E0 259
Data Analytics
Assignment 2: Mars Orbit

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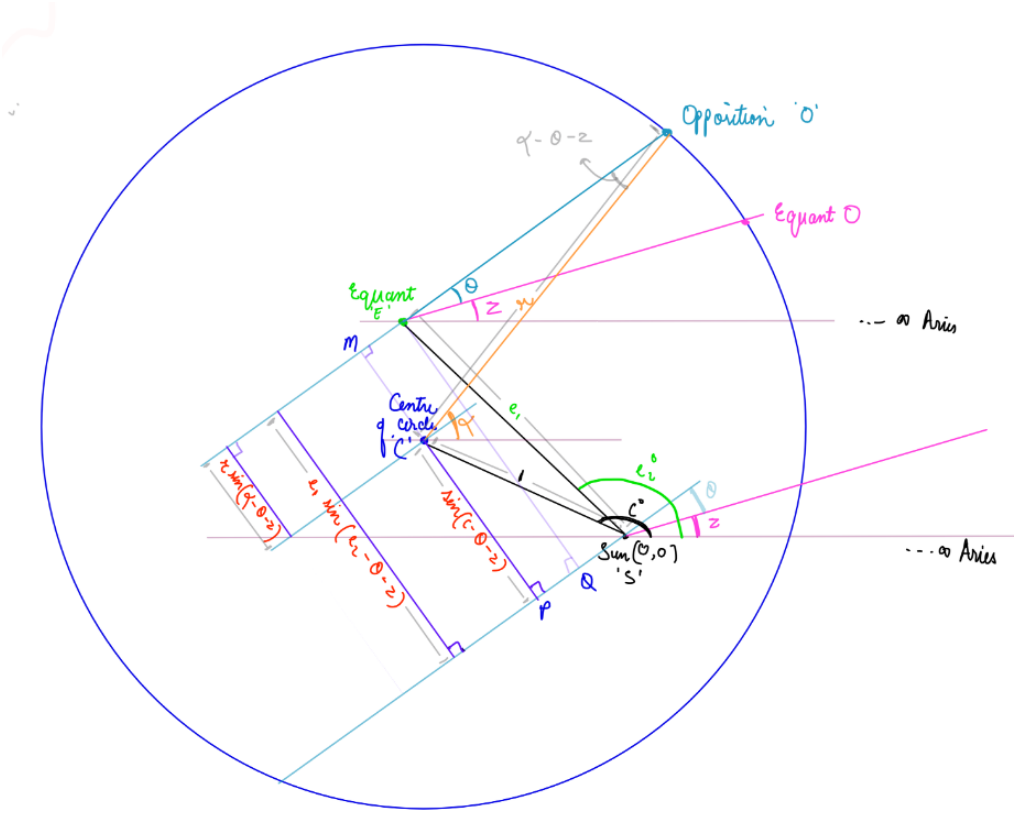
1 Libraries Imported:

datetime, pandas, numpy

2 Implementation Summary

2.1 Derivation of Measured Angle using Polar Coordinates:



from Δ PCS: $\angle PSC = 180 - (c - \theta - z))$

$\Rightarrow PC = 1 \cdot \sin\left(180 - (c - \theta - z)\right) = \sin(c - \theta - z)$

from Δ QEC: $\angle QCE = 180 - (e_2 - \theta - z))$

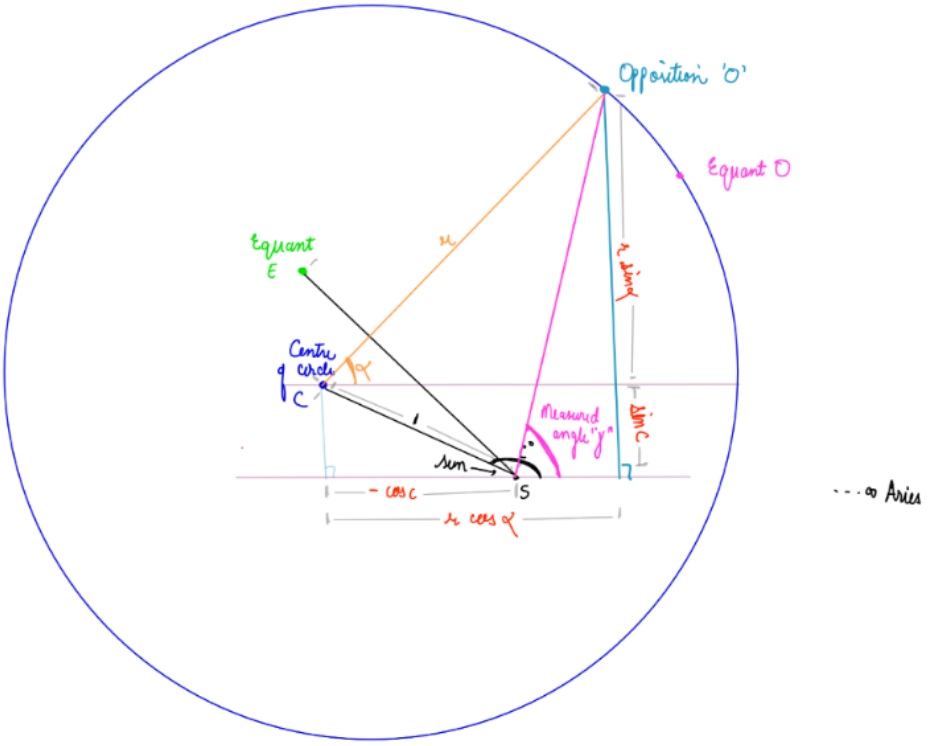
$\Rightarrow QE = e_1 \sin(e_2 - \theta - z)$

from Δ CMO: $\angle COM = \alpha - \theta - z$

$\Rightarrow CM = r \sin(\alpha - \theta - z)$

Now, $r \sin(\alpha - \theta - z) + \sin(c - \theta - z) = e_1 \sin(e_2 - \theta - z)$

$$\Rightarrow \alpha = \theta + z + \sin^{-1}\left[\frac{e_1}{r}\sin(e_2 - \theta - z) - \frac{1}{r}\sin(c - \theta - z)\right]$$



Measured angle: $\tan\gamma = \dfrac{r\sin\alpha + \sin c}{r\cos\alpha - (-\cos c)}$

$$\Rightarrow \gamma = \tan^{-1}\left[\frac{r\sin\alpha + \sin c}{r\cos\alpha + \cos c}\right]$$

Absolute error = $|\gamma - \text{Observed Angle}|$

2.2 Optimization

Now, we optimize our parameters c, e, z, r, and s such that the maximum error in each observation for the orbit model does not exceed 4'.
i.e., We need to optimize for these parameters so as to minimize the maximum Oppositions Discrepancy. This is implemented using **Discretized Exhaustive Search**.
Steps:

- Fixed r and s. Did a discretised exhaustive search over c, over e = (e1,e2), and over z to minimise the maximum angular error for the given r and s.
- Did discretized search for r and s in the neighbourhood.

2.3 Results and Graphs

Following are the parameters obtained:
Fit parameters: r = 8.8400, s = 0.5241, c = 148.5000, e1 = 1.6430, e2 = 148.9000, z = 55.8600
The maximum angular error = 0.0336

Plot: