

Introdução ao *Machine Learning*

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Education Tech Lead na DIO

Doutor em Robótica e *Machine Learning* pelo ICMC-USP



Machine Learning

Machine Learning

Prof. Dr. Diego Bruno



Máquinas que pensam como humanos



- Treinamento de sistemas de **Inteligência Artificial**;
- Tomada de decisão com suporte de **base de regras** bem definidas;
- Não toma decisão com base na emoção;
- Automação para correção e suporte de falhas humanas.

Como a IA é vista hoje?

IA Geral

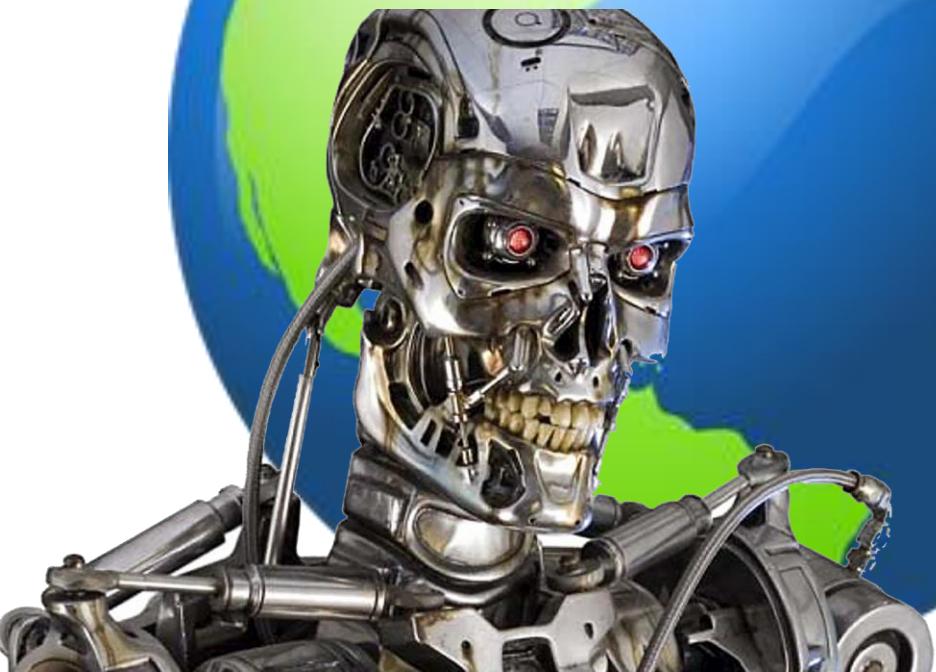
IA Restrita

Aprendizado de Máquina



Steven Spielberg

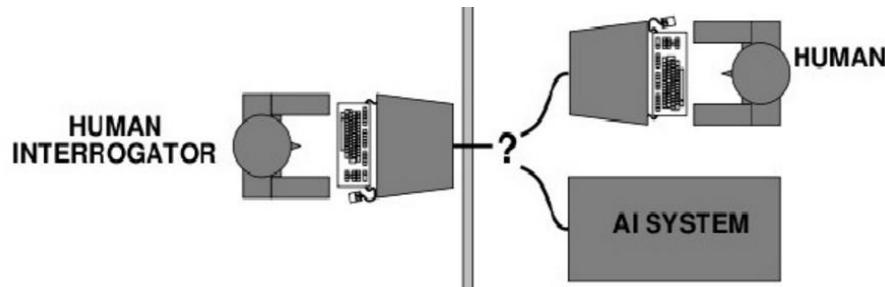
Ficção Científica



Ex Machina

Um humano escolhido para o **teste de Turing** com uma máquina com IA:

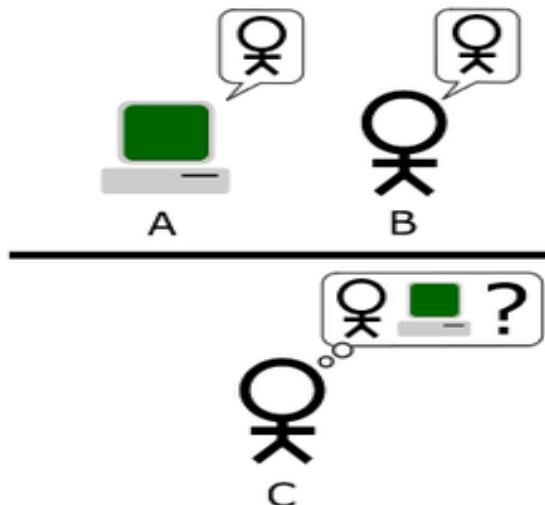
- Baseado no jogo da imitação



ex machina

Ex Machina

Um humano escolhido aplicando o **teste de Turing** em uma máquina:



O **Teste de Turing** testa a capacidade de uma máquina exibir comportamento inteligente equivalente a um ser humano, ou indistinguível deste.

Primeiro Robô a ter cidadania

Interação humano-robô

- Capaz de reproduzir 62 expressões faciais
- Objetivo é conseguir uma maior aceitação da robótica no mesmo ambiente humano
- Ainda não consegue passar no teste de Turing

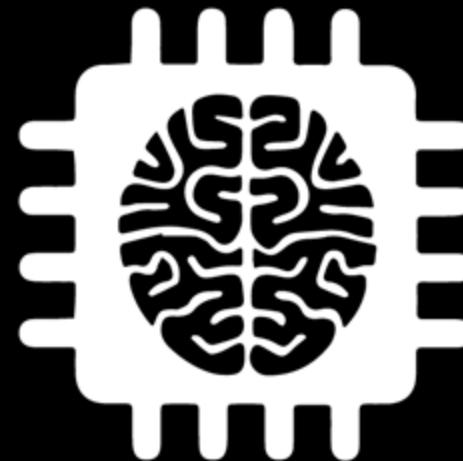


Sophia

A photograph of Sophia, a humanoid robot with a bald head and a black jacket with a polka-dot pattern. She is smiling and looking towards the camera. The background is a blurred indoor setting with blue and green lights.

Fabricante	Hanson Robotics
Inventor	David Hanson
Ano de criação	2015
Tipo	Robô humanoide
País	Hong Kong, Arábia Saudita
Website	sophiabot.com

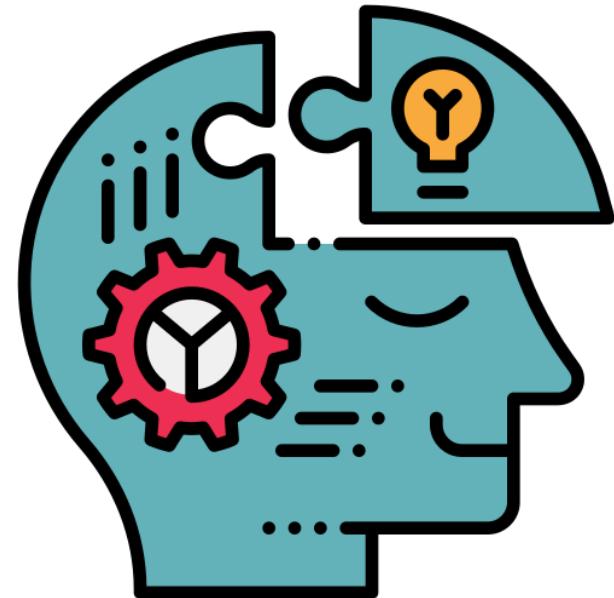
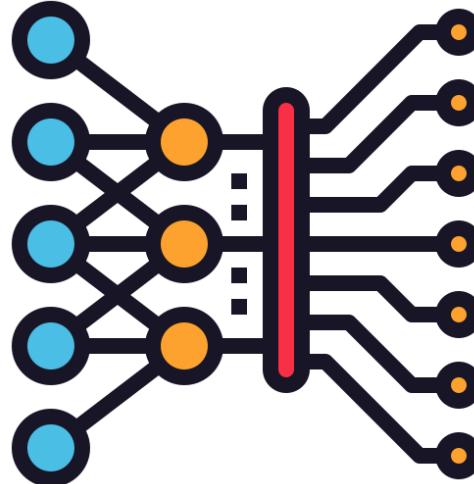
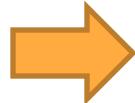
Mas qual a
relação entre ML e
IA?



Mas qual a Relação entre ML e IA?

Por meio do **ML** obtemos (ou não) uma **IA** restrita.

Aprendizado de
Máquina
(Treinamento)



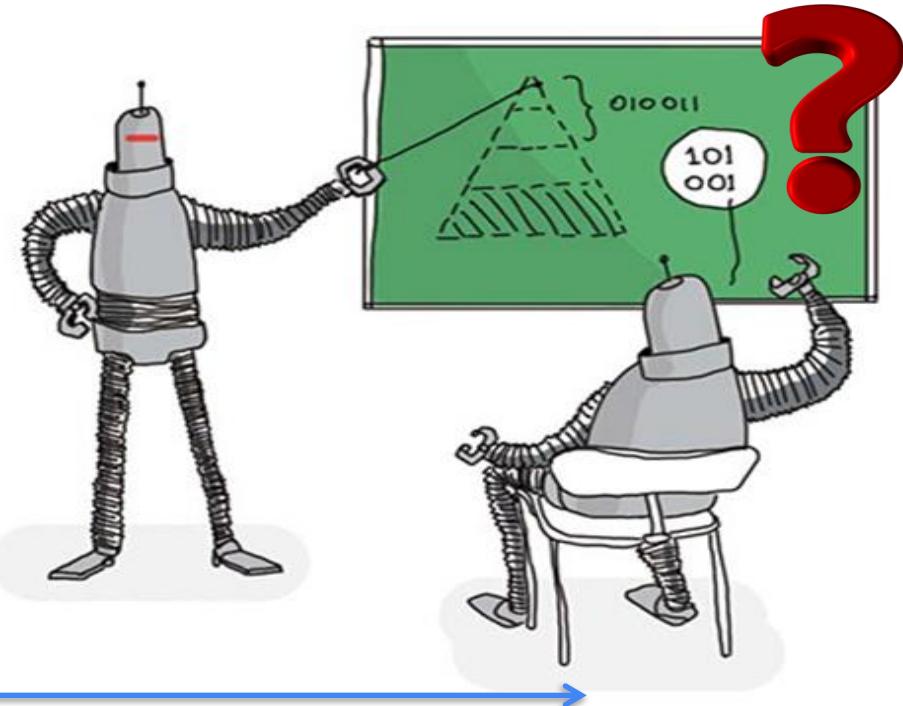
Inteligência Artificial

Mas o que é Machine Learning?

Dependente de uma base de conhecimento...

O objetivo do aprendizado de máquina (ou "*machine learning*") é programar computadores para aprender um determinado comportamento ou padrão automaticamente a partir de exemplos ou observações.

DATASETS



Inteligência Artificial Restrita

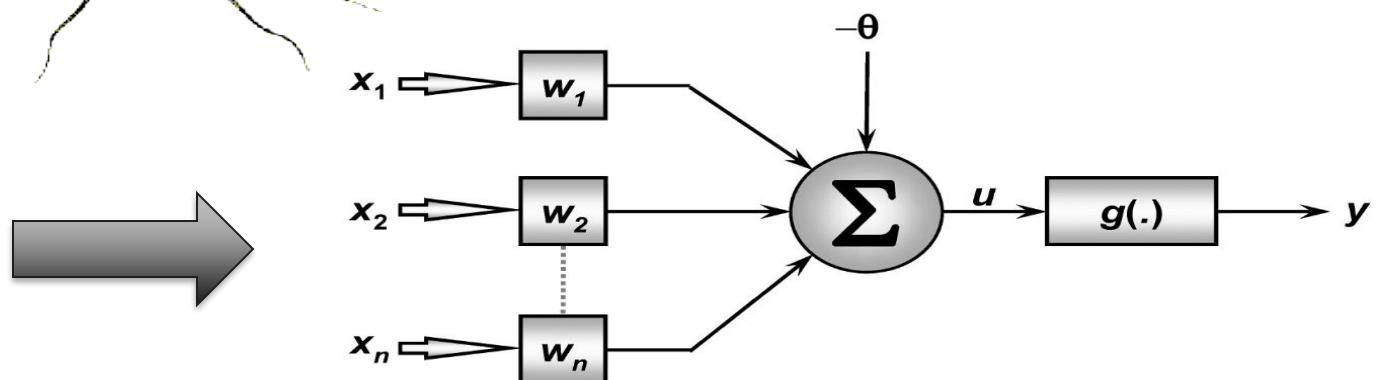
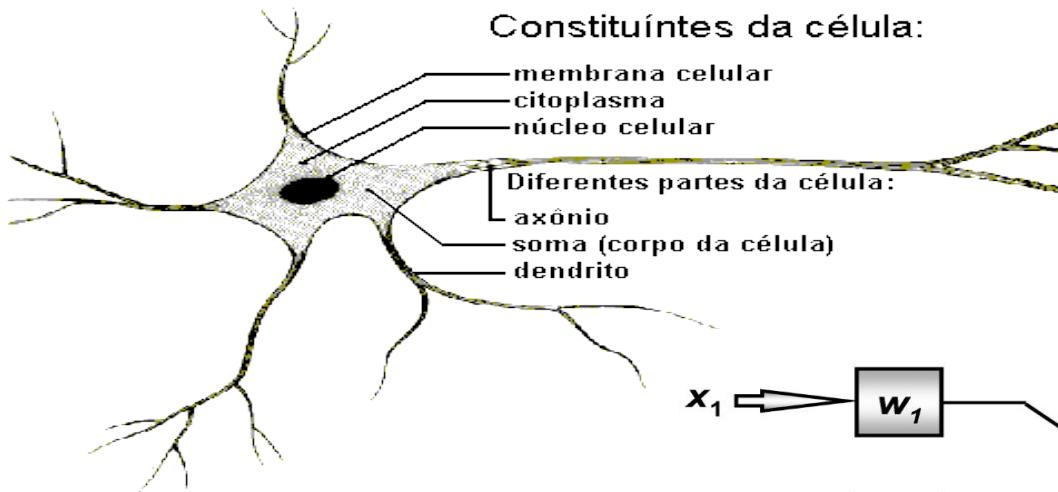


Exemplo de Aprendizado

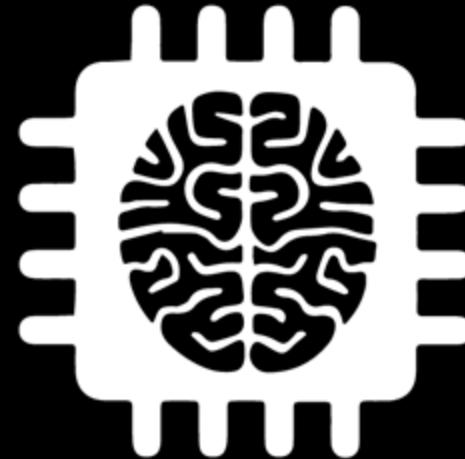


Aprendizado por Reforço

Inteligência Artificial Restrita



Aplicações em Veículos Autônomos



Pesquisa em Veículos - ADAS



Trabalho de doutorado:
Diego Renan Bruno



Serviço

SMART CITY



WAYMO

uber



Trabalhos Realizados



Laboratório de Robótica Móvel
ICMC/USP - São Carlos

CARINA 1



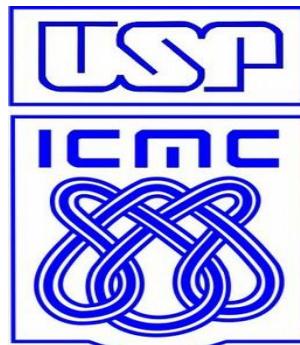
CARINA 2



Trabalhos Realizados



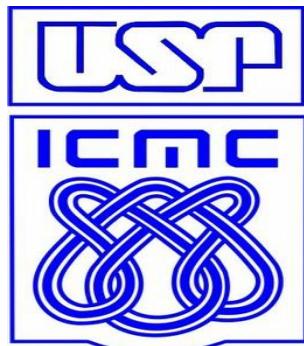
Laboratório de Robótica Móvel
ICMC/USP - São Carlos



Trabalhos Realizados



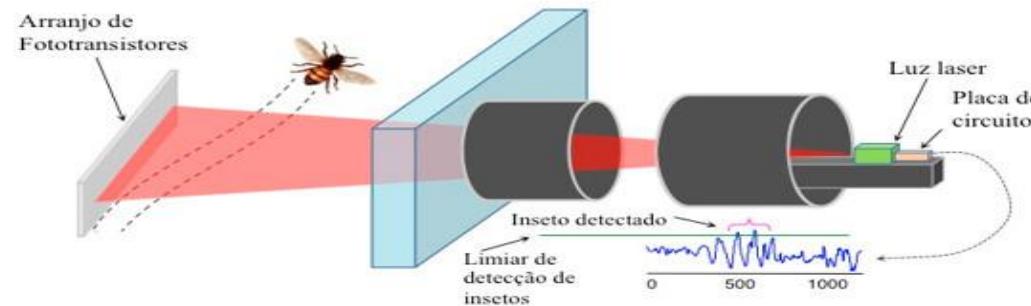
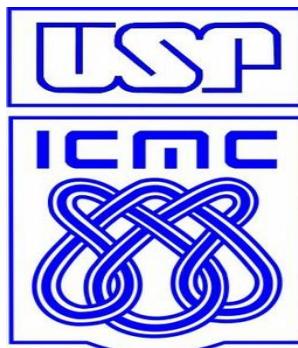
Laboratório de Robótica Móvel
ICMC/USP - São Carlos



SCANIA



Trabalhos Realizados

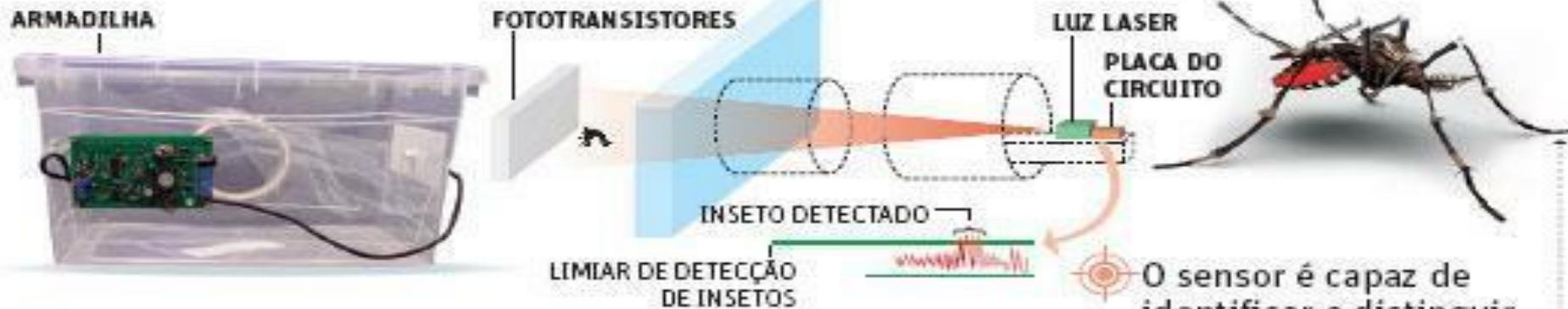


Trabalhos Realizados

EDITORIA DE ARTE / O TEMPO

COMO FUNCIONA

A armadilha de insetos

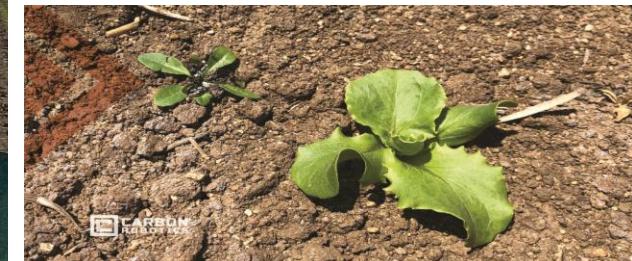
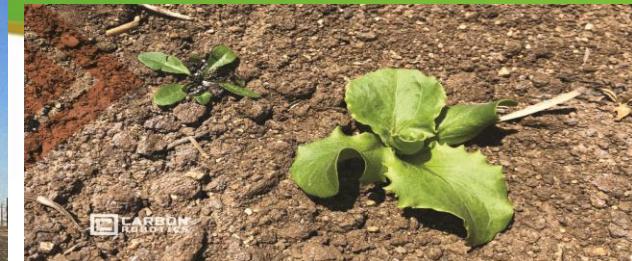


O mosquito é atraído por dióxido de carbono. Depois, ele é puxado por um fluxo de ar em direção ao sensor e lá é identificado.

A armadilha possui um dispositivo que emite uma luz a laser. Ao atravessá-la, as variações das asas do mosquito são captadas

O sensor é capaz de identificar e distinguir até o **Aedes aegypti** macho da fêmea. Isso é importante porque são as fêmeas que transmitem doenças como zika, dengue e chikungunya.

Trabalhos na agricultura



Trabalhos Realizados

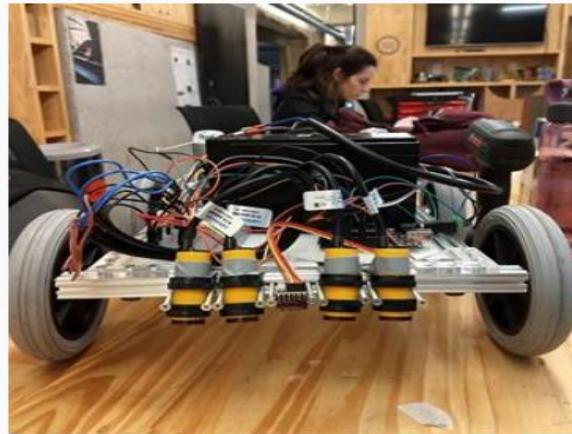


Trabalhos Realizados



Cão-guia Robótico V2

- *Hardware*
- *Controle*
- *Visão Computacional*



Dataset

Transfer Learning: Dataset de treinamento para o sistema



150 imagens



100 imagens



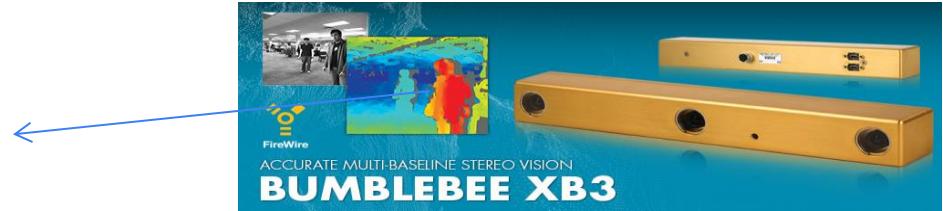
300 imagens

Sensoriamento: Dados gerados

Fusão de Sensores para Visão Computacional:

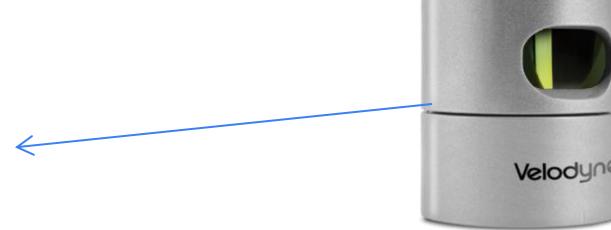
➤ Câmera estéreo 3D:

- Imagen 3D – (para detecção)
- Imagen 2D – (para reconhecimento)



➤ LIDAR - *Velodyne HDL- 32E*:

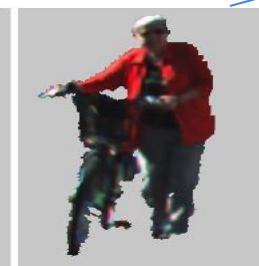
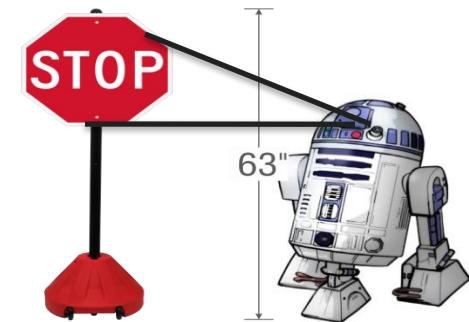
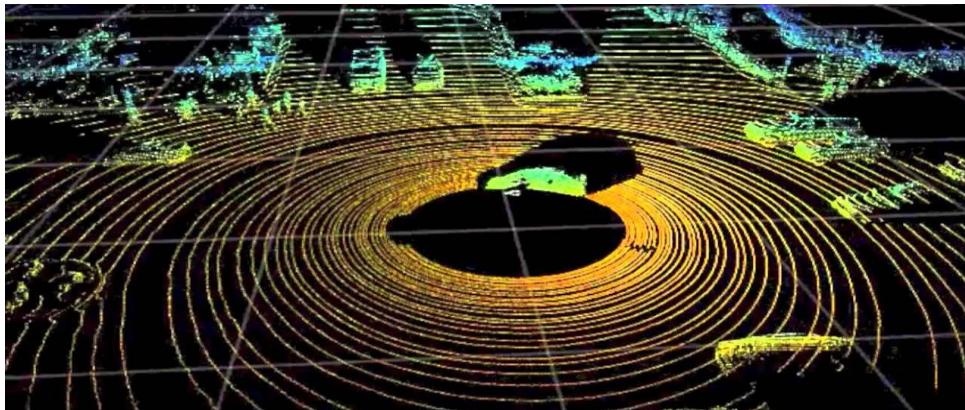
- Nuvem de pontos 3D – (para detecção)
- Fator de refletância dos objetos placas



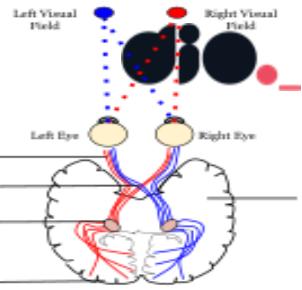
Sensoriamento

dio.

Fusão de Sensores para Visão Computacional:



Deep Learning - TensorFlow



Extração de features 2D:

- CNN: Aprendem automaticamente a extrair *features* em imagens 2D

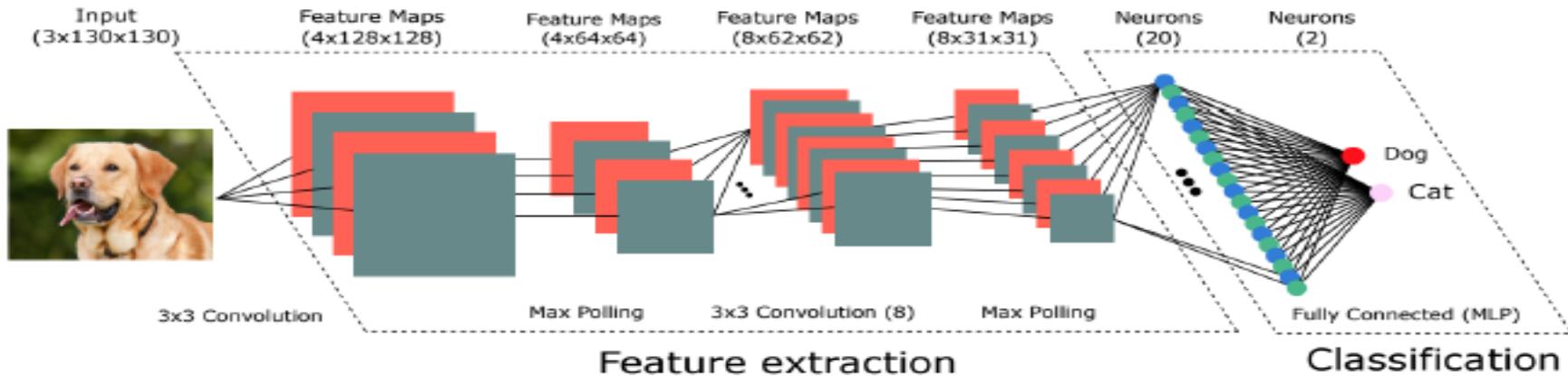
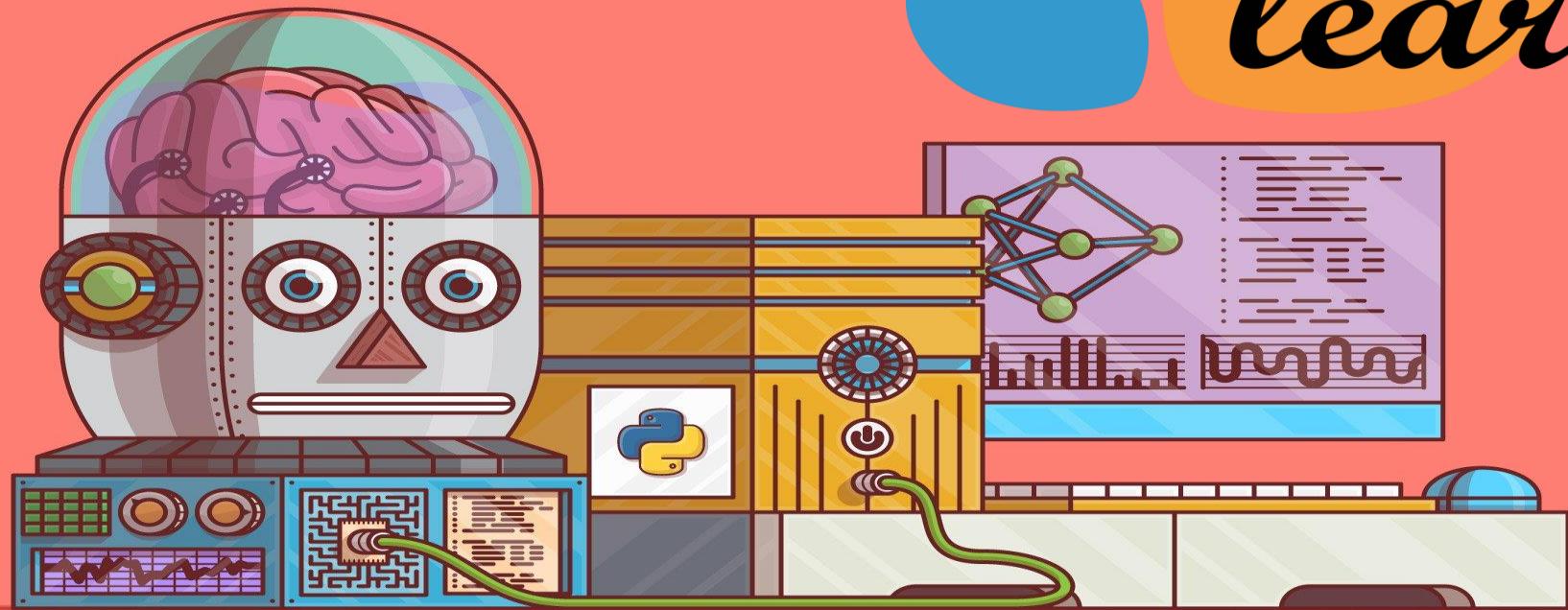


Figura 2: DCNN – [TensorFlow]

Bibliotecas de ML



scikit
learn

Real Python

Bibliotecas de ML



In [2]:

```
The convention is to import Pandas with abbreviaton "pd"
import pandas as pd
import numpy as np
```

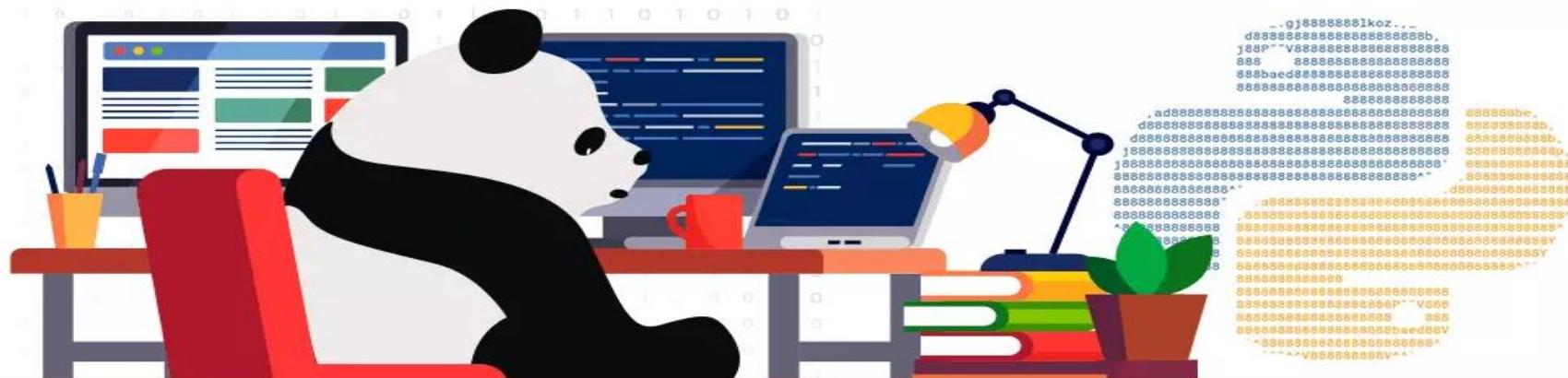
In [29]:

```
You can create a database using a dictionary of lists.
Each column is a dictionary key and the key denotes the column name.
All the lists need to be the same length, and then become the rows.
new_db = pd.DataFrame([
    {"column_1": 1, 2, 3, 4, "another_column": "string", "third_column": 1.23, "fourth_column": 1.23456789},
    {"column_1": 5, 6, 7, 8, "another_column": "string", "third_column": 1.23, "fourth_column": 1.23456789}
], columns=["column_1", "column_2", "column_3", "column_4", "another_column", "third_column", "fourth_column"])

Out[29]:
```

another column

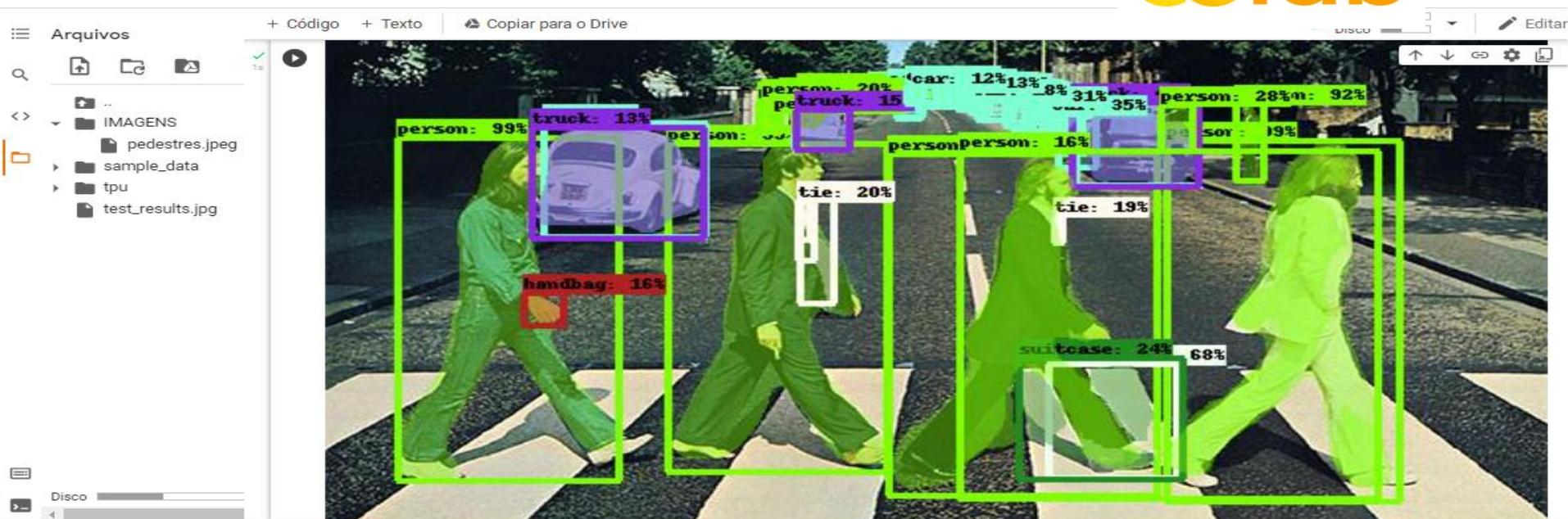
column_1	column_2	column_3	column_4	another_column	third_column	fourth_column
1	2	3	4	string	1.23	1.23456789
5	6	7	8	string	1.23	1.23456789



Vamos ver algo na prática?

dio.

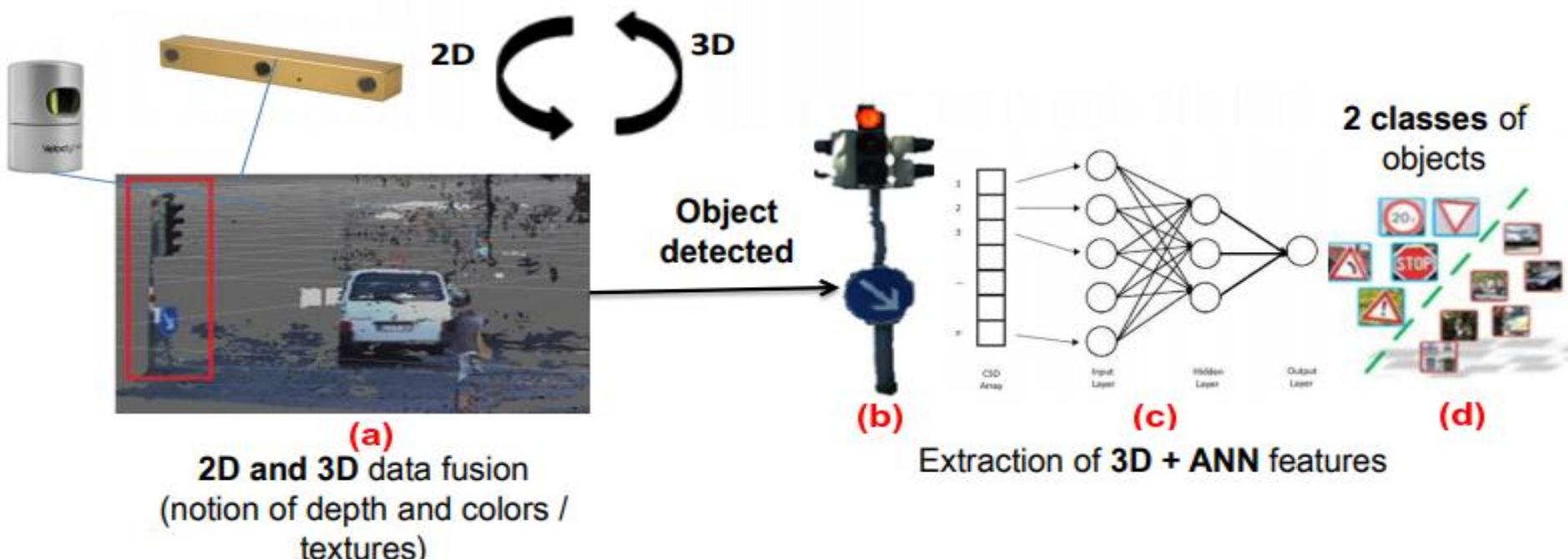
colab



COLAB: Ferramenta online de Machine Learning

Contextualização e motivação

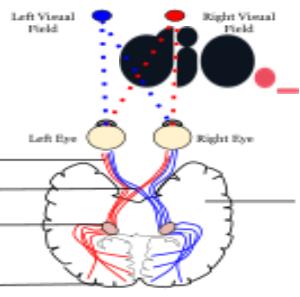
Detecção de placas e semáforos de trânsito



Redes de Detecção

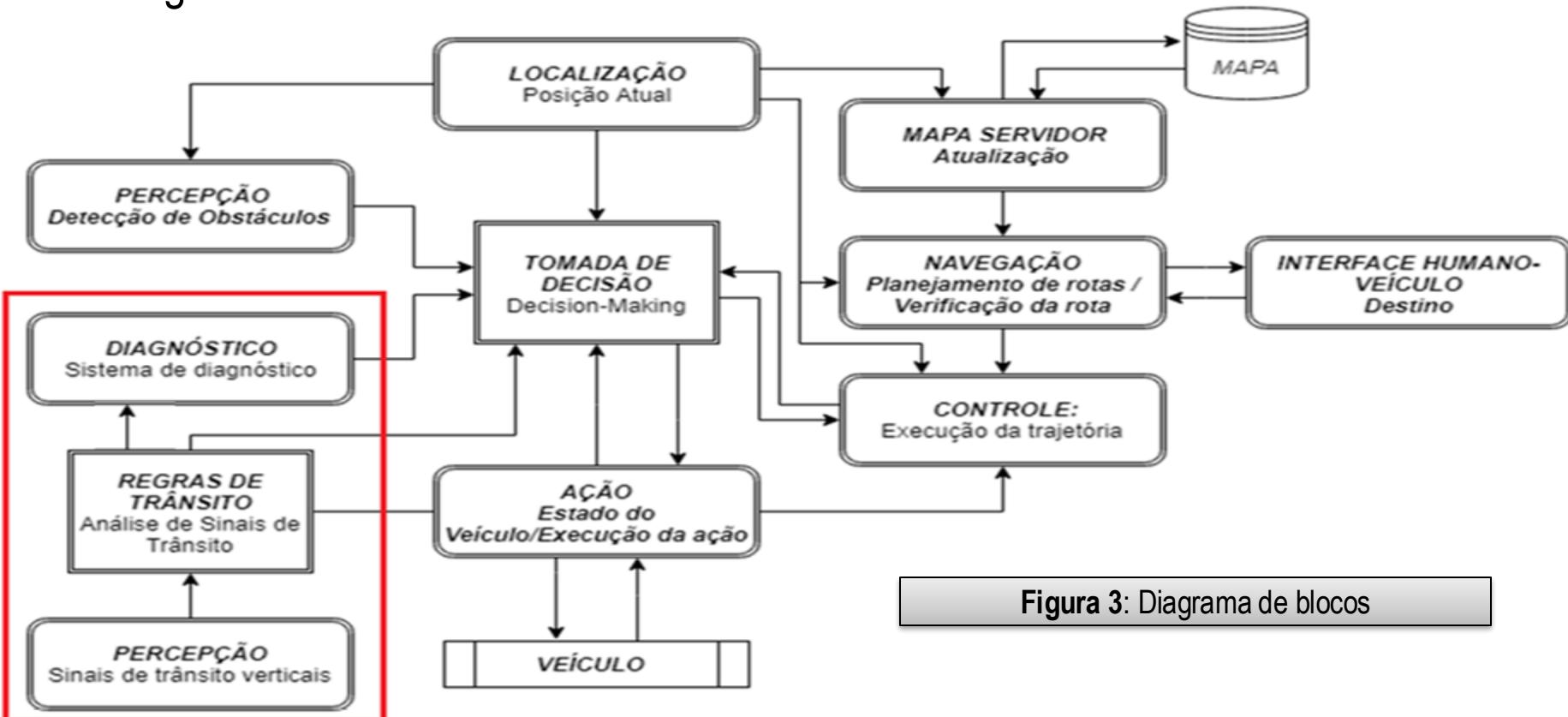


Figura 2: Transfer Learning



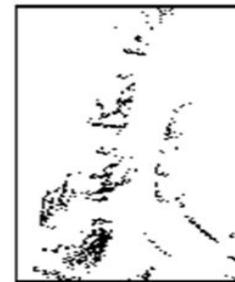
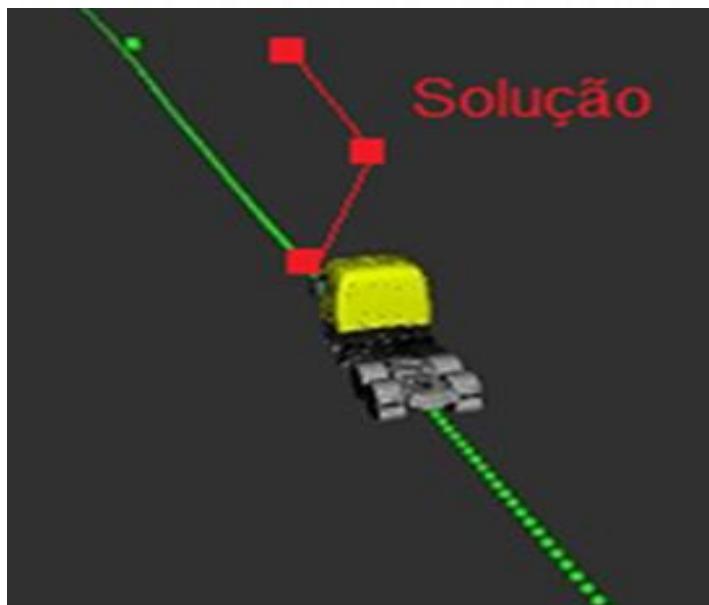
Arquitetura de um Carro Autônomo

Diagrama de blocos do sistema

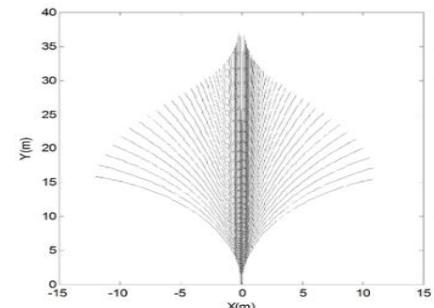


Seguidores de linha (GPS)

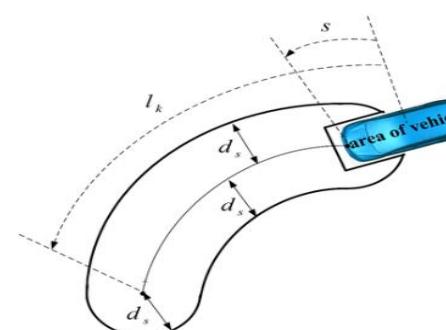
Planejamento de rotas - GPS



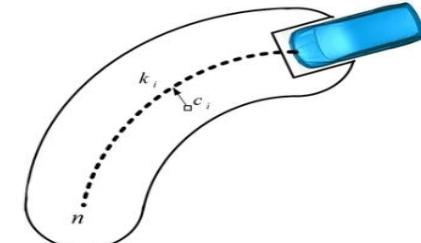
A Occupancy Grid



B 81 Tentacles in One Speed Set



C Support Area



D Obstacle Detection

Problemas...

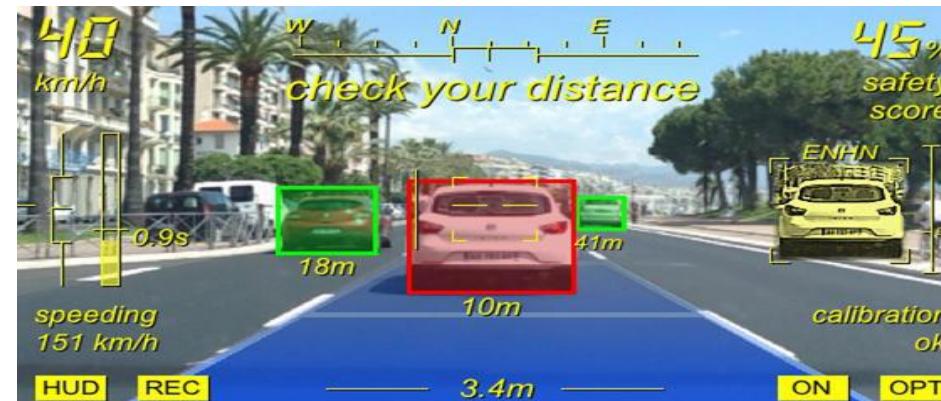
Detecção de placas móveis – (rotas não mapeadas):

- Atenção Visual: Desvios, trechos em obras, perigo na pista;

O mapeamento dos sinais de trânsito não seria eficiente neste tipo de situação

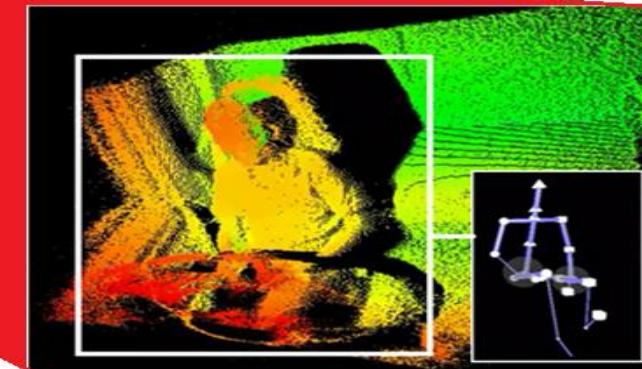


Planejamento de rotas



Atenção visual

Análise do ambiente de navegação com regras de trânsito em conjunto com o comportamento do condutor

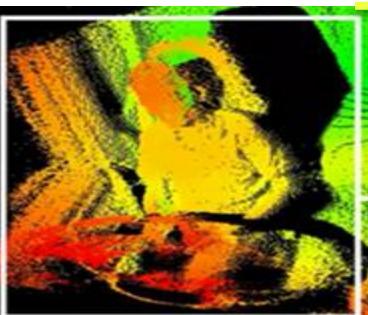


DRIVER ASSISTANCE
DRIVE SMARTER. DRIVE SAFER.

Funcionamento do Sistema

ADAS proposto:

Percepção externa + percepção interna



Máquina de Estados + RNA

Classificação dos problemas de desrespeito as leis de trânsito

- Suporte ao controle autônomo ou semi-autônomo;
- Neuro-FSM: Suporte a detecção e correção de falhas.



Figura 28: Mapa utilizado

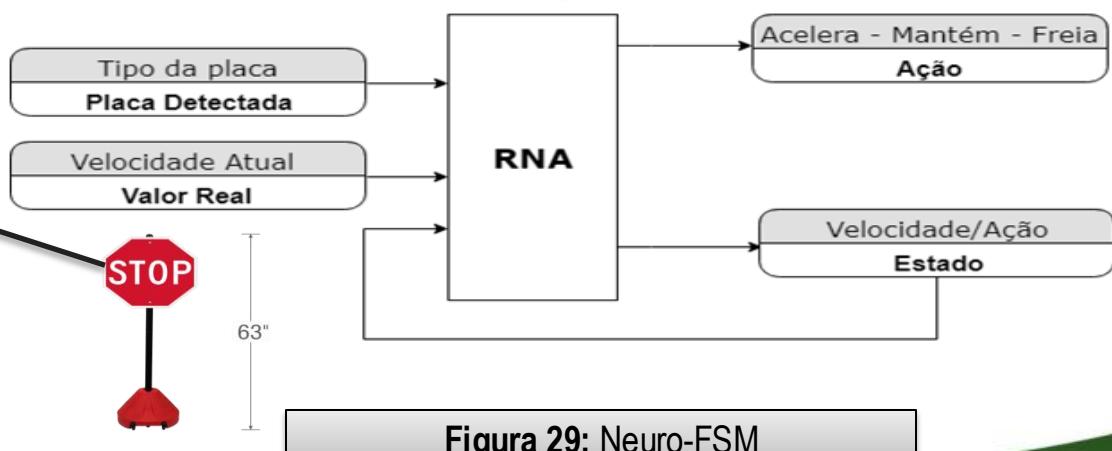
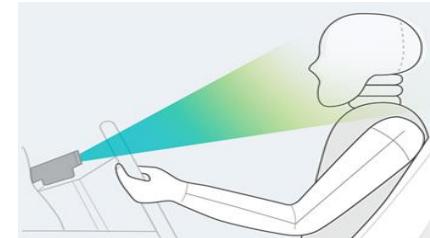


Figura 29: Neuro-FSM



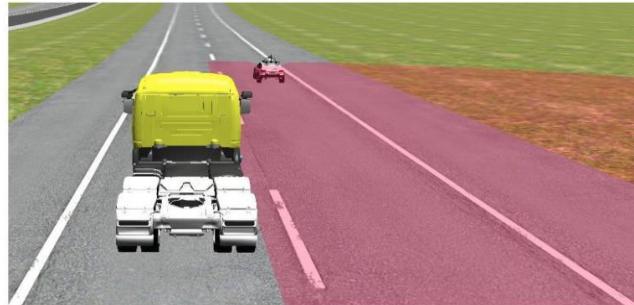
ADAS para correção de falhas humanas

Rotinas automáticas para suporte a tomada de decisão:

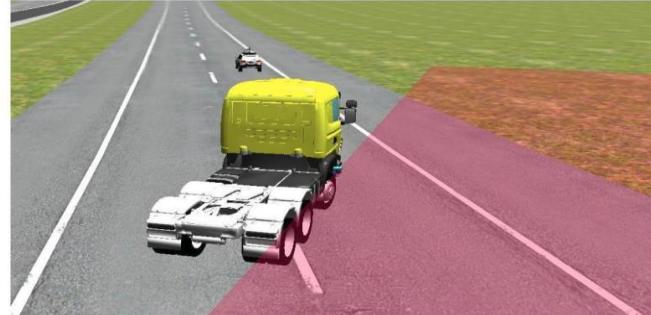
- Detecção de falhas humanas;
- Detecção de falhas de controle autônomo.



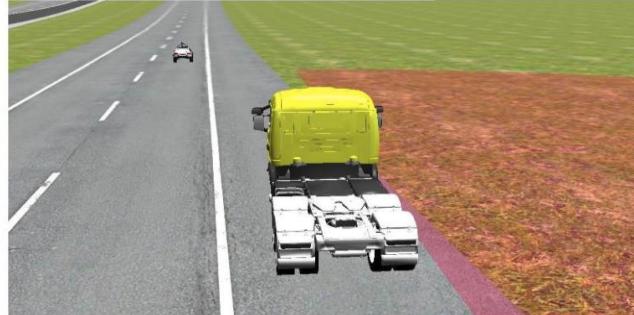
(a)



(b)



(c)



(d)

Resultados obtidos

Artigo para o LARS (*Latin American Robotics Symposium*) - 2017

Image classification system based on Deep Learning applied to the recognition of traffic signs for intelligent robotic vehicle navigation purposes

Diego Renan Bruno., and Fernando Santos Osório., Member, IEEE - University of São Paulo



2017 Latin American Robotics Symposium (LARS) and
2017 Brazilian Symposium on Robotics (SBR)

Resultados Obtidos

Algoritmo de *Slide Window*

- Poder do *Deep Learning* X Modelos de detecção 3D

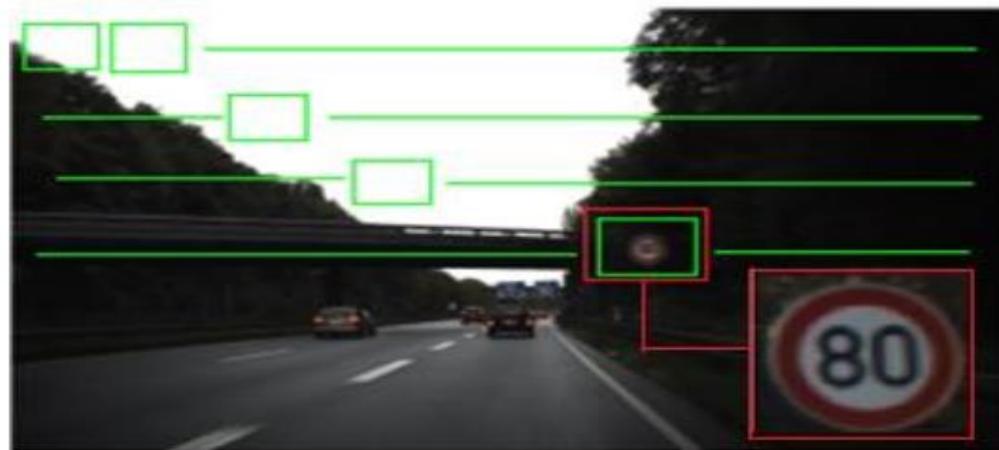


Figure 5: Slide window algorithm execution [4]

Resultados Obtidos

Resultados para oclusão de imagens

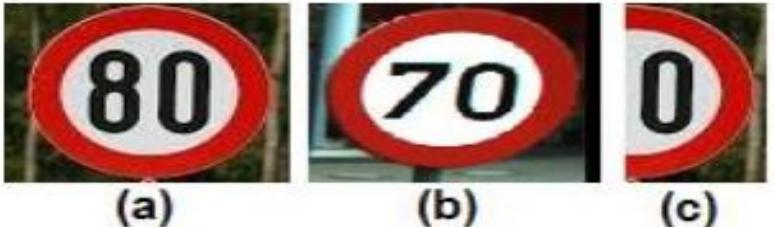


Figure 6: Severe problem of occlusion of traffic signs [6] (a) 80km (b) 70km and (c) problem of occlusion [4]

Traffic Sign	Type of traffic signal	Accuracy in classification (%)
	STOP	99.1
	STOP	99.6
	STOP	98.3
	STOP	96.2
	PREFERENCE	96.2
	PREFERENCE	97.6
	PEDESTRIAN	88.5
	PEDESTRIAN	89.2
	FOLLOW IN FRONT OR RIGHT	94.1
	FOLLOW IN FRONT OR RIGHT	88.2

Resultados Obtidos

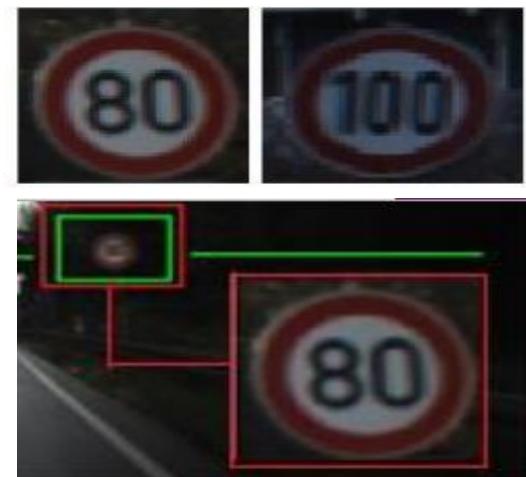
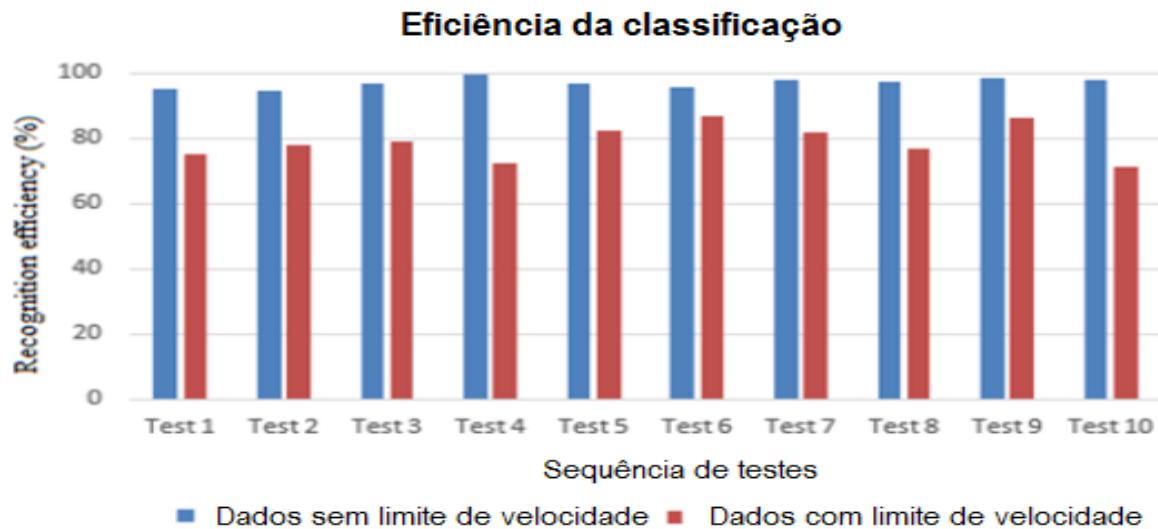
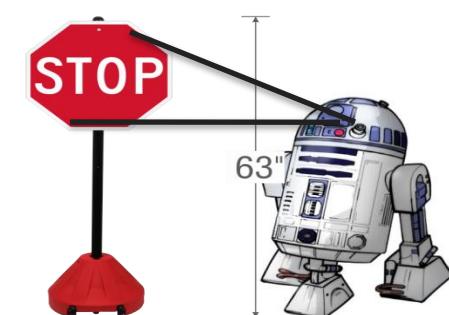


Gráfico 3: Comparação dos testes de classificação

Visão 2D – CNN Segnet

- Detecção em dados (imagens) 2D – Estado da arte em visão 2D

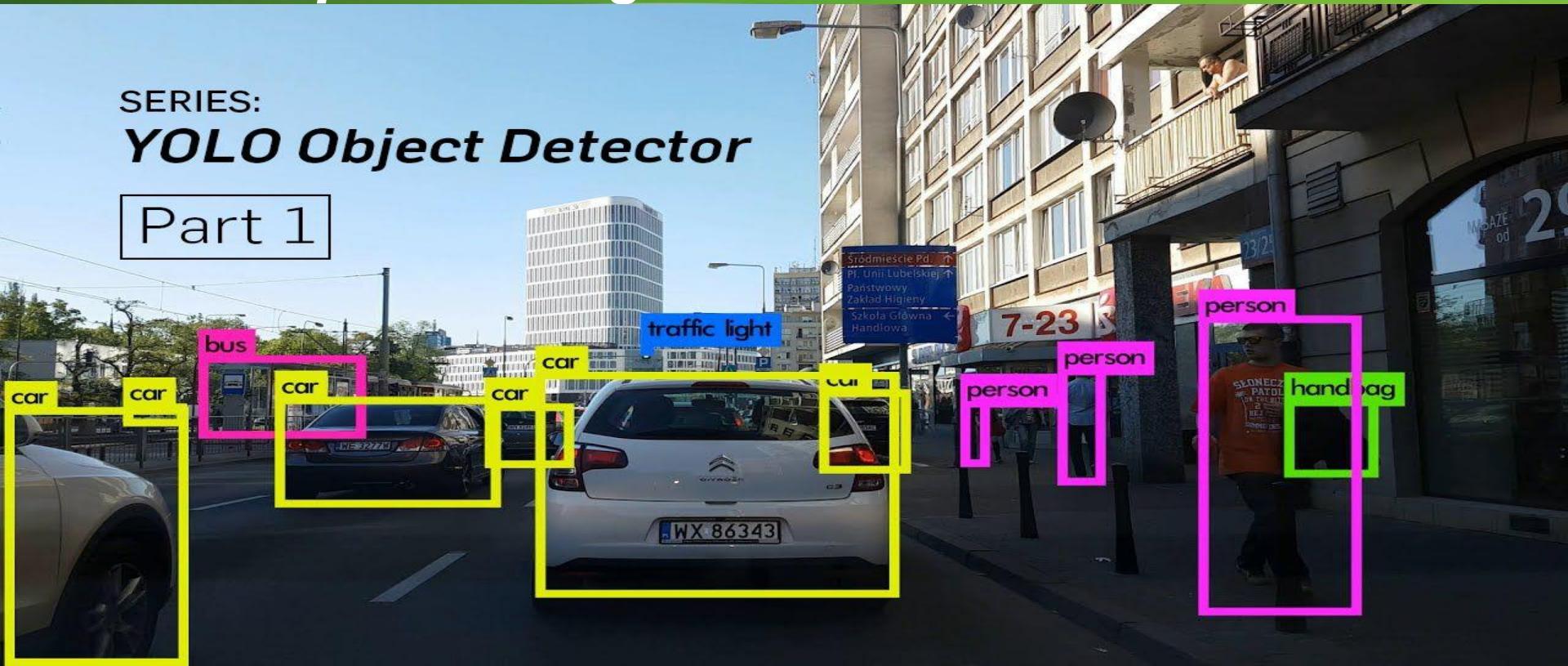


Deep Learning - YOLO

SERIES:

YOLO Object Detector

Part 1



Intelligent Robotic Applications

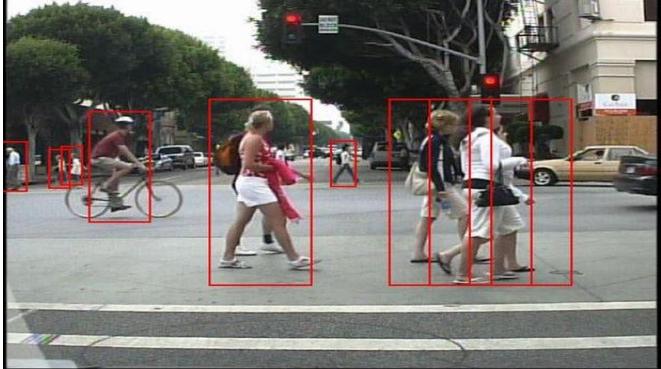
2D Computer Vision + ML / DL



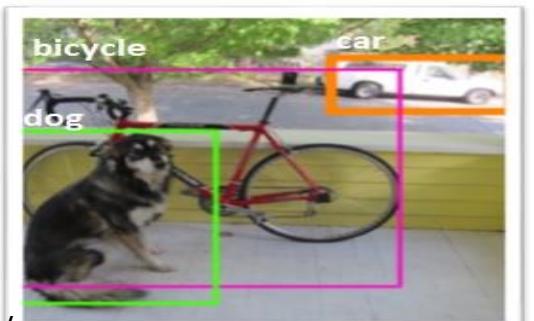
@OXDEDBEEF

<https://www.facebook.com/playgroundenglish/videos/53892067977460>

TensorFlow



http://jacobsschool.ucsd.edu/news_releases/release_sfe?i

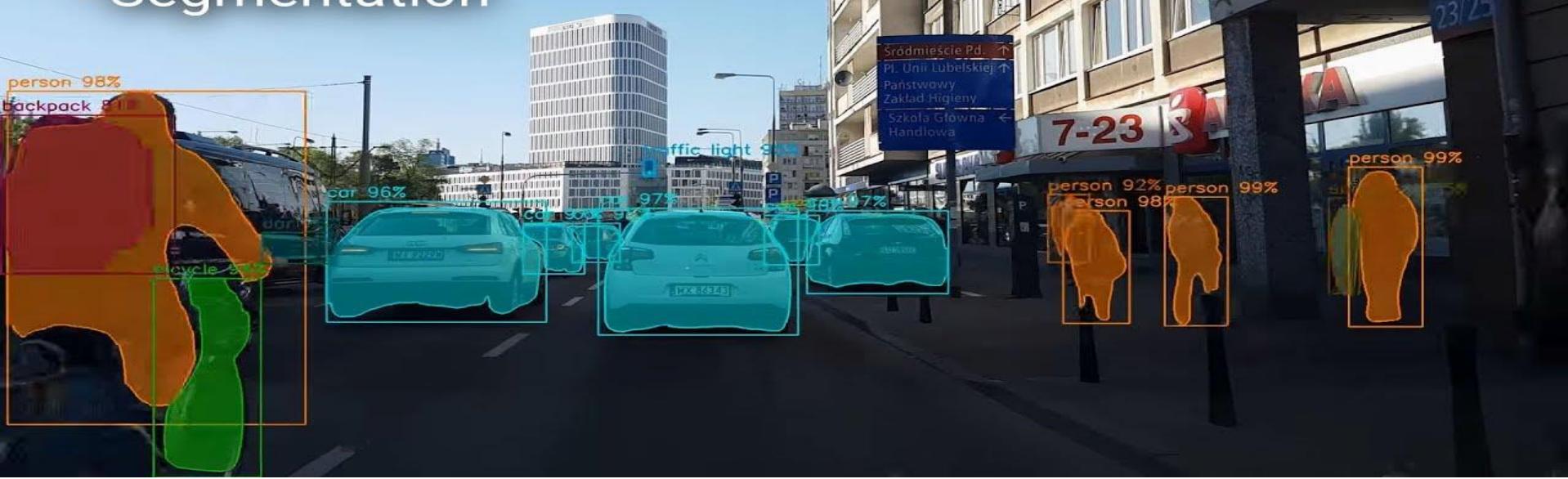


<https://pireddie.com/darknet/yolo/>

MASK-RCNN Deep Learning

Mask R-CNN

- Object Detection
- Segmentation



DeepLAB - Deep Learning

Detecção + Segmentação de objetos



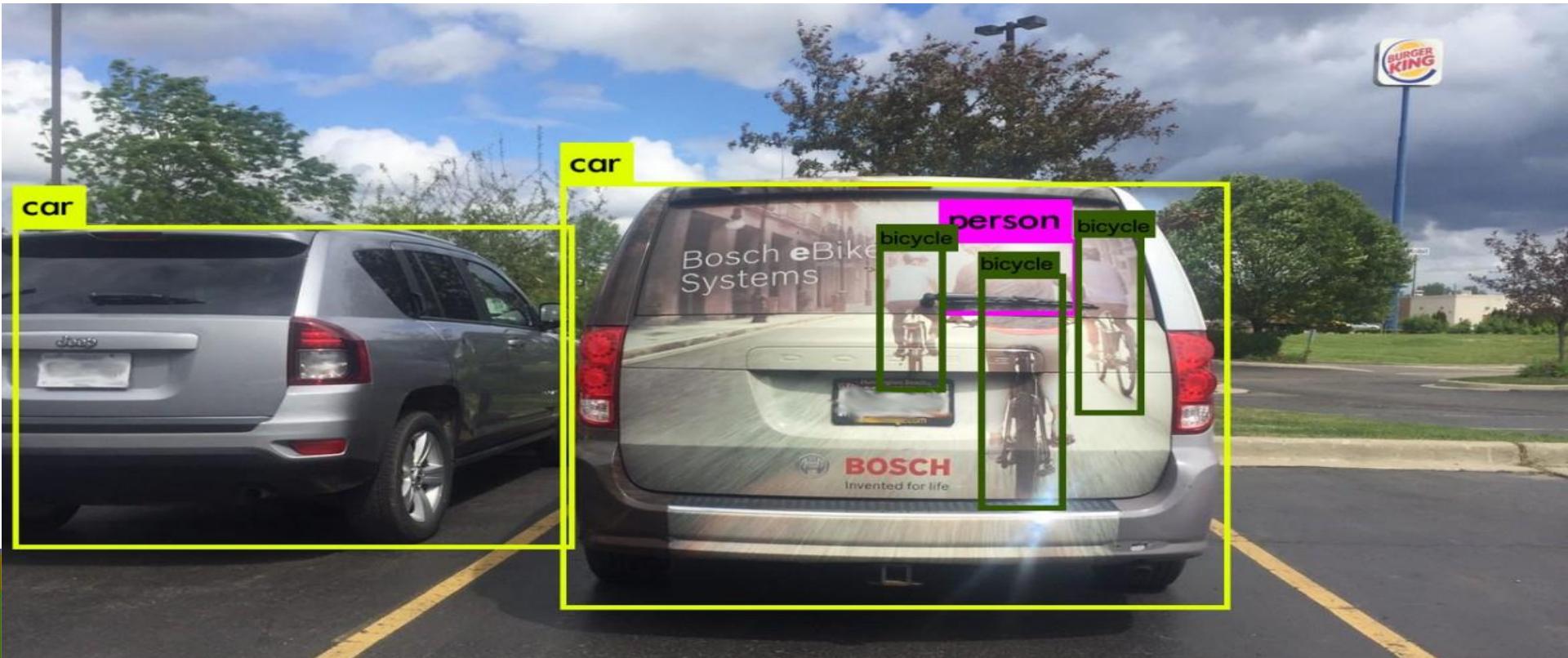
O mundo é visto de
forma 2D ou 3D?



Problemas em Visão 2D



Massachusetts
Institute of
Technology



<https://www.technologyreview.com/s/608321/this-image-is-why-self-driving-cars-come-loaded-with-many-types-of-sensors/> But also... Researchers hack a self-driving car by putting stickers on street signs
<https://www.cnetblog.com/2017/08/04/self-driving-car-sign-hack-stickers/>



Problemas em Visão 2D

Veículo Autônomo:
“Pare” para sempre...



Fotos de pessoas,
Semáforos, Placas de Trânsito,



Problemas de visão 2D



Problemas em Visão 2D

Smartphones
Face
Unlock
Fail



<https://www.youtube.com/watch?v=QS8NerjNJSc>

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



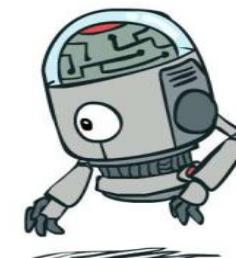
**IEEE WORLD CONGRESS ON
COMPUTATIONAL INTELLIGENCE**
8-13 July 2018, Rio de Janeiro, Brazil

Analysis and fusion of 2D and 3D images applied for detection and recognition of traffic signs using a new method of features extraction in conjunction with Deep Learning

Diego Renan Bruno and Fernando Santos Osório



**The International Joint
Conference on Neural Networks**



Metodologia

Visual attention and recognition

- Computer vision system and artificial intelligence

Our knowledge base is formed by a set of objects



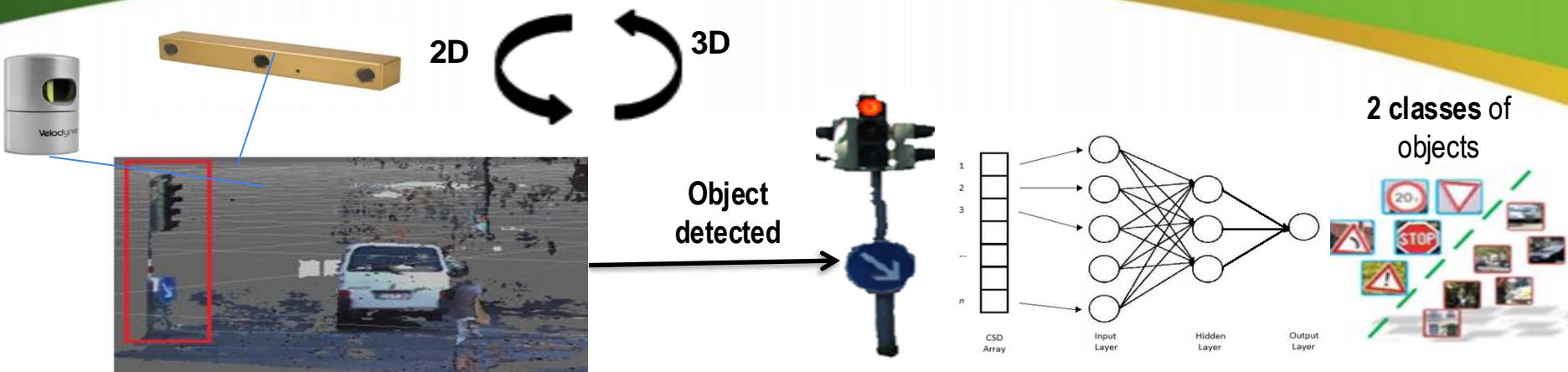
Visual attention



2D recognition – Artificial Intelligence



Metodologia



2D and 3D data fusion
(notion of depth and colors /
textures)

Extraction of **3D + ANN** features



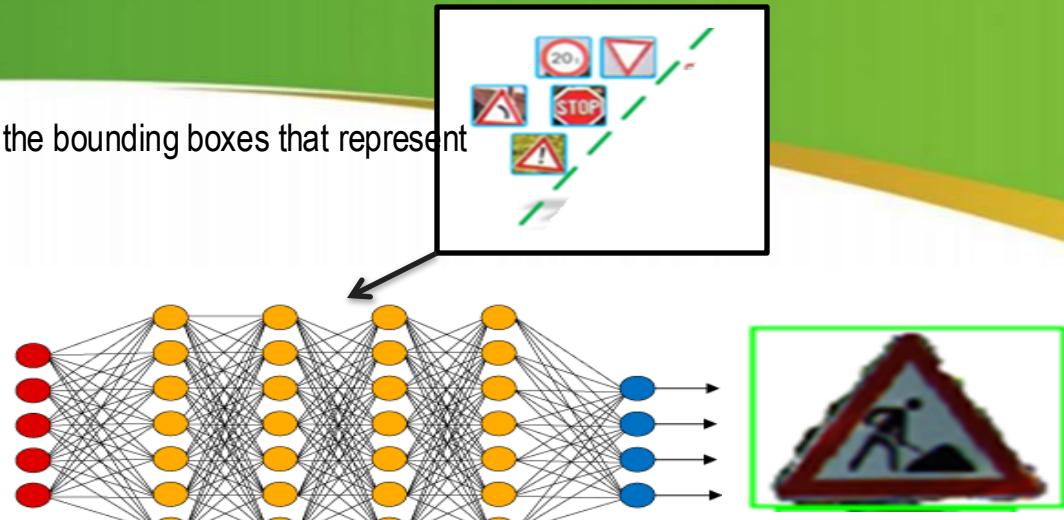
Metodologia

We apply Deep Learning to classify the bounding boxes that represent the vertical traffic signals



Detection representation in 2D (x, y)

Imagen 2D
(RGB)



Deep Learning
(Inception V3)

Traffic sign detected
and recognized

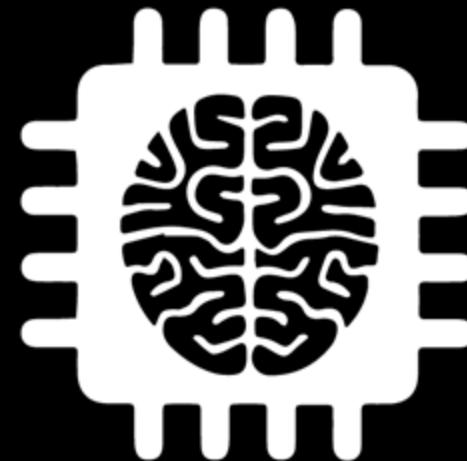


As leis de trânsito são obedecidas?

dio.



Ética para Sistemas Inteligentes



Futurism

Laws and Ethics for Autonomous Cars

Sharing the road with robots



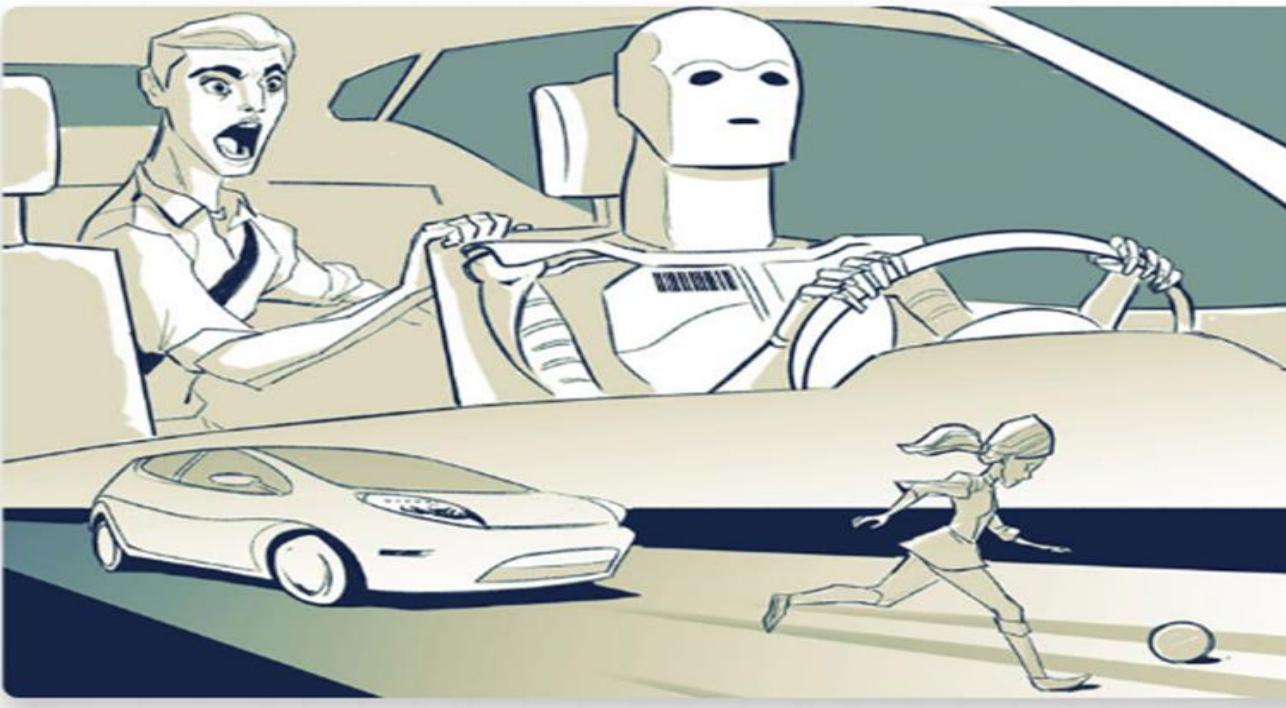
Eu, robô - Asimov

As três leis de Asimov funcionam?



Tomada de decisão sem sentimentos

--> Segurança

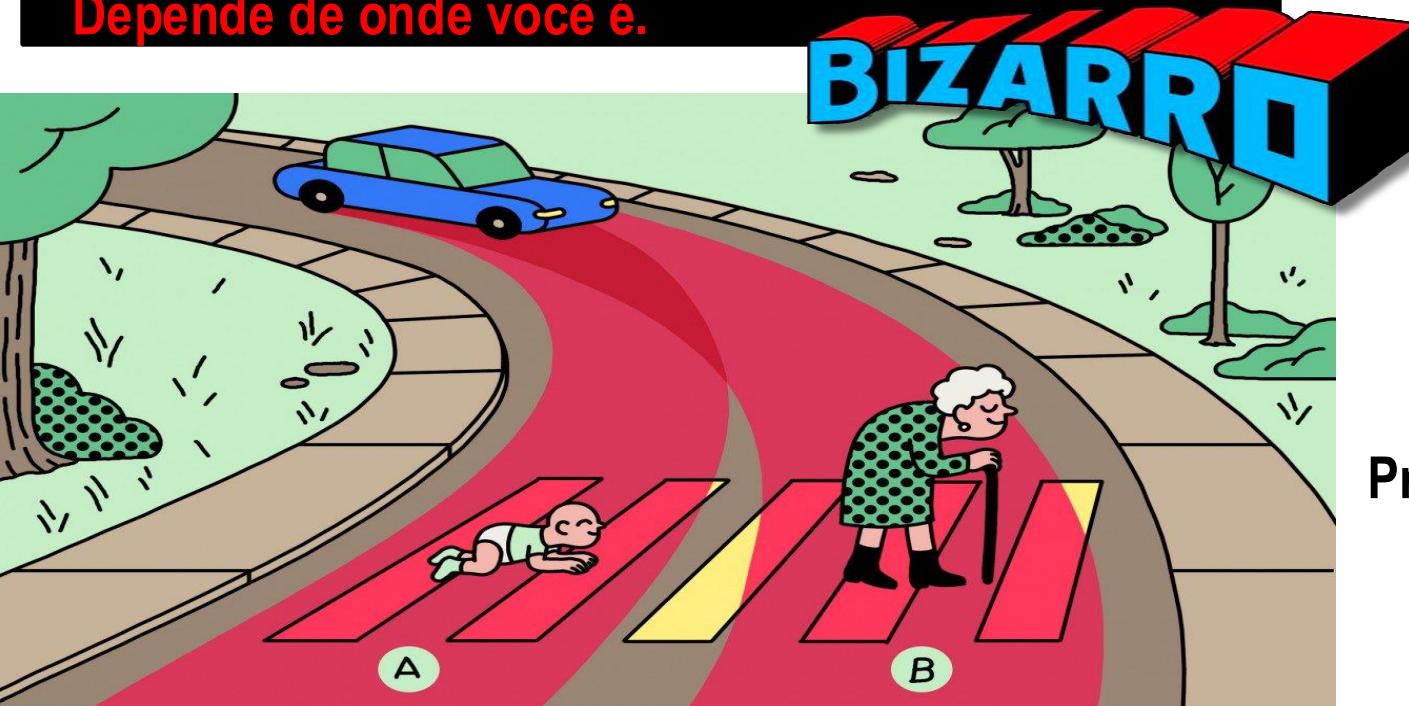


Proteger o seu dono
ou a criança...?

Tomada de atitude sem sentimentos

Um carro autônomo deve matar o bebê ou a avó?

Depende de onde você é.



Proteger o idoso ou a
criança?

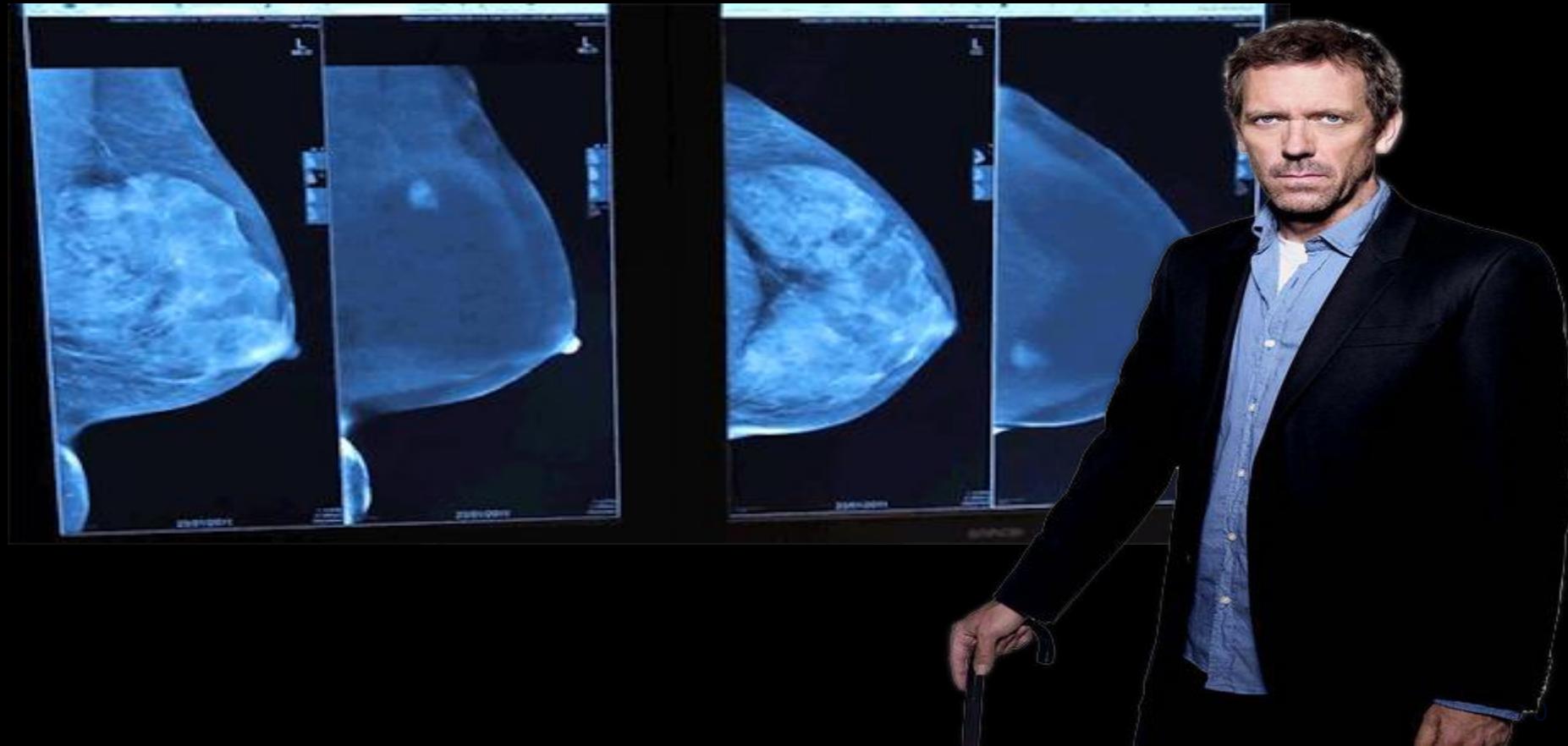
Aplicações de ML e IA



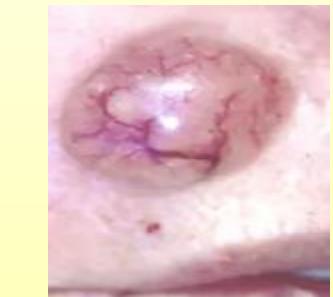
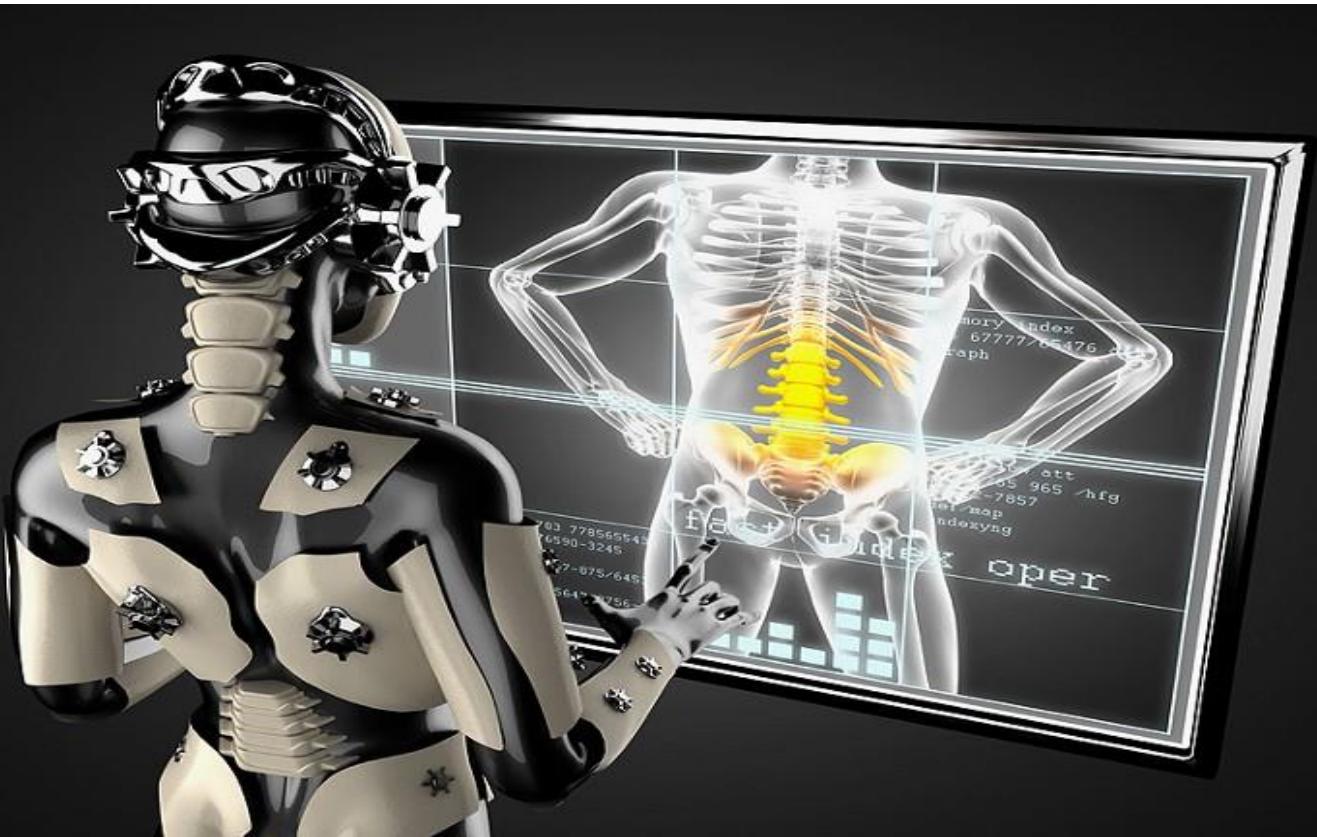
Suporte para medicina



Suporte para medicina



Suporte para medicina



Revolução Industrial



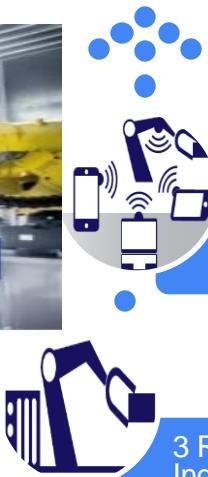
1 Revolução
Industrial

1784 Primeiro tear
mecânico



2 Revolução
Industrial

1870 Primeira linha de
produção (abatedouros de
Cincinnati)



3 Revolução
Industrial



4 Revolução
Industrial

2012 Sistemas Ciber-
Físicos

COMPLEXIDADE

Revolução Industrial



Revolução Industrial

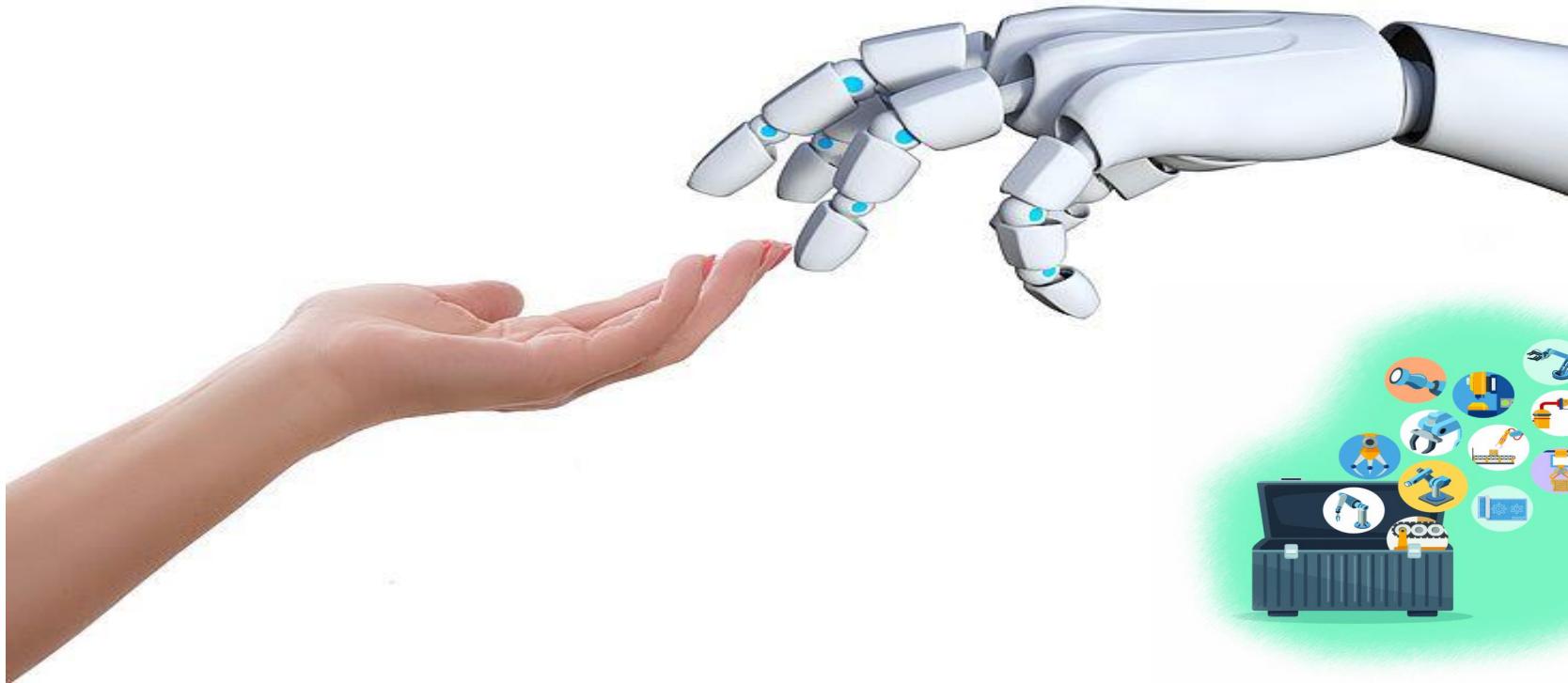
Robótica Industrial

Robôs de produção

Controle do homem morto



Robôs colaborativos



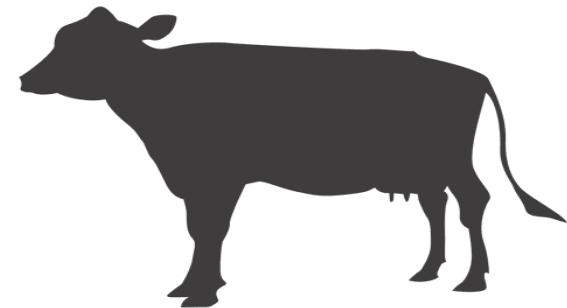
Robôs colaborativos



Problemas de IA

Reconhecer o tipo da carne

Grandes valores



Problemas de IA

Algo parecido já é feito...



BIG data

Análise de grandes volumes de dados...



Lavoura



Bancos

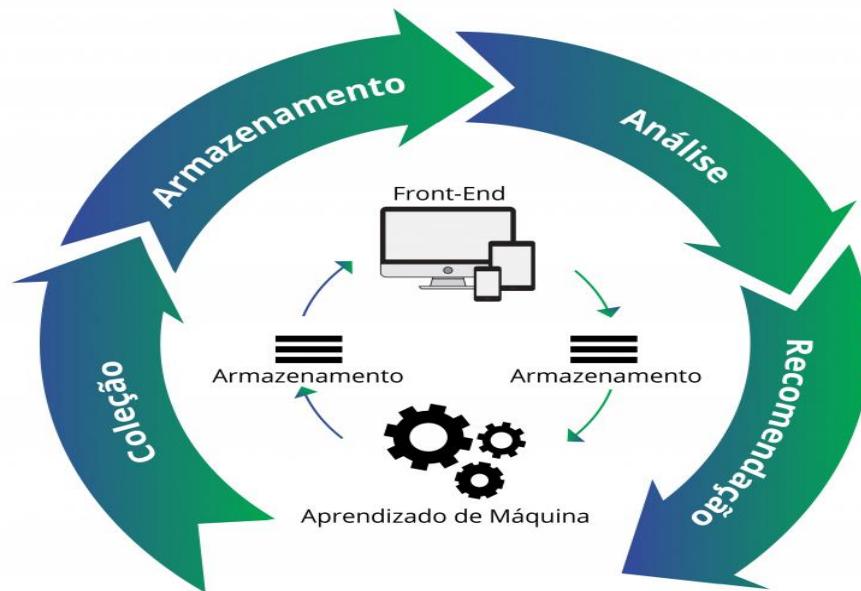
Sistemas de Recomendação

Como vender produtos relacionados...



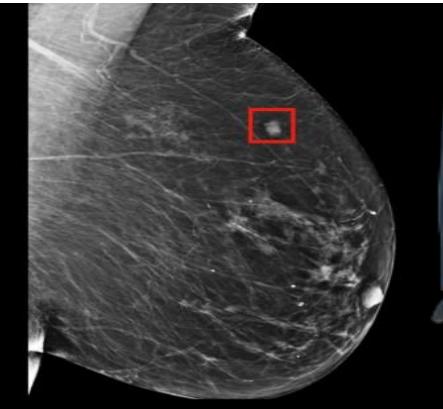
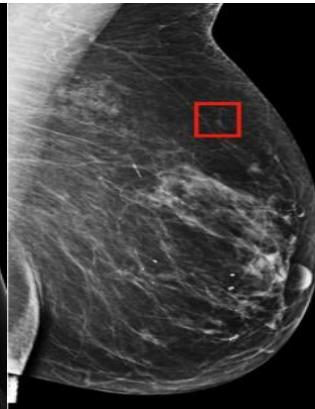
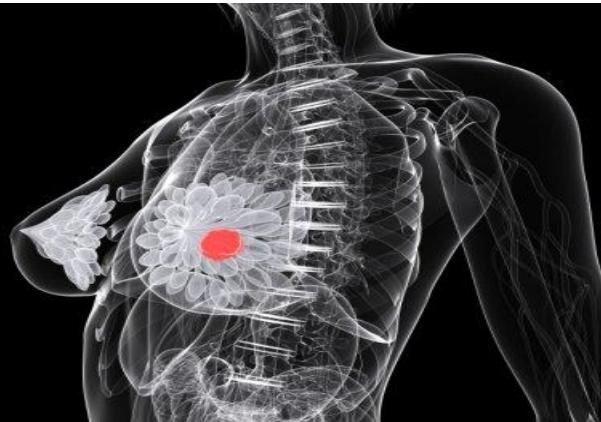
Sistemas de Recomendação

Como vender produtos relacionados...



Suporte para a Medicina

Dar suporte para um médico...



20 SEGREDOS QUE OS MÉDICOS NÃO CONTAM

BIZARRO

Cirurgias desnecessárias, remédios que não funcionam, conflitos de interesse: a medicina está doente. Para superar essa crise, é preciso enfrentar algumas verdades inconvenientes.

Alguém gostaria de vida eterna?

2045 AVATAR PROJECT MILESTONES

STRATEGIC SOCIAL INITIATIVE



Avatar D 2040 - 2045

Um avatar semelhante a um holograma

BIZARRO

Avatar C 2030 - 2035

Um avatar com um cérebro artificial no qual uma personalidade humana é transferida no final da vida

Avatar B 2020 - 2025

Um avatar em que um cérebro humano é transplantado no final da vida

Avatar A 2015 - 2020

uma cópia robótica de um corpo humano controlada remotamente via BCI



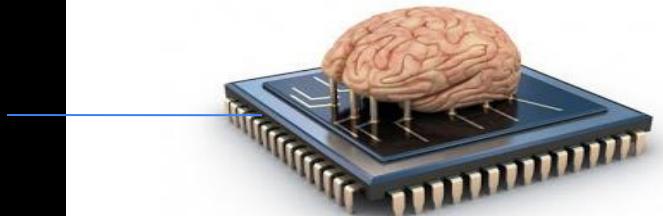
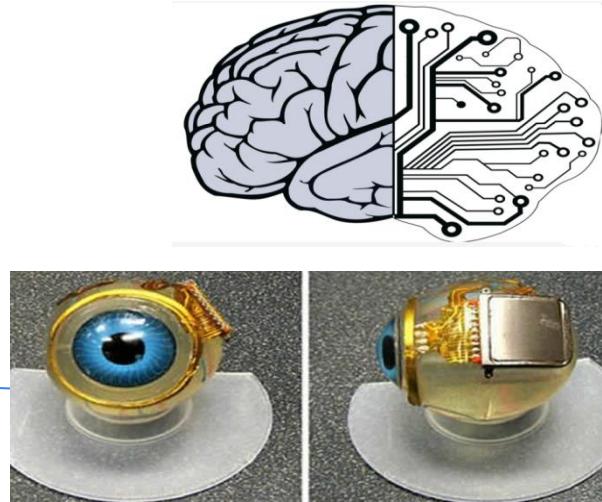
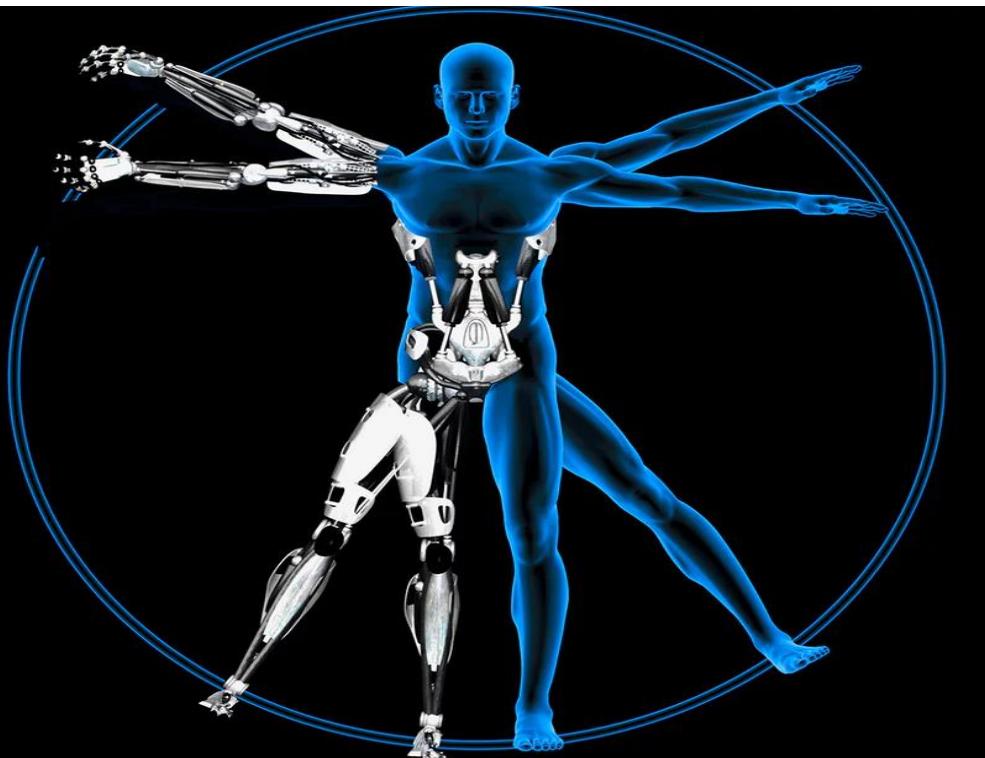
EVOLUTION

2045

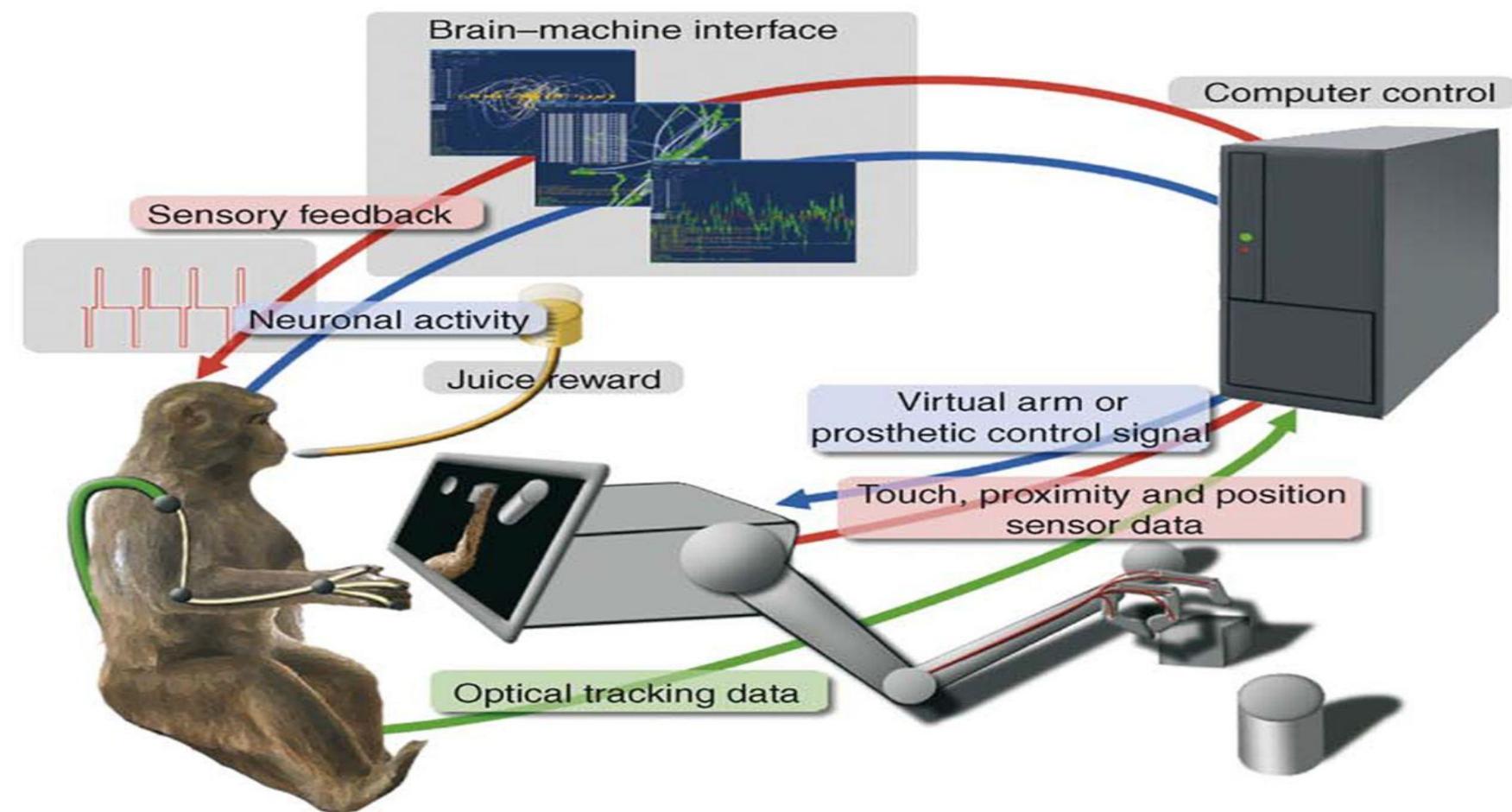
POLITICAL
PARTY

Tranhumanismo

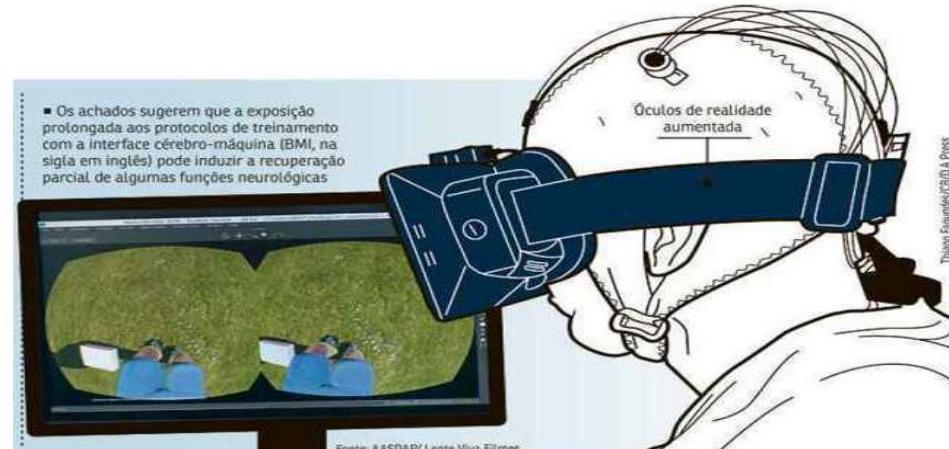
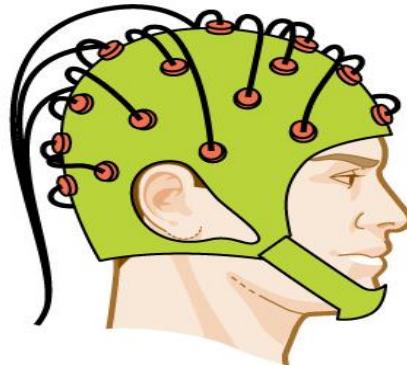
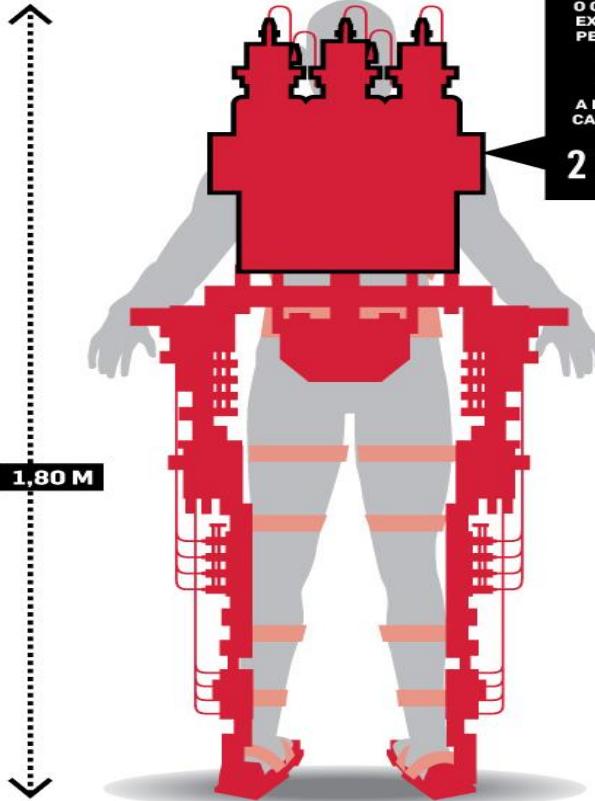
Melhoramento cerebral e corporal



Máquina que pensam como humanos

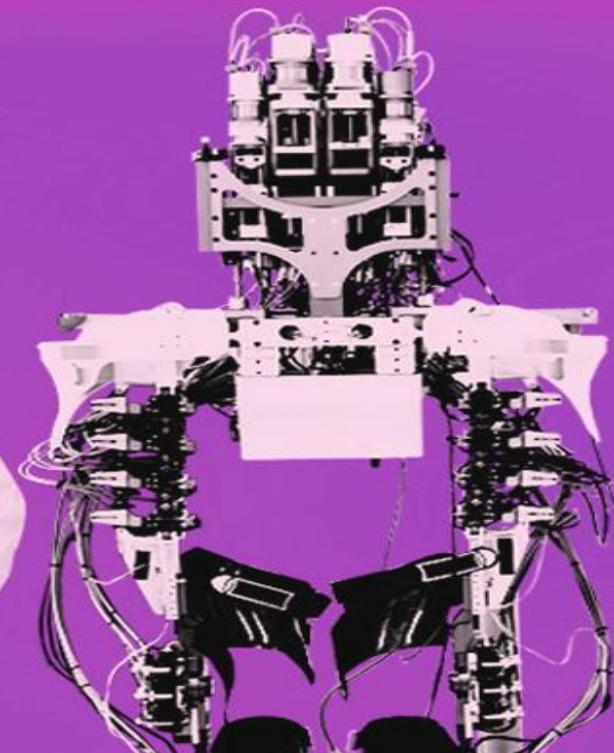
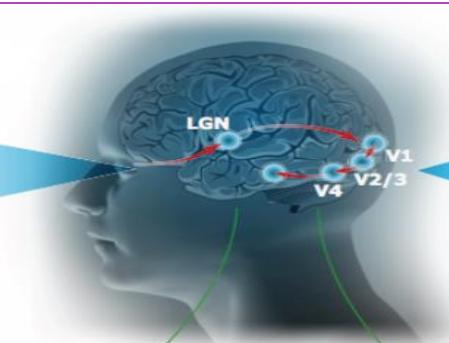


Máquina que pensam...



Máquinas que pensam...

Neurocientista brasileiro Miguel Nicolelis



Máquinas que pensam como seres humanos

dio.

Aplicações de reabilitação humana – sistemas cognitivos

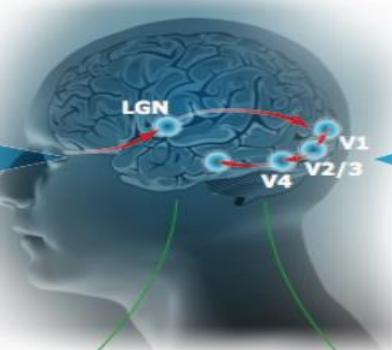
a.



encoding

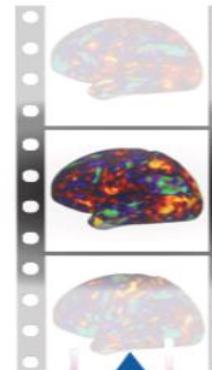


b.



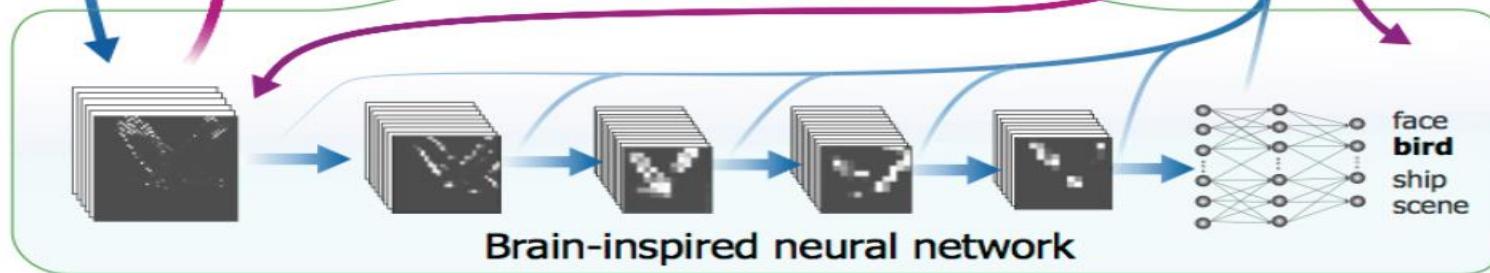
Imaging

c.



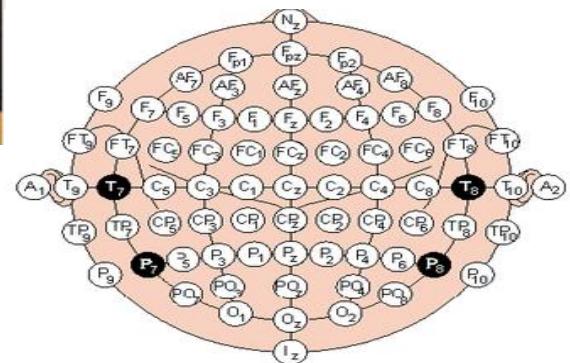
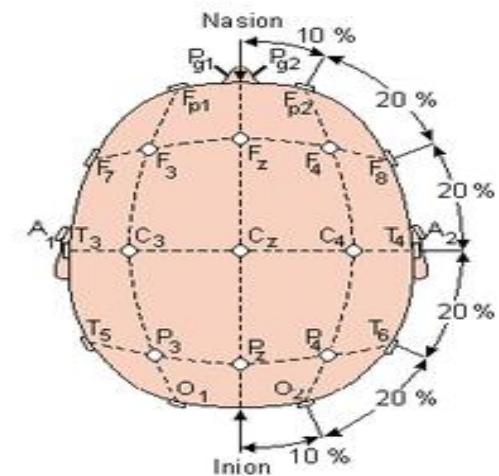
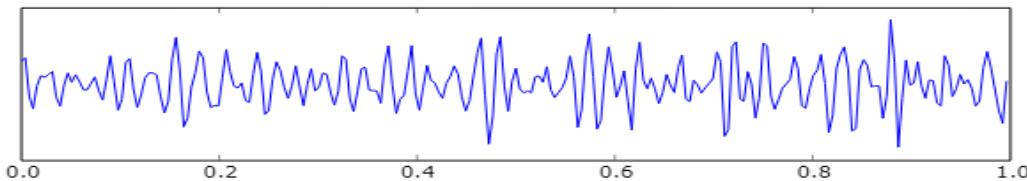
categorization

d.



Máquinas que pensam...

ndia



Obrigado!

Machine Learning

Prof. Dr. Diego Bruno

