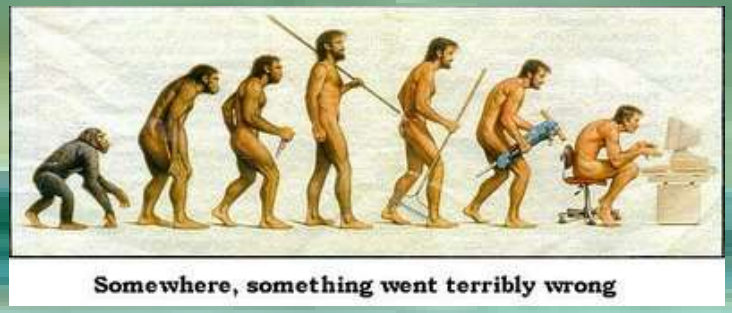
INSTITUTO FEDERAL DO CEARÁ

Mestrado em Ciência da Computação

Disciplina: Saúde Digital – março 2020

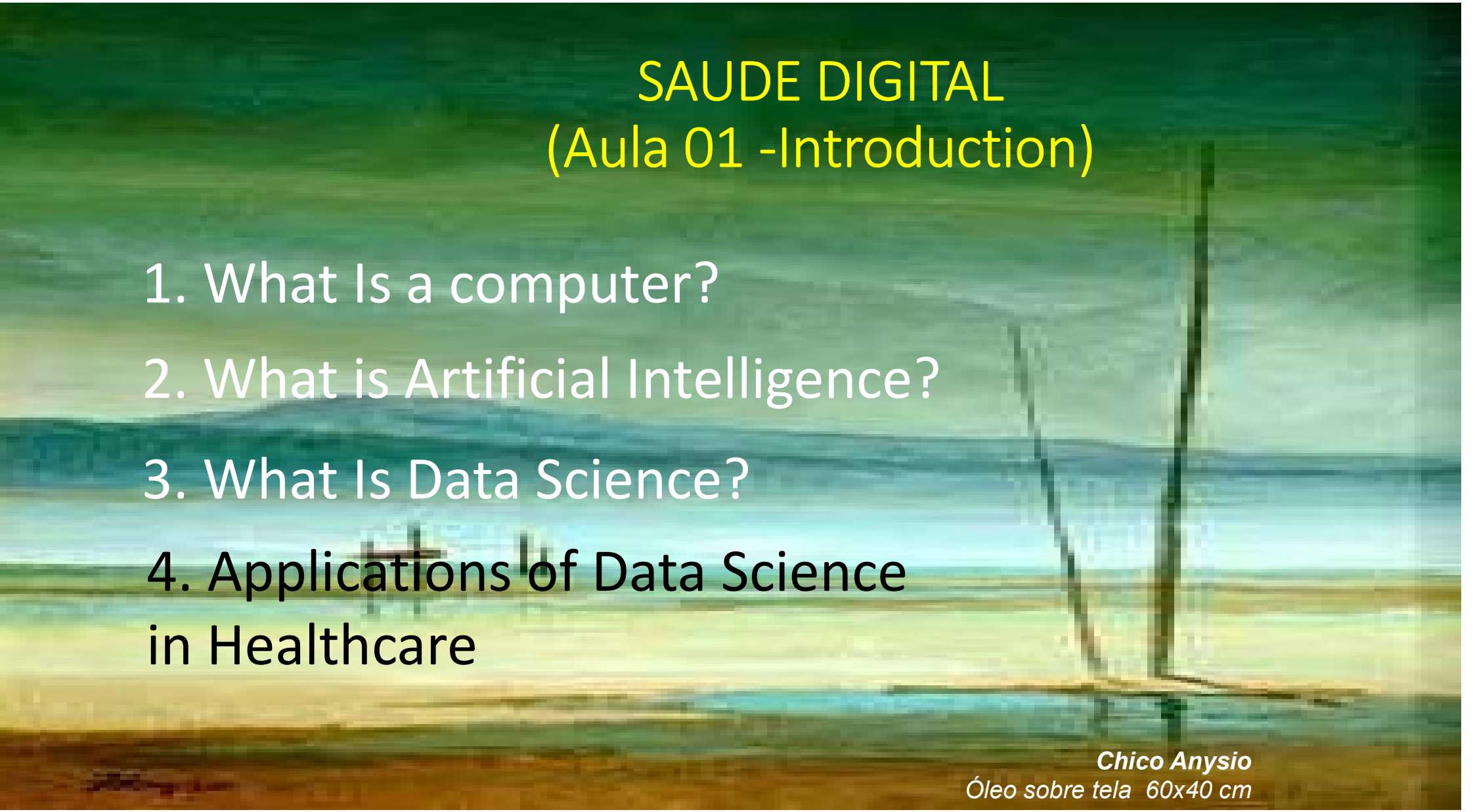


Mauro Oliveira
www.maurooliveira.com.br

Chico Anysio
Óleo sobre tela 60x40 cm

SAUDE DIGITAL
(Aula 01 -Introduction)

1. What Is a computer?
2. What is Artificial Intelligence?
3. What Is Data Science?
4. Applications of Data Science in Healthcare



1.What Is a Computer?

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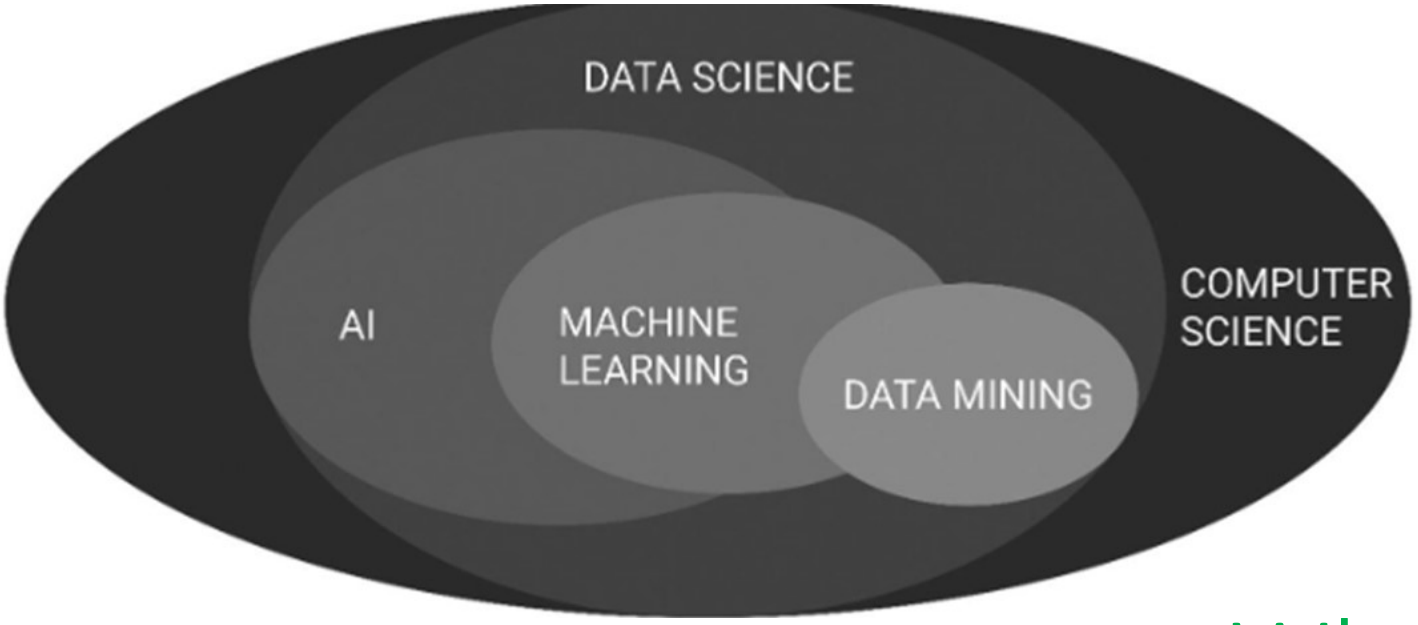
Is an electronic calculator a computer?

What Is Data Science?

What Is Machine Learning?

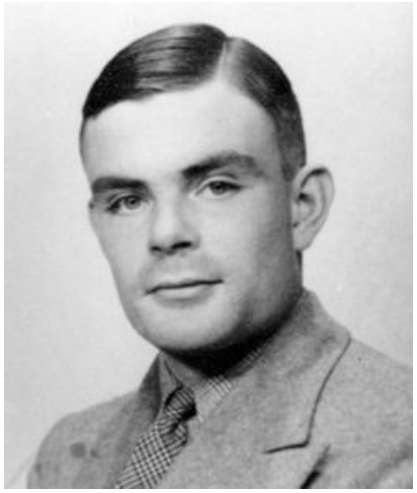
What Is Data Mining?



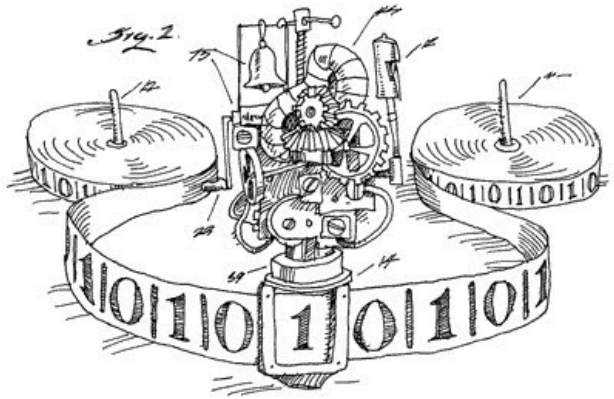
What Is Artificial Intelligence?

What Is Computer Science?

1. What Is a Computer?



Alan Turing



Turing Machine

ON COMPUTABLE NUMBERS, WITH AN APPLICATION TO THE ENTSCHEIDUNGSPROBLEM

By A. M. TURING.

[Received 28 May, 1936.—Read 12 November, 1936.]

The "computable" numbers may be described briefly as the real numbers whose expressions as a decimal are calculable by finite means. Although the subject of this paper is ostensibly the computable *numbers*, it is almost equally easy to define and investigate computable functions of an integral variable or a real or computable variable, computable predicates, and so forth. The fundamental problems involved are, however, the same in each case, and I have chosen the computable numbers for explicit treatment as involving the least cumbrous technique. I hope shortly to give an account of the relations of the computable numbers, functions, and so forth to one another. This will include a development of the theory of functions of a real variable expressed in terms of computable numbers. According to my definition, a number is computable if its decimal can be written down by a machine.

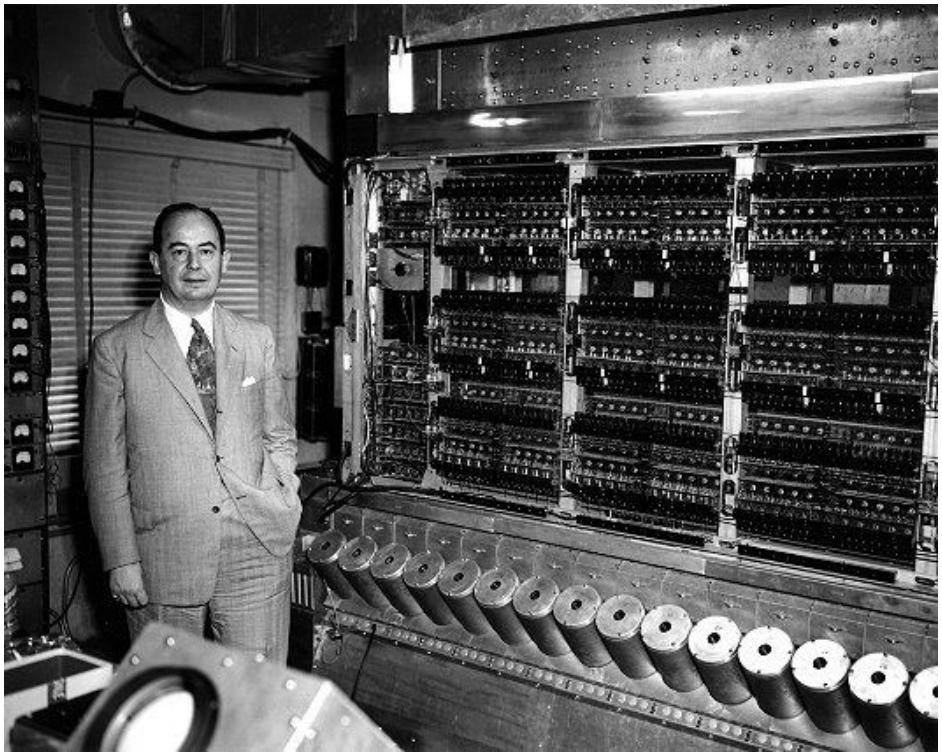
In §§ 9, 10 I give some arguments with the intention of showing that the computable numbers include all numbers which could naturally be regarded as computable. In particular, I show that certain large classes of numbers are computable. They include, for instance, the real parts of all algebraic numbers, the real parts of the zeros of the Bessel functions, the numbers π, e, etc. The computable numbers do not, however, include all definable numbers, and an example is given of a definable number which is not computable.

Although the class of computable numbers is so great, and in many ways similar to the class of real numbers, it is nevertheless enumerable. In § 8 I examine certain arguments which would seem to prove the contrary. By the correct application of one of these arguments, conclusions are reached which are superficially similar to those of Gödel†. These results

† Gödel, "Über formal unentscheidbare Sätze der Principia Mathematica und verwandter Systeme, I", *Monatshefte Math. Phys.*, 38 (1931), 173–198.

PAPER (1936): "On Computable Numbers, With An Application To The Entscheidungsproblem"

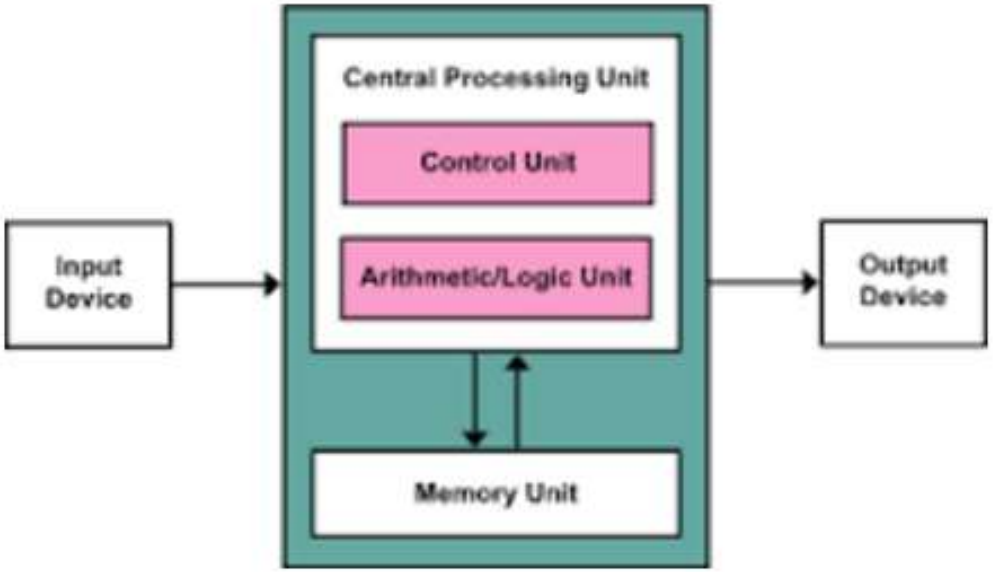
1. What Is a Computer?



“If people do not believe that mathematics is simple, it is only because they do not realize how complicate life is”

Von Neumann

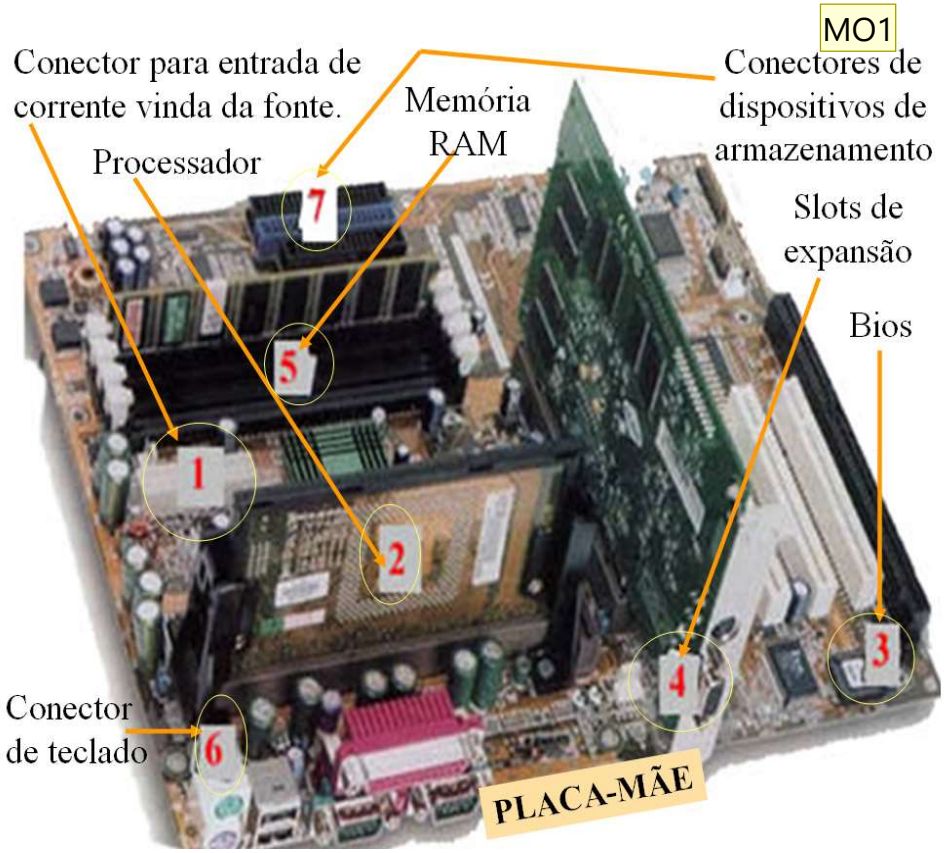
1. What Is a Computer?



The von Neumann architecture, or Princeton architecture, is a computer architecture based on a 1945 description by the mathematician and physicist John von Neumann and others in the First Draft of a Report on the EDVAC

1. What Is a Computer?

Visão TÉCNICA
de um computador

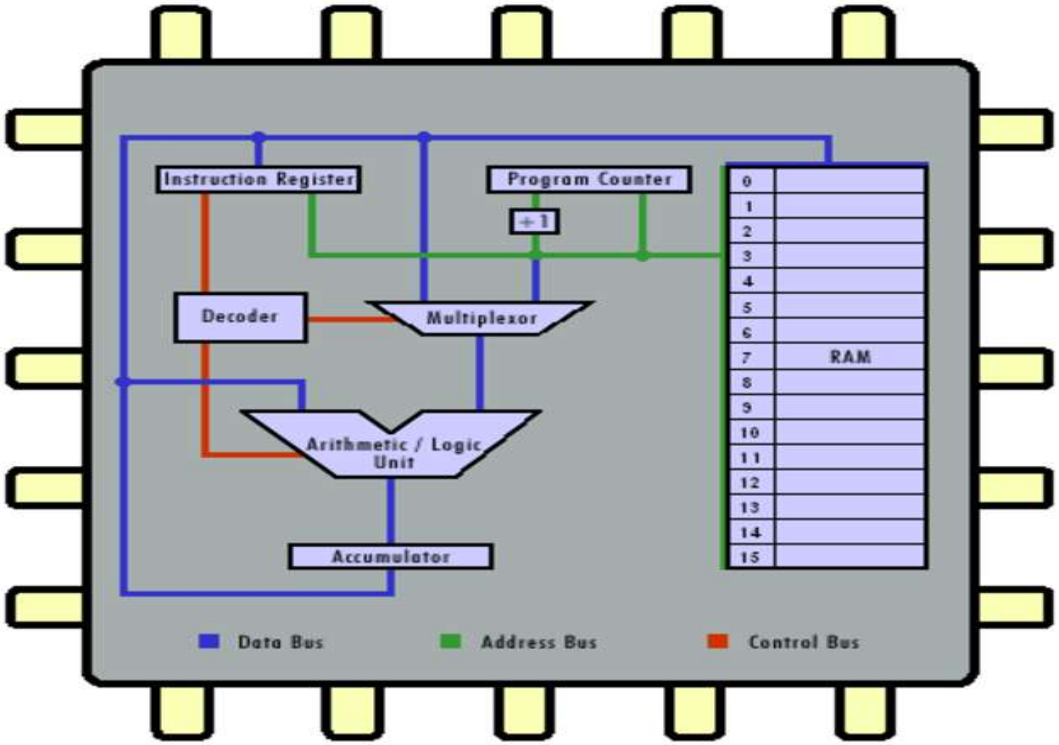


Slide 9

MO1 Mauro Oliveira; 23/05/2017

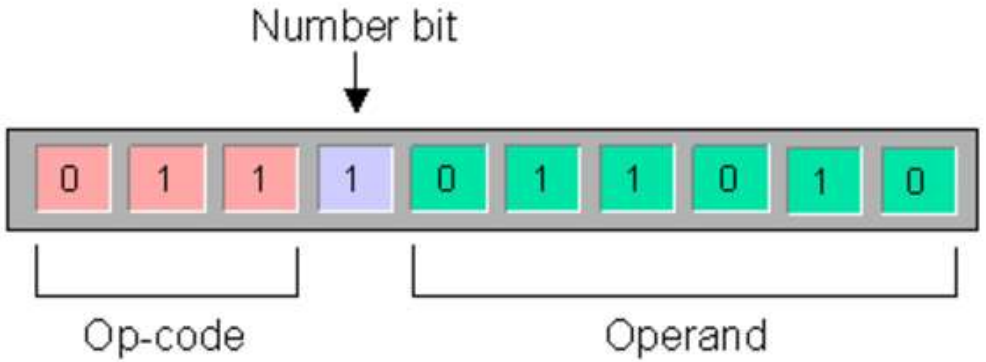
1. What Is a Computer?

Visão de ENGENHARIA de um computador



Execução de um programa na CPU

Op-code	*Mnemonic*	*Function*	*Example*
001	LOAD	Load the value of the operand into the Accumulator	LOAD 10
010	STORE	Store the value of the Accumulator at the address specified by the operand	STORE 8
011	ADD	Add the value of the operand to the Accumulator	ADD #5
100	SUB	Subtract the value of the operand from the Accumulator	SUB #1
101	EQUAL	If the value of the operand equals the value of the Accumulator, skip the next instruction	EQUAL #20
110	JUMP	Jump to a specified instruction by setting the Program Counter to the value of the operand	JUMP 6
111	HALT	Stop execution	HALT

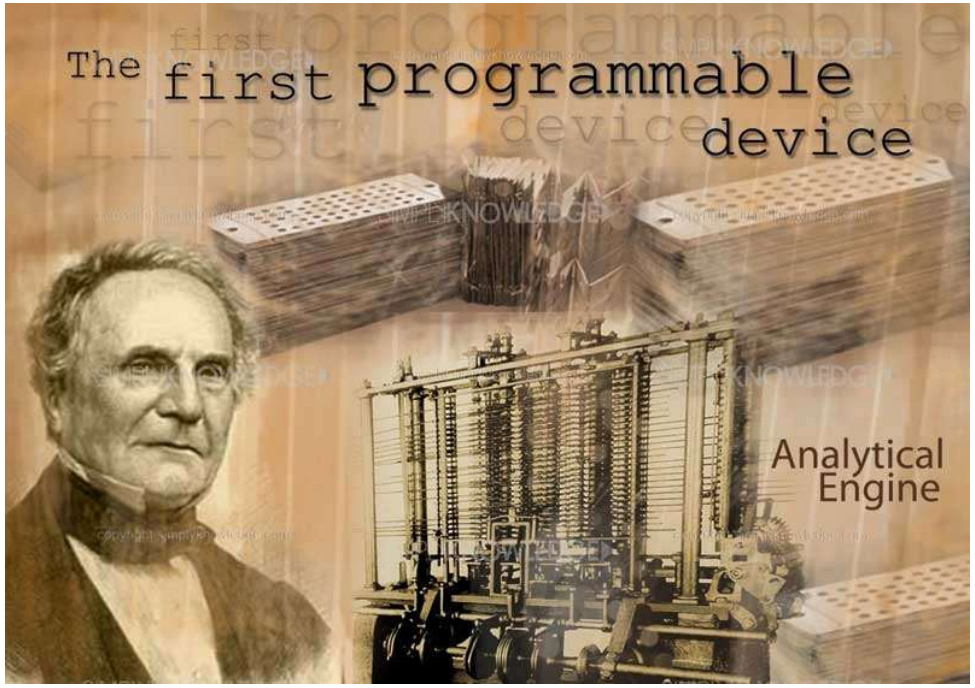


Execução de um programa na CPU

#	*Machine code*	*Assembly code*	*Description*
0	`001 1 000010`	`LOAD #2`	Load the value 2 into the Accumulator
1	`010 0 001101`	`STORE 13`	Store the value of the Accumulator in memory location 13
2	`001 1 000101`	`LOAD #5`	Load the value 5 into the Accumulator
3	`010 0 001110`	`STORE 14`	Store the value of the Accumulator in memory location 14
4	`001 0 001101`	`LOAD 13`	Load the value of memory location 13 into the Accumulator
5	`011 0 001110`	`ADD 14`	Add the value of memory location 14 to the Accumulator
6	`010 0 001111`	`STORE 15`	Store the value of the Accumulator in memory location 15
7	`111 0 000000`	`HALT`	Stop execution

Sum program [view animation]

1. What Is a Computer?



1. What Is a Computer?

"On Computable Numbers, with an Application to the Entscheidungsproblem" (1936)

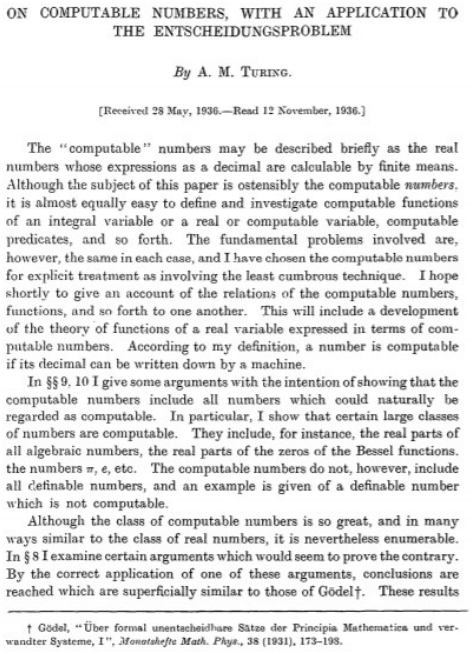
Artigo em que Turing apresenta quatro pontos fundamentais da Teoria da Computação:

1.Formalização de um "procedimento mecânico", ou um algoritmo, como uma tarefa que pode ser executada por uma Máquina de Turing.

2.Apresentação da Máquina de Turing Universal, uma Máquina de Turing capaz de simular o funcionamento de qualquer outra Máquina de Turing.

3.Prova de que existem problemas que não são algoritmicamente solúveis, mostrando que o Problema da Parada é um destes problemas.

4.Prova (no apêndice) de que o seu modelo de Máquinas de Turing é completamente equivalente ao modelo do Lambda-Cálculo de Church.



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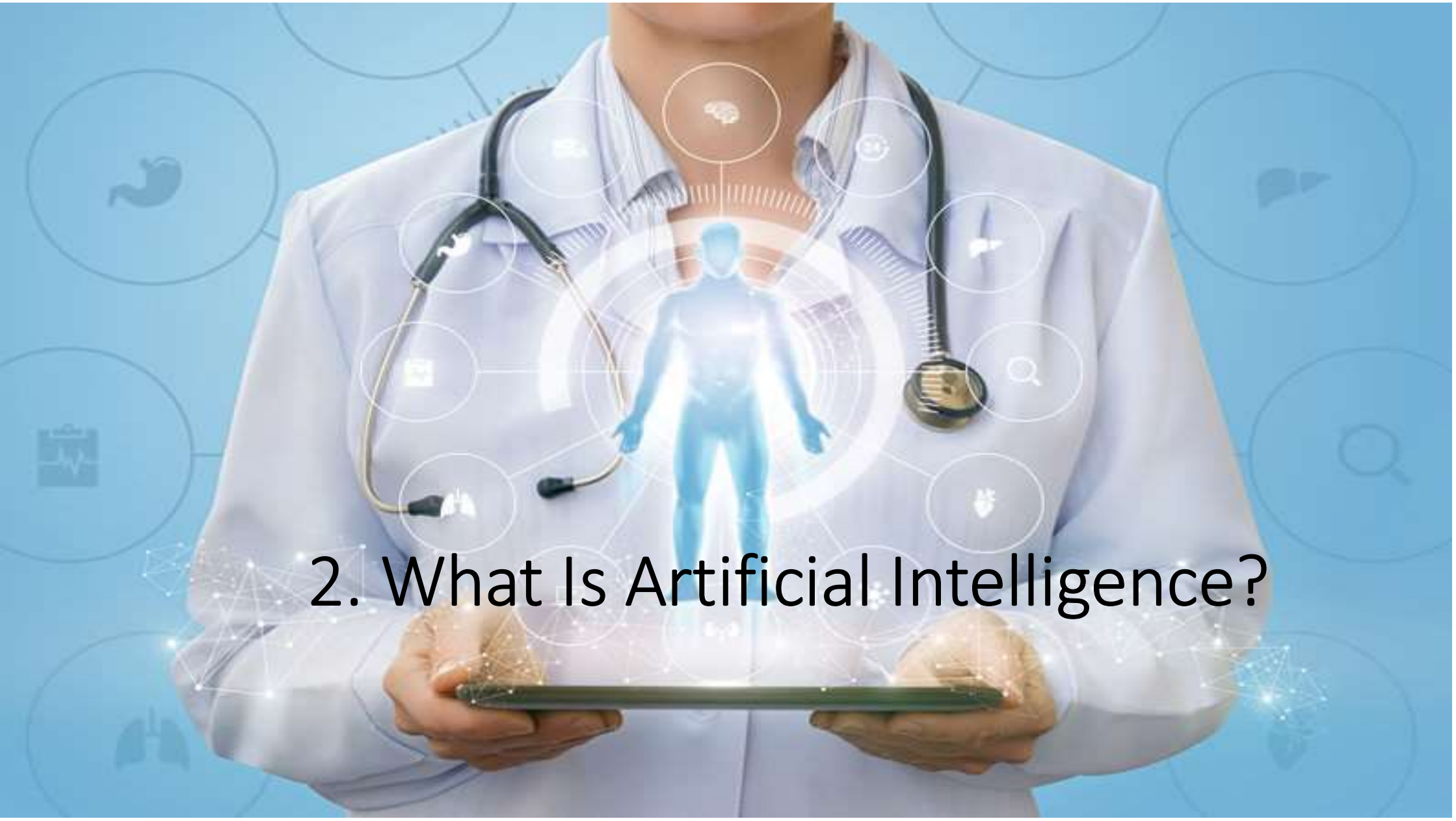

2. What Is Artificial Intelligence?

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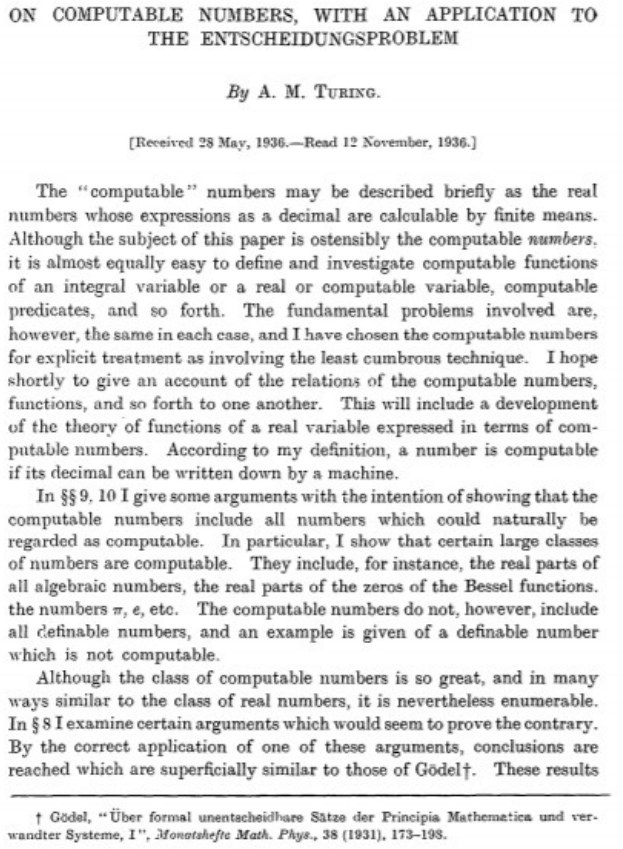
1950 when British pioneer Alan Turing published Computing Machinery and Intelligence in which he asked, can machines think?

AI is a subset of computer science that has origins in mathematics, logic, philosophy, psychology, cognitive science, and biology, among others



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2. What Is Artificial Intelligence?

Files

Databases

The term AI was first coined in 1956 by Professor John McCarthy of Dartmouth College.

Professor McCarthy proposed a summer research project based on the idea that "every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it".

Expert Systems
Neural Network
Fuzzy Logical
Genetic Algorithms
…
Machine Learning
Data Science

2. What Is Artificial Intelligence?

- Getting a system to reason rationally. Techniques include automated reasoning, proof planning, constraint solving, and case-based reasoning.
- Getting a program to learn, discover and predict. Techniques include machine learning, data mining (search), and scientific knowledge discovery.
- Getting a program to play games. Techniques include minimax search and alpha-beta pruning.
- Getting a program to communicate with humans. Techniques include natural language processing (NLP).
- Getting a program to exhibit signs of life. Techniques include genetic algorithms.
- Enabling machines to navigate intelligently in the world
- This involves robotic techniques such as planning and vision.

Expert Systems
Neural Network
Fuzzy Logical
Genetic Algorithms
…
Machine Learning
Data Science

2. What Is Artificial Intelligence?

Four Distinctive Categories of Artificial Intelligence

- Reactive Machines
  - Deep Blue, the chess-playing IBM supercomputer (It beat Kasparov en 1996).
- Limited Memory
  - System that think and Act Rationally
- Theory of Mind
  - Systems that think like human
- Self-Aware Artificial Intelligence
  - Systems that are human

Expert Systems
Neural Network
Fuzzy Logical
Genetic Algorithms
…
Machine Learning
Data Science

3. What Is Data Science?

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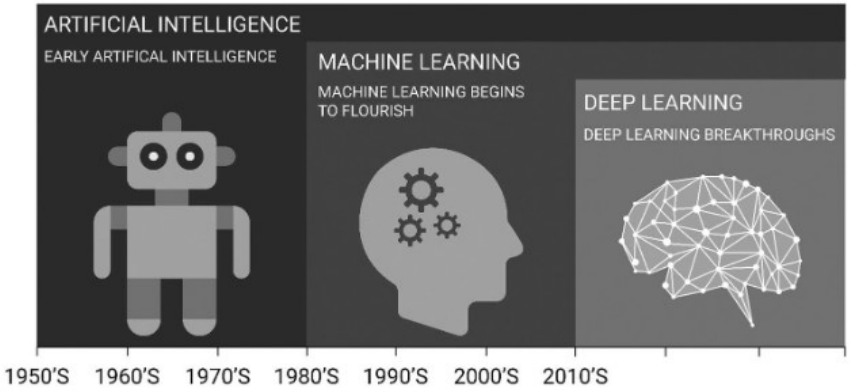
What Is Machine Learning?

Machine learning is a term credited to Arthur Samuel of IBM, who in 1959 proposed that it may be possible to teach computers to learn everything they need to know about the world and how to carry out tasks for themselves.



3. What Is Data Science?

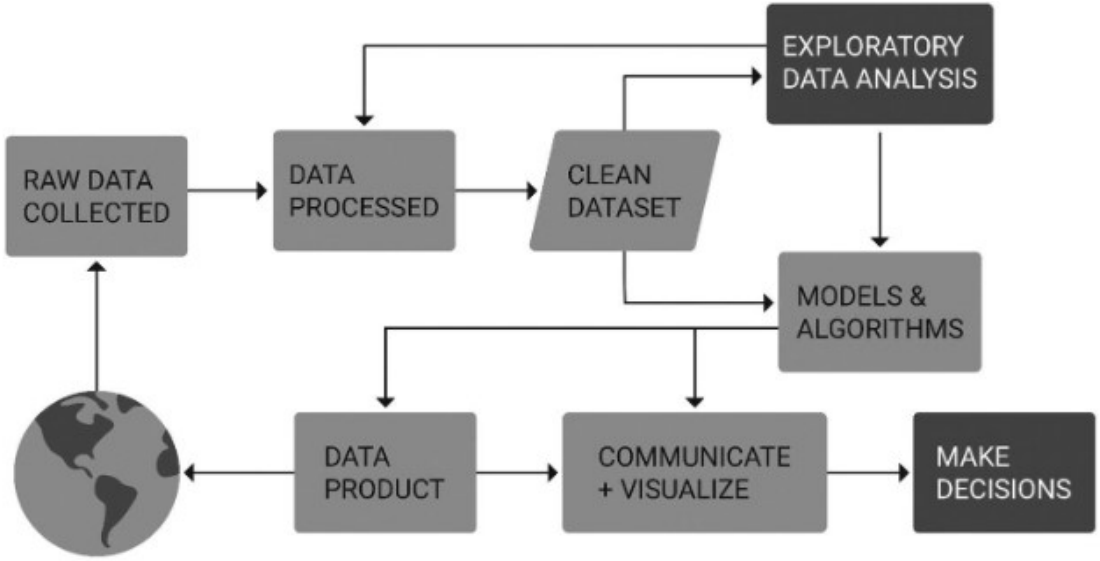
Machine learning was born from pattern recognition and the theory that computers can learn without being programmed to perform specific tasks.

- Bayesian methods
- Neural Networks
- Inductive logic programming
- Explanation-based,
- Natural language processing
- Decision tree
- Reinforcement learning

3. What Is Data Science?

What Is Data Science?

All AI tasks will use some form of data. Data science is a growing discipline that encompasses anything related to data cleansing, extraction, preparation, and analysis.



3. What Is Data Science?

The term data science was phrased by William Cleveland in 2001 to describe an academic discipline bringing statistics and computer science closer together.

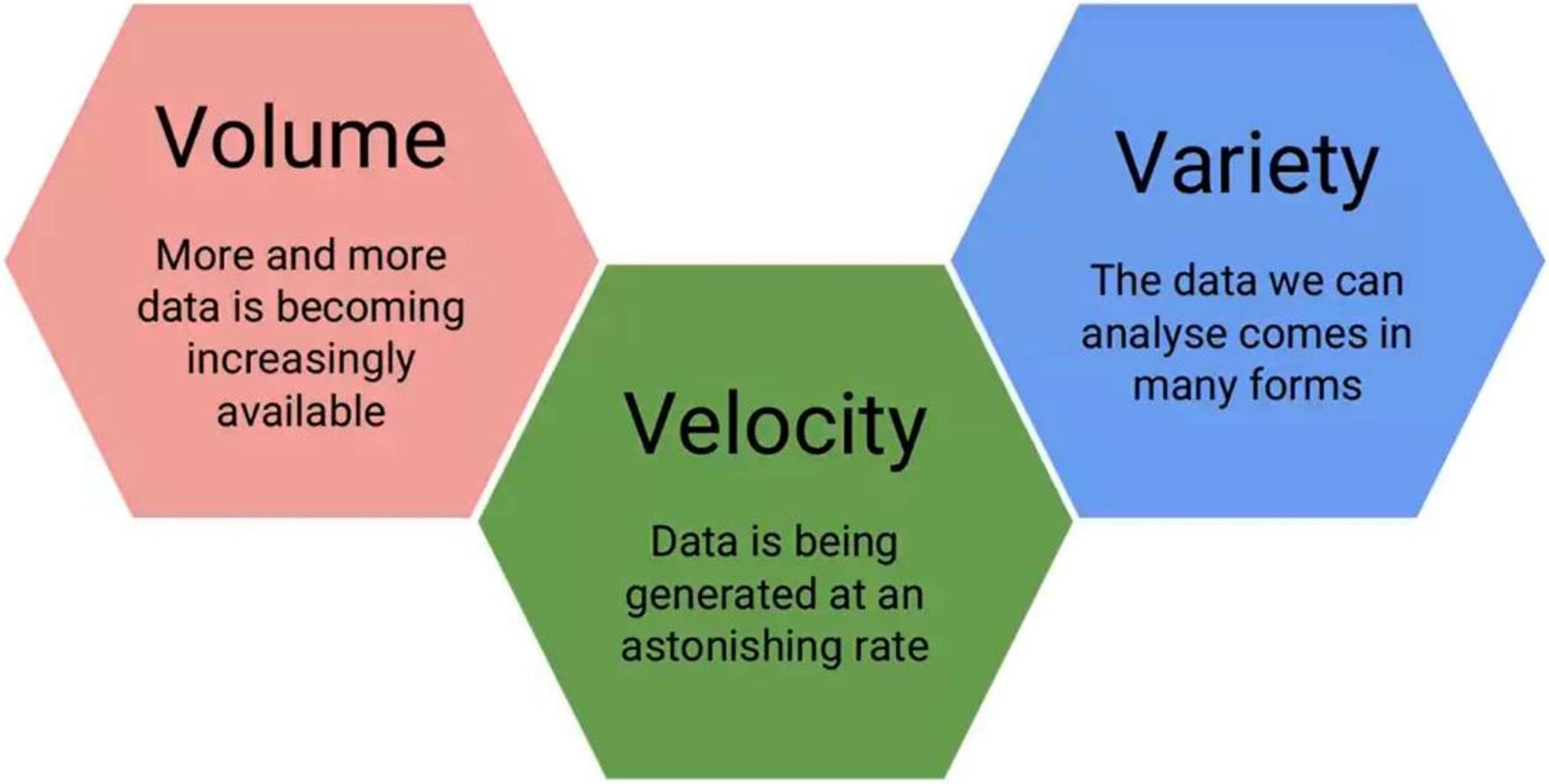
Both patients and healthcare professionals generate a tremendous amount of data. Phones collect metrics such as blood pressure, geographical location; steps walked, nutritional diaries; and other unstructured data such as conversations, reactions, and images.

3. What Is Data Science?

Value	Prefix
10^{24}	Yotta
10^{21}	Zetta
10^{18}	Exa
10^{15}	Peta
10^{12}	Tera
10^{9}	Giga
10^{6}	Mega

There is an estimated 1.2 zettabytes worth of information currently available - and this number is growing exponentially.

3. What Is Data Science?



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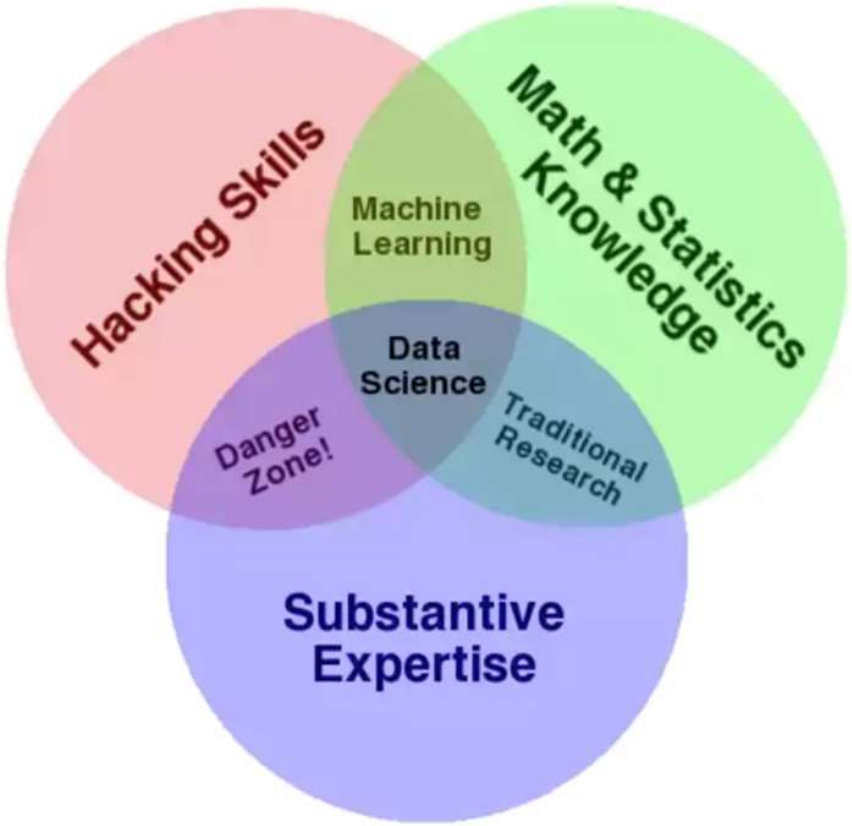
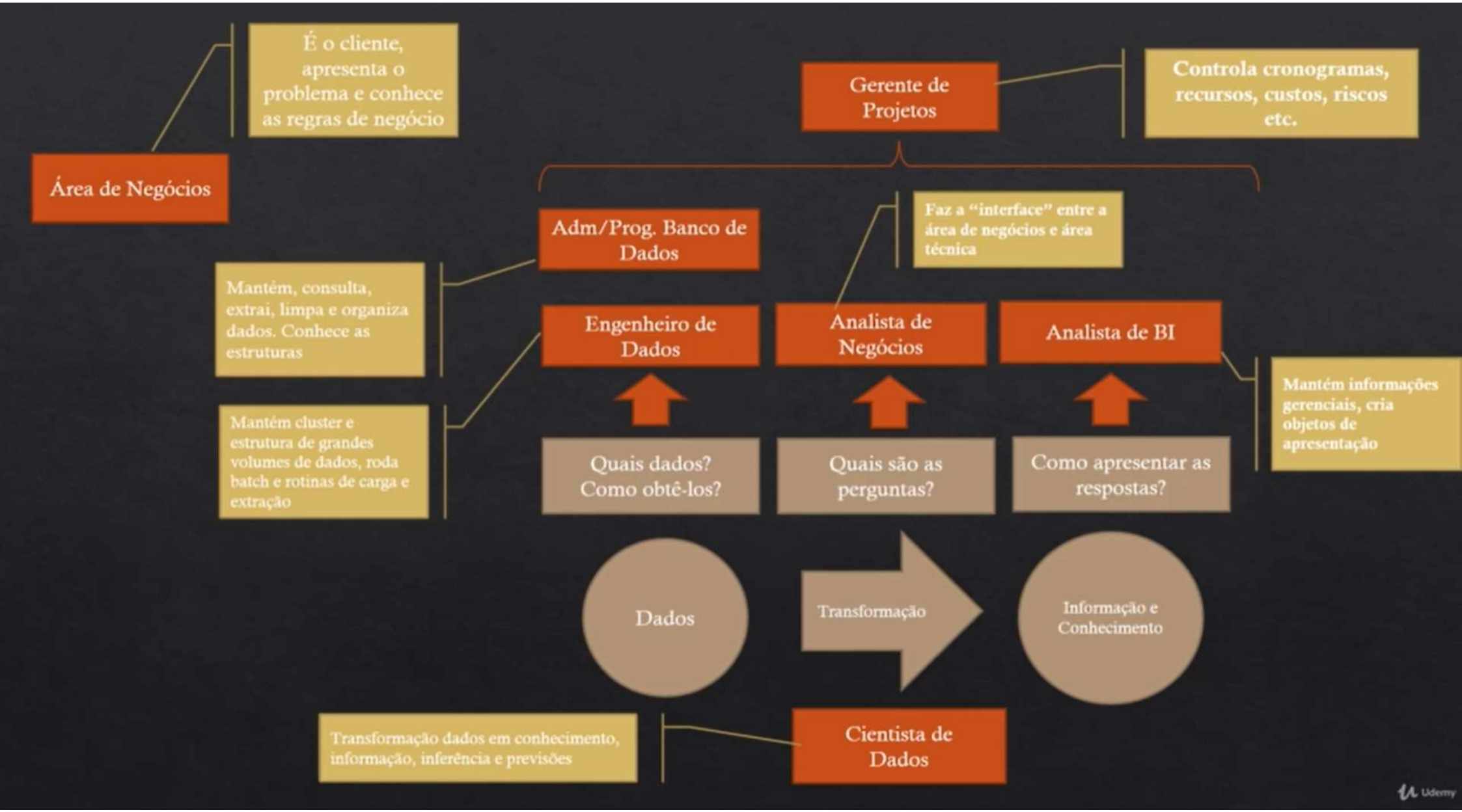
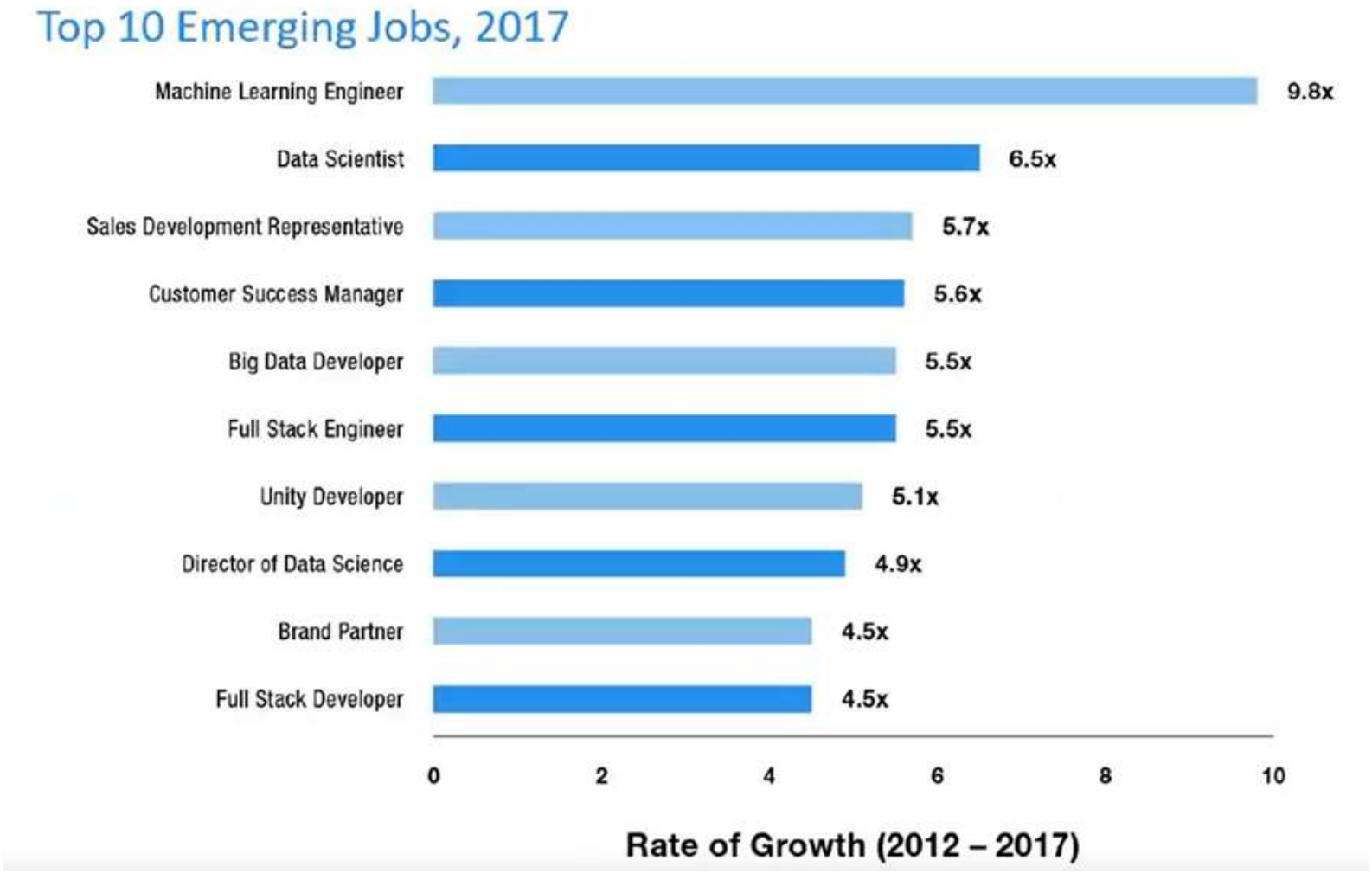



Área de Negócios
É o cliente, apresenta o problema e conhece as regras de negócio
Gerente de Projetos
Controla cronogramas, recursos, custos, riscos etc.
Adm/Prog. Banco de Dados
Faz a "interface" entre a área de negócios e área técnica
Mantém, consulta, extrai, limpa e organiza dados. Conhece as estruturas
Engenheiro de Dados
Analista de Negócios
Analista de BI
Mantém informações gerenciais, cria objetos de apresentação
Mantém cluster e estrutura de grandes volumes de dados, roda batch e rotinas de carga e extração
Quais dados? Como obtê-los?
Quais são as perguntas?
Como apresentar as respostas?
Dados
Transformação
Informação e Conhecimento
Transformação dados em conhecimento, informação, inferência e previsões
Cientista de Dados

3. What Is Data Science?



4. Applications of Data Science in Healthcare?

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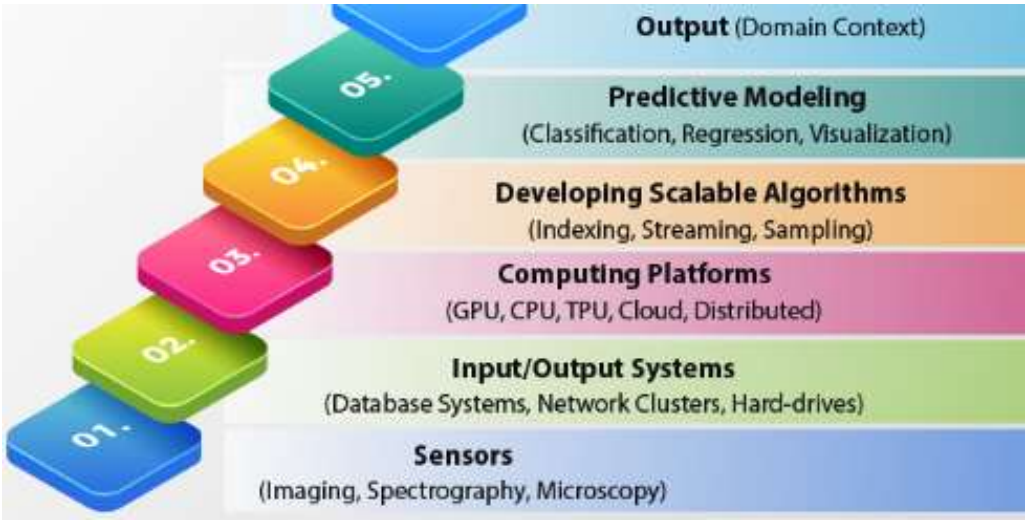
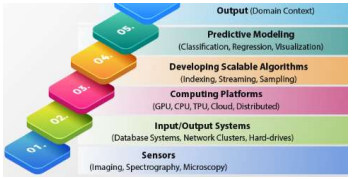


4. Applications of Data Science in Healthcare?

Prediction

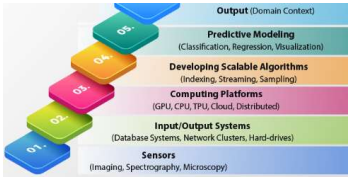
Technologies already exist that monitor data to predict disease outbreaks. This is often done using real-time data sources such as social media as well as historical information from the Web and other sources. Malaria outbreaks have been predicted with artificial neural networks, analyzing data including rainfall, temperature, number of cases, and various other data points.



4. Applications of Data Science in Healthcare?

Diagnosis

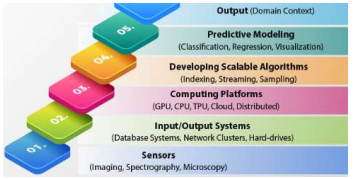
Many digital technologies offer an alternative to non-emergency health -->systems. Considering the future, combining the genome with machine learning algorithms provides the opportunity to learn about the risk of disease, improve pharmacogenetics, and provide better treatment pathways for patients.



4. Applications of Data Science in Healthcare?

Personalized Treatment and Behavior Modification

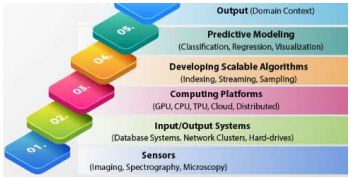
A digital therapy from Diabetes Digital Media, the Low Carb Program, assists people with type 2 diabetes and prediabetes to reverse (i.e., place into remission) their condition. The app provides personalized education and integrated health tracking, learning from the user's and wider community's progress.



4. Applications of Data Science in Healthcare?

Drug Discovery

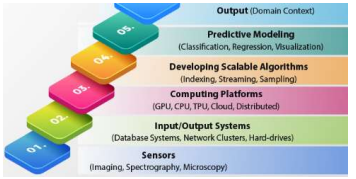
The use of machine learning in preliminary drug discovery has the potential for various uses, from initial screening of drug compounds to predicted success rate based on biological factors. This includes R&D discovery technologies like next-generation sequencing.



4. Applications of Data Science in Healthcare?

Follow-Up Care

Hospital readmittance is a huge concern in healthcare. Doctors, as well as governments, are struggling to keep patients healthy, particularly when returning home following hospital treatment.



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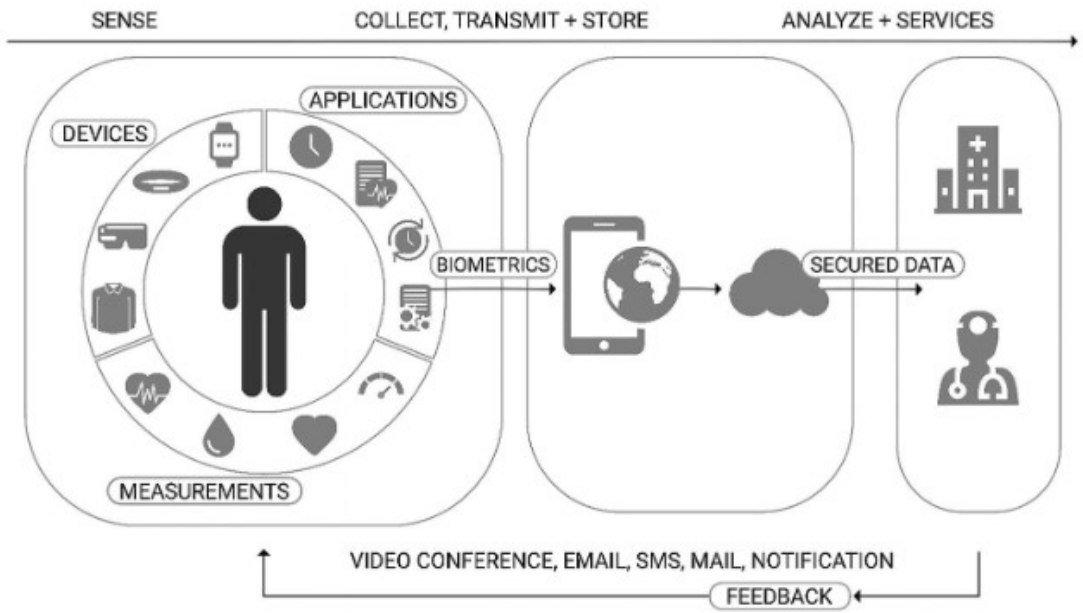

4. Applications of Data Science in Healthcare?

Realizing the Potential of AI in Healthcare

For AI and machine learning to be fully embraced and integrated within healthcare systems, several key challenges must be addressed.

Understanding Gap

Fragmented Data

Appropriated Security

Data Governance

Bias

Software

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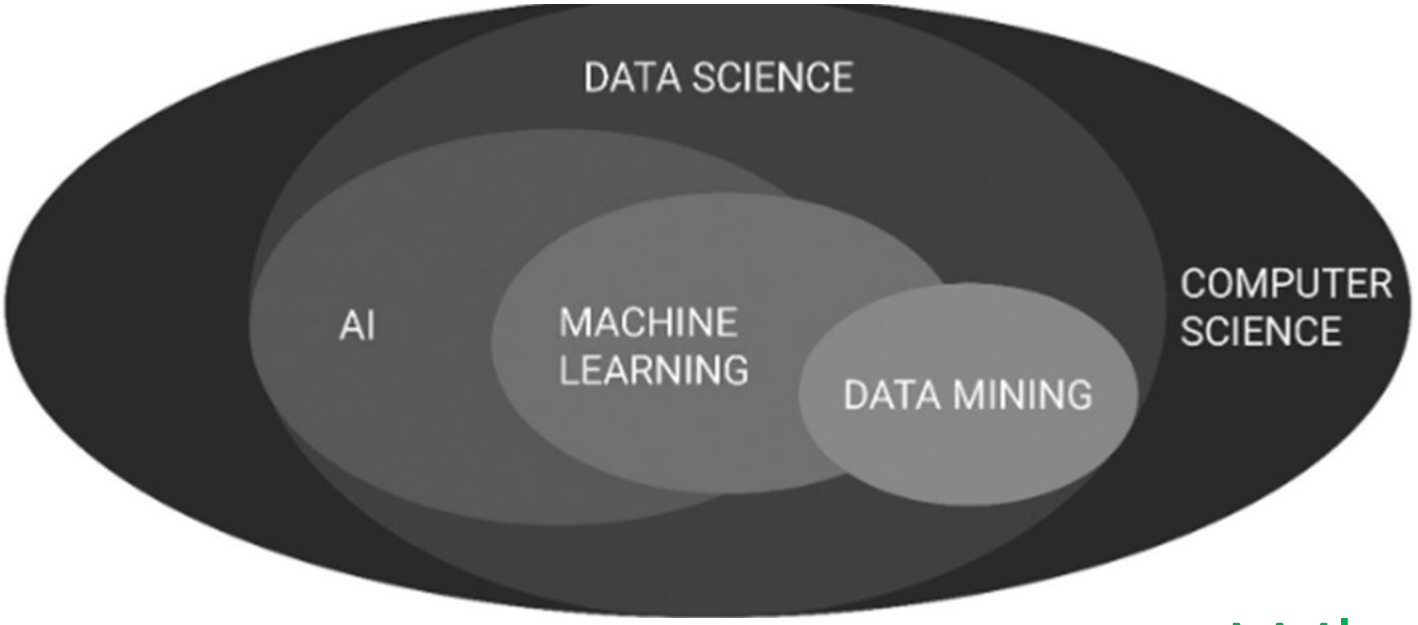
What Is Data Mining?



What Is Artificial Intelligence?

What Is Computer Science?

Material bibliográfico :

1) Virginia Tech Courses:
http://courses.cs.vt.edu/~csonline/MachineArchitecture/Lessons/index.html

2) Livro Texto: Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes - Arjun Panesar. APress, 2019

3) Artigos:
Turing: “On Computable Numbers, With An Application To The Entscheidungsproblem”
https://www.cs.virginia.edu/~robins/Turing_Paper_1936.pdf
Artificial Intelligence, Machine Learning, Deep Learning, and Cognitive Computing: What Do These Terms Mean and How Will They Impact Health Care? https://www.arthroplastyjournal.org/action/showPdf?pii=S0883-5403%2818%2930215-8

4) Slides:
Ultra-modern medicine: examples of machine learning in healthcare
https://builtin.com/artificial-intelligence/machine-learning-healthcare
Top 10 applications of machine learning in healthcare
https://www.flatworldsolutions.com/healthcare/articles/top-10-applications-of-machine-learning-in-healthcare.php
5 Ways Machine learning is Redefining Healthcare
https://www.entrepreneur.com/article/341626

5) Video:
George Dyson at the birth of the computer”
https://www.ted.com/talks/george_dyson_the_birth_of_the_computer
Better Medicine Through Machine Learning | Suchi Saria | TEDxBoston
https://www.youtube.com/watch?v=Nj2YSLPn6OY