

Eco-Cognitive Computationalism

From “Mimetic Minds” to Morphology-Based Enhancement of “Mimetic Bodies” †

Lorenzo Magnani^{1*}

¹ Department of Philosophy and Computational Philosophy Laboratory, University of Pavia, Pavia, Italy; lmagnani@unipv.it

† Presented at the IS4SI 2017 Summit DIGITALISATION FOR A SUSTAINABLE SOCIETY, Gothenburg, Sweden, 12-16 June 2017. Symposium on Morphological Computing and Cognitive Agency.

Published data: 9 June 2017

Abstract: Eco-cognitive computationalism sees computation as active in physical entities suitably transformed so that data can be encoded and decoded to obtain fruitful results. Turing’s original intellectual perspective first of all clearly depicted the evolutionary emergence in humans of information, meaning, and of the first rudimentary forms of cognition, as the result of a complex interplay and simultaneous coevolution, in time, of the states of brain/mind, body, and external environment. At the same time it furnished the conceptual framework able to show how thanks to an imitation of the above process the subsequent invention of the Universal Practical Computing Machine is achieved, that computer that in the perspective offered by Turing I call “mimetic mind”. It is by extending this framework that I think we can limpidly see that the recent emphasis on the simplification of cognitive and motor tasks generated in organic agents by morphological aspects implies - in robotics \neg - the need not only of further “computational mimesis” of the related performances - when possible - but also the construction of appropriate “mimetic bodies” able to render the accompanied computation simpler, according to a general appeal to the “simplicity” of animal embodied cognition.

Keywords: Mimetic minds, mimetic bodies, eco-cognitive computationalism, morphology.

Extended abstract

Eco-cognitive computationalism sees computation as active in physical entities suitably transformed so that data can be encoded and decoded to obtain fruitful results. When physical computation is seen in the perspective of the ecology of cognition it is easy to understand Turing’s original ideas concerning the emergence of information, cognition, and computation in organic, inorganic, and artefactual agents. Turing’s speculations on how the so-called “unorganized brains” are transformed in organized “machineries” are very important. Brains are of course continuous systems that can be treated as discrete systems able to perform “discrete” computations, so that we can describe the possible states of these brains as a discrete set, with the motion occurring by jumping from one state to another. Turing clearly says: “The cortex of an infant is an unorganized machinery, which can be organized by suitable interference training. The organization might result in the modification of the machine into a universal machine or something like it. [...] This picture of the cortex as an unorganized machinery is very satisfactory from the point of view of evolution and genetics” [1]. This intellectual perspective first of all clearly depicts the evolutionary emergence of information, meaning, and of the first rudimentary forms of cognition, as the result of a complex eco-cognitive interplay and simultaneous coevolution, in time, of the states of brain/mind, body, and external environment. At the same time it furnishes the conceptual framework able to show how thanks to an imitation of the above process the subsequent invention of the Universal Practical Computing

Machine is achieved, as the externalization of computational capacities in those artefactual physical entities that compute for some human or artefactual agents: those computers that in this perspective offered by Turing I called “mimetic minds”.

Turing on the emergence of information, cognition, and computation in organic, inorganic, and artefactual agents. Aiming at building intelligent machines Turing first of all provides an analogy between human brains and computational machines. In [1] he maintains that “[...] the potentialities of human intelligence can only be realized if suitable education is provided”. The concept of unorganized machine is then introduced, and it is maintained that the infant human cortex is of this nature. The argumentation is indeed related to showing how such machines can be educated by means of “rewards and punishments”. *Unorganized machines* (and also *paper machines*) are listed among different kinds of existent machineries:

- (*Universal*) *Logical Computing Machines* (LCMs). A LCM is a kind of discrete machine Turing introduced in 1937 that has an infinite memory capacity obtained in the form of an infinite tape marked out into squares on each of which a symbol could be printed. The importance of this machine resorts to the fact that we do not need to have an infinity of different machines doing different jobs. A single one suffices: it is only necessary “to program” the universal machine to do these jobs.

- (*Universal*) *Practical Computing Machines* (PCMs). PCMs are machines that put their stored information in a form very different from the tape form. Given the fact that in LCMs the number of steps involved tends to be enormous because of the arrangement of the memory along the tape, in the case of PCMs “[...] by means of a system that is reminiscent of a telephone exchange it is made possible to obtain a piece of information almost immediately by ‘dialing’ the position of this information in the store” [1]. Turing adds that “nearly” all the PCMs under construction have the fundamental properties of the Universal Logical Computing Machines: “[...] given any job which could have been done on an LCM one can also do it on one of these digital computers” [1] so we can speak of Universal Practical computing Machines.

I will take advantage in my presentation of the concept of unorganized brain (and machine) to stress the historical/epistemological interest of Turing’s discoveries. Unorganized Machines are largely random in their constructions. Infant brains too can be seen as unorganized machines and are organized through education. Brains very nearly fall into this class [discrete controlling machinery – when it is natural to describe its possible states as a discrete set] and there seems every reason to believe that they could have been made to fall genuinely into it without any change in their essential properties. However, the property of being “discrete” is only an advantage for the theoretical investigator, and serves no evolutionary purpose, so we could not expect Nature to assist us by producing truly “discrete brains”. Education in human beings can model “education of machinery” “Mimicking education, we should hope to modify the machine until it could be relied on to produce definite reactions to certain commands”. A graduate has had interactions with other human beings for twenty years or more and at the end of this period “[...] a large number of standard routines will have been superimposed on the original pattern of his brain” [1].

Computing machine as the “externalization” of computational capacities in artefactual physical entities that compute for some human or artefactual agents. Research in distributed cognition established that we humans delegate cognitive (and epistemic, moral, etc.) roles to externalities and then tend to “adopt” and recapitulate what we have checked occurring outside, over there, after having manipulated – often with creative results – the external invented structured model. A simple example: it is relatively neurologically easy to perform an addition of numbers by depicting in our mind – thanks to that brain device that is called visual buffer – the images of that addition thought as it occurs concretely, with paper and pencil, taking advantage of external materials. Mind representations are also over there, in the environment, where mind has objectified itself in various semiotic structures that mimic and enhance its internal representations. Turing adds a new structure

to this list of external objectified devices: an abstract tool, the (Universal) Logical Computing Machine (LCM), endowed with powerful mimetic properties. The creative “mind” is in itself extended and, so to say, both internal and external: the mind is semiotic because transcends the boundary of the individual and includes parts of that individual’s environment, and thus constitutively artificial. Turing’s LCM, which is an externalized device too, is able to mimic human cognitive operations that occur in that interplay between the internal mind and the external one. Indeed Turing already in 1950 maintains that, taking advantage of the existence of the LCM, digital computers (as external physical appropriate objects) can be constructed, and indeed have been constructed, and they can in fact mimic the actions of a human computer very closely. In the light of my perspective both (Universal) Logical Computing Machine (LCM) (the theoretical artifact) and (Universal) Practical Computing Machine (PCM) (the practical artifact) are mimetic minds because they are able to mimic the mind in a kind of universal way (wonderfully continuing the activity of the so-called “disembodiment of the mind” and of semiotic delegations to the external materiality our ancestors rudimentary started).

Computational mimesis of morphological aspects, mimetic bodies, simplicity. It is in the framework I have just described that we can limpidly see – naturally extending Turing’s perspective - that the recent emphasis on the simplification of cognitive and motor tasks generated in organic agents by morphological aspects implies - in robotics – the need not only of further computational mimesis “à la Turing” of the related performances - when possible - but also the construction of appropriate “mimetic bodies” able to render the accompanied computation simpler, according to a general appeal to the “simplicity” of animal embodied cognition.

References

1. Turing, A.M., Intelligent machinery [1948]. In: Meltzer, B., Michie, D. (eds.) *Machine Intelligence*, vol. 5, pp. 3–23. Edinburgh University Press, Edinburgh (1969)



© 2017 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>)