Polymorphic Intelligence

Luigi Pagliarini

Maersk Mc-Kinney Moller Institute
University of Southern Denmark, Campusvej 55, 5230 Odense M., Denmark

luigi@mip.sdu.dk
www.adaptronics.dk

Abstract

The need of defining a multiple, multifaceted and *Polymorphic Intelligence* concept comes up as a possible answer to many 'false' paradigms and philosophical and conceptual orientations that, recently, pervade many research fields, as psychology, pedagogy, literature, art, and, of course, science, technology and A.I.
Indeed, in this exact moment of human history, it becomes necessary to clarify with a strong theoretical construct in which relationships are machines and humans, without compromises. We need to free our thoughts from ambiguities and face a new definition of mind and intelligence.
The first step to take consists in burring the idea of *human-machine interaction* or *interaction design* – basically these two terms are out of times – to move on and start thinking of a *human-machine interrelation.* It has become necessary to abandon the scheme that the *constructive* (and, symmetrically, destructive) intelligence is an exclusive prerogative of the humans (or, more in general, biological), to fully recognize, admit, and capacitate ourselves that artefacts are able to create, to express a real collaborative and/or competitive force and to produce ideation, inspiration and to contribute to the wealth of ideas that are about to take part of our own world, and our own existences.

Introduction

Being conscious of our own final goals is one of the most important rule to follow to achieve good results while conceiving and implementing ideas. On the opposite, it is our feeling that for much too long A.I. researchers and experts when focusing on 'how to make a machine intelligent' or 'intelligent as humans and other life forms are' have been keeping in their mind the "wrong" target. It is not a case, indeed, that the word *intelligence*, itself, has gained dozens additional meanings and has had to incorporate so many extra aspects (either in psychology, literature and science) that today one could almost rename it as "*everything*". Of course, this overall tendency is not as good as we would expect since it is leading to a neutral and senseless portrait of what, on the opposite, should be the core-business of our philosophical and technological research.
Further, and more specifically, in the robotics and AI fields the inheritance of *old* paradigms, ideas and approaches seems to be strangling the upcoming needs for a new definition of human-machine *interaction* based at the moment on a sort of human-machine *extraneity*.
Unfortunately, these ideas originated from few, but very popular, scientific, philosophic and artistic theoretical constructs has been simply prejudicing and polluting the entire domain of human thought and the way we've been thinking about intelligent artefacts in the last century.

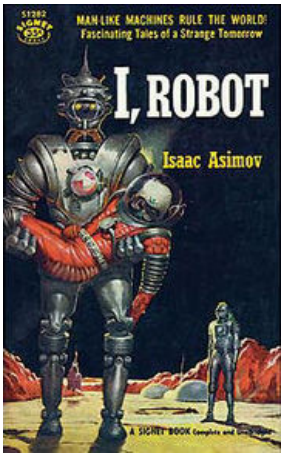

Figure 1. One of the first editions of the famous Isaac Asimov's *I, Robot* [2].

Amongst all, the most *dangerous and mining* were those theories popping out of the Turing's [1], Asimov's [2], Orwell's [3] manuscripts where, paradoxically, the distance between humans and machines is thought as absolute. Their notion of machines (and therefore *machine-intelligence*) is of a somehow isolated *external*

device, while the relationship they thought we could build is extrinsic, either physically and mentally. In our opinion, such an idea is to be demolished because generates a conceptual and structural approach to machine-thinking *disintegrated* to what is to be considered the human specie evolution. Indeed, since years now, humans and machines share the same spaces either physical and geographical, or cerebral and virtual and, in other words, machines are an integrated part of our *Ego* or, at least, part of our own world and everyday life.

To overcome the old way of thinking modern artifacts it seems to be necessary to step back to old schemata typical of Oriental, Indian or Native American cultures and integrate them with most recent western psychological and philosophical theories like those postulated by G. Bateson [4] in "*Steps to an Ecology of Mind*", or by J. Gibson [5] in "*The ecological approach to visual perception*", theories that can be seen as the bases for "Ecological Psychology" [6] or "Environmental Psychology" [7]. In short, the idea that lays behind these theories is that the whole world takes part in our own computational brain, and intellectual potentialities, and is an important component of our motor and sensory systems. If so, it would become essential for those who deal with AI and Robotics to inherit the Bateson's [4] principle for which the "blind man stick is part of his sensory-motor system of his brain associative areas, and of his mind", and facing the idea that artefacts might be integral part of our abilities of elaboration, besides perception and action. Of course, this has been true for centuries but, recently, also thanks to the IT sophistications and worldwide information digitalization, is becoming unequivocal.

Indeed, while modern *Psychotechnologies* [8] differentiate from the traditional ones - motor (e.g. bicycle) and sensory (e.g. telescope) – and accordingly with the famous De Kerckhove [9] classification, include radio, television (i.e. connectivity) and, overall, computers and Internet (i.e. interconnectivity) it is to be noticed that nowadays many automations, more than an integrative processes, are pervasive ones or, even further, are substituting human cognitive process, even at high-level, like for example creativity and problem solving.

Now, although all of that has become truth it seems that we are not fully conscious of the changes that are taking place, and while we easily understand that the mobile phones agenda are replacing part of our long-term memory functionality we find it harder to catch how the famous "cut&paste" or "undo" or "T9text input" are changing the way we write and, therefore, think and communicate. In short, the symbolic system we are inheriting by the electronic culture is affecting our minds and is likely to engrave up to the revolution of our entire semeiotic system.

In addition, elements like hypertexts, global searches, internet maps, GPS, wearable computers, autonomous robotics, and so on represent an increasing number of functions the biological brain is enriched with and, in parallel, delegating to machines. In other words, these artifacts are the witnesses of the idea of restructuring to which the same brain is pushed to, while they also represent the increasing level of "*dependency*" the human intelligence is destining to machine themselves. One practical example might be seen in the recent growth of such disciplines as *Psychogeography* [10] (i.e.: how to create geographical maps linked to humans emotional experiences) or tools like *Brain Training* [11].

Essentially, intelligence as doubled its evolution speed and hugely enlarged its domains. That's happening because, besides the natural genetic evolution, intelligence is evolving as definition as well. This is due to both the power the new technological achievements to improve our ability of self observation (and self-consciousness), and to the fact that our minds are themselves influenced by the advent of "intelligent" artifacts. Indeed, as G. Rizzolati pointed out with is *Mirror Neurons* [13] theory humans mostly learn by imitation. Of course, we all - computer scientists, AI and Robotics experts – use that knowledge to apply it to machine learning, but we must notice that by doing so we have initiated a never ending loop in which learning and teaching is somehow simultaneous (in terms of a society extended to intelligent machines). These facts, are taking us straight to the first forms of hybridized intelligences. Last but not the least, intelligence evolves in a new dimension since the latest artificial apparatuses have started creating intelligence, thinking and metacognition, themselves.

To summarize, if on one side it is very easy to predict that - as affirmed by the lucid Alexander Chislenko's analysis [12] - "the ability of future machines to directly share experiences and knowledge with each other will lead to evolution of intelligence from relatively isolated individual minds to highly interconnected structural entities" and that "the development of a network of communicating mobile and stationary devices may be seen as a natural continuation of biological and technological processes leading to a community of intentionally designed and globally interconnected structures", on the other hand, what is much harder to

comprehend to us is that the human brain is not extraneous to all of that but, on the contrary, it gets deeply influenced by A.I. in action. Part of that is what we can call the Polymorphic Intelligence.

Polymorphic Intelligence

As far as we know, humans are the most "intelligent" organisms since their brain functions are complex and sophisticated at the very same time. Indeed, when in *Frames of Mind* [14] the psychologist and neurologist Howard Gardner tried to define intelligence he came out with seven different substructures:

1. *Linguistic intelligence* (sensitivity to spoken and written language);
2. *Logical-mathematical intelligence* (the capacity to analyze problems logically, carry out mathematical operations, and investigate issues scientifically);
3. *Musical intelligence* (encompasses the capacity to recognize and compose and perform music);
4. *Bodily-kinesthetic intelligence* (the potential of using one's whole body or parts of the body to solve problems);
5. *Spatial intelligence* (the potential to recognize and use the patterns of wide space and more confined areas);
6. *Interpersonal intelligence* (the capacity to understand the intentions, motivations and desires of other people);
7. *Intrapersonal intelligence* (the capacity to understand oneself, to appreciate one's feelings, fears and motivations).

Certainly, also thanks to such a refined biological evolution of their computational functions it has become possible to human beings to reach an high level of social and technological evolution that, only recently, is flowing to such a stage that might be defined as the *intelligent machines age*. Amongst us few great artists (e.g. W. Shelley [15]; G. Orwell [16]; P.K. Dick [17]) , many years ago, envisioned we were about to get to this point and consequently depicted a possible scenario to try to prevent the moral and the ethical decay of our societies and specie. In particular, Asimov [2] who tried to define the three famous A.I. constrains:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

So, while artists were anticipating crucial philosophical goals for the future human-machine relationship, on the other side, many different scientists were defining practical objectives. Amongst them a special mention goes to A. Touring who tried to define through the famous *Turing Test* [1] the meaning of A.I.

1. A human judge engages in a natural language conversation with two other parties, one a human and the other a machine; if the judge cannot reliably tell which is which, then the machine is said to pass the test.

For what came later all these conceptual paradigms were very significant for any further theoretical development and worked as lighthouses for thinking about AI.

Despite that, as it often happens in the history of ideas, what was a fundamental and inspiring landmark in the past might represent an obstacle for further evolutions, and, most likely, either Asimov's and Turing's (and other authors) principles today are still being followed too much and believed, while they actually seem to be fully out of time.

Figure 2. The *Atron* modules [20].

Things have changed because, since then, the definition of AI itself has changed. Indeed, it is clear how the Touring Test has been surmounted and AI is moving towards the idea of *Collective Intelligence* - e.g. Swarm

[18], Boids [19] – as well as that robotics is moving away from the basic concept of mono-shaped body structure and the 'prison' of its canonical aspect – e.g. *Atron* [20], *RoboMusic* [26].

Even more, A.I. has started opening to such problems like interfacing humans, hence taking us to a *Polymorphic Intelligence* state where Artificial Intelligences deeply interacts with biological ones. This is occurring at all levels. In virtual worlds (SecondLife [21], Gazira Babeli [22] and Marco Cadioli [23]) in real world (MipTiles [24], I-BLOCKS [25], RoboMusic [26]), and in mixed realities (Stelarc [27]; Talkers [28]; Ambient Addition [29]).

Figure 3. Stelarc [27]. *ExoSkeleton*

In other words, what is happening is that we cannot point at A.I. as the result of a single, linear artificial process but, on the opposite, the new picture tells us of a multidimensional non-linear process which is difficult to handle and, more or less, impossible to fully control. Things get even more complex when, instead of the old fashioned interactivity (i.e. the switch on activate/deactivate rule) we insatiate a run-time multi interactive dynamic (i.e. interrelation) with a single 'specie' of AI artefacts or even "worse" a multitude of them, simultaneously. Obvious enough, the outcome is a scenario where the Asimov's laws largely looses sense since machines themselves are loosely controllable (i.e. often dealing with non-linear maths and non-complete problems) and largely interconnected and therefore non directly responsible of the general system outputs. In this perspective, we both need to renew our methods and move from the idea of *Human-Machine Interaction* (or *Interaction Design*) to the concept of *Human-Machine Interrelation* where the basic principles of interactivity are a bit more aleatory or, at least, less predictable and, even more important, are completely different from what we have been dealing with in the past, since the interactive procedure moves from a one way to a bidirectional intelligence flow.

Indeed, what we will call here the *Imitational Intelligence*, a factor, neglected by the Howard theory [14] but indirectly consecrated by the Rizzolati's recent discovery, seems to be a crucial issue that must be taken into consideration and that will play a large role in future human-machine theories. Theories that, inevitably so, will lead us towards a new conceptualization of the meaning of Intelligence as a domain hybridized by machine and therefore Polymorphic.

Conclusion

When looking at all ideas and definitions of AI and Robotics of the last centuries it becomes evident that there is something wrong regarding the philosophical approach that has been developed in the so called *machine* (or android, or cyborg, or robot) *thinking*. What seems to be missing is the idea of feedback that machine intelligence impose to biological intelligence therefore creating brand new forms of intelligence (either natural and artificial) that we define as *Polymorphic Intelligence* and that might be leading the way we will approach AI in the next future.

Acknowledgements

All the Adaptronics Group and, in particular, Prof. Henrik H. Lund and Vibeke Nielsen for the great support given in my Danish research activities. Sergio Lombardo for the precious conversations and the support of my researches in Art Psychology. Salvatore Iaconesi for the feedbacks and the English revision of the manuscript. All the Artificialia staff for the valuable research made along the years on the topic.

References

[1] S. Harnad (2004) *The Annotation Game: On Turing (1950) on Computing, Machinery, and Intelligence*, in Epstein, Robert and Peters, Grace, Eds. The Turing Test Sourcebook: Philosophical and Methodological Issues in the Quest for the Thinking Computer. Kluwer

[2] I. Asimov, (1950). *I, Robot*. New York: Doubleday & Company

[3] G. Orwell (1949). *Nineteen-Eighty-Four*. London: Secker & Warburg. (later ed. ISBN 0-451-52493-4)

[4] G. Bateson, (2000), *Steps to an Ecology of Mind*, Chicago: University of Chicago Press
[5] J. J. Gibson (1979), *The Ecological Approach to Visual Perception*, Boston: Houghton-Mifflin.
[6] R. G. Barker, (1968), *Ecological Psychology: Concepts and methods for studying the environment of human behavior*, Stanford University Press, Palo Alto, CA.
[7] P. Bell, T. Greene, J. Fisher, & A. Baum (1996). *Environmental Psychology*. Ft Worth: Harcourt Brace.
[8] M. Cardaci (2004) *Psicotecnologie e cognizione*. In: Immagini della emergente società in Rete. S.Martelli e S. Gaglio (a cura di) Franco Angeli (pp.169-171).
[9] D. de Kerckhove (1991), *Leonardo*, Vol. 24, No.2, Connectivity: Art and Interactive Telecommunications, pp. 131-135.
[10] M. Coverley (2006). *Psychogeography*. Pocket Essentials.
[11] Dr. Kawashima (2006) *Brain Training: How Old Is Your Brain?* Nintendo DS.
[12] A. Chislenko (1996) *Networking in the Mind Age* http://www.lucifer.com/~sasha/mindage.html
[13] G. Rizzolati (2005), *The mirror neuron system and its function in humans*. Anat. Embryol., 210(5-6):419-21.
[14] H. Gardner (1993) *Frames Of Mind. The Theory Of Multiple Intelligences*.
[15] M. W. Shelley (1918), *Frankenstein*.
[16] G. Orwell (1948), *1984*.
[17] P.K. Dick (1968), *Do Androids Dream of Electric Sheep?*
[18] V. Grimm, (*1999*). *Swarm* http://www.swarm.org
[19] C. W. Reynolds (1987) *Flocks, Herds, and Schools: A Distributed Behavioral Model*, in Computer Graphics, 21(4) SIGGRAPH '87 Conference Proceedings. p. 25-34.
[20] H. H. Lund, R. Beck, L. Dalgaard, (2005). *"Self-Reconfigurable Robots with ATRON Modules"* In Proceedings of 3rd International Symposium on Autonomous Minirobots for Research and Edutainment (AMiRE 2005), Springer-Verlag, Fukui, 2005.
[21] *SecondLife*, http://www.secondlife.com;
[22] *Gazira Babeli*, http://www.gazirababeli.com;
[23] *Marco Cadioli*, http://www.internetlandscape.it/
[24] H. H. Lund, C. Jessen, K. Moeller, T. Klitbo, (2005) "*Playware - Intelligent technology for children's play*", short position paper to appear in Workshop on Metapolis and Urban Life, UbiComp 2005.
[25] Nielsen, J., and Lund, H. H. (2004) "*Building Blocks with Spiking Neural Networks*", Submitted to *European Symposium on Artificial Neural Networks (ESANN'2004)*, 2004.
[26] H.H. Lund, M. Ottesen, (2006). *RoboMusic*, http://www.e-robot.dk/robomusic.html
[27] *Stelarc*. http://www.stelarc.va.com.au/
[28] *Talkers*. http://www.artisopensource.net/talkers/
[29] N. Vawter (2006), *Ambient Addition* http://web.media.mit.edu/~nvawter/thesis/

Professor Luigi Pagliarini is psychologist, multimedia and software designer, expert in robotics, AI and Artificial Life, and artist. He is currently Associate Professor at Maersk Institute, University of Southern Denmark; Professor of Perception Theory and Psychology of Shape at the Academy of Fine Arts of Bari, Italy; Director of the Pescara Electronic Artists Meeting; President of the Cultural Association Artificialia; Art Director of Ecoteca Café; Member of the International Committee RoboCup Junior; Board Committee of "Rivista di Psicologia dell'Arte" (Journal of Psychology of Art); Member of EvoNet and Executive Member of EvoMusArt; Partner Consultant of Entertainment Robotics; Partner Consultant of the Visual Emotion - Video Productions. He has published in different international books, journals, congresses and conferences proceedings and has been rewarded with international prizes more than once. He has exhibited his work in different museums and institutions all over the world. Luigi Pagliarini has worked for many different institutes and universities as teacher or researcher and, as consultant, with many enterprises and multinational factories. His work has often been reported on many international newspapers, magazines and televisions.