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Lab Section 8

Artificial Intelligence: Organic Transistors, Preferences and Mental States

In the exploration of creating artificial intelligence (A.I.), it is important to rely on the abilities of the system to infer (post priori) and able to give negative responses to certain questions or have mental states (will be defined later). Before continuing with the actual methods of how to construct the A.I., some philosophical inquires must be investigated.

Recent research concerning A.I. has been revolved around the idea of creating systems that are able to respond correctly to questions asked (Chalmers 2002). In the research of creating systems that have emotions is also revolved around a computational outlook that seems to model human emotion. However, this approach seems to present limited possibilities of achieving the goal of creating authentic intelligence. For an A.I. to answer questions such as "What do you see?" is almost the same as asking a child the same question. The reason being is that both will rely upon physical attributes (for the child eyes, and the A.I. some kind of sensory perception device) to first perceive the environment then computationally search for a data base that will correspond objects with a particular vocabulary set to give an answer of "I see chairs, candles, a television...etc." The question presented "What do you see?" is not just a question of perceiving the physical environment. The A.I. may see the same objects as the child and respond with the "correct" answers (it may even be able to answer in a larger set of vocabulary), but the child can attribute qualities to the objects such as bad, good, or dislike. The A.I. however, may not be able to spontaneously have preferences. A human can operate a software system as a computer does.

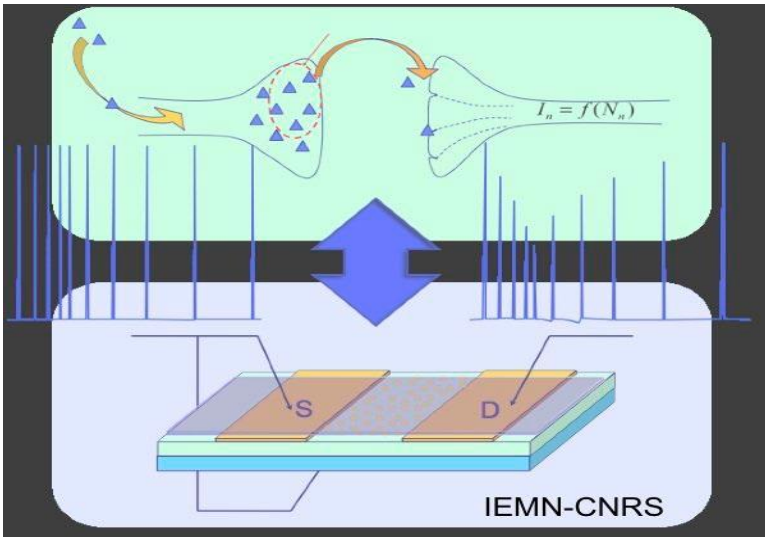
It is easily known how a certain computer thinks, but it is quite hard to know how a certain mind thinks. Therefore, it is important to note that the human mind of processing information cannot be reduced to algorithmic procedures, at least not in the mathematical sense as computers.

Furthermore, the foundations of negative responses and mental states must be established as a core element of the A.I. By negative responses, it is meant to answer questions that seem to not give a direct answer. For instance, if the same question of "what do you see?" was asked, the child may answer "I don't care." The A.I. must have the same abilities as the child to answer in such a way to qualify as being a true A.I. However, isn't this whole problem with A.I.? To answer the question, the mental states of the mind need to be explored.

If a further question "Do you like anything in here?" was asked. The current A.I. might not be able to answer the question or answer it spontaneously. The child, however, may say that he or she likes all the things, or that the chair looks nice but not the candle. It is important to define that spontaneity in this context as an answer that does not require much reasoning. To give a more concrete presentation, find random objects that you do not like and attribute reasons for not liking it. Given an example such as neon green. A person may not like neon green because the color is too bright. However, if the person were to like neon yellow, then it would not make much sense to not like neon green since the shade and brightness of the colors are similar. What if the person likes every single color and its various shades except for neon green? What will be the reasoning to it? In fact, it would probably be "I just don't like it." Such a statement does not make much sense except that it is not perceptually appealing to the person. The spontaneity here is to allude to the definition of mental states that will be a fundamental element to the creation of A.I.

After some fundamental questions concerning the A.I. are asked, it is more important to advance from the groundwork of questions to formulations of the actual system. As it has been implied, the A.I. needs to have the ability to have preferences, respond negatively and contain spontaneity. The investigation of this paper will focus on the neocortex of mammals as a model for the A.I. Furthermore, the A.I. is not going to be simply a replica, but rather a forming brain. It is found that intelligence is formed by the connection of neurons through synapses, called synaptic plasticity (Gerrow, Kimberly, Antoine 2010). The structural synapse contains two fundamental types: A chemical synapse and an electrical synapse (Gerrow, Kimberly, Antoine 2010). By focusing on the electrical synapse, it will be relevant to model random connectivity of neurons as bases for preferences of the A.I. and perhaps allowing it to have a more authentic intelligence rather than a computational one.

As it was mentioned, the A.I. will be under a construction model of a forming brain. The forming brain of the system is to rely on the ability to learn and thus creating its own ability to have preferences and mental states. An important finding that is useful to such a proposal is the idea of organic transistors.



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The transistor acts as a conducting channel between a source and an electrode. The change in voltage on the electrode affects the amount of charge flowing between the systems (Alibart 2010). Like synapses and the neocortex in simple terms, it functions like a transistor in a circuit (the brain) controlling a large amount of current or voltage and used to amplify electronic signals. The voltage is also affected by the cells of the brain and the transistor allows the connectivity of neurons to flourish thus allowing the brain to learn. Furthermore, an existing organic transistor based on pentacene and gold nano-particles already mimics the connections of neurons in the brain and its operations at a superficial level (Gerrow, Kimberly, Antoine 2010). The possibilities of this type of transistor would be that it could be employed as groups of transistors to simulate the synaptic operations that occur in the brain, though further advance investigations are needed.

If the organic transistor is taken as a building block for the A.I. then the artificial intelligence system now has a framework to build upon. A framework that is organic rather than strictly computational. Furthermore, it is crucial to observe just exactly how synaptic plasticity is achieved and formulate mathematical descriptions of it to construct transistors and simulation to an exact degree of accuracy.

Such mathematical description has already been developed and able to demonstrate various synaptic processes. The following is a brief demonstration of some fundamental mathematical model of neocortical synapses (Markram, Klaus, Misha 1998):

$$\frac{dx}{dt} = \frac{z}{\tau_{rec}} - U_{SE}x(t_{sp} - 0)\delta(t - t_{sp})$$

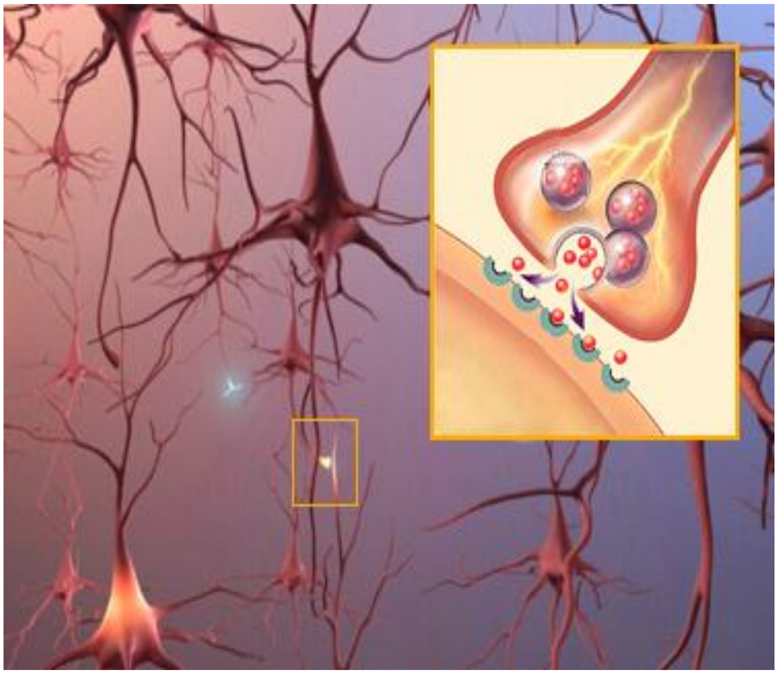
$$\frac{dy}{dt} = -\frac{y}{\tau_{in}} + U_{SE}x(t_{sp} - 0)\delta(t - t_{sp})$$

$$\frac{dz}{dt} = \frac{y}{\tau_{in}} - \frac{z}{\tau_{rec}}$$

Where x, y, and z are the fractions of resources in the recovered, active, and inactive states, respectively. The synaptic current is taken to be proportional to the fraction of resources in the active state, $I_s(t) = A_{SE}y(t)$. The two major parameters of the model are A_{SE}, the absolute synaptic strength, which can be exhibited only by activating all of the resources, and U_{SE}, which determines the dynamics of the synaptic response. For an individual synapse, the model reproduces the postsynaptic responses generated neural networks with dynamic synapses (Markram, Klaus, Misha 1998).

It has been stressed constantly that the A.I. should not be computational. However, the system should not be computationally based but it can still have computational elements to it. In fact, there are many theories that the brain is computational, or so called functionalism, but it is not particularly supported by the opinions of this paper. It is a challenge to find methods that allow the artificial intelligence to possess true intelligence. So far, basics of synaptic processes were shown and possible technological devices were introduced to give a hint of how to build the A.I. These descriptions do not solve the problem.

The transistor is the key element to the A.I. and some implications of it can be deduced. However, another synaptic process needs to be introduced. Synaptic plasticity has a process that allows electrical activity in one nerve cell to interact with another creating sparks and connections of neurons. These activities are called synaptic transmissions that are also fundamental to the learning and memory of the neocortex (Newmon 2006).



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If the organic transistor is the conducting channel between a source and an electrode, and the synapses form the circuit (and the brain), then the transistor is the channel in which outside stimulation that will cause electrical activity to be conducted into the circuit to cause the synapses to activate its synaptic transmissions. If this is the case, then perhaps the neocortex of the A.I. is created. Although the transistors might provide a blue print for constructing a brain for the A.I., it is likely that the number of transistors required to achieve this is high.

The synaptic plasticity is not the only key element to the artificial intelligence system. Computational methods need to be employed at some point to evaluate the capabilities of the system. However, by computation, it means that the A.I. needs some form of communicational skills to demonstrate that it indeed can think. If the transistors functioning as the neocortex for the artificial system works, the breakthrough would be that the A.I. can not only operate with intelligence but that it can learn and develop preferences. It will not only give a description of what a room contains, but it will also attribute values to the objects that the A.I. sees. A further implication would be that each system would have a different development and thus resulting in different personalities.

The development of such an A.I. will give great insight to the operation of the mind. Such a system will shed a great light on the studies of people with mental illness. However, there are more applications to the A.I. and implications that a society would still not be able to grasp, and much opposition to such an idea is expected.

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