Analysis of pseudorange outlier in presence of interference using machine learning algorithms
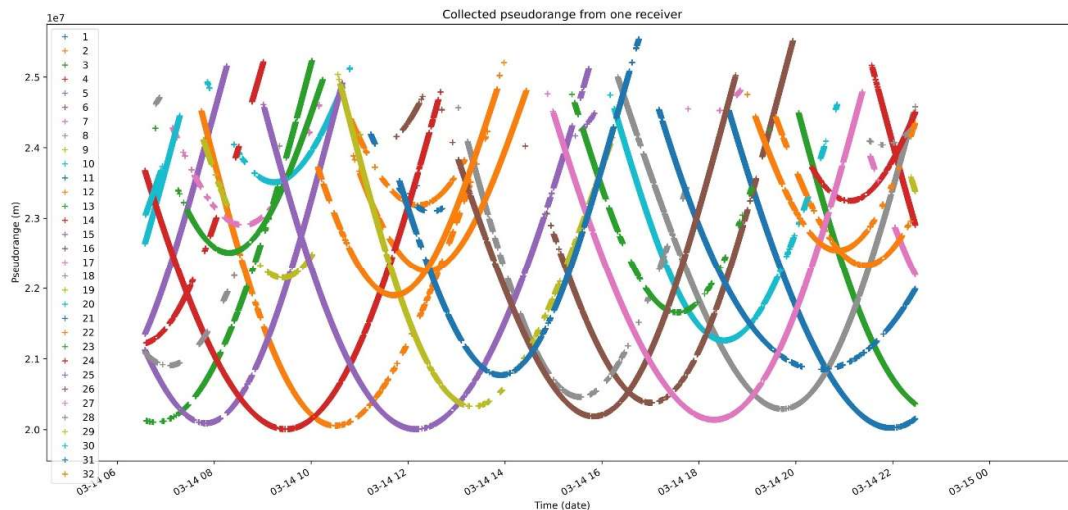
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Collected pseudorange from one receiver

I. Context

Global Satellite Navigation Systems (GNSS) has gradually become a central technology of modern civilization. In fact, the satellite system offers a free and accurate positioning system all around the word. However, the low power of reception and the public structure make the signal vulnerable to interference threats.

On a receiver point of view, the interferences distort the received signal, which induces estimation errors on the signal parameters such as Doppler frequency, carrier phase, or code delay.

II. Objectives

This project proposes an analysis of code pseudorange to detect and mitigate interference distortions from the authentic signals. The analysis will include a modelling of the authentic pseudorange to implement a simulation, allowing to find convenient representations of these signals to perform anomaly detection. The performances of these algorithms will be performed on both simulated and measured pseudoranges.

III. Acquired skills

Theoretical : GNSS, signal processing and machine learning algorithm for anomaly detection

Software : numerical (object oriented) implementations in python, machine learning libraries in python

III. Tasks

1. **Model of pseudorange in function of the satellites dynamics and receiver position**
2. **Implementation of the obtained theoretical model**
3. **Inclusion of some controlled random anomalies in the simulation**
4. **State of the art about Dimensionality reduction (eigen-vector, wavelet decomposition, Kernel basis, Principal component Analysis) and anomalies detection (Support vector machines (SVM), k-Nearest Neighbors, Auto-encoder, …)**
5. **Choice of an algorithm**
6. **Implementation of the chosen algorithms and comparison of their performances on the simulation dataset**
7. Test on a real collected signal to detect distortion ad anomalies
8. Multivariate analysis on several receivers and PRN

IV. Deliverables

At the end of the project, the students will write a scientific report and return a usable and commented python code.