

# COMPUTATIONAL INTELLIGENCE & APPLICATIONS

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## INTRODUCTION

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### What is an INTELLIGENT SYSTEM ?

... a complex system, that using new information technologies (software & hardware) combined with communication technologies, can solve difficult problems with methods and techniques that simulate natural intelligence or behavior.

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## Components of ISs

... the basics of INTELLIGENT SYSTEMS are the principles and techniques of ARTIFICIAL INTELLIGENCE and COMPUTATIONAL INTELLIGENCE:

- Expert systems
- FUZZY Systems and / or Logic
- Artificial Neural Networks
- Evolutionary computation
- Group Intelligence (Swarm Intelligence)
- Intelligent Agents

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## CI / AI - definitions

- [ IEEE CI Society ]: defines CI by its subjects of interest: neural networks, fuzzy systems, evolutionary computation, including swarm intelligence, and others.
- [Schalkoff 90]: AI → CI is a field of study that seeks to explain and emulate intelligent behavior in terms of numerical processes.

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## Natural vs. Artificial Intelligence

[Serbanati 85]: Intelligence is the ability to know and understand, is the faculty of discovering the properties of surrounding objects and phenomena, of the essential relationships between them, coupled with the ability to find a way out of certain situations and adapt to new circumstances.

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### CI / AI - definitions

- [ Shanck 87 ]: From the point of view of an engineer ... the purpose of CI is to understand human and behavioral intelligence through calculus and informatics.
- [ Duch 07 ]: CI is a branch of computer science studying problems for which there are no effective computational algorithms.

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### Natural vs. Artificial Intelligence

TURING test: 2 witnesses (a man and a machine / computer) and 1 detective (a man). The detective interrogates the 2 witnesses, trying to determine which of them is the man and which is the machine. Computer is allowed to use any strategy. If the detective classifies the computer as a man, than the Turing test will grant the attribute "intelligent" to the machine.

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### A short history of AI and CI

- 1943: The origin of CI - the first model of the formal neuron was proposed by the neurophysiologist WS McCulloch and the mathematician W. Pitts.
- 1950: publication by Turing of "Computing Mechanisms and Intelligence", which is looking for the answer to the question "Can machines thinking?".

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### A short history of AI and CI

- 1956: The conference organized by Dartmouth College (USA) where researchers discussed for the first time the possibility to elaborate computer programs that simulate human reasoning. It was used for the first time the notion of ARTIFICIAL INTELLIGENCE.
- 1956: Newell et al present the first "program with AI" called "Logical Theorist", designed to reproduce specific logic used by humans to solve problems.

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### A short history of AI and CI

- 1965: Lofti A. Zadeh introduces the FUZZY SET THEORY as an alternative to probability theory for situations dominated by uncertainty. FUZZY LOGIC contradicts the principle of excluded third (tertium non datur, in latin).
- 1969: Marvin Minsky published the book "Perceptrons", where he identifies the limits of single layer neural networks, e.g. the impossibility to approximate XOR logical functions, since the values of this function are not linearly separable.

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### A short history of AI and CI

- Years ' 70: Appearance of first expert systems, including MYCIN - for diagnosis of infectious diseases - developed at Stanford University in the USA.
- 1973: Professor John Holland at the University of Michigan establishes a branch of Evolutionary Computation, namely Genetic Algorithms, aiming to simulate natural adaptive processes in computational models of numerical optimization.

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### A short history of AI and CI

- 1986: Rumelhart, McClelland and Williams relaunch research in the field of artificial neural networks. They introduce the Multilayer Perceptron and the back-propagation learning rule (generalized delta rule).
- 1992: Marco Dorigo proposes the Ant Colony Optimization algorithm that search for an optimal path in a graph, based on the behavior of ants seeking a path between their colony and a source of food.

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### A short history of AI and CI

- 1995: Kennedy and Eberhart published an article Particle Swarm Optimization where they proposed a new searching algorithm; it was first intended for simulating social behavior as a representation of the movement of organisms in a bird flock or fish school.
- 1997: Storn and Price proposed a new searching strategy, known as Differential Evolution; DE optimizes a problem by maintaining and combining a population of candidate solutions.

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