Data Science for Everyone - Visualizing the Solar Eclipse

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How does a solar eclipse happen?

A solar eclipse happens when the Moon passes between the Earth and the Sun, blocking all or part of the Sun's light from reaching the Earth.

This can only happen during a new moon, when Sun and Moon are in conjunction as seen from Earth.

How often does a solar eclipse happen?

Solar eclipses happen 2-5 times a year, total solar eclipses once every 18 months somewhere on Earth. Any given location on Earth might experience a solar eclipse only once every few hundred years.

Why were the total solar eclipses 2017 and 2024 so close to one another?

The path of totality in 2017 moved from NW to SE, in 2024 from SW to NE. Timing between eclipses vary due to the complex geometry of Earth-Moon-Sun alignments and the cycle of eclipses ('Saros cycle').

What does "data visualization" mean?

'Data visualization' is one step in the data science workflow, which includes: data gathering, data import, data cleaning, data

transformation, and data modeling.

What is the difference between a "visualization" and "data

visualization"?

Data visualization is a scientific process: it involves using real historic (descriptive) or future (predicted) data, information about the origin of the data, a location where the data can be inspected,

What are interesting "solar eclipse" visualizations?

1. **The path of totality** - that is the path on Earth along which the Sun is totally blocked by the Moon. On April 8, 2024, Batesville AR lies in this path for a total time of 4 minutes 1.7 seconds. Examples:
   - NASA, Scientific Visualization Studio: Orthographic map showing many details; animated Gif
   - SunCalc.org: path computation with solar eclipse data for Batesville from 1500 B.C. to 3000 A.D.
   - Google maps: different lines of the path.
2. **Population impact**: how many people are in the path of totality. You need to add data sources to map approximate population density. See for example (Zeiler, 2024).
3. **Historical eclipse paths**: comparing the 2024 path with historical eclipse paths over the same region to explore frequency, duration and path. For example from eclipsophile.com.
4. **Interactive maps**: users can zoom in and out and explore specific locations. For example Google Maps.
5. **Astronomical phenomena**: visualizing the timing and positioning of other celestial bodies during the eclipse could add depth to the understanding of the event. E.g. starwalk.space, Astronomical Events 2024.
6. **Climatology and weather forecast**: weather planning for eclipse day, for example eclipsophile.com.

What is interesting the history of solar eclipse exploration?

1. Ancient Observations: Historical records from various civilizations, including the Babylonians, Greeks, and Chinese, provide evidence of solar eclipse observations, underscoring their importance in early astronomical studies. (E.g. as described by Herodotus during the Battle of Halys 585 BC when the sudden darkness was interpreted as a divine sign for peace).
2. Scientific Milestones: Solar eclipses have played pivotal roles in key scientific discoveries, including the validation of Einstein's theory of general relativity during the 1919 eclipse: Einstein had postulated that space was not the same in all directions but that gravity of large bodies could bend rays of light. Eddington measured the position of stars near the Sun's edge during an eclipse providing empirical evidence for the theory.
3. Technological Advancements: The study of solar eclipses has driven advancements in astronomical instruments and observational techniques, enhancing our understanding of the Sun and its influence on Earth. Example: the Antikythera from 100 BC (named after the Greek island where it was found in 1901), the earliest known analog computer designed to predict eclipses decades in advance.
4. Cultural Impact: Eclipses have significantly impacted human culture, inspiring myths, influencing religions, and contributing to our fascination with the cosmos. E.g. in Viking mythology, eclipses were explained as the sky wolf, Skoll, catching and devouring the Sun.

What do you need to have, know or learn to visualize the solar

eclipse?

1. **Data**.
    - All data visualizations start with data. You can get the date, time, and location of every solar eclipses of the

past 5,000 years from NASA's Goddard Space Flight Center as a CSV file (Arvidsson, 2023).
    - You can also get the path data for the total solar eclipse of 2024 on April 8 from NASA (Espenak, 2014). You have to 'scrape' these data from the web page (which can be tricky).
2. **Tools**, such as R or Python, Tableau, or Wolfram Language.
    - Let's look at one example using ChatGPT integrated with the symbolic Wolfram language (WolframGPT, WolframCloud)
    - Let's do some actual coding with R:
        (a) Download the Solar and Lunar Eclipse data.
        (b) Importing the data into two data frames `Solar` and `Lunar`.
        (c) Analyzing the data a little.
        (d) Visualizing some data.
3. Understanding of what you want to show and whom to show it to: a clear objective and a specific audience.

What can you study at Lyon to learn more about this?

- At Lyon, you can learn all about data in courses on:
    1. Introductory and advanced data science with R and Python
    2. Data visualization (to visualize data in maps or graphs)
    3. Machine learning (to predict events from data)
    4. Databases (to store large amounts of data)
    5. Algorithms (to search through large data sets)
    6. Geographical Information Systems (GIS)
    7. Data modeling (to derive statistical insights from data)

How can you find out more about us?

- Visit us on campus, come talk to me and audit any class!

- Participate in our summer programs (2024: creating games in JavaScript, HTML and CSS; 45 programming languages in 45 minutes).
- Follow us on X.com (@LyonCollege, @birkenkrahe) or on Youtube: @CareerPathwaysPodcast