

# DA Assignment 2

ARNAB DEY

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## 1 The Provided Longitudes

The following plot shows the longitudes as measured during the 12 oppositions.

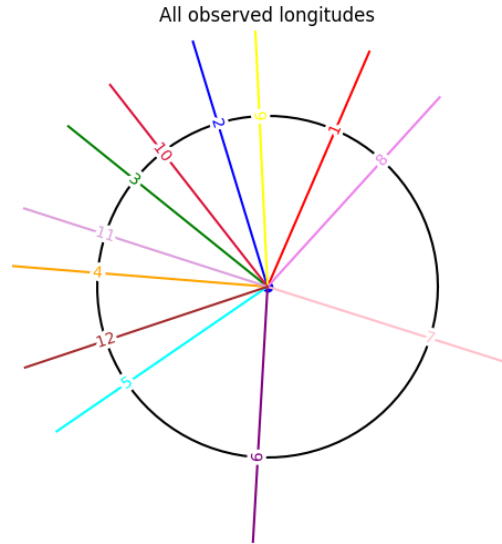


Figure 1: The opposition Longitudes

## 2 Finding out Orbital period

From the given longitudes and opposition times, we can try to fit a sun-centred model, and the orbital period comes out to be 699 earth days.

Again, from the Latitude data(shown below), the orbital period comes out to be 645 earth days.

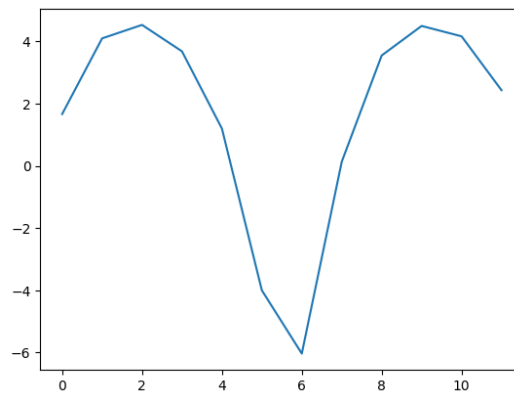


Figure 2: Observed Latitudes.

### 3 Assuming Sun-Centred Orbit

If we consider that the orbit of Mars is circular with the Sun as its centre, then the maximum error in observed and predicted longitudes is 20.48.  
The same is shown in the figure below.

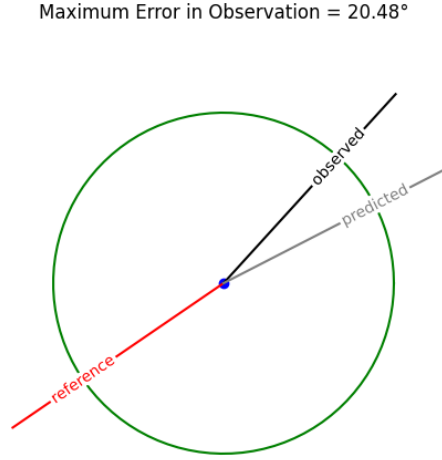


Figure 3: Maximum error for Heliocentric orbit

### 4 The Equant Model

We consider that the centre of Mars' orbit is at a distance '1' unit from the sun. Taking this as our unit distance measure, we define other distances and angles :

- **c** : Angle (degrees) Mars' centre of orbit is with respect to the Sun-Aries line.
- **r** : Radius of orbit of Mars.
- **e1** : Distance of Equant from Sun.
- **e2** : Angle (degrees) Mars' equant is with respect to the Sun-Aries line.

Also there are some hyperparameters we need to tune in order to find the best fit of our Equant model. Namely :

- **z** : The observed longitude we take as reference to compute the rest eleven oppositions.
- **s** : The angular velocity of Mars in *degrees/day*.

### Results

The best values of the parameters was swept across all reasonably plausible ranges, and then the predictions were compared against the given observed longitudes.

Below are the plots that show the observed and the predicted longitudes for eleven oppositions, each taking one as reference. The optimal parameter and hyperparameter values are :

- |                      |                                 |
|----------------------|---------------------------------|
| • <b>r</b> : 6.2870  | • <b>s</b> : 0.5245997° per min |
| • <b>e1</b> : 1.1666 | • <b>z</b> : 175.71°            |
| • <b>e2</b> : 149.22 | • <b>Min Error</b> : 0.01°      |
| • <b>c</b> : 150.°1  | • <b>Max Error</b> : 0.43°      |

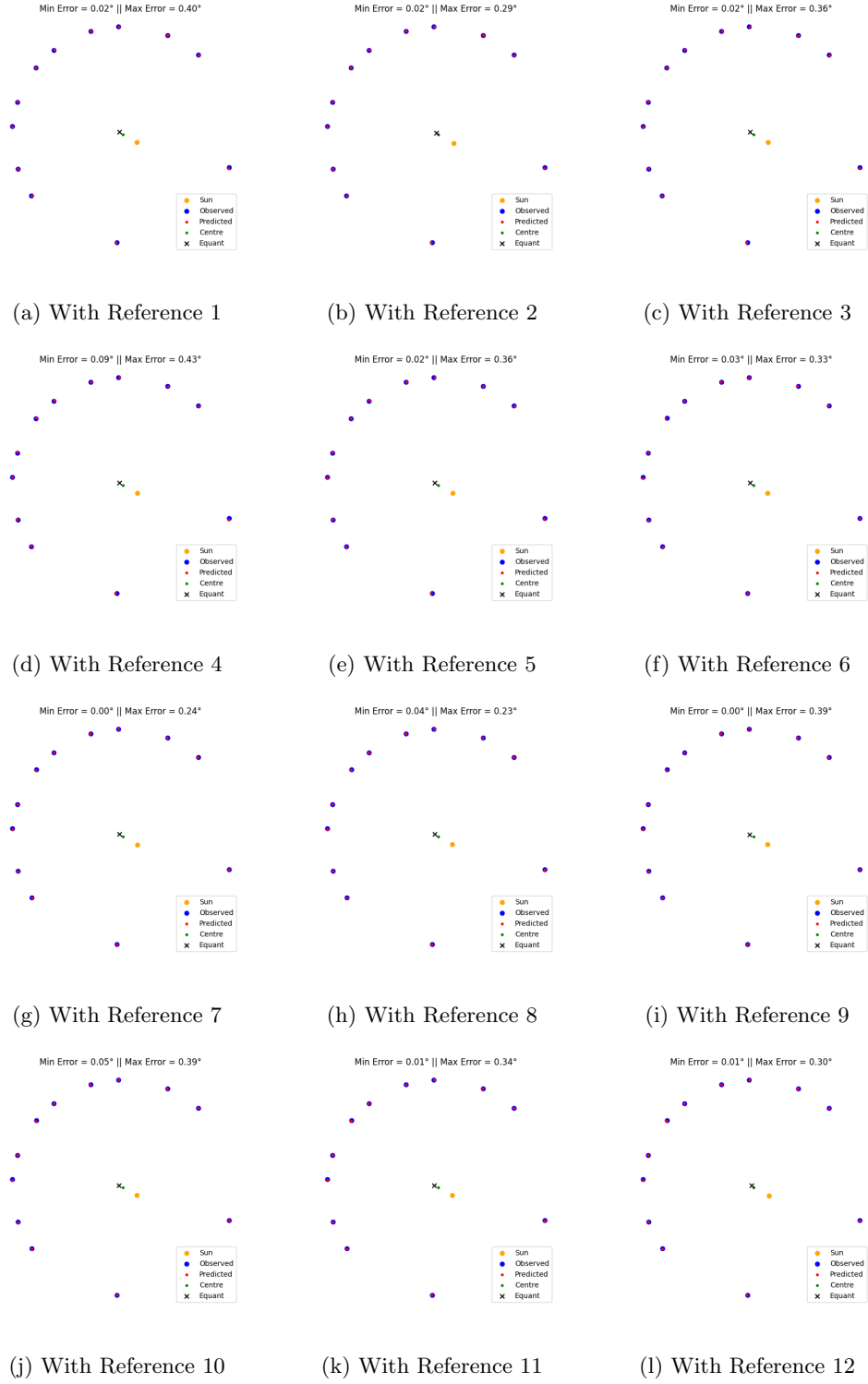


Figure 4: Predicted vs Observed Longitudes