2014 Isonomia – Epistemologica
Rivista online di Filosofia
Università degli Studi di Urbino Carlo Bo

Turing and the evaluation of intelligence

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Abstract

The article deals with some ideas by Turing concerning the background and the birth of the well-known Turing Test, showing the evolution of the main question proposed by Turing on thinking machine. The notions he used, especially that one of imitation, are not so much exactly defined and shaped, but for this very reason they have had a deep impact in artificial intelligence and cognitive science research from an epistemological point of view. Then, it is suggested that the fundamental concept involved in Turing's imitation game, conceived as a test for detecting the presence of intelligence in an artificial entity, is the concept of interaction, that Turing adopts in a wider, more intuitive and more fruitful sense than the one that is proper to the current research in interactive computing.

1. Introduction

When we think to Alan Turing, a hundred years after his birth, we cannot do without recalling a galaxy of remarkable and very deep ideas he gave to the world community of researchers in different fields, from computation theory to artificial intelligence, biological computation, and building of digital computers. The name of Turing is indissolubly and literally tied to two expressions, two real labels, concerning two different ambits with different principles, methodology, aims and outcomes, but strictly connected: Turing Machine and Turing Test. We know very well the deep impact of them on our science, culture and real world, and we have to acknowledge that their formulation and theoretical development were allowed by his open-minded

[1] Research relevant to this work has been supported by the Italian Ministry of Scientific Research within the FIRB – Futuro in Ricerca project *Structures and dynamics of knowledge and cognition* (Bologna unit code: J31J12005720001).

style of thinking. His geniality was not only in the ideas and theories he proposed, but also in the both intuitive and exact way of discussing and expounding them, a sort of example, according to Turing himself, of the use of two quintessential features of intelligence: initiative and discipline.

In this chapter, I want to discuss some ideas concerning the Turing's concept of intelligence evaluation and detecting, so especially as regards Turing Test, the debate that started in the 1950s about it and some possible contributions it could also provide to present-day research on mind, brain, artificial intelligence and neuroscience. I will begin considering the different questions Turing formulated as regards the possibility of a thinking machine. Then, I will speak about the notion of imitation with reference to, but not only, the well-known game of imitating human intelligent behavior, and therefore about Turing Test. In another section I will consider the idea of interaction as one of the most basic – as the core – of Turing's approach to evaluation of intelligence. Finally, I will try to show how such ideas could be relevant also for current research in some fields in which "detection" of intelligence, in a wide sense, is one of the main target.

Before starting the discussion of Turing Test subject, I want to suggest an analogy between Turing's 1930s (from 1936 to 1940) and 1950's (from 1947 to 1952) methodologies of theory construction and expounding, and try to draw some remarks from it.

In 1930s articles, especially in 1936 one, Turing gives his well-known contribution to computability theory by presenting an abstract machine that is able to compute every computable function, a machine we know as Turing-Machine. What is interesting for our discussion is the way in which Turing decides to expound his ideas. He starts with the very intuitive and straight presentation of how we can imagine such a machine in a very simple manner. We could say as well that, reading between the lines of his article, we are almost invited o stimulated to construct such a machine with few elements: a tape, some symbols, a device (perhaps a pen) to write these symbols. Such an intuitive manner of presenting the subject does not weaken the extremely high relevance and deepness of Turing's theory on computable numbers. On the contrary, we could say that it helps us to catch immediately the subject, "immediately" meaning in an autonomous manner as to a presentation of the theory involving a large amount of previous logical or mathematical knowledge. Even though the article continues analyzing thoroughly the subject and becoming more and more complex, the starting step create an independent theoretical scenario that supports the whole theory. We know very well what consequences had the Turing-Machine theory in terms of computer design and building, and it is not

wrong to think that the "intuitiveness" and "immediateness" of Turing's expounding had a crucial role in such fundamental consequences. And so, the analogical question could be: had the way or the style in which Turing begins the 1950s article with the proposal of an intuitive imitation game a similar impact in artificial intelligence, mind studies and epistemology of cognitive science? Is right this comparison? And if so, to what extent?

The use of an intuitive, but exact, way of communication is one of the trait of Turing's genius. It is true for 1936 article, but it is not sure that it is the same thing for 1950 article and that it obtained the same effects, even though there were many positive and actual effects. In order to understand the reasons of such a difference, we have to consider how Turing uses his intuitive strategy of idea's presentation in 1950s, and with which aims and effects. I want to suggest that Turing 1950 epistemological and philosophical considerations sacrifice exactness to intuitiveness, without losing in significance and deepness, in fact thanks to this sacrifice.

2. An evolving question I

The very first formulation of the "Turing Test problem" is in the opening words of *Computing Machinery and Intelligence*: «I propose to consider the question, 'Can machines think?'» (Turing, 1950: 441)[2]. It is a very simple and straight question, but for Turing it has the inconvenience of requiring a definition of terms "machine" and "think". This is why he introduces immediately the well-known imitation game, a situation in which an interrogator has to distinguish between two different type of entities, a man and a woman, or, in the crucial formulation, between a human being and a machine. How can he distinguish between them? By a form of communication in natural language, characterized as a sort of common ground for human entities and artificial entities.

The imitation game sets several questions, the first one of them being the nature of language communication involved in the game, a question we will consider later on. For now, we will take other questions into consideration. For example, is this an appropriate reformulation of the very first question about thinking machines, or at least of what we called before the Turing Test problem? The answer is yes, but on two conditions: that Turing would consider the imitation game as a test, and that we have a correct understanding of the nature of imitation involved in the game. The straight strategy of Turing in changing the intuitive, but vague, first question

[2]Here and further, all quotations by Turing are from Copeland edition (Copeland, 2004).

in something that is as much intuitive as the imitation game, has to conduct to a situation that gains correctness without losing simplicity. The imitation game sounds as a good candidate for it.

Imitation game, indeed, could be considered as a test, and also Turing uses such a term for referring to it. That Turing considered the situation he describes with the imitation game as a test is very manifest in the radio debate of 1952 between him, Richard Braithwaite, Geoffrey Jefferson (mentioned also in 1950 article) and Max Newmann. There, he gives a new version of imitation game, that leaves aside the man/woman identification and considers directly a machine:

> I would like to suggest a particular kind of *test* that one might apply to a machine. You might call it a test to see whether the machine thinks, but it would be better to avoid begging the question, and say that the machines that pass are (let's say) 'Grade A' machines. The idea of the test is that the machine has to try and pretend to be a man, by answering questions put to it, and it will only pass if the pretence is reasonably convincing. […] Well, that's my test. Of course I'm not saying at present either that machines really could pass the test, or that they couldn't. My suggestion is just that this is the question we should discuss. It's not the same as "Do machines think', but it seems near enough for our present purpose, and raises much the same difficulties. (Turing, 1952:495)

This passage is very illuminating, not only because Turing speaks about a test[3], but also because he states that it is the correct and explicative, even though little different, new version of the very first question. And such a difference is negligible.

So the first, and most known, formulation of the imitation game is not presented by Turing as a test, but it is fair to suppose that things were those in his view since the beginning. But, we might ask, and not trivially: a test for what?

The simplest answer to this question is: a test for establishing the intelligence of programs. So, we might also say that it could be seen, in the spirit of Turing, as a test for evaluating the intelligence. But, if we consider

[3] Turing speaks about a test also in the 1950 article, while discussing "The Argument from Consciousness": «This argument appears to be a denial of the validity of our *test*. […] Probably [Professor Jefferson] would be quite willing to accept the imitation game as a *test*. […] They will then probably be willing to accept our *test*» (Turing, 1950: 452 [emphasis added]). And more, in relation to "The Argument from Extra-Sensory Perception": «If telepathy is admitted it will be necessary to tighten our *test* up» (Turing, 1950: 458 [emphasis added]). Incidentally, one could notice that the fact that Turing considers the game as a test comes out explicitly whenever Turing deals with almost-out-of-range features of intelligence.

the imitation game in such a way, we have to admit that, in the spirit of Turing, the question of knowing what is the intelligence the test allows to evaluate leads straightly to the explanation of the problem of what intelligence is, or, that is the same, to the definition of the notion of intelligence, both in human beings and in artificial artifacts. But why is all that in the spirit of Turing?

Through imitation game Turing intends to provide a criterion for establishing whether a machine – a program – is intelligent. Also in the simplified version of 1952 radio debate, and even more in the one of the radio lecture given by Turing in 1951, the purpose of Turing does not change. But it is clearly shown that what was quickly named Turing Test became soon a test for establishing intelligence in a narrow version, that is, just in some specific tasks or performances in which the program would be indistinguishable from a human being (Cordeschi, 1998)[4]. The reason of such an evolution is that the 'wider' version, the Turing's original version of imitation game, was very hard to realize, and in two senses: as regards a program that was able to answer to questions in every domain *and* as regards the problem of establishing what intelligence is and how a human being in the role of an observer could detect it in a *scientific*, non-naïve way. The Turing Test was considered too much behavioral, for example, from Information Processing Psychology «because the test concerns responses, not the (hypothetical) processes that are intermediate between stimulus and response» (Cordeschi, 1998: 51 [*my translation*]). So, we could say that the Turing Test, in its spreading "popularization", was quickly seen also as a non-sufficient criterion for establishing intelligence, because it was too narrow, too specific, *and* because of the too much intuitive characterization of the observer role in establishing the presence of intelligence, a role that does not take the constraints of a "psychologically intelligent" program into consideration.

In any case, the development of Turing's ideas about a thinking machine was very fruitful for many epistemological matters concerning artificial intelligence and cognitive science, in spite of difficulties implied by the imitation game and its versions. So, the rising of a very long philosophical and epistemological discussion on these topics, beginning from an intuitive and direct way of setting things, complied with the spirit of Turing. However, now we might ask whether it is possible to consider it from a slightly different perspective in order to achieve some other interesting ideas or views for current research on these cognitive topics. For

[4] For this development Oettinger (1952) was crucial.

that, we have to come back to the notion of imitation, but not before ending the analysis of the evolution of the main problem.

3. An evolving question II

In the previous section, we have seen how the very first formulation – Can machines think? – of what I call the "Turing Test problem" was changed by Turing in the imitation game and we have seen that such a new formulation of the problem has had a development in other following Turing's works of the 50s, leading directly to the most popular version of the Turing Test, concerning a machine that acts in an undistinguishable manner from a human being in particular tasks. However, there is another way to consider the problem as an evolving question, and it is tightly related with the notion of *machine* suggested by Turing.

In the continuation of the 1950 article, Turing expounds some criticism to the new imitation-game-version of the problem and gives three general conditions for machines involved in the game. Then he narrows the field to a specific type of machine, digital computers:

> [We have] to abandon the requirement that every kind of technique should be permitted. We are the more ready to do so in view of the fact that the present interest in "thinking machines" has been aroused by a particular kind of machine, usually called an "electronic computer" or "digital computer". Following this suggestion we only permit digital computers to take part in our game. (Turing, 1950: 443)

Such a limitation is fundamental for Turing's argumentation, because digital computers are the only machines which are able to compete with human beings at an *abstract level*, the level of intelligence or of some peculiar features of intelligence ascribed to human beings. But digital computers are as well the only machines which can exhibit a *general*, not particular, acting or behaving, thanks to their *universal* feature, namely the possibility of being programmed for an undetermined number of different tasks. The position of Turing as regards what machines can take part in the game is tantamount to the statement that, according to him, *abstraction* and *universality* are the main characteristics of intelligence. So consistently, the new formulation of the problem is: «are there imaginable digital computers which would do well in the imitation game?» (Turing, 1950: 448). And, as digital computers are discrete state machines, or rather fall within the category of «kinds of machine which can profitably be *thought of* as being discrete state machines» (Turing, 1950: 446), the new version of the

question becomes: «are there discrete state machines which would do well [in the imitation game]?» (Turing, 1950: 448). At this point, Turing is in a position to give the last formulation of the problem. It is the junction of the two features of universality and abstraction with a material machine that is able to playing the game:

> […] in view of the *universality* property we see that either of these questions is equivalent to this, "Let us fix out attention on one particular digital computer *C*. Is it true that by modifying this computer to have an adequate storage, suitably increasing its speed of action, and providing it with an appropriate programme, *C* can be made to play satisfactorily the part of *A* in the imitation game, the part of *B* being taken by a man? (Turing, 1950: 448 [emphasis added])

Even though Turing leaves undecided the question of how such a material machine has to be programmed (the constraints, the architecture, the specific passages of the program)[5], the fact that he arrives to this formulation shows that he is at least partly aware of what the imitation game involves from the point of view of the effective building of an intelligent program, actually the only machine that can show intelligence and act in an intelligent manner. And the mention of the restrictions required for defining "the machines concerned in the game" (the title of the third section of the 1950 article) seems to strengthen this interpretation, without implying that Turing was entirely aware of the many-sided epistemological problem of not-yet-born artificial intelligence.

As a matter of fact, the 1950 article continues with a return to the very first formulation, the original form of the problem that cannot be abandoned «for opinions will differ as to the appropriateness of the substitution and we must at least listen to what has to be said in this connection» (Turing, 1950: 449). It is in this form that Turing discusses the most philosophical and epistemological "contrary views", but it is in the discrete-state-machine-form that he seems to be closer to the real enterprise to building an intelligent machinery, an enterprise in which he believes with some peculiar ideas. While the first formulation of the problem is focused on human beings, the last one is focused on machines, and such a dichotomy is always present in Turing's intuitive style of presenting his ideas.

Now we have to see how all that is in connection with the notion of imitation.

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[5] Newman underlines this fact in the radio debate: «…if I have understood Turing's test properly, you are not allowed *to go behind the scenes* and criticise the method, but must abide by the scoring on correct answers, found reasonably quickly» (Turing *et al.*, 1952: 496 [emphasis added]).

4. The nature of imitation

Before starting the discussion of the «contrary views of the main question», once again Turing comes back to very first formulation of the problem and declares its lack of sense:

> I believe that in about fifty years' time it will be possible to program computers, with a storage capacity of about 10^9, to make them play the imitation game so well that an average interrogator will not have more than 70 per cent chance of making the right identification after five minutes of questioning. The original question, "Can machines think?" I believe to be too *meaningless* to deserve discussion. Nevertheless I believe that at the end of the century *the use of word* sand general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted. (Turing, 1950: 449 [emphasis added])

The passage is interesting because by providing a statistical and temporal evaluation of the success of a machine in the game, Turing shows how this subject is parallel and tightly connected to the meaning of the question for human beings. In other terms, it seems that, accordingly to Turing, there is a strong relationship between how a machine has to be – for example how much storage capacity it needs – and to which *semantic* and *epistemological* conditions human beings could consider a machine provided with intelligence. Even though the evaluation will increase during the years[6], it is noteworthy that Turing appears always to swing between the consideration of the problem from the point of view of the machine and its requirements, and the consideration of it from the point of view of human being. And maybe, this swinging is due also to the vagueness or ambiguity of the intuitive notion of imitation.

When Turing introduces the imitation game in the first section of 1950 article, he does not speak about a test, but just about a game. The main feature of the game, in the 1950 formulation, is that it has to be played through communication in natural language in order to create a common ground for machines and human beings, with respect to the fundamental characteristics of intelligence: abstraction capability and universality. The symbolic nature of language warrants the common ground for these so much different entities. However, we have to notice two things: that the use of natural language is not vague, in fact being restricted to a question/answer form; and that natural language is not the only capability connected to intelligence involving a symbolic nature, even if it is one of the most

[6] In BBC radio debate of 1952 it will be «at least 100 years» (Turing *et al.*, 1952: 495).

important from a symbolic point of view. So, natural language and the capability to express oneself in natural language, and to produce natural language, cannot be considered as the core of imitation game, as a test for detecting intelligence. At most, we could consider them as practically necessary in order to respect the universality requirement from the point of view of the intuitive human being consideration of the problem.

What is important in the imitation game is the form in which language is used, that is just a particular use of the language and not the whole capability of producing and understanding language. The particular use is that of questions and answers, a «method [that] seems to be suitable for introducing almost any one of the fields of human endeavour that we wish to include» (Turing, 1950: 442)[7]. Such a method is profitable in penalizing not «the machine for its inability to shine in beauty competitions, nor to penalize a man for losing in a race against an aeroplane» (Turing, 1950: 442). Once again, this is another way to underline what is important in the evaluation of thinking capability: abstraction (from material world, even though not from bodily and environmental subjects, that can occur in the conversation) and universality (of the fields of human endeavour that a conversation has the possibility to concern). So what is the role of natural language in imitation game? What is the core of imitation game if natural language is not? And what about imitation?

Usually, human beings ascribe intelligence to other human beings *especially* through linguistic conversations, and this is one of the reasons for which imitation game appears so intuitive and direct. Who could object that something that is able to use appropriately natural language is not intelligent, if it is possible to do any kind of questions to that something that expresses itself with natural language? With this method we could avoid every situation in which the presence of natural language is just a trick or a deception, or there is the Eliza effect, or there are some absolutely perfect (and really very useful) semantic technologies for replying a query or

[7]An example of question/answer exchange provided by Turing himself is: «The interrogator is allowed to put questions to A and B thus: *C:* Will X please tell me the length of his or her hair? Now suppose X is actually A, then A must answer. It is A's object in the game to try and cause C to make the wrong identification. His answer might therefore be: 'My hair is shingled, and the longest strands are about nine inches long'» (Turing, 1950: 441). It is the first one of those provided by Turing and it sets aside the problem of the entity involved, whether a human being or a machine. It is just used to show the power of natural language in describing the world and the experience of the world, and it concerns just human beings. As machines will get in the game, natural language will lose its central position, as we will see later on.

providing a retrieval, that, *behind the scenes*, are not human-like yet[8]. Moreover, according to Turing such a method «has the advantage of drawing a fairly sharp line between the physical and the intellectual capacities of a man» (Turing, 1950: 442). So, is natural language crucial for imitation game? And if not, what is crucial?

The answer to the first question would seem no. In imitation game, natural language is a sort of lowest common denominator between human beings and machines – machines that are able to use it in a conversation, as digital computers o discrete state machines appears to be; or it is a sort of bridge at a symbolic and functional level between two different worlds, *placed in a condition of interacting*. So, even though natural language conversations area typical way of assigning intelligence for human beings to other human beings or whatever, natural language is not a specific requirement for assigning it, or even for having it. As a matter of fact, the imitation game was at first proposed by Turing in a different formulation.

The close of the 1948's article, *Intelligent Machinery*, shows another, previous situation in which imitation and game are involved:

> It is possible to do a little experiment on these lines, even at the present stage of knowledge. It is not difficult to devise a paper machine which will play a not very bad game of chess. Now get three men as subjects for the experiment A, B, C. A and C are to be rather poor chess players, B is the operator who works the paper machine. [...] Two rooms are used with some arrangement for communicating moves, and a game is played between C and either A or the paper machine. C may find it quite difficult to tell which he is playing. (This is a rather idealized form of an experiment I have actually done). (Turing, 1948: 431)

In the situation outlined there is nothing the implies natural language or linguistic conversation. There is a game – chess – and a symbolic exchange concerning the chess moves. Also in this case, the imitation regards a machine – an abstract machine, in fact a *paper machine* – that replaces a human being. And also in this case there will be, or there should be, a set of matches in which it will be *quite difficult* for C, the player-interrogator, establishing if he is playing with a human being or a machine. What do this early formulation and the more famous one share? Not natural language producing, nor making a conversation in natural language. The thing in common is *interaction* between two entities that are able to refer or face one

[8] If things are those, with this list of exclusions I should have been able to leave aside the Searle's Chinese Room objection (Searle, 1980) and the similar ones, that I do not think to catch the point I am dealing with. For a discussion I take the liberty to refer to Bianchini (2011).

with another. Certainly, in the chess case they have just one field of interaction, but they are free, *every time*, to choose the move in relation to the move of the opponent. So, the really very first formulation of the imitation game leaves out the universality requirement, but not the abstraction, the "symbolic nature", requirement. However, such a diversity does not make this version of the imitation game – that Turing defines "a little *experiment*" – totally, namely qualitatively, different from the one of 1950's article. And this is an evidence that confirms the fact that interaction is the crucial point of the experiment/game/test conceived by Turing.

It is interesting to notice that the section title in which this proto-imitation-game is proposed is "Intelligence as an emotional concept", to underline the point of view of human being in evaluating the intelligence of a machine, or the effectiveness of a thinking machine. Nevertheless, the first part of the section is very noteworthy and presents also the other point of view, that one of the machine:

> The extent to which we regard something as behaving in an intelligent manner is determined *as much by our own state of mind and training as by the properties of the object under consideration*. If we are able to explain and predict its behaviour or if there seems to be little underlying plan, we have little temptation to imagine intelligence. With the same object therefore it is possible that one man would consider it as intelligent and another would not; the second man would have found out the rules of its behaviour. (Turing, 1948: 431 [emphasis added])

The "properties of the object under consideration" seem to recall the requirements the machine needs to be intelligent, and maybe to anticipate the artificial intelligent trend that saw as crucial the internal features of the machines (the programs), as in the case of IPP and Newell and Simon approach. Moreover, we could add that the principal situation in which a human being is not able to explain and predict the behavior of a machine appears to be the one in which the possibility of a long and appropriate interaction with it is involved.

So, the crucial element in the imitation game is *interaction* and not natural language production. And thus, the imitation involved in the game could be seen as the imitation of every interactive behavior and situation. This fact could allow to widen the range of Turing Test to a set of situations that include also every relationship between the entity we pretend to be intelligent or under "intelligence scrutiny", and other intelligent entities or the real world (a material or virtual environment).

Therefore, there are some reasons to think that the Turing's idea of imitation is wider than the one that has become standard afterwards in

Turing Test. Such a version of the test, as we saw before, is too narrow for catching the universality requirement that Turing thought to have captured by giving the intuitive and well-known formulation of it in 1950's article. Besides, there is another reason to think that Turing has a very broad notion of imitation. He uses it, indeed, also for referring to the idea of an imitation of the brain realized by a computer. In 1951 BBC lecture, in which Turing deals with the opinion that «digital computers have often been described as mechanical brains» (Turing, 1951: 482), he states:

> I believe that [digital computers] could be used in such a manner that they could *appropriately be described as brains*. I should also say that 'If any machine can appropriately be described as a brain, then any digital computer can be so described'. […] If now some particular machine can be described as a brain we have only to programme our digital computer to *imitate* it and it will also be a brain. […] if we wish to imitate anything so complicated as the human brain we need a very much larger machine than any of the computers at present available. (Turing, 1951: 482-483 [emphasis added])

In the light of present discussion, this passage is interesting because Turing uses the notion of imitation also for referring to brain, or better, to the *functional* imitation of brain. As a matter of fact, Turing speaks of the description of a machine that is tantamount to a brain, and, thanks to the fact that digital computers can do *functionally* everything a machine can do, he builds a bridge, a *functional* bridge, between computers and brains, the machines through which human beings are able to think. Such a bridge is allowed by the use of the notion of imitation, that has therefore a wider application than the one narrowed to classic imitation game/Turing Test. The functional sense of the passage is underlined also by a following one:

> It should be noticed that there is no need for there to be any increase in the complexity of the computer used. If we try to *imitate* ever more complicated machines or brains we must use larger and larger computers to do it. We do not need to use successively more complicated one. This may appear paradoxical, but the explanation is not difficult. The *imitation* of a machine by a computer requires not only that we should have made the computer, but that we should have programmed it appropriately. The more complicated the machine to be *imitated* the more complicated must the programme be. (Turing, 1951: 483 [emphasis added])

What is notable in these words is the statement by Turing that it is not necessary an increase of the complexity of the digital computers in order to imitate brain. What is necessary is a higher complexity of the program that has to imitate the machine, that is tantamount to a higher complexity of the

description of brain as a machine, or, in other terms, the mechanical description of the brain. The whole problem lies at the functional level and with this passages Turing appears to be interested to the problem of a thinking machine also from the point of view of the machine, not only from the point of view of human attribution of intelligence to a machine, as in the classic and most known formulation of imitation game. Before the rising of artificial intelligence, Turing seems already to be aware of, or at least to suggest, the fact that intelligence is a feature whose identifying is not a mere question of what human beings think about it, but also a question of a correct, *appropriately complicated*, program that is able to imitate functionally the machine that produces intelligence in human beings. The history of the artificial intelligence, that was rising in that period, has been consistent with the Turing's vision, also in its most recent developments (new artificial intelligence and artificial brain studies), even though Turing's ideas were not as detailed as everything has occurred in this research field from a methodological and epistemological point of view during the last sixty years.

5. The perspective of interaction

The notion of imitation has a more crucial and wider role in Turing's writings than that one could think at first sight, and such a role is allowed by the intuitive use that he did of it in the different occasions in which he spoke about the "thinking machine" problem. I have underlined too that we have to consider the notion of interaction as crucial as the one of imitation, if we do not want to narrow too much the Turing's idea about the evaluation of the intelligence showed by, and thus that is present in, an entity whatever.

It is not surprising that Turing was interested in the notion of interaction. Since the 1936 article he was aware of the logical-mathematical limitation of the pure computation theory, and therefore of the Turing machines. For this reason he introduced the distinction between automatic machine and choice machine. In 1939 article[9], he spoke about an oracle machine, that is a machine with a special part – the oracle – that is able to solve problems that could be also non-computable function. Turing says of it that it cannot be a machine, but could provide an answer that is "external" to computation process, if the machine in which such a part is "interacts" with it during the execution while suspending the process. So, the use of situations in which interaction has a notable role would seem to be the

[9] That deals with the problems of his PhD thesis finished by Turing in 1938.

natural consequence of such mathematical problems he was aware since the presentation of the Turing machine and the studies on computability theory foundation. Despite these remarks due to Turing himself, it is noteworthy that a deep investigation on interactive computation in theoretical computer science is rather recent[10].However, even though Turing did not show to study in depth such a question from a mathematical point of view, he had the merit to have identified the problem and to have proposed some sketched lines of research in this direction.

Therefore, the notion of interaction was something that belonged somewhat to the Turing's constellation of ideas and it is not unexpected that it could be modeled in his way of thinking to a method for dealing with the problem of a thinking machine and the presence of intelligence in an artificial entity, provided with the two requirements of abstraction and universality. We might wonder if the notion of interaction, as the one that goes through the different formulations of thinking machine problem and as to the coexistent human being and digital computer points of view, is still useful for current research in cognitive science, beyond its value for theoretical computer science.

A more intuitive and less mathematical concept of interaction characterizes Turing's articles of the 50s, for different reasons and in different ways, but always in the perspective according to which no interaction, or the absence of interaction, is equivalent to the impossibility to detect intelligence in an entity whatsoever. First of all, we could say that interaction as language communication appears to Turing *both* a lowest common denominator for every field in which it is possible testing intelligence, as I already stressed, *and*, at the same time, a way to cut single field or domain for testing intelligence. Every field is marked by a slightly different form of interaction involving different semantic and pragmatic contexts. Interaction is the link among all of them, and it is the general, *universal*, method to detect intelligence. Besides, before the development of the classic version of Turing Test and its yes-or-no success modality, the imitation game implied a statistical evaluation of a certain number of cases, instead of one single attempt to passing once the test. This fact (statistical evaluation *versus* one attempt) seems to involve more complex capabilities having to come into play in imitation game than in Turing Test, and this is it because interaction can bear every time to (maybe, just not too much)

[10] For a survey on this kind of studies and research see Goldin, Smola, Wegner (2006). For an application to the question of interaction from a mathematical point of view see Goldin *et al.* (2004).

dissimilar outcomes, namely conversations on a generic topic, and thus can be more "probatory" of intelligence.

We have seen also that interaction is not restricted to natural language communication in order to make a conversation. For example, it is also that what takes place in a chess game. So, if it is the way in which, at least according to Turing, we could detect the presence of intelligence in an entity whatever, we could extend this intuitive idea also to other fields in which, nowadays, the research on artificial intelligence and cognitive capabilities is carried out with a synthetic method, namely a method that makes a large use of cognitive modeling; but fields in which, as well, interaction is a fundamental element, because the main purpose is to detect or recreate forms of human-like intelligence. These fields could be, for example, machine translation and other semantic domains characterized by the interaction between two different cultural/linguistic contexts; or the field of emotion interacting, as regards specific spheres of speech and behavior, like the one concerning attraction and love exchange; or the field of music creation based on the interaction between different music-maker entities; or the field of scientific discovery, especially when such a process is conducted in a tight interaction with the real world through experiments. In all such fields, we could ask what would happen if an artificial entity carried out the interaction task. We would make up in this way a Turing Test situation by means of which we can evaluate and consider artificial entities, their product and their performances, also from the point of view of their architecture and constraints, that would allow a kind or another of specific and more or less appropriate interaction[11].

At the end of this article I want to discuss just one of the field in which nowadays it is suggested a use of the Turing Test for detecting intelligence: the area of coma studies. In the last years, some researchers started to search for signals of intelligence, or better, of consciousness, in vegetative state minimally conscious patients, that are not responsive to external stimuli through sensory-motor behavior (Stins, 2008; Stins, Laureys, 2009). The standard, "traditional" method used to establish the level of consciousness in a brain damage patient is based on bodily responses – like blinks of an eyelid, eye-tracking, simple command following, response to pain – to certain stimuli. Through a motor response a patient is able to *communicate* their state of awareness. The problem rises with patients that give no motor response to external stimuli, but there is no certainty that they are in a state of entire lack of consciousness, as in deep coma. For these cases, some

[11] For a discussion on such a topic I take the liberty to refer to Bianchini, Bruni (2012).

researchers developed a method based on brain responses to auditory instructions (via natural language). In short, the method consists in comparing patients brain activations with activations of healthy subjects through fMRI techniques. The hypothesis is that, if brain activations are similar, we are in presence of a similar understanding of auditory instructions, that usually request to make a choice.

Leaving aside the objections to such a methodologies and its appropriateness in practically establishing the presence or absence of consciousness, it is interesting to discuss the approach to the problem from a theoretical point of view and formulate a set of connected questions. For example, are such responses, such activations, automatic or intentional? And how could we establish it? Is the use of natural language interaction a warrant that we are in presence of intentionality and consciousness, whether they are the same thing or not? Stins and Laureys fix four conditions to which it is possible to speak about a Turing Test for establishing the presence of consciousness and they conclude that «if we want to open up the possibility for patients who are unresponsive yet consciously aware to pass the Turing test, then we should adopt voluntary brain-controlled non-motor signals in our repertoire of recognized behavioral responses» (Stins, Laureys, 2009: 369).

If it is possible, and to what extent, to accept into our repertoire of behavioral responses voluntary brain controlled signals, is another open question both from a methodological and an epistemological point of view. However, it is very interesting the idea of using Turing Test in order to solve the old and philosophical problem of other mind existence, certainly in a contemporary form (Stins, Laureys, 2009). And it is interesting that this is allowed by a new and different consideration of interaction with entities that we take for granted as provided of intelligence. Without interaction we would hardly have a similar methodological and epistemological framework seen to arise. Maybe, it is not so far the future when we could back-transfer such ideas, whose fatherhood we can assign to Turing, to machines, and evaluating or detecting the presence (or lack) of intelligence or other capabilities, including consciousness and intentionality, by simple auditory instructions and a screening of their inside in the act of answering to our words.

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