

Inteligência Artificial

2021/22

LICENCIATURA EM ENGENHARIA INFORMÁTICA
MESTRADO integrado EM ENGENHARIA INFORMÁTICA
Inteligência Artificial



Source: Lascaux Cave
https://pt.wikipedia.org/wiki/Arte_rupestre

Ebers Papyrus

London Medical Papyrus (~ 3000 BC)



Source: Wikipedia
https://pt.wikipedia.org/wiki/Papiro_Ebers



Source: Wikipedia
https://en.wikipedia.org/wiki/London_Medical_Papyrus

Library of Alexandria (~300 BC)



Source: Nineteenth-century artistic rendering of the Library of Alexandria by the German artist O. Von Corven
https://en.wikipedia.org/wiki/Library_of_Alexandria



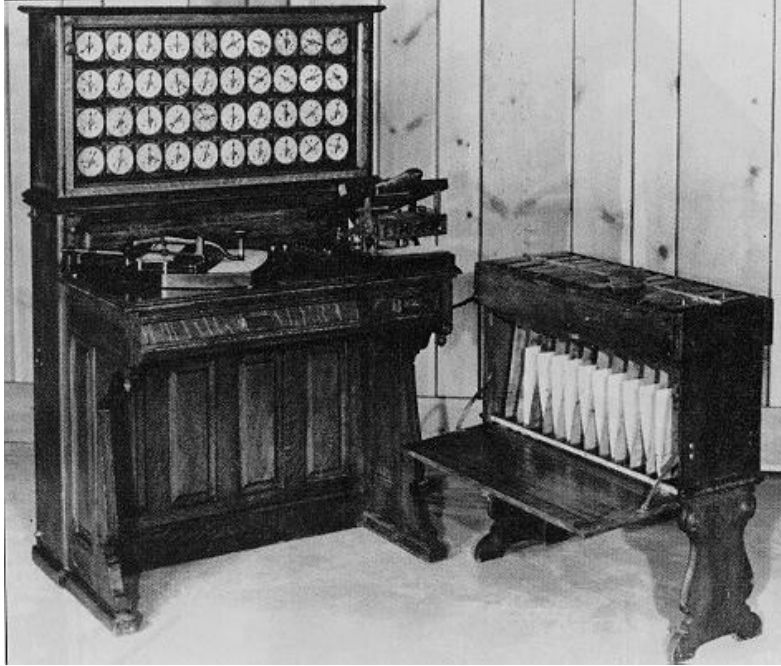
Source: Woman reading
Chronicles of the King of France, Robert Gaguin, 1514
<https://www.historytoday.com/reviews/history-knowledge>

Tree of the knowledge (of good and evil)



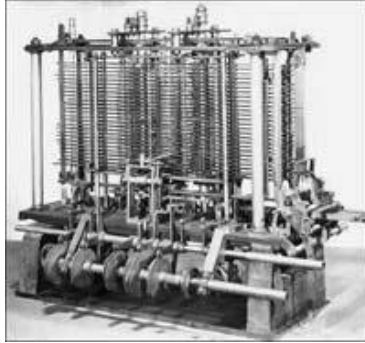
Source: "The Fall of Man" by Lucas Cranach the Elder.
https://en.wikipedia.org/wiki/Tree_of_the_knowledge_of_good_and_evil

Tabulating machine (1890)

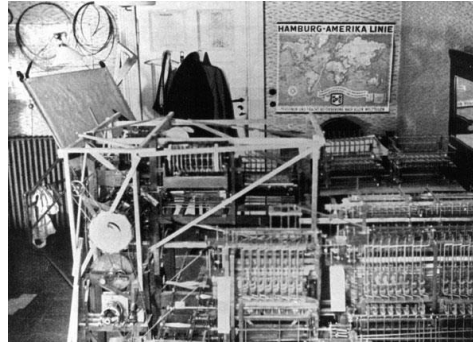


Source: Hollerith 1890 Census Tabulator
<http://www.columbia.edu/cu/computinghistory/census-tabulator.html>

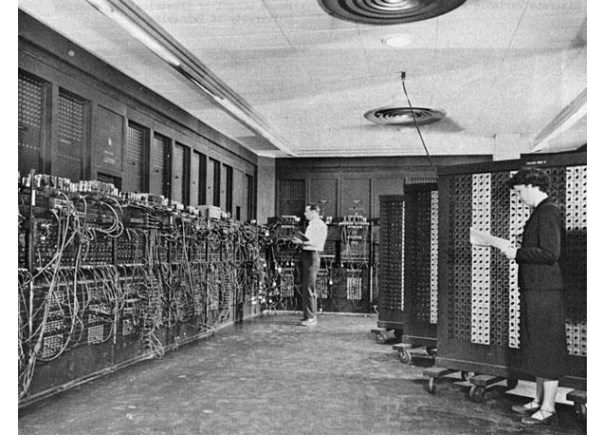
and now ... all it accelerated



1837, Charles Babbage, Analytical Engine



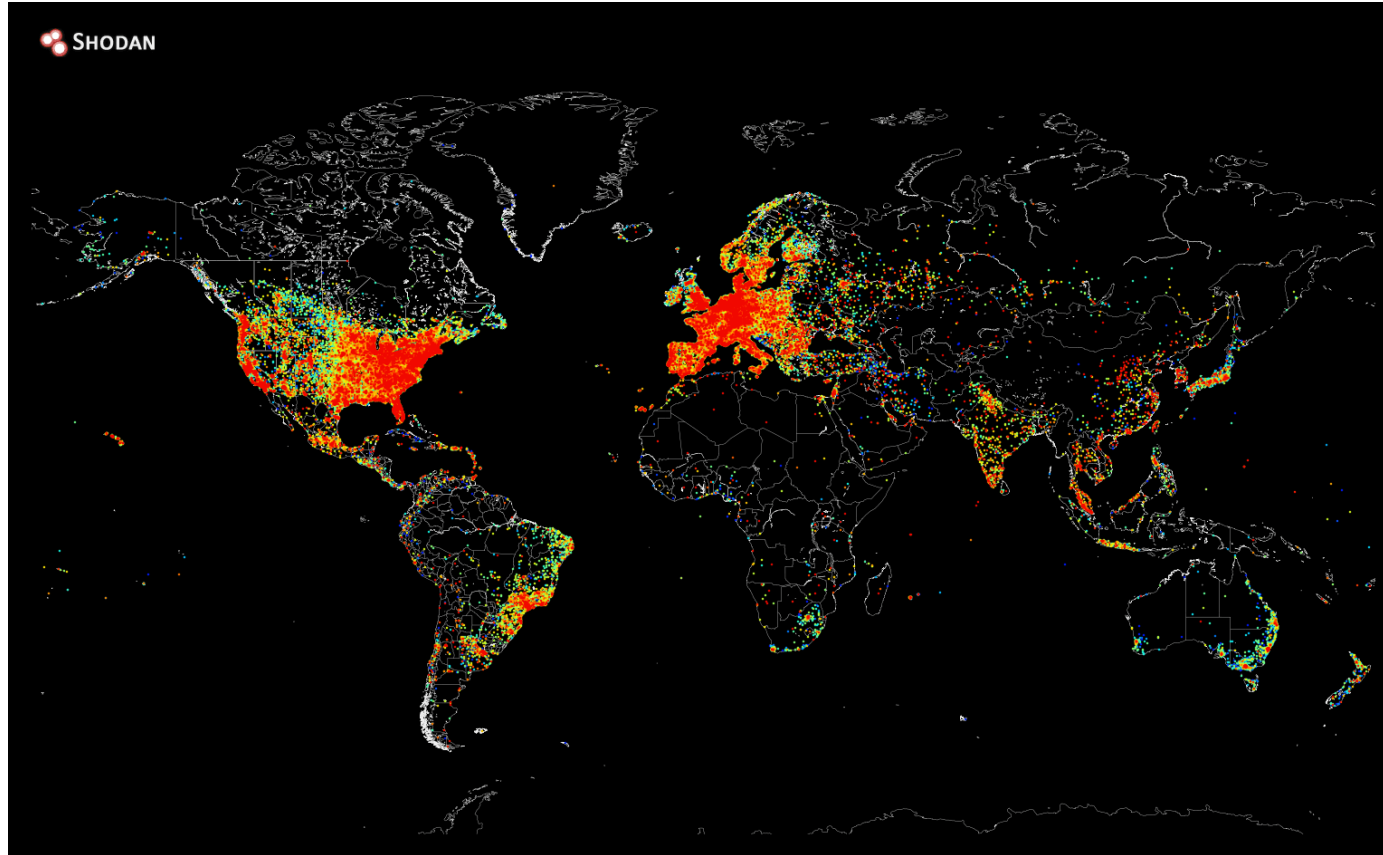
1936, Konrad Zuse, Z1



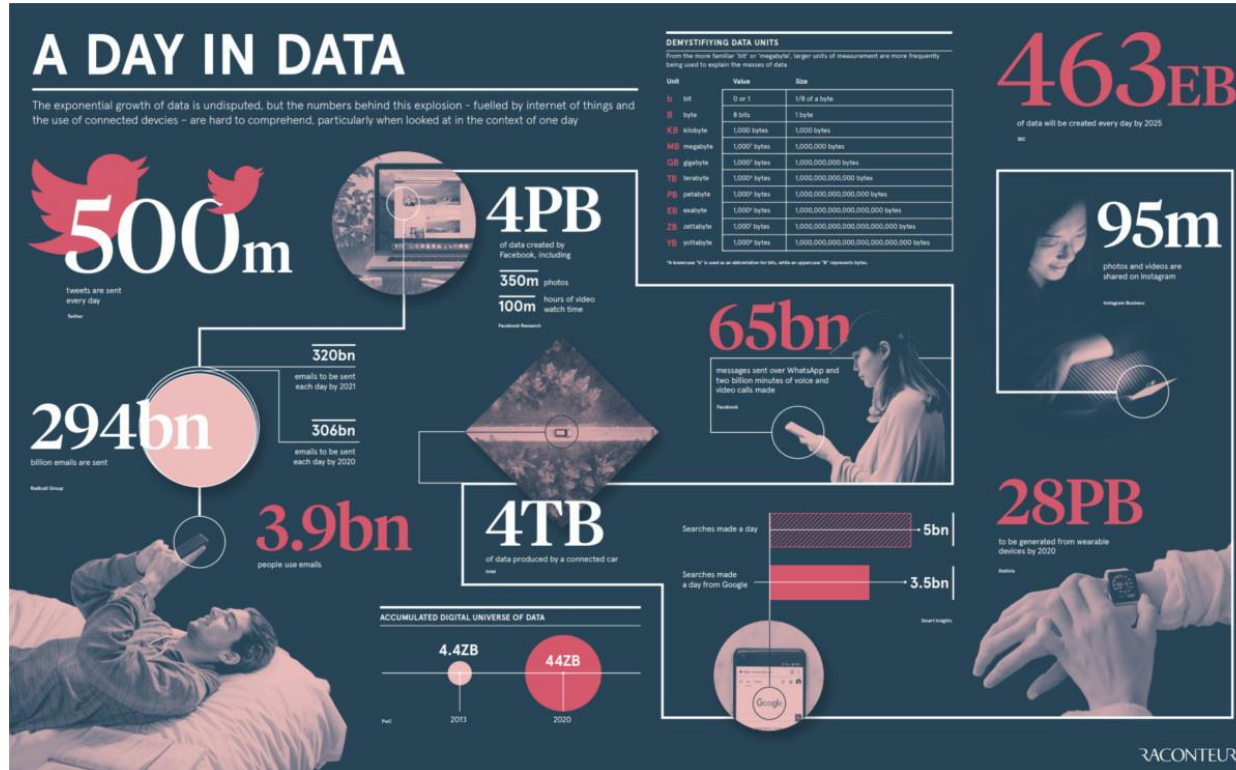
1943, J. Presper Eckert and John Mauchly, ENIAC



Source: How direct neural interfaces work
<https://www.kaspersky.com/blog/direct-neural-interfaces/8560/>



Source: John Matherly



Source: How much data is generated each day? World Economic Forum
<https://www.weforum.org/agenda/2019/04/how-much-data-is-generated-each-day-cf4bddf29f/>
 Image: Raconteur

“By 2025, it’s estimated that 463 exabytes of data will be created each day globally – that’s the equivalent of 212,765,957 DVDs per day!”

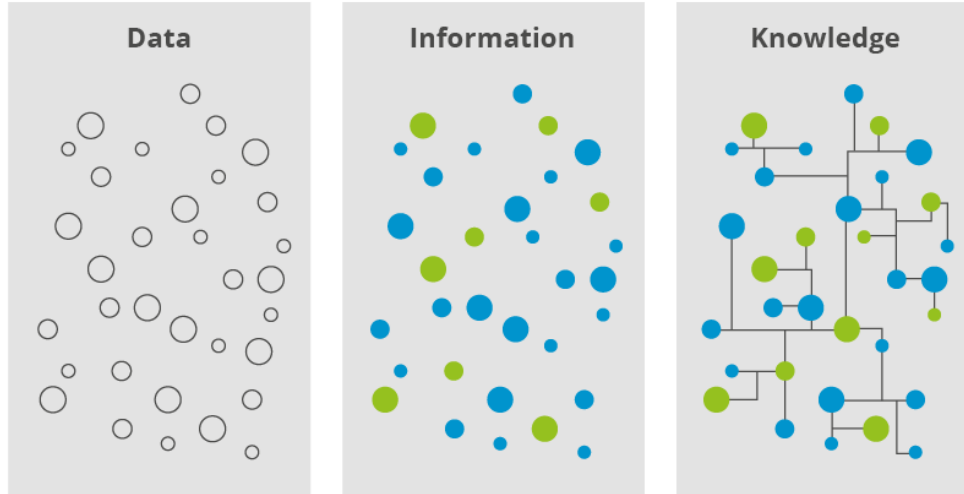
“The ability to take data — to be able to understand it, to process it, to extract value from it, to visualize it, to communicate it - that’s going to be a hugely important skill in the next decades.”

Hal Varian, chief economist at Google and UC Berkeley professor of information sciences, business, and economics

The word science suggests, in this context, knowledge acquired through systematic study.



Data, Information and Knowledge



Source: <https://www.unymira.com/en/knowledge-management/what-is-knowledge-management-for-customer-service/>

Data - Simple facts, unprocessed, unorganized, raw.

Information - Structured, organized and processed data, presented with context, which makes it relevant and useful.

Knowledge - A map of information linked together through experience. Knowledge has the ability to predict and make decisions and generalizations.

Data

- 100

Information

- 100 miles

Knowledge

- 100 miles is quite a far distance.

Wisdom

- It is very difficult to walk 100 miles by any person, but vehicle transport is okay

Source: <https://www.guru99.com/information-vs-knowledge-difference.html>



What is knowledge?

knowledge can be defined as **information** (which can be expressed in the form of propositions) **from the environment**.

What is knowledge representation?

It can be defined as **symbols used to represent** the propositions.

What is knowledge representation and reasoning?

One way to define it is as the **manipulation of symbols** encoding propositions **to produce representations** of new propositions.

The question of representing knowledge is a key issue in artificial intelligence:

How can human knowledge of all kinds be represented by a computer language, and in such a way that computers can use this knowledge for purposes of reasoning?

Modern computer applications have led to generalized use of knowledge representations in various contexts, including information search, simulation, web semantic ontology description.



Types of knowledge



Source: <https://www.javatpoint.com/knowledge-representation-in-ai>



Declarative Knowledge

- Declarative knowledge is to know about something.
- It includes concepts, facts, and objects.
- It is also called descriptive knowledge and expressed in declarative sentences.

Procedural Knowledge (Imperative Knowledge)

- Procedural knowledge is a type of knowledge which is responsible for knowing how to do something.
- It can be directly applied to any task.
- It includes rules, strategies, procedures, agendas, etc.
- Procedural knowledge depends on the task on which it can be applied.

Meta-knowledge

- Knowledge about the other types of knowledge

Heuristic knowledge

- Heuristic knowledge is representing knowledge of some experts in a field or subject.

Structural knowledge

- Structural knowledge is basic knowledge to problem-solving.
- It describes the relationship that exists between concepts or objects



Artificial Intelligence

- The study and development of systems that exhibit intelligent behaviour.

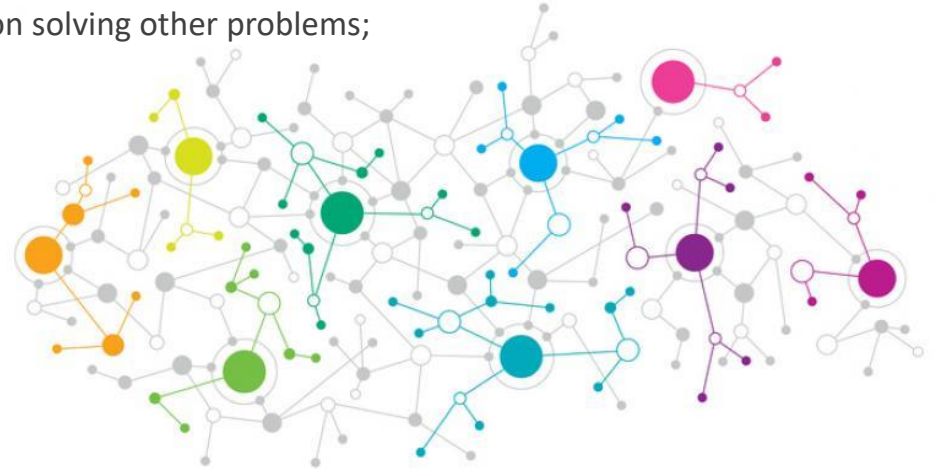
Knowledge Representation and Reasoning

- The study and development of methods to represent and reason with information in order to obtain intelligent behaviour.



The AI approach to knowledge representation is exposed (normally) through two paradigms:

- Symbolic
 - It is based on logic to represent knowledge;
 - It bases the reasoning in the construction of inference systems;
- Non-symbolic, or connectionist
 - It bases the functioning of the system on the ability to learn, generalizing;
 - Solves problems based on past knowledge or data on solving other problems;



Advantages of the symbolic approach:

- The problem of knowledge representation is simple;
- Great expressive power of representation languages;
- Solidified inference mechanisms.



Advantages of the non-symbolic approach:

- Ability to learn to solve problems;
- Ability to generalize problem solving;
- Fault-tolerant.



Symbolic methods

- Declarative Languages (Logic)
- Imperative Languages (C, C++, Java, ...)
- Prolog
- Rules
- Frames
- Semantic Networks
- Others

Non – symbolic methods

- Neural Networks
- Genetic Algorithms
- Others



Knowledge Representation seeks to answer questions such as:

- How to represent knowledge?
 - What is the nature of knowledge and how do we represent it?
 - Do we represent this knowledge all equally?
 - Should a representation scheme handle a specific domain or should it be of general use?
 - How expressive is a representation scheme?
 - Should the scheme be declarative or procedural?
 - How should so-called “smart” programs represent and use this knowledge?
 - Will we be able to represent all kinds of knowledge?
-
- Desirable characteristics, among others:
 - Explicitly define objects and their relationships;
 - Display limitations and restrictions (express how an object or relationship affects them).
 - Transparent;
 - Quick;
 - Computable.



Adequacy of representation (expressiveness)

- ability to represent the required knowledge;

Adequacy of inference

- ability to manipulate knowledge and “produce” **new** knowledge;

Inference efficiency

- ability to direct inference to productive directions;
- ability to respond with **limited** resources;

Efficiency in obtaining new knowledge

- ability to “obtain” new knowledge;

Automatically (if possible).

Efficiency vs Effectiveness



Natural Language based

- English, Portuguese,...



Informal

Graphs-based

- UML, E-R,...



Semi - formal

Logic based

- First Order Logic, ...



Formal

- Logical Representation
- Production Rules
- Hierarchical Structures
 - Semantic Network Representation
 - Frame Representation
- Scripts



EQUIPA DOCENTE



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T: Quinta-feira 14h00-16h00 (Edifício 1 – 0.08)

PL1: Sexta-feira 9h00-11h00 (Edifício 3 – 2.02)

Manuel Rodrigues: mfsr@di.uminho.pt

PL5: Sexta-feira 9h00-11h00 (Edifício 1 – 2.27)

PL6: Quarta-feira 8h00-10h00 (Edifício 2 – 2.07)



Pedro Oliveira: pedro.jose.oliveira@algoritmi.uminho.pt

PL3: Sexta-feira 9h00-11h00 (Edifício 1 – 1.15)

Marco Gomes: marcogomes@di.uminho.pt

PL3: Sexta-feira 9h00-11h00 (Edifício 1 – 1.16)

PL4: Segunda-feira 8h00-10h00 (Edifício 1 – 2.26)



INTRODUÇÃO À INTELIGÊNCIA ARTIFICIAL

1. INTELIGÊNCIA ARTIFICIAL

- 1.1 Fundamentos
- 1.2 Diferentes Paradigmas e Abordagens
- 1.3 Resenha histórica
- 1.4 Agentes e Sistemas Multiagentes
- 1.5 Aplicações

REPRESENTAÇÃO DE CONHECIMENTO E RACIOCÍNIO

2. LÓGICA COMPUTACIONAL

- 2.1. Programação em Lógica
- 2.2. Teoria da Prova versus Teoria dos Modelos
- 2.3. Algoritmo de Resolução
- 2.4. Linguagem de Programação em Lógica PROLOG

3. EXTENSÃO À PROGRAMAÇÃO EM LÓGICA

- 3.1. Negação Forte e Negação Fraca
- 3.2. Negação Forte e Pressuposto do Mundo Fechado

4. REPRESENTAÇÃO DE CONHECIMENTO

- 4.1 Simbólico vs Não Simbólico
- 4.2 Regras de Produção;
- 4.3 Programação Dirigida aos Padrões;
- 4.4 Estruturas hierárquicas:
- 4.5 Scripts.

5. REPRESENTAÇÃO DE CONHECIMENTO IMPERFEITO

- 5,1 Incerteza associada a decisão
- 5.1 Abordagens Qualitativas
- 5.2 Abordagens Quantitativas

RESOLUÇÃO DE PROBLEMAS E DE PROCURA

6. MÉTODOS DE RESOLUÇÃO DE PROBLEMAS E DE PROCURA

- 6.1 Formulação de Problemas
- 6.2 Pesquisa Não Informada
- 6.3 Pesquisa Informada
- 6.4 Pesquisa em contextos competitivos

CONSIDERAÇÕES FINAIS

7. INTELIGÊNCIA ARTIFICIAL E A SOCIEDADE

- 7.1 Caminhos para a Inteligência
- 7.2 Ameaças e Oportunidades
- 7.3 Tendências



A avaliação da aprendizagem envolve dois instrumentos de avaliação: uma PROVA ESCRITA, correspondendo à avaliação por exame final, e um TRABALHO DE GRUPO, de índole experimental e escrito, respeitante à avaliação prática.

A realização da PROVA ESCRITA, em exame final, é de carácter obrigatório e definirá a componente teórica da classificação final.

A realização do TRABALHO DE GRUPO, que será desenvolvido em duas fases, tem limite de execução temporal bem definido, nunca excedendo o período letivo, constituindo a componente prática da classificação final.

A classificação final é dada pela ponderação dos dois instrumentos de avaliação da seguinte forma:

- 50% da classificação provém da componente teórica (prova escrita);
- 50% da classificação provém da componente prática (trabalho de grupo).

É considerado aprovado o aluno cuja nota final seja superior ou igual a 10 (dez) valores, exigindo-se nota mínima de 8 (oito) valores na componente teórica e sendo obrigatória classificação positiva na componente prática.

Componente Teórica:

Prova escrita: Terça-feira, 14 de dezembro 2021

Exame: Quarta-feira, 2 de fevereiro 2022

Apresentação da Componente Prática:

Semana de 10 a 15 de janeiro 2022

Stuart Russell and Peter Norvig, Artificial Intelligence - A Modern Approach, 4rd edition, ISBN: 978-0134610993, 2020.

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