From life to life. The multiplicity of the living

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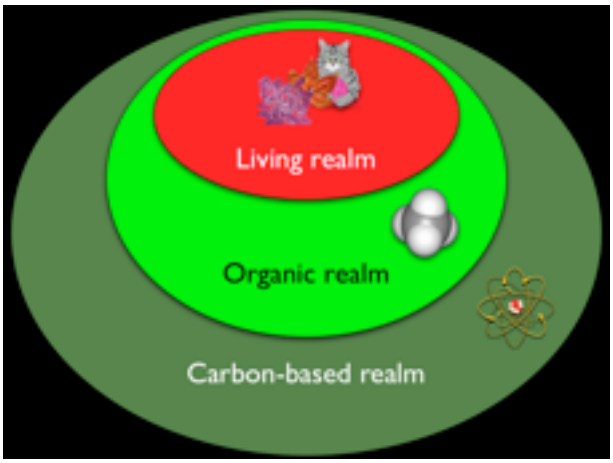
The idea – or definition – of life is indeed very challenging and fascinating, but we don't really know exactly what is, even from a scientific viewpoint.

There are many definitions of life, representing the disciplines which gave birth to these statements. So, to give some examples, life could be in turn: "what it is born and grows, procreates and dies" (in biology); "a continuous flux of energy and information" (in evolutionary biology); "what is able to procreate and correct the reproductive errors by means of the natural selection" (in neodarwinism); "what can contrast entropy preserving its physical structure constant in time and with the ability to reproduce an entity similar to itself" (in physics); "what can absorb free energy in the forms of solar light or chemical potential energy (food and oxygen) and use this energy in order to grow in accordance with the instructions coded in its genes" (in biochemistry); "an organism is a delimited system open to a matter and energy flux, which can maintain steady its internal composition and keep intact its physical state in a changing environment, that is to remain in homeostasis" (in geophysiology). And we could go on…



Life has always been considered as inherent to the organic realm[1], as a carbon-based entity, and since the end of the XVIIIth century it was well known that the organic matter always contains carbon and hydrogen (and often oxygen, azote and phosphor too). So since we don't know any life forms outside the Earth yet, we easily extrapolated the organic and carbon-based idea of life on Earth as the absolute and universal one. But in recent decades life has been expanded by some disciplines, like Artificial Life and Robotics among others. Artificial Life[2] developed the idea of studying life – in its organization in the single beings, in its social dimension and in its evolution – simulating some features[3]. Like Robotics, and opposite to Artificial Intelligence, Artificial Life operates with a bottom-up approach: starting from connected simple elements it enables the setting up of complex systems. Artificial Life simulates the processes of life by means of computer programs and simulations, like evolutionary calculations (evolutionary algorithms, genetic algorithms, genetic programming, swarm intelligence, artificial chemistry, models based on agents, cellular automata…). Unlike Robotics, which build entities with a physical body which act in our physical and personal world, Artificial Life generates lifeforms which live mainly inside computers, and may eventually act in the physical world by means of some kind of effectors.

The importance of Artificial Life is to extend the idea of life outside the organic realm, making it more general, universal. The living is no more defined by the matter it is made of, but by the instructions which rule it: the living is no more hardware based, but software based. Hence Artificial Life has freed life's dynamics from the material dimension they were imprisoned in, opening up the idea of life to a wider extent.

The symbolic dimension

The symbolic acquisition acquired by our species seems at the basis of the ongoing and future evolution of life forms. The symbolic intelligence and the forms of communication which gave rise

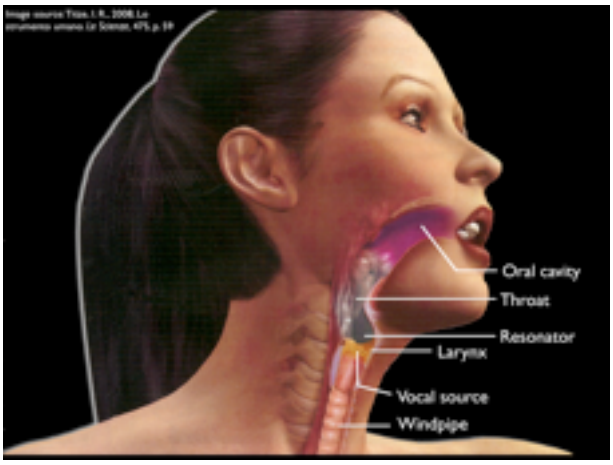
[1] An organic compound is a carbon's compound where the carbon has an oxydation number lower than +4. Hence this excludes the carbon dioxide, the carbonic acid and its salts (bicarbonates and carbonates). The carbon monoxide, which would chemically be part of the category, is considered as an inorganic compound.

[2] Artificial Life officially emerged with the first International Congress "Artificial Life I", organized by Christopher Langton at Los Alamos in 1989. See Langton, C. G., ed., 1989. *Artificial Life*. Reading: Addison-Wesley. In Italy see especially the work of Domenico Parisi. Parisi, D., 1995. Vita artificiale e società umane. *Sistemi Intelligenti*, 3(3), p. 443–475.

[3] Parisi, D., 2004. Mente come cervello. *Le Scienze*, 431, p. 80–86.

to – indical signs, orality, images, writings… until the contemporary mediascape – are the genius of our species. We don't know when all this was born. What we can say is that since we share it, although in a minor part, with some superior primates like the chimpanzee, maybe our common progenitor had *in nuce* this ability, so approximatively we can estimate its roots to 7 – 8 million years ago.

The symbolic acquisition is much more than a bare ability, it signed the humankind's evolutionary success. Among the proofs of its relevance is the fact that our ancestors' evolution privileged the phonatory system over the ability to drink and breathe simultaneously. Drinking and breathing simultaneously was, and still is, a fundamental defense against predators. In fact the predators often wait for their preys nearby or inside the water pools and the rivers, so that the time devoted to drinking has to be the shortest in order to minimize the time the animal is exposed to a weak position. In fact in humans the development of the vocal abilities, which would have led to the oral language, caused the larynx to change positon and the inability to drink and breath simultaneously. The human phonatory system and its extraordinary richness, complexity and modulation capabilities which are unique in nature[4] gave more advantages to humans and was selected by evolution.



[4] Titze, I. R., 2008, Lo strumento umano. *Le Scienze*, 475, p. 56–63. Also Lewin, R., 1993, *The Origin of Modern Humans*. New York: Scientific American Library, and in particular the chapter on the language.

By the symbolic realm and the tools which hence were produced our ancestors began to know, control and manage the environment, and at the same time they established a "safety distance" from the physical world, creating a complex anthropic sphere – knowledge, projects, artifacts, devices, prostheses, machines... With the symbolic dimension our ancestors achieved three main goals, strictly correlated: *knowledge*, *protection* and *effectiveness*[5].

Knowledge in discerning the environment and in producing, exchanging and sharing its symbolic models; protection from the environment thanks to the tools, artifacts and behaviours derived by the symbolic models; effectiveness on the environment thanks to the projects, tools and artifacts which could modify it.

The symbolic acquisition opened up a whole world of opportunities, habits. Through symbols we created a shared knowledge which is separated from the substance of phenomenic reality; a laboratory where, through the elaboration of symbolic models, we can experiment hypotheses and simulate their impact on the world, originating a designing capacity able to produce increasingly intricate artifacts. Symbols are the realm of abstraction, hypotheses, remote communication in space and time, consciousness, imagination, culture and knowledge exchange and sharing, the realm of the past and the future. Symbols are a place in which information, experience, and values can be collected and transmitted, and a place to mediate conflicts. Symbols are the laboratory where we conduct experiments on the relationship with the phenomenical world in its complexity, and the place where the correlation with the world is increasingly transferred.

Through symbols we have boosted the speed of the cultural evolution, in a process that allowed our ancestors to reduce the time of the adaptation to the environment, limiting or shifting its pressure, and improving the match. For instance, if for a species it can take roughly a million years to develop fur by natural selection as a result of the climatic pressure, our symbolic ancestors could achieve this goal in one generation, by imitating, adopting and sharing ideas, concepts, words, habits, for instance killing a bear and wearing its fur[6], in a process where a key role was probably

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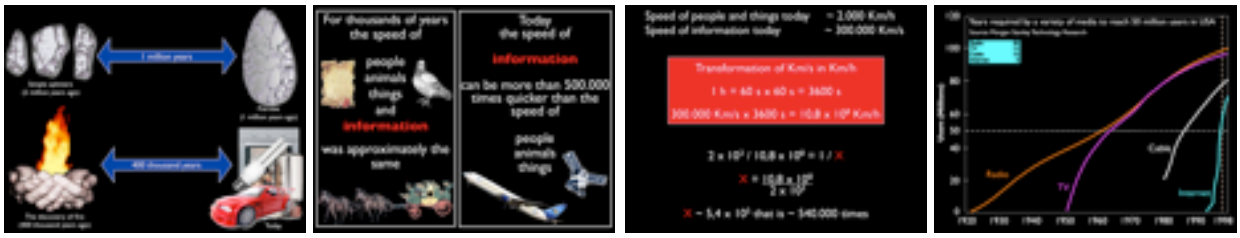
[5] Capucci, P. L. ed., 1994, *Il corpo tecnologico*. Bologna: Baskerville, p. 35.

[6] I saw this simple and beautiful example in a videopost: Capacchione, G., 2006. I neuroni specchio (Video Post). *Psicocafé. Psicologia contemporanea* [online]. Available at: http://psicocafe.blogosfere.it/2006/10/i-neuroni-specchio-video-post.html [accessed 15 April 2008].

played by the mirror neurons[7]. Like a chain reaction in a L.A.S.E.R. tube, with a spectacular growth of the photons until their energy causes the ray to shoot out, the symbolic ability produced a huge acceleration in the human culture and in the process of creating even more complex tools and artifacts.



Living in the future

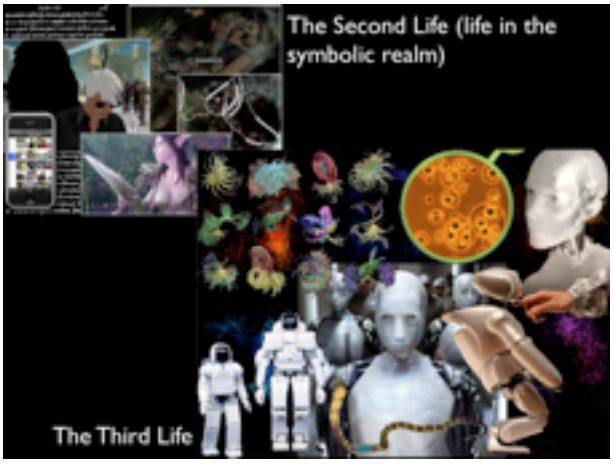
Through symbols we developed our conscience, imagination, interiority, introspection, self-awareness; we created the conditions to transcend the physical constraints of the "here and now" and crafted parallel worlds, from which mythologies, rites, and religions were born. Thanks to symbols we developed, in an almost hypertrophic fashion, the ability in projecting, imaging and designing the future, and ways to be living in the future. In fact we live in the future, a relevant part of our thoughts, acts, activities, ideas, projects, is declined to the future.

We keep agendas to match the future. We make monuments – and that particular modern form of the monument which is photography – to decline the memory to the future. We follow the weather forecastings. Some people pay magicians to have a glimpse of the future. Money is a sort of unfinished promise. We put money in the banks because it can be useful in the future, and the banks invest our money in the future. We have insurances (and some of them are mandatory) to be safe in the future. We make bets, invest money in the stock exchange market, risk gamble. We buy goods

[7] On the mirror neurons and their role see Rizzolatti G. & Sinigaglia C., 2006. *So quel che fai. Il cervello che agisce e i neuroni specchio*. Milan: Raffaello Cortina; Rizzolatti G. & Vozza L., 2007. *Nella mente degli altri. Neuroni specchio e comportamento sociale*. Bologna: Zanichelli; Rizzolatti G. & Sinigaglia C., 2008. *Mirrors in the Brain: How Our Minds Share Actions, Emotions, and Experience*. Oxford: Oxford University Press. On the mirror neurons and the imitation learning see Ramachandran, V.S., 2000. Mirror neurons and imitation learning as the driving force behind "the great leap forward" in human evolution. *Edge - The Third Culture* [online]. Available at: http://www.edge.org/3rd_culture/ramachandran/ramachandran_p1.html [accessed 14 June 2008].

on credit or using instalment plans. Most of the firms' activities are planned in the future, and rely on social, economical, cultural forecastings. There are firms whose only task is predicting the future. The same ethimology of the word "project" derives from the latin word which means "to throw beyond". But beyond what? Beyond the difficulties and obstacles that every project must go through before becoming real, of course. But it is mainly *beyond time*. Sometimes I ask my students: «Are you here for the past, for the present or for the future? Evidently you think you can acquire from the courses you follow a knowledge which will be useful in your *future* life, which fits with your attitudes and projects (and you pay money for it)». [It may seem pointless to emphasize that also teachers should be bothered by the future and should have a strong interest in transmitting knowledge, because when they are old and retired their students will be the pivots of the society they will be living in]. And what is the final meaning of "hope", a typical human construct, which is also one of the three virtues of the Christian Theology, if not believing in a future with emerging facts and opportunities which fits with our desires?

We crave to be ready for the future, the future must catch us prepared. We want to control, multiply and even subvert the future, also beyond our biologic chances, with our First Life (the biological life), with our Second Life (life in the symbolic realm) and with the Third Life. We probably are the first species with the consiousness of time, which tries to understand and question time. Maybe it is the sign of nature's evolutionary leap.



The Third Life

The symbolic dimension is an increasingly autonomous universe, constantly expanding and restructuring itself. It is a universe which is mainly based on simulation, and the simulation process is probably at the core of the evolution. This universe of simulation can mix up and often totally substitute what we call "the real world". The artifacts and machines we have invented stem from the use of symbolic intelligence, and often, such as in the case of artificial intelligence, they come from an attempt to simulate or emulate it.

Thanks to the symbolic dimension we developed a wide range of extensions to our brain, senses and body: tools, artifacts, machines, bioentities[8] which are quickly becoming more powerful, complex, automatic, autonomous, self sufficient. These entities/organisms, also inspired by the biosciences and the biodynamics, are growing smarter and independent from our control, so we could define them to a certain extent as "living entities", in a process that will be more evident and differentiated in the future. Indeed there are already many emerging or growing fields: autonomuos agents and artificial life forms, autonomous objects, robotics and biorobotics, nanoentities, hybrids (organic/inorganic), modified or expanded organisms, sinthetic life… And this growth and multiplicity will take place in a realm where connecting chances, collecting, communicating[9] and sharing information can be achieved thanks to computer technologies and the Net.

One of the most relevant differences between the carbon-based and the artificial lifeforms is supposed to be that while the first ones have naturally evolved or even have been transcendentally created, the latter are cultural products, made by humans. Today the opposition between organic and inorganic is easily crossed and these two realms blend in many fields and applications, since the cultural dimension is growing at an increasing rate. The living is the best model in making tools, machines, artifacts, devices which must autonomously work in and adapt to many environments. According with one of the most qualified theories about life's origin, starting at about 4 billion years ago the organic evolved from the inorganic[10]; hence organic and inorganic have not to be considered in opposition, but as complementary dimensions, as contiguous, osmotic universes, two declinations of the living forms. Art can also be a powerful bridge between the two and has already crossed this barrier: the genetic art sets a bridge between organic and inorganic, crossing that border[11]. But also other disciplines follow this path[12], for instance the nanotechnologies[13] and the synthetic biology[14].

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[8] Another useful concept is "biofacts", introduced by Nicole C. Karafyllys. See Karafyllis, N. C., 2008. Endogenous Design and Biofacts. Tissues and Networks in Bio Art and Life Science. In J. Hauser, ed., *sk-interfaces*. Liverpool: Liverpool University Press, p. 42–58.

[9] On the communication animal/machine/humans see in particular the work of Louis Bec. Bec, L., 2008, Les Chromatologues. Bestiaire Chromatophorique. *NoemaLab* [online]. Available at: http://www.noemalab.org/sections/ideas/ideas_articles/bec_chromatologues.html [accessed 6 April 2008].

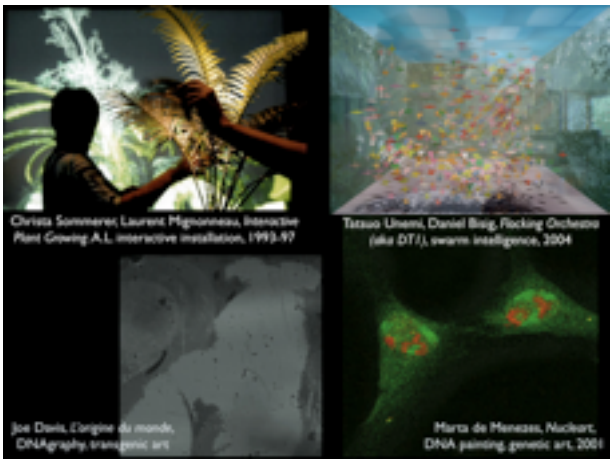
[10] Simpson, S., 2003, Le più antiche tracce di vita. *Le Scienze*, 417, p. 46–53; Russell, M., 2006. Agli inizi della vita, *Le Scienze*, 454, p. 88–97.

[11] On genetic art see Gerbel K. & Weibel P., eds., 1993, *Ars Electronica 93. Genetische Kunst – Künstliches Leben/ Genetic Art – Artificial Life*. Wien: PVS Verleger. On A-Life art see Tenhaaf, N., 2008, Art Embodies A-Life: The VIDA Competition. *Leonardo*. 41(1), p. 6–15. On technologies and vegetables in art see Gatti, G. M., 2005, *L'Erbario Tecnologico*. Bologna: Clueb.

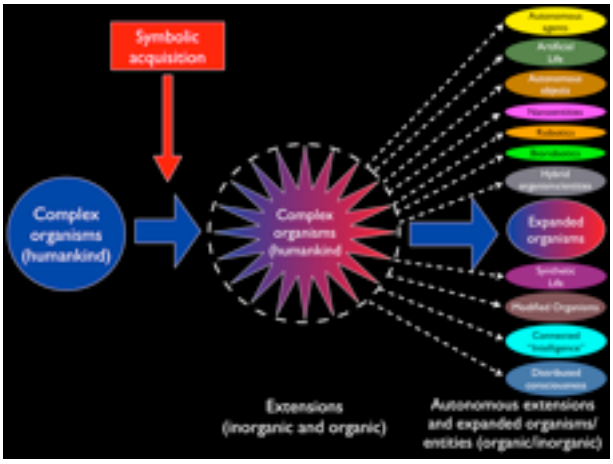
[12] Reed M. A. & Tour J. M., 2000, Molecole nel computer. *Le Scienze*, 384, p. 86–92.

[13] Seeman, N. C., 2004, Nanotecnologie a doppia elica. *Le Scienze*, 431, p. 100–109.

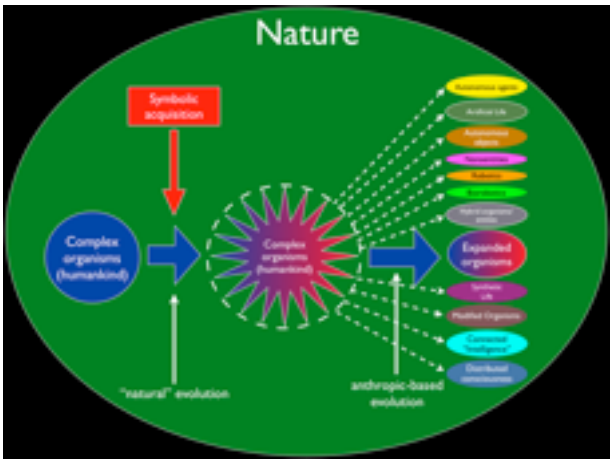
[14] Gibbs, W. W., 2004, Vita sintetica. *Le Scienze*, 430, p. 76–84; Bio Fab Group, ed., 2006, L'ingegneria della vita. *Le Scienze*. 456, p. 68–75; Shapiro E. & Benensono Y., 2006, Arriva il computer a DNA. *Le Scienze*. 457, p. 70–77.



In a sort of *divertissement* we could even interprete this tendence as leading up to the next evolutionary step but on different premises, envisaging autonomous extensions, enhanced organisms (organic/inorganic) and new forms of consciousness and intelligence. In a near future we could assist to an extension of the idea of life and of life forms from the barely organic realm to an articulated panorama with organic, inorganic as well as intermingled (organic/inorganic) life forms.



Symbolic intelligence was originated from the organic dimension, its roots are organic. Its advent generated the outburst of tools, prostheses, artifacts, and deeply changed our human interaction with the environment, generating the anthropic world we know. In an early phase – in a path which has been taking place since the Paleolithic age – the new forms depend on us and are mainly our extensions, as the current tools, machines, devices and artifacts are, which expand our bodies, our senses and our mind. But step by step these forms are becoming more and more autonomous, and due to the pressure of the antrophic environment are evolving as living entities but beyond the organic dimension, cross-breeding with it or based entirely on inorganic sources. These forms are not being selected by the same "natural" environment which selected the current living organic forms, like humans, they are not the result of the so called natural selection. Indeed they are created and selected by a cultural process, by the anthropic sphere. They are the result, the goal, of the anthropic culture and environment. The more the anthropic sphere will expand and develop, the more these forms will proliferate and evolve.



It seems that nature and evolution are devising a way to evolve on, starting up an evolution which overcomes the mere biological roots, which expands and surpasses the biological realm. An evolution which originates from one species, from our species, and relies on the symbolic ability, although the results probably won't use symbols. An evolution with many alternatives, in order to mantain a certain degree of flexibility and adaptability and so more chances and probabilities of being successful.

This path ultimately summarizes the birth of life on Earth, further diversifying life and life-forms, re-claiming the complementary relationship between organic and inorganic. We are thus the godfathers of this new, wholly natural, genesis. There are many questions that could be posed and some of them are intriguing. Why all this originated from our species? And why from the symbolic dimension? To what extent shall we assemble, manage, and give direction to these new "intelligences"? Will symbols have a guiding role for these "intelligences", or shall they be a mere vestige of the past?