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UNIVERSIDADE FEDERAL DO RIO DE JANEIRO



Engenharia de  
Sistemas e  
Computação  
PESC

# Construindo aplicações de aprendizado de máquina embarcado para Indústria 4.0

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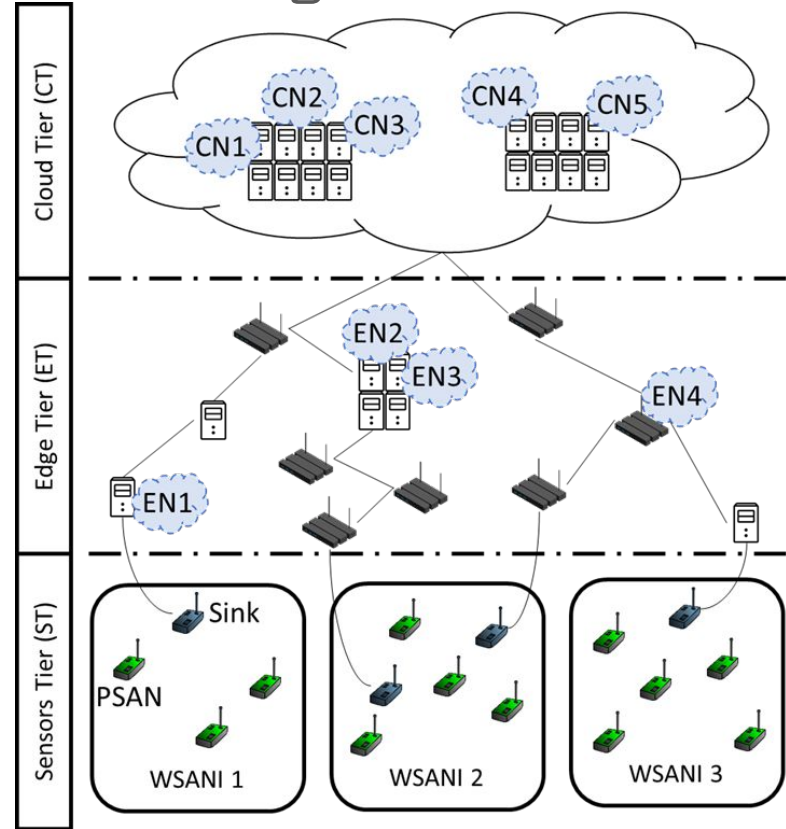
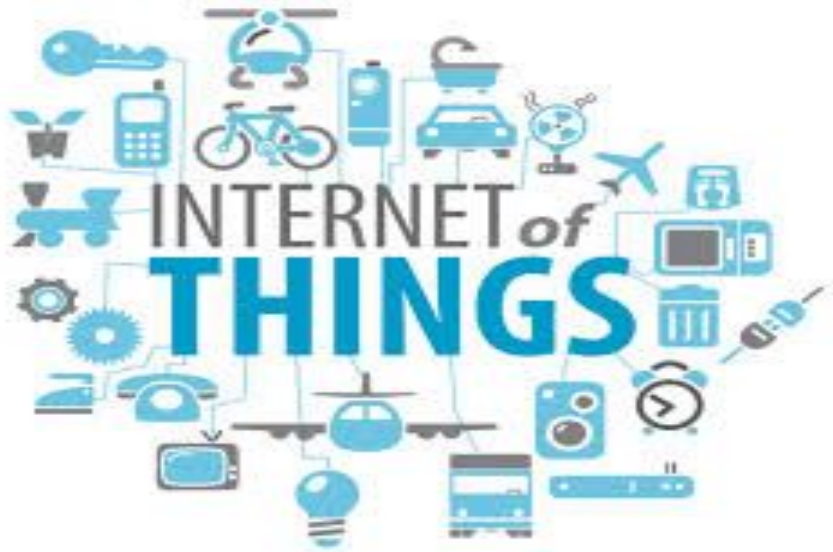
Instituto Tércio Pacitti de  
Aplicações e Pesquisas  
Computacionais



PR-2 / UFRJ

# Internet das Coisas - *Internet of Things*

- **Interconexão de dispositivos inteligentes com a internet**



# Libelium Smart World

## Air Pollution

Control of CO<sub>2</sub> emissions of factories, pollution emitted by cars and toxic gases generated in farms.

## Forest Fire Detection

Monitoring of combustion gases and preemptive fire conditions to define alert zones.

## Wine Quality Enhancing

Monitoring soil moisture and trunk diameter in vineyards to control the amount of sugar in grapes and grapevine health.

## Offspring Care

Control of growing conditions of the offspring in animal farms to ensure its survival and health.

## Sportsmen Care

Vital signs monitoring in high performance centers and fields.

## Structural Health

Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.

## Quality of Shipment Conditions

Monitoring of vibrations, strokes, container openings or cold chain maintenance for insurance purposes.

## Smartphones Detection

Detect iPhone and Android devices and in general any device which works with Wifi or Bluetooth interfaces.

## Perimeter Access Control

Access control to restricted areas and detection of people in non-authorized areas.

## Radiation Levels

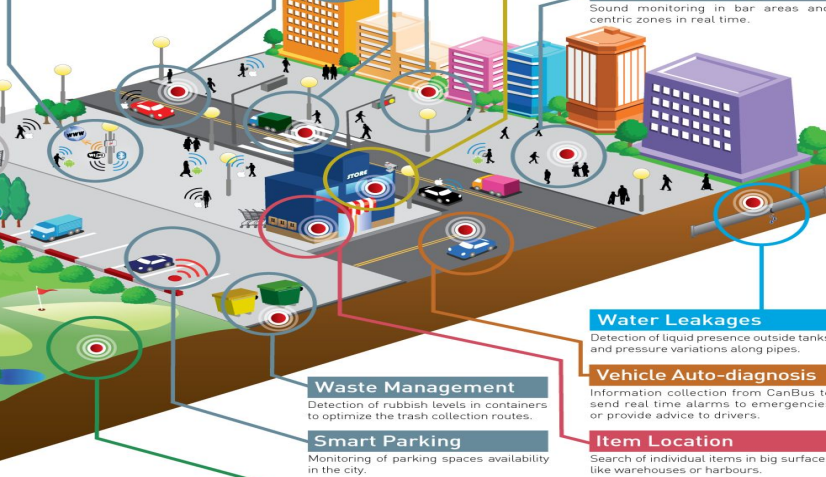
Distributed measurement of radiation levels in nuclear power stations surroundings to generate leakage alerts.

## Electromagnetic Levels

Measurement of the energy radiated by cell stations and WiFi routers.

## Traffic Congestion

Monitoring of vehicles and pedestrian affluence to optimize driving and walking routes.



## Smart Roads

Warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.

## Smart Lighting

Intelligent and weather adaptive lighting in street lights.

## Intelligent Shopping

Getting advices in the point of sale according to customer habits, preferences, presence of allergic components for them or expiring dates.

## Noise Urban Maps

Sound monitoring in bar areas and centric zones in real time.

## Water Leakages

Detection of liquid presence outside tanks and pressure variations along pipes.

## Vehicle Auto-diagnosis

Information collection from CanBus to send real time alarms to emergencies or provide advice to drivers.

## Item Location

Search of individual items in big surfaces like warehouses or harbours.

## Waste Management

Detection of rubbish levels in containers to optimize the trash collection routes.

## Smart Parking

Monitoring of parking spaces availability in the city.

## Golf Courses

Selective irrigation in dry zones to reduce the water resources required in the green.

## Water Quality

Study of water suitability in rivers and the sea for fauna and eligibility for drinkable use.

# Indústria 4.0

- Quarta revolução Industrial
- Mais do que somente sensores em fábricas - inclui toda a sociedade
- Impulsionado por diversas tecnologias



## 2022 disaster bingo

<del>asteroid</del>	<del>riots</del>	terrorists bombing	<del>volcano</del>	China invades Taiwan
sun flairs	<del>new covid strain</del>	financial crisis	<del>mass shooting</del>	dinosaurs back to life
civil war in any super power	nuclear warfair	global warming aka free space	dangerous tik tok trend	wall
queen of England dies	<del>Russia invades Ukraine</del>	scary animal discovery	<del>wildfires</del>	Cascadia earthquake or earthquake
great depression 2.0	poles switch	popular species goes extinct	zombies	poisoning of water

O mais preocupante

**O Apocalipse Zumbi**





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# Usando IoT para resolver o apocalipse Zumbi

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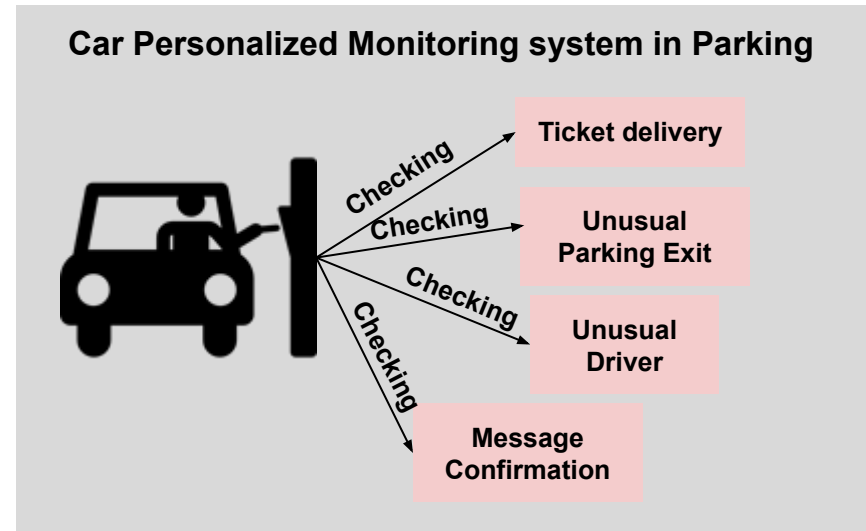
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O que eu preciso para  
sobreviver?



# Lidando com ambientes únicos

- Gerência de contexto
- Personalização do Monitoramento



# Smart Buildings

- Prédios equipados com dispositivos inteligentes
- Minimizam o consumo de energia
- Tem como objetivo o conforto e segurança



# Inserção de Energias Renováveis



# Smart Grid

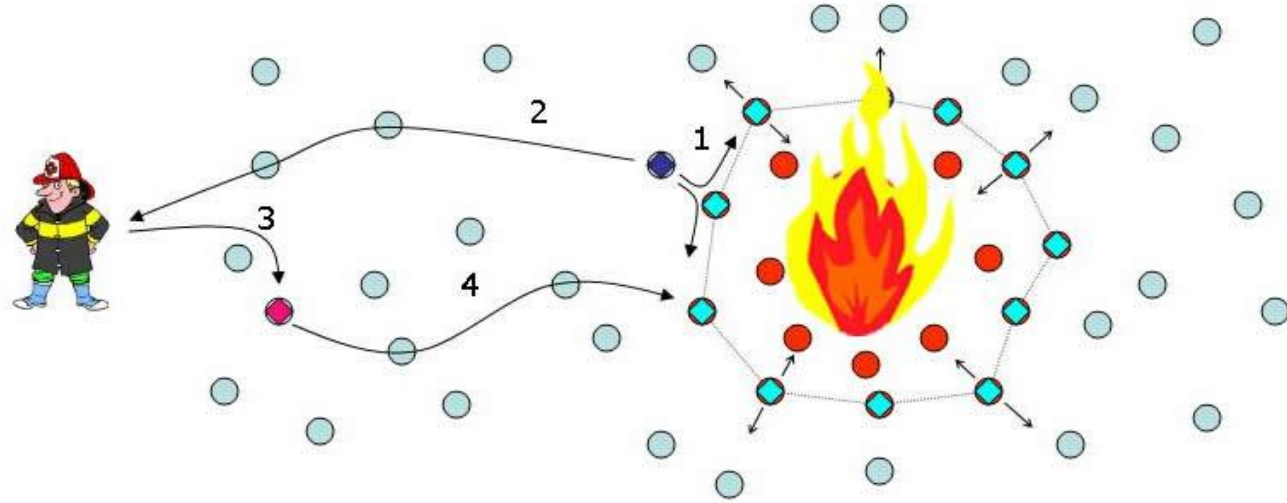


# Energias Renováveis



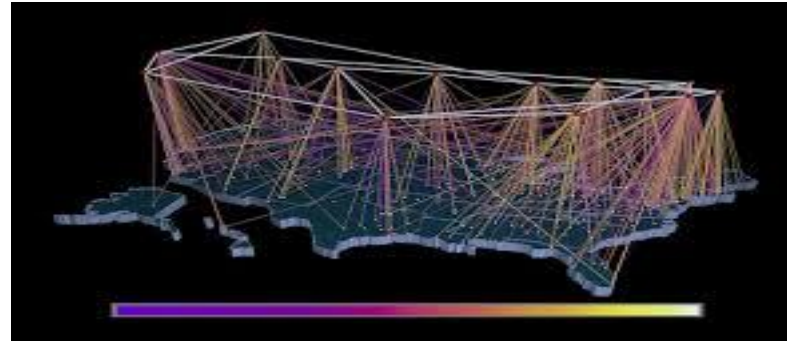
# Emergências - Suporte

- Incêndios
- Desastres
- Assaltos
- Mordidas



# Mobile Crowd Sensing

- Onde há mais sensores?
- Celulares e tablets já representam a maior parte do tráfego da Internet
- Por que não usar esse potencial?



# Smart Farms



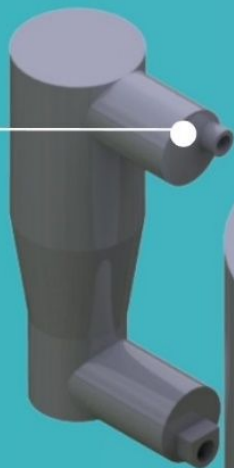




# uaiCup

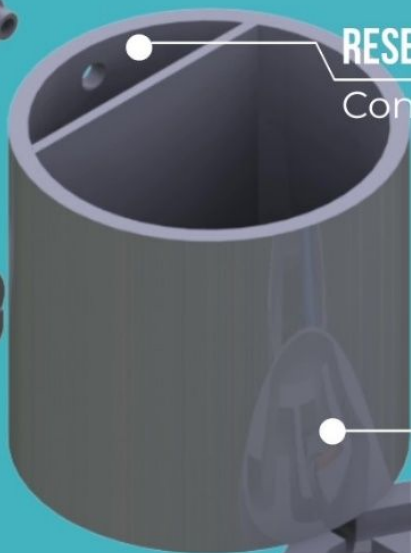
**BOMBA  
HIDRÁULICA**

Reamostragem



**RESERVA**

Contraprova



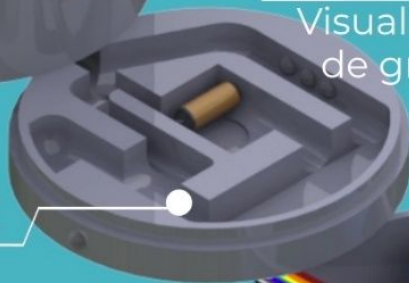
**TELA**

Visualização  
de grumos



**DIVERSIDADE**

CCS, CTB,  
%proteínas,  
%gordura,  
antibióticos



**ELETRÔNICA  
EMBARCADA**



CREATED USING  
**POWTOON**

# Robosub 2021

premiação



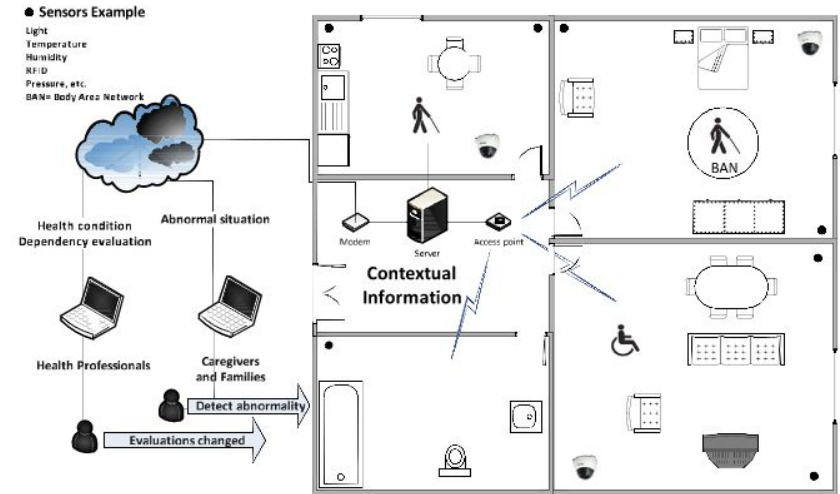
## Classificação geral

Deslize para saber mais >



# Smart Health

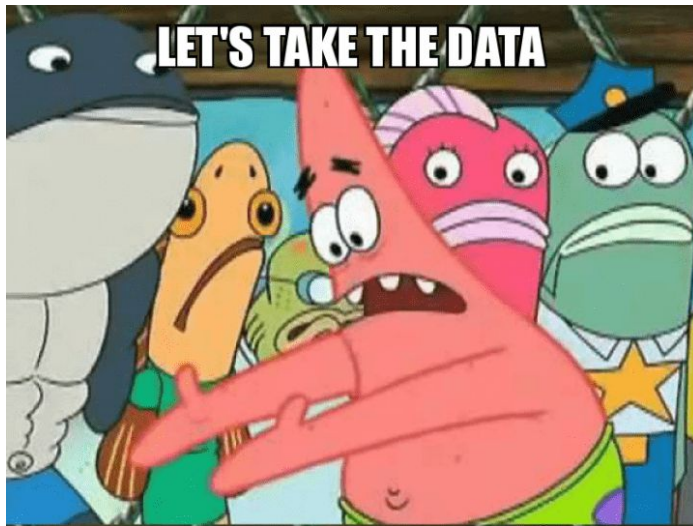
- Healthcare IoT
- Ambient Assisted Living
- Smart Health
- Smart Surgery
- Smart Hospitals \*
- Body Sensor Networks



**Fig. 1.** General overview of a Health Monitoring System (HMS). The monitoring system applies either a regular evaluation of the person's condition, or a rapid intervention in the case of detection of abnormalities.

Mas eu não sei nada!  
Quem pode me ajudar?

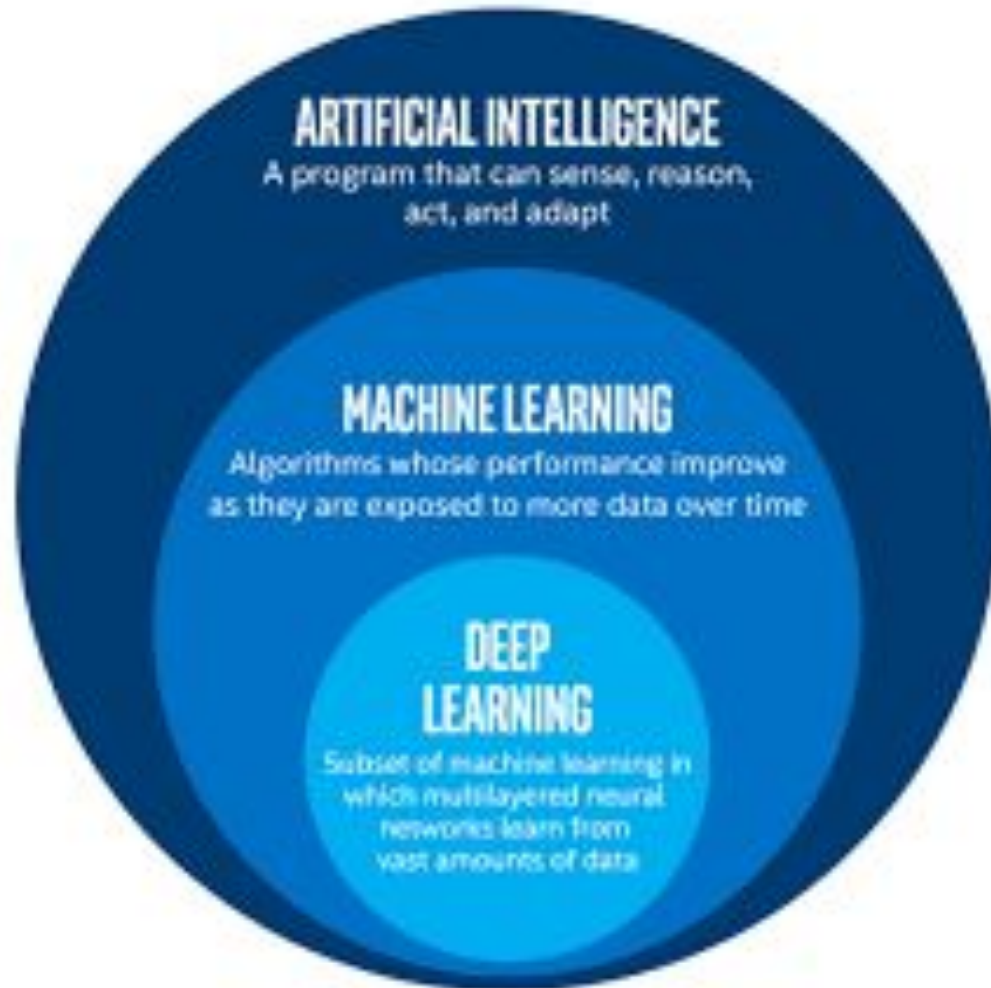
**LET'S TAKE THE DATA**



**AND PUSH IT SOMEWHERE ELSE**



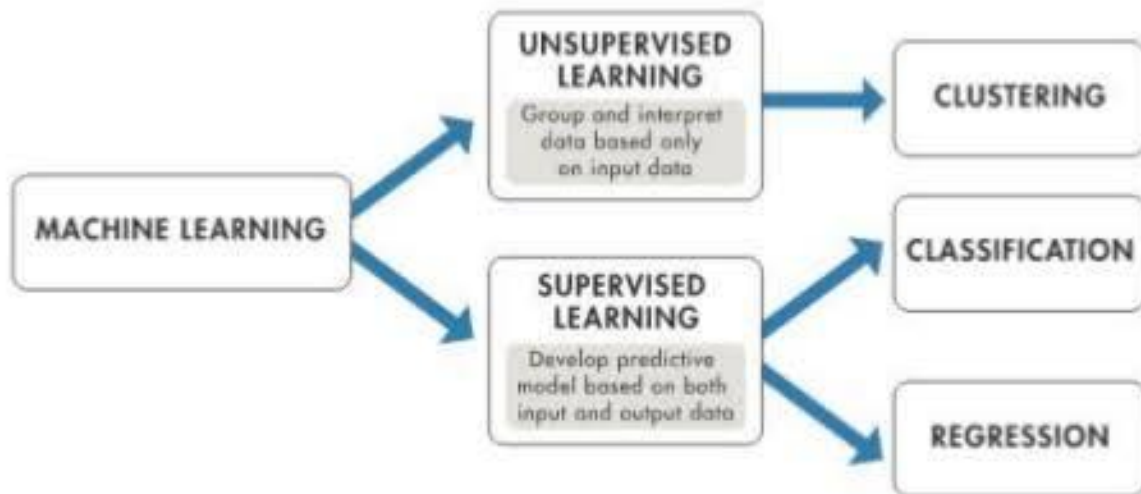
# AI vs ML vs DL



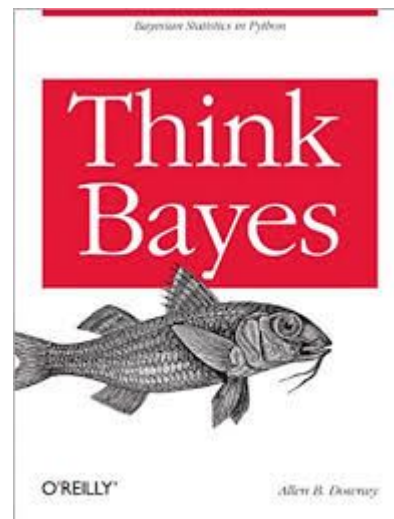
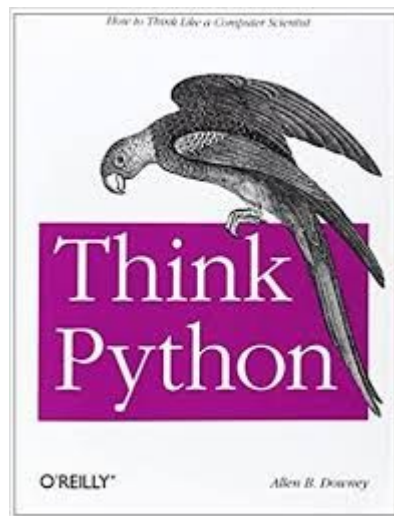
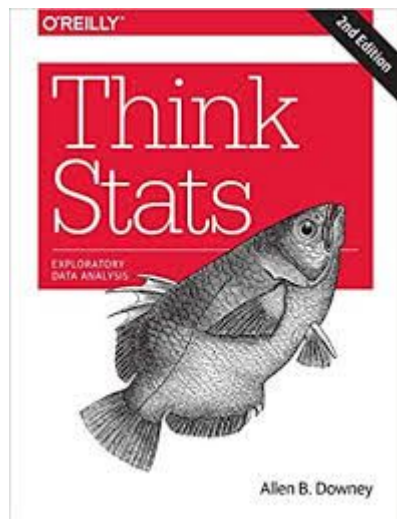




# ML Diagram



# Por onde começar?





Browse > Data Science > Machine Learning

# Machine Learning

Top Instructor

4.9 ★★★★★ 159,470 ratings

4,124,356 already enrolled

Instructor(s): Andrew Ng 

Subtitles: English, Arabic, [+11 more](#)

[Go To Course](#)

Offered By

**Stanford** | ONLINE

THIS IS YOUR MACHINE LEARNING SYSTEM?

YUP! YOU POUR THE DATA INTO THIS BIG PILE OF LINEAR ALGEBRA, THEN COLLECT THE ANSWERS ON THE OTHER SIDE.

WHAT IF THE ANSWERS ARE WRONG?

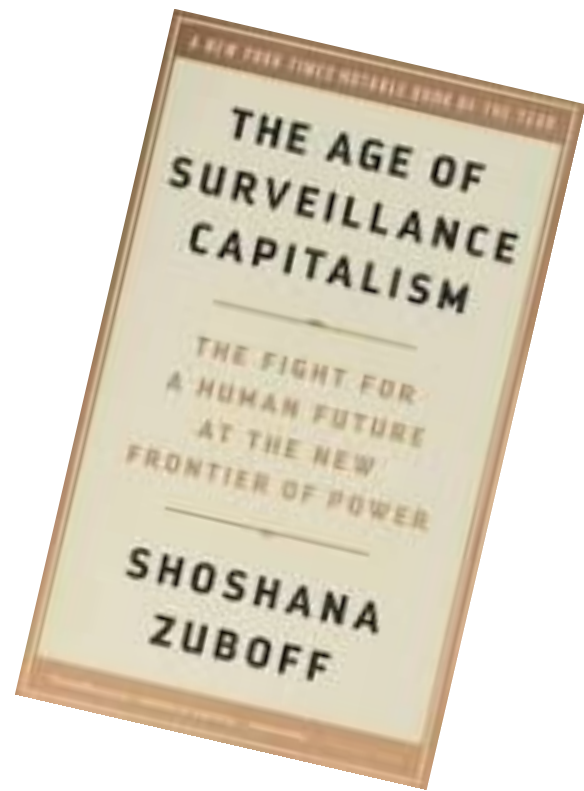
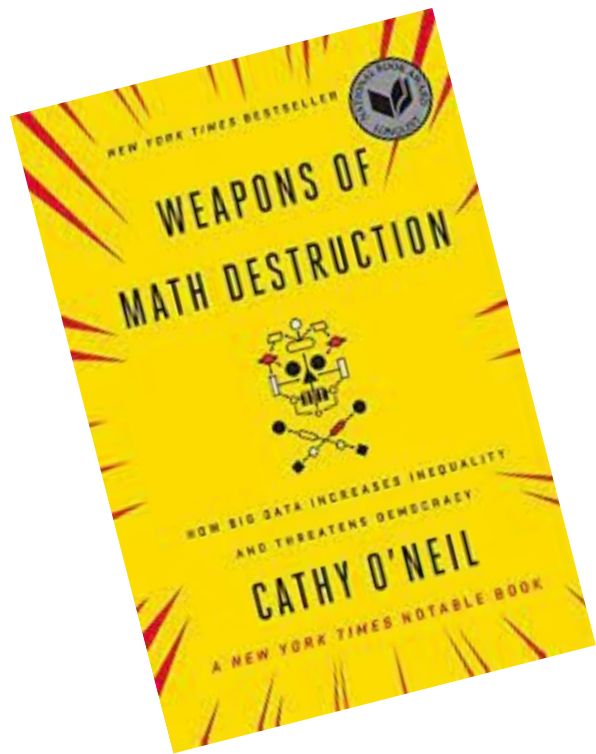
JUST STIR THE PILE UNTIL THEY START LOOKING RIGHT.



Nem um pouco ...

Justiça dá 30 dias para Metrô provar que reconhecimento facial não fere lei





# 3 Types of Artificial Intelligence

## Artificial Narrow Intelligence (ANI)



Stage-1

### Machine Learning

- ▶ Specialises in one area and solves one problem



Siri



Alexa



Cortana

## Artificial General Intelligence (AGI)



Stage-2

### Machine Intelligence

- ▶ Refers to a computer that is as smart as a human across the board

## Artificial Super Intelligence (ASI)



Stage-3

### Machine Consciousness

- ▶ An intellect that is much smarter than the best human brains in practically every field



We are here

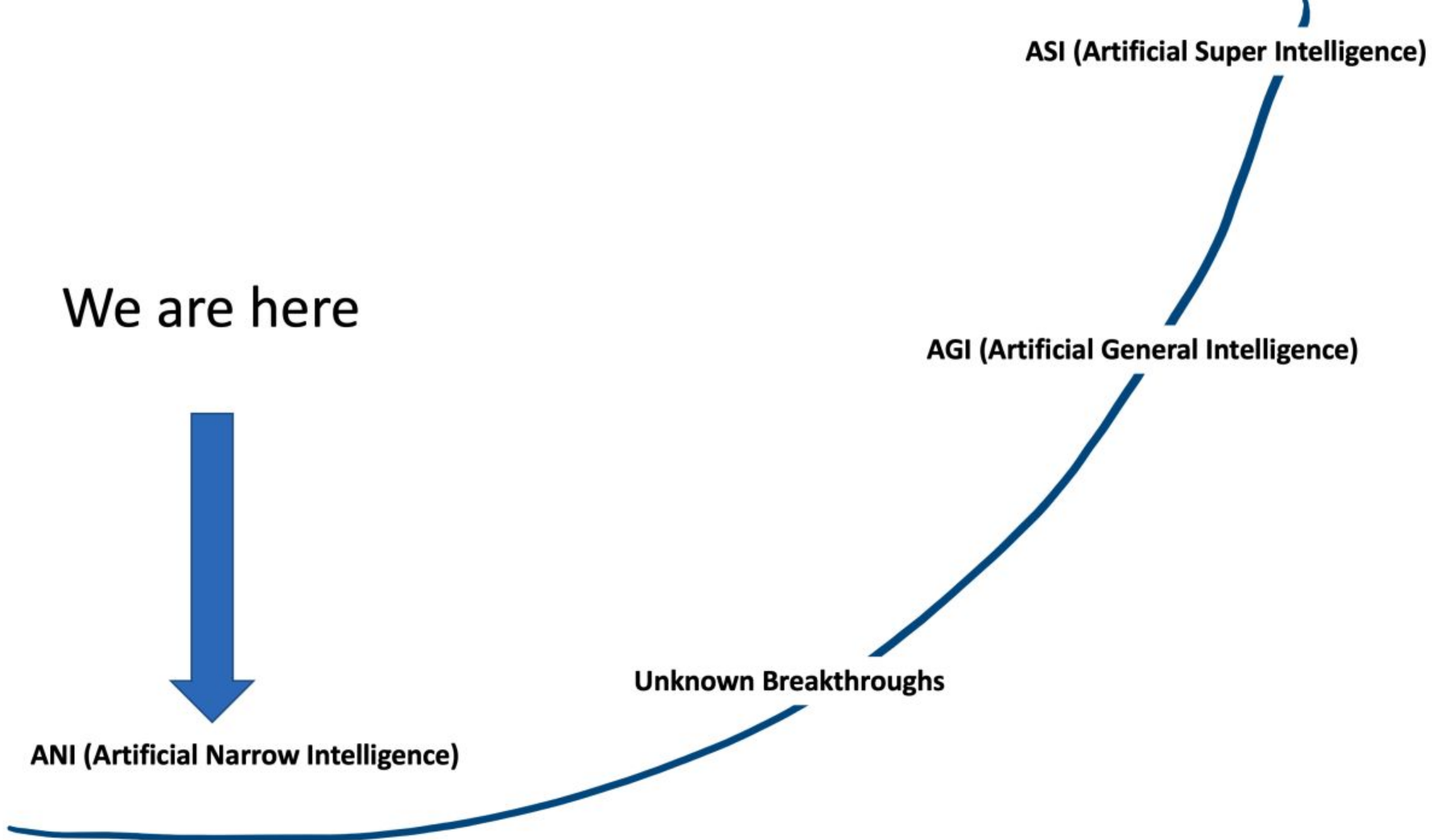


**ANI (Artificial Narrow Intelligence)**

**Unknown Breakthroughs**

**AGI (Artificial General Intelligence)**

**ASI (Artificial Super Intelligence)**



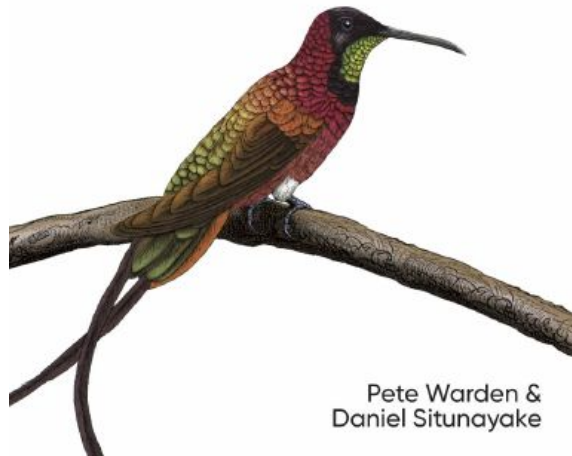
# Aprendizado de Máquina embarcado



O'REILLY®

# TinyML

Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers



Pete Warden & Daniel Situnayake

Trazendo a IA para os sensores e a borda



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Pretty wide ecosystem



arm CMSIS-NN

microTensor



Eta Compute

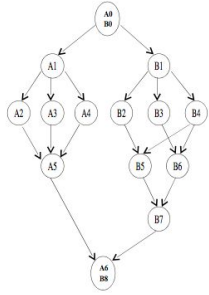
DISRUPTION AT THE EDGE



O que nós precisamos para construir aplicações nesse cenário

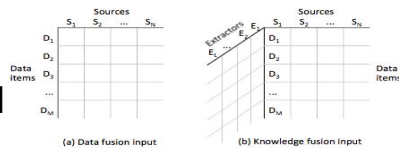
- **Formas de desenvolver aplicações**
  - **Arquiteturas**
  - **Modelos cientes de contexto**
- **Integração de aplicações**
- **Gerência do conhecimento**
- **Condições ambientais únicas**
- **Transações confiáveis**
- **MLOps**
- **Aprendizado Federado**

# Application Integration ICOIN 2013



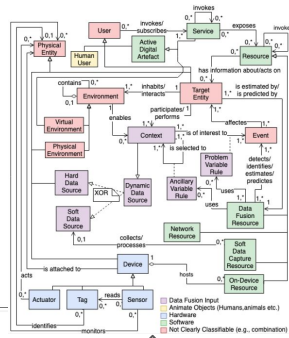
# Knowledge management/ Trusted Transactions

Fusion 2016,  
2018, 2019  
PICOM 2017-2021  
FGCS 2019



# Context-Aware - domain models

Fusion 2020

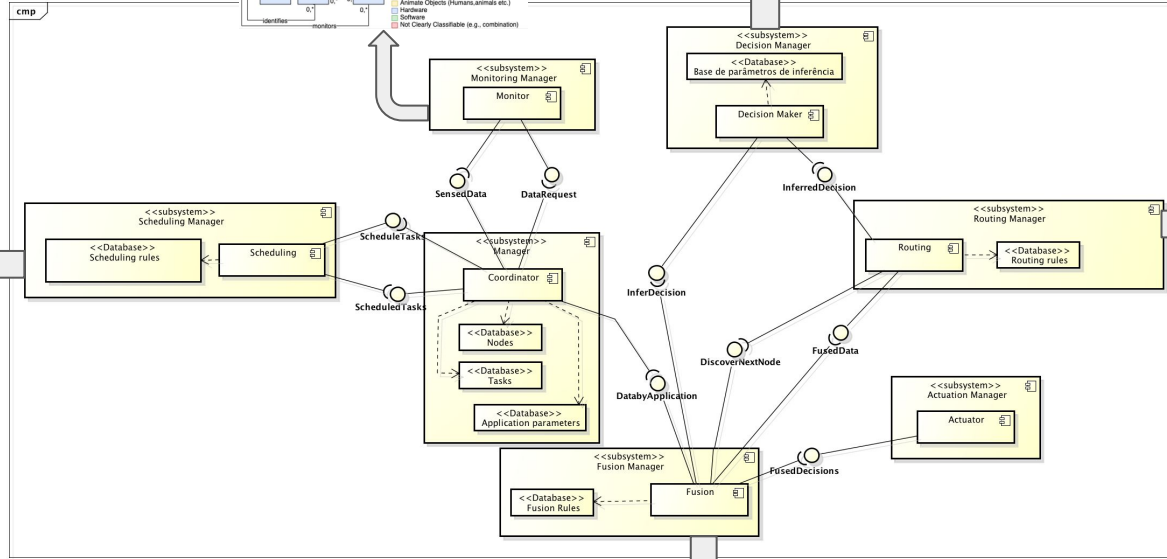


# Federated Learning and distributed decisions

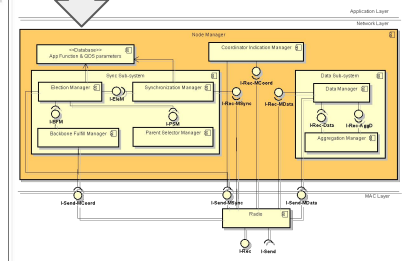
## Athena



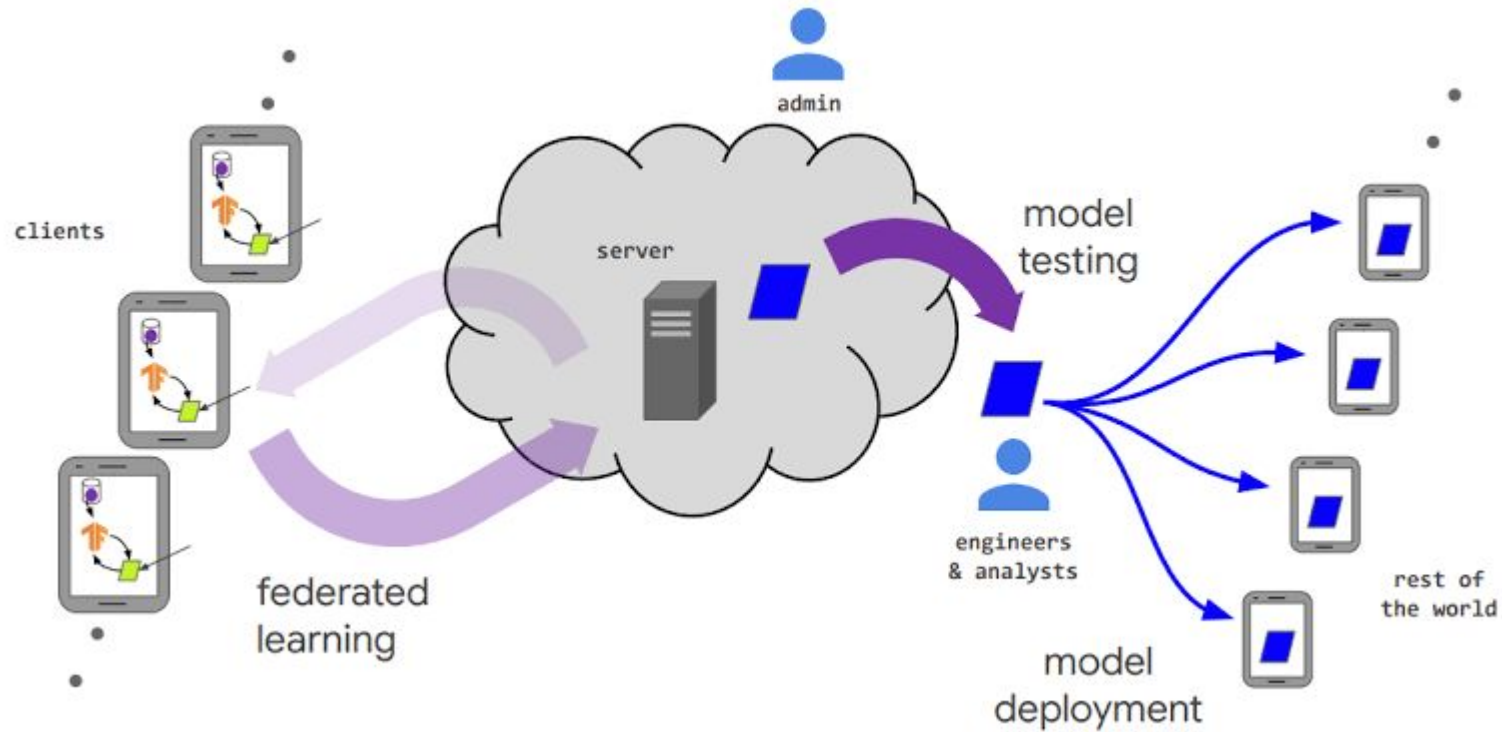
ACM Q2SWINET  
2018, 2019  
Information 2020



powered by Astar



CIT 2015  
Dealing with  
unpredictable  
environmental conditions



## Conclusões

- **Coisas têm seu lugar na Internet**
- **Melhor monitoramento significa dados melhores**
- **Dados melhores significam decisões melhores**
- **O que leva a políticas melhores**







**UMBRELLA  
CORPORATION**