A Toy Model of Consciousness and Connectomes, First Approximation

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Abstract

Former work on cooperative phenomena is adapted in order to visualize, to a first approximation, the concepts of consciousness and connectomes. It is hoped that such work can help in the treatment of Alzheimer Disease (AZ) and entice Roger Penrose et alia to continue their pioneering work in these fields. A set of phases are construed to contain neurons in their inactive form in equilibrium with other phases of neurons in their active phase in various stages of connection with each other. The active neurons are connected to each other such that their synapses conduct chemical and electrical contacts. These constellations lead to various incipient lattices that are characterized by the various strengths and number of their connections. Coordination numbers for each neuron, degrees of completion of their lattices and, the time of formation are important. Critical areas on neural networks that occur over a period of time are detailed. The degree of consciousness is deemed to be a function of particular properties which are shown in a collection of graphs.

Introduction

Hijmans and de Boer developed further a system approximation procedure of Kikuchi that decomposed a lattice into certain simple figures and various possible modes of distribution of particles among the vertices of these figures. This lattice is considered to be in equilibrium with another phase of these particles and the free energy of the lattice particles is a linear combination of the free energy of the simple figures. The chemical potential of the assembly of particles in each phase are set equal and this leads to equilibrium relations relating the pressure in the fluid phase to the coverage of the particles in the lattice phase. The distribution numbers for the configurations of the different figures are interrelated by geometric consistency relations within the lattice, and by normalization requirements. The set of all equilibrium, consistency and normalizing relations lead to the elimination of all unnecessary variables and finally provide an equation which relates the pressure to the surface coverage only in terms of parameters containing interaction energies and temperature.

In a former application of the model to physical adsorption of a gas on a solid, the first approximation yielded the Langmuir isotherm. The second approximation, in which the lattice is represented as a supposition of point and bonds yielded Fowler's more refined isotherm. All of this work was published in a doctoral thesis by Bumble and a paper was published in the Journal of chemical Physics more than fifty years ago as an application of Hijman's and de Boer's method. This approximation was then advanced from the simple bond figure to a triangle figure and then a rhombus figure, thus bringing closer agreement with experimental results, which entailed more difficult mathematical work. However, it included next nearest lateral interactions among the particles as well as nearest lateral interactions among the particles. As the detailed mathematics is presented in the earlier publications, they will not be presented in this one. This publication will use the same statistical mechanics and apply it to the problems of modeling consciousness and the connectome.

Special Note

Presently in the U. S. the number of Alzheimer (AZ) patients is over 5 million. One third of senior citizens in the U. S. die with this disease. By 2050, the number of patients is expected to rise to 11 to 16 million and a new patient will occur every 33 seconds with one million new patients every year. In 2013 the expected cost in the U S will be $203 billion rising to $1.2 trillion by 2050. The US administration prioritizes this disease. Dr. Francis Collins has designated $40 million for research in 2013 and President Obama will add $80 Billion in the fiscal year 2014 over and above what is being already supported. This paper is an attempt to fight AZ by providing fresh insight into the nature of neural networks whose functions lead to proper memory associations before AZ starts.

The Model

In more recent times, the former model for (1) the physical adsorption application was also used in (2) the astrophysics application and applied to a multiverse containing dark energy. In this case we have a number of universes, each one capable of being in equilibrium with others. The mathematical equation that was used in the model here is contained in vixra:1303.0046, Astrophysics, by Stan Bumble. This article was entitled Dark Energy: Order-Disorder in the Cosmos and entered in the Astrophysics category. The variable Z in the first graph in that paper was used to plot curves useful in the present paper (although mention of that was neglected in the published paper). This led to (3) the consciousness application, the conception of a fluid or gas, composed of inactive neurons instead of particles, which are in equilibrium with a number of universes or phases that contain an assembly of active neurons that are in the process of forming a lattice. This present phase is contained within a brain. The universes in the astrophysics application were in shapes called branes which are flat and the phases of neurons can also be conceived as branes. So the physics of the very large field (astronomy) has similarity to the small space within the brain. Thus we may use the same resulting equation but the variables or symbols have different meanings. The equation we will use in this third application is

$N_s = (\Theta_s/(1-\Theta_s)(\beta_s-1+2\Theta_s/2\Theta_sC_s)^Z$ and $\beta_s = (1+4\Theta_sC_s(1-\Theta_s)(C_s-1))^{1/2}$

which is the same as that in application 1 and 2 except that symbols have the subscript S when they pertain to the model used for consciousness and Z here is the coordination number in the neural lattice.

Now the symbols in the above equations are as follows: N_s is a variable that will be deemed "the consciousness', Θ_s is the coverage of the lattice, with unity designated as full coverage, C_s is the synapse strength and β_s pertains to the consciousness model.

The computations are carried out in Excel by inserting the values of Θ_s, C_s, Z, β_s and C_s in the proper cells and using the structure of Excel to label the axes, title and legend of the graphs 1 through 6 that follow.

Results

Critical values for the plots of N_s vs. neuron density were approximated for each of the plots shown above. This is defined as the value of C_s that causes the plot to become horizontal. This is shown for each graph below for each set of values including Z, C_s. and N_s.

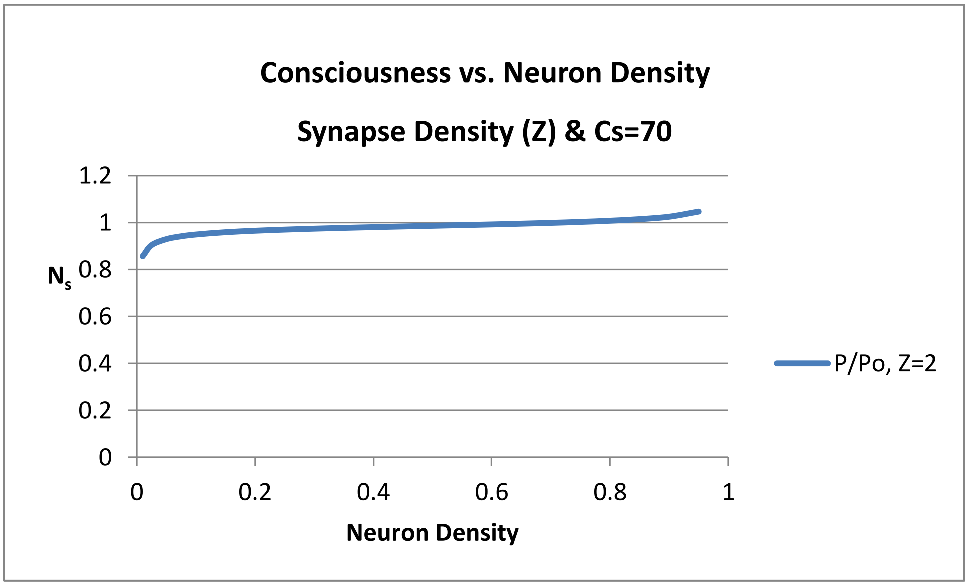

Figure 1. N_s vs.. Θ_s for Z=2 & C_s=70

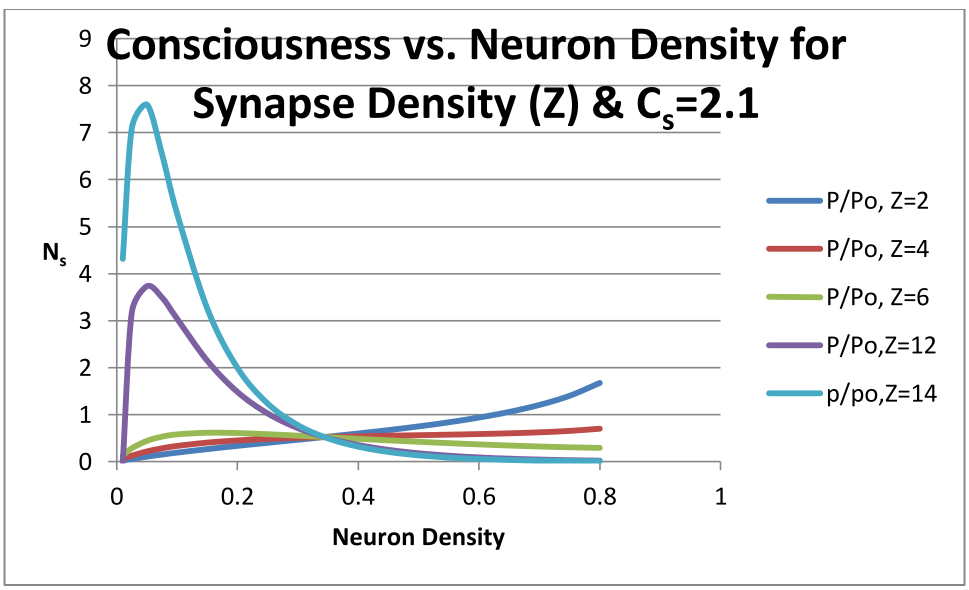

Figure 2. N_s vs. Θ_s for Z=4 & C_s=2.1

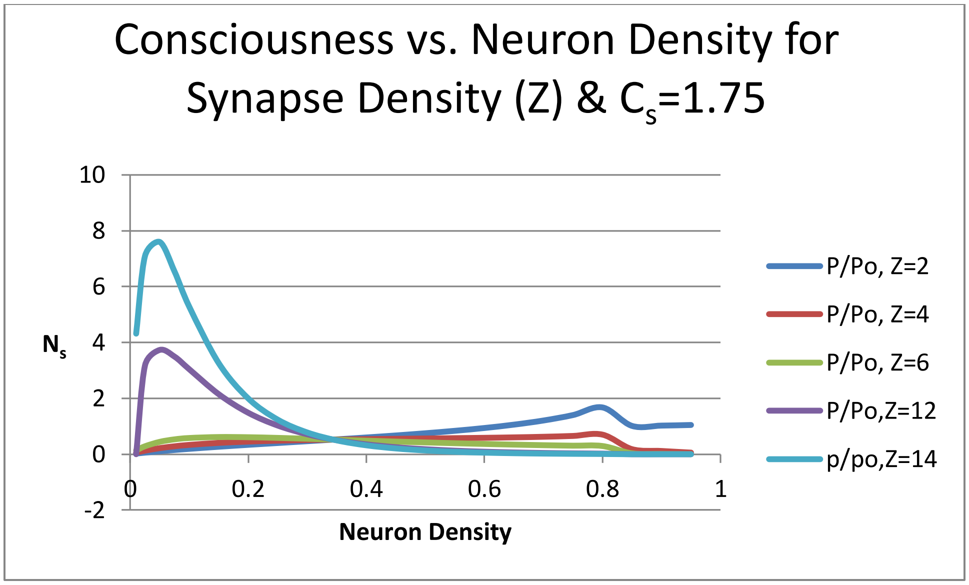

Figure 3. N_s vs. Θ_s for Z=6 & C_s=1.75

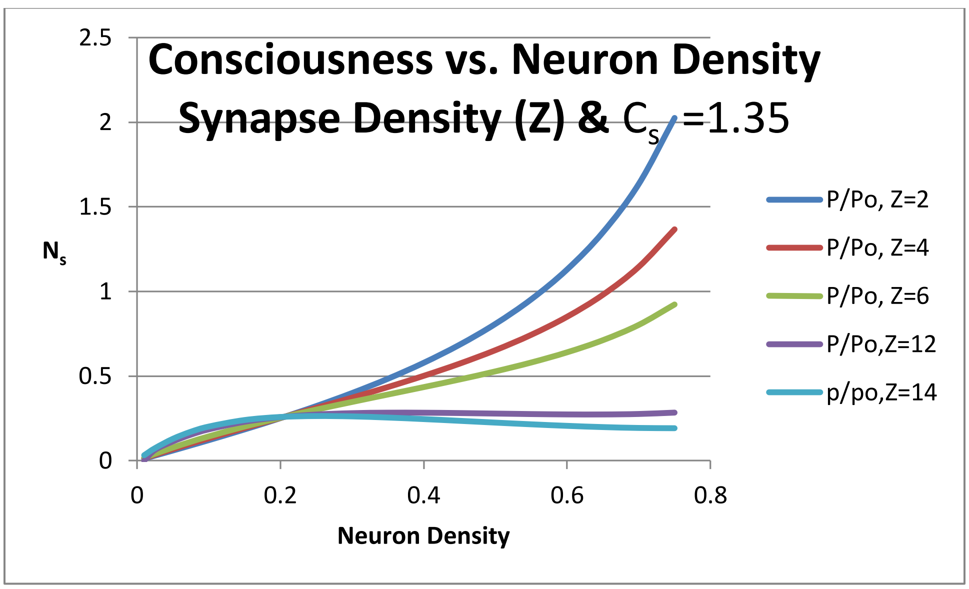

Figure 4. N_s vs. Z=12 & C_s=1.35

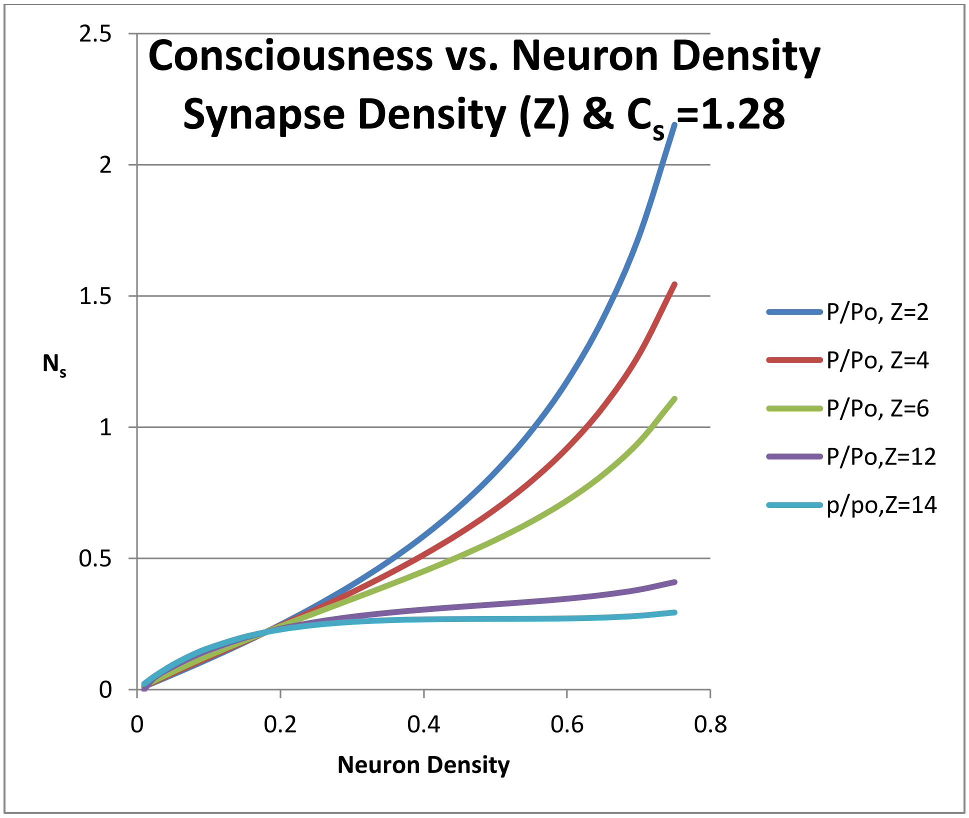

Figure 5. Z=14 & C_s=1.28

Critical Table

Z	C_s	N_s
14	1.28	.27
12	1.35	.28
6	1.75	.45
4	2.1	.5
2	70	1

This table above indicates that as the coordination number becomes higher (more connected), both the interaction energy and the consciousness become lower. This indicates that the neurons require less energy to connect when the number of connections to each neuron is high. We also know that the neural density is a function of time, (Neuron Density)=f(t), i. e., it takes time for the neurons to find each other and make connections, but when they do they touch rather then interact vigorously and they are ready to engage in electrical and/or chemical transmission rather quickly.

The model shows that the important variable in the process of consciousness is Z, which is called the coordination number or the number of neurons that meet at the same point. When Z is greater than unity, then it is possible that for a specific value of C_s the value of Consciousness can become critical or horizontally flat for a considerable range of Θ_s, thus in a critical range. Stuart Kauffman has found that life thrives at the edge of chaos and this seems to be the case in this application. In this state, neurons may be very active in the transmission of electrical and chemical signals enhancing consciousness. In order to check this phenomenon the model was used to run the case when Z was just equal to unity. The result is shown in the figure below. No critical state was found even when C_s was varied.

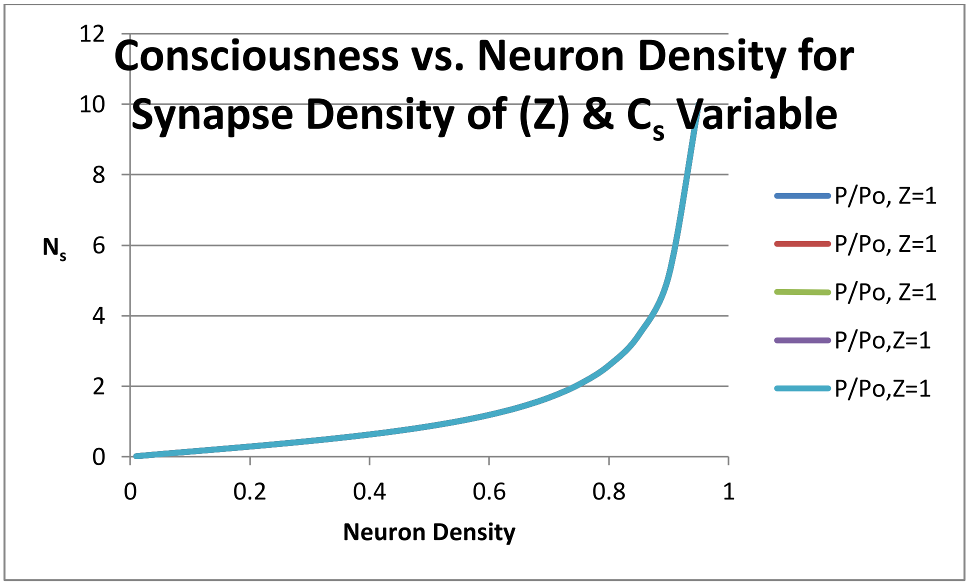

Figure 6. Z=1 & C_s is variable

Discussion

The problem with AZ is not as simple as some people believe. It is not just about the misfolding of a particular protein. Recent work shows how neurons have adapted the cell's standard fusion machinery to regulate the release of transmitters at synapses. Calcium signals have the ability to improve the neural fusion process. We are gaining knowledge of how neurons talk to each other and how this process goes awry during neurological and psychiatric diseases. Such insight will allow us to restore proper synaptic function and brain communication.

In a recent book by Lee Smolin it is suggested that there are real mysteries about consciousness, and they are beyond what science can tackle with present knowledge. Roger Penrose suggests that quantum coherence could be a part of what is needed for consciousness but he understands that in our brains there is enormous organization and that consciousness appears to be a very global feature of our thinking. This occurs in his writings about microtubules and cytoskeleton aspects and his realization that coherence has to be of a large scale.

Statistical mechanics uses devices to explain local phenomena in a non-local mathematical structure. So it is in the method used here. The features and properties of lattices are considered by using basic geometrical features within the lattice and their properties are "mapped" onto basic geometric figures. Indeed, in further work the basic figures were extended from the bond to the triangle and to the rhombus thus increasing the agreement of the properties predicted with those found by experiment. The mathematics became increasingly more difficult but it did lead to final results that agreed with experiment more closely. The simple bond approximation used here was only meant to serve as an example for further work. When more improved computers and experimental equipment are present we can proceed more directly to the correct final values.

The present method applies a holographic view on the problem and attempts to project emerging self-organizing properties of biological life. Indeed, implicate interpretations have been used before and collective unconscious, archetypes, personal resonances, etc., are prevalent in some forms of psychology. The recognition of platonic, mental and physical information to science is well appreciated.

The above work is presented here to help in the therapeutic and preventative aspects of brain diseases. It is thought that an outcome could be advanced in the same way that people today have hearing aids to help with various stages leading to deafness. It is not inconceivable that "memory boxes" could be in use in the future. They could consist of junctions of synthetic networks which come about from the new discoveries in science and engineering and human biology.

Further Notes

Penrose has discussed quantum parallelism. The brain's neural networks work in parallel. They also have passive concomitant possession of elaborate control systems. There may be a purpose for consciousness. This is the Anthropic Principle, which is often used in astrophysics to claim that we must have sentient observers of our universe. I have on many occasions had ideas come to me in a flash. This happens when I am in a semi-conscious state such as in light sleep or I am watching a moving picture in a theater. This has happened when I had been working on a difficult physics problem for some time which had possessed my mind. Thus when in a wakeful state, I suddenly knew the solution to the problem. It happened to Mozart, who claimed that in that flash he remarkably realized an entire new musical composition. It occurs to me that people can train themselves to do this by concentrating for a long time on a difficult problem when in a full active wakeful state. In that instance one has locked in the neural network with its many synapses so that it can be recalled when the individual is later in a restful state and the recall is sudden and unexpected.

Conclusions

It is difficult to describe all qualia in scientific terms. The dictionary defines consciousness as the quality or state of being aware of something within oneself. The best theoretic physicists have wrestled with this subject. This paper is written by a person who studies complexity and has used it in other aspects of science. The paper describes neural networks within the brain and seeks to find the important way they contribute to consciousness and how such knowledge can help humans to treat diseases when things go wrong. The end result is that the junctions of these networks play an important part in these aspects. An approximate model is invoked and the model is a simple first step to identify the possible culprits and is amenable to further development in the hunt for remedies. There are also reviews of some of the present work of other scientists and mathematicians who have studied the problem.

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