Appendix to VAST 2018 submission Analysis of Flight Variability: a Systematic Approach

by

Natalia Andrienko, Gennady Andrienko, Jose Manuel Cordero Garcia, and David Scarlatti Here we demonstrate the generality of the approach presented in the paper by applying it to example data and analysis tasks beyond the aviation domain.

Data and analysis task



Iris, Descartes, CommonGIS, V-Analytics 1995-2017: Milan trajectories on road A4, 1 week

Data: 667 tracks of cars that travelled along motorway A4 on the north of Milan made during 1 week from April 1 to 7, 2007; 332 eastbound and 335 westbound tracks

Task: By comparing all tracks with the fastest eastbound and westbound trajectories (i.e., with the highest average speeds), determine where and when the cars could not move sufficiently fast and how their speeds differed from those in the two fastest trajectories.

Computed derived attribute for each point of each trajectory: mean speed in 2-minutes time interval starting from the time of the point.

Trajectories in a space-time cube



2 fastest trajectories are represented by thick lines.Green: eastbound trajectoriesPurple: westbound trajectories

Point-wise matching to the respective fastest trajectories



The points of each trajectory have been matched to the nearest points of the fastest trajectory going in the same direction. That is, the eastbound trajectories were matched to the fastest eastbound trajectory and the westbound trajectories to the fastest westbound trajectory.

The links between the corresponding points are represented in a space-time cube by dark yellow lines. For better readability, only trajectories from one day (April 7) are shown, when both fastest trajectories were made.

Red: the two fastest trajectories; green: eastbound trajectories; purple: westbound trajectories.

In the following slide, the links of the east- and westbound trajectories to the respective fastest trajectories are shown separately.

Point matching for the eastbound and westbound trajectories



Based on the point-wise matching, the differences of the mean speeds by 2-minute time intervals between the points of each trajectory and their "buddies" from the respective fastest trajectory have been computed.

Average speed differences along the road



The raster layer on the geographic map represents the average speed differences with respect to the fastest trajectories. The red end of the colour scale corresponds to the highest negative differences, i.e., the slowest speeds. The upper map shows the differences for the eastbound trajectories and the lower for the westbound trajectories.

This and other attempts to represent the differences on a geographic map do not reveal clear patterns. Therefore, we shall transform the trajectories to new coordinate systems (artificial spaces).

Distance from the west end vs. speed difference



The trajectories have been transformed to a new coordinate system: distance from the west end (X-axis) vs. speed difference from the corresponding point in the fastest trajectory (Y-axis).

The upper map shows the trajectories represented by lines in the new space. The lower map contains the density surface of the set of trajectories.



This interactive map shows us where along the westeast direction many cars moving to the east and to the west had to slow down and how much slower they moved compared to the fastest trajectories.

Time vs. speed difference





Time vs. distance from the west end



X-axis: time



Time of the day vs. distance from the west end



Polar coordinates; angle: time of the day; radius: distance from the west end

Left: the trajectories are represented by lines.

Right: a coloured raster shows how the average differences to the speeds in the fastest trajectories are distributed over times of the day and along the west-east direction.



Major deviations occurred in the morning times near the east end (i.e., at the entrance to the city area).

Interactive "spatial" filtering: Eastbound trajectories with very large negative speed differences in the western part of the motorway

Coordinates: distance from the west end vs. speed difference; raster: density; red rectangle: spatial filtering window



Coordinates: time vs. distance from the west end; raster: average speed difference



Coordinates: time vs. speed difference; raster: density



Coordinates: time of the day vs. distance from the west end; raster: average speed difference



Interactive "spatial" filtering: Westbound trajectories with large negative speed differences in the middle of the motorway

Coordinates: distance from the west end vs. speed difference; raster: density; red rectangle: spatial filtering window



Coordinates: time vs. distance from the west end; raster: average speed difference



Coordinates: time vs. speed difference; raster: density



Coordinates: time of the day vs. distance from the west end; raster: average speed difference

