SNC1W – Solar System Simulator Instructions

Today we will be exploring applications of programming in our world. One of the important applications of coding today is to create and study models. Models, or simulations, allow us to recreate certain conditions and environments and see how they may change as we play around with various variables. This simulation focuses on the role of the Sun in our solar system, and we will be seeing how things here on Earth would change if we were to change the mass of the sun and our distance from the sun.

To begin we must log into our Replit.com accounts.

Navigate to the following replit template: https://replit.com/@MacSTA/SNC1W-Solar-System-Simulator?v=1

Once you have located the project click the Run button and full screen to be able to see the entire simulator. It's okay if it doesn't fill your entire screen, hit the play button when you're ready to begin. Next you will answer some questions on the worksheet you have printed off.

WORKSHEET PART 1

After completing part 1 of the questions, we're going to now play around with the arrow keys on the right-hand side of the simulator to see what happens when we change some important features of the Sun. Hopefully by now, we have seen that there are two major factors playing a role in Earth having the perfect conditions for life as we know it. The distance we are from the Sun, and our atmospheric makeup.

The atmosphere around us both protects us from too much radiation getting through and harming us, while simultaneously trapping in the heat our planet's surface reflects and warm us. Ozone molecules in the Ozone layer act as sunscreen for the Earth and protect us from the harmful radiation, too much harm to the ozone layer and we could see UV indexes of 15 during hot summer days.

Greenhouse gases such as carbon dioxide and methane in the atmosphere help to trap in the heat. Without these gases it is predicted our surface temperature would be roughly 33 ^{o}C lower and life would not flourish as it does today. Too many greenhouse gases however cause the planet to warm more rapidly. This is an issue we're facing today known as global warming. The atmosphere on Venus for example is composed mainly of carbon dioxide and thick clouds of sulfuric acid which help to explain why it is so much hotter than Mercury despite being about 50 million km further from the Sun.

Another important factor to our temperatures being "Just Right" – Goldilocks, is the size of our sun. Reset the simulator and head on over to the worksheet where you will now be using the arrow keys.

WORKSHEET PART 2

As we've now seen not only are we the perfect distance from the sun with the perfect atmospheric makeup to survive, but the Sun is also the optimal size. A simple change of 10% of the Sun's size and mass in either direction caused temperatures to plummet or skyrocket to unliveable conditions. This is an issue as the Sun is very slowly expanding and brightening which, over the next few billion years will lead to the destruction of Earth entirely. Not a fun thought but now you know why Elon Musk is so interested in Colonizing Mars.

The slingshot effect we saw with the planets when they got too close to the larger Sun was a result of the massive velocities they traveled at as they approached the Sun. These velocities were due to the extremely strong acceleration experienced by the planets due to the very large Sun. Once a body is travelling at such a large speed away from a gravitational pull it can escape the item that is attempting to pull it in. This is called an escape velocity. Scientists use this phenomenon to send items like rovers and satellites further out into space while using less rocket fuel.

Coding Connection

This simulator was coded using python and we're going to dig into the code a bit here. In your prior lessons you learned about user input, output, math, if statement, and loops. While there is no input or output in this code there are plenty of examples of the other coding techniques and a few more advanced ones as well.

On your screen if you leave the full screen mode and stop the simulator, there is an option to show files on the top left-hand side of the simulation window, directly below the title. Click on this and navigate down to the file named main.py then hide the files again.

The first 26 lines of code are setting up the pygame features needed to run this simulation. The first part of this is to import the necessary modules. Modules are premade libraries of code containing a group of functions related to the same use that future programmers can use so they don't have to start from scratch. The 100s of modules that exist for the python programming language are one of the key reasons why it's the #1 used programming language today.

After this we are simply setting up some of the key features like the window size and setting some initial variables. You can read the comments in the code to see in more depth what each section is doing.

After the setup you'll see some more advanced coding techniques Classes, Functions also know as methods, and Lists. Much like how loops allowed us to significantly improve the efficiency of our own code, these types of techniques allow an advanced programmer to improve their efficiency even further along with the organization of the code. Read through some of the comments to learn more about these features.

In total this simulator uses 237 lines of code including comments and blank lines and can be confusing to look at all at once. To help programmers as they work, most code editors such as replit.com will have

arrows next to function definitions, classes, and loops that allow us to minimize that portion of the code and focus on one task at a time. Try minimizing the planet class found on line 33 and looking at just the main function found on line 113. There's now much less on the screen at once and you can have a look at some of the comments throughout to learn a bit about the advanced techniques used.

Return to the worksheet to answer one final question.