FLAM RESEARCH AND DEVEOPMENT ASSIGNMENT

Objective :

Find the three unknown parameters θ, M and X so that the parametric curve

$$x = \left(t * \cos(\theta) - e^{M|t|} \cdot \sin(0.3t)\sin(\theta)\ + X\right)$$

$$y = \left(42 + t * \sin(\theta) + e^{M|t|} \cdot \sin(0.3t)\cos(\theta)\right)$$

Matches the provided set of (x,y) points for 6<t<60.
The assessment uses the L1 distance between uniformly sampled predicted and expected curve points, so fit the parameters to minimize that L1 error.

Given:

$$\theta bounds : 0 < \theta < 50^\circ.$$
$$\theta \in (0,\ 50^\circ) \Rightarrow \theta \in (0,\ 50\pi/180) \approx (0, 0.87266) radians.$$
$$M \in (-0.05, 0.05)$$
$$X \in (0, 100)$$

Approach

1. The dataset contains pairs of (x,y) coordinates representing points on the curve for 6<t<60.
2. Since the dataset does not include values of t, the parameter t was assumed to be uniformly distributed between 6 and 60 for all points.
3. The fitting process aimed to minimize the L1 distance (sum of absolute errors) between the observed and predicted coordinates:

$$L1 = \sum_i \left(|x_{\text{pred}} - x_{\text{data}}| + |y_{\text{pred}} - y_{\text{data}}| \right)$$

4. It first runs a global search (differential evolution) minimizing L2 squared residuals to find a good starting point, then refines by directly minimizing the L1 objective with Powell.

5. The best-fit parameters were extracted once the L1 loss converged to a minimum value.