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Alan Turing's "Computing Machinery and Intelligence"

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It is a pleasure for me to direct your attention on the recent work of Alan Turing, a brilliant scholar who, in my reckoning, is less influential than he should be. He is a mathematician, yet in this work the topic is not mathematics or formal tools, but rather a much more challenging issue: to offer a principled foundation of cognition and of its "machinery" and function, and thus also the foundation of computer science and Artificial Intelligence (henceforth, AI for short). This invites a new, much needed reflection on the nature and mission of AI, and Turing is to be applauded for bringing us back to the future, against the currently received wisdom. Nowadays, AI researchers see themselves mostly as "engineers": their mission in life is to produce technical results, software solutions of practical problems with a relevant industrial, commercial, or military impact. In sharp contrast, AI was and (involuntarily) still is a science, aimed at understanding, modeling, building computational theories of (possible) cognition, interaction, society. I appreciate that research (not researchers) needs money, but research should never forget its *basic questions*. Turing, without any aggressiveness, tries to bring the AI community back to its role and origin, and to reflect on its theoretical and methodological foundations.

Moreover, his challenge is very timely, since AI is *not* an aborted project, contrary to what many people like to claim—usually while appropriating and exploiting its solutions. On the contrary, if anything, the discipline has grown to be quite threatening in its results and perspectives. And the major threat is precisely the lack of awareness and critical discussion. AI cannot continue, out of condescension or convenience, to disguise itself just as a "technology", or to deny the radical character of its challenges. AI should demonstrate greater critical awareness and be more explicit on what it does or can do (or not). Negation and removal are not adequate reactions to its present and future developments.

In this critical notice of Turing's recent work, I trust he will forgive me for failing to give (or even try to) a correct and complete picture of his main results and ideas. I just want to present and discuss *some* issues I was very impressed with, and offer a few digressions based on them.[1]

1 Must Intelligence Just Be "Natural"? The AI Revolution

It is true that, as Turing put it in his earlier report *Intelligent machinery*, "a great positive reason for believing in the possibility of making thinking machinery is the fact that it is possible to make machinery to imitate any small *part* of a man". Just think of artificial sensors for perception, or actuators for motor action. These are the essential building blocks of any robot, whether or not they are guided by an artificial intelligence. Yet the problem of intelligence is

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[1] To my regret, so far I never had the opportunity of meeting Prof Turing personally, and to discuss directly with him our shared interests. Yet I am sure this will happen soon enough, and I look forward to chatting vis a vis with him, in my bad but vivid spoken "English". In this review I can focus only on some controversial issues; hence I invite my readers to peruse Turing's paper directly, as I am sure this will prove to be a very exciting (and possibly upsetting) experience for them, as it was for me.

much more radical. Will we have intelligence only if and when we will root artificial cognition in a perceptual and embodied substrate? Surprisingly, this is a point on which Turing remains silent—conspicuously so. Many will feel that he should have discussed more explicitly and directly the very trendy embodied approach to cognition, as well as its purported challenge to the computational view of the mind (if not to functionalism at large) that Turing seems to favor. Can something akin to the natural mind exist without its specific body, or at least a closely resembling artificial substitute for it? What kind of mind or what aspects of mind?

Some versions of embodiment raise even more radical questions. Is it not intelligence just an adaptive expression of life? That is, is life a *pre-condition* for any form of real intelligence? Can we have intelligence just as reasoning, without practical action in a world (computers) and without a human-like (or at least animal-like) body? And can we have a real body and real behavior (robots) without life?

Apparently, nature has proceeded in the opposite direction: from life to purposive behavior, to affects, to choices, onward to cognition and reasoning—with each level being built on the previous ones, rather than replacing them. With the unfair advantage of hindsight, Turing reminds us that the crazy challenge of AI, historically, is to have undertaken a *revolution*, in the sense of a "reversed evolution". It all started with a keen interest, even an obsession, with superior cognitive functions and abstract symbolic thinking (playing chess is an obvious example, but far from an isolated one); then the focus shifted on goals and thus motivation, for driving effective behaviors that could adapt to varying needs; then learning was introduced, typically based on association and reward; more recently, emotions, both as reactions and as internal states, became a key topic, under the umbrella label of affective computing; finally, modeling the body emerged as a central concern, including both proprioception and enteroception, and (perhaps) even pleasure and pain, with the thorny issue of feelings added to the mixture; should the revolution continue (and I believe it will), we will probably build full-blown living systems, with their own mechanisms for reproduction, niche construction, individual and group selection, autonomy and self-motivation, energy search and acquisition, and much more.

Importantly, this reversed path is not just a historical accident, but rather a methodological need. Many researchers, over the years, attempted to partially correct it, to have a more bottom-up, sub-symbolic approach, building intelligent behaviors not based on reasoning in terms of symbol manipulation: e.g., most of the work done in neural networks, Artificial Life, and behavioral robotics. However, even in these cases, one has to start from behavior, interaction with the environment and learning, but not from synthetic "living" systems. At best, such systems can simulate their (natural) living counterparts, progressively adding further constraints, as it is frequently done in computational neuroscience. But the starting point is, and cannot help but be, overt behavior.

Since nature solved many of the very same problems that nowadays plague AI researchers, a certain fascination with its "solutions" is understandable. But it should not be exceeded, and Turing refreshing computational view helps us staying on track. The point is not to dismiss the embodied and even emotional facets of cognition: Turing himself, in the earlier report I mentioned above, recognized that intelligence is emotional rather than mathematical in nature. But is it so out of necessity, or just due to evolutionary happenstance? Are the results of natural evolution principled or just accidental, in the sense of being accidentally adaptive to a given environment? Is, for example, just an evolutionary accident that human motivations are strongly grounded on emotions? Could we not have really purposive, goal-directed, motivated actions in a "cold" mind, that is, the mind of a non-affective agent, which would still be able to plan, solve problems, choose, achieve its goals, and learn from experience? Personally, I do not believe in the providential character of nature, thus one can in principle find different solutions from those exhibited by natural agents. Science, and therefore AI as a science, has to understand and model natural phenomena, but it should also offer normative models—that is, theories of possible worlds, of how things could (consistently) be, thus underlying potential mechanisms and solutions.

Seen in this light, AI is a fantastic experimental, non-speculative but empirical and procedural, platform for designing and understanding several possible forms of action, intelligence, and society—precisely because (and insofar as) it allows separating what in nature is accidentally combined by the circumstances of adaptation. AI has the potential to shed light not only on natural intelligences, but also on *un-natural* ones. Whether such potential will come to fruition is still in doubt, but Turing keeps pushing us in the right direction.

Should I be forced to point to a weak aspect of Turing's vision, I would probably mention that he does not stress enough the goal-oriented nature of the mind, its function in controlling and driving behavior towards some end. Knowledge, reasoning, decision, these are all just means for that. And the relation between intelligence and goals is primary even with respect to its relation with affects and emotions.

But for that shortcoming, much of great value shines through Turing's pages. As a case in point, consider how Turing elegantly side-steps the stale debate plaguing AI since the 50s, to offer us a more realistic view of cognitive systems and their functions. Not just as an all-or-nothing matter ("Either it is intelligent or is not"; "Computers already think!" versus "Computers will never think, it is impossible in principle!"), but instead in terms of *aspects*, *functions*, *types* and *degrees* of intelligence and thinking. Hence the AI challenge, though no less formidable, becomes amenable of partial and progressively positive answers. This is the sense in which Turing remarks on the possibility of integrating the "parts of a man": senses, action, language, as well as various other cognitive skills—bit by bit, but also in an appropriate architecture of layers and components.

Similarly, he is very wise in refusing to engage in any generic discussion on machine intelligence (or lack thereof) based on purely terminological grounds, that is, on how intelligence should be defined. This is a tricky discussion, since in the past several scholars deliberately proposed more and more restrictive definitions of intelligence, some of which were basically tailored on humans alone. Hence of course they were allowed to conclude that machines cannot—in principle—be intelligent. But this is a mere tautology and thus a useless move, one that Turing does well to steer clear from.

2 Male or Female? Intelligence and Deception

In this paper, Turing provocatively suggests that an intelligent machine should be able to deceive a human user. This is a very insightful hint, but one that I am sure will be taken too seriously and too literally, whereas it was meant as a simplification and a provocation (a game, in Turing's own words).[2] In that spirit, let us consider his suggestion and have some fun with it.

So, is there a specific affinity between AI and deception? Is the ability to deceive the real test of an effective AI and perhaps its real mission? Is (reciprocal) deception the real test of sociality? In considering these issues, Turing nicely ridicule our incapacity, in our daily interactions with technology, to recognize a real human, to distinguish whether we are interacting with a person or a machine (an artificial intelligence/agent). So he proposes an imitation game, which is intrinsically social, interactive and aimed at deceiving. In the game there are three agents, a man (A), a woman (B), and an interrogator (C)—either a man or a woman; C is closed in a room and communicates with A and B remotely, and his/her goal is to determine which of the two is male and which is female. The goal of A in the game is to deceive C and induce him/her to a wrong identification; while the goal of B is to help C find the truth. Both A and B have to answer C's questions. As Turing notices, B might also use such expressions as "Don't believe him! I am the woman", but this will not help much, since A too could say something like this. At this point, Turing raises the following question: What will happen when/if a computer will take the place of A, of the deceiver? Would C be wrong as frequently as in the previous situation? *And he claims that those questions are equivalent to the question "Can machines think?"*.

Here I feel Turing should have been more careful in making clear that this was intended as an anti-skeptical divertissement, a way of teasing his readers and making them realize the futility of excessive incredulity on machine intelligence. In contrast, I worry that it will be taken very seriously by philosophers and computer scientists, engendering a wealth of useless disputes and alleged demonstrations. But of course this game is played every day on the Internet by billions of people, and the so called "test" is passed (*implicitly*) in millions of interactions with artificial systems. What is amazing is precisely that for a lot of users this is *not relevant*: we do not care to understand whether the answer is from a human operator or from a machine. In fact, there is not such a big difference, also considering that both of them can try to deceive us, and some measure of trust is required to interact with both. Moreover, there is another risk in the proposed game: that it is centered on linguistic interaction, as if this was the hallmark of intelligence and sociality. For sure several people will distort its interpretation in this direction, making language a necessary condition of intelligence. On the contrary, Turing would have been wise to note that the same game may be played on *practical* cooperative or competitive behaviors, on social "games" (like scripts and roles), or in emotional interaction based on expressions and reactions, with no language involved.

Despite these lingering caveats, the real meaning of Turing's game to me is primarily methodological, and it is very clear. It invites reflecting on the real meaning of the question "Can machines think?", and it suggests we should answer it for machines *in the same way we answer it every day for our fellow human beings!* Indeed, at some point in his article Turing is quite explicit on this: "Likewise according to this view the only way to know that a *man* thinks is to be that particular man. It is in fact the solipsist point of view. It may be the most logical view to hold but it makes communication of ideas difficult. A is liable to believe 'A thinks but B does not' whilst B believes 'B thinks but A does not'. Instead of arguing continually over this point it is usual to have the polite convention that everyone thinks". Turing here makes it clear that our ascription of intelligence to other human beings is a matter of convention, not one that we can ever hope to demonstrate or test.

[2] People already started to propose this game as the litmus test of machine intelligence, and call it "the Turing test"! Alas, this completely misconstrues Turing's point, which is about how we in fact *ascribe* intelligence, and not on how we should define it.

Thus, Turing suggests, let us extend the same courtesy also to our social machines! We are in fact just building/evolving “a general educated opinion” and the appropriated broader “use of words” for simply *presupposing* that machines are thinking—exactly as we do with any natural being, whenever we deem him/her to be intelligent.

Far from suggesting any litmus test for the possession of intelligence by a machine, Turing is arguing that, like we *ascribe* mental contents and processes to humans on the mere basis of their performances and interactive responses, so we should (necessarily) do with computers too. This symmetry, if anything, is what makes us unable, and often uninterested, to distinguish machines from human partners. Why, for example, should we not ascribe a mind to an interactive entity able to help us by understanding what we have in mind, what we are doing or would like to do, what we need without an explicit request? After all, this is the same reason and process by which we ascribe a mind to people, according to Dennett’s intentional stance.

Turing is also correct in emphasizing that intelligence is socially ascribed as a fundamental presupposition for social interaction, which is much more than just its physical manifestation. Witness his following remark, from the earlier report mentioned before: “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”.

Somewhat surprisingly, Turing does not feel the need to back up his arguments with any of the numerous examples where intelligence was indeed ascribed to machines, precisely along the lines he discusses. For instance, there is now abundant evidence that children playing with various types of robot companions end up trusting these robots to truly understand their needs and feelings, and interpret their behavior as meaningful interaction on a personal level, well beyond the typical make-believe involved with stuffed animals and other traditional toys. This is, after all, our spontaneous attitude towards entities that demonstrate autonomy and rationality. This is why, in the 60s, even scholars were deceived by ELIZA (or, more precisely, by its script DOCTOR, which emulated a Rogerian psychotherapist): although its linguistic contributions were based on a very small knowledge base and simple pattern matching techniques, people could not help but feel that the machine understood what the patient was saying and reacted in an empathetic way. An illusion, later known as “the ELIZA effect”, very much in line with Turing’s game.

Another way of putting Turing’s point is to note that AIs, computational systems, computer mediated interactions, interfaces, robots, etc. —they all deceive us, even when they do so not on purpose or intentionally. They deceive us functionally, in the sense that such deception is built in the basic architecture of our (deeply social) mind. So we are mistaken, deceived into seeing intelligence where there is none, and we cannot stop that deception. Indeed, perhaps we do not want to, since we need, or at least find incredibly expedient, to adopt an intentional attitude and ascribe mental states. This creates a loop (vicious or virtuous, depending on circumstances), which reinforces our spontaneous and unconscious tendency towards self-deception in intelligence ascription. Designers and producers of artificial interactive systems just exploit (do not create) such vulnerability in our cognitive make up. Sure enough, they make sure to cover it with fancy labels, such as “believable agents”—as if believability was not just a form of deception, by definition! But the machinery of intelligence attribution remains the same across the natural versus artificial divide, as Turing aptly reminds us with his provocative game.

As an aside, I also enjoyed Turing further provocation in making the game not just about the issue “human or machine?”, but also about gender—“male or female?”. The possibility of deceiving others about one’s gender is of course a popular refrain on the Internet, but here I think it has special significance, for political reasons: not just as a reflection on how these seemingly hard gender “identities” are actually very weak, but also as a reminder of their strongly conventional nature. So that we are immediately made aware of how the alleged consequences of “natural” gender differences are utterly arbitrary, including the inferior status allotted to women in society, as well as the absurd persecution of gay people,[3] just to mention a couple of notable examples.

Turing seems to suggest, although he does not explicitly say so, that the right answer to these dilemmas, natural versus artificial and male versus female, is: “Neither!”, or, even better, “Both!”. In the currently dominant perspective in AI, we look at what we are building and is emerging in a sort of “black and white” fashion, while the most interesting result is the progressive hybridization of intelligence. Social networks are a case in point: Are they endowed with (collective) intelligence, and, if they are, is it natural, artificial, or both? Turing’s paper invites us to change our mind and our perspective on how the mind

[3] We should never forget that gay people for a very long time, and still nowadays in many countries, were forced to hide their nature, condemned in courts and put in prison (like Oscar Wilde), and subjected to mandatory “medical” treatment, e.g. taking hormones. Some of them even decided to commit suicide to stop this persecution—all based on a purely conventional distinction.

itself is changing, to become more creative and open-minded in our critical reflection on AI and its implications, and to invent new categories for understanding the ongoing socio-technical revolution.

3 From the Impossibility Litany to Responsible Social Engineers

By putting on the same level the question of natural and artificial intelligence, Turing also manages to skip (and rightly so!) the stale debate on the alleged impossibility of an artificial brain, a computational intelligence, or a "child machine", as Turing puts it—probably having in mind the well-known *iCub* humanoid robot. This debate is simply blind to the bare facts: to what is actually already realized, or under development. We now have machines playing chess at the top level, demonstrating theorems, making good medical diagnoses, understanding language, interacting appropriately, expressing emotions and reacting to them, being pro-active in understanding what we need, negotiating and arguing, and much more. Turing moderate optimism on the prospects for machine intelligence has ample backing, even if he is modest enough not to swamp his opponents with the sheer number of AI successes. But he is certainly aware of how chess programmes nowadays regularly beat chess grand masters, employing very smart strategies; not to mention *Watson*, the IBM system answering to natural language questions that recently, in an exhibition match on the television quiz show *Jeopardy!*, prevailed against two of the best human players of all times.[4] Instead of raising such obvious counterexamples against the repetitive litany on the impossibility, or failure, of AI, Turing proposes his deception game, thus making manifest the absurdity of the concern that has plagued the field for over 60 years.

Sadly, that litany is likely born out of fear and confusion, held against the impressive results of AI as a talisman of good luck, to ward off any unwanted, immoral or politically dangerous consequences of such results. But this is an ill-fated strategy: it would be much better to explicitly discuss the ethical aspects and political problems raised by AI (as many indeed do nowadays), rather than just repeating "It is impossible to achieve!". In that respect, Turing's message is very clear, direct, and timely. I would like to summarize it as follows: we (engineers) are building not just new technical systems, but *new socio-cognitive-technical systems*, that is, *new forms of intelligence and of sociality*. This is absolutely right. And, I would add, perhaps we also need a better involvement of social and cognitive scientists in the quest for AI. It is not sufficient to appropriate and formalize their theories, as AI scholars already do—quite often in rather sketchy and naive terms. Cognitive and social scientists need also be involved to help understanding what we are *obliviously* building, so that we can build it (or not) in a more conscious way; to change people (education, practices, interactions) and support them in adapting to this new ecology; and also to develop new theories, thanks to the new conceptual and experimental instruments that AI can provide to social sciences.

In fact, another key message behind Turing's game is that intelligence is intrinsically *social*: in its origins (evolutionary and developmental), in its function (intelligence is for power and dependence, for cooperation, exploitation, competition), in its instruments (like language), and in its ascription to others, as a precondition for meaningful interaction. So an intelligent machine is a socially working (i.e., deceptively interacting) machine; either when competitively playing chess, or when engaging in conversation.

Turing is very much aware of this fact, and he is right in stressing that we are not just building an intelligent machine, but also, and unexpectedly, a *hybrid new society*, where social interaction of any kind is not just between humans, but instead it is mediated by artificial systems. In such a society, there are social interactions (in the proper sense), social networks, and collective behaviors between humans and software agents, humans and robots, robots and agents, and so on for all possible combinations—including, less and less frequently, even interactions between humans without any technological mediation. And, as Turing emphasizes, most of the time it is practically impossible to be sure of the nature of your partners. Even more crucially, it often does not matter, it is *irrelevant*.

The system is radically hybrid, a seamless mixture of "natural" intelligences (although they are rather acculturated and artificial in their habits) with "artificial" ones (even if these accrue more and more traits of natural systems, e.g., embodiment, affect, motivation). In such a scenario, how can we miss the fact that to be a "person" and fit a social role (seller, buyer, doctor, friend, priest, judge, etc.) is in large part an institutional construction? This is the take-home message of Turing's game, couched in typical British irony. The implication, of course, is that now AI researchers should feel the full responsibility of such a momentous enterprise. They are building the new institutional characters, roles, and scripts for intelligent interactions—that is, they are re-writing the rules for the hybrid games of our future society, no less.

[4] However, as Turing reminds us, these impressive results are far from sufficient, before we can consider the AI challenge answered: we also need to achieve more practical and embodied manifestations of intelligence, capable of sustaining open-ended action in the world (to see, to react, to act, to learn from direct experience), as well as richer forms of social intelligence (mind ascription, initiative, etc.).

4 Not Just Intelligence but Also Autonomy in Interaction

Autonomy is a central concept to understand the rationale of what is happening in computing and in human–machine interaction. These fields are no longer concerned with just abstract intelligence, but rather with intelligence for *initiative in interaction*. Turing is keenly aware of this development, and this shows up in his discussion of Lady Lovelace's (Ada Byron) remarks on Babbage's Analytical Engine, in the prehistory of computing. Her observation that such a machine could not originate anything new, since it just did whatever the user knew how to order it to perform, was of course correct, and indeed prophetic of many similar attempts to come over the decades. For a long time, our intention in building computers had been that of treating them like slaves, of giving them tasks that were completely specified. Indeed, Turing observes, this has been the dominant attitude up to now; but must this remain the case forever? He thinks not, and it is a fair guess that he has in mind much work done in distributed computing, especially within the multi-agents paradigm. There we are already beyond the limits mentioned by Lady Lovelace, and this comes precisely from the relative autonomy of such artificial agents: in evolving and learning, in directly accessing information from the world, in moving, planning and problem solving, in taking initiatives, in having their own goals, and so forth.

For some, the challenge of autonomy is the last frontier of computing, as well as a topic to inspire heated debate. For instance, the philosopher Karl Popper is known to endorse Peirce's view that machines necessarily lack initiative, although it is something that any small children and animal has. Thus how he must have felt provoked, when Turing, on a recent radio interview, boldly stated: "Tell me what, in your view, a computer cannot do… and I will build one on purpose!". I suspect that Popper, even more drastically, sees initiative as something that in principle *cannot* be clearly described and operationally defined. If that is the case, I can only disagree with him. On the contrary, I believe it is not only possible to characterize initiative and in general autonomy in social interaction, but even that we already have achieved such a definition. Agents are autonomous when they are self-regulated, developing, learning, reasoning systems endowed with initiative (they are *pro-active*) in interaction with humans; for example, they give more or better information than required, or they interrupt us to inform us about some event relevant for what we are doing. If anything, artificial agents' autonomy is growing so quickly and evidently that we are now focused on bridling it, or at least channeling it within appropriate boundaries. Hence in multi-agent systems there is much discussion on how to design "mixed initiative systems" and "adjustable autonomy", and how to balance delegation and trust with proper control.

Eventually, I believe we will have *two types* of proactive, autonomous, self-governing, learning systems, in interaction with each other, and increasingly similar. On the one hand, artificial agents are becoming different but competitive intelligences, or human-like intelligences, or even artificial "persons" with their rights and duties; on the other hand, humans too are changing, partaking more and more of the opportunities for distributed, technology-mediated collective thinking, thus developing distributed and *artificial* minds and even bodies.

5 AI as Science

With a Turing-inspired *computational radical attitude*, I would like to claim that there are no alternatives at all to computational modeling, if we are to understand the proximate causes of a given phenomenon, as well as its superficial dynamics; that is, if we aim to uncover the *underlying mechanisms that determine observed behaviors*. In fact, we even need a form of synthetic modeling, that is, the material construction of the modeled entity to show how it actually produces the predicted behaviors/effects in interaction with the environment.

In his recent radio interview, Turing was right in reminding us of this seminal intuition of AI, so frequently lost in recent works: "The whole thinking process is still rather mysterious to us, but I believe the attempt to make a thinking machine *will help us greatly in finding out how we think ourselves*". Exactly—except that Turing should have also discussed whether or not his "universal and recursive machine" (even including "a random element in a learning machine") is a good model of the brain and the complexity of neural processing, since this is a much debated issue in the literature.

Nonetheless, there is little doubt that *computational/synthetic modeling* will be pervasive for studying any hidden mechanism and dynamics involved in scientific explanation: from chemical reactions to DNA, from evolution to psychological mechanisms, to social, economic, historical simulations. This is the message and the *gift* that technology, and in particular AI, is offering to science.

Nor is the gift limited to models and conceptual instruments for theory construction. On the contrary, it also include endless *experimental platforms*, to generate new empirical data through simulation, and thus test new predictions, or old ones that were not easily amenable of direct empirical verification before (think for instance of many evolutionary theories). In my view, this should also include experiments that are impossible in nature, either for practical, social, moral reasons, or for the inseparability in living organisms of features bonded together by natural selection, e.g., motivation and emotion in humans. This will be crucial for modeling both proximal and distal causes, as well as their interplay.

Not to mention the key role of AI in intelligently *collecting, sorting, and analyzing relevant data*, out of the multitude produced every day on the Internet, but also by human behavior in natural conditions (traffic, investments, migration, etc.). This is the challenge of so called Big Data science, and it is a challenge that only machine intelligence can help us face. At some point, machines will no longer only support traditional human scientists, but rather will start making major scientific discoveries on their own, by intelligently managing huge amounts of data, demonstrating theorems, interpreting the laws and mechanisms of those data, and more.

In sum, in a few years, no computing no science. Whatever the details of the incoming revolution, Turing demands from us that we face it with open eyes, instead of squabbling over petty disputes and ill-formulated problems. Had this paper been published at the onset of the AI enterprise, 60 years ago, it would have probably been drowned in a wave of misplaced enthusiasm, or hailed for all the wrong reasons. Nowadays, instead, its message can resound all the more clearly, offering us a much needed call to arms. Intelligence, artificial *and* natural, is changing, and we better be ready for it.