**The limit doesn’t exist: report on the functionality and use of the library; finding the maximum height, and flight time of a projectile.**

The library we have built takes the parameters that affect a projectile’s motion and returns the maximum height that projectile will reach, the time to reach the ground, the distance traveled through the air and the time to reach the max height. Defining a projectile with the mass, diameter, initial velocity and angle of release is all that is needed for the program to run the calculations that find the desired data.

The intended users of the library are those who need to work with the motion of projectiles and is built in such a way that they don’t need to understand the mathematics behind how to find out the desired outputs. The basic use of the library is intended for those, with the additional ability for the library to access a CSV. All of which is hosted on the GITHUB page and with the documentation to show how to use both functions of the library under the docs folder.

While researching into the mathematics behind the calculations of projectile motions we found an exercise in SciPy’s (SciPy) book where they have a program that performs some of the calculations that we wanted to find. We did refer to their program and have not only adapted it to allow for easier use by only having to define the particle and then running the function ‘SimBrain.calculateFor’. We also made it so that all the data gets appended to that particle so that it can be called on and stored easier than the original program made by SciPy. Furthermore, we added the ability to use a CSV to perform the calculations for multiple projectiles and compare the results between them.

We also added in the documentation additional functionality of the library by accessing the CSV and displaying the trajectories of the projectiles through the use of a GUI. An example of one, we built into the GITHUB page with the way to access it in the documentation under examples.md in the docs folder. These are both to show the additional functionality and possible uses of our library, beyond the standard calculations. Another additional functionality we added in is that we have made it such that the initial x and z velocities can be used and stored. This is currently not being used in the functions as we are using the initial velocity and angle of projection. We left in the ability to use these as we thought that it might be something that some users of the library would appreciate being able to work with the velocities in those directions instead of the magnitudinal velocity (this may be something added at a later date)

One common use case for our library is to see whether a projectile will end up hitting a target if fired with the current resistances acting on it. This can be done as the function stores the height of the projectile at any given point in time or distance and allows you to see how many of the projectiles will hit the target and which would hit the target first.

This program makes it easy for the user to simulate using different variables until a specific condition is reached, i.e. finding the velocity and angle required to launch a particle of mass m and diameter d to land at a certain distance x.

Work Cited

SciPy. “SciPy Examples A projectile with air resistance.” *Learning Scientific Programming with Python*, https://scipython.com/book2/chapter-8-scipy/examples/a-projectile-with-air-resistance/. Accessed 3 May 2023.