Trajectory Characterization Using Tracktable

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Abstract

Through the use of Python and object-oriented programming, the Sandia National Laboratories Corporate Partners Learning Community focused on categorizing and identifying patterns in airplane flight data. Through using R-Tree sorting, clustering, and distance geometry, trajectories were analyzed based on various characteristics. These characteristics will be used to find correlations between various components in a trajectory to ultimately predict features of a trajectory based on early conditions.

Background

- The goal of this project is to look for trends in large sets of flight data and use these trends to characterize flight trajectories.
- These characteristics can then be used to predict the trajectories of other flights based on early-flight conditions.
- There are over 10 million flights each year in the United States alone,.
- By assessing the common characteristics of flights, it should be possible to identify and correct anomalies before they turn into more serious issues.
- The main tool used in this project is Tracktable, a Python module written by researchers at Sandia National Laboratories for the purpose of analyzing trajectory data.

Figure 1: Flights filtered by R-tree query.

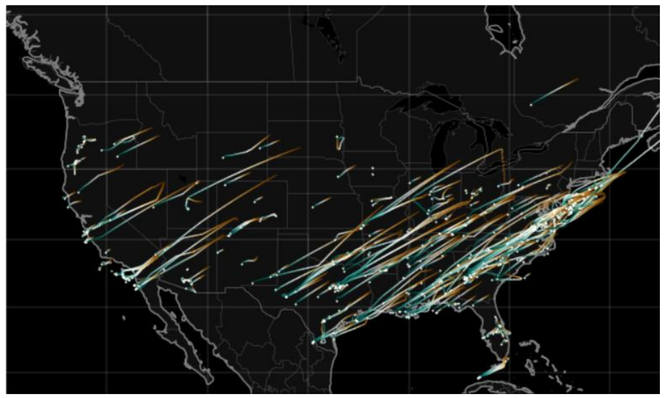

Figure 2: A cluster of flights, clustered by bearing.

Figure 3: Flights with similar distance geometry.

R-Tree Sorting

- Data tree structure used for sorting multi-dimensional information, we can group together data.
- Finds points that would fall into a “box” given the value of two corners.
- flight paths can be filtered through an R-Tree by using their feature vectors
- We can group a set a flights based on many things, like length and shape.
- Figure 1 contains flights that have similar straightness ratios.

Clustering

- We use DBSCAN, an implementation of the k-nearest neighbor algorithm
- With DBSCAN, flights were sorted into clusters based on various features.
- Each flight in figure 2 has a bearing within .2 degrees of at least four other flights.
- Clustering based on different features allows us to characterize groups of trajectories and look for which features tend to correlate.

Distance Geometry

- Distance geometry is a way to measure a curve, by breaking it into smaller parts, giving information about bends and wiggles in curve and the sizes
- The algorithm generalizes 3 parameters: a trajectory, depth, and normalization.
- The depth is used to determine the fidelity of the measurement, higher depth levels have more shape info.
- Normalization determines whether info about size is included.

Results

- The methods of R-tree sorting, clustering, and distance geometry were used to characterize flights.
- These characteristics will be used to find correlations between different aspects of trajectories.
- By leveraging these correlations, we aim to make accurate predictions of future flight conditions based on early characteristics.

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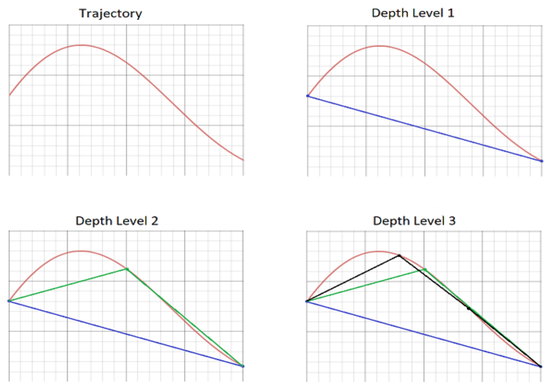

Figure 4: An example of distance geometry.