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Editorial

Turing Learning Machines

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Alan Mathison Turing was born in London on June 23rd, 1912. In 1934, he graduated with top marks from King's College, University of Cambridge, and in 1936, he obtained his Ph.D. from Princeton University, located in New Jersey, USA. In 1940, he worked at Bletchley Park for the Communications Department, using the Colossus machine to decipher Nazi codes. After the war, he moved to the National Physical Laboratory in Teddington, near London. In 1947, he returned to the University of Cambridge, and in 1951, he went to the University of Manchester.

Turing is one of the founding fathers of computer science. He achieved theoretical results that profoundly influenced its development, including technology. He was the first to address the theme of artificial thought, launching a challenge called the "Turing test", which only recently has been passed by machines. The test is a conceptual experiment based on the "imitation game", very popular in his time. In Turing's version, a person asks questions to two other people (a man and a woman) trying to discover who the woman is and who is the man. Turing modified this game by replacing the woman (or man) with a machine and asking the questioner to find out who is the machine. Turing believed that if a machine could deceive a human, then the machine would be capable of thinking. Many have criticized this reasoning, stating that the only result of the experiment would be the phenomenological demonstration of the ability to deceive but not the ontological ability to think.

His 1950 paper, *Computing Machinery and Intelligence*, published in the journal *Mind*, begins with the famous question «*Can machines think?*» and with the proposal, provocative at that time, to use a simple test to answer. The article, very detailed and complex, contains a meticulous enumeration of potential opposing positions to his proposal. It ranges from the theological objection «*Thinking is a function of man's immortal soul*» to the mathematical one, to the one related to consciousness, up to extrasensory perception. Reading again his reasoning, one never ceases to discover details, insights, allusions.

The perhaps lesser-known part of the article is dedicated to «*Learning Machines*». In the last two years, the successes of artificial intelligence have been made possible by a particular technique called *Machine Learning*. Despite the linguistic similarity, the two concepts have a significantly different meaning. In the former, Turing describes the procedure to follow for the realization of a learning machine, and then to use for his test. The latter is a field of computer science developing computational models that can adapt with experience, which have recently demonstrated their enormous power and effectiveness.

After formulating his idea, to build a machine capable of imitating the human mind, Turing analyzes in detail the operational steps to realize such a machine. He starts from an observation that Lady Lovelace reports in her account of Charles Babbage's analytical machine «*The analytical machine has no pretentions to originate anything, it can do whatever we know how to order it to perform*», but he adds, perhaps unintentionally, a small but significant variation «*The machine can only do what we know how to order it to do it*». The following is an exciting crescendo of passages, in which he first hypothesizes the realization of a "child machine" «*Instead of trying to produce a programme to simulate the adult mind, why not rather try to produce one which simulates the child's?*» and then explains in minute details the learning process to which such a machine must be subjected. He concludes with a dry and opti-

mistic statement «*We may hope that machines will eventually compete with men in all purely intellectual fields*». Moreover, he qualifies this event as something positive, even beneficial for humanity, using the verb "hope". In subsequent years, other scientists have taken diametrically opposed positions, believing that an artificial intelligence capable of performing "all" human intellectual activities would be a serious threat to humanity. This is the much discussed and controversial artificial general intelligence (*AGI*).

What is striking in the analysis of the construction process of his thinking machine are the numerous themes that have then revealed their importance in the debate on the opportunities and risks of artificial intelligence. Turing shows to have a staggering vision of the future, based on a world, that of the Fifties, in which there were few examples of electronic computers, with very limited computational capabilities. He prescribes that the child machine should not have a physicality «*It will not, for instance, be provided with legs, so that it could not be asked to go out and fill the coal scuttle. Possibly it might not have eyes*» but neither emotion «*These definitions do not presuppose any feelings on the part of the machine*». He identifies the essential role of randomness «*It is probably wise to include a random element in the learning machine*», looking forward its use in generative artificial intelligence systems. He poses the problem of explainability «*Its teacher will often be ignorant of what happens inside it*», anticipating an intense and current research strand that does not want to treat artificial intelligence systems as "black boxes", whose contents are inaccessible, but seeks to understand how they work. But what is striking is the idea of treating intelligence as an emergent ability. His words are clear and unequivocal «*Intelligent behaviour presumably consists in a departure from the completely disciplined behaviour involved in computation*» and lapidary «*It will not give rise to random behavior, or to pointless repetitive cycles*». Recent advances in generative artificial intelligence are bringing down the hypothesis that they are only "stochastic parrots", based on chance. At least from a phenomenological point of view, some experiments have instead demonstrated in these systems the existence of "sparks of intelligence".

At the end of his article, Turing wonders which goals thinking machines might achieve by the end of the twentieth century. He lists two: the game of chess and the mastery of the English language, achieved in recent years. Strangely, however, he connects the last goal, mastery of the English language, to something he had initially excluded, the physicality of the child machine. His words are clear «*It is best to provide the machine with the best sense organs that money can buy*» and anticipate an entire research strand, robotics, which has among its objectives precisely that of building artificial entities capable of interacting with the environment, through appropriate "sensory organs".

The sentence that closes his article is a solemn declaration of trust and optimism «*We can only see a short distance ahead, but we can see plenty there that needs to be done*». His mind saw and lucidly evaluated the great scientific and technological achievements of the 1950s and sensed a future full of challenges not only technological but also conceptual, with significant philosophical and social implications. Unfortunately, he did not get to see his future. On March 31st, 1952, he was arrested and convicted of homosexuality and, as an alternative to prison, accepted chemical castration. Seventy years ago, on June 7th, 1954, at the age of 42, he committed suicide by eating a poisoned apple.

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