

# Brain Modeling :

A very simple Network model of the  
Human Brain

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# Presentation Overview

1. Introduction : Brain, Neuron and Connections
2. Objectives :
3. Model and Implementation
4. First Results
5. A couple of comparisons
6. Conclusion
7. Limitations
8. Futur work

# 1- Introduction : Brain, Neuron and Connections

- The nervous system is a set of a billion of neurons that communicate with each-other through a billion of billions of synaptic connections. It is apparent to a set of electrical cables connecting nodes, forming a huge network. Most published studies on diseases of the nervous system face the problem of complexity of the nervous system as its whole.
- It is difficult to tell accurately the reason of a dysfunction; this is the case of Autism: Although symptoms of the disease are known, there is no consensus on the reasons of such a phenomenon. Some authors talk about spend energy related to long-distance connections, others talk of poor synchronization between the left hemisphere and the right hemisphere, others talk about poor quality of the gray matter, namely, the myelination of axons, key for inter-regional communication, ... Those are known through Infra-red and a bunch of scanning tools.
- It is very hard for Biologists to figure out what is really going on. We then need model with which we can manipulate different possibilities and observe the results.

## 2- Objectives

- Multi data processing with network implementation in order to mimick the Humain Brain, and try to identify potential reason for dysfunctions like Autism, Alzheimer, Parkinson, ...
- Build 2 X 3D networks with as much as neuron possible  
(Abnormal Network → Dysfunction Vs Normal Network → Safe).
- Analysing :
  - Simple Correlations between parameters such as ATP and length all along the signal processing.
  - How does a specific parameters change between those 2 Networks can make a difference
  - ... (if time allows)

# 3-Model and Implementation

## A) Model

- I choose not to use in a first step the huge and enormous equations that rules neurons input and signal transfer we may see in the literature, in Electrical and physics. Instead, I used the simplified model of neuro-psychology, which is easier to implement. However, those equations in Electrical can be included in the model.
- Action Potential that decide whether a Neurone fires or not is not based on Boolean value but based on both time and neurotransmitter abundance.

$$\sum ( \text{neurotrans} \times \text{action} ) = \text{received impulse}$$

if  $\text{received impulse} \geq \text{Threshold}$  then  $\rightarrow$  Fire

- I consider the time in the entire Network, and this time is based on the time recorded at signal input (button press).

# 3-Model and Implementation

## A) Model

- I started with 64 neurons in the Network (just to avoid long time running more than 1000 Neurons which is the final goal for now).
- I have **1 Main\_File that store the information on all Neurons** (ID, myelinated or not, strength of myelin, if it is an Activator, if it is an Inhibitor, coordinates X, Y, Z in 3D space, Action\_Potential\_Threshold).
- I designed a **graphical interface that allows to directly Update that File** (In a random way, and also in specific way : Ex: one can choose how one want the Neuron\_X to behave with its neighbor).
- I have 64 Files That store each Neuron interaction (**1 File per Neuron**).
- With the graphical interface, one can **directly update** the behavior of any Neuron with its Neighbors. Then, there is 2 ways to update :
  - ✓ Either by area (you update interactions of neurons located in the selected area : the best choice for general analysis).
  - ✓ Either by ID (you update interactions of neurons taping is ID: this would be the best choice for very-very deep analyse, but extremely long to do with 1 million neurons).
- Regarding Neuron Interactions: it is information such as : Neighbors (consequently I have 64 lines), behave = Activation or Inhibition or Nothing (this depend on the previous **Main\_file**), Strenght of that interaction, duration of signal transmission, length with the Neighbor, ATP spent while the signal is travelling, Current time of signal perception.
- In the next slide, all stuff put in color are not random; They depend on the interaction with the neighbors on the Network.

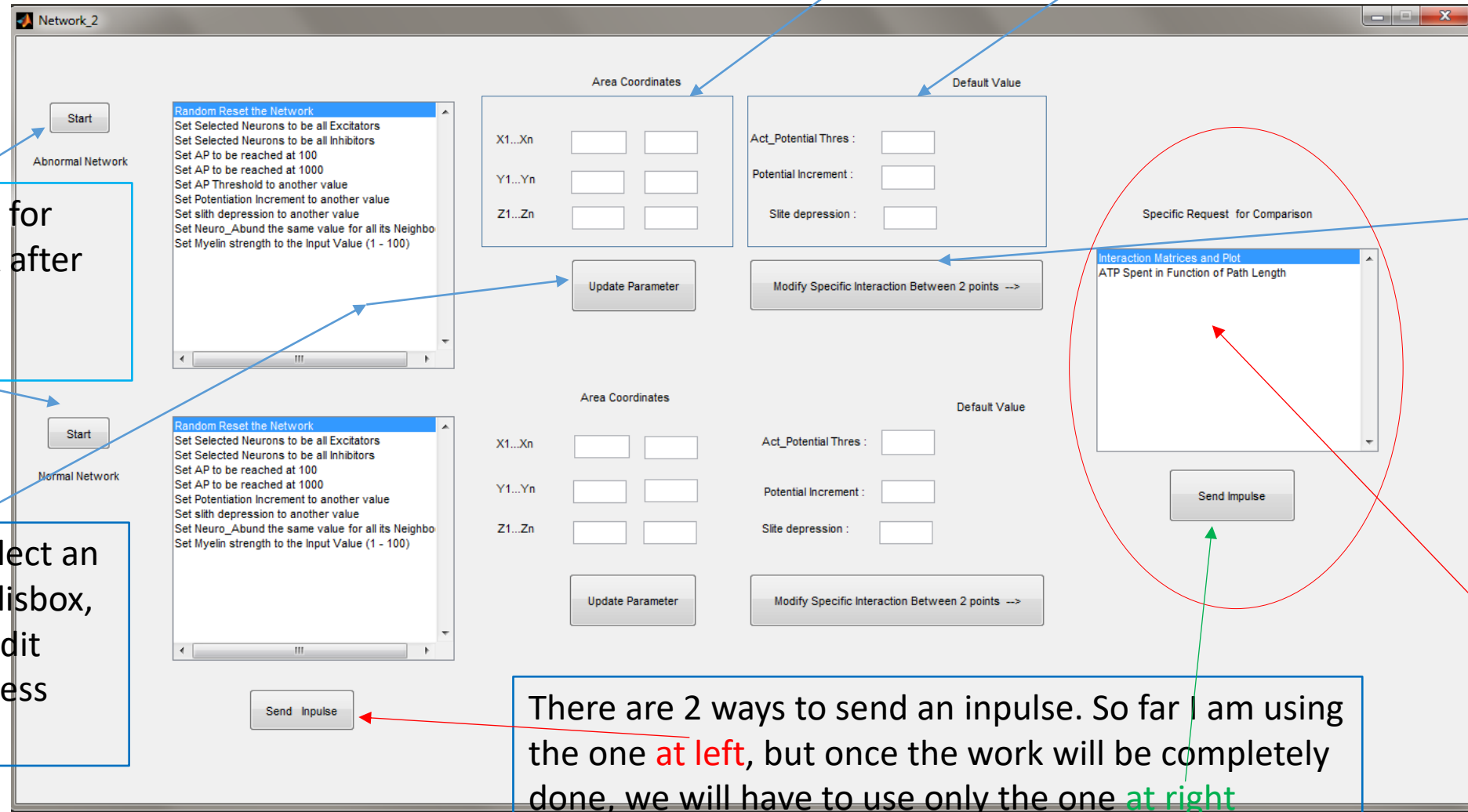
# 3-Model and Implementation

## A) Model

- **Activation or Inhibition or Nothing** (this depend on the previous **Main\_file**) : When a Neuron is an activator, it is a **(+1)**. When it is a inhibitor, it is a **(-1)**. When He receives a signal, He transfers that signal to its neighbors. Then there is 2 cases : He may transfer a negative signal (inhibitory signal) or a positive signal (activator signal).
- If He transfers a **positive signal**, and that neighbor fires, that **firing strengthens their relationship** ; in case of non-firing, it diminish their relationship
- If He transfers a negative signal, and that neighbor fires, that firing diminishes their relationship ; in case of non-firing, it strengthen their relationship.
- Strength of that interaction : Dependent on quantity of neurotransmitter.
- **Duration of signal transmission** : **depends on both distance** between 2 neurons, **and the force of the Myelin layer**; The longer is the distance, the longer it takes the signal to travel. The thicker is the myelin layer, the faster the signal can travel.
- **Length with the Neighbor** : It s **based on the Cartesian distance between 2 neurons**. I added 0 - 10% margin because neural connections are almost never straight.
- **ATP spent while the signal is travelling** : Inversely proportional to the **thickness of the myelin** and **the length of the axon**.
- **Current time of signal perception** : This **allows Matlab to follow the signals**. Actually, there are no real signal : those are just timing to follow **an imaginary signal** through the network.

# 3-Model and Implementation

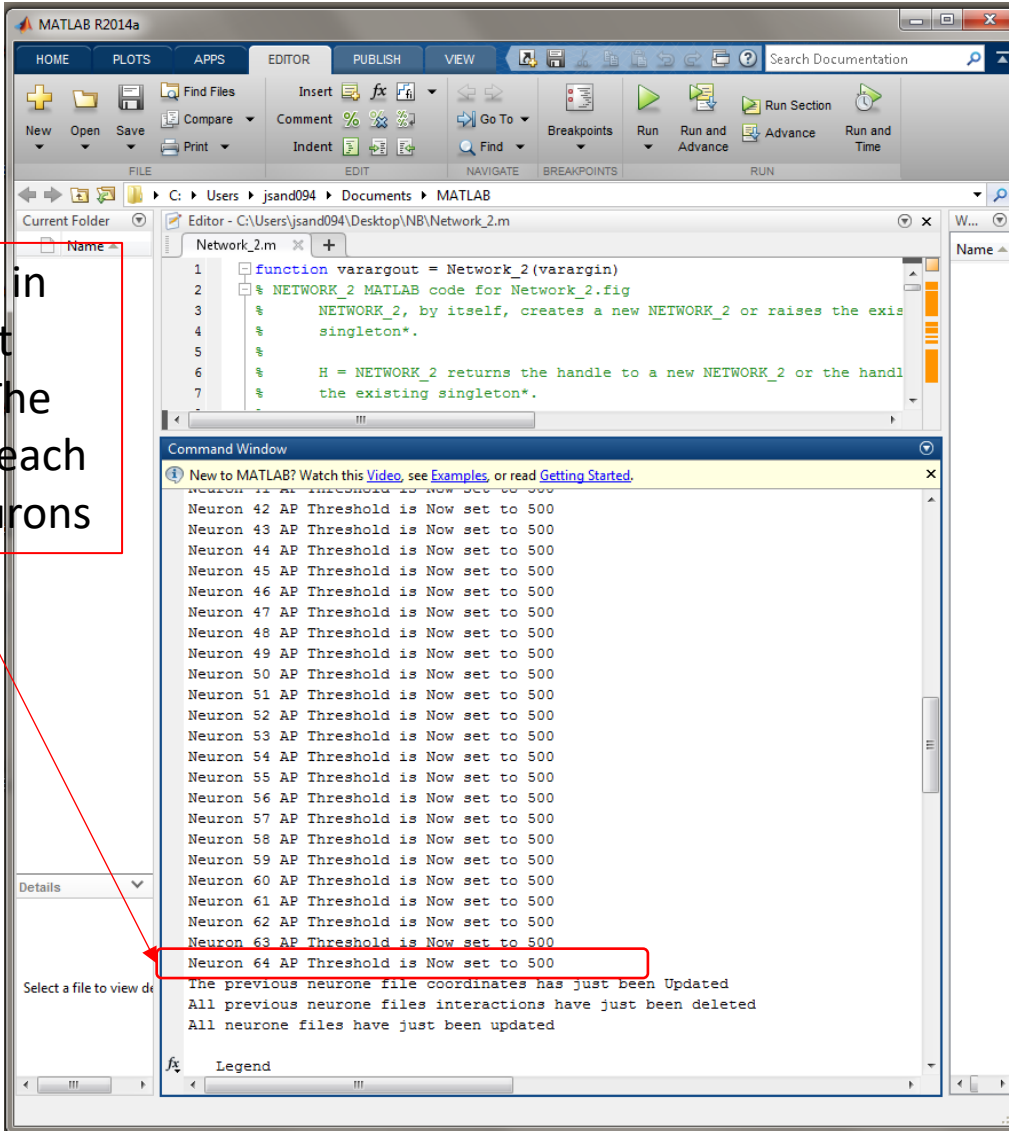
## B) Implementation : done with Matlab



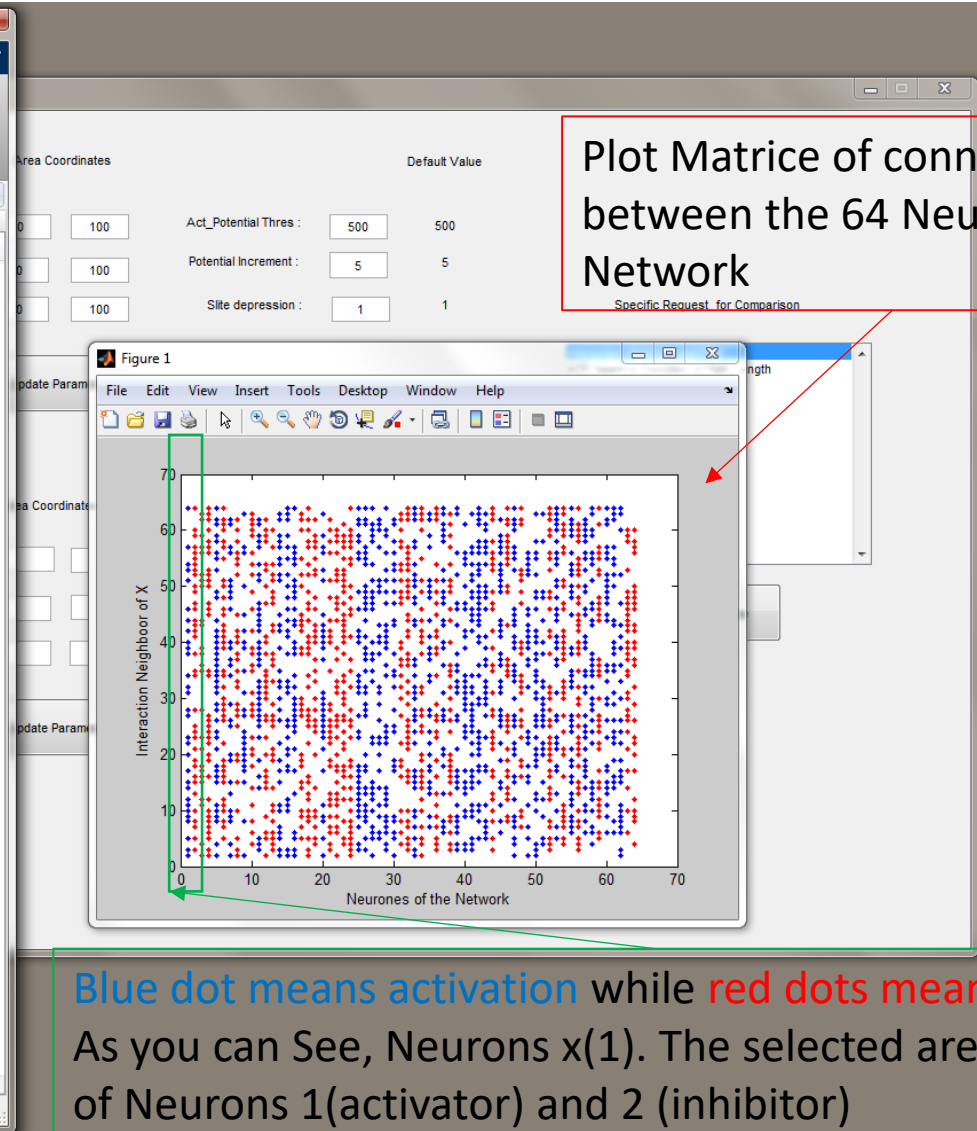


# 4-First Results

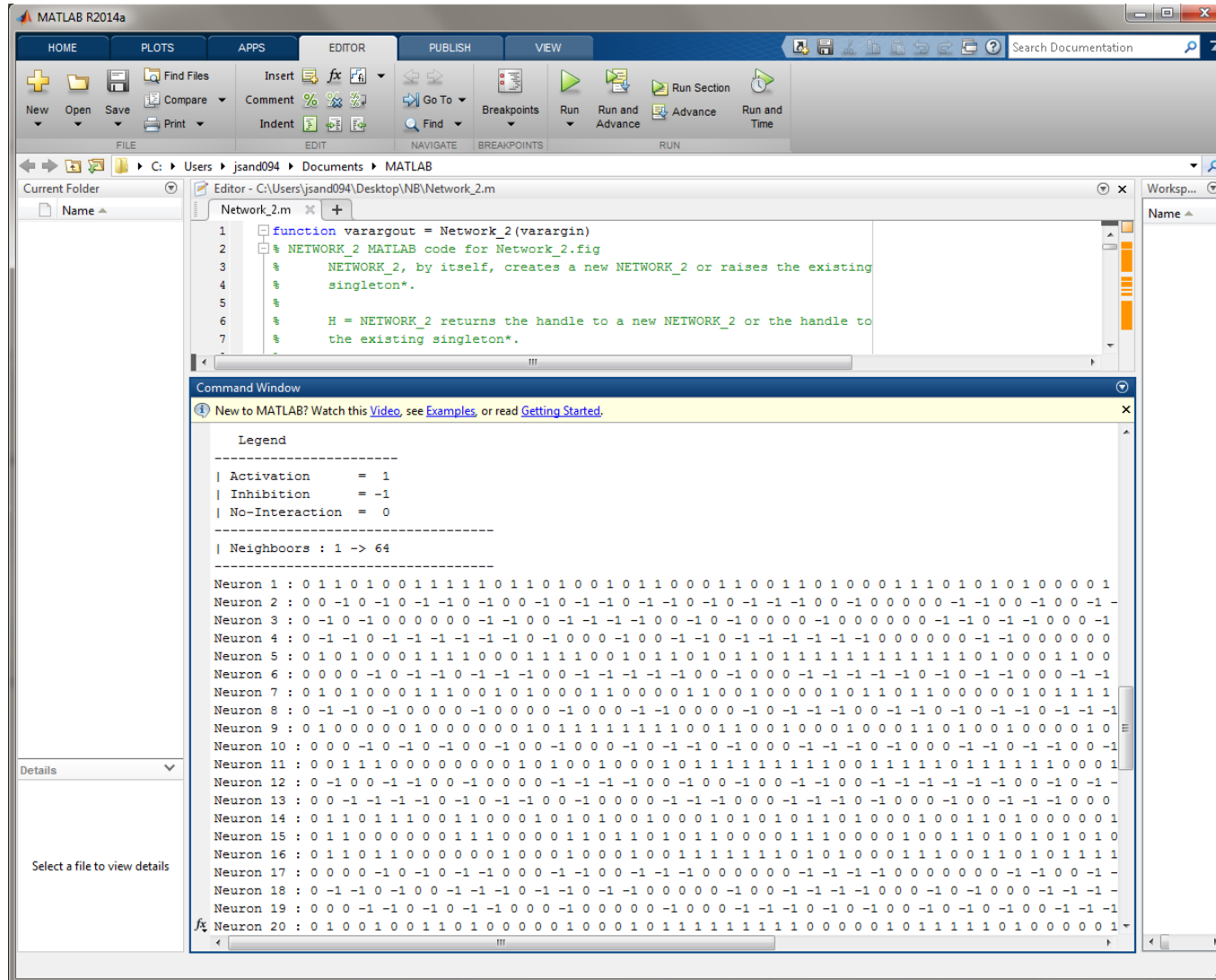
64 Neuron in the current network. The goal is to reach 1000+ Neurons



Plot Matrice of connection between the 64 Neurons of the Network



# 4-First Results



The image shows the MATLAB R2014a interface. The Editor window displays a function file named `Network_2.m` with the following code:

```
1 function varargout = Network_2(varargin)
2 % NETWORK_2 MATLAB code for Network_2.fig
3 %     NETWORK_2, by itself, creates a new NETWORK_2 or raises the existing
4 %     singleton*.
5 %
6 %     H = NETWORK_2 returns the handle to a new NETWORK_2 or the handle to
7 %     the existing singleton*.
```

The Command Window displays a message: "New to MATLAB? Watch this [Video](#), see [Examples](#), or read [Getting Started](#)." Below this, a legend is shown:

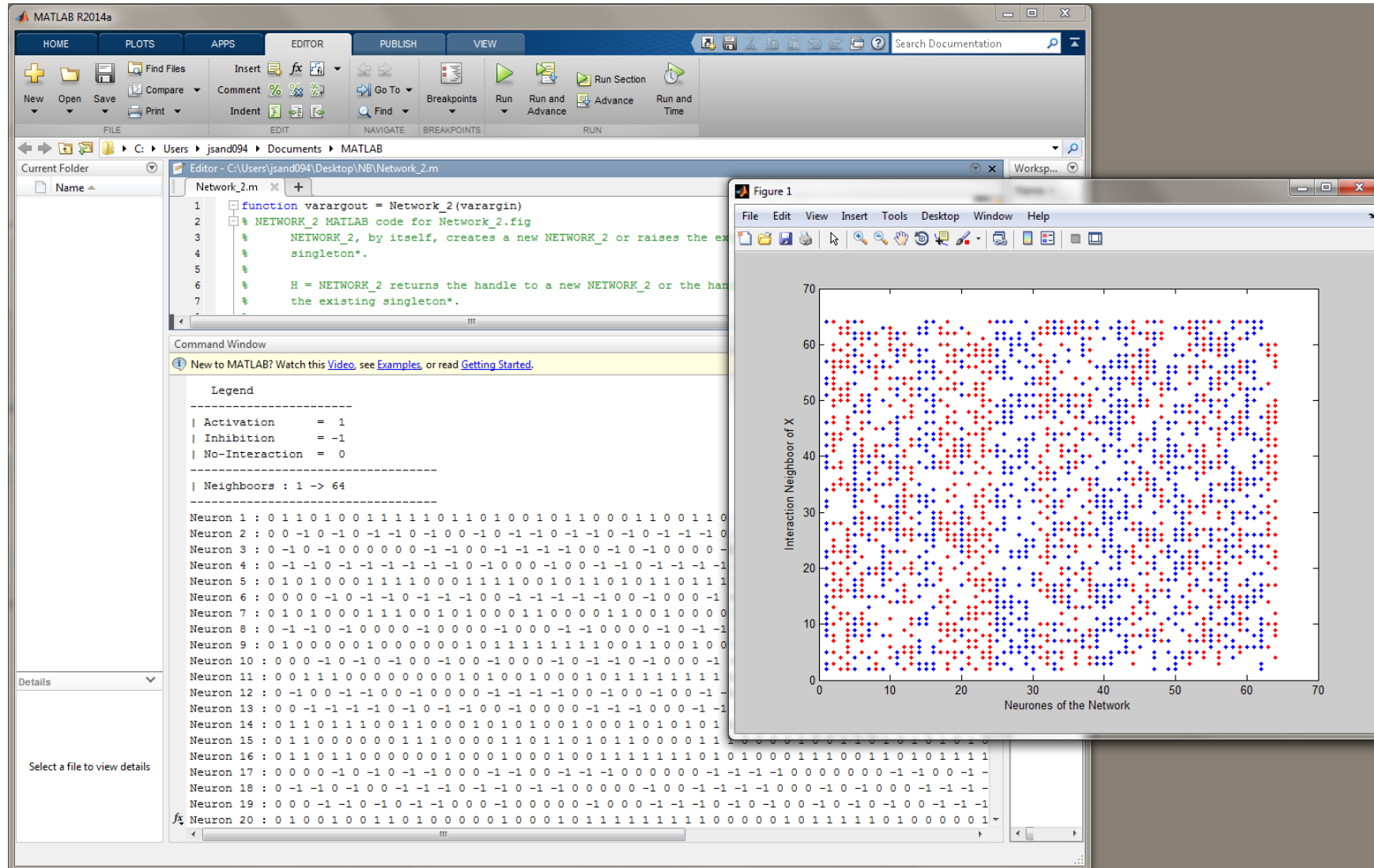
```
Legend
-----
| Activation      = 1
| Inhibition      = -1
| No-Interaction  = 0
-----
| Neighbors : 1 -> 64
-----
```

The Command Window then displays a large matrix of values representing the connection matrix for 20 neurons. The matrix is organized as follows:

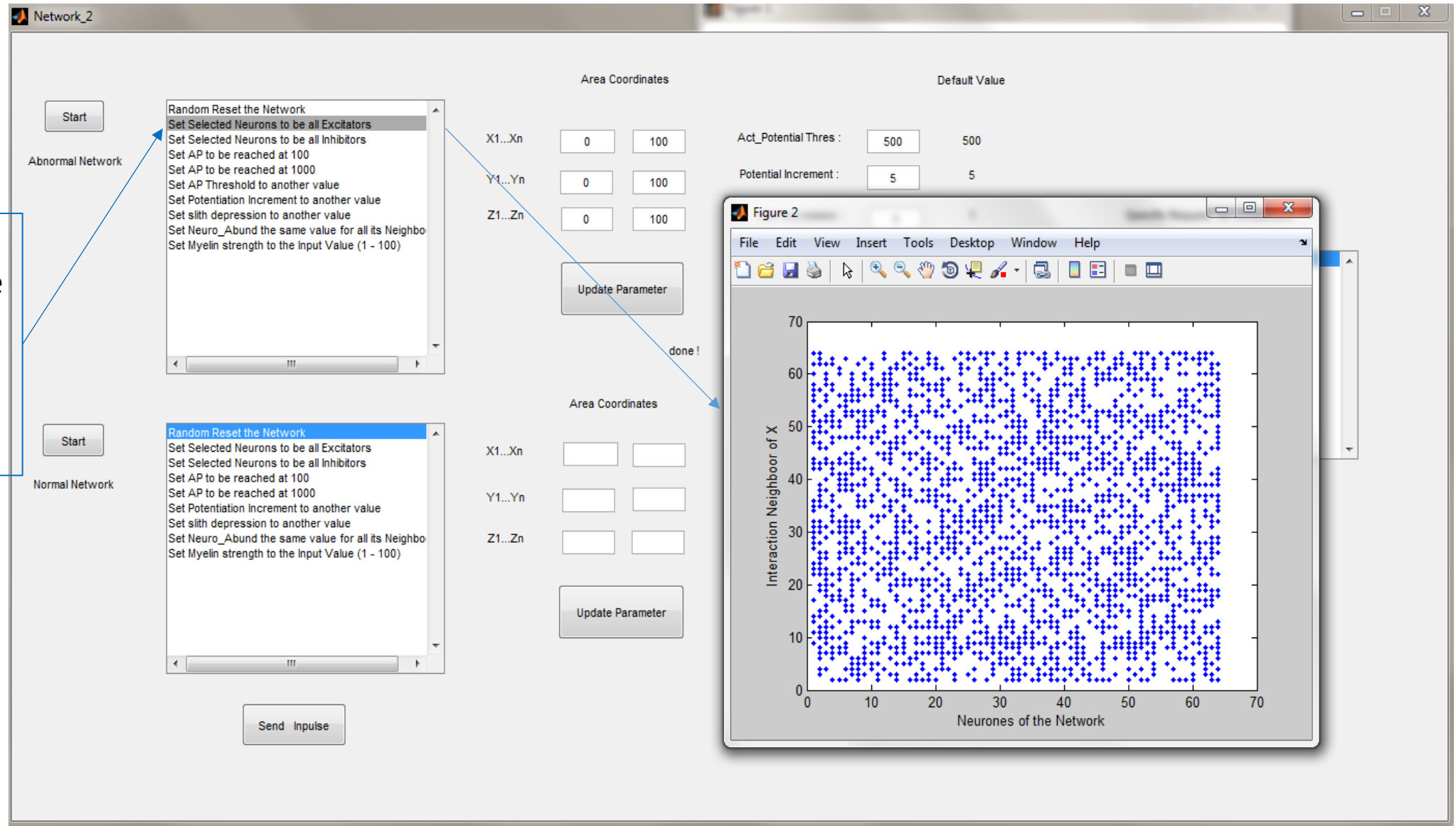
Neuron	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Neuron 1	0	1	1	0	1	0	0	1	1	1	1	1	0	1	1	0	1	0	0	1
Neuron 2	0	0	-1	0	-1	0	-1	-1	0	0	-1	0	-1	-1	0	-1	0	-1	-1	-1
Neuron 3	0	-1	0	-1	0	0	0	0	-1	-1	0	0	-1	-1	-1	-1	0	0	-1	-1
Neuron 4	0	-1	-1	0	-1	-1	-1	-1	-1	0	0	-1	0	0	-1	0	-1	-1	-1	-1
Neuron 5	0	1	0	1	0	0	1	1	1	1	0	0	1	1	1	0	1	1	1	1
Neuron 6	0	0	0	-1	0	-1	-1	0	-1	-1	-1	0	-1	-1	-1	-1	-1	0	-1	-1
Neuron 7	0	1	0	1	0	0	1	1	1	0	0	1	1	0	0	0	1	1	0	1
Neuron 8	0	-1	-1	0	-1	0	0	0	-1	0	0	0	-1	0	0	0	-1	0	-1	-1
Neuron 9	0	1	0	0	0	0	1	0	0	0	0	0	1	0	1	1	1	0	0	1
Neuron 10	0	0	0	-1	0	-1	0	-1	0	-1	0	-1	0	-1	-1	-1	-1	0	-1	-1
Neuron 11	0	0	1	1	1	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1
Neuron 12	0	-1	0	0	-1	-1	0	0	-1	-1	-1	-1	0	0	-1	-1	-1	-1	-1	-1
Neuron 13	0	0	-1	-1	-1	0	-1	0	-1	-1	0	0	-1	-1	-1	0	0	-1	-1	-1
Neuron 14	0	1	1	0	1	1	0	0	1	1	0	0	1	0	1	0	1	1	0	1
Neuron 15	0	1	1	0	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	1
Neuron 16	0	1	1	0	1	1	0	0	0	0	1	0	0	1	1	1	1	1	0	1
Neuron 17	0	0	0	-1	0	-1	0	-1	-1	0	0	-1	-1	0	0	0	0	-1	-1	-1
Neuron 18	0	-1	-1	0	-1	0	-1	-1	-1	0	-1	-1	-1	-1	-1	-1	-1	0	0	-1
Neuron 19	0	0	0	-1	-1	0	-1	0	-1	0	0	0	-1	0	0	-1	-1	-1	0	-1
Neuron 20	0	1	0	0	1	0	1	1	0	1	0	0	0	1	1	1	1	1	0	1

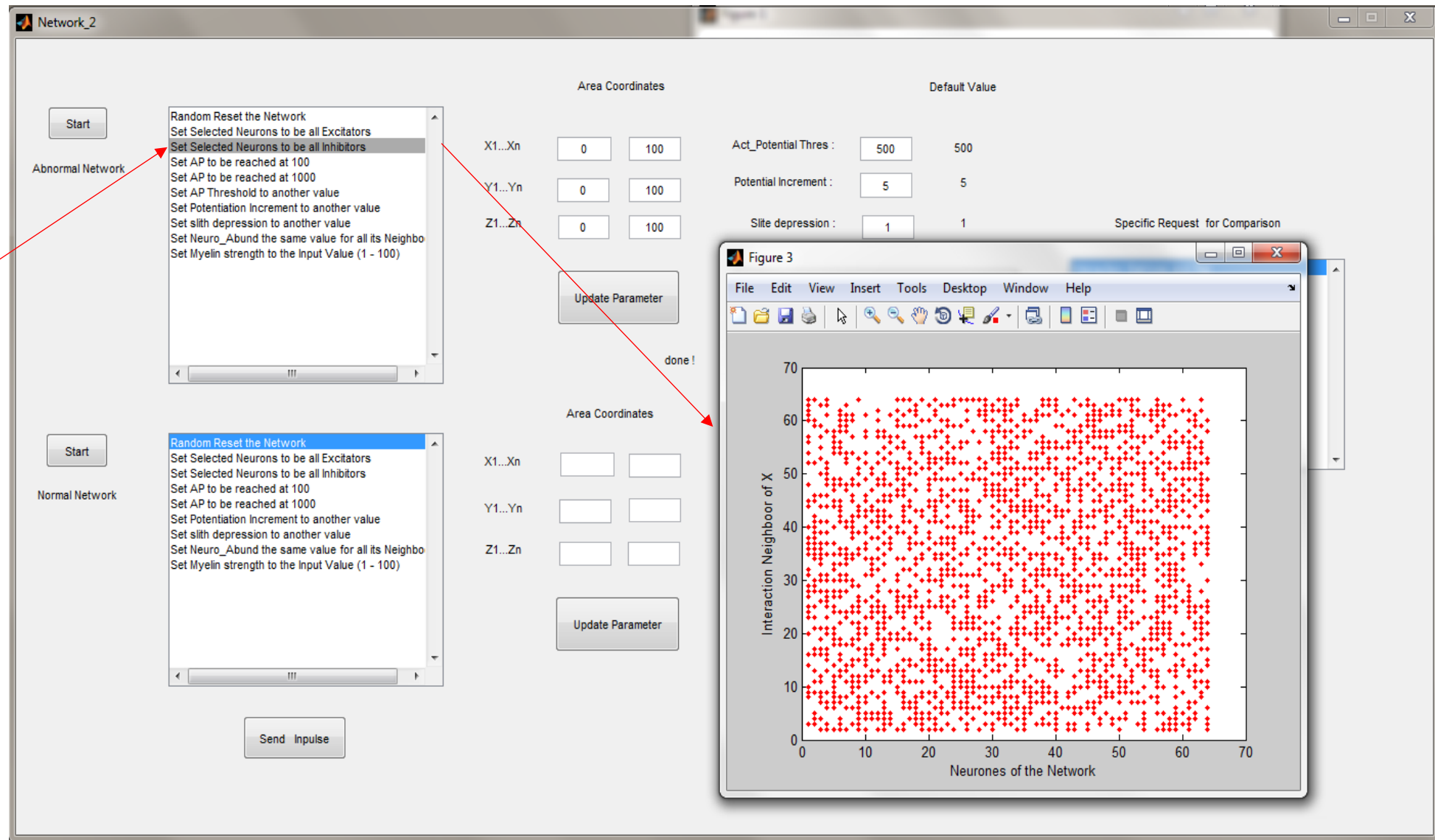
Another view of the Connection Matrice

# 4-First Results



# 4-First Results

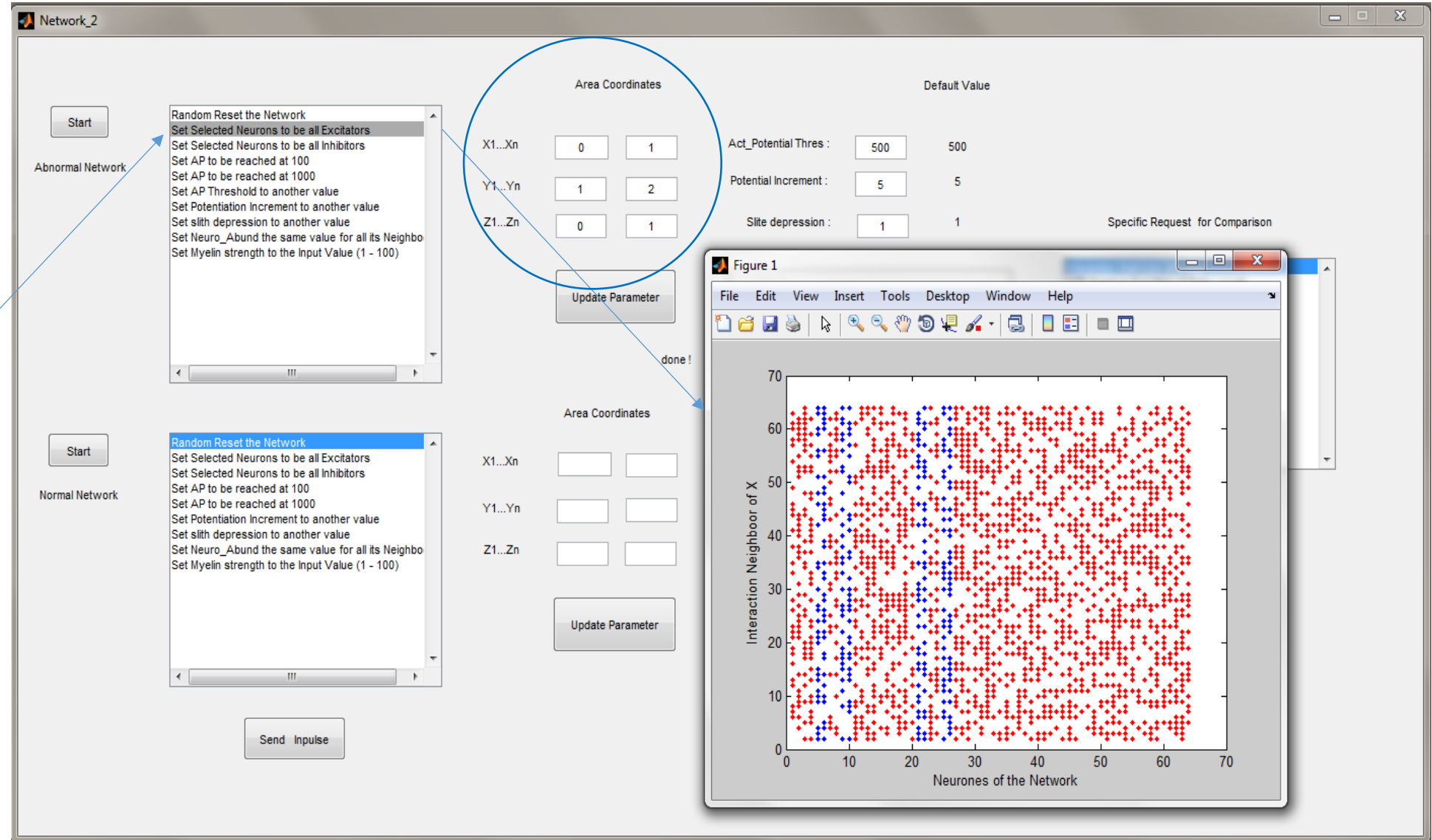




Let's set all neurons to be inhibitors. Remember, inhibitors is red.

# 4-First Results

Let select only neurons which coordinates are inside selected Area, to be Excitators.

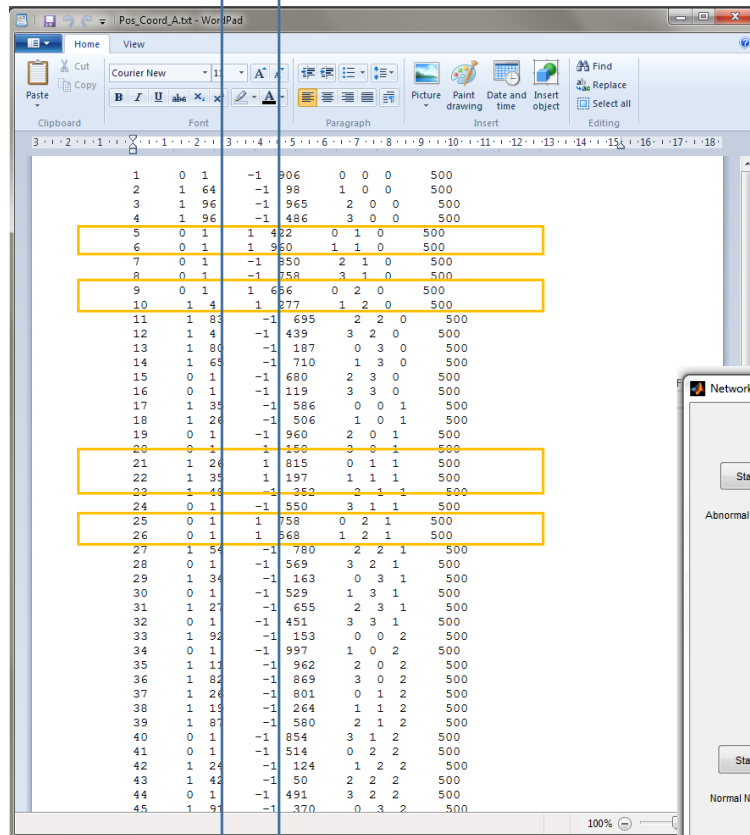




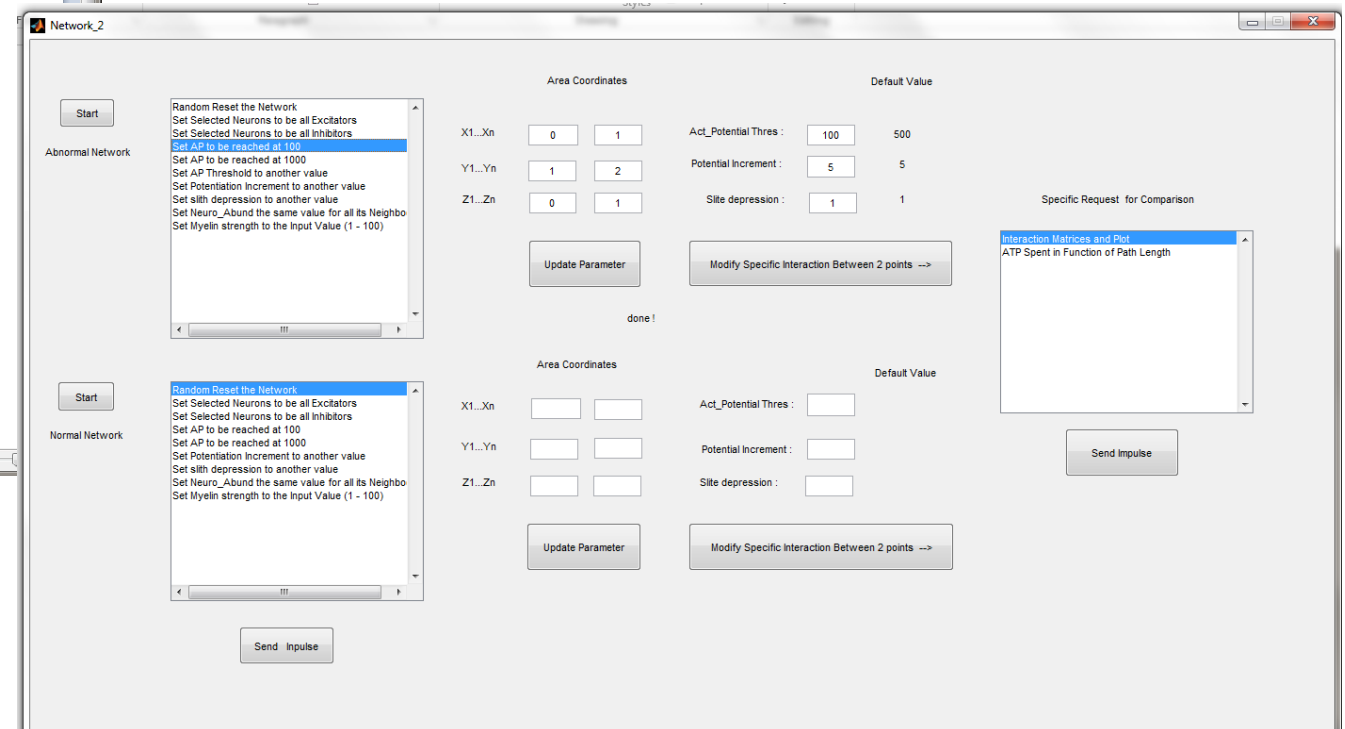
# 4-First Results

This is the Main\_file that stores all initial Neurone information.

As you can see, we have 8 neurones Excitator (+1) from last set up.



1	0	1	-1	906	0	0	0	500
2	1	64	-1	98	1	0	0	500
3	1	96	-1	965	2	0	0	500
4	1	96	-1	486	3	0	0	500
5	0	1	1	422	0	1	0	500
6	0	1	1	960	1	1	0	500
7	0	1	-1	550	2	1	0	500
8	0	1	-1	758	3	1	0	500
9	0	1	1	656	0	2	0	500
10	1	4	1	277	1	2	0	500
11	1	83	-1	695	2	2	0	500
12	1	4	-1	439	3	2	0	500
13	1	80	-1	187	0	3	0	500
14	1	63	-1	710	1	3	0	500
15	0	1	-1	680	2	3	0	500
16	0	1	-1	119	3	3	0	500
17	1	35	-1	586	0	0	1	500
18	1	24	-1	506	1	0	1	500
19	0	1	-1	960	2	0	1	500
20	0	1	1	150	3	0	1	500
21	1	24	1	815	0	1	1	500
22	1	35	1	197	1	1	1	500
23	1	40	-1	362	2	1	1	500
24	0	1	-1	550	3	1	1	500
25	0	1	1	758	0	2	1	500
26	0	1	1	568	1	2	1	500
27	1	54	-1	780	2	2	1	500
28	0	1	-1	569	3	2	1	500
29	1	34	-1	163	0	3	1	500
30	0	1	-1	529	1	3	1	500
31	1	27	-1	655	2	3	1	500
32	0	1	-1	451	3	3	1	500
33	1	92	-1	153	0	0	2	500
34	0	1	-1	997	1	0	2	500
35	1	11	-1	962	2	0	2	500
36	1	82	-1	869	3	0	2	500
37	1	24	-1	801	0	1	2	500
38	1	13	-1	264	1	1	2	500
39	1	87	-1	580	2	1	2	500
40	0	1	-1	854	3	1	2	500
41	0	1	-1	514	0	2	2	500
42	1	24	-1	124	1	2	2	500
43	1	42	-1	50	2	2	2	500
44	0	1	-1	491	3	2	2	500
45	1	91	-1	370	0	3	2	500



Network\_2

Start

Abnormal Network

Random Reset the Network  
Set Selected Neurons to be all Excitators  
Set Selected Neurons to be all Inhibitors  
Set AP to be reached at 100  
Set AP to be reached at 1000  
Set AP Threshold to another value  
Set Potentiation Increment to another value  
Set slith depression to another value  
Set Neuro\_Abund the same value for all its Neighbo  
Set Myelin strength to the Input Value (1 - 100)

Area Coordinates

X1..Xn 0 1  
Y1..Yn 1 2  
Z1..Zn 0 1

Default Value

Act\_Potential Thres : 100 500  
Potential Increment : 5 5  
Site depression : 1 1

Update Parameter

Modify Specific Interaction Between 2 points -->

done !

Normal Network

Start

Random Reset the Network  
Set Selected Neurons to be all Excitators  
Set Selected Neurons to be all Inhibitors  
Set AP to be reached at 100  
Set AP to be reached at 1000  
Set AP Threshold to another value  
Set Potentiation Increment to another value  
Set slith depression to another value  
Set Neuro\_Abund the same value for all its Neighbo  
Set Myelin strength to the Input Value (1 - 100)

Area Coordinates

X1..Xn  
Y1..Yn  
Z1..Zn

Default Value

Act\_Potential Thres :  
Potential Increment :  
Site depression :

Update Parameter

Modify Specific Interaction Between 2 points -->

Send Impulse

Specific Request for Comparison

Interaction Metrics and Plot  
ATP Spent in Function of Path Length

## 4-First Results

Set selected Neurons  
Action Potential to  
be reached at 100  
neuro-transmitters.

The screenshot shows the MATLAB R2014a environment. The top toolbar includes options like HOME, PLOTS, APPS, and various tool icons. The Editor window is open, showing a file named 'Network\_2.m' with the following MATLAB code:

```

1 function varargout = Network_2(varargin)
2 % NETWORK_2 MATLAB code for Network_2.fig
3 %
4 % NETWORK_2, by itself, creates a new NETWORK_2 or raises the existing
5 % singleton*.
6 %
7 % H = NETWORK_2 returns the handle to a new NETWORK_2 or the handle to
  the existing singleton*.

```

The Command Window displays the output of the script, showing a large matrix of neuron coordinates and AP thresholds. The output is as follows:

```

Neuron 51: 0 -1 -1 0 -1 0 -1 0 -1 0 -1 0 -1 0 0 -1 -1 -1 -1 0 0 0 -1 0 0 -1 0 -1 0 -1 0 -1 0 0 -
Neuron 52: 0 0 -1 0 -1 -1 0 -1 -1 -1 0 -1 0 -1 0 0 0 -1 -1 -1 -1 -1 -1 0 -1 0 -1 -1 -1 0 -1 -1 0 -1
Neuron 53: 0 0 -1 0 -1 0 -1 0 -1 0 -1 -1 -1 0 0 0 -1 -1 -1 -1 -1 0 -1 -1 -1 -1 0 -1 0 0 0 -1 -1 -1
Neuron 54: 0 -1 -1 -1 0 0 -1 -1 0 -1 -1 0 -1 -1 0 -1 0 0 0 -1 0 0 0 -1 -1 -1 -1 -1 0 -1 -1 0 0 -1
Neuron 55: 0 0 -1 0 0 -1 0 0 0 0 -1 0 -1 -1 -1 0 0 0 -1 -1 -1 0 -1 -1 0 0 0 0 0 0 -1 -1 -1 -1 0 0 -1 -
Neuron 56: 0 0 0 -1 0 0 0 0 -1 -1 -1 0 0 0 0 0 -1 0 0 0 0 0 -1 -1 0 0 -1 -1 0 -1 -1 0 -1 -1 -1 -1
Neuron 57: 0 0 -1 0 -1 0 0 0 -1 0 0 0 -1 0 0 0 0 0 -1 -1 0 0 0 0 0 -1 -1 -1 0 0 0 0 -1 -1 0 -1 -1 -1
Neuron 58: 0 -1 -1 -1 0 0 0 -1 -1 0 -1 0 0 -1 0 0 0 -1 0 0 0 -1 0 0 -1 -1 0 0 0 0 -1 -1 -1 -1 0 0 0 -1
Neuron 59: 0 -1 0 -1 -1 0 0 -1 -1 0 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 0 0 -1 -1 0 -1 -1 -1 0 -1 0 -1
Neuron 60: 0 0 0 0 -1 0 0 -1 -1 -1 -1 0 0 0 0 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 0 -1 -1
Neuron 61: 0 0 0 -1 -1 0 0 0 -1 0 -1 -1 0 0 0 -1 -1 -1 0 0 0 -1 0 0 0 0 -1 -1 -1 0 0 0 -1 -1 0 -1 0
Neuron 62: 0 0 -1 -1 -1 -1 0 0 -1 -1 -1 0 0 -1 -1 -1 0 0 -1 -1 -1 -1 0 0 -1 -1 -1 0 0 0 -1 0 -1 -1 0
Neuron 63: 0 -1 -1 -1 -1 -1 0 0 -1 0 -1 -1 -1 -1 0 -1 0 0 -1 -1 -1 -1 0 0 -1 -1 0 -1 -1 0 0 0 -1 0 -1 -1 0
Neuron 64: 0 0 0 0 -1 0 -1 -1 0 -1 0 0 -1 -1 -1 -1 0 0 -1 0 0 -1 0 0 -1 0 -1 -1 -1 0 -1 0 0 0 -1 0 -1 0

All neurone files have just been displayed
Set AP to be reached at 100
The previous neurone file coordinates has just been deleted
Neuron 5 AP Threshold is Now set to 100
Neuron 6 AP Threshold is Now set to 100
Neuron 9 AP Threshold is Now set to 100
Neuron 10 AP Threshold is Now set to 100
Neuron 21 AP Threshold is Now set to 100
Neuron 22 AP Threshold is Now set to 100
Neuron 25 AP Threshold is Now set to 100
Neuron 26 AP Threshold is Now set to 100
Finished to Update some neurone AP_Threshold to the value of 100
fx >>

```

Pos\_Coord\_Abct - WordPad

Home View

Clipboard Font Paragraph Image drawing Insert Editing

3 2 1 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

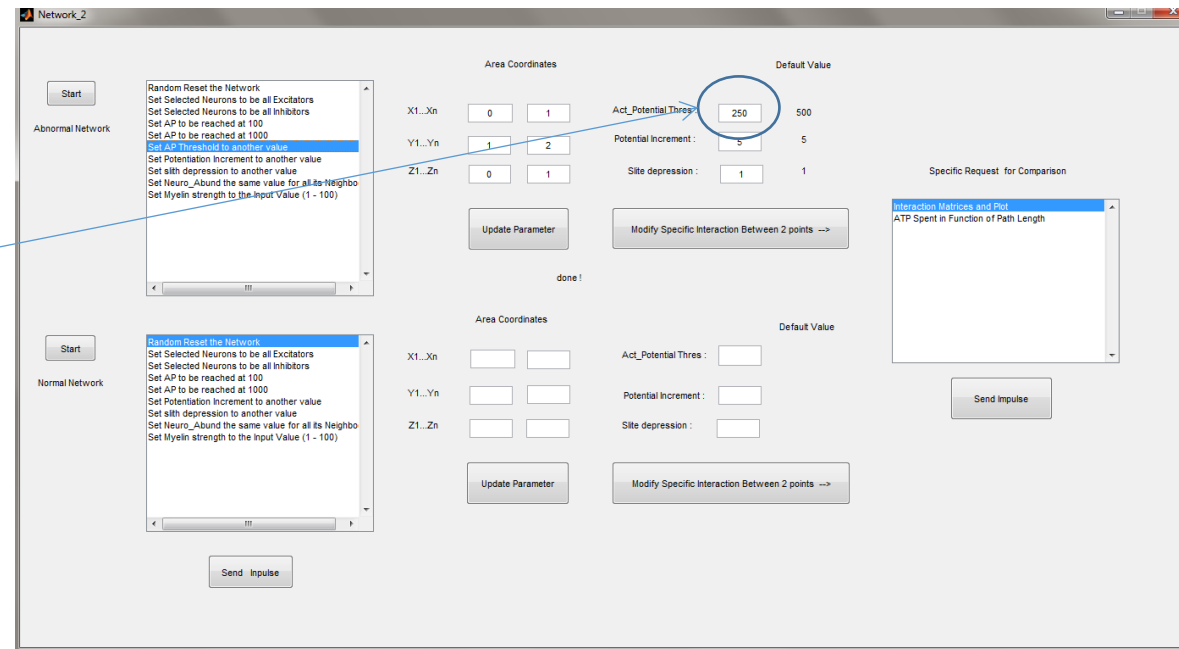
1	0	1	-1	906	0	0	0	500
2	1	64	-1	98	1	0	0	500
3	1	96	-1	965	2	0	0	500
4	1	96	-1	486	3	0	0	500
5	0	1	1	422	0	1	0	100
6	0	1	1	960	1	1	0	100
7	0	1	-1	850	2	1	0	500
8	0	1	-1	758	3	1	0	500
9	0	1	1	656	0	2	0	100
10	1	4	1	277	1	2	0	100
11	1	83	-1	695	2	2	0	500
12	1	4	-1	439	3	2	0	500
13	1	80	-1	187	0	3	0	500
14	1	65	-1	710	1	3	0	500
15	0	1	-1	680	2	3	0	500
16	0	1	-1	119	3	3	0	500
17	1	35	-1	596	0	0	1	500
18	1	26	-1	506	1	0	1	500
19	0	1	-1	960	2	0	1	500
20	0	1	-1	150	3	0	1	500
21	1	26	1	815	0	1	1	100
22	1	35	1	197	1	1	1	100
23	1	48	-1	352	2	1	1	500
24	0	1	-1	550	3	1	1	500
25	0	1	1	758	0	2	1	100
26	0	1	1	568	1	2	1	100
27	1	54	-1	780	2	2	1	500
28	0	1	-1	569	3	2	1	500
29	1	34	-1	163	0	3	1	500
30	0	1	-1	529	1	3	1	500
31	1	27	-1	655	2	3	1	500
32	0	1	-1	451	3	3	1	500
33	1	92	-1	153	0	0	2	500
34	0	1	-1	997	1	0	2	500
35	1	11	-1	962	2	0	2	500
36	1	82	-1	869	3	0	2	500
37	1	26	-1	801	0	1	2	500
38	1	19	-1	264	1	1	2	500
39	1	87	-1	580	2	1	2	500
40	0	1	-1	854	3	1	2	500
41	0	1	-1	514	0	2	2	500
42	1	24	-1	124	1	2	2	500
43	1	42	-1	50	2	2	2	500
44	0	1	-1	491	3	2	2	500



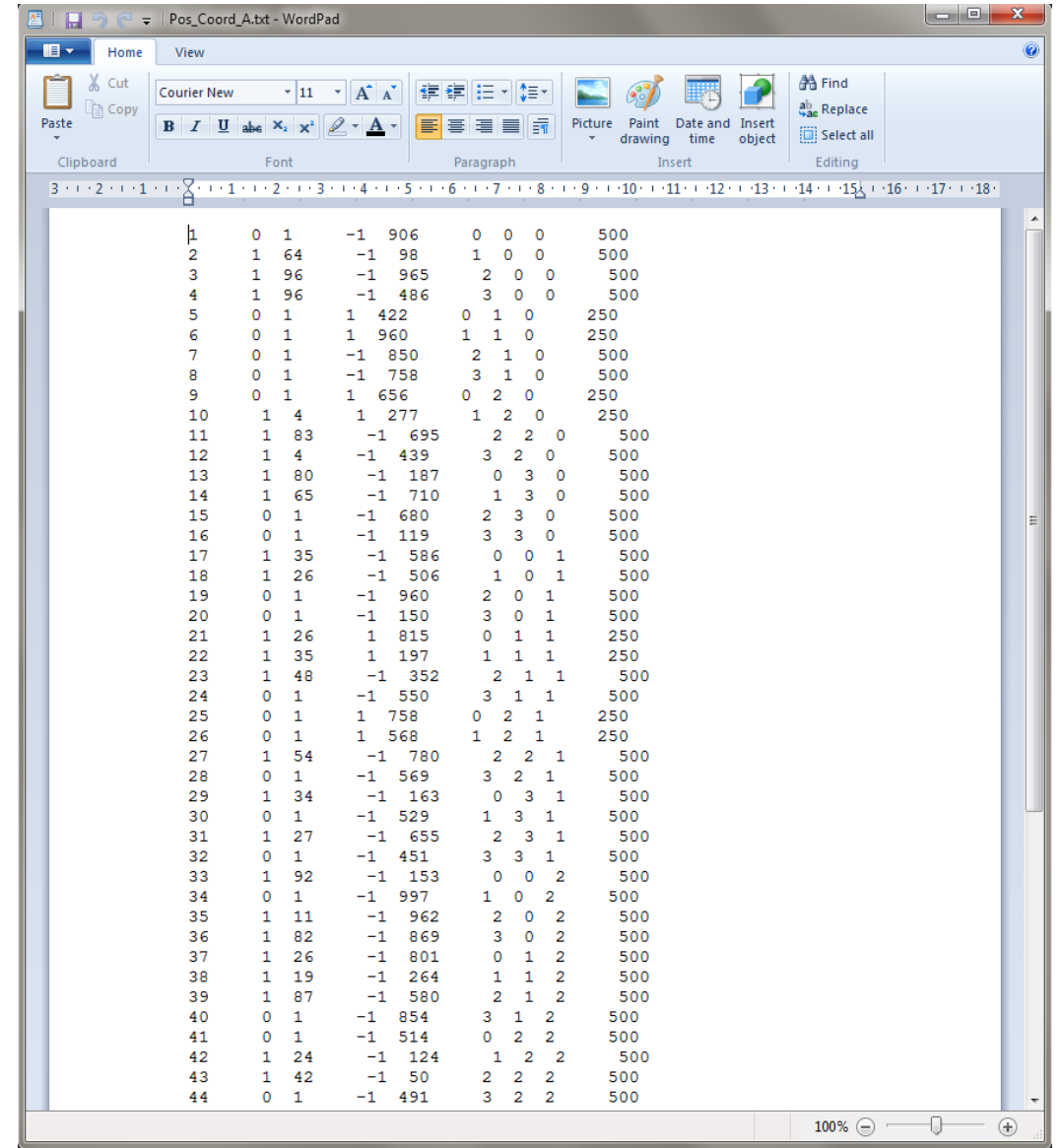
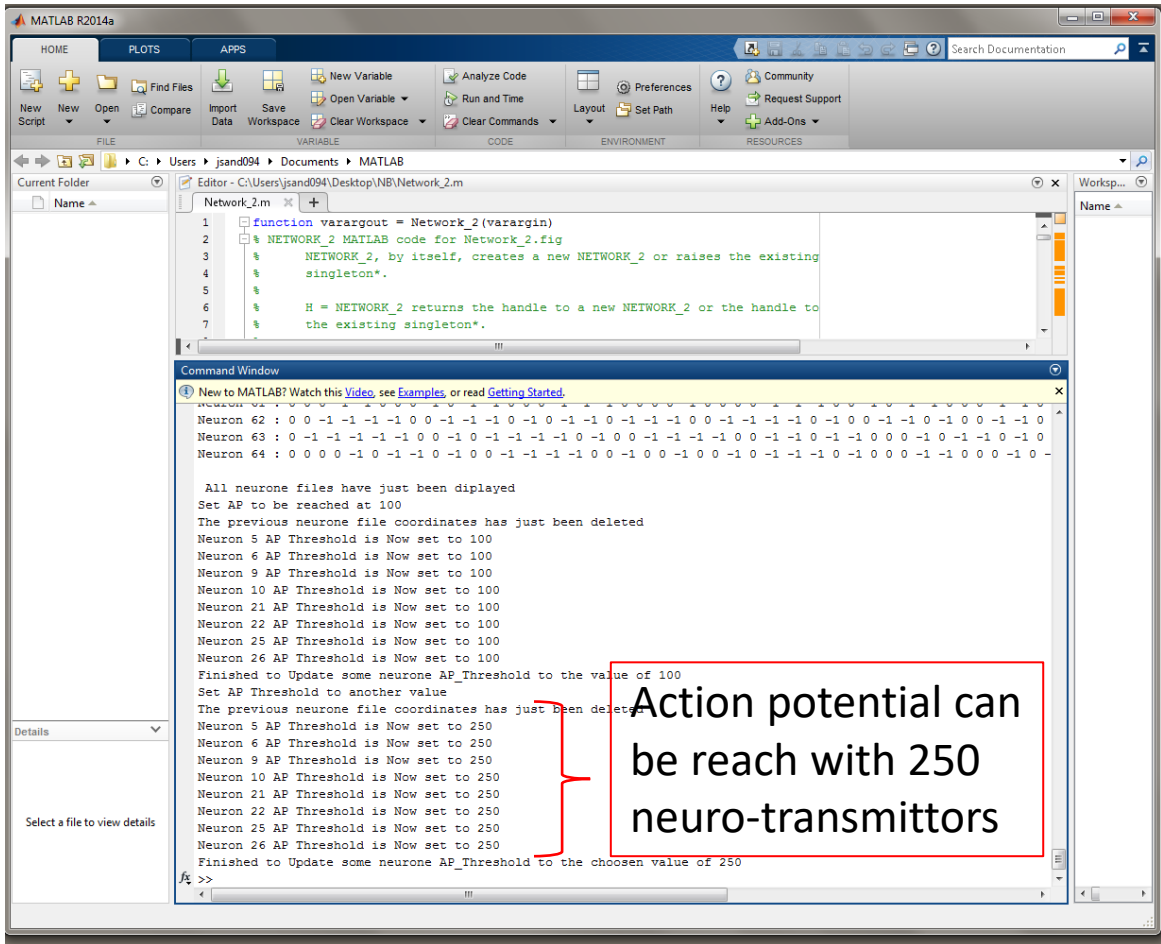
# 4-First Results

Set selected Neurons Action Potential to be reached at another number of neurotransmitters.

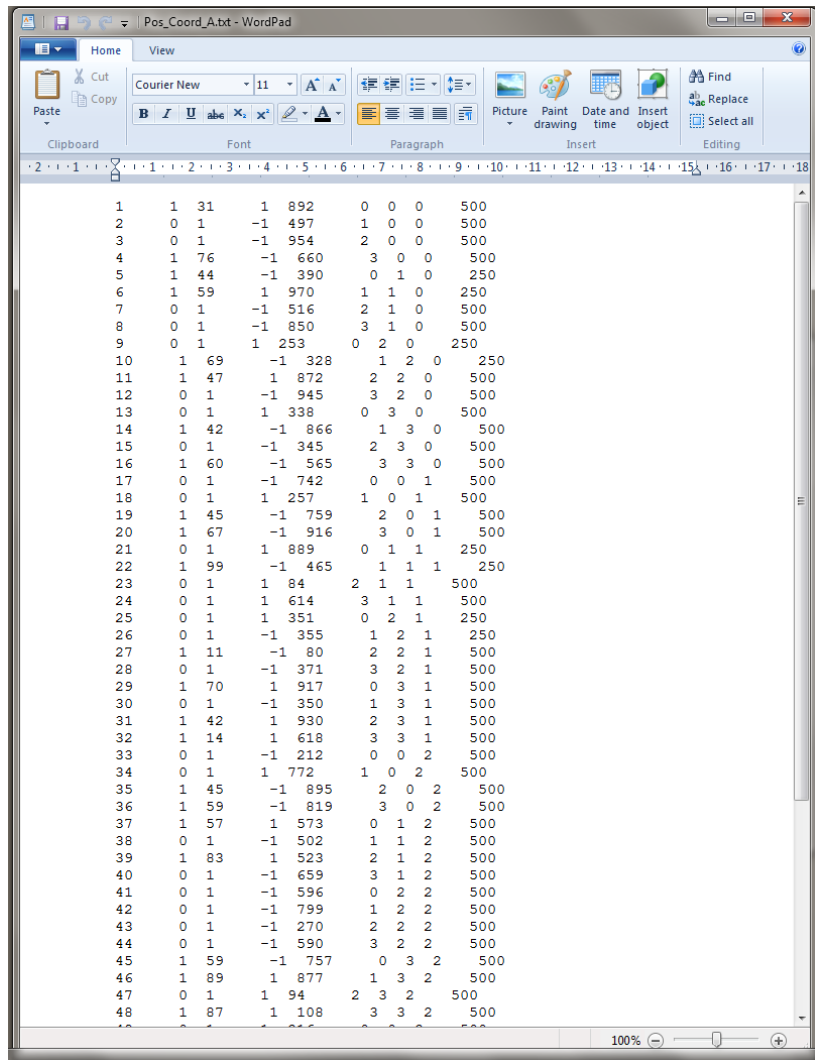
Random value here is 250



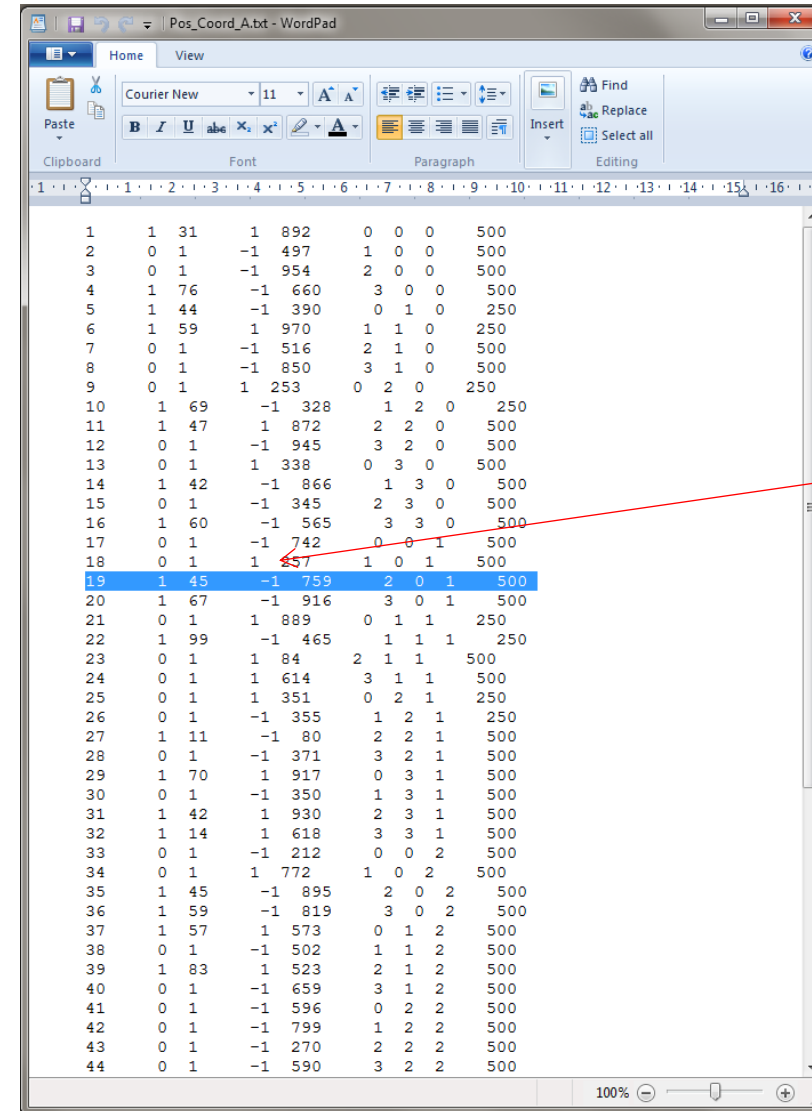
# 4-First Results



# Let's randomly take Neuron 19



1	1	31	1	892	0	0	0	500
2	0	1	-1	497	1	0	0	500
3	0	1	-1	954	2	0	0	500
4	1	76	-1	660	3	0	0	500
5	1	44	-1	390	0	1	0	250
6	1	59	1	970	1	1	0	250
7	0	1	-1	516	2	1	0	500
8	0	1	-1	850	3	1	0	500
9	0	1	1	253	0	2	0	250
10	1	69	-1	328	1	2	0	250
11	1	47	1	872	2	2	0	500
12	0	1	-1	945	3	2	0	500
13	0	1	1	338	0	3	0	500
14	1	42	-1	866	1	3	0	500
15	0	1	-1	345	2	3	0	500
16	1	60	-1	565	3	3	0	500
17	0	1	-1	742	0	0	1	500
18	0	1	1	257	1	0	1	500
19	1	45	-1	759	2	0	1	500
20	1	67	-1	916	3	0	1	500
21	0	1	1	889	0	1	1	250
22	1	99	-1	465	1	1	1	250
23	0	1	1	84	2	1	1	500
24	0	1	1	614	3	1	1	500
25	0	1	1	351	0	2	1	250
26	0	1	-1	355	1	2	1	250
27	1	11	-1	80	2	2	1	500
28	0	1	-1	371	3	2	1	500
29	1	70	1	917	0	3	1	500
30	0	1	-1	350	1	3	1	500
31	1	42	1	930	2	3	1	500
32	1	14	1	618	3	3	1	500
33	0	1	-1	212	0	0	2	500
34	0	1	1	772	1	0	2	500
35	1	45	-1	895	2	0	2	500
36	1	59	-1	819	3	0	2	500
37	1	57	1	573	0	1	2	500
38	0	1	-1	502	1	1	2	500
39	1	83	1	523	2	1	2	500
40	0	1	-1	659	3	1	2	500
41	0	1	-1	596	0	2	2	500
42	0	1	-1	799	1	2	2	500
43	0	1	-1	270	2	2	2	500
44	0	1	-1	590	3	2	2	500
45	1	59	-1	757	0	3	2	500
46	1	89	1	877	1	3	2	500
47	0	1	1	94	2	3	2	500
48	1	87	1	108	3	3	2	500



1	1	31	1	892	0	0	0	500
2	0	1	-1	497	1	0	0	500
3	0	1	-1	954	2	0	0	500
4	1	76	-1	660	3	0	0	500
5	1	44	-1	390	0	1	0	250
6	1	59	1	970	1	1	0	250
7	0	1	-1	516	2	1	0	500
8	0	1	-1	850	3	1	0	500
9	0	1	1	253	0	2	0	250
10	1	69	-1	328	1	2	0	250
11	1	47	1	872	2	2	0	500
12	0	1	-1	945	3	2	0	500
13	0	1	1	338	0	3	0	500
14	1	42	-1	866	1	3	0	500
15	0	1	-1	345	2	3	0	500
16	1	60	-1	565	3	3	0	500
17	0	1	-1	742	0	0	1	500
18	0	1	1	257	1	0	1	500
19	1	45	-1	759	2	0	1	500
20	1	67	-1	916	3	0	1	500
21	0	1	1	889	0	1	1	250
22	1	99	-1	465	1	1	1	250
23	0	1	1	84	2	1	1	500
24	0	1	1	614	3	1	1	500
25	0	1	1	351	0	2	1	250
26	0	1	-1	355	1	2	1	250
27	1	11	-1	80	2	2	1	500
28	0	1	-1	371	3	2	1	500
29	1	70	1	917	0	3	1	500
30	0	1	-1	350	1	3	1	500
31	1	42	1	930	2	3	1	500
32	1	14	1	618	3	3	1	500
33	0	1	-1	212	0	0	2	500
34	0	1	1	772	1	0	2	500
35	1	45	-1	895	2	0	2	500
36	1	59	-1	819	3	0	2	500
37	1	57	1	573	0	1	2	500
38	0	1	-1	502	1	1	2	500
39	1	83	1	523	2	1	2	500
40	0	1	-1	659	3	1	2	500
41	0	1	-1	596	0	2	2	500
42	0	1	-1	799	1	2	2	500
43	0	1	-1	270	2	2	2	500
44	0	1	-1	590	3	2	2	500

It is an inhibitor (-1)

The screenshot shows a Windows File Explorer window with the address bar set to 'NB > Connections > Abnormal'. The left sidebar shows the 'Abnormal' folder selected under the 'NB' drive. The main pane displays a list of files with columns for Name, Date modified, Type, and Size. The files are named 'Con\_Neur\_10.bt' through 'Con\_Neur\_32.bt'. A tooltip is displayed over the file 'Con\_Neur\_19.bt', showing its details: Type: Text Document, Size: 2.92 KB, and Date modified: 28/06/2016 10:47 AM. At the bottom of the window, a status bar provides additional information for the selected file: 'Con\_Neur\_19.bt Date modified: 28/06/2016 10:47 AM Date created: 28/06/2016 9:45 AM Text Document Size: 2.92 KB'.

Name	Date modified	Type	Size
Con_Neur_10.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_11.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_12.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_13.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_14.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_15.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_16.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_17.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_18.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_19.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_20.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_21.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_22.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_23.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_24.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_25.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_26.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_27.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_28.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_29.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_30.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_31.bt	28/06/2016 10:47 ...	Text Document	3 KB
Con_Neur_32.bt	28/06/2016 10:47 ...	Text Document	3 KB

Con\_Neur\_19.bt Date modified: 28/06/2016 10:47 AM Date created: 28/06/2016 9:45 AM  
Text Document Size: 2.92 KB

The screenshot shows a Microsoft WordPad window with the file name "Con\_Neur\_19.txt". The ribbon at the top includes tabs for Home, View, Font, Paragraph, Insert, and Editing. The main editing area displays a table of numerical data. The data is organized into rows and columns, with some values highlighted by a red circle.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0	0	0	0	0	0	00	00	00	000						
2	-1	45	206	15.5563	0.3457	3.457	00	00	00	000						
3	-1	45	624	11	0.24444	2.4444	00	00	00	000						
4	0	0	0	0	0	0	00	00	00	000						
5	0	0	0	0	0	0	00	00	00	000						
6	-1	45	178	19.0526	0.42339	4.2339	00	00	00	000						
7	0	0	0	0	0	0	00	00	00	000						
8	-1	45	165	19.0526	0.42339	4.2339	00	00	00	000						
9	-1	45	477	33	0.73333	7.3333	00	00	00	000						
10	-1	45	65	26.9444	0.59876	5.9876	00	00	00	000						
11	-1	45	102	24.5967	0.54659	5.4659	00	00	00	000						
12	-1	45	73	26.9444	0.59876	5.9876	00	00	00	000						
13	0	0	0	0	0	0	00	00	00	000						
14	0	0	0	0	0	0	00	00	00	000						
15	0	0	0	0	0	0	00	00	00	000						
16	-1	45	168	36.4829	0.81073	8.1073	00	00	00	000						
17	0	0	0	0	0	0	00	00	00	000						
18	-1	45	510	11	0.24444	2.4444	00	00	00	000						
19	0	0	0	0	0	0	00	00	00	000						
20	0	0	0	0	0	0	00	00	00	000						
21	0	0	0	0	0	0	00	00	00	000						
22	0	0	0	0	0	0	00	00	00	000						
23	-1	45	603	11	0.24444	2.4444	00	00	00	000						
24	-1	45	102	15.5563	0.3457	3.457	00	00	00	000						
25	-1	45	499	31.1127	0.69139	6.9139	00	00	00	000						
26	0	0	0	0	0	0	00	00	00	000						
27	-1	45	661	22	0.48889	4.8889	00	00	00	000						
28	0	0	0	0	0	0	00	00	00	000						
29	-1	45	190	39.6611	0.88136	8.8136	00	00	00	000						
30	0	0	0	0	0	0	00	00	00	000						
31	-1	45	581	33	0.73333	7.3333	00	00	00	000						
32	-1	45	191	34.7851	0.773	7.73	00	00	00	000						
33	-1	45	744	24.5967	0.54659	5.4659	00	00	00	000						
34	0	0	0	0	0	0	00	00	00	000						
35	0	0														

# Mod

The last request in the listbox is not achieved for time reasons.

We update that strength to 680

The image shows the MATLAB R2014a environment. The main window displays a script editor with a file named `Network_2.m`. The script contains a function `function varargout = Network_2(varargin)` that manages a network of neurons. The command window shows the output of the script, displaying a list of neurons and their connections. A dialog box titled `Modify_Specific_Interaction` is open, allowing the user to modify the connection strength between two neurons. The dialog box includes fields for `Neuron ID` (19) and `Neighbor ID` (37). It also has a listbox with options: `Modify the Connection Strength`, `Increment the Connection Strength`, `Decrement the Connection Strength`, and `Modify the Interaction (Act / Inhi)`. The `Increment Jump` field is set to 680. The `New Strength` field is set to 680. The `No / Act / Inhi` dropdown is set to 0. The `Update Interaction` button is highlighted. The dialog box also displays the message "the neurone file has just been updated" and "New Strength between Neuron 19 and Neuron 37 is 680".

**Script Editor: Network\_2.m**

```
1 function varargout = Network_2(varargin)
2 % NETWORK_2 MATLAB code for Network_2.fig
3 % NETWORK_2, by itself, creates a new NETWORK_2 or raises
4 % singleton*.
5 %
6 % H = NETWORK_2 returns the handle to a new NETWORK_2 or
7 % the existing singleton*.
```

**Command Window**

```
New to MATLAB? Watch this Video, see Examples, or read Getting Started.
Neuron 49 : 0 0 1 1 1 0 1 1 0 1 0 1 1 1 1 1 1 0 0 1 0 1 1 0 0 1 1 0
Neuron 50 : 0 -1 0 -1 -1 -1 -1 0 -1 -1 -1 -1 -1 -1 -1 -1 0 0 -1 0 -
Neuron 51 : 0 1 0 0 1 1 1 0 0 0 1 0 0 1 0 0 1 0 1 1 1 1 1 1 0 1 1
Neuron 52 : 0 -1 0 -1 -1 -1 -1 -1 -1 -1 0 0 -1 -1 -1 0 -1 -1 -1 0 -
Neuron 53 : 0 1 1 0 0 1 1 0 1 0 1 0 0 0 0 0 1 1 0 1 1 1 1 1 0 1 0
Neuron 54 : 0 0 0 -1 -1 0 0 -1 -1 0 -1 -1 -1 -1 0 -1 -1 0 -1 0 -1 0 -
Neuron 55 : 0 1 1 1 0 1 1 1 1 0 1 0 0 0 0 1 0 0 1 1 1 1 1 0 1 0 0 1 0
Neuron 56 : 0 0 0 1 0 0 0 1 1 0 1 0 0 0 0 1 0 0 1 0 1 0 0 1 1 1 0 0 0
Neuron 57 : 0 0 0 0 1 0 1 1 0 1 0 0 1 0 0 1 0 0 1 0 1 0 1 0 0 1 0 0 0
Neuron 58 : 0 -1 -1 -1 0 -1 -1 0 0 -1 -1 0 0 0 0 0 -1 -1 0 -1 -1 0 -1
Neuron 59 : 0 -1 -1 0 0 0 -1 -1 0 -1 -1 0 -1 -1 0 -1 -1 -1 0 0 0 0 -1
Neuron 60 : 0 1 1 0 0 1 1 1 1 1 0 1 1 0 0 1 0 0 0 0 0 0 0 0 1 0 1 1
Neuron 61 : 0 -1 0 0 -1 0 0 0 -1 0 -1 -1 -1 0 -1 0 -1 -1 -1 -1 0 0 0
Neuron 62 : 0 1 1 1 0 0 0 1 1 0 1 0 1 0 1 0 1 1 0 1 1 1 0 1 1 1 0 0 0
Neuron 63 : 0 1 1 1 1 0 1 1 1 1 0 1 1 0 0 1 0 0 1 0 1 0 0 0 0 0 1 1 1 0
Neuron 64 : 0 1 1 1 0 0 1 0 0 0 0 1 1 1 0 0 1 1 1 0 1 0 0 1 1 1 1 1 1
```

**Modify\_Specific\_Interaction Dialog Box**

The more Neuron we have in our Network, The harder will be to use this interface

Neuron ID : 19 Neighbor ID : 37

Modify the Connection Strength  
Increment the Connection Strength  
Decrement the Connection Strength  
Modify the Interaction (Act / Inhi)

Increment Jump : [ ] Decrement Fall : [ ]

New Strength : 680 No / Act / Inhi : 0

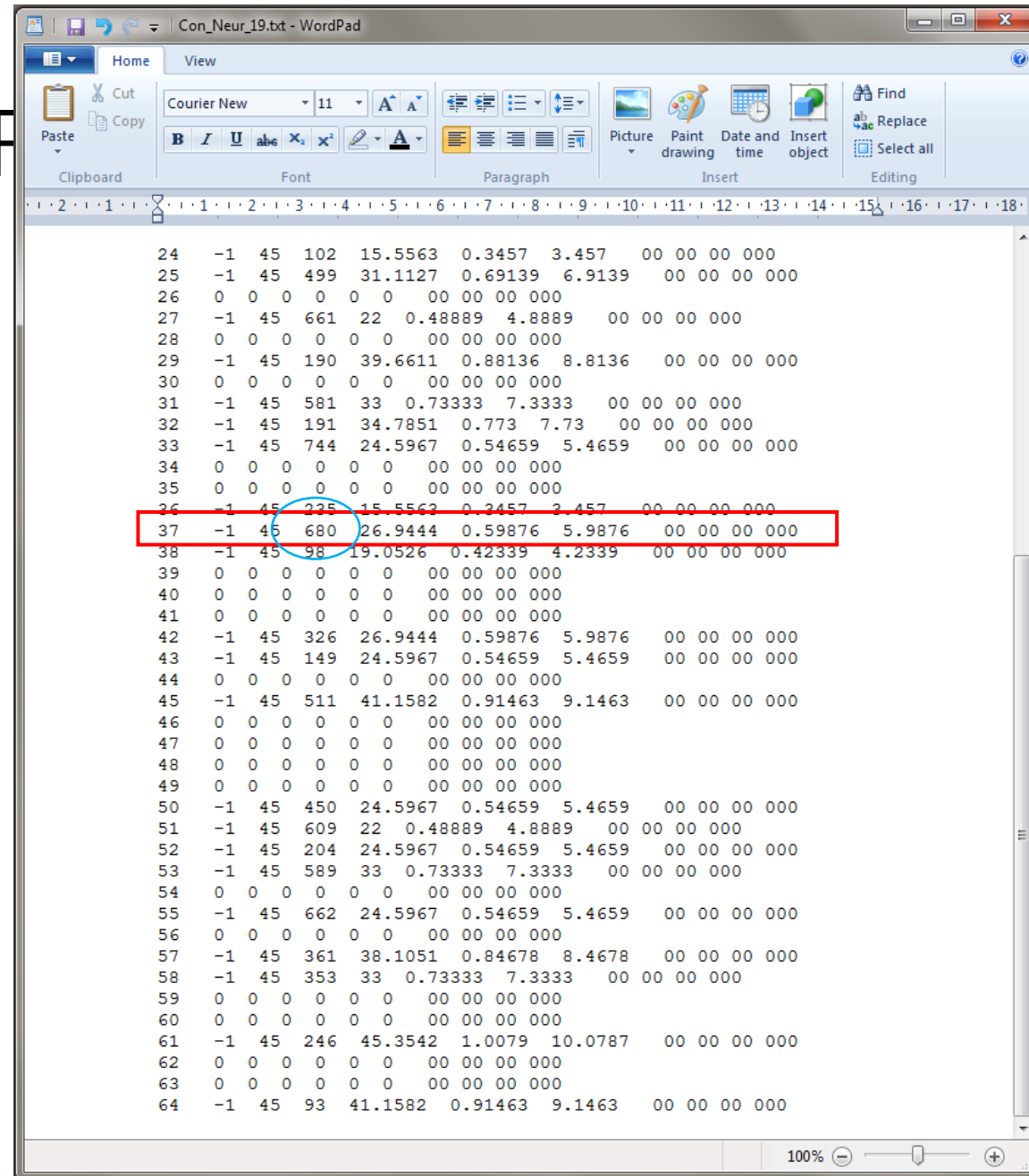
Update Interaction

Back to the Network

the neurone file has just been updated

New Strength between Neuron 19 and Neuron 37 is 680

# Back to the P



24	-1	45	102	15.5563	0.3457	3.457	00	00	00	000
25	-1	45	499	31.1127	0.69139	6.9139	00	00	00	000
26	0	0	0	0	0	0	00	00	00	000
27	-1	45	661	22	0.48889	4.8889	00	00	00	000
28	0	0	0	0	0	0	00	00	00	000
29	-1	45	190	39.6611	0.88136	8.8136	00	00	00	000
30	0	0	0	0	0	0	00	00	00	000
31	-1	45	581	33	0.73333	7.3333	00	00	00	000
32	-1	45	191	34.7851	0.773	7.73	00	00	00	000
33	-1	45	744	24.5967	0.54659	5.4659	00	00	00	000
34	0	0	0	0	0	0	00	00	00	000
35	0	0	0	0	0	0	00	00	00	000
36	-1	45	235	15.5563	0.3457	3.457	00	00	00	000
37	-1	45	680	26.9444	0.59876	5.9876	00	00	00	000
38	-1	45	98	19.0526	0.42339	4.2339	00	00	00	000
39	0	0	0	0	0	0	00	00	00	000
40	0	0	0	0	0	0	00	00	00	000
41	0	0	0	0	0	0	00	00	00	000
42	-1	45	326	26.9444	0.59876	5.9876	00	00	00	000
43	-1	45	149	24.5967	0.54659	5.4659	00	00	00	000
44	0	0	0	0	0	0	00	00	00	000
45	-1	45	511	41.1582	0.91463	9.1463	00	00	00	000
46	0	0	0	0	0	0	00	00	00	000
47	0	0	0	0	0	0	00	00	00	000
48	0	0	0	0	0	0	00	00	00	000
49	0	0	0	0	0	0	00	00	00	000
50	-1	45	450	24.5967	0.54659	5.4659	00	00	00	000
51	-1	45	609	22	0.48889	4.8889	00	00	00	000
52	-1	45	204	24.5967	0.54659	5.4659	00	00	00	000
53	-1	45	589	33	0.73333	7.3333	00	00	00	000
54	0	0	0	0	0	0	00	00	00	000
55	-1	45	662	24.5967	0.54659	5.4659	00	00	00	000
56	0	0	0	0	0	0	00	00	00	000
57	-1	45	361	38.1051	0.84678	8.4678	00	00	00	000
58	-1	45	353	33	0.73333	7.3333	00	00	00	000
59	0	0	0	0	0	0	00	00	00	000
60	0	0	0	0	0	0	00	00	00	000
61	-1	45	246	45.3542	1.0079	10.0787	00	00	00	000
62	0	0	0	0	0	0	00	00	00	000
63	0	0	0	0	0	0	00	00	00	000
64	-1	45	93	41.1582	0.91463	9.1463	00	00	00	000



Modify\_Specific\_Interaction

The more Neuron we have in our Network, The harder will be to use this Interface

Neuron ID : 19      Neighbor ID : 37

Modify the Connection Strength

Increment the Connection Strength

Decrement the Connection Strength

Modify the Interaction ( Act / Inhi )

Increment Jump : 5      Decrement Fall :

New Strength :      No / Act / Inhi : 0

1

-1

the neurone file has just been updated

Update Interaction

Back to the Network

Strength between Neuron 19 and Neuron 37 has been incremented to 685

Modify\_Specific\_Interaction

The more Neuron we have in our Network, The harder will be to use this Interface

Neuron ID : 19      Neighbor ID : 37

Modify the Connection Strength

Increment the Connection Strength

Decrement the Connection Strength

Modify the Interaction ( Act / Inhi )

Increment Jump : 5      Decrement Fall :

New Strength :      No / Act / Inhi : 0

1

-1

NB : A couple of function arent achieved for time reason

Update Interaction

Back to the Network

iPad

4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
26	24	26	0	0	0	0	0	0	0	0	0	0	0	0
2	24.5967	0.54659	5.4659	00	00	00	000							
	26.9444	0.59876	5.9876	00	00	00	000							
	0	0	00	00	00	000								
	0	0	00	00	00	000								
	0	0	00	00	00	000								
3	36.4829	0.81073	8.1073	00	00	00	000							
	0	0	00	00	00	000								
0	11	0.24444	2.4444	00	00	00	000							
	0	0	00	00	00	000								
	0	0	00	00	00	000								
	0	0	00	00	00	000								
	0	0	00	00	00	000								
	0	0	00	00	00	000								
3	11	0.24444	2.4444	00	00	00	000							
2	15.5563	0.3457	3.457	00	00	00	000							
	31.1127	0.69139	6.9139	00	00	00	000							
26	0	0	0	0	0	0	00	00	00	000				
27	-1	45	661	22	0.48889	4.8889	00	00	00	000				
28	0	0	0	0	0	0	00	00	00	000				
29	-1	45	190	39.6611	0.88136	8.8136	00	00	00	000				
30	0	0	0	0	0	0	00	00	00	000				
31	-1	45	581	33	0.73333	7.3333	00	00	00	000				
32	-1	45	191	34.7851	0.773	7.73	00	00	00	000				
33	-1	45	744	24.5967	0.54659	5.4659	00	00	00	000				
34	0	0	0	0	0	0	00	00	00	000				
35	0	0	0	0	0	0	00	00	00	000				
36	-1	45	235	15.5563	0.3457	3.457	00	00	00	000				
37	-1	45	685	26.9444	0.59876	5.9876	00	00	00	000				
38	-1	45	98	19.0526	0.42339	4.2339	00	00	00	000				
39	0	0	0	0	0	0	00	00	00	000				
40	0	0	0	0	0	0	00	00	00	000				
41	0	0	0	0	0	0	00	00	00	000				
42	-1	45	326	26.9444	0.59876	5.9876	00	00	00	000				
43	-1	45	149	24.5967	0.54659	5.4659	00	00	00	000				
44	0	0	0	0	0	0	00	00	00	000				
45	-1	45	511	41.1582	0.91463	9.1463	00	00	00	000				
46	0	0	0	0	0	0	00	00	00	000				
47	0	0	0	0	0	0	00	00	00	000				
48	0	0	0	0	0	0	00	00	00	000				
49	0	0	0	0	0	0	00	00	00	000				
50	-1	45	450	24.5967	0.54659	5.4659	00	00	00	000				
51	-1	45	609	22	0.48889	4.8889	00	00	00	000				

100%

Modify\_Specific\_Interaction

The more Neuron we have in our Network, The harder will be to use this Interface

Neuron ID :  Neighbor ID :

Modify the Connection Strength

Increment the Connection Strength

**Decrement the Connection Strength**

Modify the Interaction ( Act / Inhi )

Increment Jump :

Decrement Fall :

New Strength :

No / Act / Inh : 

0

1

-1

the neurone file has just been updated

Update Interaction

Back to the Network

Strength between Neuron 19 and Neuron 37 has been incremented to 685

Modify\_Specific\_Interaction

The more Neuron we have in our Network, The harder will be to use this Interface

Neuron ID :  Neighbor ID :

Modify the Connection Strength

Increment the Connection Strength

**Decrement the Connection Strength**

Modify the Interaction ( Act / Inhi )

Increment Jump :

Decrement Fall :

New Strength :

No / Act / Inh : 

0

1

-1

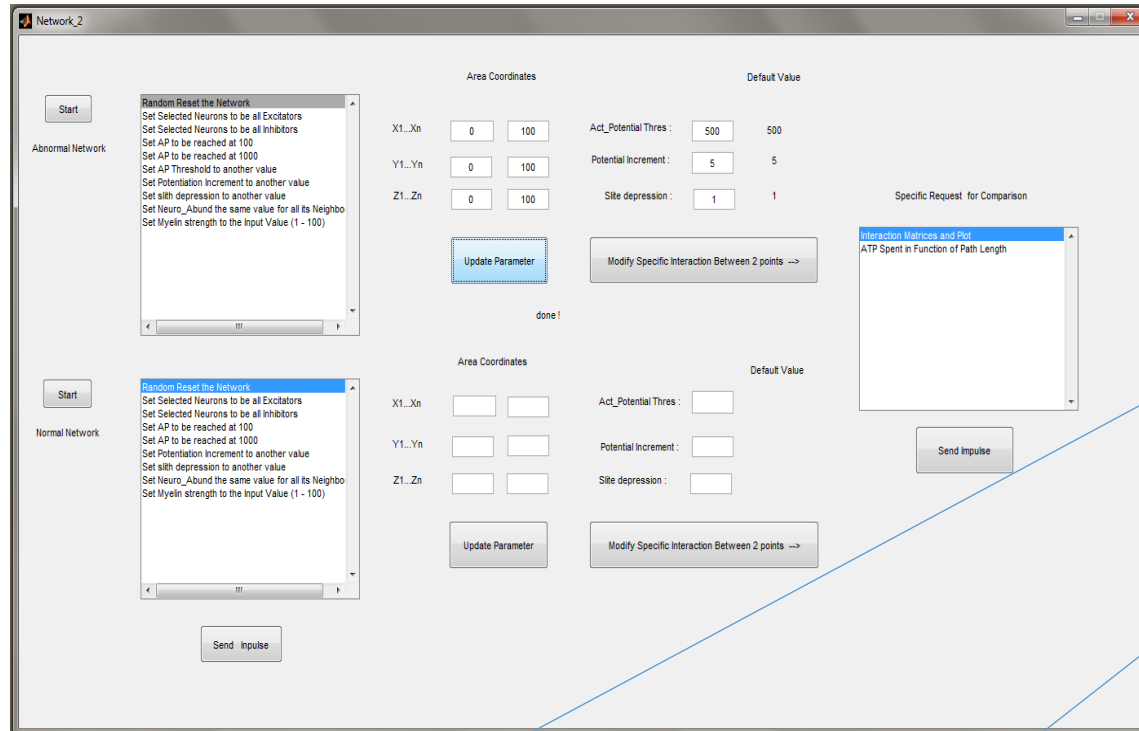
Update Interaction

Back to the Network

Strength between Neuron 19 and Neuron 37 has been decreased to 665



# Let's go back to the Network

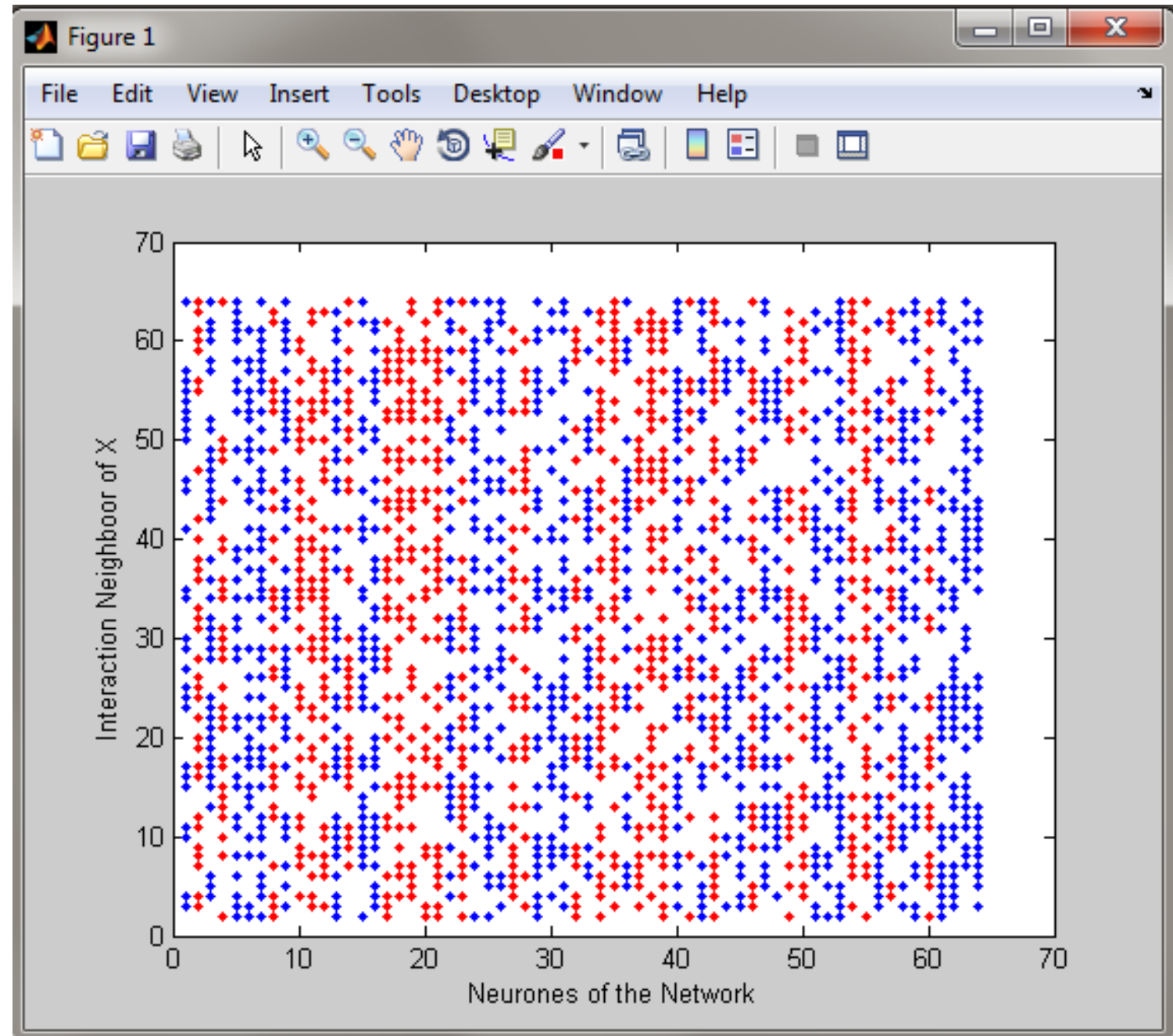


When one submit an impulse, the Neuron1 is the first neuron that it : **Receptor Neuron**. The last column is the action potential threshold. When neuron 1 will send its signal to its neighbors, for this simulation, I manually put its neurotransmitters (the power with which he excites its neighbors) to 100. In that case, he cannot excite none of its neighbors which threshold is  $500 > 100$ .

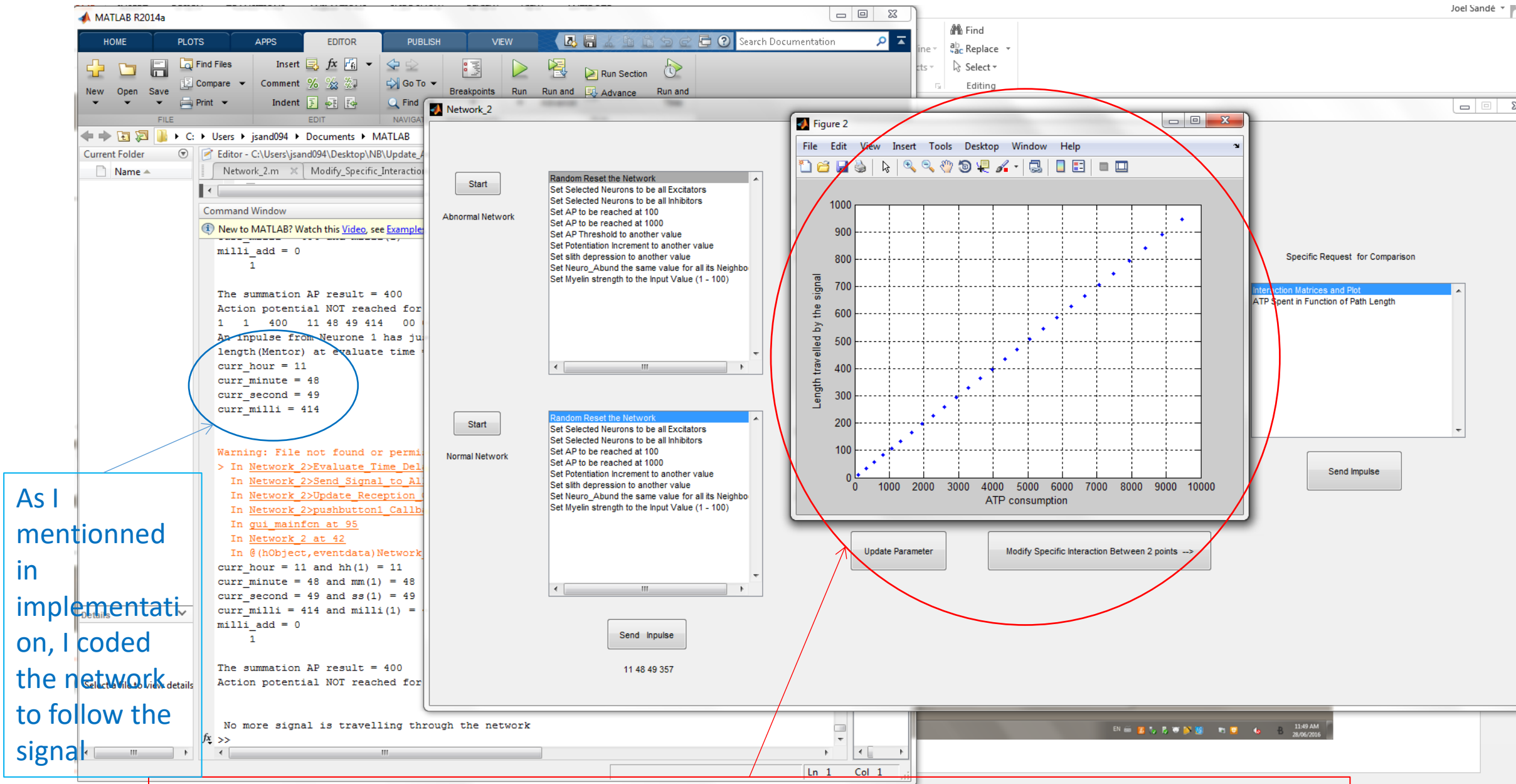
The screenshot shows a WordPad window titled 'Pos\_Coord\_A.txt - WordPad'. It contains a table with 45 rows and 10 columns. The last column, representing the action potential threshold, is highlighted with a red box. A blue circle highlights the value '100' in the first row, first column, which corresponds to the 'Receptor Neuron' mentioned in the text.

1	0	1	1	400	0	0	0	500
2	0	1	-1	540	1	0	0	500
3	1	1	-1	386	2	0	0	500
4	0	1	-1	262	3	0	0	500
5	0	1	1	775	0	1	0	500
6	0	1	1	574	1	1	0	500
7	1	73	1	856	2	1	0	500
8	0	1	-1	586	3	1	0	500
9	1	59	1	770	0	2	0	500
10	1	47	-1	986	1	2	0	500
11	1	52	-1	721	2	2	0	500
12	1	93	-1	161	3	2	0	500
13	1	55	1	469	0	3	0	500
14	1	35	-1	541	1	3	0	500
15	1	70	1	66	2	3	0	500
16	0	1	1	18	3	3	0	500
17	0	1	-1	19	0	0	1	500
18	1	15	-1	15	1	0	1	500
19	0	1	-1	600	2	0	1	500
20	1	40	-1	882	3	0	1	500
21	1	35	-1	308	0	1	1	500
22	1	83	1	252	1	1	1	500
23	1	91	-1	980	2	1	1	500
24	0	1	1	925	3	1	1	500
25	1	25	1	74	0	2	1	500
26	0	1	1	885	1	2	1	500
27	1	97	-1	844	2	2	1	500
28	0	1	-1	493	3	2	1	500
29	0	1	1	257	0	3	1	500
30	0	1	1	964	1	3	1	500
31	1	19	1	826	2	3	1	500
32	1	90	-1	877	3	3	1	500
33	1	85	1	237	0	0	2	500
34	1	10	-1	184	1	0	2	500
35	1	88	-1	306	2	0	2	500
36	0	1	1	36	3	0	2	500
37	0	1	-1	997	0	1	2	500
38	1	100	-1	200	1	1	2	500
39	0	1	-1	226	2	1	2	500
40	0	1	1	714	3	1	2	500
41	0	1	-1	532	0	2	2	500
42	0	1	1	6	1	2	2	500
43	1	90	-1	841	2	2	2	500
44	1	35	1	432	3	2	2	500
45	0	1	1	866	0	2	2	500

After updating the network, this is the interactions profile for this simulation

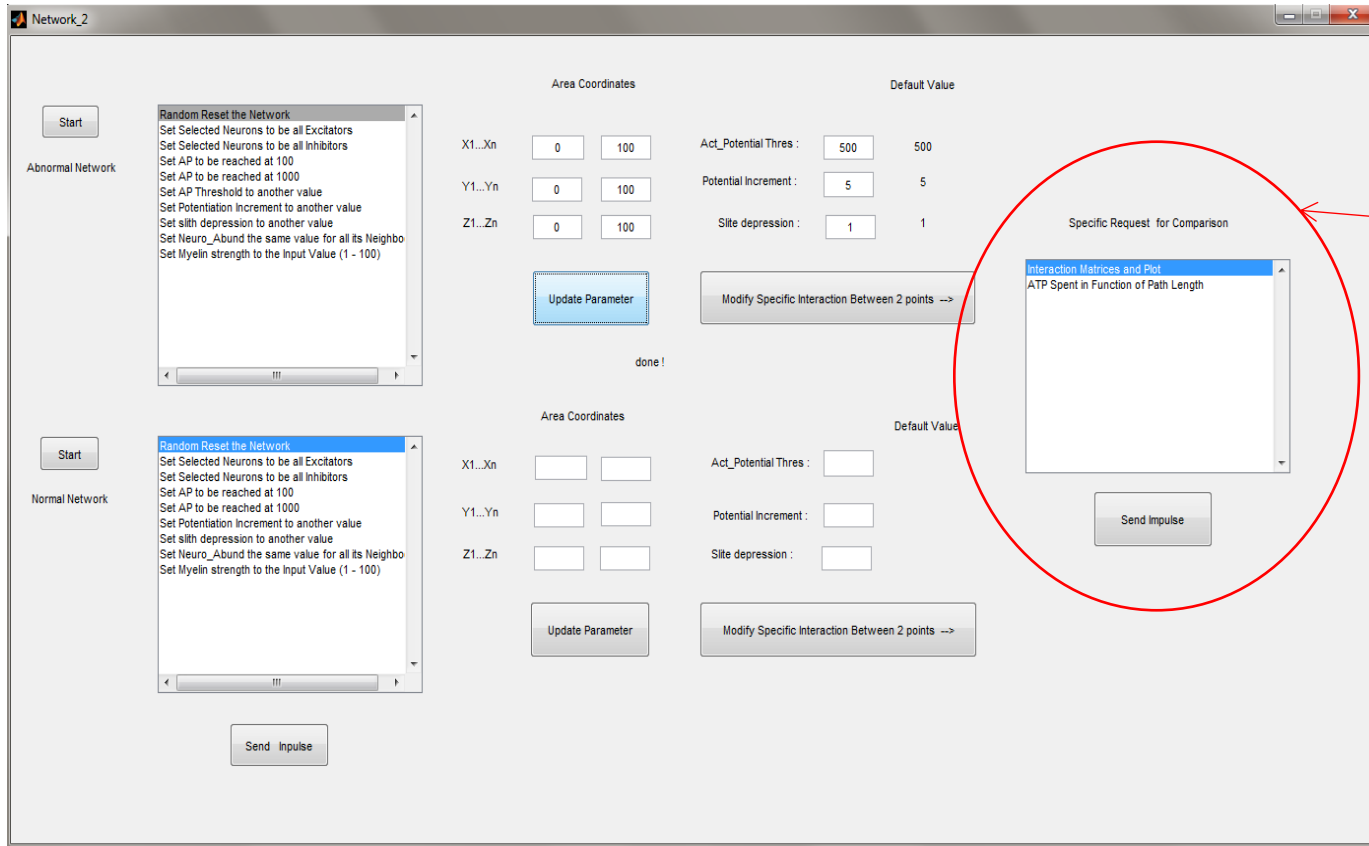


As I mentioned in implementation, I coded the network to follow the signal



When the myelin is not altered, and we consider one neuron at the time, we can see a direct relationship between ATP consumption and Length travelled by the signal.

# 5-A couple of comparisons



This part is to compare the Normal Network and the Abnormal network. Right now, while I am writing this, I am reviewing a function that unfortunately saturates Matlab while running the whole simulation, because of iterations error. Matlab stores too much data, and stop running after.. 5 - 10 min. I will be able to do more simulations once I fix that problem.

Current work

# 6-Conclusion

- The conclusion we can make from slide 27 is that : When the myelin is not altered, and we consider one neuron at the time, we can see a direct relationship between ATP consumption and Length travelled by the signal.
- Not enough results on the network processing itself because of time constraints.
- However, session 4 provides good results regarding the network implementation.

# 7-limitation

- As I don't have huge computer to do a multithread,
- 1) I cannot run simultaneously both Abnormal and normal Network. I have to run one network at the time.
- 2) As I don't have huge computer to do a multithread, I can only send one signal and wait for that signal to disappear completely before I send another one

Solution : To use Supercomputers to do the simulations

# 8-Futur work

- I found a function named Digraph available in Matlab 2016. A powerful function that :
  - ✓ gives the shorter path in a given network, from a point A to a point B,
  - ✓ topology that allow to connect neighbour neuron in specific pattern,
  - ✓ ... a lot of new stuff we can do, such as representing areas for the frontal lobe, visual lobe, ...
- Run more simulations varying different parameters :
  - ✓ I can base the neuroplasticity on function available via matlab 2016 in addition to what I already did.
  - ✓ As the brain is lasy, I can easily choose in a simulation to keep only paths that spend the less energy possible and see how it impacts the network topology, using functionalities available on Matlab 2016.

# 8-Futur work

- I have a solution to implement data memory, and even, artificial intelligence within the system (algorithms based on this work). We can perform reminding based on synaptic-connections. What is interesting with those algorithm, they can give you (in output) only what you input, starting at a completely stupid stage : at the beginning there is no output possible until you start putting repetitively the same inputs.



# 8-Futur work

- I believe that to understand how disease like Alzheimer and Autism (memory disease) work, we have to get that kind of algorithm coded inside a network (and make difference between different compartments of the brain), and if that works well in the simulations, we can understand far beyond ATP and length issue, but also at the connection level.
- → this is not for today 😊