Idan Segev: THE MYSTERIES OF THE BRAIN

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Idan Segev is Professor in Computational Neuroscience, Head of the Department of Neurobiology and of the Drahi Brain Computation and Communication Lab at the Hebrew University of Jerusalem. He is one of the leaders of the *Human Brain Project* in collaboration with the École Polytechnique Fédérale de Lausanne which received a support of €1 billion from the EU for 10 years. The HBP team is aiming to replicate and mathematically simulate and model in fine detail the human brain on a computer. Such a digital copy of the human brain will significantly deepen our understanding of both the healthy and the sick brain; the hope is that this will provide revolutionary understanding of brain operations and create new treatments for brain diseases. We met Professor Segev in London in March 2018, where he gave a talk, with the artist Sir Antony Gormley, discussing "brain and creativity". This event took place at the White Cube and was organised by the *Brain Circle UK* and *Spirit Now London.*

Is our brain very similar to a computer?
The brain is very different compared with the present-day digital computer in both its structure and principles of operation. Among the many differences, one major difference is that the brain, with its sophisticated "microchips" (synapses) constantly changes (physically) in response to the ever-changing environment (namely, it learns). The digital computer is structurally static. Another fascinating difference is that the brain does all its computation with minimal energy consumption (20 Watts); the digital computer (especially the supercomputer used for our large-scale brain simulations) is terribly expensive energetically.

Is the brain more than just what it is made of?
No – the brain (like any other body organ) is composed of physical units. In the case of the brain it consists of nerve cells, glia supporting cells, blood vessels, connections between cells (synapses) forming large neuronal networks of connected cells, forming various brain regions, etc. It is this whole physical organ, with its electrical and chemical activity, which creates the emergent phenomena that we experience – emotions, consciousness, creativity, memory. The human brain is particularly complex as it contains 100 billion nerve cells and 1015 synapses; this enables unique capabilities for our brain as compared to other species.

How will the modelling of the brain help us to cure degenerative diseases?
We actually do not fully understand any of the 360 neurological and neuropsychiatric brain-related diseases. All of these diseases are the result of many parameters (death of certain cell types, dysfunction of certain synapses, etc.) that go out of their normal "balance". We need a comprehensive way for integrating the many parameters that give rise to a disease.

Will the simulated version of our brain also have emotions such as love?
Not in near future but probably yes at some point. This modelled brain should be connected to a body with relevant sensors (vision, hearing, smell etc…), and should undergo real-life ongoing interaction with the environment (with loving parents, with other such computer models). The computer circuit should also be able to learn and change as in our brain. Then, in principle, I see no reason why this machine will not behave like us, including feeling. But this will take some time to get there. Much before that, the machine we are building will help us understand ourselves, and become our companion for many purposes, not our replacement.

Is emotion and love just a chemical reaction instructed by the brain?
Yes, it is amazing and fantastic that a chemical / electrical reaction could give rise to subjective feelings and to consciousness. This is a fascinating aspect of our material brain.

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