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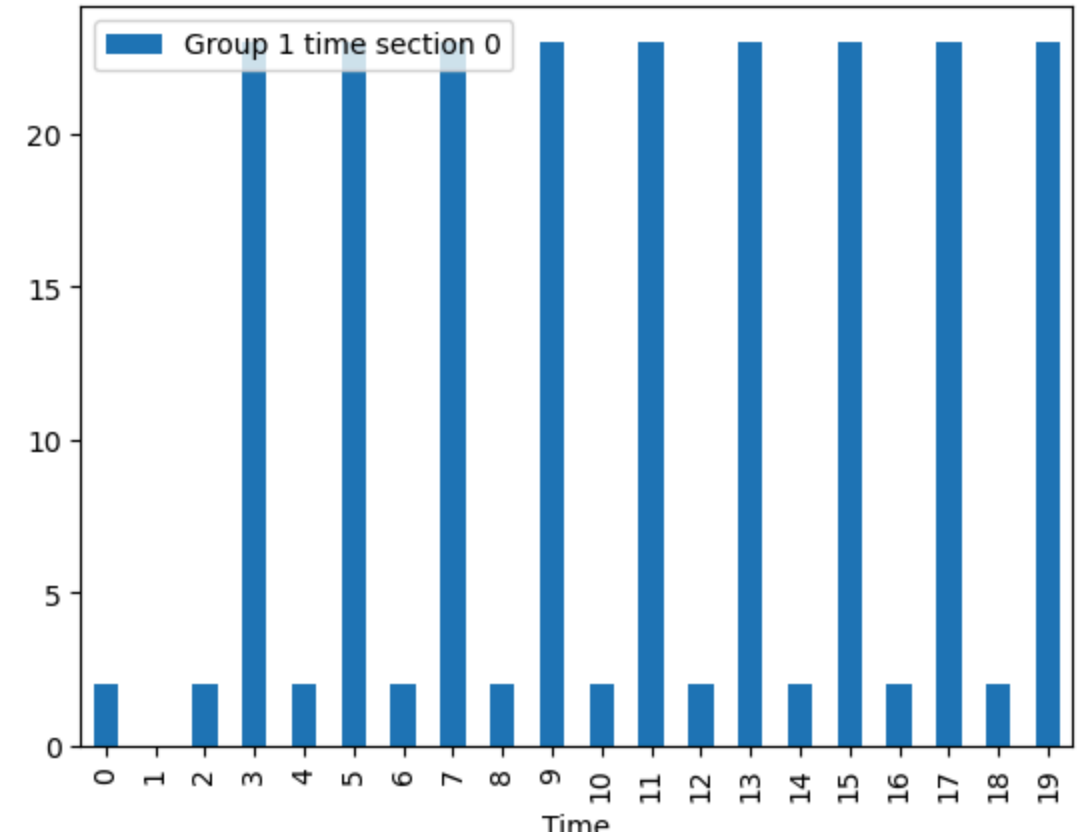
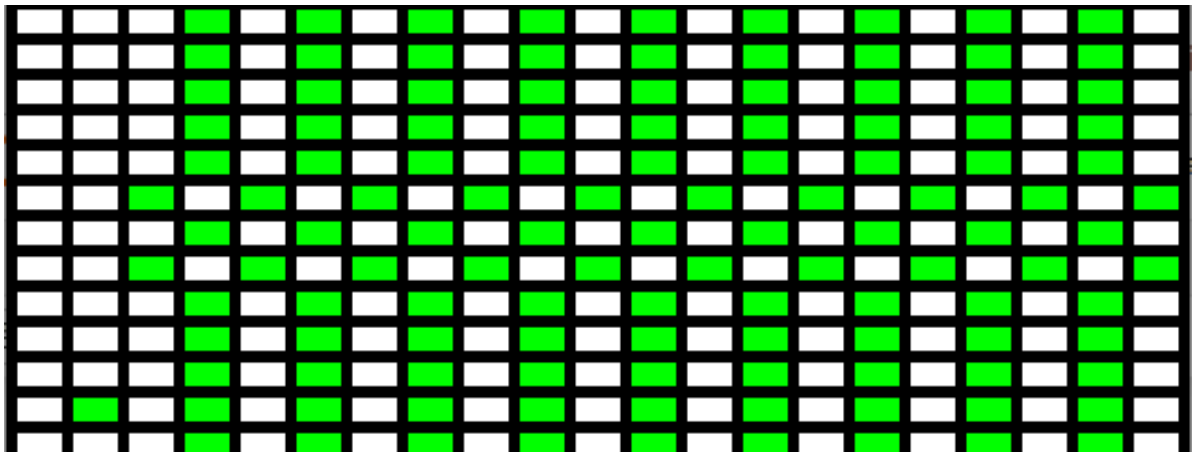
EEG Simulation of Epileptic Seizures FURSCA Report

My project this summer was on the EEG Simulation of Epileptic Seizures. I worked on this project with Dr. Cho of the Physics department. Epileptic seizures are a medical condition that I myself have that are basically soft resets of the brain. Most people think of flashing lights when it comes to seizures but there are many other causes. One thing about seizures however is that we don't know what event in the brain causes them. There are currently two that are proposed called the super-critical brain avalanche and neuron synchronization. Thus what Dr. Cho and I did this summer is code neural networks in Python and then cause these two neurological events along with a normal brain pathway. Next we also in the code made it read the electrical signal that is released in the brain in the same fashion that the main clinical device for seizures does. Known as an electroencephalogram (EEG).

Overall this summer we accomplished a lot. We first made the code to do the calculations for if a neuron fires in the next time step. This would allow us to eventually have the computer build what is known as an initial state that tells us which neurons are fired in the beginning. Once we have that initial state we then could run it for a certain amount of time steps and have a full sequence of states of the neurons. We then built the rest of the code in a list version. Meaning that it would do all of the calculations needed via lists.

However we eventually noticed that this list version was taking way too long to do the calculations. Thus we ended up moving on to create the code but instead using what are known as matrices and using matrix multiplication. This ended up making the code run a lot faster. In the end we ended up causing a neuron synchronization and getting the EEG signal from that. All that we have left is to cause criticality without all neurons being included. Then we test some changes in the parameters to see if we can cause a more steady super-critical brain avalanche. Once that is done it will already give us the EEG signal and we will be complete and can hopefully in the spring move onto a more complicated neuron model. Below are some screenshots of the code and results


Group 1 time section 0
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Time



```
MM = numpy.matmul
TIM = int(input("How many time steps do you desire? "))
count = 0
past = []
PA = past.append
True == 1
False == 0
IN = OM > ZM
PA(IN)
prob = int(input("1 in ___ chance to randomly fire "))
while count < TIM:
    WO = MM(WM,OM)
    COM = (WO > TM)
    OM = COM
    for i in range(0,N):
        chance = randrange(0,prob)
        if chance == 1:
            OM[i] = True
        for k in range(1,ref+1):
            if past[len(past)-k][i][0] == True:
                OM[i] = False
    PA(OM)
    count += 1
```

```
How many time steps do you desire? 20000
1 in ___ chance to randomly fire 10000
```

```
ROW_COUNT = 100
COLUMN_COUNT = 25
WIDTH = 20
HEIGHT = 10
MARGIN = 5
```

```
SCREEN_WIDTH = (WIDTH + MARGIN) * COLUMN_COUNT + MARGIN
SCREEN_HEIGHT = (HEIGHT + MARGIN) * ROW_COUNT + MARGIN
SCREEN_TITLE = "Neuron time raster"
```

```
class MyGame(arcade.Window):
    def __init__(self, width, height, title):
        super().__init__(width, height, title)
        self.grid = []
        for row in range(ROW_COUNT):
            self.grid.append([])
            for column in range(COLUMN_COUNT):
                self.grid[row].append(0)
        arcade.set_background_color(arcade.color.BLACK)
    def on_draw(self):
        arcade.start_render()
        for row in range(ROW_COUNT):
            for column in range(COLUMN_COUNT):
                if past[column][row][0] == True:
                    color = arcade.color.GREEN
                else:
                    color = arcade.color.WHITE
                x = (MARGIN + WIDTH) * column + MARGIN + WIDTH // 2
                y = (MARGIN + HEIGHT) * row + MARGIN + HEIGHT // 2
                arcade.draw_rectangle_filled(x, y, WIDTH, HEIGHT, color)
```

```
def main():

    MyGame(SCREEN_WIDTH, SCREEN_HEIGHT, SCREEN_TITLE)
    arcade.run()


if __name__ == "__main__":
    main()
```

Overall this experience has been very important to my future. Not only have I learned more about my family, as it turns out more members have had seizures than I knew about, but I also feel like I am getting a better understanding of myself and others who have this condition. Although our results from these 8 weeks by itself can't change the medical scene, it can become the basis of something that will. I have fully through the use of this experience figured out what I want to do for the rest of my life and even potentially could make a way more complicated

version of this for my PHD thesis. These results will be presented at the Elkin Isaac in the spring. It will also be presented as a poster in Ohio during the SPS zone 7 meeting. Which is a major Physics conference. I have through this project learned many important things and believe I have found my place in this world and what I can do for it.

In the end I would like to acknowledge Dr. Cho for going above and beyond even while in another country. He has been talking to some of his colleagues about the project and has gotten a professor in one of the graduate schools I want to go to interested in the project as well as an important graduate of that school as well. I would also like to acknowledge FURSCA for allowing me to do this as well as both Bruce A. and Peggy Kresge of the class of 1953 Endowed Science Fellows for the support. I couldn't have done any of this without all of you.