Visual Analysis of Multivariate Movement Data using Interactive Difference Views

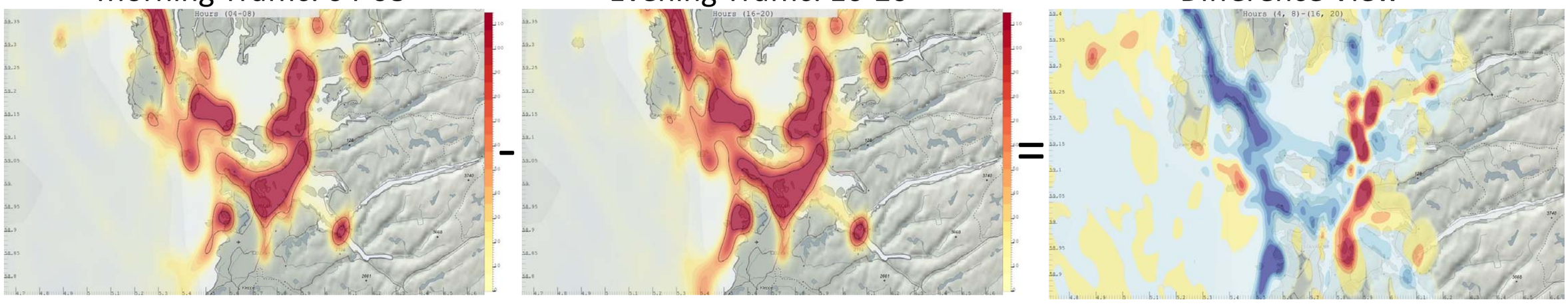
Ove Daae Lampe
odl@cmr.no
Chr. Michelsen Research
Department of Informatics, University of Bergen

Johannes Kehrer
Johannes.Kehrer@UiB.no
Department of Informatics, University of Bergen
ii.UiB.no/vis

Helwig Hauser
Helwig.Hauser@UiB.no
Department of Informatics, University of Bergen
ii.UiB.no/vis

Difference Views:

Morning Traffic: 04-08 | Evening Traffic: 16-20 | Difference View



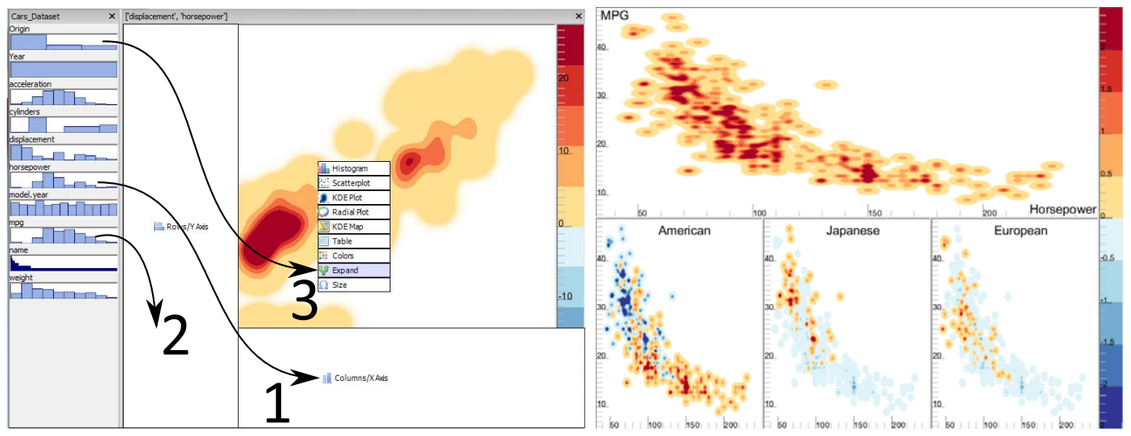
The images show kernel density sum of all ship traffic close to Stavanger in a given time period. These plots gives a good quantitative measurement on the volume of traffic in the different areas. If the user investigates how the traffic volume changes over time, however, a side by side presentation will only provide a qualitative idea on changes.

Changes (or differences) are made explicit by calculating the difference view and, can be read out in a quantitative manner. In image to the right, the difference view, red indicates higher morning traffic, and blue indicates higher evening traffic. This is an example of a direct difference view, where we have two directly comparable density volumes.

Introduction:

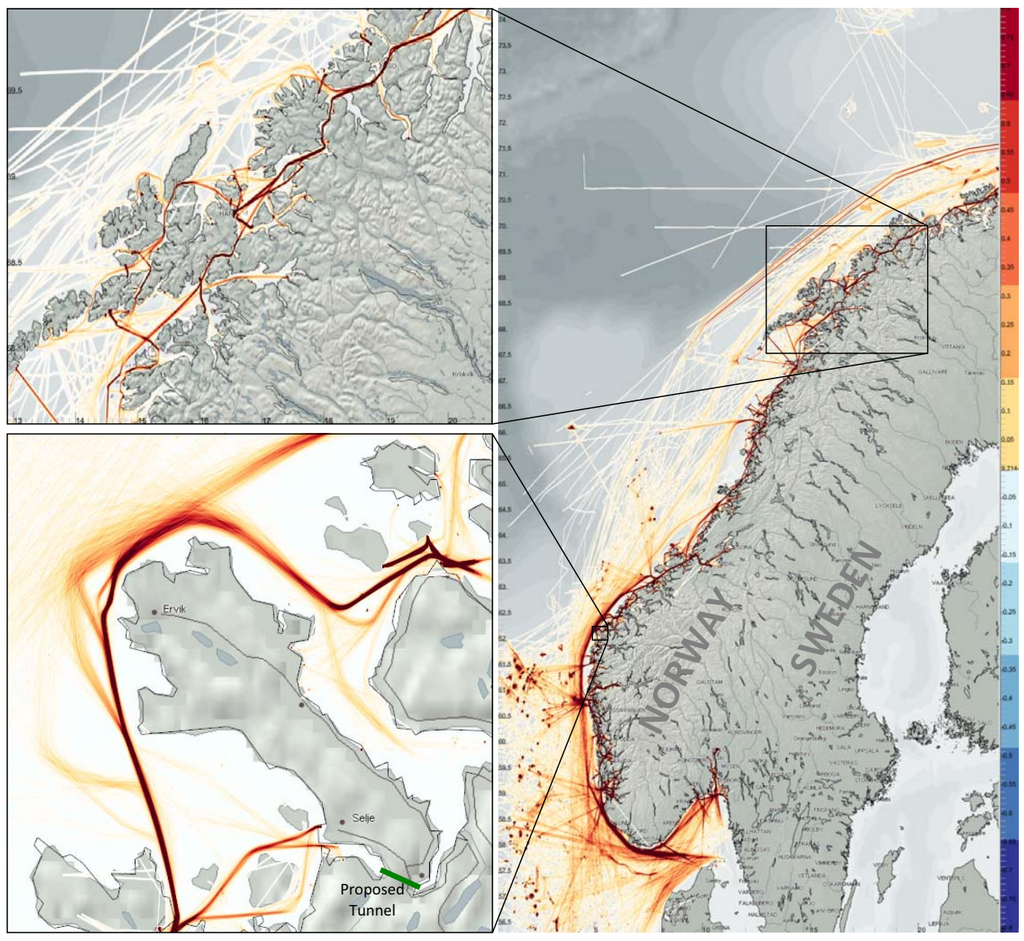
Movement data consisting of a large number of spatio-temporal agent trajectories is challenging to visualize, especially when all trajectories are attributed with multiple variates. We demonstrate a visual exploration of movement data using interactive difference views. We analyze large amounts of movement data using a frequency-based visualization, kernel density estimates (KDE). Using these techniques, we show how the user can produce quantifiable movement differences and compare different categorical attributes, e.g., comparing weekdays, ship-type, or general wind direction. In this work we present results from the exploration of vessel movement data from the Norwegian Coastal Administration, collected by the Automatic Identification System (AIS) coastal tracking.

Interactive Difference Views:



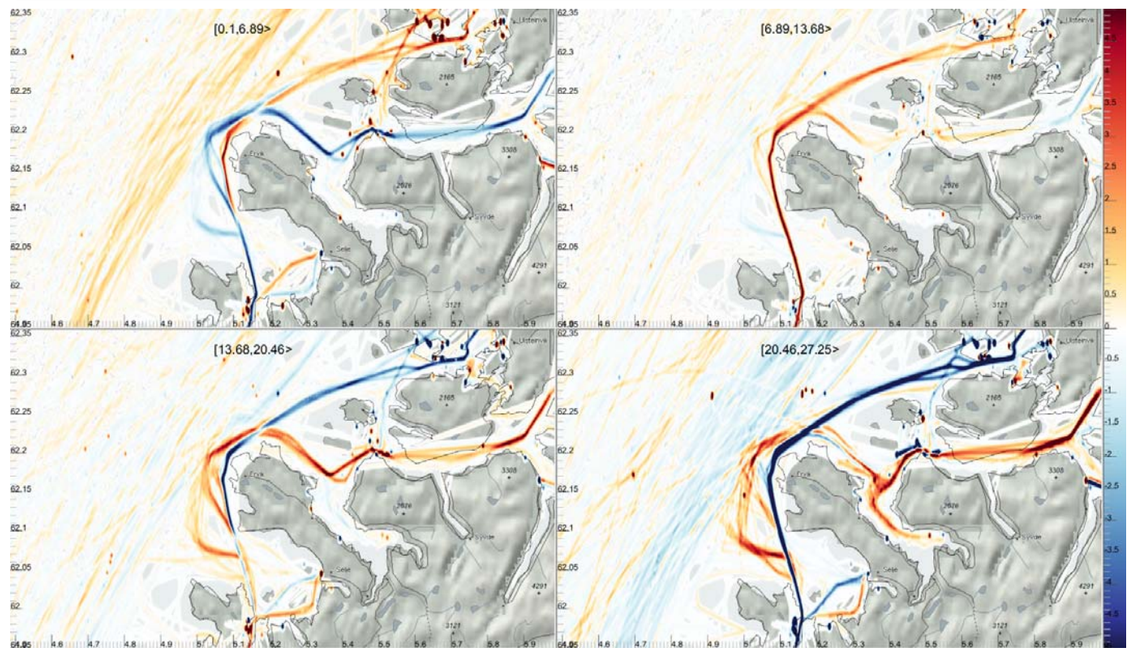
First the user creates a KDE of two attributes (1,2), then the user selects an attribute she/he wishes to see the differences in distribution of, and drags and drops this to the Expand icon (3). As shown here, the user selected the place-of-origin for the cars. The three bottom rigth views are then automatically created as a difference between a third of the average subtracted by all cars matching the current category. These three views show how the distribution of the average differs from the different origins. Japanese cars, e.g., have less horsepower, but better MPG than American.

Application Case:



The Automatic Identification System (AIS) collects the position, heading and several other attributes on all vessels close to the coast. The top inset shows how traffic is protected in-shore by a series of islands. The bottom inset shows how the traffic passing Stad is forced to take a route that is exposed to the harsh weather conditions of the North Sea. This inset also shows a proposed tunnel in green, wich would allow traffic to bypass Stad alltogether.

Traffic Patterns vs. Wind Speed:



These four images show how the traffic pattern differs from the average, with increasing wind speeds. In the top left, with the lowest wind speeds, the route far off shore is less used than average. The bottom right, with the highest wind speeds, however, indicates that the route close to shore is almost not used at all, and that most the traffic is placed at the longer route further out. This discovery highlights the choice of safe routes with difficult weather.

UNIVERSITETET I BERGEN