Sunspot Dashboard Abstract
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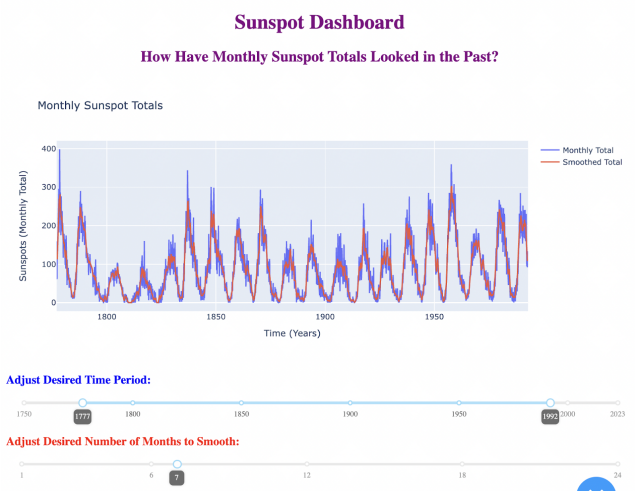
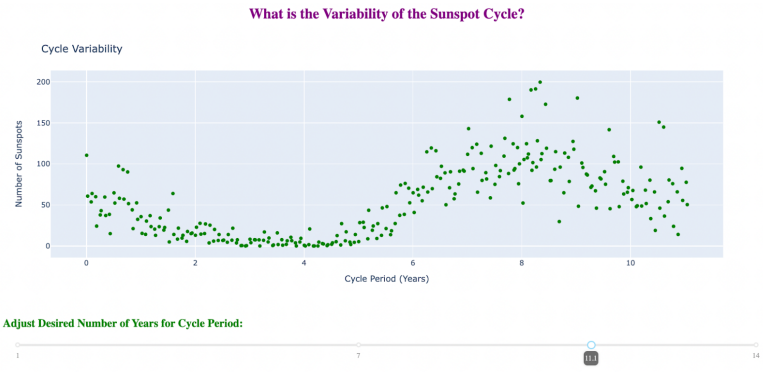
Though the sun may be millions of miles away, solar activity affects the human experience on a daily basis. From creating majestic displays of light in the sky to interfering with satellites and power systems, Earth's societies can benefit a lot from monitoring the sun. Scientists track this solar activity using sunspots. According to NASA, "Sunspots are areas that appear dark on the surface of the Sun… because they are cooler than other parts of the Sun's surface… They form [in] areas where magnetic fields are particularly strong. These magnetic fields are so strong that they keep some of the heat within the Sun from reaching the surface" ("Sunspots and Solar Flares"). This activity is periodic, with a cycle completing approximately once every eleven years. Thus, this project aimed to explore general trends in sunspot activity and its cyclical nature.

All of the data used to create this dashboard comes from the Royal Observatory of Belgium's "Sunspot Index and Long-Term Solar Observations" page. The specific CSV used is the "Monthly mean total sunspot number," which features 3,289 rows of its seven columns, though this project focused solely on the three columns that contained the year, the fractional date, and the monthly mean total number of sunspots.



To make the Monthly Sunspot Total Graph—the first component of the dashboard—I created two identical data frames from the CSV file. Both would go on to be whittled down using the narrow_df() function to only show data from a user-inputted time period, and one would later be smoothed to the user's liking using the pandas rolling method in the smooth_data() function. Then, I used the plotly graph objects module to create a time-series graph with two traces (one of the smoothed line, one of the unsmoothed line). Using the dashboard's sliders, the user can control the range of time for which data is displayed and the smoothing window.

The second component of the dashboard is the Cycle Variability Graph. This part of the dashboard allows the user to change the amount of time in a cycle period via a slider, thus displaying the validity of asserting the sunspot cycle as an 11-year period and exploring the widening of the variability as the



user-selected time frame moves further from 11 years. It uses data from the user-selected date range and displays the monthly mean total sunspot number at different points of the cycle, regardless of the year (i.e. any data from 6 years into a cycle has the same x-value, regardless of whether it's from the first cycle in the time period or the final cycle in the time period).

The final component of the dashboard is the section that contains three real-time images of the sun, provided by NASA. The first and third images are Michelson Doppler Imager (MDI) images that show how the sun looks in the visible range of the spectrum, as if looking at the sun using glasses designed to look at an eclipse. The third image displays the sun's magnetic field, with black and white representing opposite ends of the polar spectrum. The picture in the middle, the blue sun, is an Extreme Ultraviolet Imaging Telescope (EIT) image, meaning it captures solar material at a certain temperature. This photo, taken at 171 Angstrom, displays material at one million degrees. These images are helpful as they allow the user to see the sunspots in real time and attach a concrete visualization of how the numbers in the graphs above physically manifest on the sun.

Overall, this dashboard offers an array of interesting information about sunspot activity. The first graph clearly reveals the cyclical nature of sunspots, as evinced by the repeated peaks and valleys in the graph over time. The inconsistencies in the top value among the peaks of the graph are thought-provoking; this presents a good possibility for future work in determining what caused some years to have a higher number of sunspots. The second graph affirms that sunspot cycles last around 11 years. As the user-selected time period gets closer to 11, there is a much clearer pattern in solar activity. The further the user moves the slider away from 11, the more variability is presented in the graph.

References

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