Paper Review : Levels and Loops

Kartik Srinivas

IIT Hyderabad, India

Hyderabad, India

es20btech11015@iith.ac.in

I. GENERAL NOTES

The paper [Bel99] is well organized and has been divided into several sections, describing the History and latent questions in the fields of Artificial intelligence and Neuroscience. We shall review them in order, and later as a whole.

II. INTRODUCTION AND SCIENCE TODAY

The author starts with an extensive anecdote of how society views the future of Humanity and the universe. The anecdote is humorous and captivates the reader, it also shows the immense expectations that society has with respect to Science. He, later on, gives us another humorous story about the cutting of Military funding on research projects due to the "inability" to produce self-automated tanks. The author then gives a brief introduction to Symbolic and behavioral AI [1]. The Introduction is perfect, it draws attention and forces the reader to inquire about the real limitations of Science.

III. ON ARTIFICIAL INTELLIGENCE

The author claims that the main goal of AI is to build a model of the brain(a Turing machine) that runs a 'mental program'. He calls this the *functionalist* point of view. The functionalist point of view is supported by many(not including Roger Penrose whose claim's essence is that the brain's physical and mental parts may not be actually separable). The author discusses a fundamental rule in the action-perception system of Behavioral models, he states that the perception system of a behavioral AI model will affect its actions which will in turn affect its perception(input statistics), making the learning **cyclic**. Further he states that this cyclic behavior is what is causing the statisticians to wander away from generalized goals like *"finding hidden symmetries"* and instead fix their models to do *special* goals(Supervised Learning). However, he claims that this only works because we are *"familiar enough with the flux of goals in our personal experiences to desire something more invariant to underly action selection"*[2] Many statements made in this section are lacking rigor, but that can be excused since it is meant to only give an intuitive idea for the non-mathematical readers.

IV. ON NEUROSCIENCE

The author first abolishes the widespread theory that the genome controls the phenotypes, he gives a series of extensive examples that explain the *cyclic* molecular-biophysical processes that control the actual structure of the proteins and amino acids that are in play. This is a very insightful paragraph for non-biological readers, since it spills the beans on the widespread saying that we are "Puppets of our own genome". He also gives us a good idea of how statistical inferences are made to create a *feed-forward system*. He states that if X and Y are statistically correlated, then people tend to assume that $X \implies Y$, and they estimate the joint after measuring the marginal $p(x)$ and prior $p(y|x)$, (which will be wrong if X and Y are being controlled by a latent Z). The argument is valid, but does not show/value the ease of analysis after assuming a certain direction of causality.

Levels: The author circles back to his criticism of the *functionalist* point of view by challenging it to state a *level* where the brain can be separated into *independent* logic gates that *deterministically* give results as functions of their input. He goes on to show that this statement will surely hold wrong at the Neuron level and later on shows that not even the type and number of molecules will suffice to give a *state specification* for the brain. The only alternative was to then look at molecular computing, which the author disproved by quoting results related to "quantum effects" and "structured water", showing that interactions between molecules also change the outputs of this *functionalist "Turing Machine"*.

The author still is optimistic about the prospects of AI and neuroscience despite his harsh comments, stating that they will eventually *come around* to this new theory of cycles which will despite be a *blow to the present feed forward analysis*, will not lead to the extinction of Neuro-scientists and Physicists. He shows the vulnerability of all sorts of models by citing *Gödel's* Incompleteness theorem, and teaches the readers that all models have their "paradoxes".

V. OVERALL REVIEW

The paper has been written very systematically. It is an entertaining paper filled with anecdotes and cross references, but because of this, it also lacks real **rigor** in the argument. The author does claim that several papers have shown that molecular biophysical processes are controlling spiking of neurons and also are creating a feedback system, but there are no citations for this critical argument [3]. The author should also pay a *little emphasis* on the merits of the functionalist point of view also. Simply his belief in it, won't be sufficient to convince the skeptical reader. Overall the paper does an

---

[1] For more on Behavioral AI, see [III]

[2] Section 4 Last line

[3] Sec 7(c)

excellent job of showing us both sides of the coin of Neuro-science.

Paper rating -8/10

REFERENCES

[Bel99] Anthony J Bell. Levels and loops: the future of artificial intelligence and neuroscience. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, 354(1392):2013–2020, 1999.