

# The Society of Brains: How Alan Turing and Marvin Minsky Were Both Right

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**Abstract.** In his well-known prediction, Alan Turing stated that computer intelligence would surpass human intelligence by the year 2000. Although the Turing Test, as it became known, was devised to be played by one human against one computer, this is not a fair setup. Every human is a part of a social network, and a fairer comparison would be a contest between one human at the console and a network of computers behind the console.

Around the year 2000, the number of web pages on the WWW overtook the number of neurons in the human brain. But these websites would be of little use without the ability to search for knowledge. By the year 2000 Google Inc. had become the search engine of choice, and the WWW became an intelligent entity. This was not without good reason. The basis for the search engine was the analysis of the 'network of knowledge'. The PageRank algorithm, linking information on the web according to the hierarchy of 'link popularity', continues to provide the basis for all of Google's web search tools. While PageRank was developed by Larry Page and Sergey Brin in 1996 as part of a research project about a new kind of search engine, PageRank is in its essence the key to representing and using static knowledge in an emergent intelligent system.

Here I argue that Alan Turing was right, as hybrid human-computer internet machines have already surpassed our individual intelligence - this was done around the year 2000 by the Internet - the socially-minded, human-computer hybrid *Homo computabilis-socialis*. Ironically, the Internet's intelligence also emerged to a large extent from 'exploiting' humans - the key to the emergence of machine intelligence has been discussed by Marvin Minsky in his work on the foundations of intelligence through interacting agents' knowledge.

As a consequence, a decade and a half decade into the 21st century, we appear to be much better equipped to tackle the problem of the social origins of humanity - in particular thanks to the power of the intelligent partner-in-the-quest machine, however, we should not wait too long...

## 1. Introduction

Our ability to form a functional unity with the tools we use is almost proverbial. And indeed we are particularly good at making and using machines. This ability to form functional 'imaginary' unity scales both up and down. It scales down to brain modules and neuronal assemblies, possibly to individual cell interactions. And it scales up to interpersonal relations, social assemblies of individuals and organisational modules and structures - along the dimension of social network



interactions. Analysing the properties and understanding the mechanisms of emergence of such functional networks (of networks) of interactions may be essential in grasping the origins and basis of human conscious intelligence.

## 2. Networks of Brain Networks

The neurons and glia cells in our brains form a hybrid network of networks and an apparent, albeit as of today still only speculative, scaling continuum of social interactions with the outside world. Throughout the evolutionary refinement leading to the modern organisation of our (*Homo Sapiens*) complex society, one mechanism appears dominant. The organisation of our brains adapts to the increasing complexity of societal organisation. As this complexity of societal organisation increases, apparently so does that of our self-aware, conscious existence.

The amazingly complex working of hybrid brain networks is far from being understood. Yet, the bonding concept behind our interpretation of the guiding principle behind the adaptive complexity of this system is its ability ‘intelligently’ to process information. Even the neuronal networks grown *in vitro* are capable of developing ‘intelligent’ communication resembling that of human social interactions. Orlandi et al. [1] recently studied the mechanism of burst propagation in cultured neuronal networks observed with high-resolution calcium imaging and *in silico*. They identified what could be described as an emerging ‘functional adaptive network’ - a set of points specific to each culture and selected by a non-trivial interplay between the dynamics and the topology of the network. On the basis of the statistics of avalanche size at different scales, they have shown that one may identify different effective networks which decompose the dynamics into separate layers. The focal points which appeared to be most influential in the global dynamics did not exactly follow local properties of the original or the effective network for large avalanches, but resulted from complex patterns of propagation. This mechanism appears to have direct correspondence with that of rumour propagation in social networks, where the role of the integrate-and-fire response is played by the so-called illusion-of-truth effect, that is, the requisite of repeated inputs to grant credibility, before propagation. Accordingly, not only the rumour activity network will differ from the underlying social network, but the points of rumour ignition will in general depart from the actual community structure of both the social and the effective networks.

Such functional mapping may exist at the level of higher brain networks. Indeed, neuronal networks of our brains have an amazing capability to form a functional unity with the tools we create, including the ‘instruments’ of our societal, religious and cultural systems. One such mechanism, of ‘mirror neurons’ claimed to have been discovered in macaques, shows that premotor and parietal cortical areas are not only involved in executing ones own movement, but are also active when observing the action of others. To date there is, however, relatively weak evidence for the existence of a circuit with ‘mirror properties in humans, such as that described in monkeys [2]. Although debates about the evolution of the mirror neuron system imply that it is an adaptation for understanding of actions, an alternative, simpler explanation suggests that mirror neurons may be a by-product of associative learning. Heyes [3] argues that the mirror neuron system is a product, as well as a process, of social interaction. The associative account implies that mirror neurons come from sensorimotor experience, and that much of this experience is obtained through interaction with others.

While the ‘mirror neuron network’ primarily aims at explaining sensorimotor behaviour, the paradigm and research questions of ‘neuroeconomics’ address the greater concept of social mechanism and choices. However, they may lead to a paradox, as other primates are likely better than us at survival games [5]. What they apparently miss are the multi-dimensions and multi-scales of both the social and temporal horizons and the associated complexity of conscious strategy making. Humans are particularly good at deception games, rumour spreading and social bonding through ‘gossip’. These and other social tools have been highly developed by

Homo sapiens and constitute the intrinsic fabric of our social intelligence. Furthermore, humans have perfected ‘scaling’ principles in applying these social interaction practices, through which they apply the rules to social structures of arbitrary size. One recent study of interest in this context analysed the bonding effect of pro-social lies as opposed to destructive anti-social lies [4]. Indeed, such manipulative practices are considered to be distinctly ‘human’. Yet, the possibility of simulating these on ‘non-human’ models and von Neumann computer architectures suggests something quite to the contrary - that our treasured ‘intelligent’ behaviours may be shared by any social group of machines.

There are recent ongoing efforts to model and study through simulation in the context of the increasingly popular discipline of ‘socio-physics’. Indeed, the agents which are studied do possess only minimal ‘intelligence’ yet their collective behaviour may exhibit capacities to form emergent intelligent behaviours – which may also be scaling.

Intrapolating (extrapolating downwards the scales) social bonding mechanisms is at this point highly speculative. Yet, one cannot exclude the possibility that the neuronal networks could behave just like ourselves and ‘play’ ‘mirroring’ - or ‘aping’ and ‘imitation’, ‘deception’, pro- and anti-social ‘rumour’ and ‘gossip spreading’ games. While the similarity of the behaviour observed by Orlandi et al. [1] in neuronal networks and our social interactions may be strictly formal, the possibility that such behaviour scales across the ‘brain-society-barrier’ is captivating and deserves future formal and experimental exploration.

### 3. Homo computabilis-socialis

The title of this article purposefully resembles that of the Marvin Minsky’s highly acclaimed book. Indeed, as also discussed above, not necessarily intelligent agents may develop ‘machine’ intelligence through network-scale interactions – which is also the central concept behind Minsky’s work<sup>1</sup>. However, there is an irresistibly tantalising twist to this idea, which is also somewhat petrifying. The concept of mindless agents can be – and indeed is – explored in the context of socio-physics to model ourselves i.e. Homo sapiens involved in a network of interactions leading to emergent intelligence.

For this reason, the apparent re-use of the title is to echo the famous work and the concept but it is not supposed to mimic the subject of the book - at least not within this section. Here, the title of the book is evoked in a new meaning, as here humans play the role of not necessarily intelligent ‘agents’ involved in social interactions and advanced into an intelligent society. This evolution process is reciprocal in that the agents locally ‘mirror’ to a certain degree the intelligence of the societal network in which they are embedded. Such ‘mirroring’ or social subgroup formation has been discussed in the previous section in the example context of bonding mechanisms of information spreading. The mechanisms involved are, however, multi-level and multi-modal and these have been extensively studied in the field of human individual psychology and reciprocal social behaviours. There would be little to add to these well established insights if we were to evaluate the ‘intelligence’ of human beings. But we are not – in his well-known prediction, Alan Turing stated that computer intelligence would surpass human intelligence by the year 2000. Although the Turing Test, as it became known, was devised to be played by one human against one computer, this is not a fair setup. Every human is a part of a social network, and a more fair comparison is that between one human at the console and a network of computers behind the console.<sup>2</sup>

Towards the year 2000, the number of web pages on the WWW overtook the number of neurons in the human brain. But these websites would be of little use without the ability to

<sup>1</sup> Minsky postulated that human intelligence arises from interactions of mindless ‘agents’ as constituting a ‘society of mind’, hence the title.[6]

<sup>2</sup> The Turing Test was debatably passed by a stand-alone computer during the 2014 University of Reading competition. This test was, however, subject to constraints and has been criticised.

search for knowledge. By the year 2000 Google Inc. became the search engine of choice [7] and the WWW became an intelligent entity. This was not without good reason. The basis for the search engine was the analysis of the ‘network of knowledge’. The PageRank algorithm, linking information on the web according to the hierarchy of ‘link popularity’, continues to provide the basis for all of Google’s web search tools [8]. While PageRank was developed by Larry Page and Sergey Brin in 1996 as part of a research project about a new kind of search engine, the idea of formulating a link analysis problem as an eigenvalue problem was apparently first suggested in 1976 by Gabriel Pinski and Francis Narin, in their work in the context of the ‘scientometrics’ discipline of ranking scientific journals [9].

While the Pinsky and Narin were among the pioneers of ‘scientometrics’, the discipline is now flourishing in the modern physics of social interactions, in particular in more recent efforts aiming at modelling and characterising knowledge flow and innovation emergence. Yet, while physics provides models and experiments, these efforts have remained far behind an unprecedented development in the history of mankind and apparently of any kind of intelligent life of which we are aware. Indeed – Alan Turing was right, as hybrid human-computer internet machines powered by ‘enslaved’ humans feeding them with information and interacting with them have already surpassed our individual intelligence. This, coincidentally or not, has happened around the year 2000 with the Internet – the socially-minded, human-computer hybrid *Homo computabilis-socialis*.

Through engaging unparalleled conjoint effort of neuroscience, physics, psychological and social sciences, we are now much better equipped to tackle the problem of the social origins of humanity. Yet, as of today, we may still be unable to obtain sufficient insight to understand the very basis of our individual and social conscious intelligence. We cannot, however, delay much longer with making the understanding our own human nature a priority. Paradoxically, the machines we produce and with which we interact may understand us before we do.

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