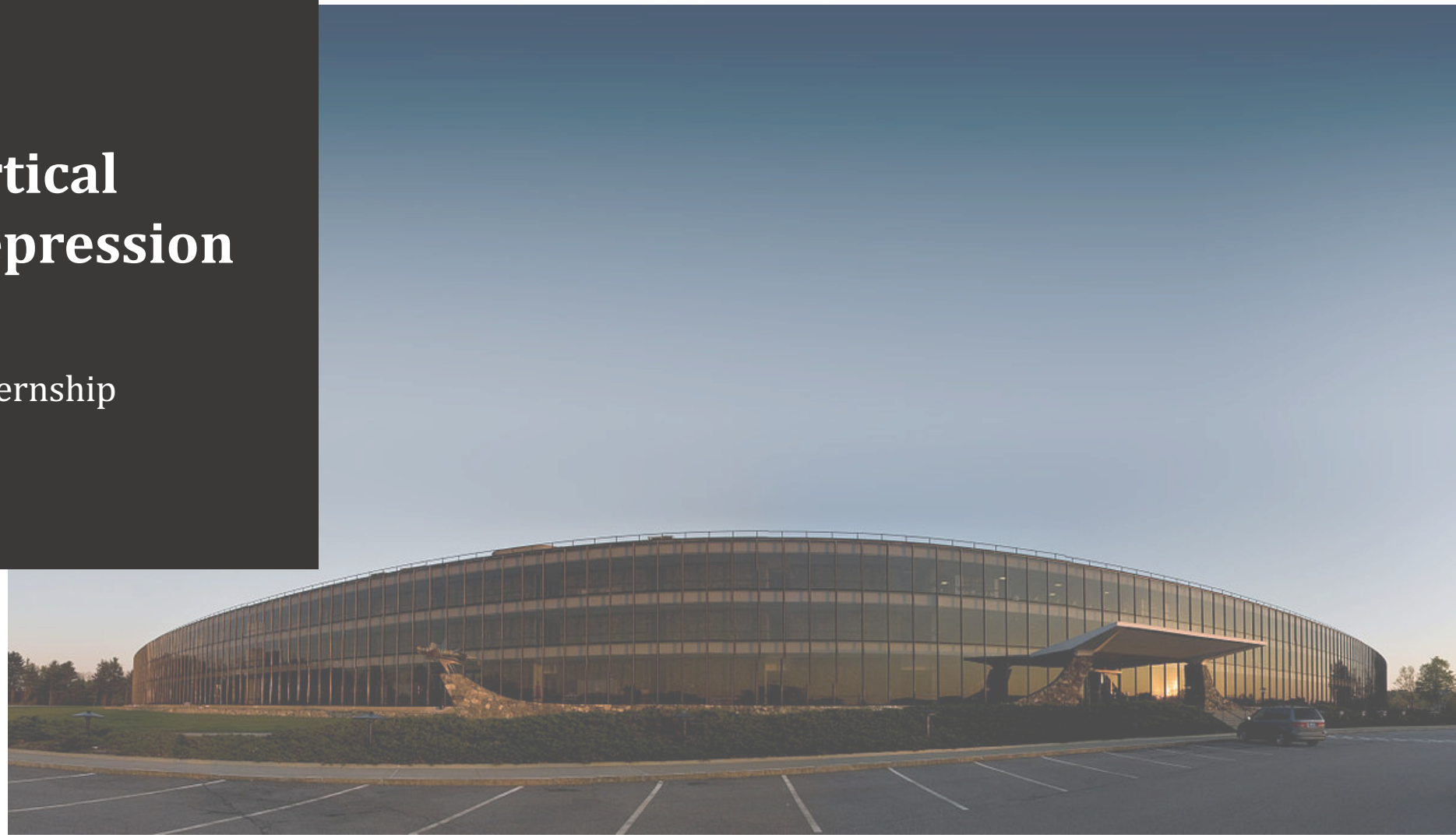
Modeling Cortical Spreading Depression

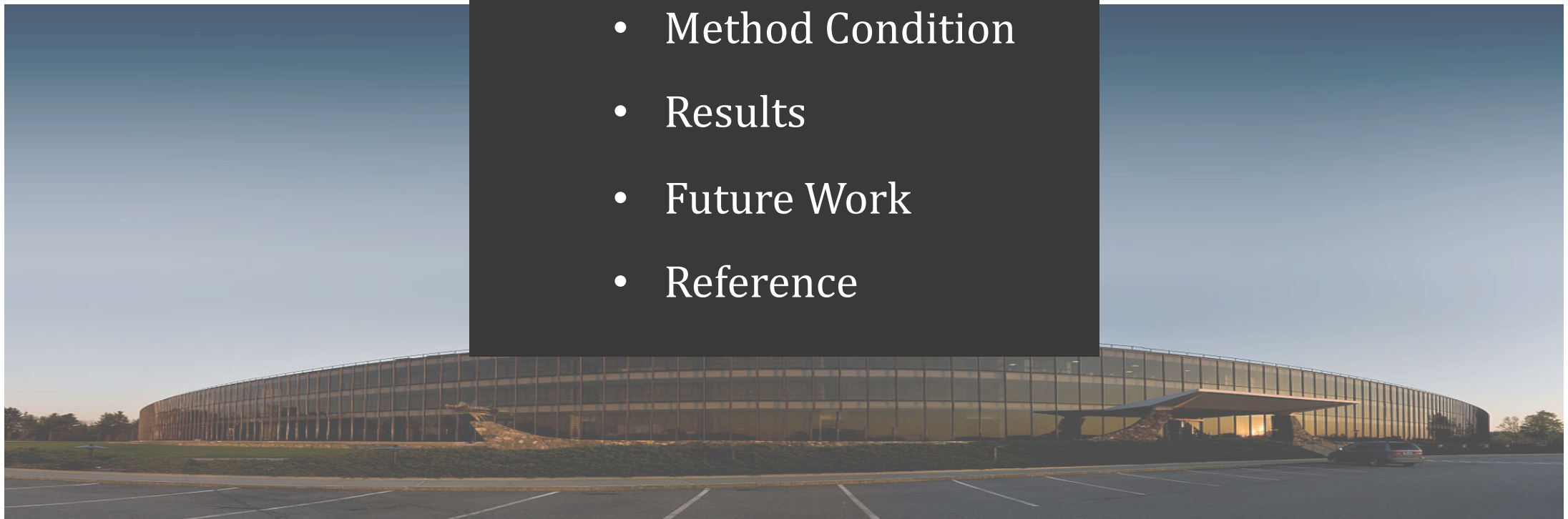
The project of IBM internship

Yueh-Chou Lee



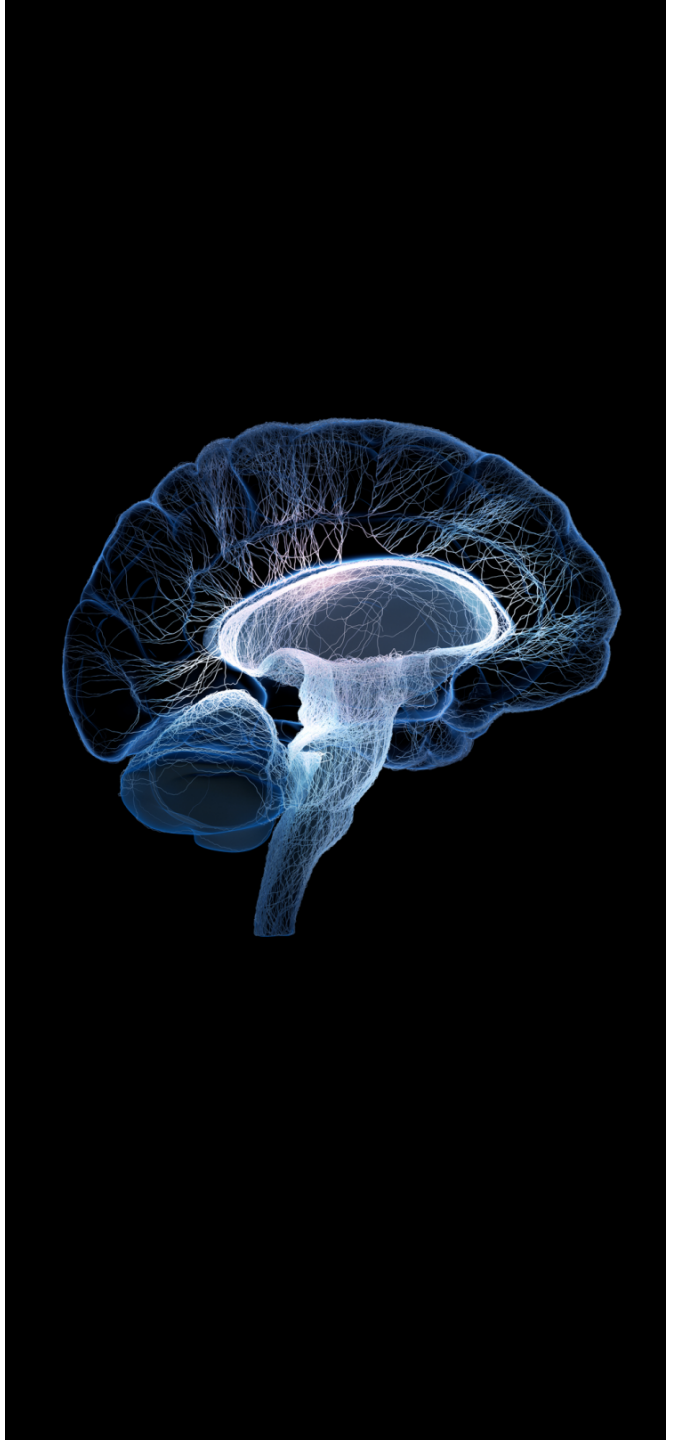
CONTENT

- Introduction
- Method
- Method Condition
- Results
- Future Work
- Reference



Introduction

- CSD is an electrical silent wave.
- CSD will impair some cortical activities.
- CSD is strongly correlated with a number of neurological disorders.
- Potassium (K^+) is the most important ion in CSD.



The Formula in CSD Model

Fick's Law:

$$\frac{\partial K}{\partial t} = D\nabla^2 K + f(K)$$

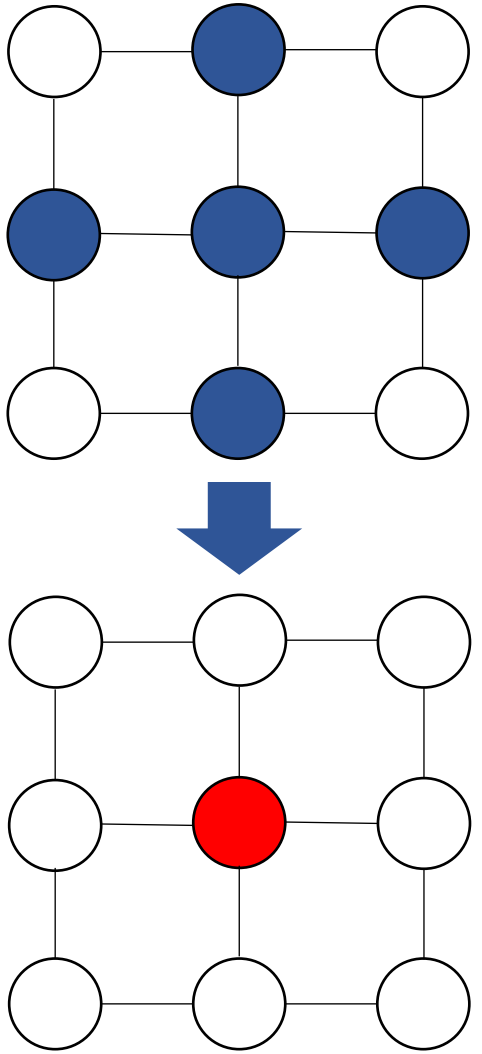
$$f(K) = A(K - K_r)(K - K_\theta)(K - K_m)(K + 0.1) - rK$$

$$\frac{\partial r}{\partial t} = B((K - K_r) - Cr)$$

Finite Difference Method

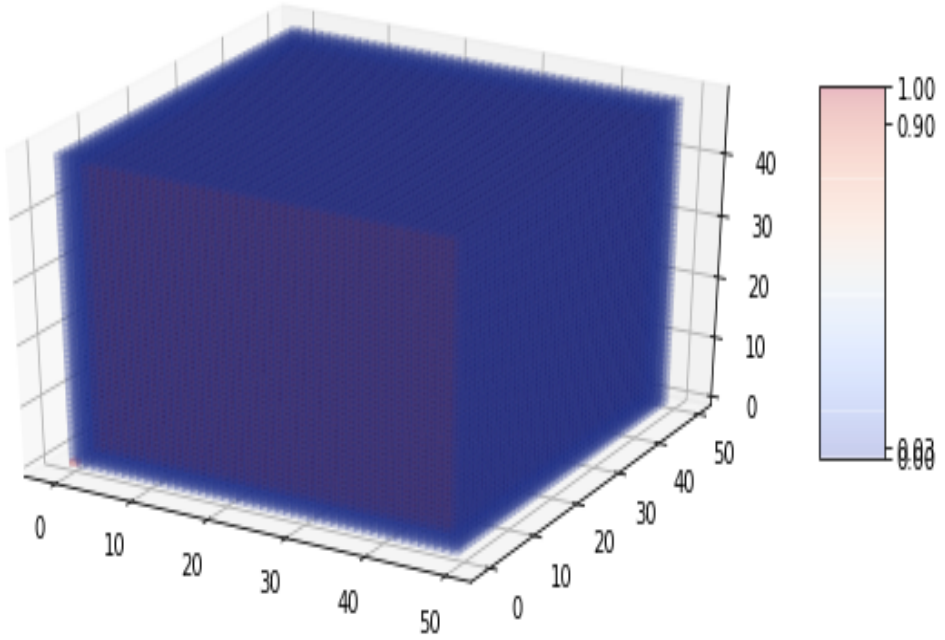
$$\begin{pmatrix} 0 & \frac{1}{\Delta y^2} & 0 \\ \frac{1}{\Delta x^2} & -\frac{2}{\Delta x^2} - \frac{2}{\Delta y^2} & \frac{1}{\Delta x^2} \\ 0 & \frac{1}{\Delta y^2} & 0 \end{pmatrix}$$

Convolution



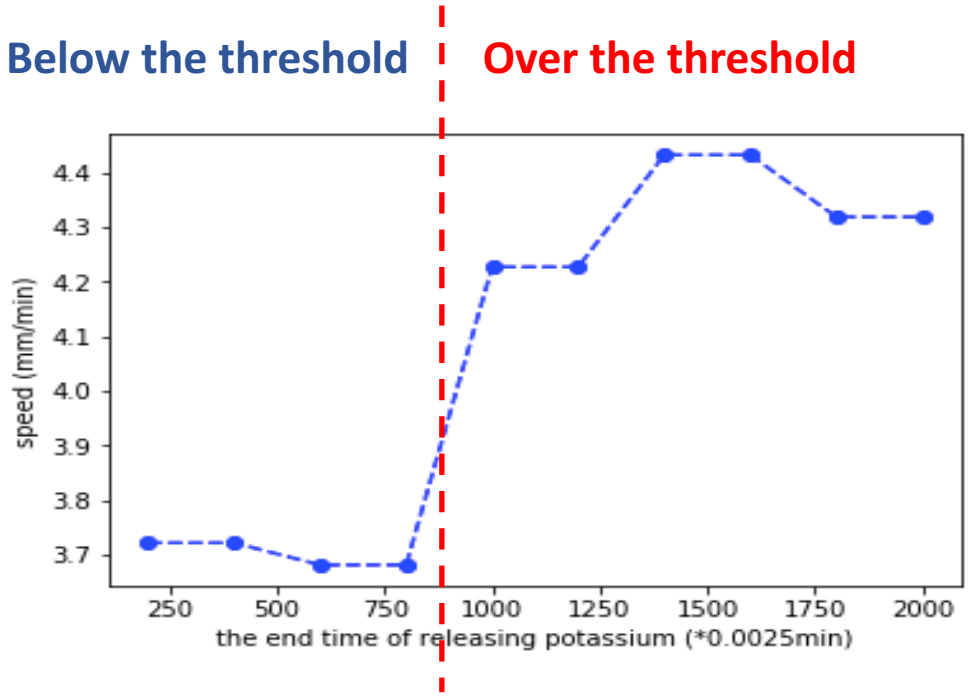
Method Condition

- Take *50x50x50* mesh cube to simulate CSD.
- Each grid cell in mesh cube is *0.025mm x 0.025mm x 0.025mm.*
- Each time step is 0.00025 min. and time interval is 0~0.5 min.

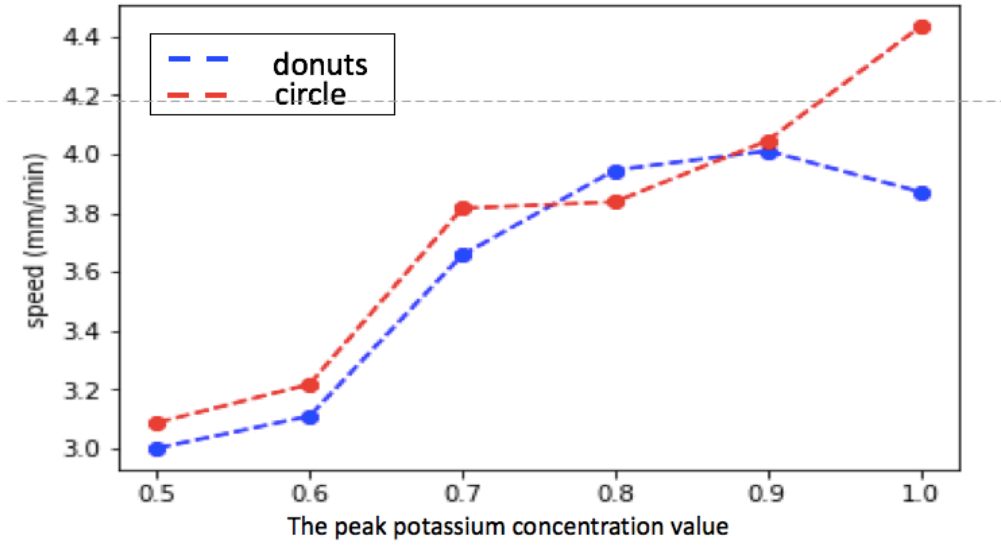


Results

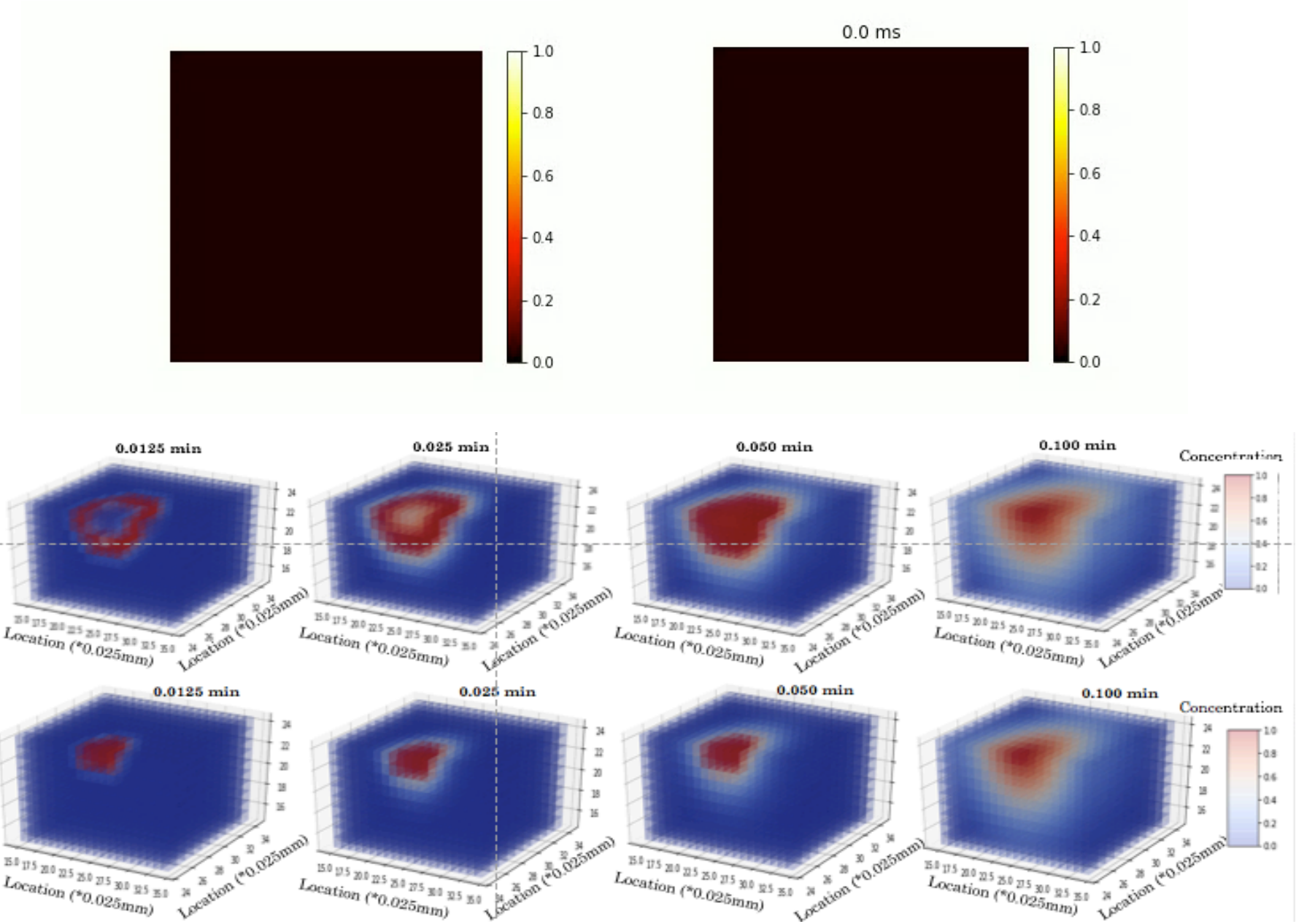
The speed of diffusion wave
vs.
The time of releasing potassium



The speed of diffusion wave
vs.
Different shape of releasing potassium



Results


0.0 ms
1.0
0.8
0.6
0.4
0.2
0.0
0.0125 min
0.025 min
0.050 min
0.100 min
Concentration
Location (*0.025mm)

Future Work

Write IBM’s Neural Tissue Simulator (NTS) Code

Reference

[1] James A. Reggia & David Montgomery, *Modeling Cortical Spreading Depression*

[2] H. Kager,1 W. J. Wadman1& G. G. Somjen, *Conditions for the Triggering of Spreading Depression Studied With Computer Simulations*

THANK YOU