Glossary

A

Aconscious. It is mental content or activity that has always been placed outside of the consciousness domain and might never be brought to consciousness. It might include nondeclarative and procedural memory.

Action. In bios theory, it is the change of energy in time. Sabelli (2005) affirms that "action is the one and sole constituent of the universe."

ADHD (Attention Deficit/Hyperactivity Disorder). It is a neurobehavioral disorder characterized by pervasive inattention and/or hyperactivity-impulsivity and resulting in significant functional impairment, affecting 3 to 5% of the population. ADHD is most commonly diagnosed in children and, over the past decade, has been increasingly diagnosed in adults. It is hard for these people to control their behavior and/or pay attention. ADHD was first described by the German physician Heinrich Hoffman (1809-1894) in 1845; he wrote books on medicine and psychiatry. ADHD was first clinically observed by the English pediatrician George Still (1868-1941) in 1902.

ADMET Processes. It refers to the absorption, distribution, metabolism, excretion, and toxicity processes of a molecule within an organism. Optimizing these properties during early drug discovery is important for reducing ADMET problems later in the development process.

Agent. In computer science, an agent (or software agent) is a part of software that acts for a user or other program in a relationship of agency. Such action on behalf of another implies the authority to decide when (and if) action is appropriate. The idea is that agents are not strictly invoked for a task, but activate themselves.

Algorithm. In mathematics and in computing, it is an explicit step-by-step list of instructions for producing a solution to a problem given an initial state. The term is derived by the misspelling of the name of the Persian mathematician and astronomer Muhammad ibn Mūsā al-Khwārizmī

(born around 780 in Khwārizm, now Khiva, Uzbekistan, and died around 850). He wrote a treatise in Arabic entitled *On Calculation with Hindu Numerals* in 850. It was translated in Latin in the 12th century with the title *Algoritmi de Numero Indorum*. During the translation, the term *algoritmi* was erroneously considered as a synonym of the term *calculation* and not the misspelling of the author's name.

Ant Colony Optimization Algorithm (ACO). It is a probabilistic technique inspired by the behavior of ants in searching for paths from the colony to food. This technique is used for solving computational problems that can be reduced to finding good paths through graphs, and it was introduced by the Italian engineer Marco Dorigo (born 1961) in his doctoral dissertation (1992). ACO is able to find approximate solutions to difficult optimization problems.

Apophenia. It is an unmotivated seeing of connections accompanied by a specific experience of an abnormal meaningfulness. Apophenia is the experience of making connections where none previously existed in random or meaningless data. Apophenia can be a normal phenomenon or an abnormal one, as in paranoid schizophrenia. The term was coined in 1958 by Klaus Conrad (1905-1961).

Arc. In graph theory, it is the line that connects different nodes in a graph.

Aristotelian Logic. It is a deductive method of logic introduced by the Greek philosopher Aristotle (384 B.C. to 322 B.C.). Logic is the study of the principles and criteria of valid demonstration and inference.

Artificial Intelligence (AI). It is a branch of computer science concerned with producing machines to automate tasks requiring intelligent behavior. The term was coined in 1956 by John McCarthy (Massachusetts Institute of Technology) who considers it to mean "the science and engineering of making intelligent machines." AI is studied in overlapping fields of computer science, philosophy, psychology, neuroscience, and engineering. A possible classification is that between strong AI and weak AI. Strong AI affirms that computers can be made to think on a level (at least) equal to humans and possibly even be conscious of themselves. Weak AI makes no such claim and denies this possibility. Areas of artificial intelligence activity include (a) expert systems used in programming computers to make decisions in real-life situations (for example, helping doctors diagnose diseases based on symptoms), (b) neural networks, which are artificial systems that simulate intelligence by attempting to reproduce the types of physical connections that occur in the human brain, (c) robotics, in which scientists are programming computers to see and hear, and react to other sensory stimuli, and (d) in programming computers to play games (for example, chess).

Artificial Neural Network (ANN). ANN is a kind of computer model that finds inspiration from the neural network structure of the brain, consisting of interconnected processing units that send signals to one another and turn on or off depending on the sum of their incoming signals. Artificial neural networks may be composed of either computer software or hardware, or both. ANN is also called a simulated neural network (SNN) or just a neural network (NN), and it is an interconnected group of artificial neurons that uses a mathematical model or computational model for information processing based on a connectionist approach to computation.

Artificial Neuron. It is an abstraction of biological neurons. An artificial neuron is the basic unit in artificial neural networks. It is also called

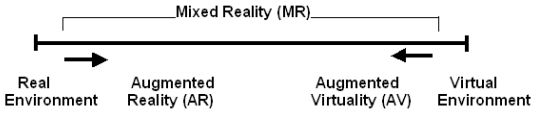
a McCulloch-Pitts neuron, binary neuron, or node. It receives different inputs and sums them, producing an output. Usually the sums of each node are weighted, and the sum is passed through a nonlinear function known as a transfer function. The canonical form of transfer functions is the sigmoid (a curve that has an *S* shape), but they also have the form of other linear functions, nonlinear functions, or step functions piecewise (a function whose definition is given differently on disjoint subsets of its domain).

Asymmetry. It is the absence of balanced proportions between parts of a thing, or to be without symmetry.

Attention. It is one of the cognitive processes associated with the human mind. It is the ability to concentrate mentally on one aspect of the environment while ignoring other things. Attention is one of the most intensely studied topics within cognitive neuroscience and psychology. Sometimes attention shifts to matters unrelated to the external environment; this phenomenon is referred to as "mind-wandering" or "spontaneous thought." Using an engineering point of view, attention is analyzed as the superior control system in the brain.

Attractor. In classical chaos theory, an attractor is an invariant set to which all nearby orbits converge. It represents a way to describe the long-term behavior of a system. Equilibrium and steady states correspond to fixed-point attractors, periodic states to limit-cycle attractors, and chaotic states to strange attractors. It can also be described as a fractal structure with noninteger dimensionality whose shape is shown in phase space and to which trajectories are attracted.

Augmented Reality (AR). It is a growing area in virtual reality research that deals with the combination of real-world and computer-generated data. Milgram and Kishino (1994) and Milgram, Takemura, Utsumi, and Kishino (1994) describe a taxonomy that identifies how augmented-reality and virtual-reality work are related, as shown in the figure.



B

Bi-Causality. It is a neologism that shows the relation in which every action in the physical reality has an effect in the artificial reality, and vice versa. For example, a mouse click activates an object in a virtual world; this gesture can interact with a device that produces an effect on the physical reality. The term was coined by the Italian scientist Giovanni Degli Antoni (1989).

Bifurcation. It is a term used in chaos theory for a sensitive decision point of a complex system. At a bifurcation, a choice is made between two possible outcomes. Bifurcation occurs when a small, smooth change made to the parameter values (the bifurcation parameters) of a system causes a sudden qualitative or topological change in the system's long-term dynamical behavior.

Bioavailability. In pharmacology it is the degree to which a drug or other substance is absorbed or becomes available at the site of physiological activity after administration. Absolute bioavailability refers to the availability of the active drug in systemic circulation after nonintravenous administration.

Bionic. It is an application of biological principals to the study and design of engineering systems (especially electronic systems). The word bionic is formed from two terms: One is derived from the Greek word *βίον*, which means *unit of life*,

and the other is the suffix *-ic*, which means *like* or *in the manner of*, hence, it means *like life*. Bionics is also known as biognosis, biomimicry, biomimetics, or bionical creativity engineering.

Bios Theory. It is a theory introduced by Hector Sabelli and colleagues who state,

BIOS is a causal and creative process that follows chaos in sequences of patterns of increasing complexity. Bios was first identified as the pattern of heartbeat intervals, and it has since then been found in a wide variety of processes ranging in size from Schrodinger's wave function to the temporal distribution of galaxies, and ranging in complexity from physics to economics to music.

Bios attempts to characterize the behavior of certain nonlinear dynamical systems that are sensitive to initial conditions and generate novelty. The term *bios*, adopted by Sabelli, derives from the Greek *bio*, meaning *life*, *course*, or *way of living*.

Biotic Logic. It integrates physics, logic, and dialectics by proposing that opposite processes display three different forms of interaction according to the size and complexity of the level of organization: quantum superposition, local macroscopic separation (logical, no contradiction), and global complementarity (dialectic contradiction; Sabelli, 2001).

Boolean. It is an item that can only have two states, like on or off, or yes or no, or true or false, often coded as 1 and 0, respectively. The term was coined in honor of the British mathematician George Boole (1815-1864) who introduced Boolean algebra, the basis of all modern computer arithmetic.

Bootstrapping. In computing, it is a process where a simple system activates another more complicated system that serves the same purpose. The term is shortened to booting. This process is often applied to the process of starting up a computer, in which a mechanism is needed to execute the software program that is responsible for executing software programs (the operating system).

Broadband. It refers to telecommunication in which a wide band of frequencies is available to transmit information with high speed. Related terms are wideband (a synonym) and baseband (a one-channel band).

Broca's Area. It is the section of the human brain that is involved in language processing, speech production, and comprehension. It was discovered by the French physician, anatomist, and anthropologist Paul Broca (1824-1880).

Brownian Motion. It is a phenomenon that describes random movements. It was observed by the British botanist Robert Brown (1773-1858). In 1827, while examining pollen grains and the spores of mosses and equisetum suspended in water under a microscope, Brown saw some minute particles within vacuoles in the pollen grains executing a continuous jittery motion. He also observed the same motion in particles of dust. It is the random movement of particles suspended in a fluid. The mathematical model used to describe such random movements is often called the "Wiener process." Brownian motion has several real-world applications (e.g., in physics, economy, computer science, hydrodynamics).

Building Design. In architecture, it is the science of designing exterior and interior spaces, and constructing buildings and engineered elements.

C

CAD (Computer-Aided Design). It is a term used for indicating a wide range of computer-based tools that assist architects, engineers, and other design

professionals in their design activities. There are 2-D and 3-D CADs.

Castration Anxiety (Castration Fears). In psychoanalysis, the word castration is associated with several others that define it and that it in turn defines. These include anxiety, fear, terror, disavowal, and above all, complex. Beyond the everyday connotations of the term, the specifically psychoanalytic definition of castration is rooted in the act feared by male children, namely, the removal of the penis.

Catastrophe Theory. It is a field of mathematics that studies how the behavior of dynamic systems can change drastically with small variations in specific parameters. This theory was introduced by the French mathematician René Thom (1923-2002) in the 1960s, and became very popular with the works of Christopher Zeeman (born 1925) in the 1970s.

Cellular Automaton or Automata (CA). Cellular automaton (cellular automata) is a simplified mathematical model that consists of an infinite, regular spatial lattice of cells, each of which can have any one of a finite number of states (the state represents a unique configuration of information in a program or machine). The lattice can be in any finite number of dimensions. The state of a cell at time t is a function of the states of a finite number of cells (called its neighborhood) at time t-1. CA are studied in mathematics, computer science, and theoretical biology. Cellular automata have their origin in systems described by John von Neumann (1903-1957) and Stanislaw Marcin Ulam (1909-1984) in the 1940s, followed by Arthur W. Burks (born 1915) and Edward F. Codd (1923-2003), to solve the problem of the nontrivial self-reproduction in a logical system.

Chaos. The term derives from the Greek *Χάος*, which in ancient Greece did not mean *disorder*, but meant *the primal emptiness space*. In physics and mathematics, the actual chaos theory presents the behavior of certain nonlinear dynamical systems that show dynamics, under particular initial conditions, that are sensitive to initial conditions (for example, the popular "butterfly effect" described by American mathematician and meteorologist Edward Lorenz, born 1917, in 1963). The chaotic systems have a behavior that appears to be random because it is generated by an exponential growth of errors in the initial conditions.

Chaos Theory. In physics, it is the qualitative study of unstable aperiodic behavior in deterministic nonlinear dynamical systems.

Characteristic Equation. In mathematics, it is any equation that has a solution, subject to specified boundary conditions, only when a parameter occurring in it has certain values. In linear algebra, the characteristic equation of a square matrix A is the equation in one variable λ: $\det(A - \lambda I)=0$, where det is the determinant and I is the identity matrix. In physics, the characteristics equation is an equation relating a set of variables, such as pressure, volume, and temperature, whose values determine a substance's physical condition.

Chemostat. It is a device used in microbiology for growing and harvesting bacteria. It consists of two primary parts: a nutrient reservoir and a growth chamber or reactor, in which the bacteria reproduce. Via an inflow from the reservoir, fresh nutrition is added, and from an outflow bacteria are harvested.

Chinese Room (Argument). It is an experiment designed by John Searle in 1980 for supporting the studies in the artificial intelligence field. The heart of the experiment is an imagined human simulation of a computer, similar to Turing's paper machine. The human, a monolingual English speaker, is in the Chinese room and follows English instructions for manipulating Chinese characters, where a computer "follows" a program written

in a computing language. The human produces the appearance of understanding Chinese by following the symbol-manipulating instructions, but does not thereby come to understand Chinese. The argument is intended to show that while suitably programmed computers may appear to converse in natural language, they are not capable of understanding language, even in principle. Searle argues that the thought experiment underscores the fact that computers merely use syntactic rules to manipulate symbol strings, but have no understanding of meaning or semantics.

Chromosome. It is a component in a cell that contains genetic information. Each chromosome contains numerous genes. In genetic algorithms, a chromosome is a set of parameters that represents a solution to the problem that the genetic algorithm is trying to solve. The chromosome is often represented as a simple string (sequence of characters), and the binary alphabet {0,1} is often used to represent these genes, but sometimes, depending on the application, integers or real numbers are used.

Ciphertext. It is a set of data that has been encrypted. It is unreadable until it has been converted into original text (decrypted) with a key.

CODAM (Corollary Discharge of Attention Movement). It is a generic model of consciousness that has been developed by John G. Taylor, where the prereflective self arises from experience of the attention copy signal at an early stage in the processing. This model considers the so-called "corollary discharge" or copy of the control signal causing the movement of the focus of attention to be the crucial element for consciousness creation.

Code. In communication, a code is the usage of a set of rules, characters, or words to represent words, sentences, or ideas. It is used for converting a piece of information (for example, a letter, or word) into another form or representation. Morse code is a common example, where the combinations of dashes and dots represent numbers and letters.

Coevolution. In biology, it is the mutual evolutionary influence between two species that become dependent on each other. In computer science, it is the evolutionary computation paradigm where both the measure of fitness and the solution evolve separately and affect each other.

Cognition. The term derives from the Latin *cognoscere* (that means *to know*). It is used in different ways by different disciplines. For example, in psychology and in artificial intelligence, it is used to refer to the mental processes involved in knowledge and comprehension including the knowing, remembering, thinking, learning, problem solving, and judging of intelligent entities (humans, human organizations, and autonomous robots).

Collage Theorem. The theorem describes how to find an iterated function system whose attractor is close to a given set. One must endeavor to find a set of transformations and contraction mappings on a suitable set, within which the given set lies, such that the union (or the collage) of the images of the given set under transformations is near the given set. The theorem has been enunciated and demonstrated by Michael Barnsley (1988).

Collective Unconsciousness. In analytical psychology, it is a part of the unconscious mind shared by a society, a people, or all humankind that is the product of ancestral experience and contains such concepts as morality, religion, and science. Thus, it refers to that part of a person's unconscious that is common to all human beings. The term was coined by Carl Jung (1875-1961).

Communication. It is a process of exchanging information and ideas. It is an active process that

involves encoding, transmitting, and decoding intended messages. The term derives from the Latin *cum* (that means *with*) and *munire* (that means *bind* or *build*).

Complexity. It is the quality of being intricate and compounded. In physics, it is study of the behavior of macroscopic collections of simple units (e.g., atoms, molecules, bits, neurons) that are endowed with the potential to evolve in time. The term derives from Latin word *complexus* (that means *entwined*, *twisted together*).

Complex System. This is a system with a large number of interrelated parts.

Compression. It is a process that reduces the number of bytes required to define a digitized document in order to save disk space or transmission time. Compression is achieved by replacing commonly occurring sequences of pixels with shorter codes. It is possible to compress a movie or an image (see image compression).

Computational Fluid Dynamic (CFD). It is the branch of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems that involve fluid flows. Computers are used to perform the millions of calculations required to simulate the interaction of fluids and gases with the complex surfaces used in engineering.

Computer Graphics. This is a branch of computer science that deals with the theory and techniques of computer image synthesis. Computer graphics uses methods and techniques for converting data to or from visual presentation using computers. It is concerned with generating and displaying three-dimensional objects in a two-dimensional space.

Computer Network. It is multiple computers connected together using a telecommunication system for the purpose of communicating and sharing resources.

Computer Networking. It is the engineering discipline concerned with communication between computer systems.

Computer Science. It is the study of the theoretical foundations of information and computation and their application in computer systems. It comprises many subfields. For example, some relate to the properties of computational problems (such as computational complexity theory), while others focus on the computation of specific results (such as computer graphics). Still others study the challenges in implementing computations. For example, programming language theory studies approaches to describing computations, while computer programming applies specific programming languages to solve specific computational problems with solutions.

Connectionism. It is an approach that models mental or behavioral phenomena as the emergent processes of interconnected networks of simple units. Connectionism is in the fields of artificial intelligence, cognitive psychology and cognitive science, neuroscience, and philosophy of the mind.

Connectivity. In computer science it is the ability to connect computer or communications systems to exchange data or share resources. It is a perception related to link to people and resources.

Consciousness. It is the quality of being aware of what is happening around us and responding in kind. It can also be defined as the process of a thinker focusing the thought on some aspect of existence. The term derives from Latin *conscientia* (that primarily meant *moral conscience*). There are many layers or levels of consciousness ranging from the ordinary, everyday conscious-

ness of our body and mind to omniscient states of superconsciousness.

CPU (Central Processing Unit). It is the component in the computer that processes data and that interprets computer program instructions; sometimes it is called the processor. Today, the CPUs of almost all computers are contained on a single chip.

Crossover (Recombination). In genetic algorithms, it is a genetic operator that is used to modify the programming of a chromosome or chromosomes from one generation to the next. It is analogous to reproduction and biological crossover.

Cryptographic Encoding. In cryptography, it is the activity of converting a message from plain text into code.

Cryptography (Cryptology). It is the art of protecting information by transforming it (encrypting it) into an unreadable format, called ciphertext, for transmitting it over a public network. The original text, or plaintext, is converted into a coded equivalent called ciphertext via an encryption algorithm. The ciphertext is decoded (decrypted) at the receiving end and turned back into plaintext. The term derives from the Greek word *κρυπτός* (*kryptós* that means *hidden*), and from the verb *γράφω* (*gráfo* that means *write*).

Cryptosystem (Cryptographic System). It represents the entire process of using cryptography. This includes the actions of encrypting and decrypting a file or message, or authenticating the sender of an e-mail message.

Cybernetics. The science of communication and control processes as applied to the physiologic systems. The term derives from the Greek *Κυβερνήτης* (*kybernetes* meaning *governor* or *steersman*). Plato used it in *The Laws* to signify the governance of people. The French physicist André-Marie Ampère (1775-1836) used the word cybernetics to denote the sciences of government in his classification system of human knowledge. In 1948, the mathematician Norbert Wiener (1894-1964) used the word cybernetics to denote the science of communication and control in the animal and the machine. Cybernetics involves different disciplines such as electrical engineering, mathematics, biology, neurophysiology, anthropology, psychology, and computer science. First-order cybernetics studies a system as if it were a passive, objectively given thing that can be freely observed, manipulated, and taken apart. Second-order cybernetics studies how observers construct models of other cybernetic systems.

Cyberspace. It is a term coined by author William Gibson in his novel *Neuromancer* (1984) for indicating a futuristic computer network that people use by plugging their minds into it. Cyberspace refers to the electronic space created by computers connected together in networks like the Internet.

D

Darwinian Evolution. In biology, it is the Darwinian theory according to which higher forms of life have arisen out of lower forms with the passage of time.

Database (DB). It is a collection of information organized so that its contents can easily be accessed, managed, and updated. The most prevalent type of database is the relational database.

Decision Theory. It is a newly proposed extension to the theory of games that is based on the same logic as are causal processes in nature.

Decode. This means to convert coded data back into its original form.

Decoder. It is the device that executes a process of decoding.

Destratification. It is vertical mixing within a lake in which the water is mixed in order to eliminate stratified layers of temperature, plant, or animal life.

Deterministic Model. This is a mathematical model whose output is determined by the mathematical form of its equations and the selection of a single value for each input parameter. A mathematical model is deterministic if the relations between the variables involved take on values not allowing for any play of chance.

Dialectics. In philosophy, it represents an exchange of propositions (theses) and counter-propositions (antitheses) resulting in a qualitative transformation in the direction of the dialogue. The term derives from the Greek *διαλεκτική* (*dialektikē* that means *to converse*, *to discuss*).

Dynamic Systems. These are systems in motion. Most dynamic systems, and all living systems, are open. The human body, for example, is an open system. There are two main types of dynamic systems: discrete and continuous.

E

Ecosystem. An area that includes living organisms and nonliving substances interacting to produce an exchange of materials. It culminates in a stable, though not necessarily permanent, community of living organisms and nonliving components that have developed interrelationships with each other to form a distinct, self-sustaining system.

Ectoderm. It is the primary germ of a tissue that covers the body surfaces. Ectoderm gives rise to the nervous system and the epidermis of skin and its derivatives. The term derives from the Greek words *ecto (which means outside*) and *derma* (which means *skin*).

Electroencephalogram (EEG). It is a test that measures and records the electrical activity of the brain by using sensors (electrodes) attached to the head and connected by wires to a computer that records the brain's electrical activity (postsynaptic potentials) on the screen or on paper as wavy lines. EEG is a tool for monitoring and diagnosis in certain clinical situations, for example, for epilepsy, sleep disorders, coma, and brain death.

Emotion. It is a mental state that arises spontaneously rather than through conscious effort. It can evoke either a negative or positive psychological response. Many psychologists adopt a model based on three fundamental attributes for defining emotions: (a) physiological arousal, (b) behavioral expression (e.g., facial expressions), and (c) conscious experience, the subjective feeling of an emotion. The term emotion derives from the Latin *emovere* (that means *to set in motion*).

Encode. It means to convert from one format or signal to another, or to assign a code to represent data.

Epilepsy. The term sometimes is referred to as a seizure disorder. It is a chronic neurological condition that causes people to have recurring seizures. The seizures happen when clusters of nerve cells in the brain send out wrong signals. Epilepsy has many possible causes, including illness, brain injury, and abnormal brain development. In many cases, the cause is unknown.

Epilimnion. It is the upper layer of water in a thermally stratified lake or reservoir. This layer consists of the warmest water and has a fairly uniform (constant) temperature. The layer is readily mixed by wind action.

Erosion. The term is used in geology and it represents the carrying away of weathered soil, rock, and other materials on the Earth's surface by gravity, water, wind, or ice.

Ethernet. A physical and data link layer technology for local area networks (LANs). Ethernet was invented by engineer Robert Metcalfe.

Evolution. It is the changes in species as a consequence of processes such as mutation and natural selection. Evolution is a unifying principle of biology, but it extends beyond biology and can be used as an engineering principle that can be applied to computer science, where individuals in a population of candidate solutions to some particular problem undergo random variation (e.g., mutation and recombination) and face competition and selection based on their appropriateness for the final task.

Evolutionary Algorithms (EAs). They are computer programs that attempt to solve complex problems by mimicking the processes of Darwinian evolution: from natural selection and survival of the fittest in the biological world. An EA uses some mechanisms inspired by biological evolution, for example, reproduction, mutation, recombination, natural selection, and survival of the fittest. In an EA a number of artificial individuals (candidate solutions to the optimization problem) search over the space of the problem. The shared environment determines the fitness or performance of each individual in the population. The individuals compete continually with each other to discover optimal areas of the search space. It is hoped that over time the most successful of these creatures will evolve to discover the optimal solution. Each iteration of an EA involves a competitive selection that weeds out poor solutions. The fittest individuals are more likely to be selected for reproduction (retention or duplication), while recombination and mutation modify those individuals, yielding potentially superior ones. The solutions with high fitness are recombined with other solutions by swapping parts of a solution with another. The solutions can also be mutated by making a small change to a single element of the solution.

Evolutionary Computation. It is a general term used for several computational techniques that are based to some degree on the evolution of biological life in the natural world. A number of evolutionary computational models have been proposed, including evolutionary algorithms, genetic algorithms, the evolution strategy, evolutionary programming, and artificial life.

Evolutionary Systems. They are systems that undergo evolutionary processes.

Extinction. In biology, it is the elimination of a species (also applicable to levels other than species) due to natural processes or human activities.

F

False Nearest Neighbor. It is a method for determining the minimal sufficient embedding dimension. This method is important for the application of nonlinear methods in the reconstruction (embedding) of the time series in a phase space with appropriate dimension. The method determines when the points in dimension d are neighbors of one another by virtue of their projection onto too low a dimension. It was introduced by Kennel, Brown, and Abarbanel in a paper published in 1992.

Feedback. It is the mechanism whereby the consequences of an ongoing process become factors in modifying or changing that process. The original process is reinforced in positive feedback and suppressed in negative feedback.

Feed-Forward Networks. They are a particular kind of neural networks whose architectures are composed by neurons that can be divided into layers, with the neural activities in one layer only being able to influence the activity in later (not earlier) layers. They are also called multilayer perceptrons.

Financial Trading System (FTS). In economy, it is a widespread class of tools that are used to support risky financial decisions.

Fitness. In genetic algorithms and genetic programming, the term fitness is used to guide the search by deciding which individuals will be used as future points to look for better solutions. The fitness value is a comparative index for how close the corresponding value is to the ideal. This is in analogy with natural selection.

Fold Catastrophe. It is a catastrophe that can occur for one control parameter and one behavior axis.

Formal Grammar. In computer science, a formal grammar is the syntax of each programming language. The two main categories of formal grammar that exist are generative grammars and analytic grammars. Generative grammars are sets of rules for how strings in a language can be generated. A string is a sequence of symbols. Analytic grammars are sets of rules for how a string can be analyzed to determine whether it is a member of the language.

Fractal. It is an irregular or fragmented geometric shape that can be subdivided in parts, each of which is (at least approximately) a reduced-size copy of the whole. The term was coined by Benoit Mandelbrot in 1975. It derives from the Latin verb *frangere*, *to break*, and from the related adjective *fractus*, meaning *fragmented and irregular*.

Fractal Compression. In computer science, it is a method used to compress digitized images using fractal geometry for minimizing images' dimension. The fractal compression technique relies on the fact that in certain images, parts of the image resemble other parts of the same image. Fractal compression causes the loss of the quality of the images compressed.

Fractal Geometry. It is the geometry used to describe the irregular pattern and the irregular shapes present in nature. Fractals display the characteristic of self-similarity, an unending series of motifs within motifs repeated at all length scales.

Fractal Mountain. In computer graphics, it is a mountain generated using fractal algorithms based on iterative and recursive operations.

Fractality. It is the quality of an object that shows some typical properties of fractal geometry (e.g., self-similarity).

Fractional Brownian Motion (fBm). It is defined as W_t^H on [0, T], $T \in R$. It is a continuous-time Gaussian process that starts at zero, with mean zero, and that has the following correlation function: $E[W_t^H W_s^H] = \frac{1}{2}(|t|^{2H}+|s|^{2H}+|s|^{2H}-|t-s|^{2H})$, where H is the Hurst parameter associated with the motion. H is a real number in the interval [0, 1]. Fractional Brownian motion has important properties: self-similarity, long-range dependence, regularity, and integration. The first two properties permit one to realize the connection between fBm and fractal geometry. The main difference between fBm and regular Brownian motion is that while the increments in Brownian Motion are independent they are dependent in fBm. This dependence means that if there is an increasing pattern in the previous steps, then it is likely that the current step will be increasing as well.

Frequency. It is the number of repetitions in a given interval of time. In mathematics it is the number of times that a specified periodic phenomenon occurs within a specified interval. In physics it is the number of complete cycles of a periodic process (or waveform) occurring per unit of time. It is usually measured in Hertz (Hz), where 1 Hz = 1 s^{-1}. In statistics the frequency is the ratio of the number of times an event occurs in a series of trials of a chance experiment to the number of trials of the experiment performed. The frequency also represents the number of measurements in an interval of a frequency distribution. The term derives from the Latin *frequentia* (that means *multitude*).

FTP (File Transfer Protocol). It is a communications protocol used to transmit files without loss of data over any network that supports the TCP/IP protocol (such as the Internet or an intranet). It is usually implemented as an application-level program, so it also uses the Telnet. A file transfer protocol can handle all types of files. The FTP transfer involves two computers: a server and a client.

G

Gene. It is a segment of nucleic acid that contains information necessary to produce a functional product, usually a protein. Genes correspond to units of inheritance.

Genetic Algorithm (GA). It is a technique used in computing to find true or approximate solutions to optimization and search problems. Genetic algorithms are categorized as global search heuristics. Genetic algorithms are a particular class of evolutionary algorithms that use techniques inspired by evolutionary biology such as inheritance, mutation, selection, and crossover (also called recombination).

Genetic Operator. In genetic algorithms, it is a process that is used to maintain genetic diversity. The genetic operators applied in this field are analogous to those that occur in the natural world that imply the survival of the fittest.

Genetic Programming (GP). Genetic programming is an automated method for creating a working computer program from a high-level problem statement of a problem. It uses some optimization techniques to evolve simple programs, mimicking the way humans construct programs by progressively rewriting them. It is a methodology inspired by biological evolution to find computer programs that perform a user-defined task. In nature, each species needs to adapt to a complicated and changing environment in order to maximize the likelihood of its survival. In GP, populations of programs are genetically bred to solve problems, for example, system identification, classification, control, robotics, optimization, game playing, and pattern recognition. The basis of GP began with the evolutionary algorithms first utilized by Nils Aall Barricelli in 1954 as applied to evolutionary simulations. Other works were developed by John Holland in the early 1970s. The first results on the GP methodology were reported by Stephen F. Smith (1980) and Nichael L. Cramer (1985). John R. Koza is a main proponent of GP and he was a pioneer in the application fields of genetic programming.

Gestalt. It is a German word typically translated as meaning *whole* or *form*.

Gradient Descent/Ascent Technique. It is a general framework for solving optimization problems to maximize or minimize functions of continuous (differentiable) parameters.

Grammar. It is the branch of linguistics that studies syntax and morphology with a set of rules (and sometimes also deals with semantics).

The set of those rules is also called the grammar of the language, and each language has its own distinct grammar. The term derives from the Greek *γραμματική* which is the feminine adjective of *γράμμα* (meaning *letter*), ultimately from *γράφω* (*write*).

Graph. In mathematics and in computer science, a graph is a set of objects called points, nodes, or vertices connected by links called lines or edges. The father of graph theory was the Swiss mathematician Leonhard Euler (1707-1783). In his paper entitled *Seven Bridges of Königsberg*, published in 1736, he presented a solution of the problem using a graph.

Group. In abstract algebra, it is a set (collection of elements) with a binary operation that satisfies certain axioms. A binary operation is an operation that involves two input elements.

H

Heat. A type of energy that is associated with atoms' and molecules' movement inside matter. It is capable of being transmitted through solid and fluid media by conduction, through fluid media by convection, and through empty space by radiation.

Homo Habilis. A species of the genus Homo that lived approximately 2.4 million to 1.5 million years ago in Tanzania, Kenya, Ethiopia, and South Africa. Homo habilis is an extinct species of humans considered to be an ancestor of modern humans and the earliest hominid to make tools. The terms derive from the Latin *Homō* (that means *man*) and *habilis* (meaning *skillful*).

Human-Computer Interaction. It is a discipline concerned with the design, evaluation, and implementation of interactive systems (both traditional and computerized systems) for human use and with the study of major phenomena surrounding them.

Hydrodynamic. It is the study of fluids in motion, and it is based upon the physical conservation laws of mass, momentum, and energy. The mathematical models of these laws may be written in either integral or differential form. The integral form is useful for large-scale analyses particularly for engineering applications. The differential form of the equations is used for small-scale analyses.

Hypolimnion. It is the bottom and most dense layer of water in a thermally stratified lake. It is the layer that lies below the thermocline. Typically, it is noncirculatory and remains cold throughout the year.

I

Image (Picture). It is a representative reproduction of an object, especially an optical reproduction formed by a lens or mirror. Images may be classified as follows: two-dimensional images, such as a photograph, or three-dimensional images such as in a statue. In computer graphics, an image is an array of values, where a value is a collection of numbers describing the attributes of a pixel in the image. The dimensions of the array are called the width and height of the images, and the numbers of bits associated with each pixel in the array is called the depth.

Image Compression. In computer science, image compression is a technique that reduces the redundancy of the image data in order to be able to store or transmit data in an efficient form. Image compression can be **lossless** or **lossy**. Lossless compression is sometimes preferred for artificial images such as technical drawings. Lossless compression methods may also be preferred for high-value content, such as medical imagery or image scans made for archival purposes. This is

because lossy compression methods, especially when used at low bit rates, introduce image quality loss. Lossy methods are especially suitable for natural images such as photos in applications where minor (sometimes imperceptible) loss of fidelity is acceptable to achieve a substantial reduction in bit rate.

Interaction. It is an action that involves two or more objects that have an effect upon one another. Interaction has different tailored meanings in various sciences. For example, in physics interaction represents one of four fundamental ways in which elementary particles and bodies can influence each other, classified as strong, weak, electromagnetic, and gravitational.

Interface. It is a surface that forms a common boundary between adjacent substances, bodies, phases, or regions. In computer science, an interface represents the point of interaction or communication between a computer and any other parts of software, hardware devices, or entities, such as printers or human operators.

Internet. It is the global network that connects millions of computers in the world via the TCP/IP protocol. The term derives from the phrase *interconnected network* and it was coined by the American computer scientist Vinton Cerf (born 1943) in 1974. The Internet evolved from the *ARPANET* of the late '60s and early '70s.

Isomorphism. It is a one-to-one mapping between two sets that preserves the relationship of elements under corresponding operations on each set.

Iterated Function System (IFS). It is a finite set of affine mappings in the plane that are combinations of translations, scalings, and rotations. Each mapping has a defined probability and should be contractive; that is, scalings are less than 1. Iterated function systems can be used for generating fractal objects and image compression. A finite set of contraction F_i: $X \rightarrow X$ is defined on a metric space X.

Iterative Algorithm. It is a kind of algorithm that uses repetitive constructs like loops and sometimes additional data structures like stacks to solve given problems.

K

Key. In computer science, it is a set of bits, usually stored in a file, that is used to encrypt or decrypt a message.

L

Language. It is a set of finite arbitrary symbols combined according to rules of grammar for the purpose of communication. A language is a system of communicating based on sounds, symbols, and words in expressing a meaning, idea, or thought. A **natural language** is a language that is spoken, written, or signed by humans for general-purpose communication.

Large Eddy Simulation (LES). It is a numerical technique used to solve the partial differential equations governing turbulent fluid flow. Using this technique, only the large-scale motions of the flow are directly computed, while the effects of the smaller universal scales (called subgrid scales, SGS) are modeled using a subgrid scale model.

Lattice. In physics, it is a regular, periodic configuration of points, particles, or objects throughout an area or a space, especially the arrangement of ions or molecules in a crystalline solid.

Learning. Learning is the process of acquiring knowledge, attitudes, or skills from study, experience, or instruction.

Learning Environment. It is the physical or virtual setting in which learning takes place. It is also defined as the instructional, interpersonal, and physical characteristics of the classroom that may influence student performance.

Limnology. It is a branch of hydrology that concerns the study of fresh waters, specifically lakes, including their biological, physical, and chemical aspects. The term derives from the Greek *limne*, (that means *lake*) and *λόγος* (*logos* that means *knowledge*). The founder of limnology was the Swiss physician and scientist François-Alphonse Forel (1841-1912) with his studies concerning Lake Geneva. Limnology traditionally is closely related to hydrobiology, which is concerned with the application of the principles and methods of physics, chemistry, geology, and geography to ecological problems.

Local Area Network (LAN). A LAN is a computer network that is limited to a relatively small spatial area such as a room, a single building, a ship, or an aircraft. Local area networks are sometimes called a single-location network.

Logarithmic Spiral. It is a spiral whose polar equation is given by $r = \alpha e^{b\theta}$ where r is the distance from the origin, θ is the angle from the x-axis, and α and b are arbitrary constants. It is also known as an **equiangular spiral** or **growth spiral**. This curve was first described by the French mathematician René Descartes (1596-1650) and later extensively investigated by Jakob Bernoulli (1654-1705), who called it *spira mirabilis*, "the wonderful spiral." Bernoulli was charmed by this curve and he wanted its drawing on his tomb stone.

Logic. It is the study of principles and criteria that guide reasoning within a given field or situation. The term derives from the Greek *λόγος* (*logos* that means *word*, *account*, *reason*, or *principle*). Logic is studied as a branch of philosophy, one part of the classical trivium (that consisted of grammar, logic, and rhetoric).

L-System (Lindenmayer System). It is a formal grammar (a set of rules and symbols) commonly used to model the growth processes of plant development, but also able to model the morphology of a variety of organisms. L-systems were introduced and developed in 1968 by the Hungarian theoretical biologist and botanist Aristid Lindenmayer (1925-1989). L-systems can also be applied to generate self-similar fractals such as iterated function systems.

M

Machine Intelligence (see Artificial Intelligence).

Markovian Model. The most general Markovian model describes a set of random variables and is defined by a strong Markovian property.

Markovian Process. A process for generating a time series where the value at any new time depends only on the previous value plus some random component.

Markovian Property (Markov Property). In probability theory, it is a property that refers to a stochastic process that has its conditional probability distribution of future states depending only upon the present state and not on any past states. The system has the Markov property if only the present state predicts future states; that is, the process is memory-less.

Mars Orbiter Laser Altimetry (MOLA). An instrument currently in orbit around Mars on the Mars Global Surveyor (MGS) spacecraft. The instrument transmits infrared laser pulses

toward Mars at a rate of 10 Hz and measures the time of flight to determine the range of the MGS spacecraft to the Martian surface.

Mathematical Model. It is a representation of a system, process, or relationship in mathematical form, for example, using equations for simulating the behavior of the system or process under study. This model consists of two parts: the mathematical structure and some particular constants, or parameters associated with it.

MEA (Microelectrode Arrays). It is an implementation of passive metal electrodes, typically 60, allowing the targeting of several sites for stimulation and extracellular recording of electrically active cells (single cells, neuronal, muscle, or cardiac tissue) at once. MEA offers the unique possibility for noninvasive extracellular recording. MEA represents an ideal system to monitor both acute and chronic effects of drugs and toxins and to perform functional studies under physiological or induced pathophysiological conditions that mimic in vivo damages.

Meme. The term was coined in 1976 by the biologist Richard Dawkins in his book *The Selfish Gene*. It refers to a "unit of cultural information" that can propagate from one mind to another in a manner analogous to genes (the units of genetic information). Dawkins derived the term from a shortening of the Greek *mimeme*, making it sound similar to *gene*.

Memetics. This is the study of memes and their social and cultural effects. The term was introduced in 1904 by the German evolutionary biologist Richard Semon (1859-1918) in his work entitled *Die Mnemische Empfindungen in ihren Beziehungen zu den Originalenempfindungen*. The work was translated into English in 1921 as *The Mneme*. The term is made of two parts: *meme* and *tics* (derived from *aesthetics*).

Memory. It is the function of the brain for storing, retaining, and subsequently recalling information about past events or knowledge. Different ways are used to classify memories based on the duration, the nature, and the retrieval of information. A general classification of memory is based on the duration of memory retention, and identifies three distinct types of memory: (a) **sensory memory**, which is the ability to retain impressions of sensory information after the original stimulus has ceased, (b) **short-term memory** (or **working memory**), which recovers memories of recent events, and (c) **long-term memory**, which is concerned with recalling the more distant past. In computer science, memory (also called **computer memory**) is the device where information is stored while being actively processed.

Message. A primary element of the communication process, a message consists of the information passed from the sender (communicator) to the receiver. Thus, the message is an object of communication. In computer science, a message is any set of transmitted data.

Metabolism. It is the sum of chemical and physiological processes by which the living organism builds and maintains itself and by which it breaks down food and nutrients to produce energy. These processes include both synthesis (anabolism) and breakdown (catabolism) of body constituents.

Metaheuristic. It is a heuristic method for solving a general class of computational problems by combining user-given black-box procedures in a hopefully efficient way. The name combines the Greek prefix *meta* (*beyond*, here in the sense of *higher level*) and *heuristic* (from *ευρισκειν*, *heuriskein*, *to find*).

Metaphor. It is a rhetorical device of saying something as if it were something else. The term

derives from the Greek *metapherin* (that means *rhetorical trope*). It is also defined as an indirect comparison between two or more seemingly unrelated subjects that typically uses *is-a* to join the first subjects, for example, "Time is money."

Metaphorical Thinking. It is the linking of a topic and a vehicle through a common ground. The topic is what the metaphor is about. The vehicle is the means by which the speaker refers to the topic. The ground is the sum of possible attributes shared by the topic and vehicle. Thus, metaphors can create strong images that can be used to great effect in everyday communications and thinking.

Metropolitan Area Network (MAN). It is a network that connects two or more local area networks or controller area networks together, but does not extend beyond the boundaries of the immediate town, city, or metropolitan area. Multiple routers, switches, and hubs are connected to create a MAN.

Microtubules. They are protein structures found within cells, composed chiefly of tubulin. They have a diameter of about 24 nanometers and have varying length from several micrometers to possible millimeters in axons of nerve cells.

Mind-Body Problem. It is a famous problem that tries to find an explanation for the relationships between minds, or mental processes, and bodily states or processes. The philosophers who work in this area tried to explain how a supposedly nonmaterial mind can influence a material body and vice versa. The modern mind-body problem stems from the thought of the French philosopher René Descartes (1596-1650), who was responsible for the classical formulation of dualism (which is a set of views about the relationship between mind and matter).

Mirror Neuron. It activates itself when an animal performs an action and when the animal observes the same action performed by another animal (possibly of the same species). This neuron mirrors the behavior of another animal as though the observer were itself performing the action. Mirror neurons have been argued to support simulation theories of action understanding and mind reading (Gallese & Goldman, 1998).

Mirror System Hypothesis. It states that the matching of neural code for execution and the observation of hand movements in the monkey is present in the common ancestor of monkey and human.

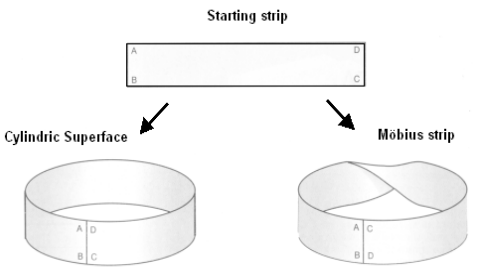
Mobile Network. It is the set of facilities operated by a carrier for the purposes of providing public mobile telecommunications services. Mobile network is the synonym of cellular network, which is a radio network constituted by a number of radio cells (or cells) each served by a fixed transmitter that is known as a cell site or base station.

Model. It is a description, illustration, small reproduction, or other representation that is used to explain an object, a system, or a concept.

Modulation. It is the process of imposing an information signal on a carrier. The process modifies some characteristic of a wave (the carrier or channel signal) so that it varies in step with the instantaneous value of another wave (the modulating wave) in order to transmit a message. This can be done by changing the frequency (frequency modulation, FM), the amplitude (amplitude modulation, AM), or the phase (phase modulation, PM), or any combination of these.

Möbius Strip (Möbius Band). It is a one-sided surface that can be created by taking a strip of paper and taping the two ends together with a half-turn in the middle. German mathematicians

August Ferdinand Möbius (1790-1868) and Johann Benedict Listing (1808-1882) independently discovered this surface in 1858.



Monte Carlo (Method). It is an analytical technique in which a large number of simulations are run using random quantities for uncertain variables and looking at the distribution of results to infer which values are most likely. The name of this method comes from the city of Monte Carlo, which is known in the world for its casinos.

Mutability. Mutability is the quality of being capable of mutation.

Mutation. It is a permanent change, a structural alteration, in the DNA or RNA. In genetic algorithms, the term mutation refers to a genetic operator used to maintain genetic diversity from one generation of a population of chromosomes to the next. It is analogous to biological mutation.

Mythology. This is a collection of stories belonging to a people and addressing their origin, history, and heroes. It typically involves supernatural beings or forces, and embodies and provides an explanation or justification for something such as the early history of a society, a religious belief or ritual, or a natural phenomenon.

N

Neighborhood (Neighbourhood). The term is used for indicating a vicinity: a surrounding or nearby region. In mathematics, it is a small set of points surrounding and including a particular point. More rigorously, a subset N of a topological space is called a neighborhood of a subset K if every point of K belongs to the interior of N.

Network. It is a set of connections among a multiplicity of separate entities sharing a common characteristic. In computer science, a network, also called net, is a system of computers interconnected by telephone wires or other means in order to share information.

Networking. It is the linking of a number of devices, such as computers, workstations, and printers into a network (system) for the purpose of sharing resources.

Network Topology (Physical Topology). It refers to the configuration of cables, computers, and other peripherals. Physical topology should not be confused with logical topology, which is the method used to pass information between workstations.

Neural Darwinism. It is a theory of brain development presented by the American neurobiologist Gerald Edelman (born 1929) in his book *Neural Darwinism: The Theory of Neural Group Selection* (1989). Natural Darwinism is the process of selection that is the basis of evolution and operates not only on the individual and species levels, but also on the cellular level, in the various major systems of an organism. Two different contexts of application can be identified. One refers to the theory that human intelligence can be explained using the Darwinian selection and evolution of neural states. The other context presents a physical process in neurodevelopment where the used neural connections (synapses) are strengthened, while unused connections weaken and are eventually pruned for establishing some efficient neural pathways.

Neural Network (NN). It is an interconnected group of artificial neurons that uses a computational model for information processing based on a connectionist approach to computation. In most cases an NN is an adaptive system that changes its structure based on external or internal information that flows through the network.

Neurobiology. This is the branch of biological sciences that studies the cells of the nervous system and the organization of these cells into functional circuits that process information and mediate behavior.

Neurofeedback (NFB). It is a noninvasive treatment approach that allows us to gain information about the brainwave activity as measured by electrodes on the scalp, and uses the information to produce changes in brainwave activity. The brainwave activity is presented as feedback in the form of a video display, sound, or vibration.

Neuron. It is also known as *neurone* and nerve cell. It is an electrically excitable cell in the nervous system that transmits and processes information. Neurons are composed of a soma, or cell body, a dendritic tree, and an axon. In vertebrate animals, neurons are the core components of the brain, spinal cord, and peripheral nerves.

Neuroscience. It is the branch of biological sciences that is devoted to the scientific study of the anatomy, physiology, and pathology of the nervous system. The scope of neuroscience includes any systematic scientific experimental and theoretical investigation of the central and peripheral nervous system of biological organisms.

Niche. In ecology, it is a term that describes the relational position of a population (or species) in an ecosystem. The term was coined by the American naturalist Joseph Grinnell (1877-1939) in 1917, but it was the British ecologist Charles Sutherland Elton (1900-1991) that gave the first working definition of the niche concept in 1927.

Niche Construction. It refers to the activities, choices, and metabolic processes of organisms, through which they define, choose, modify, and partly create their own niches.

Node. An object (gene, molecule, or computer) connected in a network.

Nystagmus. An involuntary rhythmic shaking or wobbling of the eyes of a sleepy or inebriated individual. Nystagmus may be inherited, be idiopathic (no known cause), or be associated with a sensory problem. The term derives from the Greek word *nýstagma* (that means *drowse*). Nystagmus has also been described as "dancing eyes" or "jerking eyes."

O

Object Relations Theory. It is a branch of psychoanalytic theory that emphasizes interpersonal relations, primarily in the family and especially between mother and child. The object is that to which a subject relates (e.g., persons, parts of persons, or symbols of one of these). The fundamental idea is that the ego-self exists only in relation to other objects that can be classified as external objects and internal objects. An external object is an actual person, place, or thing that a person has invested in with emotional energy. An internal object is one person's representation of another, such as a reflection of the child's way of relating to the mother. The theory was developed in the 1940's and 1950's by British psychologists Ronald Fairbairn (1889-1964), Donald Winnicott (1896-1971), Harry Guntrip (1901-1975), and others.

Oedipus Myth. Oedipus (*Οιδίπους*, *Oidĭpous*, that means *swollen-footed*) was the mythical

son of the king of Thebes Laius and Jocasta. In ancient Greece, Thebes was the richest city in the world. The myth begins with Laius and Jocasta received a warning from the Delphic oracle that their soon-to-be-born son will kill his father and marry his mother. To avoid the prophecy, after his birth Oedipus' feet were pierced and bound, and he was given to a shepherd who was instructed to abandon the child on Mount Cithaeron. Oedipus was instead brought to Polybus and Merope, king and queen of Corinth, who adopted him as their son. When he reached adulthood, Oedipus learned from an oracle that he was destined to kill his father and marry his mother. To evade his fate, he left Corinth and during the journey, his chariot met another at a point where three roads cross. Neither occupant was willing to cede the other's right of way. During the violent discussion, Oedipus killed the other man who was King Laius, his biological father. Sometime later, Oedipus reached Thebes and was confronted at the city's gate by the Sphinx, a mythological creature with the head of a woman and the body of a lion. She terrorized the city by asking all travelers who attempted to pass through the gate a riddle, and killing them when they could not answer it. The Sphinx asked Oedipus the same riddle: "Which creature in the morning goes on four feet, at noon on two, and in the evening upon three?" He answered "Man," solving the riddle (man crawls on all fours as a baby, then walks on two feet as an adult, and walks with a cane in old age). The Sphinx threw herself from her high rock and died. Oedipus came into Thebes as the victor. He married Jocasta, his biological mother. Four children were born from this marriage: two sons, Eteokles and Polynices, and two daughters, Antigone and Ismene. During a long time, Oedipus reigned over Thebes. Then, suddenly, a plague broke out. Oedipus sent Kreon to the oracle of Delphi to ask the cause of the divine punishment. He brought back the answer that the wrath of the gods was upon the people because the murderer of Laius had not been punished and exiled. Upon discovery of the truth, Jocasta hangs herself, while Oedipus blinded himself, going away from Thebes with his daughter Antigone.

OOP (Object-Oriented Programming). It is a programming paradigm that uses the concept of objects to design applications and computer programs. An object is a collection of private data and a set of operations that can be performed on that data. This paradigm originated in the 1960s, but OOP was not commonly used in mainstream software application development until the 1990s. OOP uses several techniques different from previously established paradigms, including inheritance, modularity, polymorphism, and encapsulation. Encapsulation means that a user sees only the services that are available from an object, but not how those services are implemented. Today, many popular programming languages support OOP.

P

Paradigm. It is a thought pattern in any scientific discipline or other epistemological context. The term derives from the Greek word *παράδειγμα* (*paradeigma*, which means *pattern*) and from the word *παραδεικνύναι* (*paradeiknunai*, that means *demonstrate*).

Paradox. It is a statement formulated in clear contradiction to the common experience or its elementary beginnings of logic, but when submitted to a strict criticism proves to be valid. The sentence "Less is more" is an example of paradox. The term derives from the Greek *paràdoxos*, which is composed of *parà* and *doxa* (meaning *against the opinion*).

Pareidolia. It is a type of illusion or misperception involving a vague or obscure stimulus being

perceived as something clear and distinct. The term derives from the Greek *para* (that means *amiss*, *faulty*, *wrong*) and *eidolon* (that means *image*). Pareidolia is a type of apophenia.

Pattern. It is a repeated sequence of natural occurrences, or a configuration of shapes or other objects arranged in such a way as to demonstrate a specific repeat in design.

Perceptron. It is a simple computational model of a biological neuron that comprises some input channels, a processing element, and a single output. Each input value is multiplied by a channel weight, summed by the processor, passed through a nonlinear filter, and put into the output channel. The perceptron was invented by the American scientist Frank Rosenblatt (1928-1969) in 1957.

Phase Space. Phage space is the state space of a system, a mathematical abstract space used to visualize the evolution of a dynamic system. Phase space for the ego is defined here as a two-dimensional chart showing relationships between consciousness, the personal unconscious, and the collective unconscious over time.

Pixel. It is the smallest part of a digitized or digital image. It is the smallest individual dot that can be displayed on a computer screen, and it can be also used in measuring image size and resolution. The term is an abbreviation for *picture element*.

Plaintext. It is information used as input to an encryption algorithm or the output of a decryption algorithm (decryption transforms ciphertext into plaintext).

Portfolio. In finance, it is a collection of the financial assets held by an individual or a bank or other financial institution. In marketing and strategic management, a portfolio is a set of products, projects, services, or brands that are offered for sale by a company. The term derives from the Italian word *portafoglio*, composed of *porta* (meaning *to carry*) and *foglio* (meaning *sheet*).

Portfolio Theory. It is a theory that proposes to the investors a diversification for optimizing their portfolios, and how a risky asset should be priced**.**

Principle of Least Action. It describes action as an integral quantity used to determine the evolution of a physical system between two defined states, that is, a change of energy in time; influenced by the economic spirit, the principle requires the action to be least.

Psychoanalysis. The theory of personality developed by the Austrian neurologist Sigmund Freud (1856-1939) in which free association, dream interpretation, and analysis of resistance and transference are used to explore repressed or unconscious impulses, internal conflicts, and anxieties. Psychoanalysis was devised in Vienna in the 1890s.

Psychology. It is the science that studies human behavior, mental processes, and how they are affected and/or affect an individual's or group's physical state, mental state, and external environment.

Psychoneurobiology. It is the field of scientific research into the relationship between psyche (spirit, emotions), neurones (nervous system, mind), and biology. Psychoneurology represents a scientific reframing of the ancient mind, body, and spirit concept of traditional Chinese medicine.

Q

Quantum Computer. It is a device for computation that directly uses the quantum mechanics

phenomena (e.g., entanglement and superposition) to perform operations on data. The amount of data is measured by qubits (quantum bits). Quantum computer encodes information as a set of quantum-mechanical states such as the spin directions of electrons or the polarization orientations of a photon that might represent a 1 or a 0, might represent a combination of the two, or might represent a number expressing that the state of the qubit is somewhere between 1 and 0, or a superposition of many different numbers at once.

Quantum Computing. It is the area of study focused on the development of computer technology based on the laws of quantum mechanics, and the way that atoms can be in more than one state at once to do computational tasks. The physicist Paul Benioff, working at Argonne National Labs, is credited with first applying quantum theory to computers in 1981. Benioff theorized about creating a quantum Turing machine.

Quantum Entanglement. It is a phenomenon that happens in quantum mechanics where the quantum states of two or more particles have to be described with reference to each other, even though the individual particle may be spatially separated.

Quantum Gate. It is a basic quantum circuit operating on a small number of qubits. The quantum gate is also known as the quantum logic gate, and it is the analogue for quantum computers as the classical logic gate is for conventional digital computers.

Quantum Mind (Theory). It is a set of theories that propose that classical mechanics cannot explain consciousness. It suggests that quantum mechanics phenomena (for example, superposition and quantum entanglement) may play an important role in the brain's function and could form the basis of an explanation of consciousness.

Quantum Mechanics. A branch of physics that studies the light, the elementary particles, and the atoms replacing classical mechanics and classical electromagnetism at the atomic and subatomic scales. The foundations of quantum mechanics were established during the first half of the 20th century by Werner Heisenberg (1901-1976), Max Planck (1858-1947), Louis de Broglie (1892-1987), Niels Bohr (1885-1962), Erwin Schrödinger (1887-1961), Max Born (1882-1970), John von Neumann (1903-1957), Paul Dirac (1902-1984), Wolfgang Pauli (1900-1958), and others. It was developed between 1900 and 1930 and it was combined with the general and special theory of relativity, revolutionizing the field of physics. Quantum mechanics introduced new concepts, for example, the particle properties of radiation, the wave properties of matter, and the quantization of physical properties. The Latin term *quantum* (*how much*, *quantity*) in quantum mechanics refers to a discrete unit that quantum theory assigns to certain physical quantities, such as the energy of an atom at rest.

Quantum Superposition. It is a principle of quantum theory that describes a challenging concept about the nature and behavior of matter and forces at the atomic level. The principle of superposition states that any given particle that is unobserved and has more than one possible state is simultaneously in all possible states until it is observed.

Qubit. It is a short term for *quantum digit*, the basic unit of a quantum computer; it can be in state 0, 1, or a quantum superposition of the two.

R

Radiation. The term generally means the transmission of waves, objects, or information from a source into a surrounding medium or destination.

In physics, the radiation is the energy that travels through empty space or through a transparent material without heating the empty space or transparent material.

Receiver. In information theory, it is the receiving end of a communication channel. It receives decoded messages and decoded information from the sender, who first encoded them.

Recursive Algorithm. It is a kind of algorithm that invokes (makes reference to) itself repeatedly until a certain condition matches.

Reflexivity. In mathematics and in logic it is a relation such that it holds between an element and itself. In sociology, the reflexivity refers to circular relationships between cause and effect.

Rendering. In computer graphics, it is the process of adding realism to a graphics object by adding three-dimensional qualities such as shadows, variations in color, and variations in light source.

Residence Time. It is usually defined as "the time taken by a water/tracer parcel to leave the domain of interest." This time scale is one of the most widely used concepts to quantify the renewal of water in semi-enclosed water bodies. In environmental studies, it provides, for instance, a quantitative measure of the time of exposure to pollution stresses.

Recombination (see Crossover).

Robot. It is an electromechanical system that responds to sensory inputs. It sometimes resembles a human and is capable of performing a variety of complex human tasks on command or by being programmed in advance. The term derives from the Czech noun *robota* (meaning *servitude*, *forced labour*). The word robot was introduced by Czech writer Karel Čapek (1890-1938) in his science fiction work *R.U.R.* (*Rossum's Universal Robots*) written in 1920. Robotics is the science and technology of robots and their design, manufacture, and application.

Routing. It is the techniques for selecting paths in a computer network along which to send data. Routing directs forwarding, the passing of logically addressed packets from their source network toward their ultimate destination through intermediary nodes; typically hardware devices called routers.

S

Schrödinger Equation. It is the fundamental equation of physics for describing quantum mechanical behavior (the space- and time-dependence of quantum mechanical systems). It has been proposed by the Austrian physicist Erwin Schrödinger (1887-1961) in 1925. It is also called the Schrödinger wave equation, and is a partial differential equation that describes how the wave function of a physical system evolves over time.

Second-Order Cybernetics (also known as Cybernetics of Cybernetics). It is a branch of cybernetics that studies how observers construct models of other cybernetic systems.

Security. It is the condition of being protected from danger or risk. In computer science, the term is used in a variety of contexts. For example, information security is the process of protecting data from unauthorized accesses. Network security consists of the provisions in the computer network infrastructures for defining the policies adopted by the network administrator to protect the network and the network-accessible resources from unauthorized accesses.

Selection. In a genetic algorithm, it is the stage of a in which individual genomes are chosen from a population for later breeding (recombination or crossover).

Self-Reference. In natural or formal languages, it is a phenomenon consisting of a sentence or formula referring to itself directly.

Self-Similar. It is an object that is exactly or approximately similar to a part of itself, for example, the whole has the same shape as one or more of the parts. There are many self-similar shapes in nature, for example, ferns, and in the human body.

Self-Similarity. It is the property of fractal objects whereby a shape is repeated on different scales. The object need not exhibit exactly the same structure at all scales, but the same type of structure must appear on all scales. Many objects in the real world, for example, coastlines, are statistically self-similar. Parts of them show the same statistical properties at many scales.

Self-Organization. It represents the spontaneous emergence of nonequilibrium structural organization on a macroscopic level due to collective interactions between a large number of simple, usually microscopic, objects**.**

Sender (Source). In information and communication processing, it is an object that encodes message data and transmits the information, via a channel, to one or more receivers.

Simulation. It is the practice to mime some or all the behaviors of one system. Generally, it refers to the use of a mathematical model to recreate a situation, often repeatedly, so that the likelihood of various outcomes can be more accurately estimated.

Skill. It is a natural or acquired facility by training in a specific activity. This term also means an ability to produce solutions in some problem domain.

Social Learning. It means learning something from other people. It is a kind of learning that involves observing, retaining, and replicating behavior observed in others. Social learning includes true imitation, but there are other kinds of social learning as well.

Spiral. It is a curve that emanates from a central point, getting progressively farther away as it revolves around the point.

Spiral Architecture (SA). In computer graphics, it is an image structure on which images are displayed as a collection of hexagonal pixels. SA is an approach to create a machine vision system. It is inspired from anatomical consideration of the primate's vision system. The natural data structure that emerges from geometric consideration of the distribution of photo receptors on the primate's retina has been called the spiral honeycomb mosaic (SHM).

Spiral Honeycomb Mosaic (SHM). It is a structure that emerges observing the distribution of photo receptors on the primate's retina. SHM is made up of hexagonal lattices that consist of groups of 7^n hexagons ($n > 0$). It has very useful geometric properties. Two operations are defined on spiral honeycomb mosaic: spiral addition and spiral multiplication.

Spiral Similarity. It is a combination of central similarity and rotation with the same center.

Stratification (Water). It is the phenomenon that occurs when cold water and warm water (thermocline) form some layers that act as barriers to water mixing.

String. In computer science, it is a sequence of symbols, where these symbols are chosen from a predetermined set.

Structured Mesh. It is a mesh that has a regular arrangement of its cells, and that can be defined by specifying the parameters of the arrangement. Each cell is not defined separately. The topology of the cells in an structured mesh is specified for the mesh as a whole, and is not deduced from the nodes. Using this application module, the number of instances is independent of the number of cells in the mesh.

Stochastic Model. It is a model of a system that includes some sort of random forcing. Its inputs are expressed as random variables, and its output is a distribution of possible results.

Stochastic Process. It is a set of random variables dependent upon a parameter that usually denotes time.

Stochastic Universal Sampling (SUS). In genetic algorithms, it is a genetic operator used for selecting useful solutions for recombination.

Symmetry. It is a property of a mathematical object that causes it to remain invariant under certain classes of transformations (for example, rotation, reflection, inversion, or more abstract operations). The mathematical study of symmetry is systematized and formalized in the area of mathematics called group theory. The term symmetry derives from the Greek word συμμετρία (*summetria*, that means *same measurement*), and is composed of σύν (*sun*, that means *with*, *together*) and of μέτρον (metron, that means measures). The concept of symmetry can be generalized, thus the objects can be symmetric (a) over time (if they do not change over time), (b) over space (if they look the same even from different points of view), and (c) over size (if it looks the same even if we zoom in or out).

Synchronization. It is the process that involves events occurring at the same time. For example, a hearing system uses information from each ear arriving at a common (synchronized) set of signal processing parameters.

System. A set of objects or parts connected in some way so as to form a whole. Modern thermodynamics classifies three basic kinds of systems: isolated, closed, and open. **Isolated systems** are those that are totally independent of their environment. **Closed systems** are closed to matter (no matter may pass through the boundaries of the system) but are open to energy and information. **Open systems** are dependent on environment. Matter, energy, and information may pass through the boundaries of open systems.

Systems Biology. It is an emergent field that seeks to integrate high-throughput biological studies to understand how biological systems function.

T

TCP (Transfer Control Protocol). It is a set of rules (protocol) used along with the Internet protocol (IP) to send data in the form of message units between computers over the Internet. TCP takes care of keeping track of the individual units of data (called packets) that a message is divided into for efficient routing through the Internet. TCP/IP is the suite of protocols that defines the Internet.

TELNET (Teletype Network). It is a network protocol that enables a computer to function as a terminal working from a remote computer. It is used on the Internet, on TCP/IP-based networks, on a local area network, or on connections. In origin, it was developed for ARPAnet in 1969. Telnet is a common utility in the TCP/IP protocol suite now. It has limitations that are considered to be security risks; in fact, it is not secure and

transfers commands in the clear. The term telnet also refers to software that implements the client part of the protocol.

Temperature. It is the measure of the average energy of motion of the particles of a substance. The temperature is a physical property of a system.

Texture. In computer graphics, it is the digital representation of the surface of an object.

Thermocline. It is the middle layer in a thermally stratified lake or reservoir. In this layer there is a rapid decrease in temperature with depth. Thermocline is also called the metalimnion.

TNGS (Theory of Neural Groups Segregation). It is also referred to as the Darwinian brain, and is an application of this principle. This theory is based on three principles: ontogenetical selection, secondary synaptic reinforcements or decay, and interactions among cerebral repertoires by a bidirectional reentry.

Topology. It is a branch of mathematics that studies the properties of geometric figures or solids that are not changed by homeomorphisms, such as stretching or bending. The term derives from the Greek words τοπος and λογος (*topos* and *logos* that mean *place* and *study*).

Traffic Control. In computer science, it is the control of the flow of traffic in the computer networks (local area networks, metropolitan area networks, wireless area networks, and the Internet).

Triadicity. It is a fundamental form that repeats in many processes at multiple levels of organization.

Turing Test. A hypothetical test for computer intelligence, proposed by the English mathematician Alan Turing (1912-1954) in 1950. In his paper *Computing Machinery and Intelligence*, Turing described a dialogue in which a person tries to guess which of two conversations is being conducted with a person and which with a computer. This test has become a standard model used to judge the intelligence of many AI applications.

U

Unconscious. This is all psychic contents or processes that are not conscious. It represents the lacking of the awareness and the capacity for sensory perception. It is usually divided into **repressed** or **dynamic unconscious** (which has been conscious and can be recalled to consciousness) and **primary unconscious**, which has never been conscious and might never be brought to consciousness.

Universal Grammar. It is a system of grammatical rules and constraints shared by all languages. It does not describe specific languages but attempts to explain language acquisition in general.

Universal Turing Machine. It is a general-purpose programmable computer that can perform any computable sequence of operations.

Utility Function. It is a function that measures the utility of an investment for an economic agent.

V

Virtual Reality. This is a form of human-computer interaction in which a real or imaginary environment is simulated and users interact with and manipulate that world. It is a modern technology that gives to its users the illusion of being immersed in a computer-generated virtual world with the ability to interact with it. The origin of the term is uncertain. It has been credited

to *The Judas Mandala*, a 1982 novel by Damien Broderick where the context of use was somewhat different from that defined now.

VRML (Virtual Reality Modeling Language, originally known as the Virtual Reality Markup Language). VRML is a language that specifies the parameters to create virtual worlds networked together via the Internet and accessed via World Wide Web hyperlinks. The aim of VRML is to bring to the Internet the advantages of 3-D spaces, known in VRML as worlds whether they compromise environments or single objects. It was conceived in the spring of 1994 and it has been presented to the first annual WWW conference in Geneva, Switzerland. Mark Pesce (born 1962) was one of the inventors of this language, and he is recognized as the man who brought virtual reality into the World Wide Web.

Virtual Spiral Architecture. In computer graphics, it is a geometrical arrangement of pixels on a hexagonal structure described in terms of a hexagonal grid. This method is used to smoothly convert images to and from rectangular and hexagonal representations. The methods present the following advantages: Little, if any, distortion is introduced, and regular pixels are divided up into subpixels. The term virtual refers to the characteristic that the hexagonal pixels do not physically exist.

Virtual World. It is an artificial world maintained by a computer that a user may interact with or view.

W

Wide Area Networks (WAN). A WAN is a data communications network that covers a relatively broad geographic area and that often uses transmission facilities provided by common carriers, such as telephone companies. WAN technologies generally function at the lower three layers of the OSI reference model: the physical layer, the data link layer, and the network layer.

Working Memory (Short-Term Memory). In cognitive psychology, it is the collection of structures and processes within the brain used for temporarily storing and manipulating information. Working memory is a mental work space consisting of a small set of data items representing the current state of knowledge of a system at any stage in the performance of a task, and that is transformed into a new set, in humans by the application of a discrete mental operation (operator), and in production systems on the firing of a new production rule.

World Wide Web (WWW or Web). A system of Internet servers that support particular formatted documents. The documents are written using a markup language called HTML (hypertext markup language) that supports links to other documents, as well as graphics, audio, and video files. The World Wide Web uses the HTTP (hypertext transfer protocol) protocol to transmit data over the Internet. The Web was invented around 1990 by the Englishman Timothy (Tim) Berners-Lee (born 1955) and the Belgian Robert Cailliau (born 1947) while working at CERN (European Center for Nuclear Research) in Geneva, Switzerland. The World Wide Web is not the same thing as the Internet. The Internet is a massive network of networks, a networking infrastructure. WWW is a way of accessing information over the medium of the Internet.

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