

Sandia Flight Trajectory Analysis

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Introduction and Motivation

Who We Are: We are a multidisciplinary team made up of 12 members of the Data Mine Learning Community from all grade levels.

What We Do: We examine flight trajectories and paths of airplanes to find patterns, groupings, and outliers.

Why We Do it: For defense and security, it is important to know the major flight paths and behaviors as well as how to spot outliers.

What's Trackable?: Tracktable is a python kernel designed to make analyzing flight data easier. In this poster we showcase many of tracktable's capabilities.

Reader and Builder

Reader

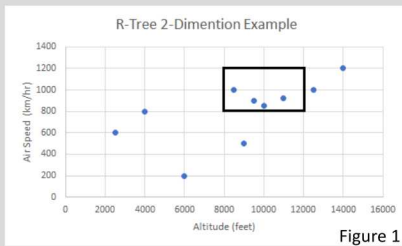
- Convenient way to assign and isolate our points of interest in the data for trajectory formation
- Transforms inputted .CSV data into point objects readable to the builder

Builder

- Groups each set of point belonging to the same flight
- Constructs trajectories objects from these points

R-Tree

- Allows for items within the "box" to be passed and discards all other values
- Can be applied to an Nth dimensional characteristics (as many as you want)
- Used to reduce the amount of values passed to later sorting methods
- Example with 2 dimensions
- The altitude range is from 8000 feet to 15000 feet and the airspeed is from 800 to 1000 km/hr



Feature Vectors

- A vector containing aggregate features or descriptors of a trajectory
- A vector is specific to a trajectory 1:1
- Examples of individual features include: total length, end to end length, maximum airspeed, average altitude, etc.
- Feature vectors are used as a way of comparing trajectories with both R-tree filtering and clustering

Calculated from trajectory A:
<580, 8900, 2000, 2500, 0.8>

<max. airspeed,
avg. altitude,
end to end dist,
total dist,
straightness ratio>

Distance Geometry

Distance geometry calculates the length of the trajectory along increasingly short segments. Include all the segment lengths up to a certain depth in a single feature vector. An example is given for the given trajectory (shown in black) and going to a depth of 3.

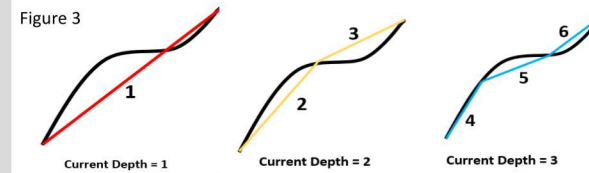


Figure 4 Resulting Feature Vector

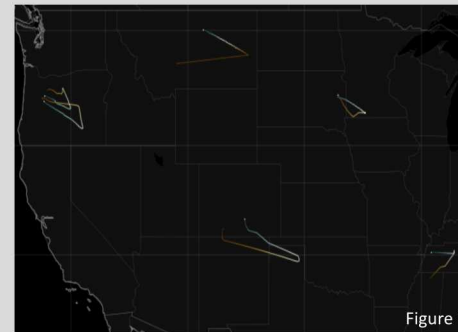
[1, 2, 3, 4, 5, 6]

Length of Each Line Segment

This vector can be normalized by dividing each entry by the maximum possible value of that entry. This maximum value is calculated by dividing the total length of the trajectory by the current depth. This yields a feature vector where all values are between 0 and 1.

Figure 5 Example of Normalized Vector

[0.5, 0.234, 0.7, 0.98, 0.1, 0.4]



Clustering

- Once we have successfully created our feature vectors containing the desired trajectory characteristics, then we can use clustering to filter out the vectors with uninteresting attributes
- This is incredibly useful for finding specific patterns, unusual shapes, and abnormalities!
- You can then use clustering to group feature vectors together based on whatever you choose and then you can visually display them to see the similarities of the flight paths contained within the different cluster groups like the example above

Conclusion:

Future Goals:

- Onboard new members
- Use these tools to predict the future characteristics of trajectories
- Explore unanswered questions about trajectory characterization and look for correlations between different characteristics

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