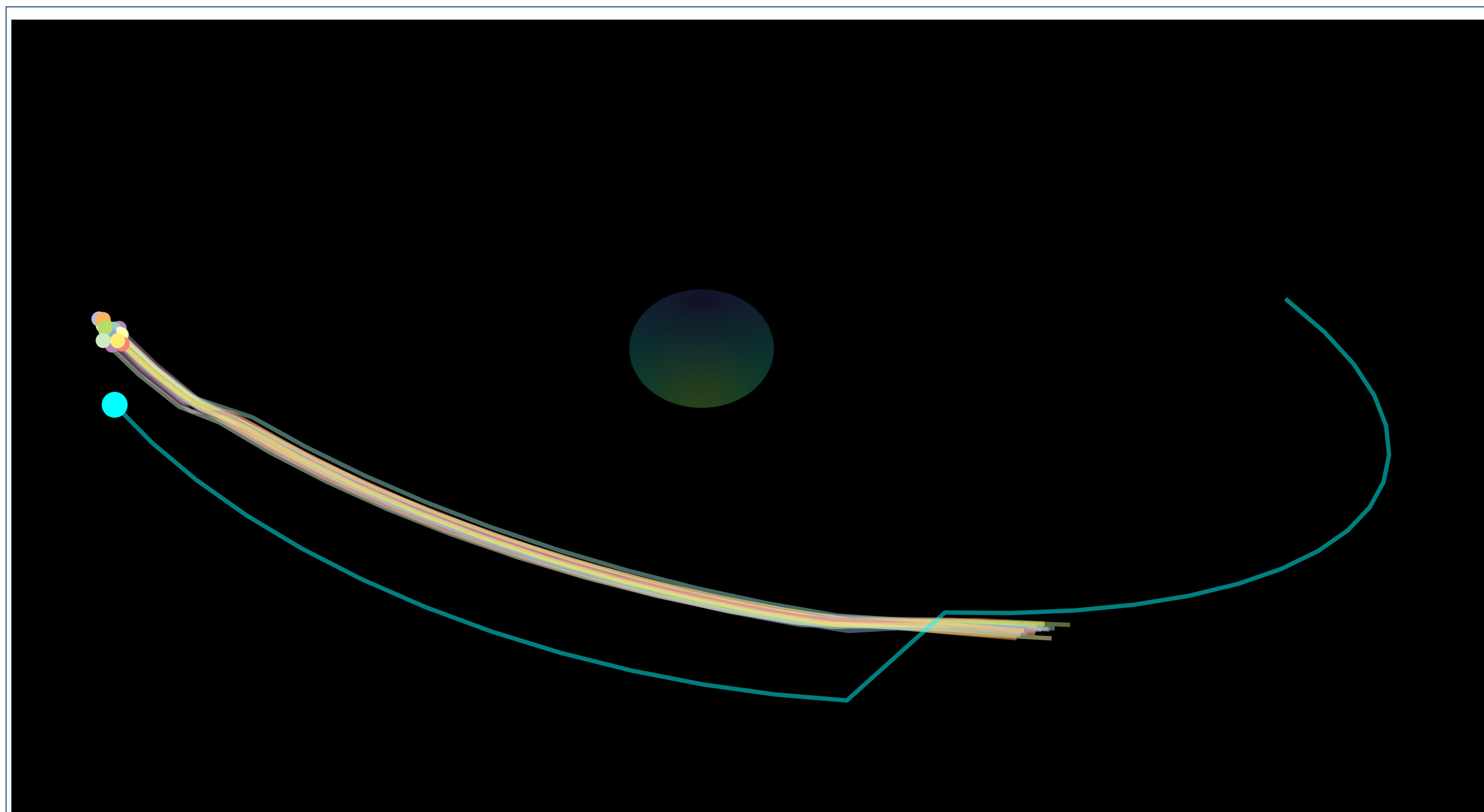


A System for Satellite Orbit Anomaly Detection

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Introduction

- Detects anomalies caused by e.g. malfunction, manoeuvres or collision
- Knowledge of these events aids space situational awareness
- NORAD Two Line Element (TLE) input data
- Intelligent chat interface



Visualization of particle filter operation.

Particle Filter Detection

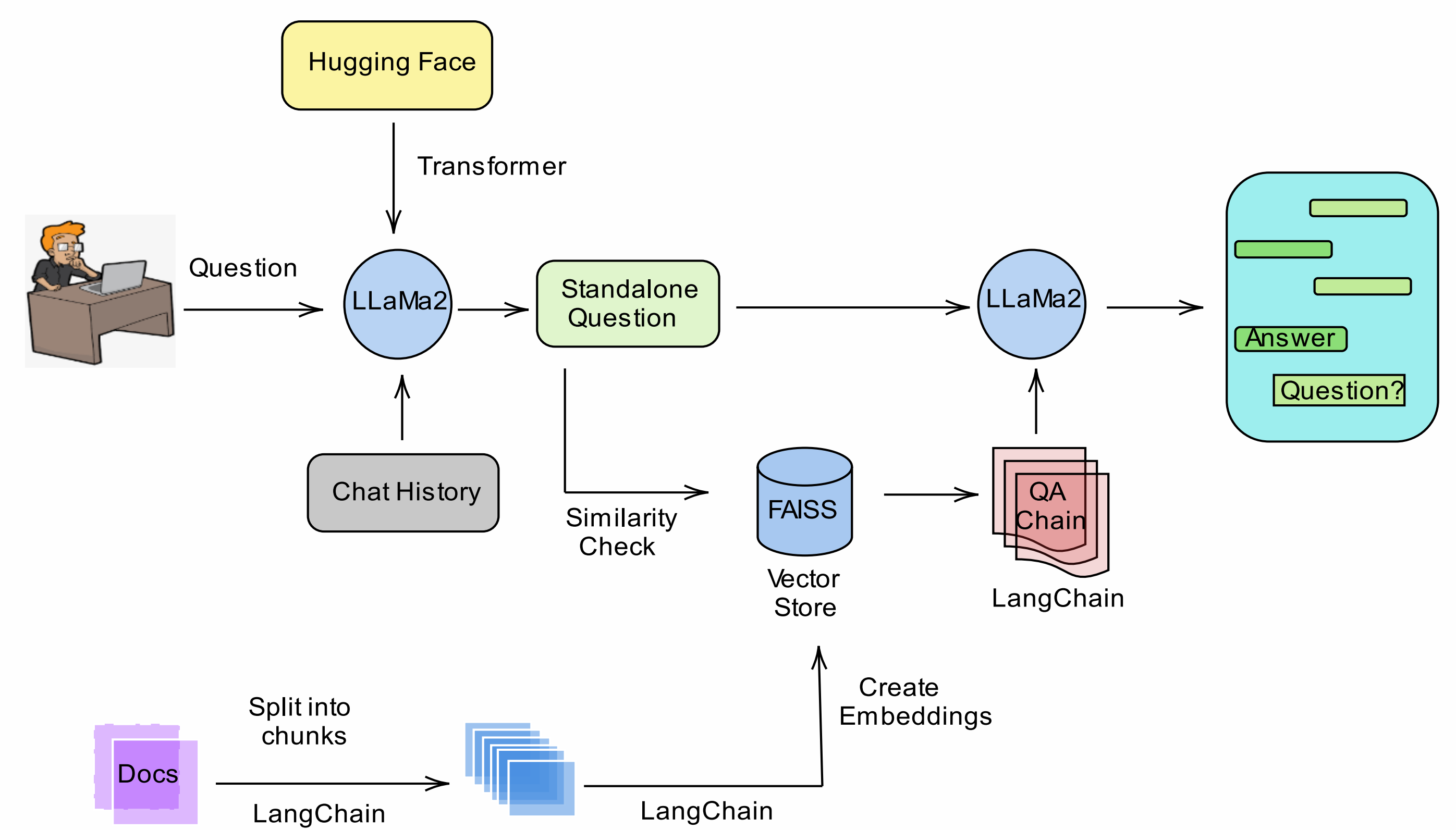
- Tracks the mean elements of the satellites' orbits [1] from noisy observations in TLE sets
- Estimates the uncertainty of our belief in these mean elements
- Unlikely future observations, given our current belief are anomalous
- Implementations of both bootstrap and optimal proposal filters - overcome accuracy limitations of the standard SGP4 propagator
- Diagram shows particles tracking orbit (longer trace) after a manoeuvre

Benchmark Dataset

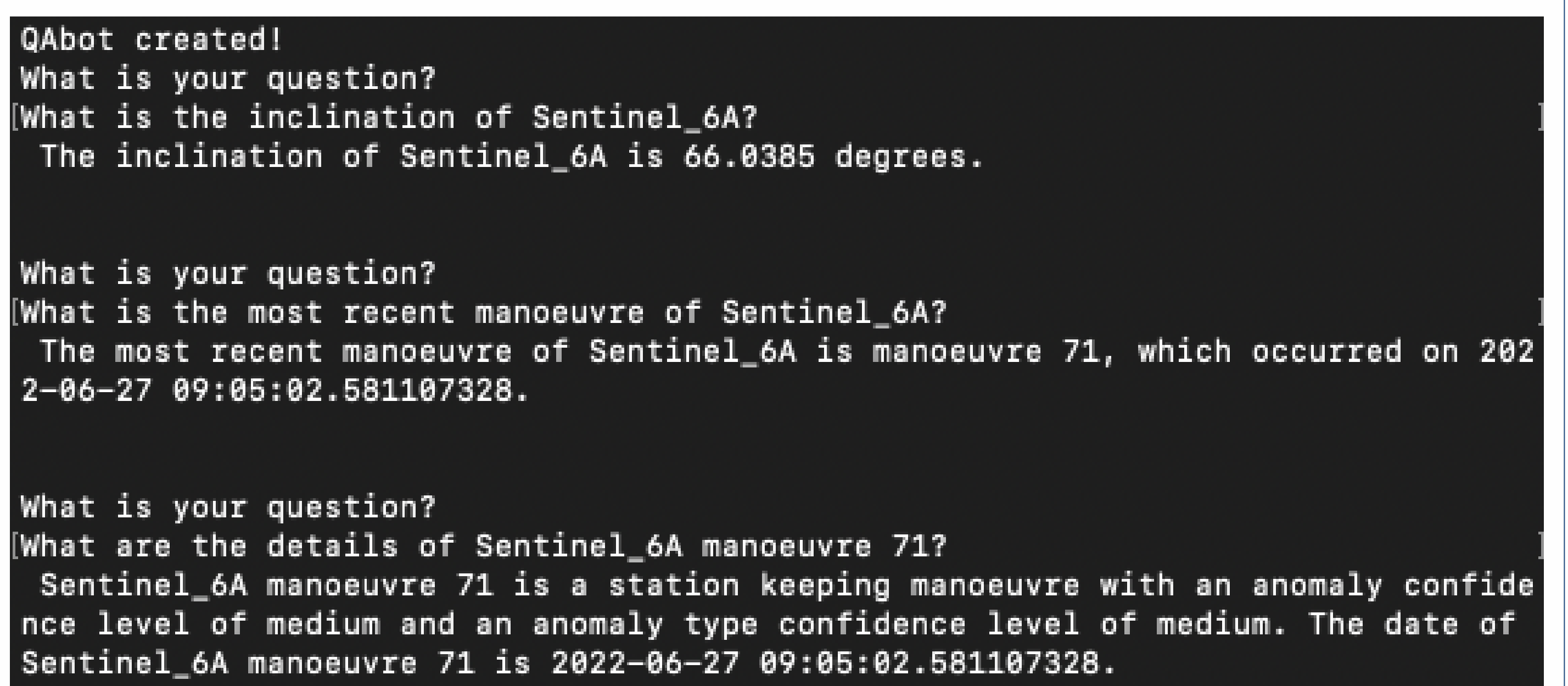
- TLEs and ground-truth manoeuvres for 15 satellites [1]
- Precise positions for some satellites

Natural-Language Interface

- We utilised LLaMa2 model by meta along with LangChain in designing a Question Answering System.
- The interface facilitates the user to query about general satellite features and manoeuvre patterns.



Flowchart of the process of Question Answering System development



Natural Language Interface

References

1. Shorten, D. P., Yang, Y., Maclean, J., & Roughan, M. (2023). Wide-Scale Monitoring of Satellite Lifetimes: Pitfalls and a Benchmark Dataset. *Journal of Spacecraft and Rockets*, 1-5.

Paper Link:

