Milestone Report 3

Tools thus far: numpy, differentiation by finite differences, midpoint quadrature, Diagonalization, Solving an eigenvalue problem, 2D,3D Heat maps, time complexity

Methodology/Progress Summary: With the Wavefunction Solver function, I was able to figure out a process of taking as input two vectors of parameters (barrier width, barrier height, initial position, or sigma of gaussian) and creating a square matrix of their probability outputs then plotting them onto a series of heatmaps. Although I have yet to interpret some of the results, and would like to collect more precise data using more samples, it seems that the candidate which affects tunneling probability the most is barrier width, although there are some uncertainties in terms of some of the other variables. In addition, in preparation for the presentation I began creating latex text to represent my process for creating the wavefuntion_solver, which serves more as a rough script for my presentation as well as physical formulas which I can import onto my slides.

Challenges: One of the main challenges from this part of the project was the code runtime when creating the data for the 3D heatmap. In order to get a more descriptive representation of probability effects, I needed to obtain more and more data points. However when I did a time complexity analysis it takes around 9 seconds per data points, which adds up significantly when attempting to generate a large dataset. Something I may have to do is a long run of the code in which I simply wait it out (will have incremental print statements to verify it is not stuck)

I initially had issues figuring out how to generate a matrix for the heatmap which correctly represented the probabilities of the different combinations. However, I was eventually able to figure out a method that worked for different numbers of samples.

Next Steps:

- Figure out concretely which parameter most effects tunneling probability (see if I can identify this quantitatively)
- Finish explanation of solution of the eigenvalue problem
- Potentially animate/visualize minima/maxima circumstances based on results to show tunneling probability differences.

Citations: *Griffiths, David J.; Schroeter, Darrell F. (2018). Introduction to quantum mechanics (3rd ed.). Cambridge: Cambridge University Press.*, https://www.dam.brown.edu/people/alcyew/handouts/numdiff.pdf
https://pythonnumericalmethods.berkeley.edu/notebooks/chapter20.02-Finite-Difference-Approximating-Derivatives.html