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International Journal of Combinatorial Optimization Problems and Informatics, 15(3), Sep-Dec 2024, 164-170. ISSN: 2007-1558.
https://doi.org/10.61467/2007.1558.2024.v15i3.524

A brief review of the History of Computational Intelligence, Bio-Inspired Computing and Scientific Computing

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Abstract. The use of computational tools to solve real problems of different industries has been in increased significantly. Software is used to solve problems of the air, sea, ground, pipes, and aerospace transportation planning; problems related to the science of sport, chemistry, medicine, nursing, mechatronics, robotics; business problems related to minimize costs and maximize profits, problems of management of small, medium and large companies; agro-industrial problems, environment, among many others. To solve real problems using scientific computation, Bio-inspired and computational intelligence. This paper aims to present a review of the history of Computational Intelligence Bio-Inspired Computing and scientific computing.
Keywords: Computational Intelligence, Bio-Inspired Computing and Scientific Computing

Article Info
Received Jun 26, 2024
Accepted Sep 11, 2024

1 Introduction

Scientific computing is the process of solving complex problems in science, engineering, and technology through computational and mathematical models. One of the important tools for the development of scientific computing is the server and the cluster. The cluster is a grouping of different computers (2 or more) connected to a network to be able to solve a complex problem by dividing the problem into small fragments. The cluster behaves as a unified computing resource. A server is hardware of computation that contains redundant, redundant hard drives, different processors and lots of RAM and needs to keep power 24 hours a day 365 days of the year.

Scientific computation is made up of the following elements:

- Computational intelligence (CI) is related modelling of systems, and in particular with modelling systems that prove difficult with conventional mathematical models. CI is done by observing and optimizing heuristics based on gathered data. On the other hand, machine learning relies on learning from observation, involving online learning. CI and machine learning require intensive computing power. CI is the pragmatic adaptation and self-organization definitions paradigms and algorithms that enable intelligent behaviour in complex and changing environments. CI is formed by a set of computational methodologies inspired by nature and in approaches to address the complex problems of the real world to traditional or mathematical modeling may be ineffective due to its complexity for reasoning mathematician, the existence of uncertainty during the process or its likely stochastic nature. The methods used try to emulate the form of reason and human decisions, using vague, uncertain and incomplete, knowledge which is capable of producing a way to control actions Adaptive or make decisions under complex conditions. The IC uses a combination of 5 complementary techniques: fuzzy logic, which allows the computer to understand and reason with natural language; Neural artificial network, which enables the system to learn experimental data operating as biological networks; Evolutionary Computation, which is based on the process of natural selection; the theory of learning; and probabilistic methods, which help to deal with imprecision and uncertainty (RED ICA-Conacyt, 2017).
- Soft computing. Soft computing is the process of solving complex problems in science, engineering, and technology through the tolerance associated with imprecision, uncertainty, and partial truths to get real solutions and low cost. Soft computation or soft-computing using Fuzzy logic, the Neurocomputing, probabilistic reasoning, genetic algorithms, belief networks, chaotic systems and some sections of the theory of learning.

- Cloud Computing. Cloud computing is the process of solving complex problems in science, engineering, and technology through the income of mission-critical and high-performance servers.
- Mobile computing. Mobile Computing is the process of solving complex problems in science, engineering, and technology through mobile devices access to web servers.
- Parallel Computation. Parallel computing is the process of solving complex problems in science, engineering, and technology by means the execution of various computational calculations at the same time or in parallel using more than one processor. There are several architectures to perform parallel computing: computers with multiple processors (cores), clusters and graphics cards (GPUs). The GPUs are flexible processing general processors. The GPUs can solve problems in various areas such as finance, image and video processing, linear, algebra, physics, chemistry and biology. The technology that allows executing code on GPUs for parallel computation is called CUDA. NVIDIA developed CUDA in 2006. CUDA supports c/c++, Fortran, Matlab, Python and LabView programming languages. There are various parallel programming languages: Open Message Passing Interface - OpenMPI (distributed memory), OpenMP (shared memory) and OpenCL (Open Computing Language) for GPUs and CPUs. • Distributed computing. Distributed computing is the process of solving complex problems in science, engineering, and technology through a collection of independent computers (different locations and each one with its network and hardware resources) who behave as a single computer.

2 History of the Computational Intelligence

Efforts to reproduce some human mental skills in machines and androids go back a long way in history. The myth of the Colossus of Rhodes among the Greeks, the talking statues of the Middle Ages, Von Kempelen's droid who played chess with Napoleon, and Charles Babbage's analytical engine calculating logarithms are just a few examples of This ancient interest. Similarly, the conception of human intelligence as a mechanism is not recent or dissociated from psychology: Descartes, Hobbes, Leibniz, and Hume they referred to the human mind as a form of mechanism.

During the nineteenth and the first half of the twentieth, biological and phenomenological analogies displaced the notion of mechanism in the study of the human mind. However, from the second half of our century, the notion of mechanism renewed its heuristic power with the formalization of the notion of computation.

As some machines, especially calculators, were designed to avoid having to think and to do the thinking faster and accurate, it was inevitable that from its origins the calculators, and later the computers, would be related to the intelligence and the thinking emphasizing their similarities.

AI was introduced to the scientific community in 1950 by the Englishman Alan Turing in his article Computational Machinery and Intelligence. Although research on the design and capabilities of computers began some time before, it was until the Turing's article that the idea of an intelligent machine captivated the scientists' attention.

The basic question that Turing tried to answer affirmatively in his article was: can machines think? Turing's arguments in favour of the possibility of intelligence in the machines initiated an intense debate that marked the first stage of interaction between AI and psychology. The debates at that time focused on the analysis of the series of problems involved in the application of mentalistic terms to computers. Turing's intention was not to use these terms as analogies but to eliminate the distinction between natural intelligence and artificial intelligence.

Two of Turing's most important contributions to AI was the design of the first computer capable of playing chess and, more importantly, the establishment of the symbolic nature of computing.

The work of Turing, who died prematurely, was continued in the United States by John Von Neumann during the 1950s. Their central contribution was the idea that computers should be modelled on the human brain. Von Neumann was the first to anthropomorphize the language and conception of computing by talking about memory, sensors, etc., of computers. He built a series of machines using what in the early fifties was known about the human brain and designed the first programs stored in the memory of a computer.

However, this line of research soon encountered serious limitations. The concentration on the imitation of the physicochemical constitution of the brain did not allow Von Neumann and his followers to see that the analogy would be much more efficient if the functions of the brain were studied, that is, their capacities as an information processor.

It is for McCulloch, in the mid-1950s, to formulate a radically different position by arguing that laws governing thought must be sought among the rules governing information rather than between those governing matters. This idea opened up great possibilities for AI. In this vein, Minsky (1959), one of the founding fathers of AI, modified his position and argued that imitation of the brain at the cellular level should be abandoned.

It is more or less at this time that an event occurs that would organize and give a great impulse to the development of AI: the conference in Darthmouth (1956). At this Congress, in which the founding fathers of the discipline met, the basic presuppositions of the theoretical nucleus of AI were arrived at:

1. The recognition that thought can occur outside the brain, i.e., in machines.
2. The presupposition that thought can be understood in a formal and scientific way.
3. The assumption that the best way to understand it is through digital computers.

Since the late 1950s, AI research has expanded and multiplied in different directions. The symbolic capacity of computers is studied, among others, by Shanon (1950) and by Newell, Shaw, and Simon (1958) who design the first intelligent program based on their information processing model. This model of Newell, Shaw, and Simon would soon become the dominant theory in cognitive psychology. Some researchers focused on the study of the nature of computer learning and the process of recognizing visual patterns.

As a result, Selfridge and Dinneen succeed in designing the first program capable of learning from experience (see McCorduck, 1979). Based on associative memory studies, the Newell-Shaw-Simon team built the first information processing languages (IPL-I, IPL-II) used in the design of their Logic Theorist Machine which became the first machine intelligent. This machine was able not only to memorize and to learn, a place that was able to demonstrate in some original and creative way, but that is also to say not foreseen by its creators, some of the theorems proposed by Bertrand Russell in the Principles (Russell and Whitehead, 1925).

From its origins the AI was related to games like chess and the ladies, probably because the table games are models of real situations in which to calculate, to solve problems, to make decisions, to correct errors, to remember, etc. Although this line of research has been almost totally abandoned today, many of the theoretical and methodological advances in AI are due to it. For example, Samuel designed in 1961 a program that played ladies and was able to learn from his mistakes, that is, he was able to adapt his behaviour to past events. The amazing thing about this program was that, coupled with its capacity for learning the memory, over time managed to defeat its creator invariably.

Bernstein obtained the same result through a program that played chess (Boden, 1977). The great challenges between computers and humans multiplied the most famous of which occurred between Dreyfus (a bitter critic of AI) and the Machack program, in which Dreyfus was defeated in multi-chess game hours. In the early sixties, AI begins a different phase of development. In 1962, McCarthy and Raphael began their work on the design and construction of a mobile robot they would call "Shakey." The fundamental difference between this robot and the computer programs used so far by AI is that Shakey would have to face the challenge of interacting with the real world regarding space, time, movement, etc. In other words, the robot would have to have some form of knowledge of the world around it. This challenge initiated a strong concern in AI for the study of epistemology and cognitive processes. The discussion centred on problems of mental or internal representation of knowledge, perception and meaning problems. Raphael's basic idea was to gather, in a single one, different machines with the capacity to learn by experience, to recognize visual patterns, to model, to manipulate symbols, etc., and to hope that the whole was greater than the sum of Parties. The result of the experiment was not the success that Raphael had hoped for, but it was an unprecedented achievement that made possible major advances. The most important learning of this experience was the realization that the most difficult problem to solve in AI was to build a machine capable of operating with high levels of uncertainty, as a human being does. It became clear that building a machine that did not effectively deal with uncertainty would be one of two: or trivial, because of the simplicity of the task, or impossible because of the complexity of it.

By the mid-1960s AI became an area in which specialists from various disciplines were interested and interacted: logicians, psychologists, mathematicians, linguists, philosophers, etc. One of the major themes of AI in this decade was the study of language.

In most of the initial studies of language, the problem of designing a machine capable of translating from one language to another was tackled. Emphasis was placed on the analysis of syntax rather than meaning, a strategy that was abandoned relatively soon. Researchers interested in this area of AI soon discovered that translation is not the same as transformation and that as a consequence; somehow the machine would have to understand a text before being able to translate it. Efforts were directed toward a definition of understanding that could be simulated on a computer. With this idea as a heuristic guideline, a series of programs were developed that explored this series of skills related to language and comprehension: Phillips' Oracle, Lindzay's Sad Sam which was one of the most successful, and "Eliza "by Wizenbaum and Colby. The Lindzay's program was oriented towards the study of meaning, connotative and denotative, and is capable of making inferences, knowing, and paraphrasing about the world.

3 History of the Bio-Inspired Computing

A Bio-inspired Computing originated in the same early computing. It has had a Renaissance in recent years thanks to limitations in conventional techniques to solve complex problems. Increase in capacity of the hardware that makes it possible to the practical implementation of the algorithms. Interesting intersections between different areas of knowledge. Techniques with more tradition (Neurocomputing and evolutionary computation) have been consolidated. New techniques they are still developing, and there are still many paths to explore. The search for systematic procedures (algorithms) that provide solutions to problems has been a constant of man throughout history. Leibniz put the need for a universal language (lingua characteristica) in which to express an idea, as well as the convenience of machining any reasoning (calculus ratiocinator).

In 1928, at the International Congress of Mathematicians, held in Bologna, Hilbert asked three questions about mathematics which would mark its evolution: are they complete? Are they consistent? Are decidable? In 1931, Gödel presented his incompleteness theorems, showing that Hilbert's program (which tried to justify the use of the transfinite methodology and, at the same time, provide a full formalization of mathematics) was unworkable. Gödel considers an axiom system that contained the numeracy and builds a true proposition that could not be proven in that system. Also, it showed that assuming the consistency of the same and the verification of some basic properties, the system was not able to prove their consistency. Throughout the 20th century abstract models have been developed for machines trying to implement procedures for calculating machines (Turing, RAM, URM, etc.), for formal languages (regular, free of context, recursively and Numerable, etc.), for software systems (compilers, operating systems, etc.), data structures (stacks, etc.) and databases (relational, oriented objects, etc.). Define a model of computing consists of formalizing the concept of a mechanical procedure. To do this, it should be specified syntactically it is a such a procedure and defines rigorously the same semantics. The semantics of a model of computation must be accompanied ˜ from the concept of solving a problem, through different modes of computing (deterministic, non-deterministic, sequential, parallel, approximately, etc.).

The works of Gödel, Church, Kleene, and Turing, between 1931 and 1936, providing the first formalization of the concept of algorithm, giving rise to the appearance of the first models of computation. Specifically, in 1931 Gödel defines the concept of recursive relationship and introduces the class of functions that I call recursive (and which today are known as primitive recursive). Later, in 1934, Gödel and Kleene, extend the class before the General recursive functions (which are that we know today with the name of recursive). In 1931, Church and Kleene developed the concept of λ-calculus relating it directly to the intuitive concept of computable function. In 1936, Turing first used the abstract concept of the machine to formalize the intuitive idea of the algorithm. Towards the middle of the Decade of the thirties, Church and Turing formulated independently definitions given of the concept of mechanical procedure completely capture the intuitive idea of the same (Church-Turing Thesis). In 1936, Turing established the equivalence of their model. Thus, the thesis above can be expressed thus: a Turing machine can calculate every effectively computable function.

In 1936, Church provided the first example of an irresolvable problem algorithmically (the formalization of the λ - calculus): decision problem concerning the logic of first order, responding negatively to the third question raised by Hilbert. A few months later, Turin establishes independently the same result trying it on his model.

The rise and development of theoretical computational devices would contribute decisively to the construction of the first computer's electronics at the end of the forties of the last century, based on the conceptual model of Von Neumann, Burks and Goldstine described in 1946, in which the theoretical bases of the future computers that are susceptible to manipulate stored programs are formulated. Moreover, already, in the beginning, began to use some ideas of biology in the computational framework (for example, through neural networks models of mobile computing with 59 artificial membranes of McCulloch and Pitts, in 1943).

Since then, great efforts have been made to understand, from a computational optical, processes that occur in nature, aimed at obtaining more efficient algorithms or even for the design of new types of computers. Bioinformatics is a discipline that studies the application of tools and techniques of information for the handling of biological data. Its objectives include the development of a database Specifies that it allows store and update the large amount of data that have been and are being generated continuously and uninterrupted; the design of efficient algorithms for the comparison of sequences of strings; the research of methods of prediction of the three-dimensional structure of organic molecules, in general, and of the proteins, in particular; and, finally, the definition of physical or mathematical models of biological systems. And during the last decade, the field of research called Natural computing has undergone a huge development.

Among the areas that fall within the Natural computing, are the following: Genetic algorithms (or more generally, evolutionary computation), introduced by J. Holland in 1975, making use of some operations inspired by evolution and by natural selection in order to find a good solution from a large number of possible solutions candidates. Two artificial neural networks, introduced by McCulloch and Pitts in 1943 that are inspired by the interconnections and the functioning of neurons in the brain. The molecular computing, which aims to use organic molecules (DNA, RNA, proteins, etc.) as biological hardware which allows computations. Genetic algorithms and artificial neural networks have been implemented through programs in a conventional electronic computer. The DNA-based molecular computing has been implemented in biochemical means (Adleman's experiment allowed to solve an instance with Pérez, Romero, Sancho create with two nodes and the problem of the Hamiltonian path, directed version through the manipulation of DNA molecules in the laboratory). On the other hand, cellular computing with membranes still has not been implemented either in electronic or biochemical means. Recently, in October 2003, the Institute for Scientific Information (ISI, USA), has appointed cellular computing with membranes as Fast Emerging Research Front in the area of Computer Science.

4 History of the Scientific Computing

Navarro-Alberto and Barrientos-Medina (2013), points out that the creation of the calculations through the scientific computation was using the statistic. An example is the automated census of human beings that took place in the United States in 1890 Hollerith punch-card machines.

The first tab of punch cards used mechanical machines for the calculations at the beginning of 1920, invented by Herman Hollerith since 1890, used to conduct the census in the United States. In 1911, they formed the company CTR (Computing Tabulating and Recording Company), which was later named International Business Machines.

Grier (2012) mentions that Glover developed an operating laboratory in 1910 which was related to the observatories and astronomy departments. In this laboratory had as main activities reducing the statistical summaries, table’s actuaries, cross tables of information development, and development projects with statistical models. International Business Machines (IBM), founded in 1926 by Herman Hollerith, leases machines to form a computer lab for the first time. Grier (2012) describes in his article computer laboratories were employed in statistical research and econometric applications (Indiana University in 1927) since the beginning of 1920.

In 1923, Henry Wallace used a tab to calculate correlations using punch cards of data, then, the calculations of insurance companies, presenting different publications. With the support of George Snedecor, Wallace prepared the manuscript of its algorithm to solve the normal equations entitled correlation and calculation of the machine for 1925.

In 1927, Snedecor worked in the laboratory of statistics at Iowa State College, and used the tabulation equipment to perform statistical calculations related to basic agriculture, published the results of the agricultural fairs in the County, and the book related to livestock. From these developments, other researchers performed the tab of higher mathematical functions and interpolation of a polynomial function.

Alfred Cowles was interested in the study of regression in an economy with 20 or 30 independent and variables supported by Davis development math techniques to perform the calculations for regression models. During the Second World War, Abraham Wald developed the theory of sequential testing with the support of a team consisting of 20 human computers.

In 1945, William Shanks with the help of a calculator could locate the error number 527 of Pi, the 707 decimal had been calculated. In 1946, the International Statistical Institute used electronic computers, where leading exponent represented by John Mauchly presented ENIAC computer to perform calculations of linear regressions and correlations. Change of generation of electronic computers was launched in 1970, to start the commercialization of the minicomputers of low cost with statistical software.

Pier Giorgio Perotto (1930-2002) electrical engineer and Italian inventor, invented in 1964 when he was working for the Olivetti company the first personal computer called Programma 101. Began manufacturing in 1965.

Víctor Glushkov (1923-1982) Soviet mathematician during the 60s and 70s produced the PROMINJ, Mir-1, Mir-2, and Mir-3. Since the Mir-2 model, it already contained a keyboard, a monitor, and a stylus to correct texts and draw on the screen.

Frenchman François Gernelle (1944-) developed the computer staff based on an Intel 8008 microprocessor called Micral N for the Institut National de la Recherche Agronomique (INRA), and the French company Réalisation d' études électroniques (R2E) in 1972-1973, which sold 90000 pieces in the United States. The Commodore company produced in 1977 the Commodore PET (Personal Electronic Transactor) which had a 6502 microprocessor and 4 or 8 KB of TAM, a MOS 6545 video driver, a black and white monitor of 40 X 25 characters, a cassette and a keyboard.

Steven Paul Jobs (1955-2011) American businessman and Stephen Gary Wozniak (1950-) American inventor and engineer invented the Apple I personal computer and it was put on sale in 1976. It was a MOS Technology 6502 CPU of about 1 MHz, 4 KB of standard RAM expandable to 8 KB on the card or up to 48 KB using expansion cards, and a ROM of 256 bytes where lay the monitor wrote in Assembly language program and 40 × 24 graphics characters.

The Xerox company in 1981 created 10 laptops experimental non-tradable call Xerox NoteTaker in 1976 with a monochrome screen, a disk drive, 128 kb RAM, a 5 Mhz Intel processor and a mouse. Osborne Computer Corporation sold 11000 units in 1800 the first dollars called Osborne 1 portable computer was a processor Intel 8088 4,77 MHz memory RAM 128 KB expandable to 640 KB, 9 inch monochrome 80 x 25 lines of text, graphics card compatible with CGA, 2 units of 5.25-inch 360 kb, 1 parallel port, and MS-DOS operating system. The Osborne 1 was similar to the Xerox NoteTaker from Xerox.

5 Conclusions

The history of Scientific Computing, Computational Intelligence and Bio-inspired Computing reveals how these disciplines have evolved to become fundamental tools in solving complex problems in various industries. Over the decades, the use of these technologies has grown exponentially, addressing challenges in fields as diverse as transportation, medicine, robotics, agribusiness and business management. The integration of techniques inspired by nature, together with advances in artificial intelligence and computational algorithms, has significantly expanded problem-solving capabilities, providing more efficient and effective solutions.

This article has reviewed the historical development of these areas, highlighting how the convergence of science and technology has led to innovative methodologies that are now crucial to address modern challenges. As industries continue to adopt and adapt these technologies, we are likely to see continued growth in their application, driving innovation and improving responsiveness to complex problems. In conclusion, the advancement in Scientific Computing, Computational Intelligence and Bio-inspired Computing will continue to play a vital role in global technological transformation, with significant impact on process improvement and resource optimisation in a variety of industries.

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