Application of Semigraph and Directed Graph in Neurology of Mental Illness (Anxiety)

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Abstract— Semigraph is such a conception of a graph and it is similar to a graph when drawn in a plane. A Semigraph contains more than two vertices. As the Graph Theory can abstract anything, the Semigraph can also abstract anything which has any two edges at most one common vertex according to the definition. Besides in the Medical field or human neurology, Semigraph can also be very useful.

The human body works with the functions of the brain and nervous system. The human body suffers from some different types of diseases which may affect the human brain too or it may responsd to the diseases.

The research paper "Application of Semigraph and Directed Graph in Neurology of Mental Illness (Anxiety)" represents how the semigraph and the directed graph can be used to know the diseases that affect the human brain and how it may responsd to it.

Key-Words: - Semigraph, Directed Semigraph, Neurology, Human brain, Illness, Directed Graph

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1 Introduction

The notion of semigraph, [1], is a generalization of that of a graph. While generalizing a structure, one naturally looks for one in which every concept in the structure has a natural generalization. Semigraph is such a natural generalization of a graph and it resembles a graph when drawn in a plane.

Semigraph is similar to a graph but it allows for many new important or meaningful outcomes that may or may not be possible with a Graph Theory, [2]. The human brain functions similarly to a computer's CPU. It carries all the information received from the human body senses, sends messages back to the human body, and begins to function.

As diseases affect the human body or the organs, diseases can also affect the human brain which is referred to as a mental disorder or a mental illness. Most commonly the person suffers from anxiety which affects the human brain and results in a mentally depressed person.

It is crucial to know and comprehend quickly how this sickness or condition might affect the human brain and nervous system given that it is a widespread disorder or illness among people worldwide.

It's kind of fascinating how the medical field area interacts with Semigraph and Directed Graph

Theory. Knowing what you could need in the future is crucial in today's society. To learn about a condition or the relationship between an illness and another in your neurology or any other body system, you don't have to work in the medical field.

The objectives of this work are, first create a graphical representation of the disease analysis in the medical field, then to apply Semigraph and Directed Graph in modeling interactions between objects, and finally to use Graph Theory to discover the process of neurology of the Brain, [3], [4], responding to Diseases.

2 Preliminary

Definitions

Graph: A graph H=(V,E) consist of a set of objects H=[$v_1, v_2, \ldots\ldots$] called vertices and another set E=[$e_1, e_2 \ldots\ldots$], whose elements are called edge.

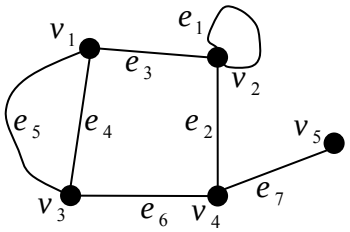

Figure 1-Example of Graph

Directed Graph: A Directed Graph is made up of an ordered collection of X pairs of distinct points and a finite nonempty set V of points. Figure 2 is a example for Directed Graph.

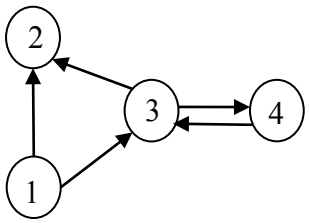

Figure 2-Example of Directed Graph

Semigraph: A semigraph G is a pair (V, X) where V is a non-empty set whose elements are called vertices of G and X is a set of n-tuples, called edges of G, of distinct vertices, for various $n \geq 2$, satisfying the following conditions.

(a) Any two edges have at most one vertex in common.

(b) Two edges $(u_1,u_2,\ldots,u_n)$ and $(v_1,v_2,\ldots,v_m)$ are considered to be equal if and only if

(i) $m = n$ and

(ii) either $u_i = v_i$ for $1 \leq i \leq n$, or $u_i = v_{n-i+1}$ for $1 \leq i \leq n$.

An edge e is represented by a simple open Jordan curve which is drawn as a straight line whose endpoints are called the end vertices of the edge e and the m-vertices of the edge e each of which is not an m-vertex of any other edge of the semigraph G are denoted by small circles placed on the curve in between the end vertices, in the order specified by e. The end vertices of edges that are not m-vertices are specially represented by thick dots. If an m-vertex of an edge e is an end vertex of an edge e' i.e. an (m, e) vertex, we draw a small tangent to the circle at the end of the edge e'.

Example 1: Let $G = (V, X)$ be a semigraph. Then the edges of the semigraph in Figure 3 are $(v_0, v_1, v_2), (v_2, v_6, v_7, v_8), (v_1, v_3, v_4), (v_4, v_5), (v_5, v_6)$.

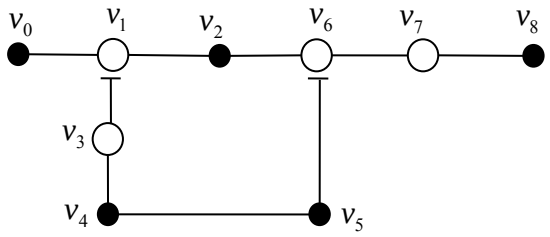

Figure 3-Example of Semigraph

Dendroid: A Dendroid is a connected Semigraph without strong cycles, and a forest is a semigraph in which every component is a dendroid.

Pendant Dendroid: A Pendant Dendroid is a dendroid with a pendant on each edge. For example Figure 4 is a pendant dendroid

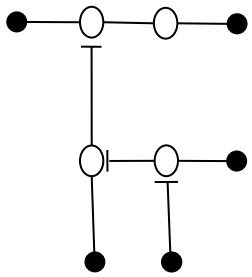

Figure 4-Example of Pendant Dendroid

3 Application of Semigraph in Neurology of a Brain

3.1 Structure of a brain

In humans, the structure of a Brain Figure 5 which has 100 billion of nerves system, controls every aspect of function. Our emotions, including happiness, tension, and depression as well as any diseases are tied to or controlled by the brain, as I have already discussed how the brain operates and manages the human body similarly to how the CPU manages a computer. Similar to anxiety, the Amygdala is a component of the human brain that has a neural system. The brain's amygdala reacts to any type of human emotion including stress and worry.

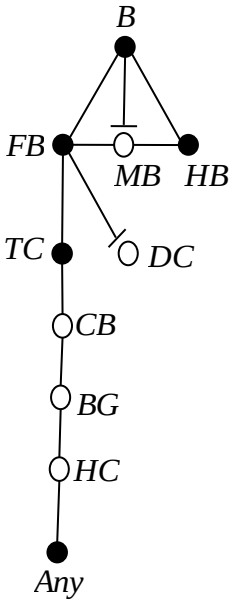

Figure 5- Structure of a brain

Let sets of vertices in a Semigraph H be all the name vertex (V, E). Where H= $\{v_1,v_2,v_3,v_4,v_5,v_6,v_7,v_8,v_9,v_{10}\}$ and the edges of semigraph H are (v_1,v_2) , (v_2, v_3,v_4) , (v_1,v_3), (v_1,v_4). This meets the requirements of the semigraph.

This demonstrates that, unlike the Brain structure diagram below in Figure 6, which is complicated, the structure of the area of the brain associated with anxiety can be presented and illustrated simply.

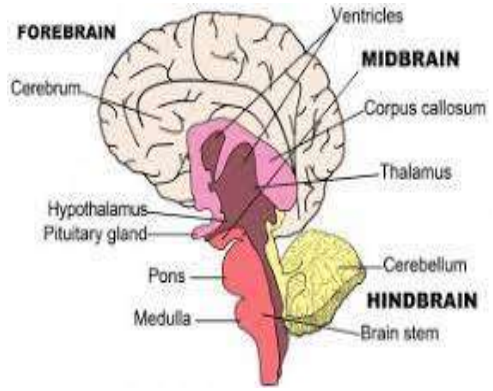

Figure 6- Area of the brain

The major components of a brain's anatomy are a little more difficult for non-medical departments to comprehend. Next observe Figure 7 and Figure 8 of a Forebrain, which is divided into two portions, the Telencephelon and Diencephelon, each of which has a unique set of connecting structures and functions. Instead of observing the other portions, let's observe the portion that contains the Amygdala, the portion that reacts to anxiety.

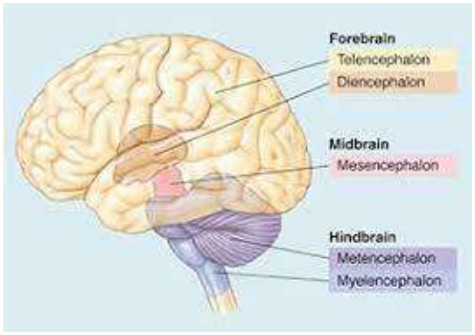

Figure-7- Portion of Brain

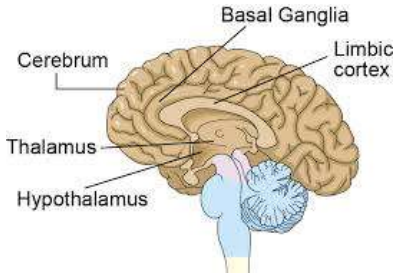

Figure 8- Brain

3.2 Applications of Dendroid in Alzheimer's Disease:

The most prevalent kind of Dementia, Alzheimer's disease, primarily affects elderly people. Alois Alzheimer in 1906 created the disease. Alzheimer's is a neurological disorder Figure 9 and Figure 10 that results in brain shrinkage and the loss of brain cells.

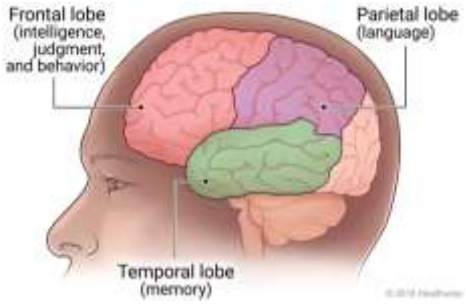

Figure 9- Neurological disorder

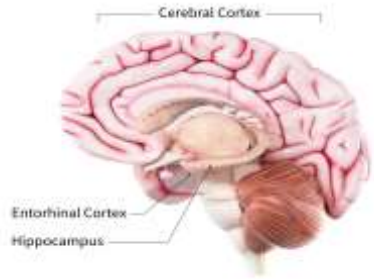

Figure 10- Alzheimer disease

Let us now discuss how Alzheimer's disease impacts the human brain using a Pendant Dendroid Semigraph. Take a node of Figure 11.

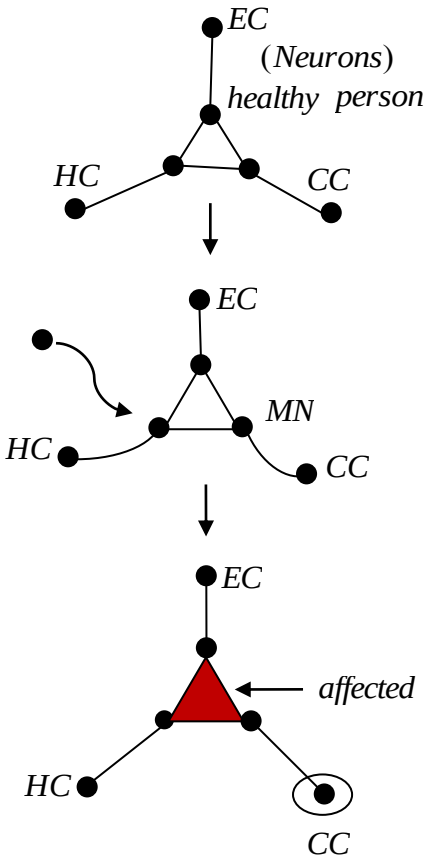

Figure 11-Human brain using Pendant dendroid

The healthy brain is depicted in the first graph, followed by Alzheimer's disease's attempt to damage memory-related neurons, and the neurons and the remainder of the vertex associated with neurons, including the entorhinal and hippocampus, are affected. The cerebral cortex is the last area affected when it affects those three vertices

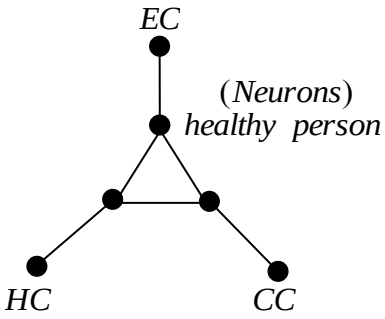

Figure 12- Pendent dendroid semigraph

The given Figure 12 is the pendant dendroid semigraph which can be considered as a normal brain of a healthy person. The triangle shapes of the figure represent neurons of a healthy person's brain, assume it as v_1. The vertex EC represents the entorhinal cortex, consider it as v_2, HC represents the vertex v_3 and at last, CC represents the vertex v_4.

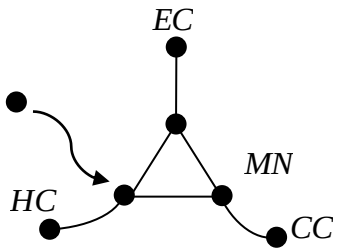

Figure 13-Alzheimer disease contact with neurons

Now, from Figure 13 consider a white vertex entering the neurons, and assume it as an Alzheimer's disease which is trying to get contact with Memory connected with a number of neurons.

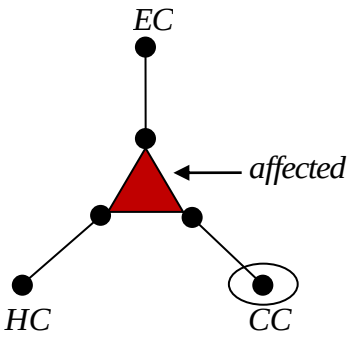

Figure 14-Triangle shape of Alzheimer disease

From the above Figure 14 observe the triangle shape colored completely which we can consider as totally affected by Alzheimer's disease.

In this way, we can figure out easily how Alzheimer's Disease can affect the parts of a healthy person's brain and know the way for the treatment of a patient without observing to a critical structure of a brain.

4 *Directed Graph on Amygdala Responding to Anxiety*

The amygdala is the part of the human brain that has a central role in anxiety responses to stress in whole situations. During the response of the amygdala to anxiety their activation influences anxiogenic effects while their inactivation causes anxiolytic effects. Also, neurotransmitter and stress mediators having a role in amygdala nuclei can regulate the character of anxiety.

All human beings go through anxiety in some cases every person has faced it or facing it. It is a physiological response that we face in our everyday life. Anxiety is so common that it is one of the most common symptoms of neurological disorders.

In this section we will try to describe the connections of neurons of a brain associated with anxiety with the help of Directed Graph. It is a little difficult to understand the process with the help of a general diagram given below in Figure 4.1.

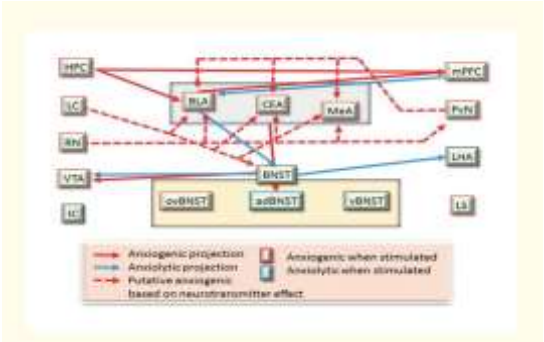

Figure 15-Directed graph of a brain

Now let us represent it by the directed graph, observe the graph given below:

Figure 16 is the graph of a response of the amygdala to anxiety when the patient is given an anxiogenic projection.

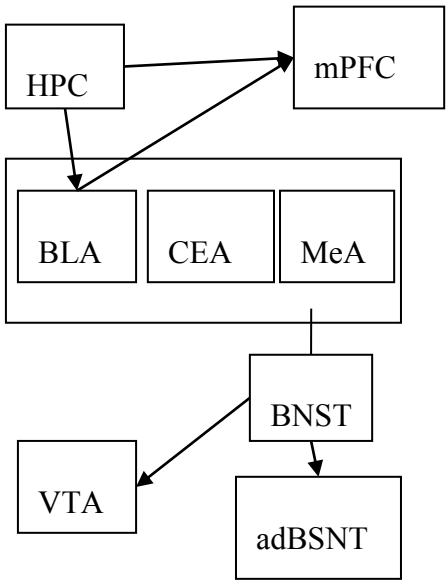

Figure 16- anxiogenic projection

Here, the BLA represents a basolateral amygdala considered as a vertex v_1 which is directed to mPFC. mPFC represents a medial prefrontal cortex. Again HPC represents a Hippocampus directed to BLA. And BLA, CEA, MeA are directed to BNST (Bed nucleus of stria terminalise). And BNST is directed to VTA (Ventral tegmental area) also to adBNST(antidorsal BNST). Next let us observe the other Figure 17 . Which determines the directed graph, an Anxiolyti projection process of the amygdala responding to Anxiety. Here the dot lines represent the anxiolytic projection of the Amygdala responding to anxiety where each named vertex is directed to the other vertex creating an edge.

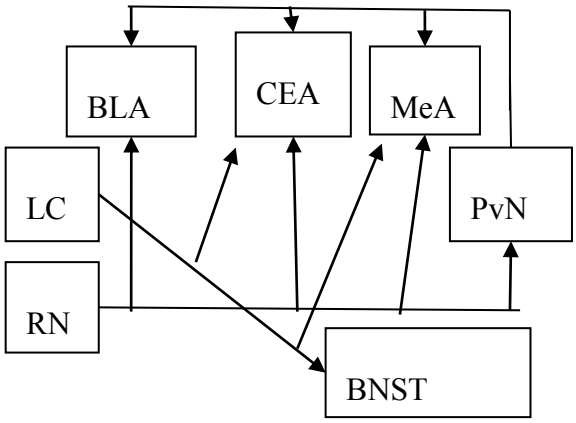

Figure 17- Anxiolyti projection process of the amygdala responding to Anxiety

Next observe Figure 18, where each vertex is directed to another vertex with an edge having a transmitter process of the amygdala responding to anxiety.

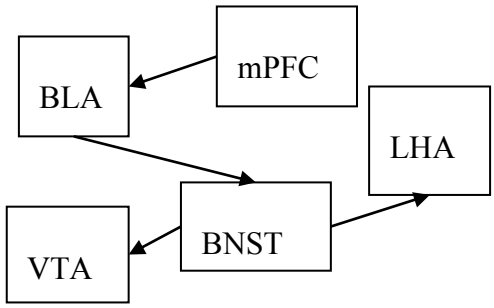

Figure 18- Transmitter process

Here BNST vertex is directed to LHA and VTA and mPFC is directed to BLA and BLA is directed to BNST.

As mentioned all vertices (V) are the neurons attached to the Amygdala and directed lines are the edges (E) connecting to other vertex and it take part during the process while the amygdala responds to Anxiety.

5 Conclusion

In this research work, the we initiated application of both Semigraph and Directed Graph Theory in the Neurology of the human brain and also in a Disease of a mental disorder or an illness with different types of tools in different types of ways. We also tried to show how the critical figure can be shown in a simple and easy way to make understand in a proper and easy way to the people with a Graph or a Semigraph.

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