Towards an Evolutionary Epistemology

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Abstract

This work concerns a non-traditional approach to logic and epistemology, based on a challenging, albeit conjectural, articulation of views proceeding from Evolutionary Psychology and Biology, Non-Monotonic and Decision Logics, and Artificial Intelligence. The hinges to the latter inevitably suggest the emergence of an innovative symbiotic form of evolutionary epistemology.

1. Evolution and the Brain

The first bipedal primates establish the separation between the human species and the other simians. To fathom the abilities of the human brain it is necessary to understand what exactly the problems our ancestor primates were trying to solve that led them to develop such an extraordinarily intricate brain. We cannot look at the modern human brain, and its ability to create science, as if the millions of evolution-years which attuned it to its present configuration had never taken place. Among the eventual problems we certainly have those of status, territorialism, mating, gregariousness, altruism versus opportunism, the building of artifacts, and the mappings of the external world.

To *Homo Sapiens Sapiens*' brain, considered indistinguishable from our current one, we assign an estimated age of one or two hundred thousand years. The Palaeolithic started at about 60 or 30 thousand years before that, the period in which language, and much later writing, began to develop. By the Upper Palaeolithic times however, from 40,000 to 10,000 before the present, the tempo of cultural evolution quickened dramatically. According to the theory of population genetics, most of the change was far too fast to be tracked closely by genetic evolution.

As the psychiatrist must look at a patient's past in order to better understand him in the present, so must we look also at our species' past in order to understand our modern peculiarities. This stance is called Evolutionary Psychology - a fascinating field of study - born some 40 years ago. It is a consummate example of successful ongoing scientific unification, engendered by a deeply significant combination of Psychology, Anthropology, Archaeology, Evolutionary Biology, Linguistics, Neurosciences, and Artificial Intelligence (David M. Buss, 2005). Evolutionary Psychology has been studying the brain from the evolutionary perspective, thereby originating some extremely relevant contributions. In that perspective, it has been strongly supported by Anthropological Archaeology in its empirical study of the cultural evolution of mankind (Stephen Shennan, 2002).

2. Evolutionary Psychology: Genes and Memes

In human life, we have two reproductive mechanisms: one is sexual reproduction, in which the replication unit is the gene; the other is mental reproduction. Some authors from Evolutionary Psychology have construed the notion of "meme", in complement and contrast to that of gene. A meme is that which substantiates a second reproductive system executed in the brain. It is the mental unit corresponding to the gene. Memes gather in assemblies, in patterns, similar to the way genes gather in chromosomes. Memes are patterned by ideologies, religions, and common sense ideas. Indeed, certain memes work well together, mutually reinforcing each other, others not, so that correcting (and correctional) mechanisms may be triggered.

We have a genetic reproduction system and, on top of it, Nature - through evolution - has created a second one, which we employ in pedagogy. We reproduce ideas: generally, good ideas propagate and replicate, being selected over the bad ones, although no one is around to guarantee it. Genes persist because they reproduce, and memes are the reproduction units associated with the brain - the brain being a reproductive organ. What we are doing, in schools and universities, is to reproduce knowledge. Educational systems consist of a means for "infecting" students with good memes, ideas having proven themselves able enough to self-reproduce and persist, while despising others that fail to survive. There are many educational systems variants, for instance madrasas.

When people interact they communicate ideas, and those which are infectiously good tend to reproduce. There are assemblies of ideas, sets of beliefs, which reproduce together. The memes in such memeplexes - like the genes in chromosomes - are in competition amongst themselves and also with the gene base. They exist because they are part of a reproductive mechanism which is necessary to achieve faster local adaptations, as genes take too long to reproduce with respect to the time scale of the individual bearing the memes. Thus the individual phenotype may be given more of a chance to reproduce its genotype. This leads directly to the meme-gene co-evolution.

Memes however could not spread but for the biologically valuable tendency of individuals to imitate, something afforded by the brain. There are plenty of good reasons why imitation should have been favoured by conventional natural selection working on genes. Individuals that are genetically predisposed to imitate enjoy a fast track to skills that may have taken others a long time to build.

Consequently, the brain and its accompanying mind are the result of a deep symbiosis, a genetic product influenced by the mechanism of memetic reproduction. In this faster system of adaptation we have reached the point of being able to predict our own memetic (and genetic) mutations, as necessary changes to prepare for the future by anticipating it. That is why we imagine the future - we create hypothetical scenarios, predict the possible futures, and choose to pursue some of them.

However, beyond simple reproductive success there are also pressing concerns in regard to social interaction. As communal beings, we need to develop some sort of status in order to be respected, copied, or obeyed. We must worry about territorial expansion and its defence, if we are to have descendants and, moreover, descendents with descendents. We need to sign contractual agreements with those who share our social and cultural ecology. There is also the important requisite of personal expression opportunity. If we do not express ourselves, no one will copy even our dearest memes, let alone our scientific theory memeplexes.

In this view, scientific thought emerges from distributed personal interaction, albeit it at a special and temporal distance, and never in an isolated way. It must be erected from several confluences, or in teams, as is the case in science. In truth, knowledge is not constructed in an autonomous way; rather it is engendered by networks of people. In science it is important to work as a team. The stereotype of the isolated and enlightened aristocratic scientist has been defeated for quite some time: science is institutionalized, organized and has proper methodologies, conferences. It is processed in appropriate environments, one being the educational one, in which we carry out *memetic* proliferation.

3. Specific Modules versus General Intelligence

Theoretical and field archaeologists, like Steven Mithen in *The Prehistory of Mind* (1996), are bringing in historical and pre-historical evidence that our ancestors began with a generic intelligence, such as we find in apes. There has been a broad discussion - in fact reproduced within the Artificial Intelligence (AI) community - about whether intelligence is a general functionality or else best envisaged as divided into specific ability modules or components. When it first appeared, Evolutionary Psychology developed a trend, which Chomsky had begun in insisting on innate specialized areas for language processing in the brain, and it was generally accepted that a plethora of specific modules for a diversity of certain brain functions do exist. Indeed, in the beginnings of Evolutionary Psychology, the likes of Steven Pinker, Leda Cosmides, John Tooby, and David Buss, in consonance with AI's own vision of specific modules, believed all brain function to be founded on such modules - for language, for mating, religion, etc.

Meanwhile, archaeologists have demonstrated, via historical record, that human species went from a first phase of general intelligence to a second phase of three major specialized modules: one for natural history and naive physics (knowledge of Nature); the one for knowledge and manufacture of instruments; and one for cultural artifacts, i.e. the rules of living in society and the very politics of coexistence.

These three specialized intelligences were separated, and it is only at a newer stage - corresponding to *Homo Sapiens*, with the appearance of spoken language - that it becomes necessary to have a cupola module, articulating the other ones. How else do the different specialized modules connect, and how can people communicate among themselves? That need gave birth to the generic cupola module, a more sophisticated form of general intelligence, the cognitive glue bringing the specialized modules to communicate and cooperate.

4. The Evolution of Reason: Logic

The formal systems of logic have ordinarily been regarded as independent of biology, but recent developments in evolutionary theory suggest that biology and logic may be intimately interrelated. William S. Cooper (2001) outlines a theory of rationality in which logical law emerges as an intrinsic aspect of evolutionary biology. This biological perspective on logic, though at present unorthodox, could change traditional ideas about the reasoning process (Robert Hanna 2006).

Cooper examines the connections between logic and evolutionary biology and illustrates how logical rules are derived directly from evolutionary principles, and therefore have no independent status of their own. Laws of decision theory, utility theory, induction, and deduction are reinterpreted as natural consequences of evolutionary processes. Cooper's connection of logical law to evolutionary theory ultimately results in a unified foundation for an evolutionary science of reason. According to Cooper, today, in the general drift of scientific thought, *logic* is treated as though it were a central stillness. For the most part, the laws of logic are taken as fixed and absolute. Contemporary theories of scientific methodology are logico-centric. Logic is seen commonly as an immutable, universal, meta-scientific framework for the sciences, as for personal knowledge. Biological evolution is acknowledged, but it is accorded only an ancillary role, as a sort of biospheric police force, whose duty is to enforce the logical law among the recalcitrant. Logical obedience is rewarded and disobedience punished by natural selection, it is thought. All organisms with cognitive ability had better comply with the universal laws of logic on pain of being selected against!

Comfortable as that mind set may be, Cooper believes he is not alone in suspecting it has things backward. There is a different, more biocentric, perspective to be considered. In the alternative scheme of things, logic is not the central stillness. The principles of reasoning are neither fixed, absolute, independent, nor elemental. If anything, it is the evolutionary dynamic itself that is elemental. Evolution is not the law enforcer but the law giver - not so much a police force but a legislature. The laws of logic are not independent of biology but implicit in the very evolutionary processes that enforce them. The processes determine the laws.

If the latter understanding is correct, logical rules have no separate status of their own but are theoretical constructs of evolutionary biology. Logical theory ought then in some sense to be deducible entirely from biological considerations. To paraphrase, the hypothesis is that the commonly accepted systems of logic are branches of evolutionary biology. Indeed, evolution has provided humans with symbolic thought, and symbolic language communication abilities. Objective common knowledge requires thought to follow abstract, content independent rules of reasoning and argumentation, which must not be entirely subjective, on pain of making precise communication and collective rational endeavour impossible. Such rules have become ingrained in human thought, and hold an enormous joint survival value. In human cognitive evolution, both mimetic knowledge (such as that inherent in reality-simulating maps and models), and imitation knowledge (such as that present in ritual observation, or in artefact reproduction), were essential first steps towards socially situated, joint rule following behaviour, required by, say, hunting plans.

Decision theory is the branch of logic that comes into most immediate contact with the concerns of evolutionary biology. They are bound together by virtue of their mutual involvement in behaviour. The logic of decision is concerned with choices regarding the most reasonable courses of action, or behavioural patterns. Behaviour is observable, it is amenable to scientific prediction and explanation, and there is the possibility of explaining it in evolutionary terms. This makes behaviour an interdisciplinary bridge approachable from both the biological and the logical sides. Ultimately, behaviour is the fulcrum over which evolutionary forces extend their leverage into the realm of logic. Viewed through the lenses of biology, favoured behaviour is evolutionary fit. Through the lens of logic it is rational decision behaviour (Cooper, 2001), according to rules for reasoning and rules for action.

On the heels of rational group behaviour, throughout human cultures there emerged abstract rule following social games. Game rules encapsulate concrete situation defining patterns, and concrete situation-action-situation causal sequencing, which mirrors causality-obeying physical reality. From games, further abstraction ensued, and there finally emerged the notions of situation-defining concepts, of general rules of thought and their chaining, and of legitimate argument and counter-argument moves. Together they compose a cognitive meta-game (John Holland, 1998).

The pervasiveness of informal logic for capturing knowledge and for reasoning, a veritable *lingua franca* across human languages and cultures rests on its ability to actually foster rational understanding and common objectivity. Crucially, objective knowledge evolution dynamics, whether individual or plural, follows ratiocination patterns and laws. Furthermore, and more recently, the very same rules of reasoning can and are employed to reason about reasoning. Moreover, new reasoning methods can and have been invented and perfected throughout human history. Examples of these are transfinite induction, *reductio ad absurdum* (proof by contradiction), recursion, abduction, and contradiction removal, to name but a few.

Though some reasoning methods are well known, some are still unconscious but, like the rules of grammar, can be discovered through research. Indeed, humans can use language without learning grammar. However, if we are to understand linguistics, knowing the logic of grammar, syntax and semantics is vital. Humans do use grammar without any explicit knowledge of it, but that doesn't mean it cannot be described. Similarly, when talking about the movement of electrons we surely do not mean that a particular electron knows the laws it follows, but we are certainly using symbolic language to describe the process, and it is even possible to use that description to implement a model and simulation which exhibits precisely the same behaviour.

New purported reasoning methods may be disputed, just like any specific train of reasoning can. But reasoning can only be disputed by further reasoning, if any consensus is to be found! (Thomas Nagel, 1997). Some argue that scientific and philosophical discussion is necessarily a tantamount to a culture sensitive, and culturally relative, persuasive informal *ad hoc* argumentation, allied to anything goes rhetoric (criticized by Paul Gross, Norman Levitt, 1994). They ignore that argumentation is just another form of reasoning which has itself been made the subject of logical formalization, and are oblivious to the fact that rhetoric may be fine for preachers, but is not conducive to the two-sided communication required to reach common agreement in the all rigorous scientific praxis that lead to cumulative knowledge.

Logic, we sustain, provides the overall conceptual cupola that, as a generic module, fluidly articulates together the specific modules identified by evolutionary psychology. In that respect, it is mirrored by the computational universality of computing machines, which can execute any program, compute any computable function.

The relationship of this argument to logic is ensured by the philosophical perspective of functionalism: logic itself can be implemented on top of a symbol processing system, independently of the particular physical substrate supporting it. Once a process is described in logic, we can use the description to synthesize an artefact with those very same properties. As long as it is a computational model, any attempt to escape logic will not prove itself to be inherently more powerful.

On the other hand, there is an obvious human capacity for understanding logical reasoning, a capacity developed during the course of brain evolution. Its most powerful expression today is science itself, and the knowledge amassed from numerous disciplines, each of which with their own logic nuances dedicated to reasoning within their domain. All that has been learned empirically about evolution in general, and mental processes in particular, suggests that the brain is a machine assembled not to understand itself, but to survive. Understanding the mind at work, then, needs to be brought about by the methods of science.

5. Epistemic Tools

The canonical definition of objective scientific knowledge avidly sought by the logical positivists is not a philosophical problem nor can it be attained, as they hoped, simply by logical and semantical analysis. It is an empirical question too, that can be answered only by a continuing probe of the possible functionality of the thought process itself and its physical basis. In some cases, the cognitive tools and instruments of rationality will be found hardware independent. Even then, the appropriateness of their use in specific real circumstances and goals will need to be empirically determined. There is no universal one-size-fits-all epistemological recipe, but agreement can be had on the relative success of any given tool kit.

In any case, partial understanding may also be sought by building intelligent machines, functionalism coming to the rescue when positing that the material substrate is often not of the essence, that it suffices to realize equivalent functionality albeit over different hardware. Moreover, distinct functioning roads to the same behaviour may be had, thereby accruing to our understanding of what general intelligence means, toward their symbiotic entwining, the most recent step in evolutionary epistemology. Functionalism can only make that more adroit.

The most fruitful procedures will almost certainly include the use of Artificial Intelligence, theory and technique, aided in due course by the still embryonic field of artificial emotion, to simulate complex mental operations. This modelling system will be joined to an already swiftly maturing neurobiology of the brain, including the high-resolution scanning of computational networks active in various forms of thought.

With this background in mind, and namely the discussion about specialized modules and general intelligence, I would like to introduce at this point the informal notion of *cognome*, by analogy with genome, standing for an individual's particular structural combination of cognitive memes.

When consider scientific knowledge, if the computer processing of the human genome is what leads us to Bio-informatics then, by analogy, we may state that the cognome will be the basis of a future "Cognotechnology", applicable in any science. This way, the future of AI is connected to the characteristic of it being an epistemological instrument, not only for an autonomous agent, but a symbiotic one which will help humans in performing science itself.

And I'm not just talking about data mining, pattern recognition, ontology building, although in those fields we can approach more structured aspects of epistemology. I'm thinking about that which every scientist does, which is to abduce, invent and prophesy theories, put them to the test, create experiments, draw conclusions to support additional observations, discuss those observations and his conjectures with other scientists.

Veritably, the capacity for cognition is what allows us to anticipate the future, to pre-adapt and imagine scenarios of possible evolutions - of the world and of ourselves as cognitive agents - to make choices, to use preferences about some hypothetical worlds and their futures, and meta-preferences - preferences on which preferences to employ and how to make them evolve. The activity of prospecting the future is vital and characteristic of our species and its capacity to understand the real world and ourselves, living in society, where distributed cognition is the normal and regular way to do science. Prospective consciousness allows us to pre adapt to what will happen. For that, a capacity to simulate, to imagine "what would happen if", i.e. is hypothetical thinking, becomes necessary. Such thinking is indispensable in science; for it gives us the rules to predict and explain what will or can happen, without which technology would not be possible.

How does natural selection anticipate our future needs? Well, by creating a cognitive machine called brain that can create models of the world, and even of itself, and process hypotheticals much like a Universal Turing Machine can mimic any other Turing machine, and just like any given computer can run any program. This plasticity provides for its universal versatility (cf. Martin Davis, 2000).

Lately, I've been working towards automating this capacity, by implementing programs which can imagine their futures, making informed choices about them, and then modify themselves to enact those choices - the inklings free will. We call it prospective computing (Gonçalo Lopes, Luís Moniz Pereira, 2006).

There is an ongoing meta-argumentation about what is good reasoning, what are the conclusions we can draw from a discussion (i.e. a semantics), which is inherent to all scientific activity. The computer will be used more and more as a research aide, not just to automate but also propose experiences and hypotheses and, in the end, by making our own conceptions on epistemology application repeatable and externalized it will make them more objective too.

Epistemology will eventually have the ability to be shared, be it with robots, aliens or any other entity who must needs perform cognition to go on existing and program their future. Creating situated computers and robots means carrying out our own cognitive evolution by new means. With the virtue of engendering symbiotic, co-evolving, and self-accelerating loops. Computerized robots reify our scientific theories, making them objective, repeatable, and part of a commonly constructed extended reality, built upon multi-disciplinary unified science. Artificial Intelligence and the Cognitive Sciences, by building such entities, provide a huge and stimulating step towards furthering that construction. To this end, the functionalist stance is most helpful.

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