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Machines that Dream: a New Challenge in Behavioral-Basic Robotics

Gilberto Marzano[a]*, Alessandro Novembre[b]

[a]*Rezekne Academy of Technology, Atbrivosanas aleja 115, Rezekne LV-4601, Latvia*
[b]*University of Salento, Piazza Tancredi 7, 73100 Lecce, Italy*

Abstract

The digital revolution is transforming contemporary society. Connective intelligence is an emerging property deriving from the embedding of intelligence into the connected data, concepts, applications, and people. Furthermore, the progress in behavioral-basic robotics opens new fields of innovative investigation.
In this challenging context, might it make sense to provide machines with dreaming-like functions? Indeed, machine inactivity can be assimilated to the sleep state of living beings. Furthermore, when dreaming, we can interact with what we take to be other individuals and things and, in certain respects, the same happens in the virtual world.
This paper highlights some new directions that have emerged in the field of Artificial Intelligence, focusing on the total Turing test and dreaming machines.

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1. Introduction

In the 1990s it was argued that software configurable hardware and software that accelerates the simulation of digital devices could be used to build, in the near future, machines that are capable of evolution[1].

Indeed, in those years, various forms of machine-simulated evolution were proposed, although doubts were also expressed as to their adequacy for real life contexts[2].

* Corresponding author. Tel.: +39 3357035566.
E-mail address: gilberto.marzano@ru.lv

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At the time, Calvin, an American theoretical neurophysiologist, suggested the implementation of an autonomous robot, the Darwin machine. In his short essay "The brain as a Darwin Machine"[3] Calvin argued that parallel computer simulation of human brain activity suggested that human beings would have a better claim on the title Homo seriatim than Homo sapiens, also due to the fact that humans are more consistently serial than wise. In accordance with this presumption, he hypothesized a machine that would have the capacity to chain together stochastic sequences of data following the analogous ways of Darwinian evolutionary biology. This machine was supposed by Calvin to be able to shape thoughts in milliseconds rather than millennia, using innocuous remembered environments rather than noxious real life ones.

Nowadays, the growth of information systems, and of the internet in particular, continues to inspire the parallel between the human brain and computer-based artificial systems[4,5]. Despite the fact that the market is currently oriented towards artificial systems that are still based on Newtonian physics and on the assumption that every element obeys simple and static rules, it has been observed that the experience of the internet and the progress made in robotics suggests a different way of designing the next-generation of information systems and robots[6,7,8]. Indeed, new information systems and robots might not be controlled but be self-organized as the result of autonomous and self-determining software or firmware agents.

This paper focuses on two issues related to the new wave of intelligent systems. The first concerns the Turing test and its revision in the light of the perspective of so-called Android science. The second reports on dreaming machines, an emerging research field that can stimulate new investigative perspectives, either in Artificial Intelligence (AI) or in cognitive and behavioural psychology.

2. Old and new intelligent systems

In the early 1960s, in an article illustrating the state of art of AI at the time, Minsky, the American cognitive scientist and co-founder of the Massachusetts Institute of Technology's AI laboratory, highlighted the lack of a generally accepted theory of intelligence[9].

Fifty years later, the definition of intelligence continues to be controversial[10], although considerable advances have been made in the cognitive sciences and in the five areas of AI that Minsky examined in his article: Search, Pattern-Recognition, Learning, Planning, and Induction.

However, something has changed in AI research over the past decades[11], particularly in the last few years[12]. Nowadays, the most current research focuses on specific scientific and engineering problems, and maintains a distance from the idea of performing the full range of human cognitive abilities. Furthermore, the research focuses on the interaction of programs and machines with the environment and with people.

Only a small number of researchers are now involved in so-called General Artificial Intelligence (AGI), whose aim is the development of programs and machines that can successfully perform any intellectual task that a human being can.

Recently, AI applications, notably in the form of neural networks and expert systems, can be found all around us. They are widely used in the fields of medicine, robotics, law, stock trading, etc., while intelligent programs are employed by the military, as well as in factories and homes. Moreover, experts forecast that, in the near future, speech recognition systems will be able to communicate with humans, both by text and voice, in unstructured English.

Due to the diffusion of the internet, a relatively new but expanding sector of current AI research is that of the Semantic Web. This will provide an infrastructure for allowing Web data to be used by a computer, making new powerful forms of information retrieval possible, as well as strengthening the fast-growing area of data mining, which is part of a process called Knowledge Discovery in Databases (KDD) that includes data selection, data cleaning, pre-processing of data, and data transformation.

Finally, the main changes in AI concern robotics and the attempt to simulate human social attitudes[13,14]. In traditional Artificial Intelligence, robot brains were conceived as serial processing units. The keystone was a Cartesian approach based on:

- Hierarchical organization of knowledge
- Symbolic manipulation
- Automatic reasoning
- Planning as problem-solving