 'think'.
…
Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

The new form of the problem can be described in terms of a game which we call the **'imitation game'**.



A. M. TURING, I.—COMPUTING MACHINERY AND INTELLIGENCE, Mind, Volume LIX, Issue 236, October 1950, Pages 433–460



Time Line - The 3rd AI Wave

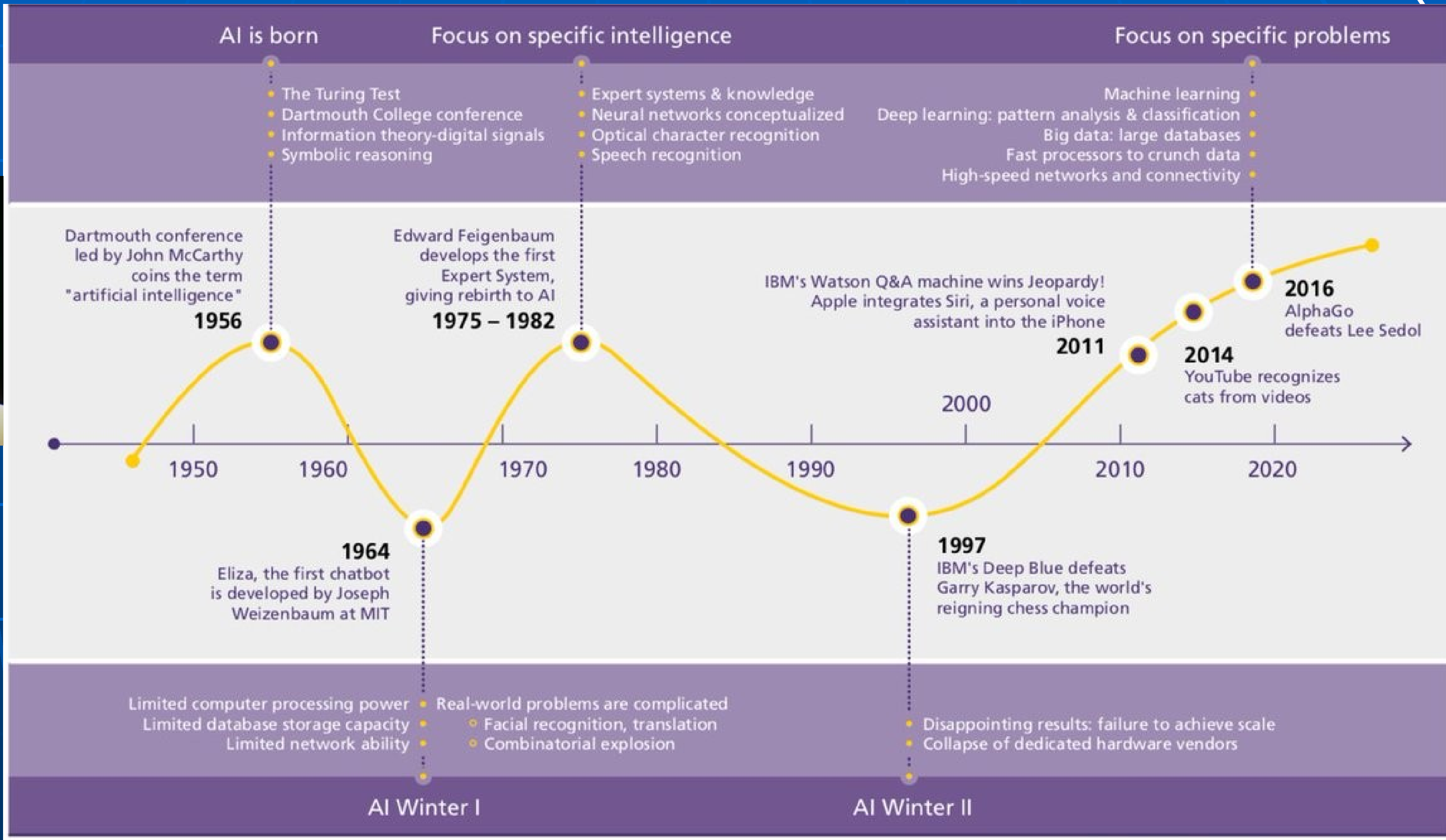


Figure 1: An AI timeline; So ?

source dhl via @mikequindazzi

Cities Evolution

City of neighbors ➛ City of Strangers

André de Oliveira Bueno, Julho 2019 – Trilha Smart Cities – The Developer’s Conference

The world’s cities occupy just 3% of the Earth’s land, but account for 60%-80% of energy consumption and 75% of carbon emissions.

Prathombutr – Smart Cities Development in Thailand
https://www.nstda.or.th/nac/2019/images/seminar/26_Smartcity_passakorn.pdf

Future Smart City (?)

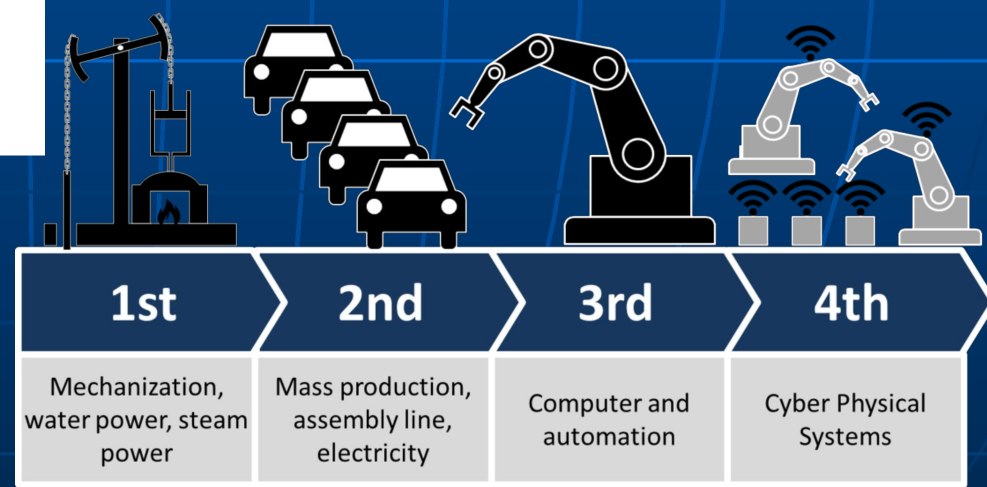
@Pinterest

Future Smart City (?)

@Pinterest

Cyber-Physical Systems

INDUSTRY 4.0

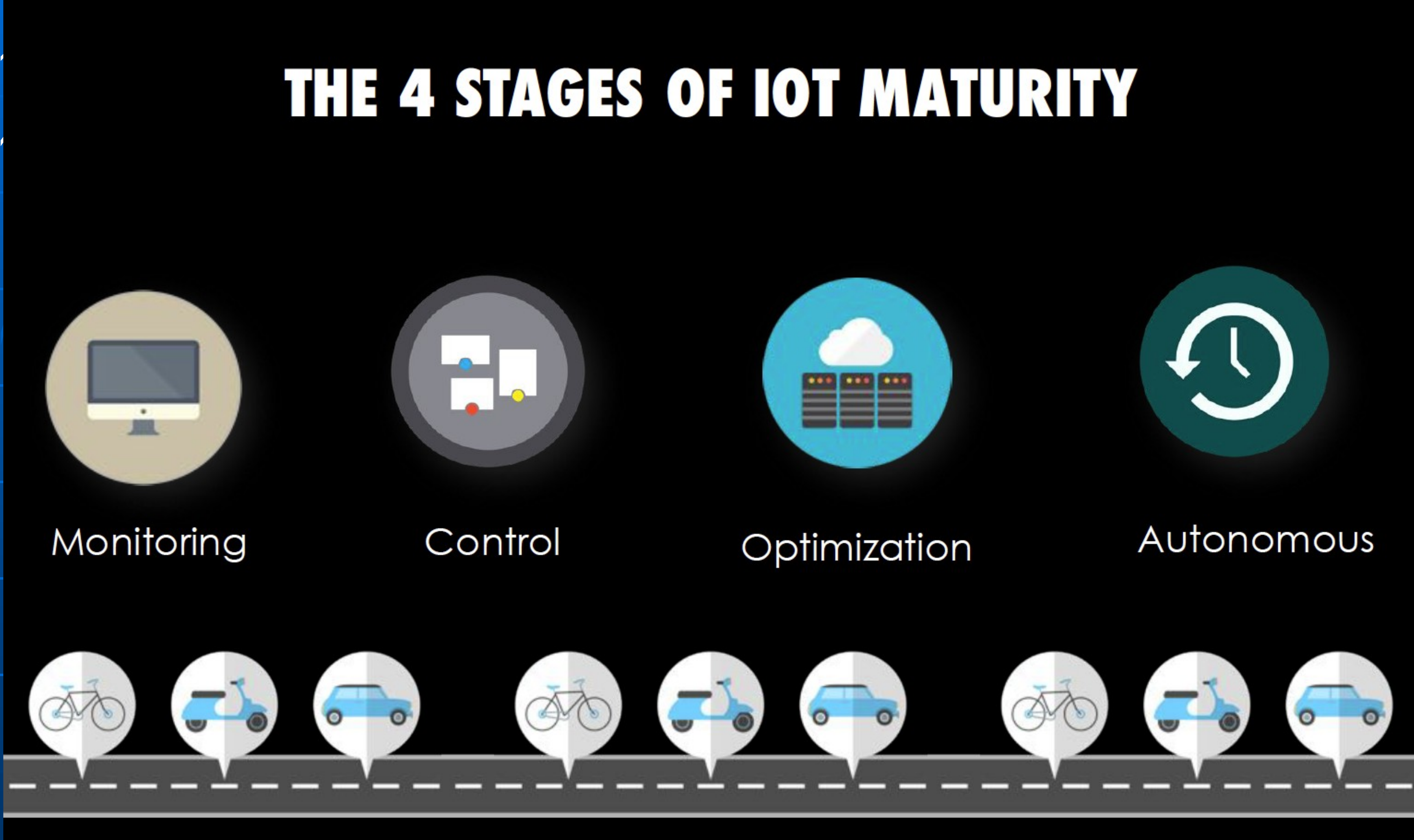


Breakthrough Technologies:

- Steam

- Electricity

- Computer

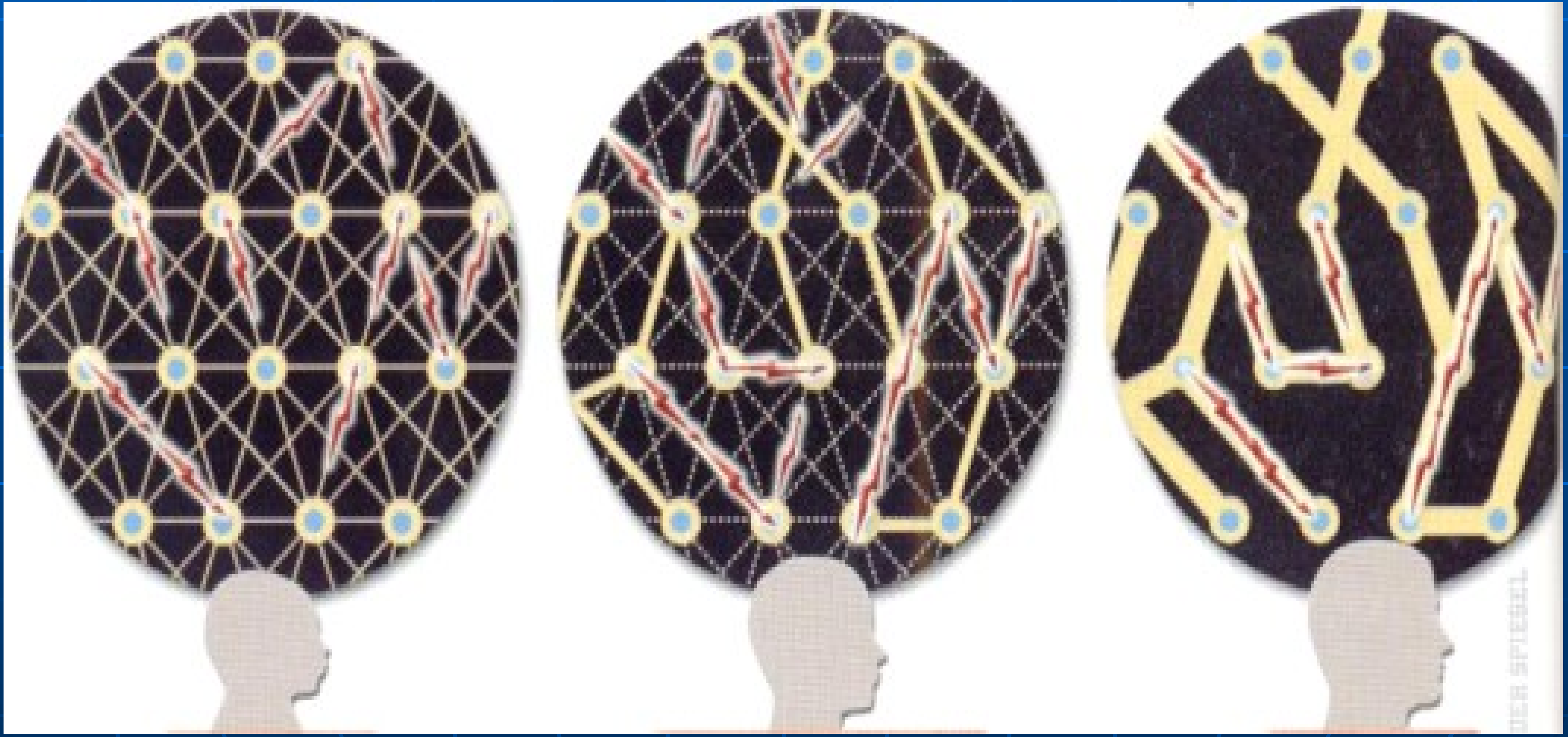


https://www.slideshare.net/mazlan1/introduction-to-iot-smart-city/18-FUNCTIONAL_VIEW_OF_IOTTECHNOLOGIES

M C O A

Intelligent Systems - The Brain is the model !!

Build Neuron Synaptic *Connections* - Learning!



0-2 years

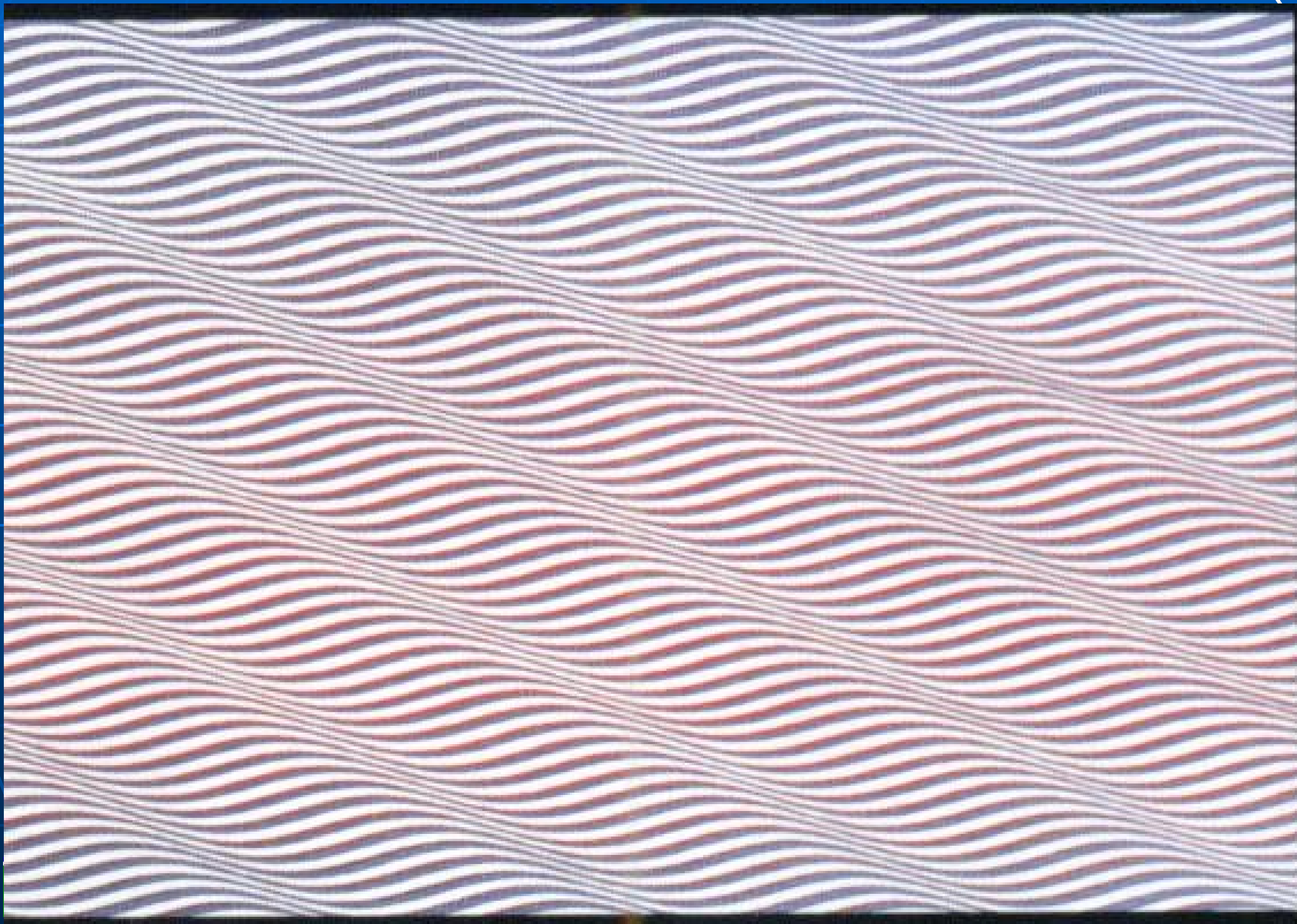
2 years to puberty

Adult

From Natural Intelligence to Artificial Intelligence
Ex. Dislexia?

I cnduo't bvleiee taht I culod aulaclty uesdtannrd waht I was rdnaieg. Unisg the icndeblire pweor of the hmuan mnid, aocdcrnig to rseecrah at Cmabrigde Uinervtisy, it dseno't mttaer in waht oderr the lterets in a wrod are, the olny irpoamtnt tihng is taht the frsit and lsat ltteer be in the rhgit pclae. The rset can be a taotl mses and you can sitll raed it whoutit a pboerlm. Tihs is bucseae the huamn mnid deos not raed ervey ltteer by istlef, but the wrod as a wlohe. Aaznmig, huh? Yaeh and I awlyas tghhuot slelinpg was ipmorantt! See if yuor fdreins can raed tihs too.

Waves?



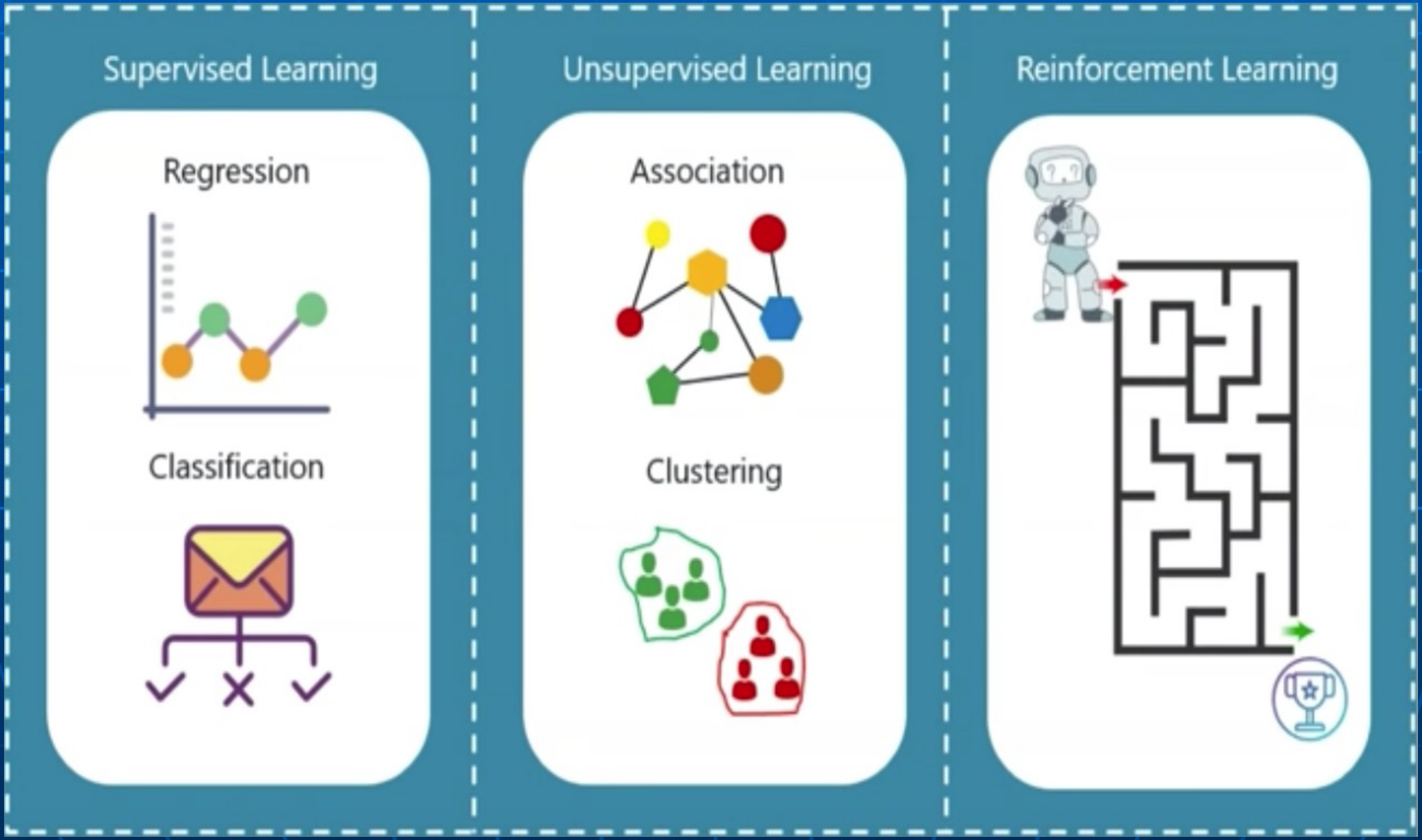
Simpathic?


GRIMASSE STEHT KOPF
Auf den ersten Blick scheint das Foto von Margaret Thatcher nicht ungewöhnlich. Das ändert sich, wenn Sie das Bild auf den Kopf stellen. Der verblüffende Effekt tritt auf, weil Augen und Mund auf dem Foto um 180 Grad gedreht sind – und damit genau die Merkmale, auf die das Gesichtserkennungsprogramm des Hirns besonders sensibel anspricht.
EMILE LUIDER / RAPHO / AGENTUR FOCUS (L.); PERCEPTION (R.)

Antipathic?

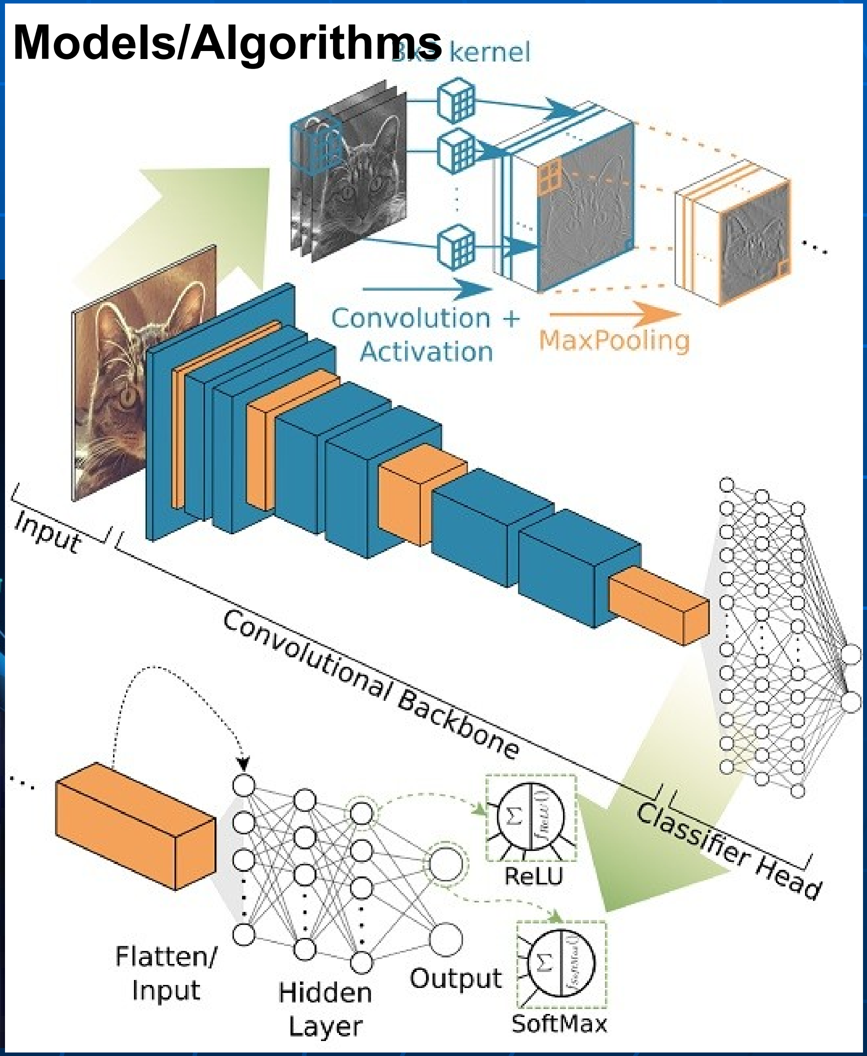

EMILE LUIDER / RAPHO / AGENTUR FOCUS (L.); PERCEPTION (R.)
GRIMASSE STEHT KOPF
Auf den ersten Blick scheint das Foto von Margaret Thatcher nicht ungewöhnlich. Das ändert sich, wenn Sie das Bild auf den Kopf stellen. Der verblüffende Effekt tritt auf, weil Augen und Mund auf dem Foto um 180 Grad gedreht sind – und damit genau die Merkmale, auf die das Gesichtserkennungsprogramm des Hirns besonders sensibel anspricht.

Machine Learning

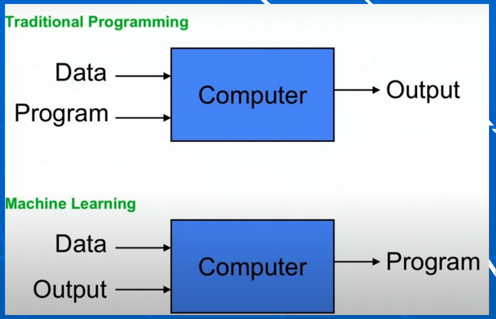


AI Enablers:

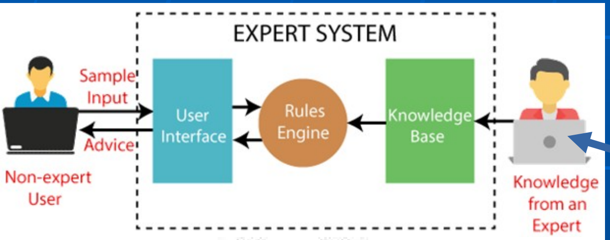
- data
- processing
- algorithms

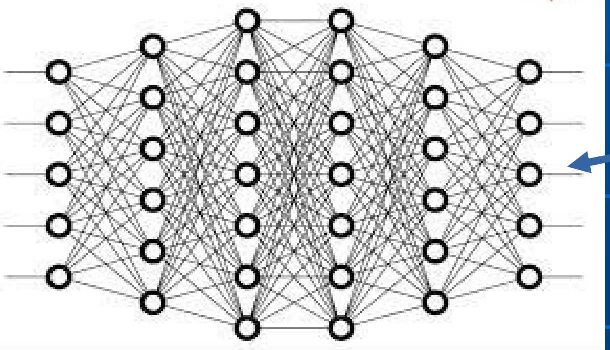


ML Algorithm “Tribes”

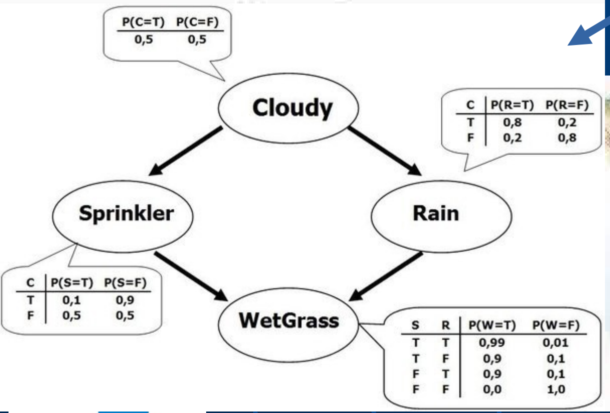


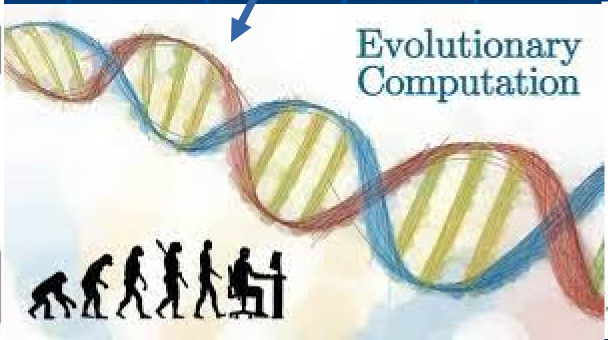
Pedro Domingos, U. Washington
“The Master Algorithm, Basic Books, 2015

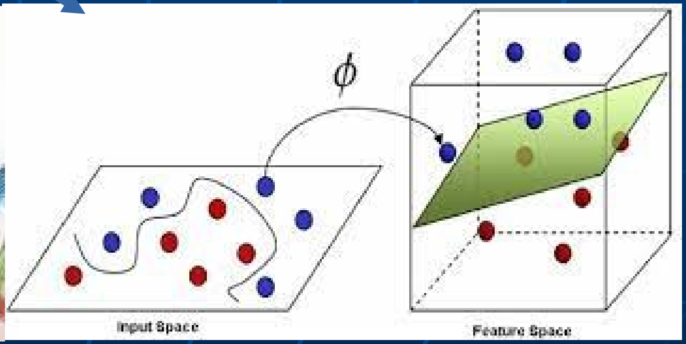




Tribe	Strength	Technology
Symbolists	Structure Inference	Production Rule System Inverse Deduction
Connectionists	Estimating Parameters	Backpropagation Deep Learning
Bayesians	Weighing Evidence	HMM Graphical Model
Evolutionaries	Structure Learning	Genetic Algorithms Evolutionary Programming
Analogizers	Mapping to Novelty	kNN SVM

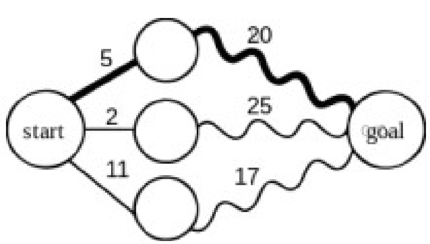


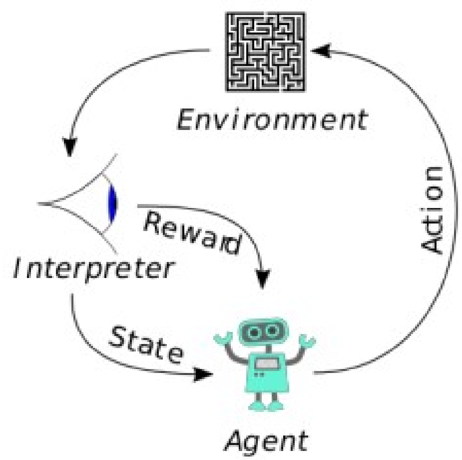


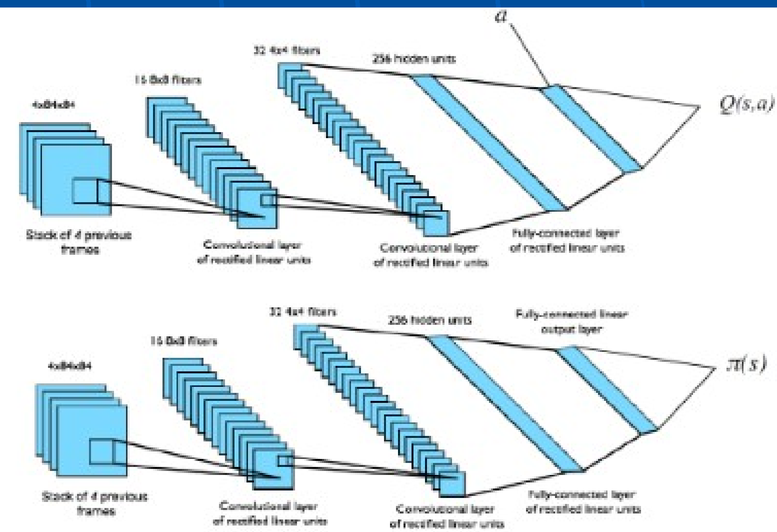


Reinforcement Learning

- Optimal Control
- Trial & Error
- Temporal Difference (max. future expected rewards)





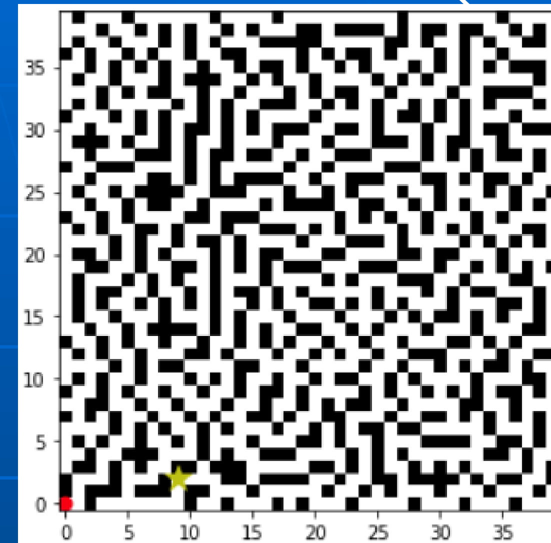


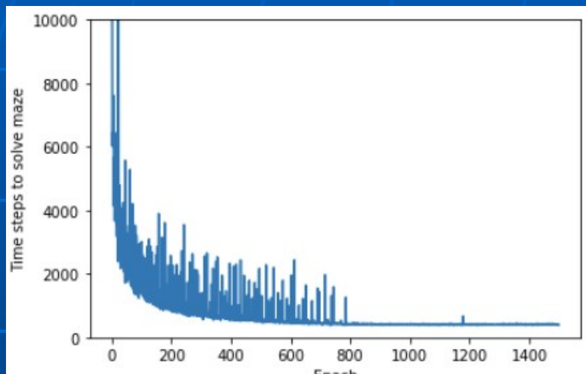
Dynamic Programming 1953

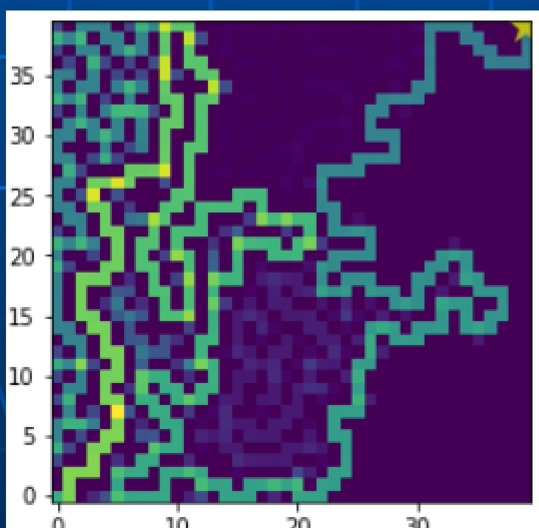
Reinforcement Learning 1984

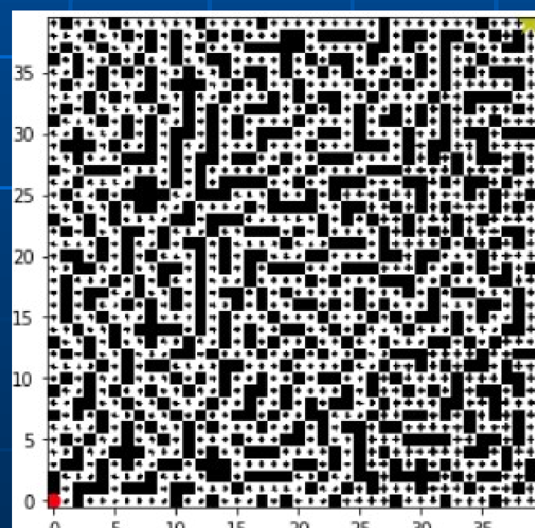
Deep RL DeepMind Google 2010

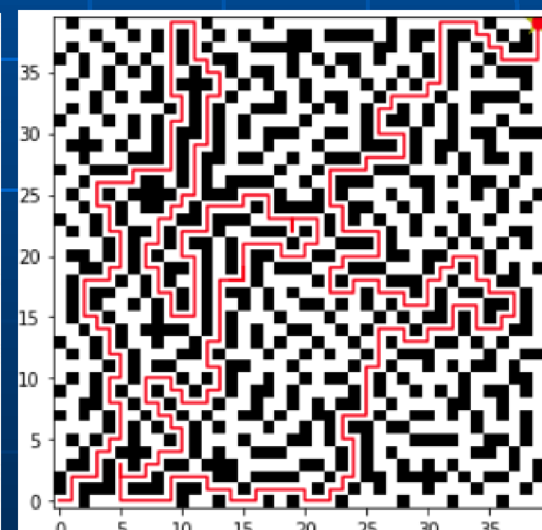
Maze RL





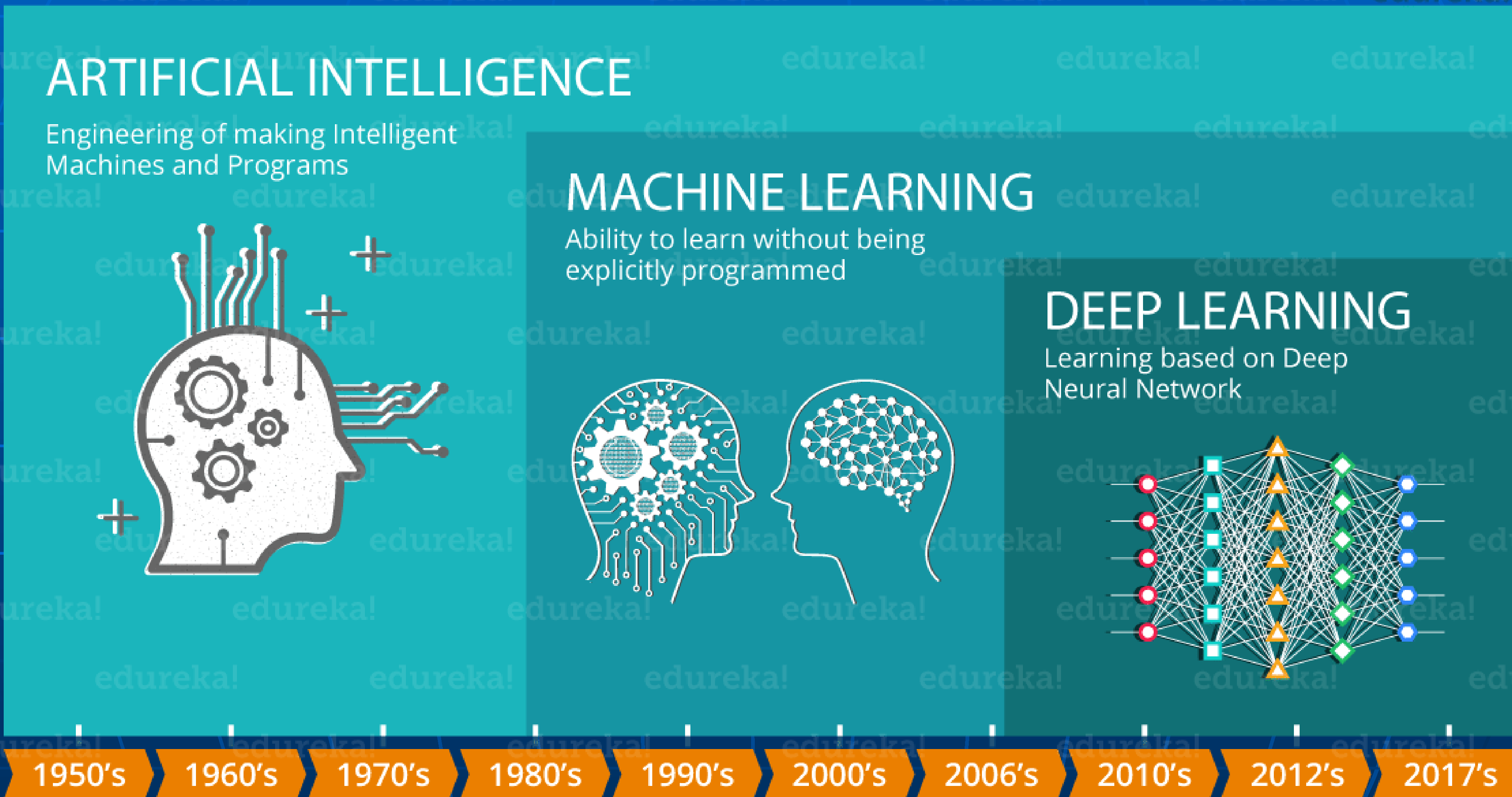






env.treasure = (mx-1,my-1)

Time Line – AI != ML! AI⊃ML⊃DL



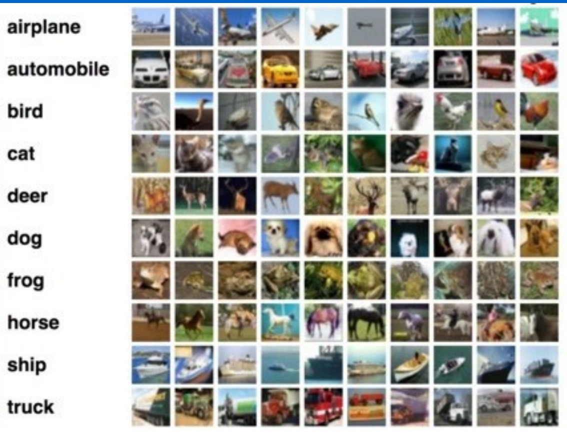
The Deep Learning Superheros

Juergen Schmidhuber(?), LSTM | Ian Goodfellow; GAN | François Chollet; Keras | Yann LeCunn, CNN | Andrew Ng, GoogleBrain | Geoffrey Hinton, BackProp.KL,etc | Larry Page, Google | Yoshua Bengio GAN

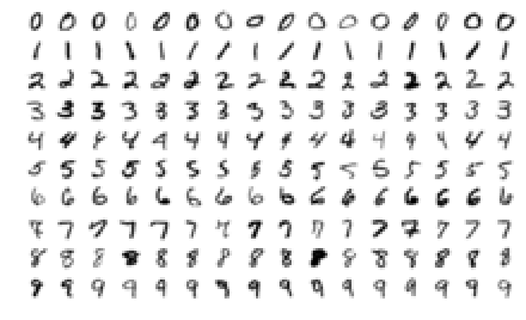
Examples

Visual Classification

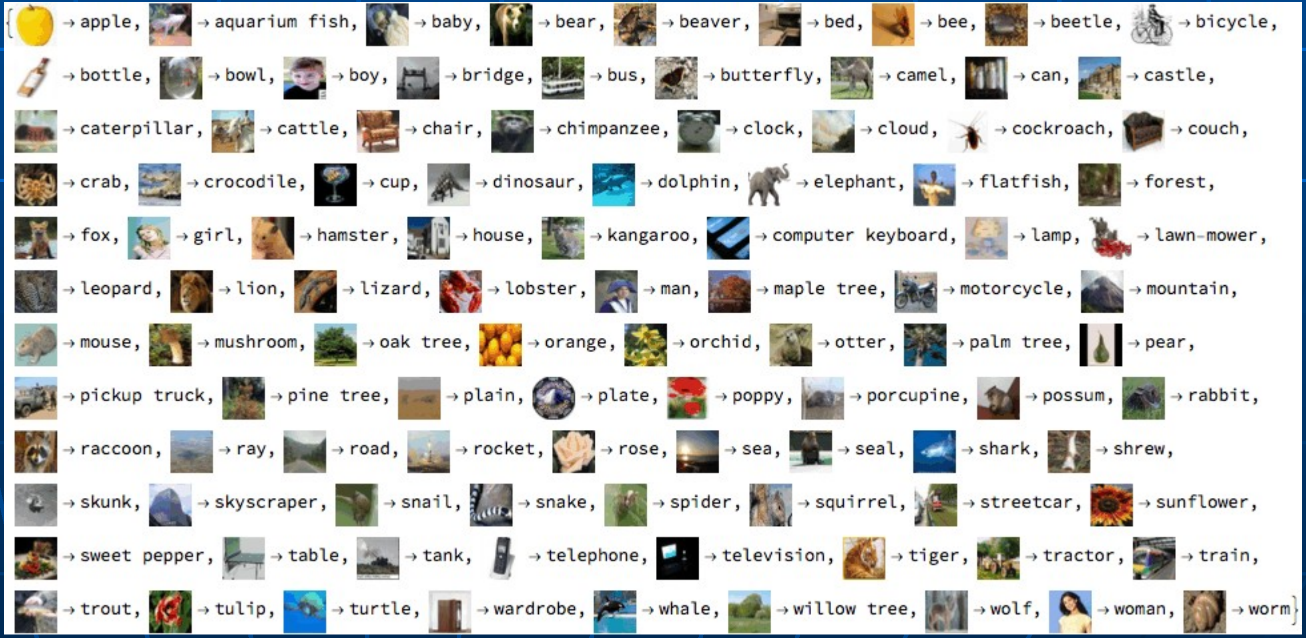
CIFAR 10



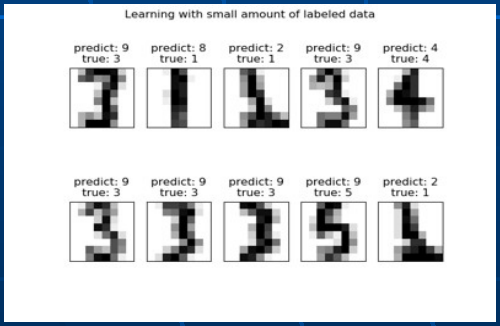
MNIST



CIFAR 100

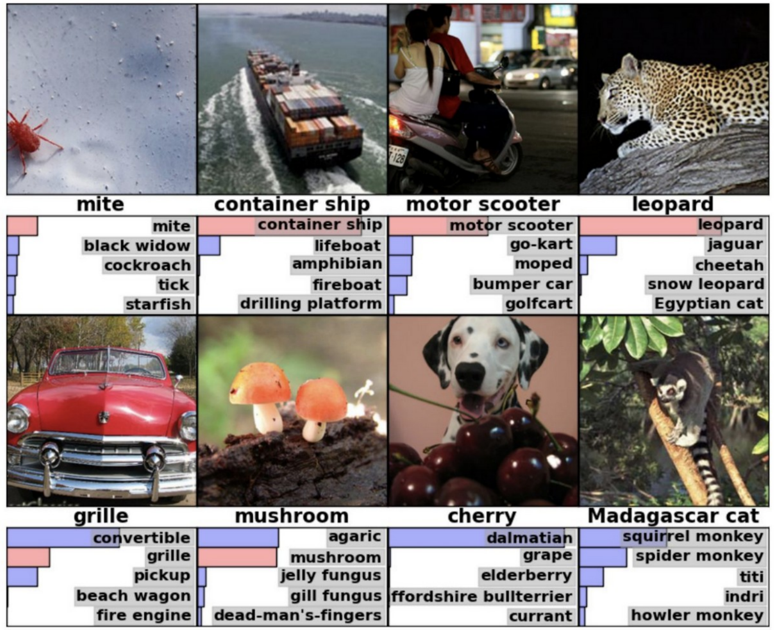


Sklearn.load_digits



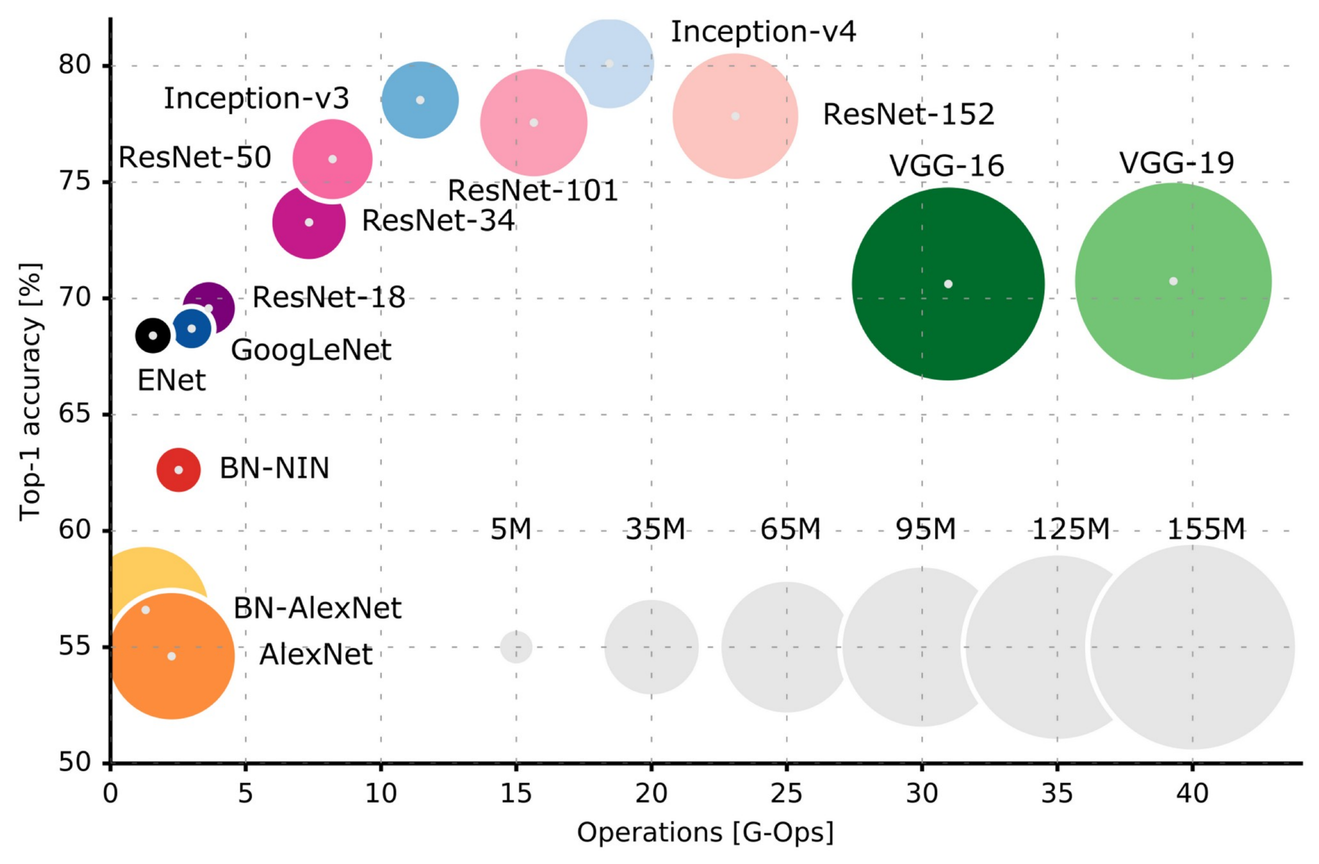
ImageNet Challenge

- 1,000 object classes (categories).
- Images:
  - 1.2 M train
  - 100k test.



ILSVRC 2018 Winner (ImageNet Large Scale Visual Recognition Competition)

Inception-v4 (Evolved from GoogLeNet, Merged with ResNet Idea)

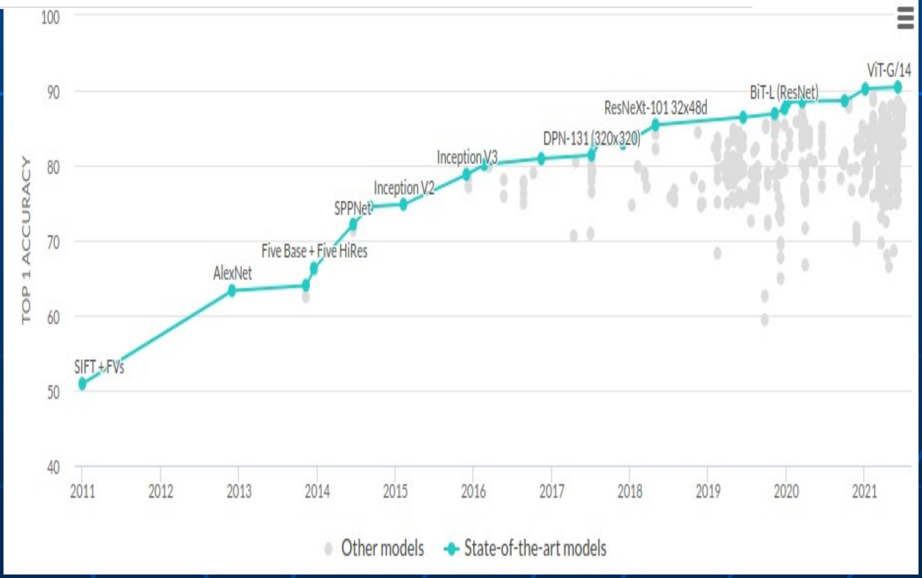


The **Top-1 error** is the percentage of the time that the classifier did not give the correct class the **highest** score. The **Top-5 error** is the percentage of the time that the classifier did not include the correct class among its **top 5** guesses.

Network	Top-1 Error	Top-5 Error
BN-Inception (Ioffe and Szegedy 2015)	25.2%	7.8%
Inception-v3 (Szegedy et al. 2015b)	21.2%	5.6%
Inception-ResNet-v1	21.3%	5.5%
Inception-v4	20.0%	5.0%
Inception-ResNet-v2	19.9%	4.9%

https://paperswithcode.com/**sota**/image-classification-on-imagenet

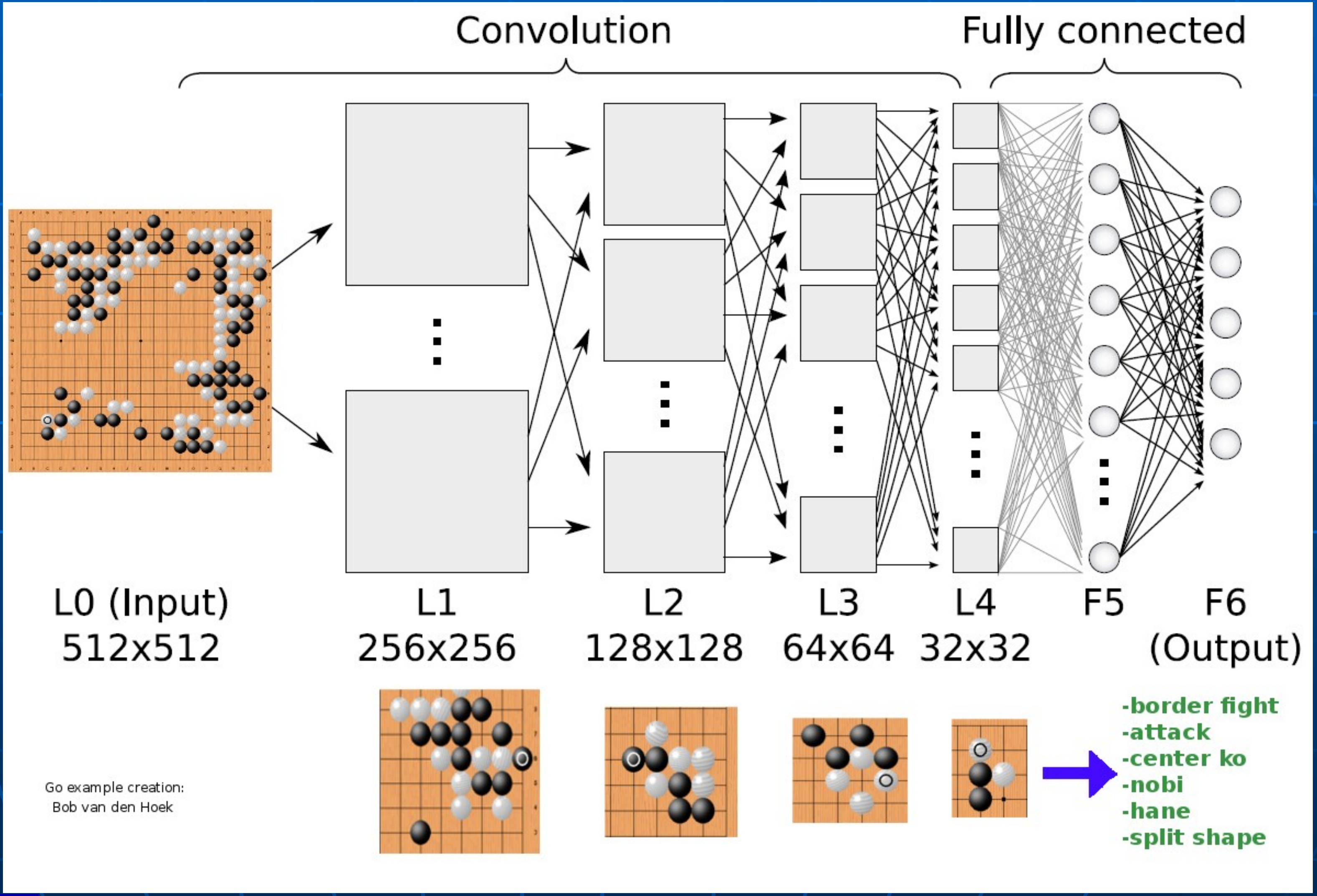
Rank	Model	Top 1 Accuracy	Top 5 Accuracy	Number of params	Extra Training Data	Paper	Code	Result	Year
1	**ViT-G/14**	90.45%		1843M	✓	Scaling Vision Transformers			2021
2	**ViT-MoE-15B** (Every-2)	90.35%		14700M	✓	Scaling Vision with Sparse Mixture of Experts			2021
3	**Meta Pseudo Labels** (EfficientNet-L2)	90.2%	98.8%	480M	✓	Meta Pseudo Labels			2021
4	**Meta Pseudo Labels** (EfficientNet-B6-Wide)	90%	98.7%	390M	✓	Meta Pseudo Labels			2021
5	**NFNet-F4+**	89.2%		527M	✓	High-Performance Large-Scale Image Recognition Without Normalization			2021



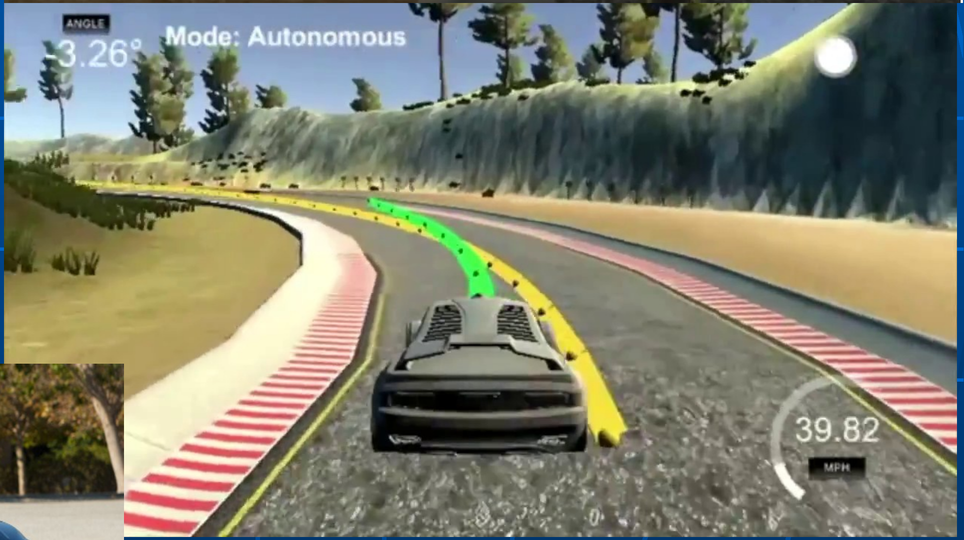
Go

Chess: 10^{47}
Deep Blue, Feb 10, 1996

Go: 10^{170}
AlphaGo, March, 2016

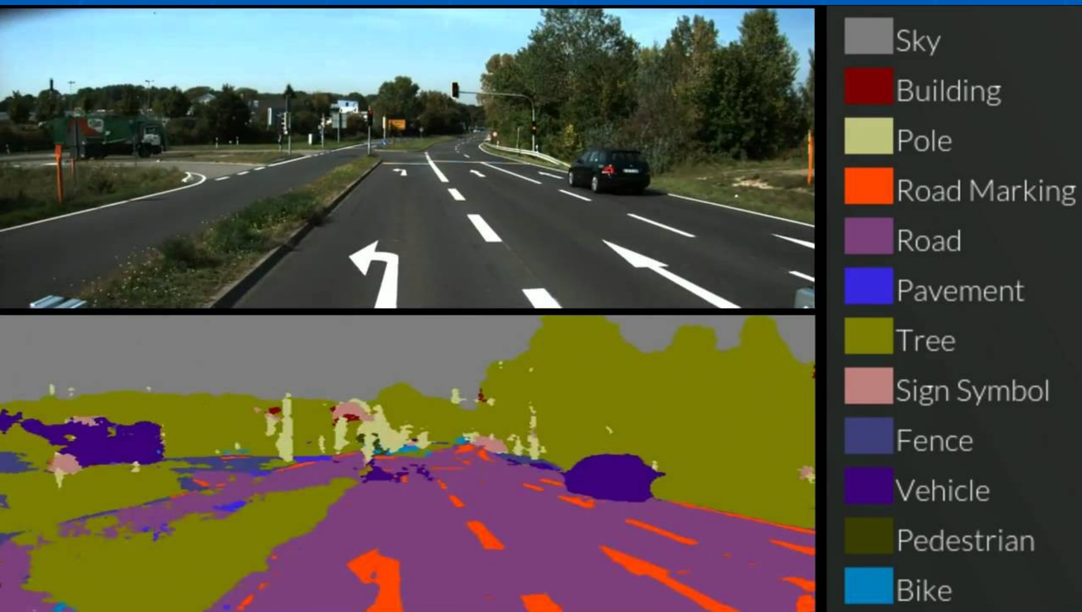


Model Predictive Control – Udacity Self-Driving Car



https://www.youtube.com/watch?v=r14Ll3Jycbw

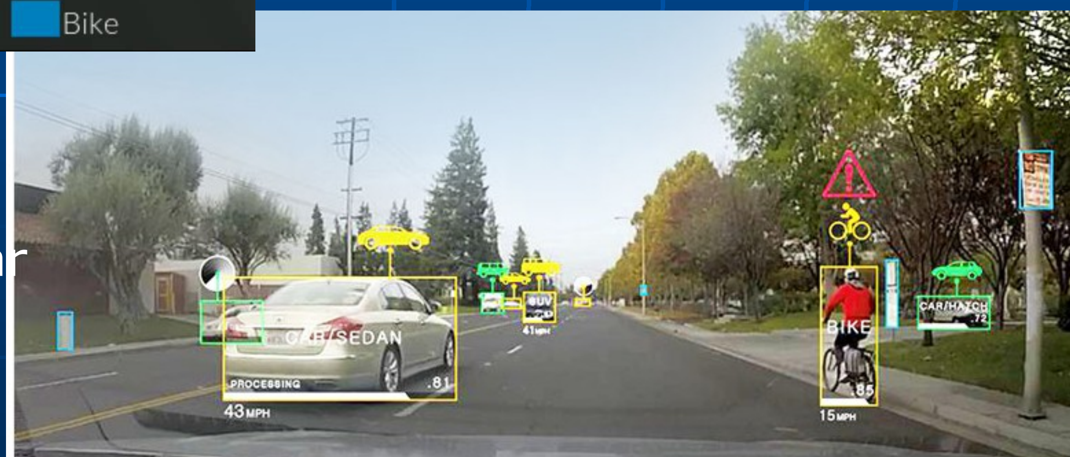
RL – Examples: Self Driving Cars



https://www.youtube.com/watch?v=kMMbW96nMW8

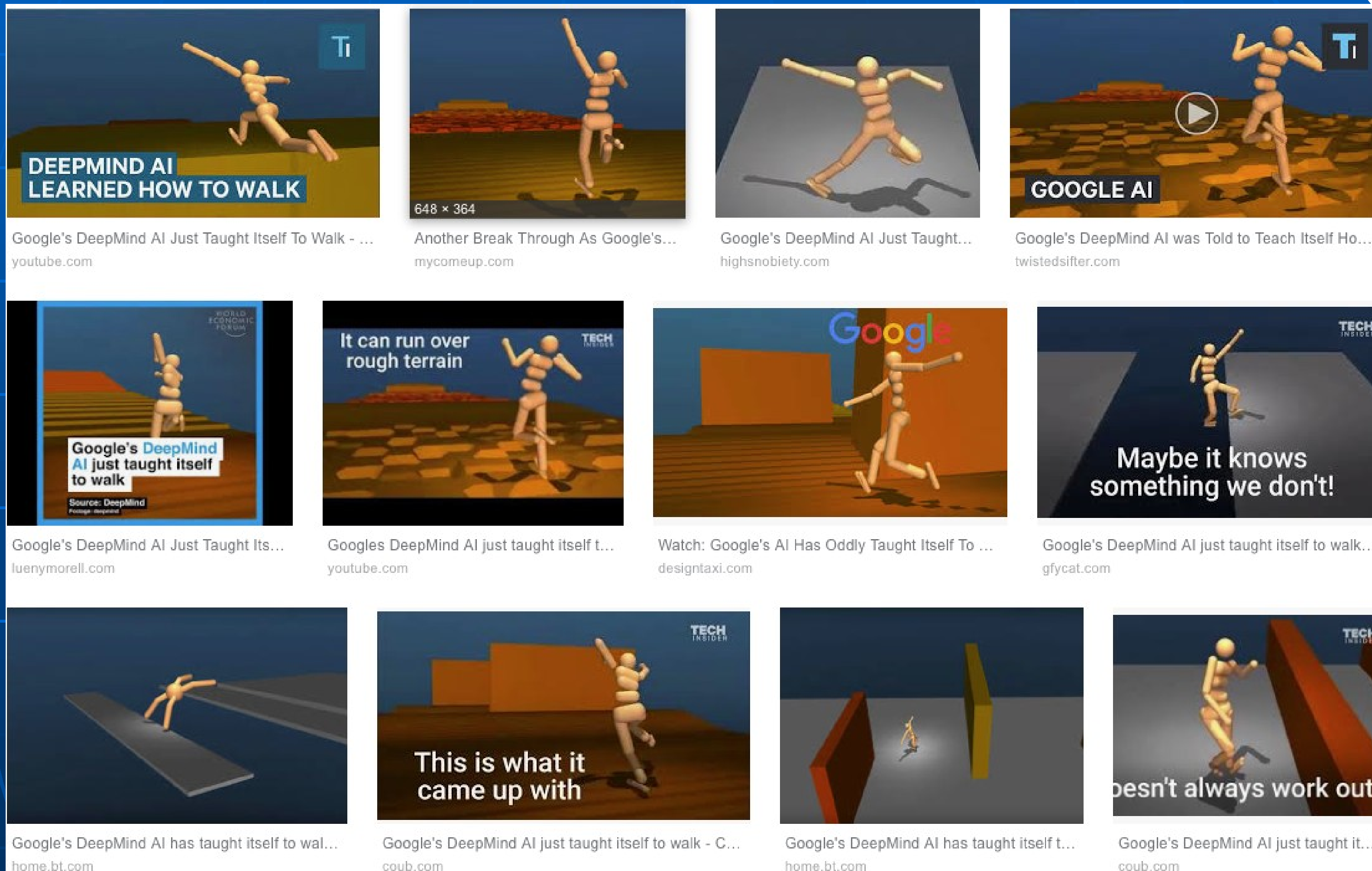
https://www.linkedin.com/pulse/machine-lea
fundamentals-self-driving-cars-david-silver/

Deep Learning:
Technology behind self-driving car
6.194 visualizations
Pub. 25/dec/2016



http://www.alphr.com/cars/1001713/practice-makes-perfect-driverless-cars-will-learn-from-

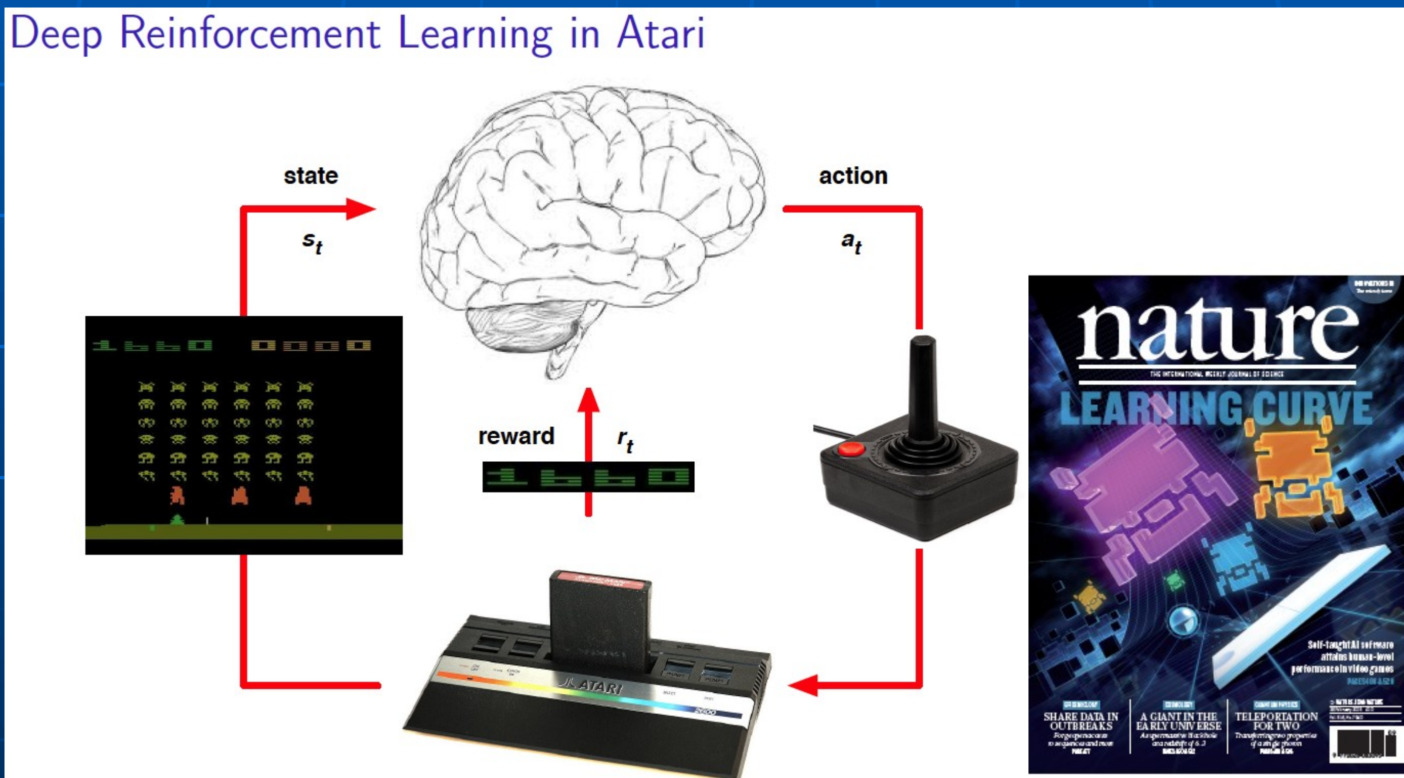
RL – Examples: Learn To Walk



Google's DeepMind AI
Just Taught Itself to Walk
5.985.455 vis. 12/jul/2017

https://www.youtube.com/watch?v=gn4nRCC9TwQ

Deep Reinforcement Learning



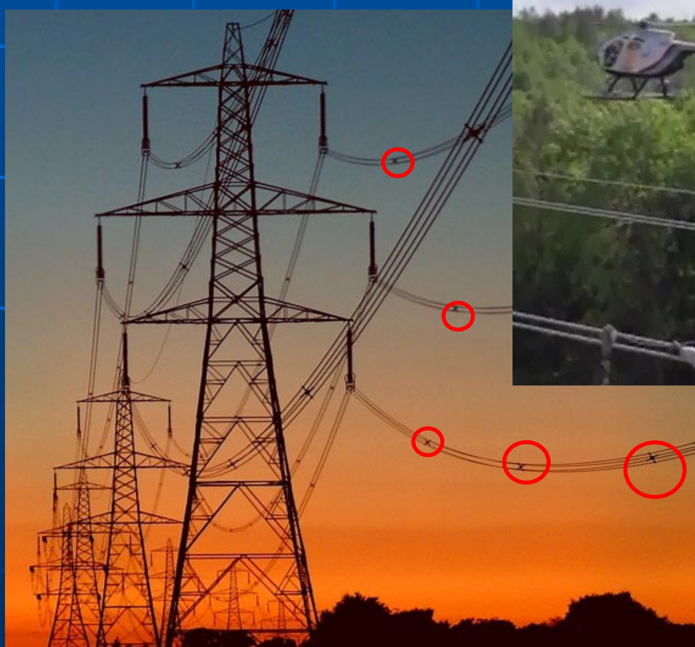
27 Fev 2015

28 jan 2016

Adapted from: Deep Reinforcement learning – D. Silver, Google DeepMind, 2016

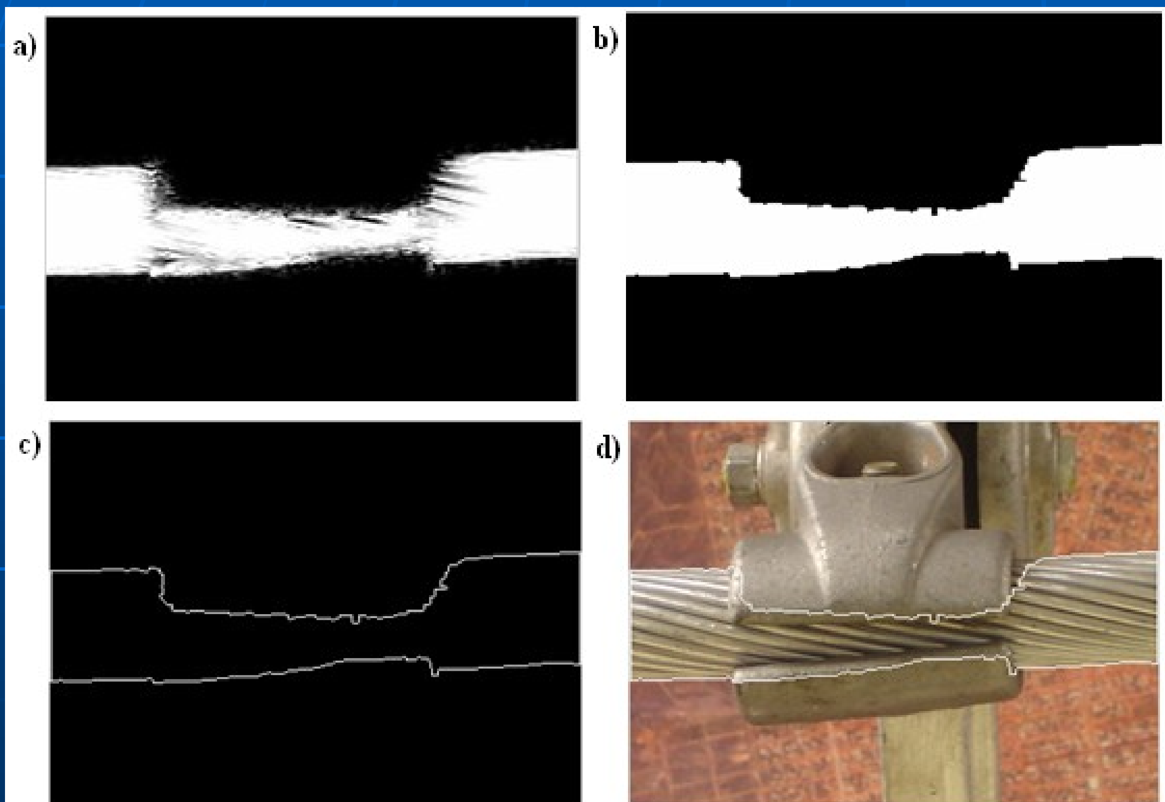
Inspection of Transmission Lines

- Autonomous system - visual inspection of electricity transmission lines
- Detection of flaws in the gripper of the line spacers

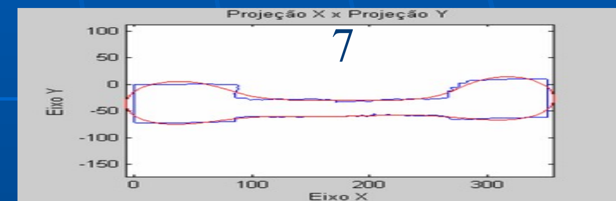


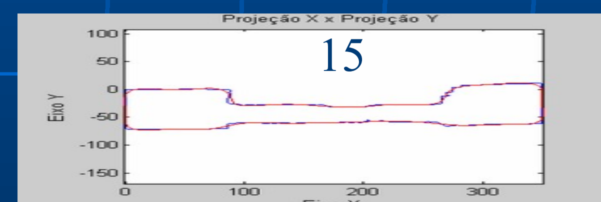
Need Maintenance!!

Gripped cable contour:
FFT coefficients of directional chains



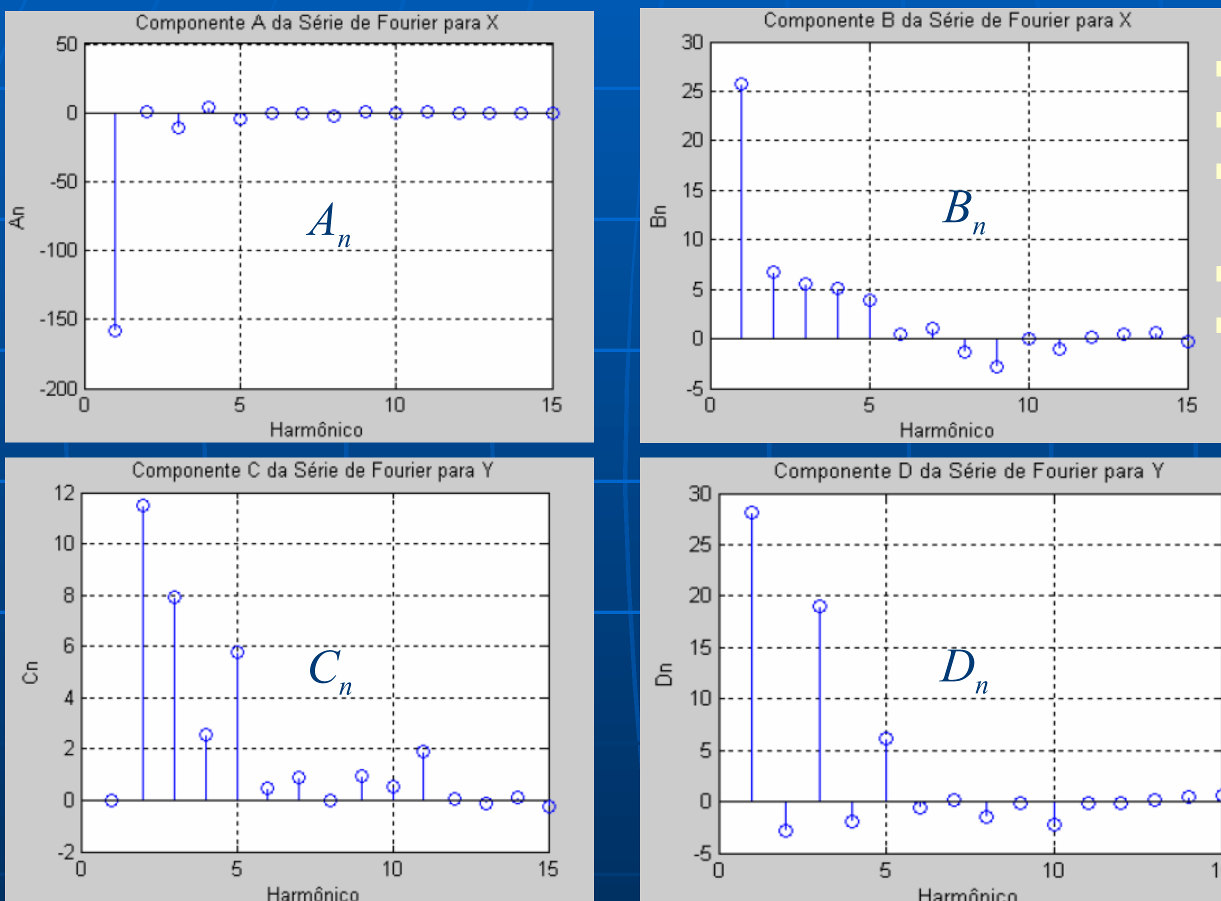
a) Gabor – b) Closing – c) Border – d)Image





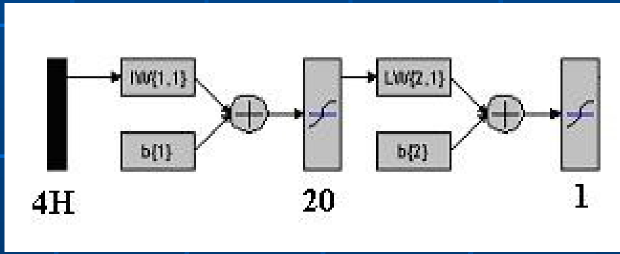
Reconstruction -
7 and 15 Harmonics

Gripped cable contour:
FFT coefficients of directional chains



- ANN –
- "Need Maintenance"
- classification

- Training, Test, Validation
- 80, 25, 25 images



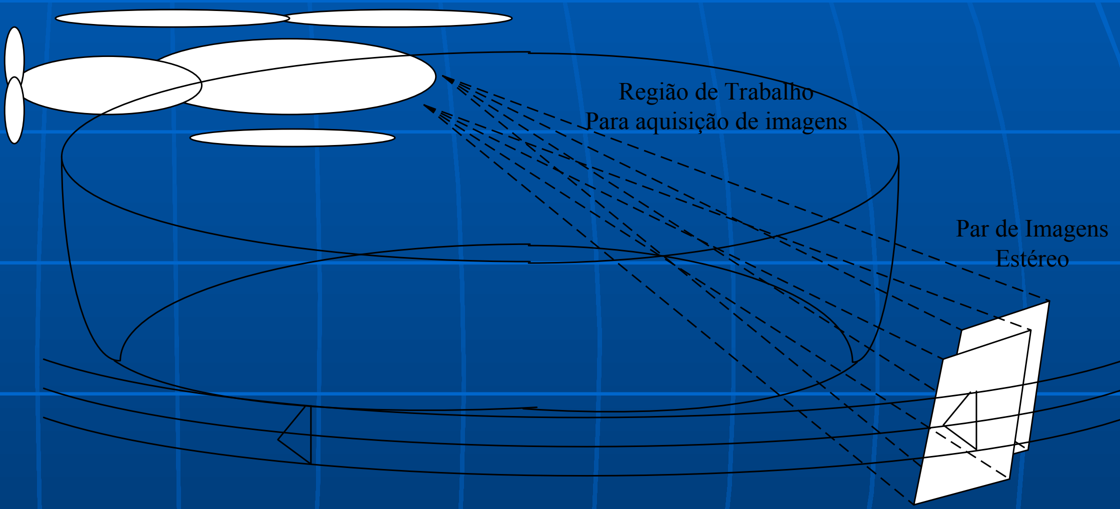
H=10 ➛
2 Misclassified images

H=12 ➛
1 Misclassified image

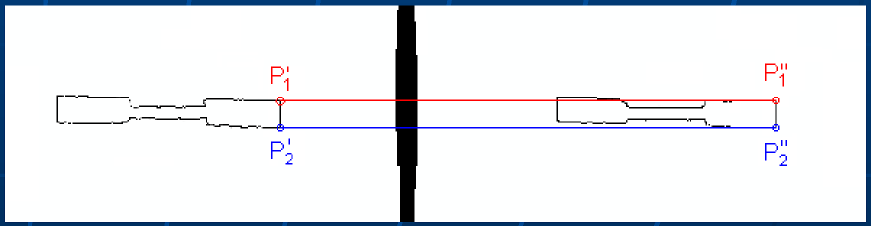
Flávio Oliveira & Alexandre Dias, 2007

Gripper inspection with 3D reconstr.

- It is not possible to train an ANN for every position/orientation in the visual field of the VANT.
- ANN trained for a fixed point of view.
- Build 3D contour model
- Reproject 3D contour to ANN point of view
- Classify with ANN

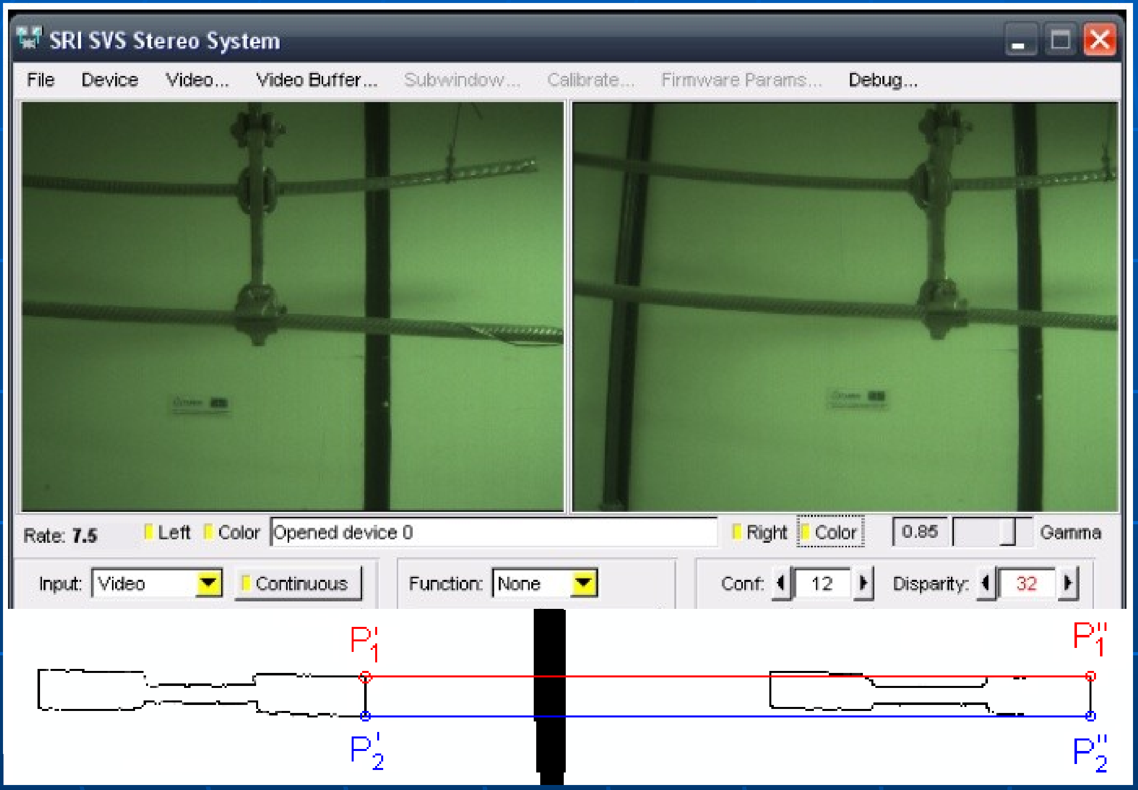


Different ROI’s

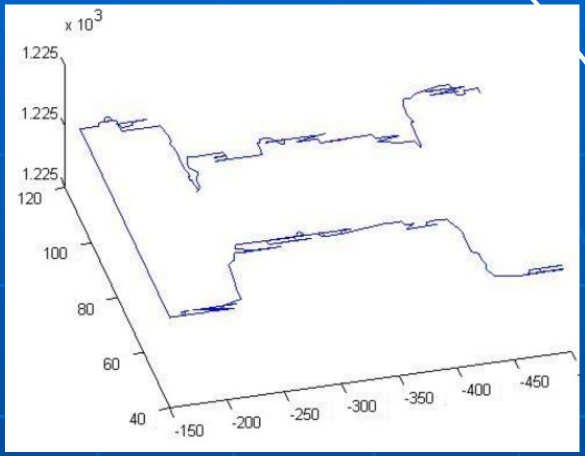


Correspondence –ROI contour in stereo pai

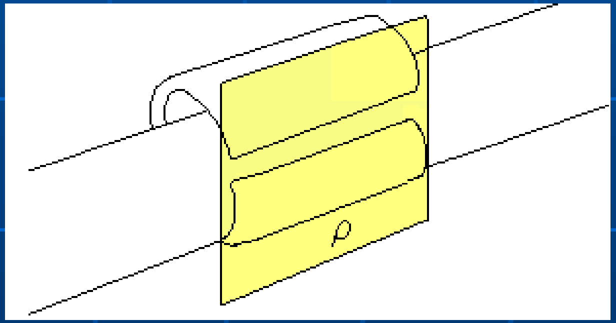
3D gripped cable



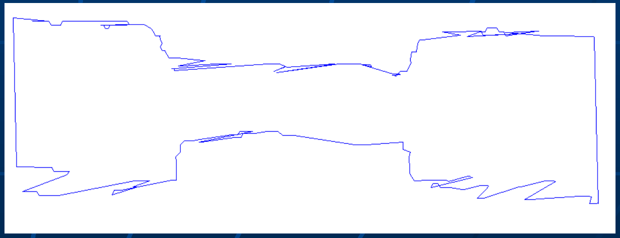
3D Reconstruction



ANN data bank Image plane



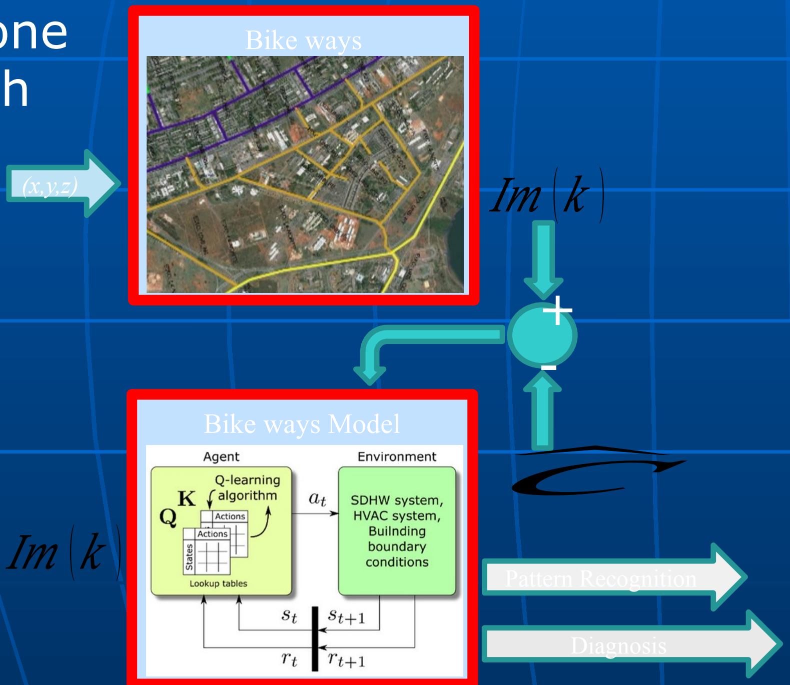
Reprojected contour for ANN



Results:
20 stereo pairs – 1 false pos., 1 false neg.
Elder Oroski, 2011

ChangeNet as Cycleway
Digital Twin

Drone
path

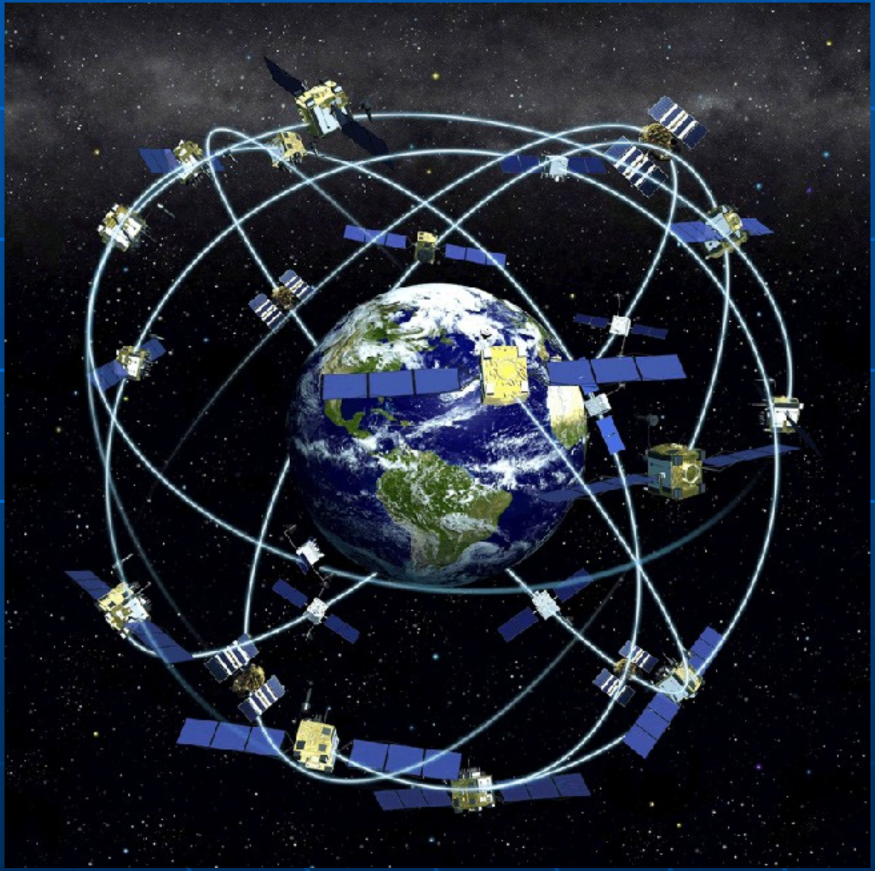


= *f* (Im(k), Im(k-1), Map, Inference Engine, Rule Basis)

@AB2020 BLL

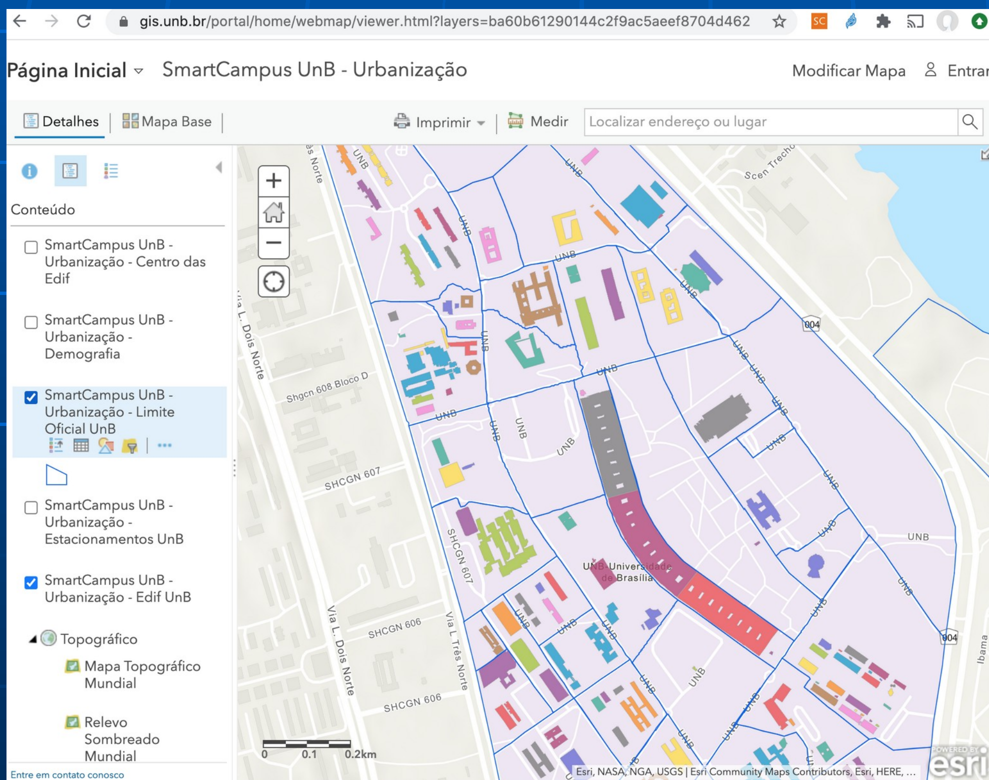
GPS + GIS

- Global Positioning System
- Geographical Information System



GPS + GIS + CPS ⇢ CyberGIS

- CPS - Cyber-Physical Systems



DRL Drone Bikeway Inspection
Digital Twins

BSB Living Labs - ENE/ENC-UnB 2020

DRL Drone Bikeway Inspection
Digital Twins

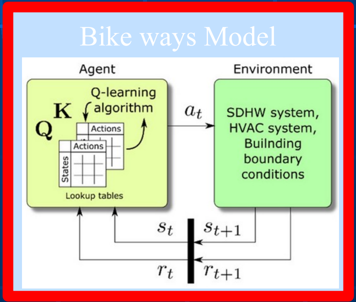
BSB Living Labs - ENE/ENC-UnB 2020

Stored Info
-Map
-Registered Bikes

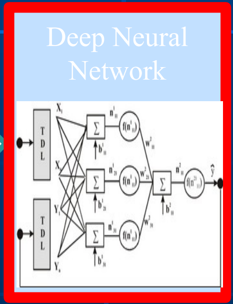
Trajectories
(*x,y,z,,t*)

$Im(k)$

$Im(k)$

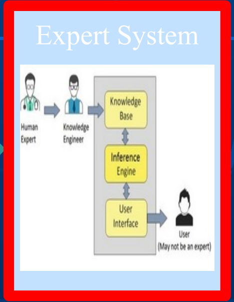


hange



attern Recognition

-*Hole*
-*Near FT Block F*
-Coord. (*23N,300W*)

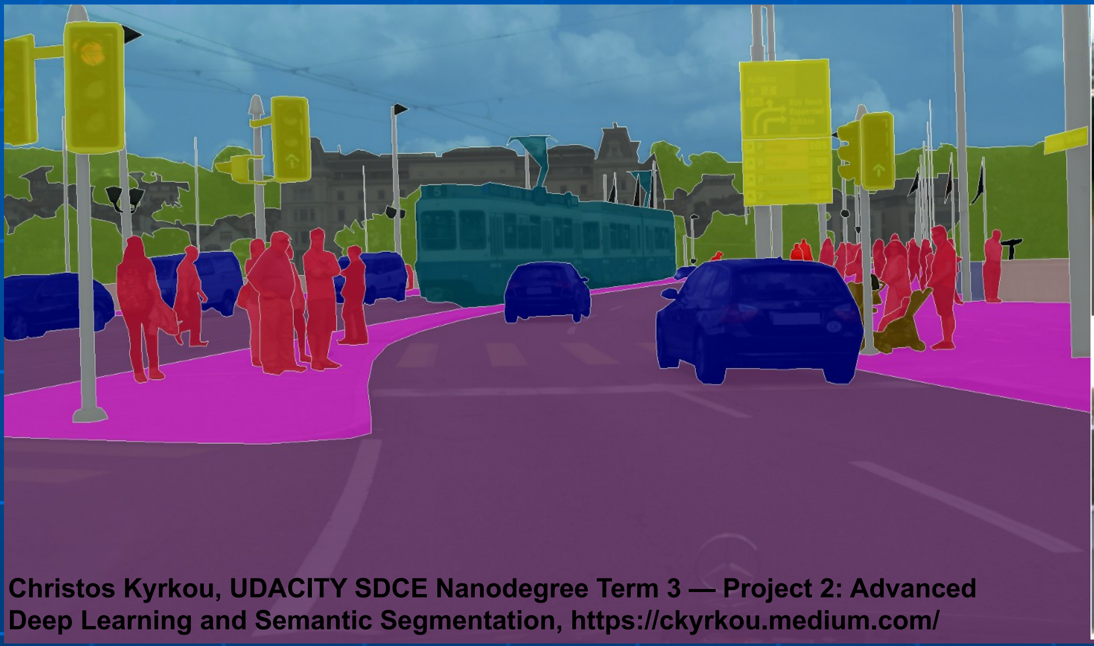


- iagnosis
- Recommended actions at (x,y)

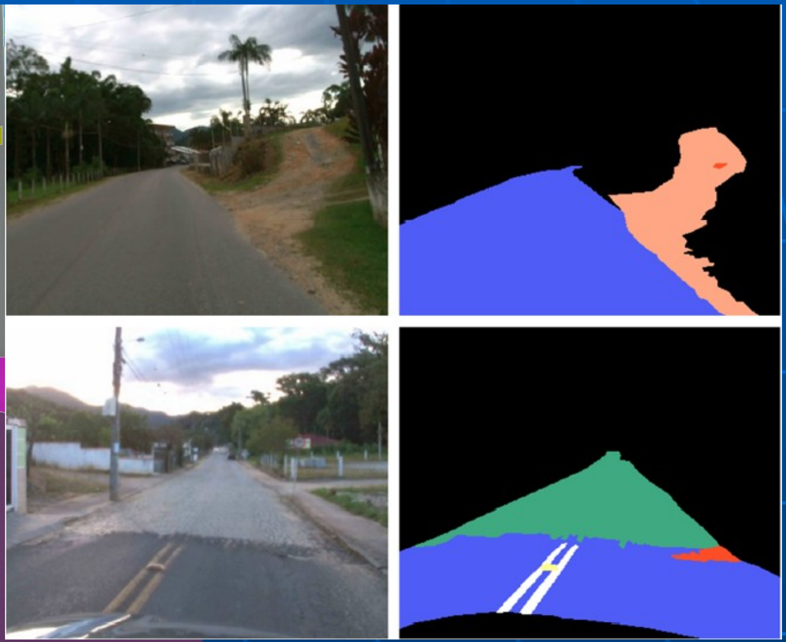
-*Urgent*
-*Send Mantainance*

$= f\,(Im(k), Im(k\text{-}1), \ldots\ Map, Rule\ Base, Inference\ Engine)$

Semantic Segmentation

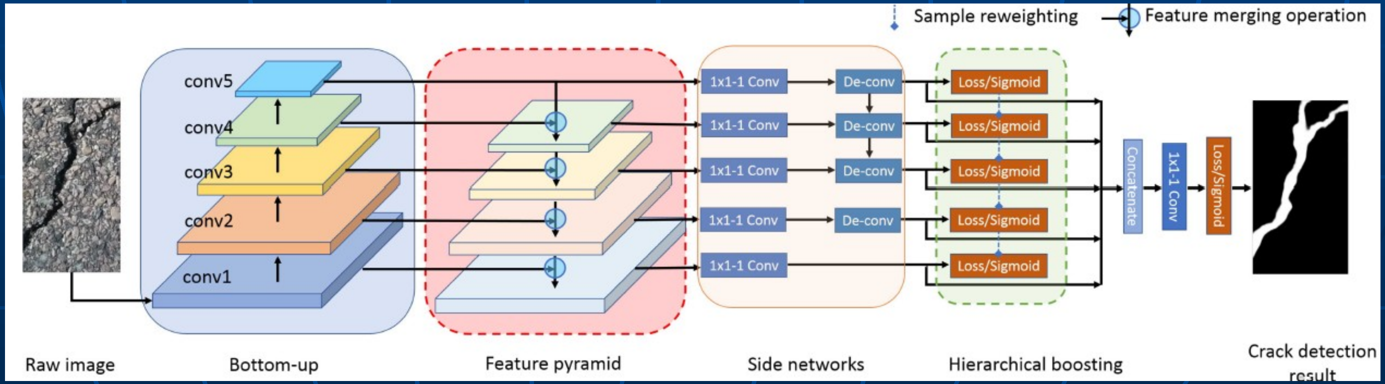


Christos Kyrkou, UDACITY SDCE Nanodegree Term 3 — Project 2: Advanced Deep Learning and Semantic Segmentation, https://ckyrkou.medium.com/



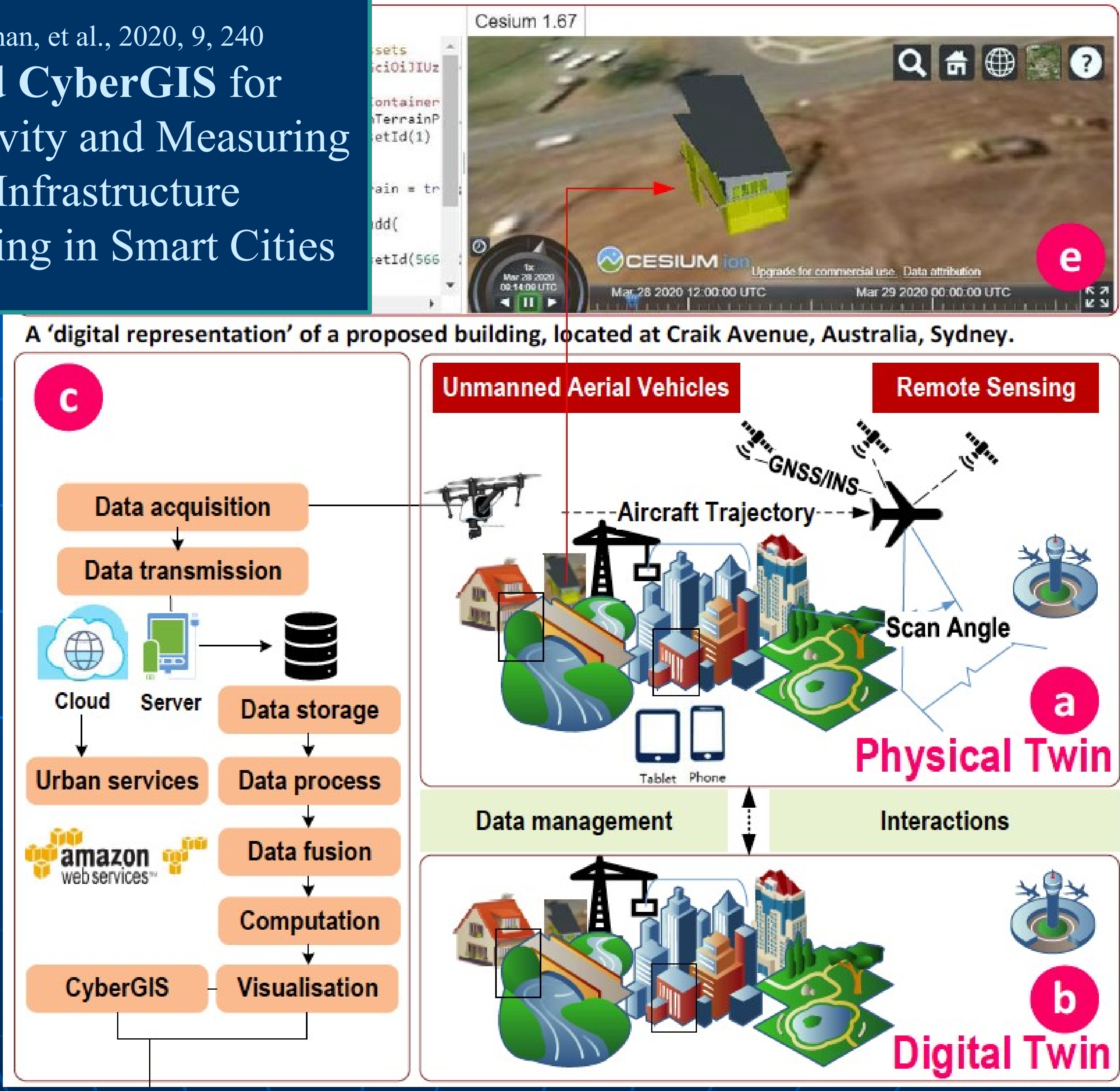
Thiago Rateke and Aldo von Wangenheim. Road surface detection and differentiation consideringsurface damages. 6 2020.

Gang Yang, Heng Chao Li, Wen Yang, Kun Fu, Yong Jian Sun, and William J. Emery. Unsupervised Change Detection of SAR Images Based on Variational Multivariate Gaussian Mixture Model andShannon Entropy.IEEE Geoscience and Remote Sensing Letters, 16(5):826–830, 2019



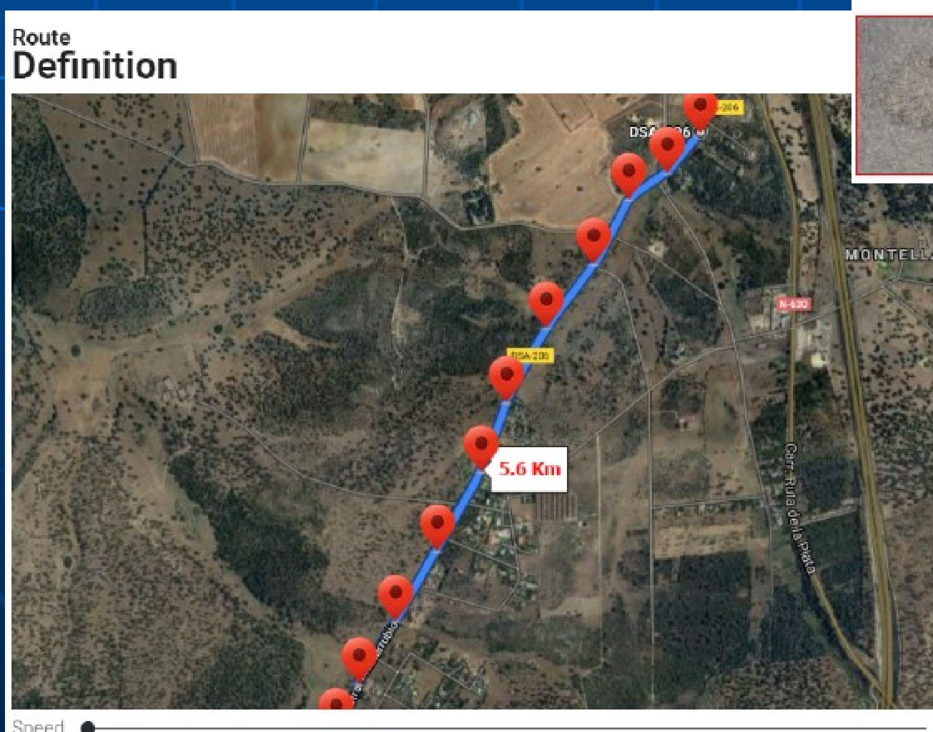
Ijgi Editorial – Shirowzhan, et al., 2020, 9, 240

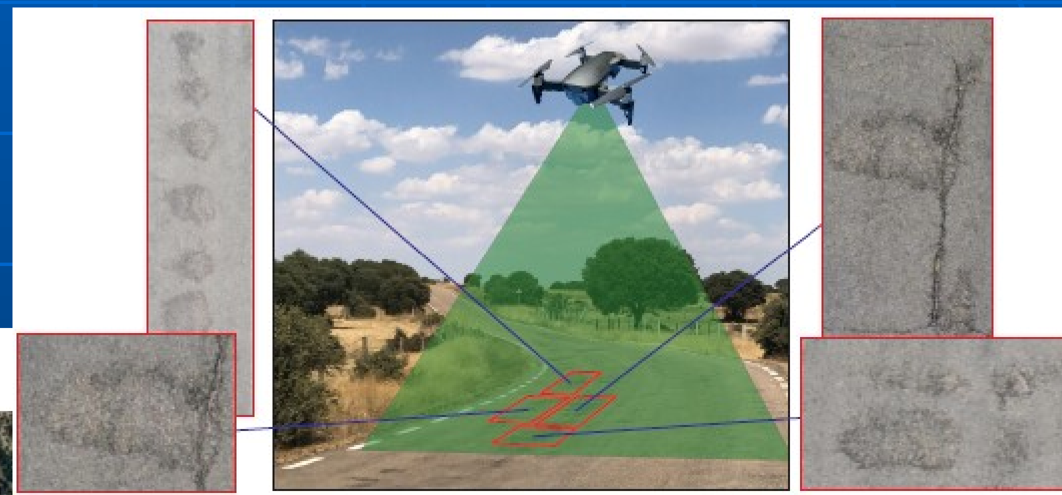
Digital Twin and **CyberGIS** for Improving Connectivity and Measuring the Impact of Infrastructure Construction Planning in Smart Cities

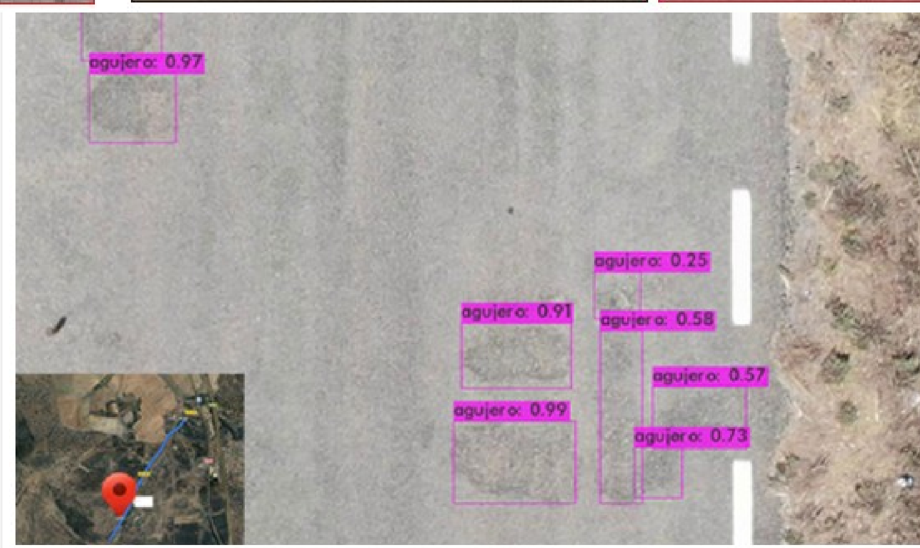


An Architectural Multi-Agent System for a Pavement MonitoringSystem with Pothole Recognition in UAV Images

L.A. Silva, H.S. San Blas, D.P. García, A.S.Mendes, and G.V. González. Sensors , 20(21), nov 2020.

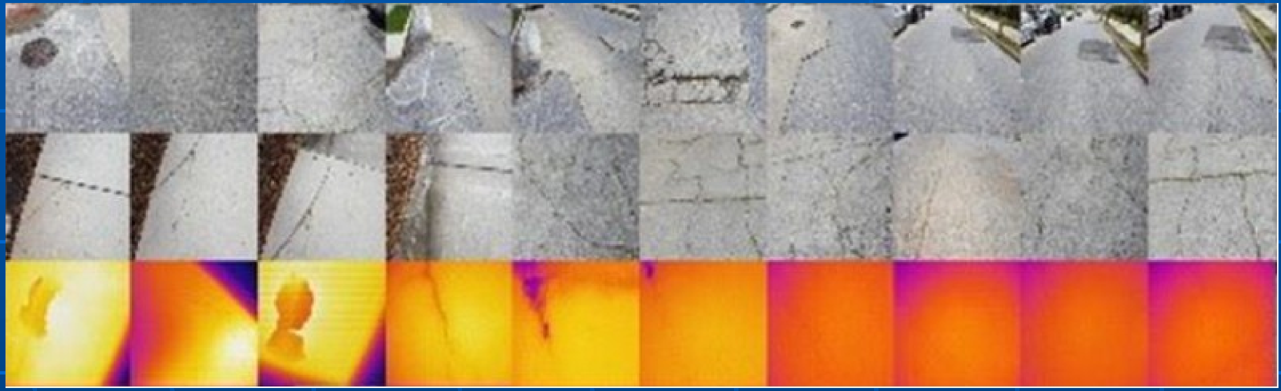






Low-cost deep learning uav and raspberry pi solution to realtime pavement condition assessment

Murad Al Qurishee and Weidong Wu, Univ. of Tennessee at Chattanooga, 2019.



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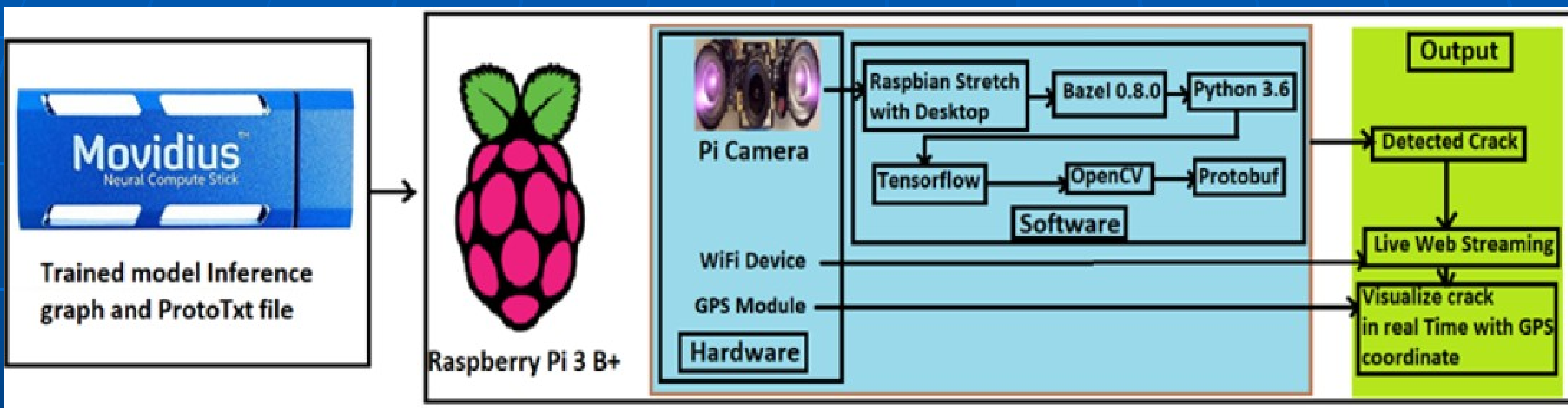

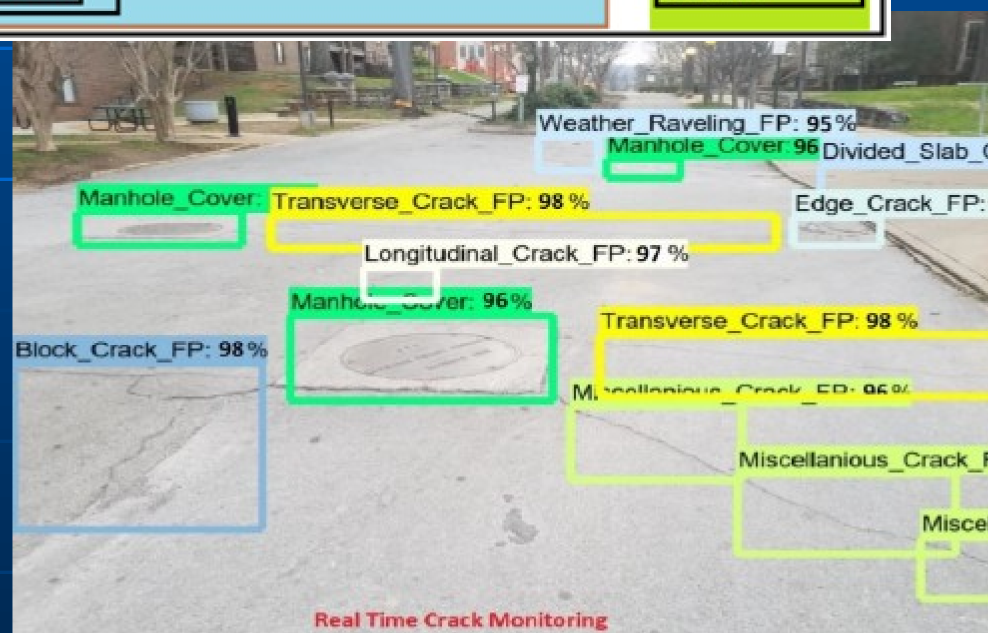

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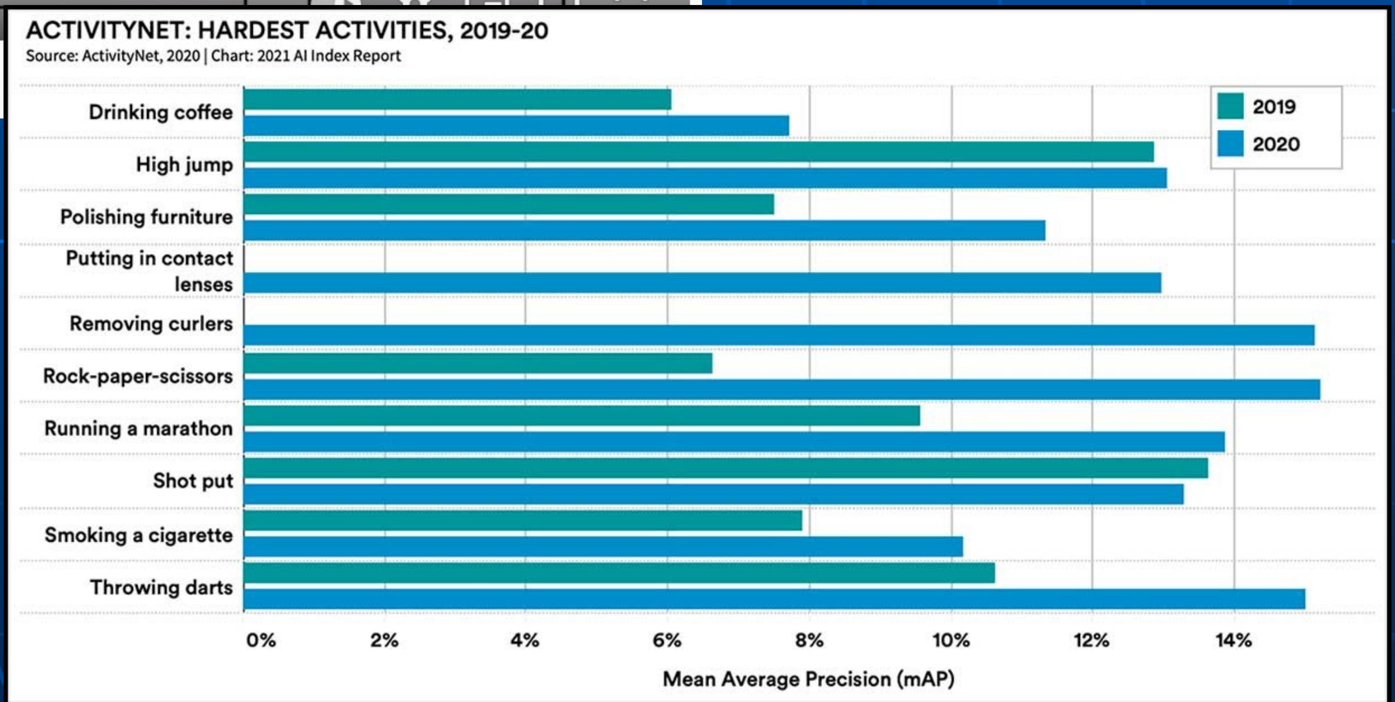
Models	Mean Average Precision (mAP)	Real-time speed (FPS)
Faster R-CNN + inception V2	98%	0.5
Faster R-CNN + NasNet	94%	0.01
Faster R-CNN + ResNet101	97%	0.1
R-FCN + ResNet101	87%	0.15
YOLO	26%	5
SSD + MobileNet V1	96%	13.8
SSD + Inception V2	86%	3.6

Perspectives

ActivityNet A Large-Scale Video



AI Opportunities

- Deep Learning

- Reinforcement Learning

- Explanation Components

"They shouldn't allow humans to drive!"

Challanges

- AI with emotions

- AI consciosness

- ethics in AI

- non-human intelligence

- AGI (General, Strong AI)

Learn to Drive:
Self-Driving Car: >>1000 h
Human ~ 20 h

Super-human in one task != Intelligent!!

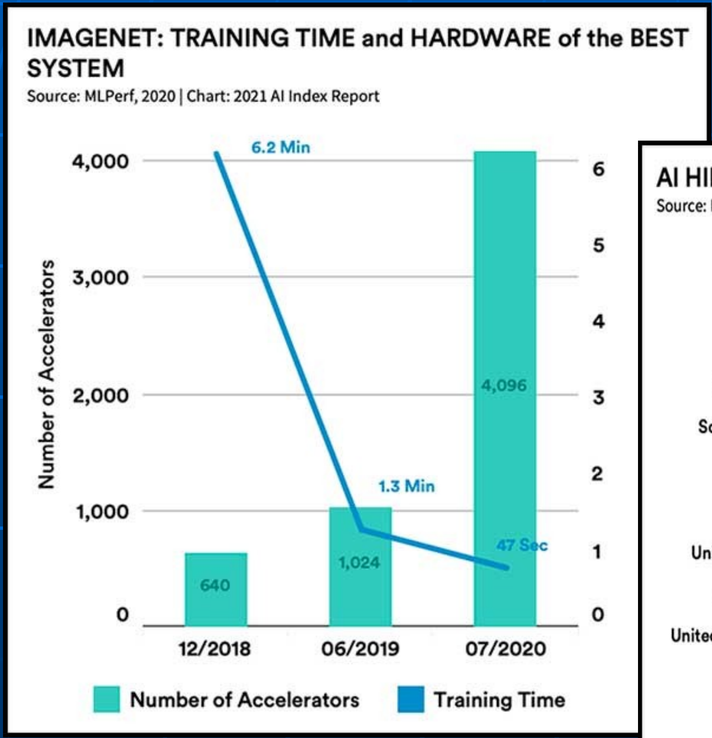
The 10 most in-demand **Jobs in AI** - 2021

1. Machine Learning Engineer
2. Deep Learning Engineer
3. Senior Data Scientist
4. Software Engineer
5. Interns
6. AI Specialist
7. Robotics Engineer
8. Full Stack Engineer
9. Site Reliability Engineer
10. Cybersecurity Specialist

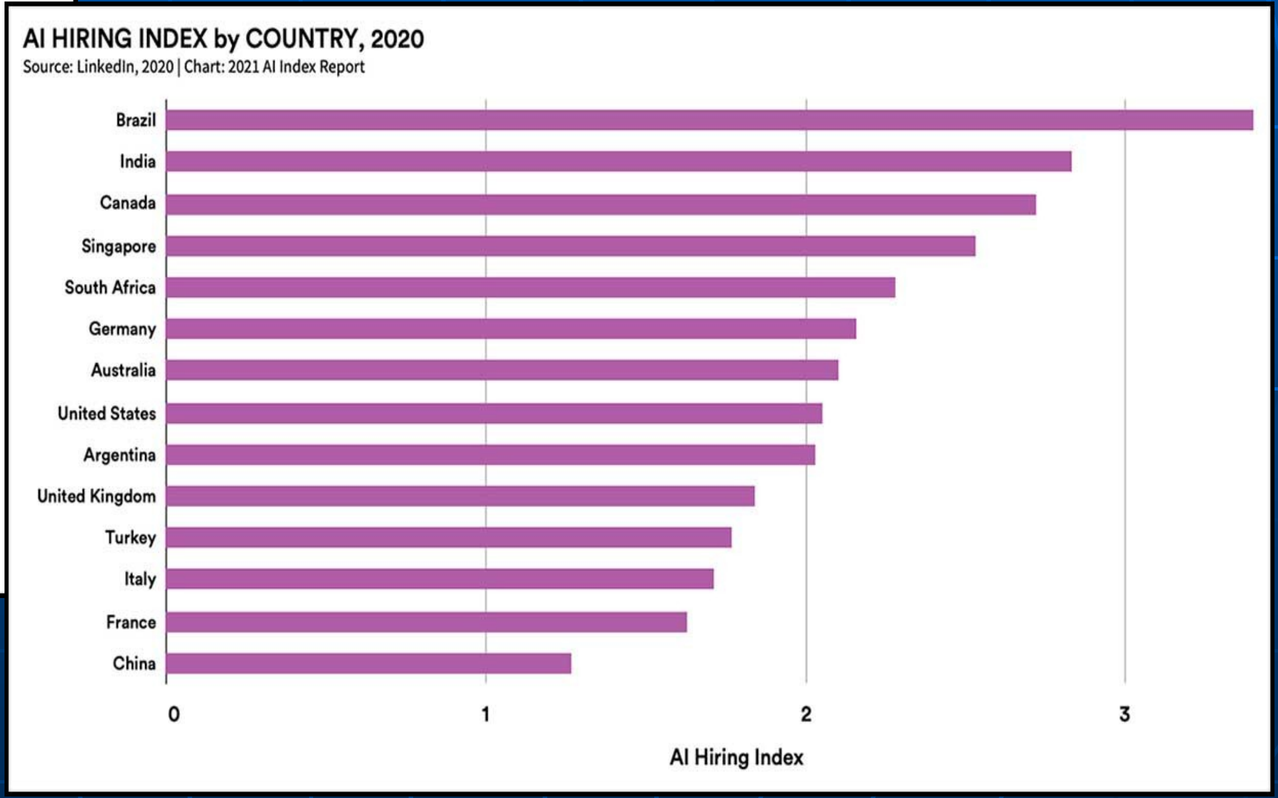
https://moneyinc.com/most-in-demand-jobs-ai-2021/

15 Graphs You Need to See to Understand AI in 2021

The 2021 AI Index provides insight into jobs, publications, diversity, and more



https://spectrum.ieee.org/tech-talk/artificial-intelligence/machine-learning/the-state-of-ai-in-15-graphs



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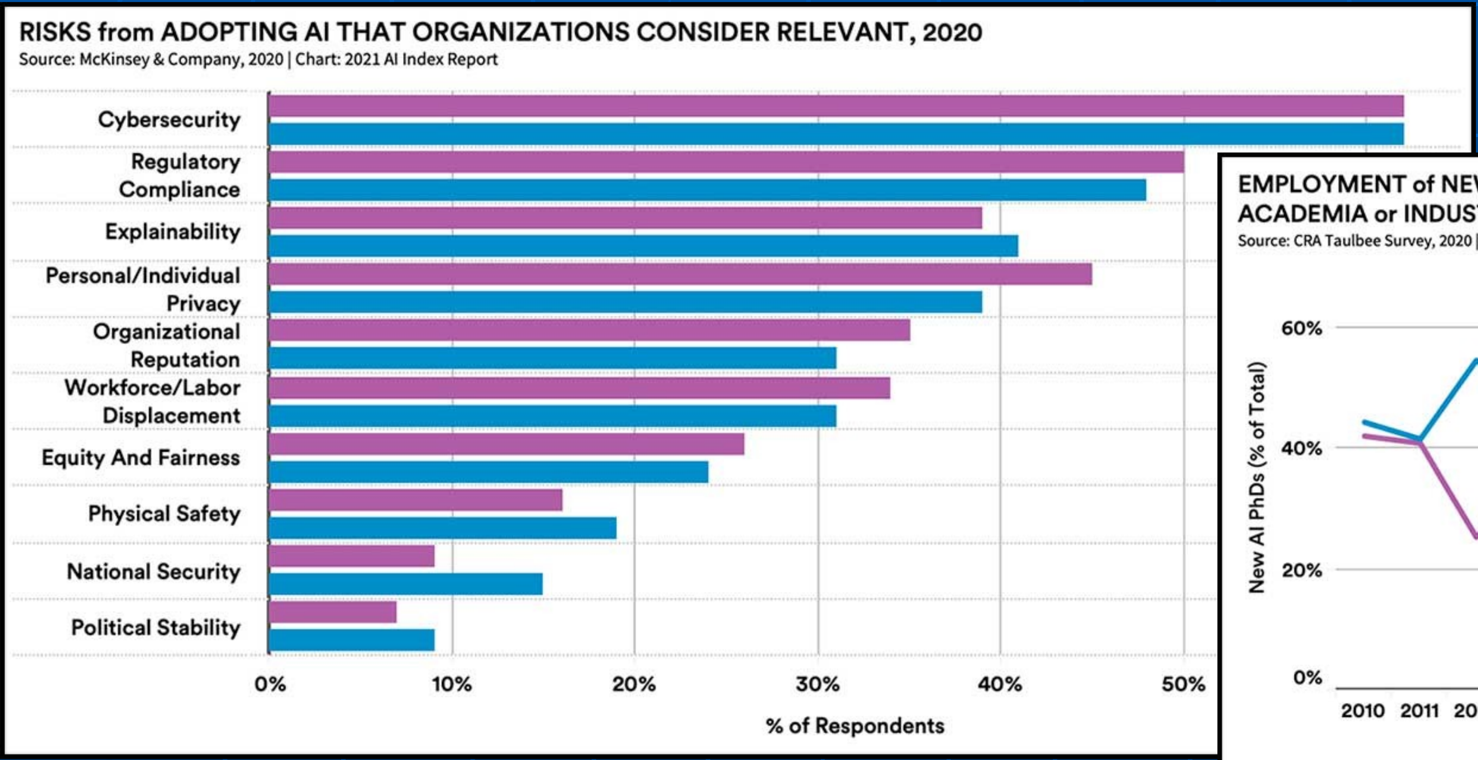

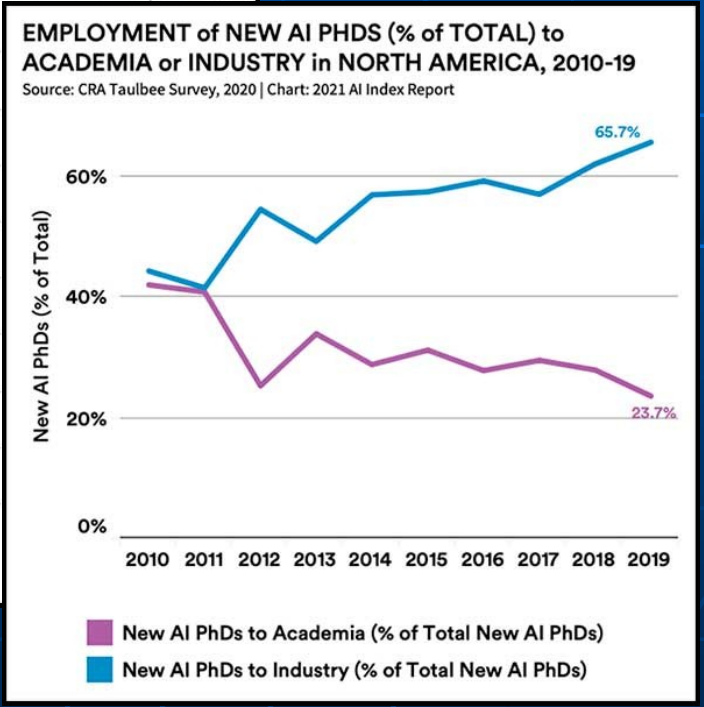

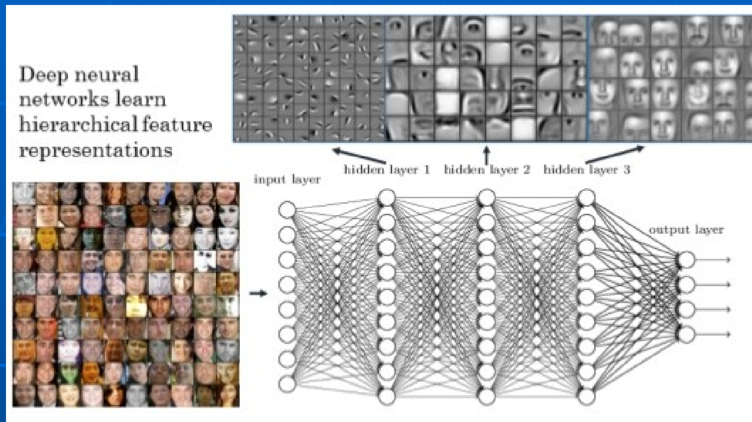

Thank You!

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adolfobs@ene.unb.br