Mayan Astronomy - Team JSA

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Abstract

Our project concentrated on the ancient Mayan astronomy and particularly focused on the observations they made regarding the planet Venus. Using tools such as the Stellarium API, a planetarium software, and the NASA Horizons website, we collected datapoints and images that helped us determine the position of Venus during the time period and location of the Mayan civilization. Ultimately, our goal was to create a dataset that would best model the various attributes of Venus that the ancient Mayans had interest in. The link to our Github repository is listed below.

https://github.com/zhoujc999/CS189-Early-Project-S-Dataset

1 Introduction

Our project focuses on Ancient Mayan astronomy and how they'd track the movements and position of Venus throughout time.

1.1 Background

Astronomy was an important aspect of the daily life of ancient Mayans and they were especially interested in the movements of the planet Venus, studying its orbit around the sun. The Mayans took note of the four phases of Venus: first came the 250-day long "Evening Star" phase where Venus follows the setting sun, then an 8-day period where Venus disappears, then the "Morning Star" period where it rises just before dawn, and then finally a 90-day disappearance of Venus before the cycle restarts.

They associated Venus with the sky God, Kukulcan, and placed much importance on the planet with various war rituals and celebrations based on the four phases. Some Mayan architecture was also designed with the observation of Venus in mind and observatories like El Caracol, Chichen Itza would allow one to see Venus rising at its northern and southern extremes, an occurrence that signifies the end of Venus's eight-year cycle.

1.2 Model Motivation

Although we do know that the Mayans were quite knowledgeable about the movements of Venus and astronomy in general, most of their data, calculations, and observations no longer exist. The ancient Mayans would keep detailed records of their astronomical knowledge in folded books called codices; however, the majority of these texts were destroyed by the Spanish conquistadors and priest.

Currently, only three verified codices exist: Dresden, Paris, and Madrid. While the Dresden Codex does contain detailed Venus tables that correlate with the movements of Venus, there is not much more data available. Our motivation for this model and the overall project was to collect data-sets that would emulate the data that the Mayans would observe and from there, extrapolate details such as its orbit and phases.

1.3 Potential Usages

Our data-set is catered towards data analysis groups who would like to further explore the heavens and perform machine learning to determine the position and orbit of Venus based on the El Caracol, Chichen Itza during the tenth century BC.

2 Method

2.1 Data Collection

[1] NASA Horizons Web Interface
In order to collect data regarding the location of Venus during the time of the Mayans, we utilized the NASA Horizons Web Interface, a web application that generated ephemerides, a table that provides the calculated positions of a celestial object.

Our target body was the planet Venus and the location of the hypothetical observer was set to be the coordinates of El Caracol, Chichen Itza. We gathered data points from 1000AD to 1049AD in twelve-hour time steps (collecting at 13:00 UTC or at 7:00AM local time as well as 1:00 UTC or 7:00PM local time) as these times align with the rise and setting of the sun.

These settings gave us a table with around 730 rows and various data points, including the RA – right ascension and DEC – declination of Venus. After downloading this table, we then wrote a Python script write_csv.py to convert the tables into a csv file that we could easily analyze and interpret.

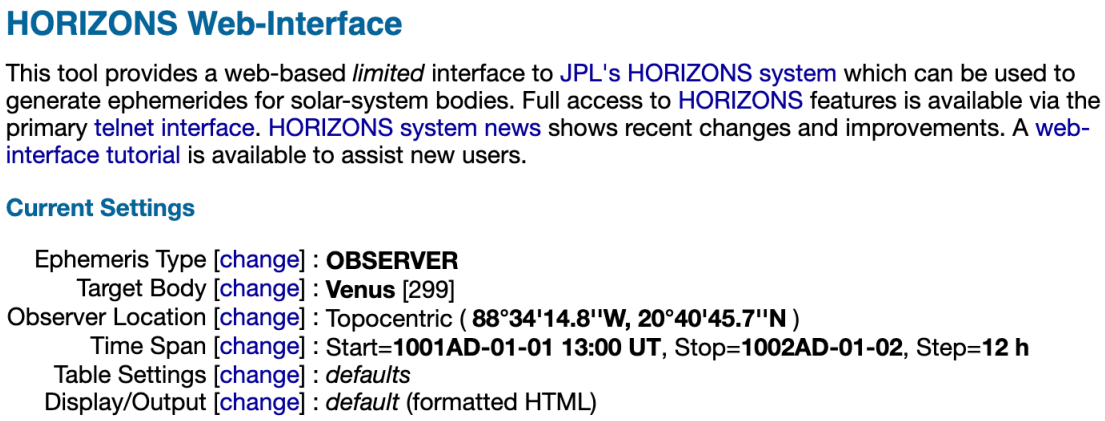

Figure 1: NASA Horizons Web Interface

[2] Stellarium API
In order to determine where Venus would be located and how it would look in the sky above El Caracol, Chichen Itza, we used the Stellarium API, a planetarium software, to capture images of the sky. In order to capture all of these screenshots, we wrote a Python script - take_screenshot.py - which automated image creation based on current time.

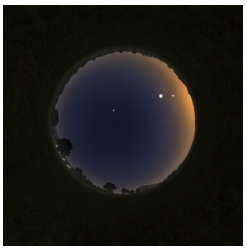

Figure 2: Image of the Sky Above El Caracol

Our dataset consists of a collection of location data points (RA – right ascension and DEC – declination) as well as screenshots of the sky from El Caracol, Chichen Itza.

For both our models, we did not have to do any manual data cleaning. We automated the data collection, extraction, and cleaning process using Python so while we did have to write those scripts, the two websites we used made the collection quite efficient.

3 Results

Overall, we were able to generate what we intended to extract from the data-set: a model of how the ancient Mayans would see the movement of Venus.

3.1 Analysis of NASA Horizon Data

When looking through the NASA Horizon portion of our data-set, we mainly focused on the location data, or the right ascension and declination of Venus. Right ascension and declination are akin to longitude and latitude, but in the celestial sphere. By analyzing these data points throughout time, we were able to determine the ten month period where Venus disappears as well as the eight month cycles where it appears as a "morning star" and "evening star."

3.2 Analysis of Stellarium Stereographic Captures

When looking through the data we captured through Stellarium, we concentrated on how we could use machine learning on the screenshots to better understand the movements of Venus. While we did not perform any of this analysis ourselves, we believe that using regression, one could potentially generate the position of Venus from the stereographic captures of celestial sphere (the image data we captured) by using computer vision.

4 Conclusion

4.1 Contributions

Our goal was to collect information that had previously been lost so data-analysis groups can apply machine learning concepts on this data. In terms of contribution to this space, we believe we achieved our goal and with the help of computer software, generated a data-set for those who are interested in the analysis of Venus and ancient Mayan astronomy.

4.2 Information for Data-Set Users

- When generating data with the Horizons Web Interface, we set our data collection times at 7AM and 7PM local time as we believed that these times would best align with the rise and setting of the sun. However, the time the sun rises and sets is quite variable and varies day by day. Therefore, our assumption is not entirely correct and may cause some inaccuracies in data.
- Our stereographic images not only captures Venus in the sky, but also other planets such as Jupiter and Mars. Those who utilize our data should take this into account, especially when conducting image recognition, and ensure they are analyzing the correct planet. This also allows for the potential analysis of other planets apart from Venus.

References

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