Computation, Humanities, and the Brain:

The Benefit to Cross-Disciplinary Neuroscience and Computation

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HUMN-2007-001 Computational History & Theory

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March 21, 2017

Abstract

The materiality of computation comes into play in its constant referral back to the human form; specifically, this will be explored in the context of the computation done by the human brain, and the technology the attempts to copy and improve on it. Looking at the history of two fields – neurovirology and the study of artificial neural networks – and regarding them both under the umbrella of computational neuroscience, this paper explores now both fields could benefit from each other in joint study of viral infections. Of the current projects out there, the Human Brain Project serves as a foundational project in further exploring this topic with the attempt to create a fully working model of the human brain.

Keywords: neurovirology, artificial neural networks, computation, neuroscience, viruses

Computation in a humanities context means to study the diversity of applications, rather than limiting computational studies to merely the mathematical equations involved in computation. Of fields to benefit, technological and medicinal studies could advance greatly come out of a collaboration between the studies of artificial neural network technology, and neurovirology.[1] Looking at this in the context of biological computation, and regarding past studies done overlapping the two fields, it is clear there is a great potential for both to benefit from further research in the coming decades, as technology advances to be able to create working simulations of the original physical models.

While one is a technological study and one is a biological, both can be viewed from the perspective of neurosciences; both deal with the nervous systems of their respective studies, the brain being the most complex of all the neurological systems to study. Artificial neural networks, sometimes just referred to as ‘neural nets’, have been created to mimic these systems, and are defined by Hopfield and Tank, as “models [that] abstract from the complexity of individual neurons and the patterns of connectivity in exchange for analytical tractability” (as cited in Seinowski, Koch and Churchland, 1988, p. 1301). Companies such as Brain Corporation have thus far created smaller, novel models of the human brain and neurological systems (Artificial Brains, 2013) with neural net technology.[2] However the projection for a fully working model of the brain is currently set at the year 2023, according to *Artificial Brains* in their article on the

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[1] Johnson states that the term NeuroVirology was created in 1961 by Elizabeth Hartman (Johnson, 1995). She is also said to have worked in NeuroRadiology (JMT).

[2] Brain Corporation has focused on mainly building autonomous A.I. models for purposes such as navigation. Their website is listed at https://www.braincorp.com/

Human Brain Project (Artificial Brains, 2013).[3] They have started to touch on one aspect of use for these models besides advanced artificial intelligence, and that is stated in their objectives in that they wish to "[g]ather, organise and disseminate data describing the brain and its diseases" (Human Brain Project). This is where the tie to fields such as neurovirology emerge. Neurovirology specifically focuses on a combination of studying viruses, neuroscience, immunity and molecular biology all in one field (Johnson, 1995). Having a digital model of a brain to stand in for a live one would allow for research to be conducted on the spread of viruses through a neurological system without needing a human patient. Through this, studies could be conducted on rare brain viruses, such as both version of encephalitis[4] and how it can spread through the brain, via a simulated version of it created for a version of the neural network.

Regarding this through a joining field of computational neuroscience, the project being attempted by the Human Brain Project would fall under the category of a *realistic brain model*[5], despite being a neural network, on the basis of its scale in comparison to the human brain. Unlike

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[3] A longer article on the subject can be found at http://www.nature.com/news/brain-simulation-and-graphene-projects-win-billion-euro-competition-1.12291

[4] The two types of encephalitis are primary and secondary encephalitis, and both types are generally caused by other viruses in the human body first (Johnson, 2015).

[5] This is based on the classifications provided by Sejnowski, Koch and Churchland in their paper entitled *Computational Neuroscience*. The types of brain model defined by them are classified as *realistic* and *simplified* models, which are defined based on the scale of the simulation (Seinowski, Koch and Churchland, 1988, p. 1301).

the reference Seinowski, Koch and Chuchland make to the work of Mead[6], who uses hardware circuits to mimic the physicality of circuits in our brain (Seinowski, Koch and Churchland, 1988, p. 1301), the Human Brain Project is focusing solely on the use of a neural network to accomplish their goals. As this project is still in the early stages of its lifespan, we can only project for the future. Based on the spread of viruses like encephalitis and how they travel through nerves to attack the temporal lobe of the brain (Johnson, 2015), this model could be viewed in real time to see how the virus would spread through the brain, and the simulation used in encephalitis research on how to combat the virus, rather than just treat symptoms in the future. This could be done via infecting a version of the neural network with a digital creation of that virus and then observing how the simulation progresses, the benefit being to this that while it would affect the neural network, it would be a digital creation that could be replicated across multiple simulations and studied with a greater efficiency than a patient by patient basis.

In reverse, biological methods of combating viruses can be in turn incorporated into a neural network on the opposite side of benefits. As neural network technology advances and we gain a better understanding of how they function, we can begin to use them to protect digital devices via immunization. A computer virus functions much the same way as a virus that infects humans, so it is not implausible to suggest that a vaccine could be developed for a neural network as well, administered, and used as a training method for more advanced anti-virus systems than what are currently present and available for use. A neural network could be taught, over generations, to recognize computer viruses that have been rendered almost dormant to

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[6] For further reading, Seinowski et al have cited Mead's work, entitled *Analog VLSI and Neural Systems.*

detect the patterns through which they spread through a system, and learn to combat them, or deny them immediately without risk of infection.

One potential argument against this is the processing power currently necessary to run such an extensive neural network – a home computer would not have the capability of running a network such as this one on its system. However, since cloud computing has gained increased usage and recognition, such a service could be provided from the cloud, rather than directly on the end-user's hardware. This anti-virus software could then be hosted on an alternate server, and be more robust, providing protection for people's personal devices more efficiently than current anti-virus programs. With the use of machine learning, it would be able to keep up with any changes made to computer viruses, and stop them before they reach the end destination.

While the technology might not be available yet, there is a large chance it will be able to fulfil these requirements in the future, as Geoffrey Hinton discovered. When he began researching neural networks in the 1980s, computers were neither fast enough nor powerful enough to keep up with the demands needed to process a neural net (Hernandez, 2014). It is comparable to the work of Ada Lovelace and Charles Babbage in that their own machines were too advanced in design for what the technology could support at the time (Lauder, 2017). What remains consistent between both of their works is that both parties persisted in their research, and while Lovelace and Babbage may never have seen their machine come to creation, Hinton did as technology continues to advance at an increasingly rapid pace. With Hinton leading a front on neural networks and the success he's shown[7], the ambitious work of the Human Brain Project,

[7] "In 2011, an NCAP researcher and Stanford processor named Andrew Ng founded a deep learning project at Google, and today, the company is using neural networks to help recognize

their ten-year time period is a reasonable period of time to make this leap to a working, realistic model of the human brain.

With technological advances finally making research possible on neural networks, we have not even begun to reach the limitations of this field, and within the next ten years it will undoubtedly cause an explosion of progress not limited to just artificial intelligence. With the potential to benefit neurology, in fields like neurovirology, it also has the capacity to be of benefit in other fields of neurology, biological sciences and in the study of evolution across a number of generations of neural networks that each learn from the last. There is no doubt that it will continue to transform the physical world from it's digital space, and in turn, will grow further from advances we make, leading to a continuous, positive feedback loop.

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voice commands on Android phones and tag images on the Google+ social network. Last year, Hinton joined the company, alongside other researchers from the University of Toronto" (Hernandez, 2014)

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