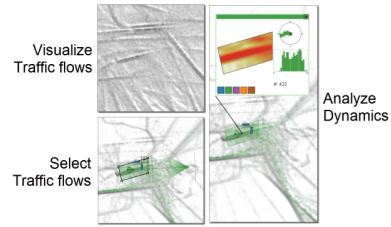


Visualization, Selection, and Analysis of Traffic Flows

Roeland Scheepens, Christophe Hurter, Huub van de Wetering, and Jarke J. van Wijk
IEEE Transactions on Visualization and Computer Graphics, Vol 22, No 1, January 2016

Presentation by Alistair Wick

Overview



2

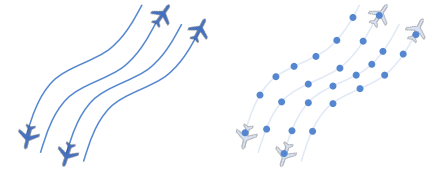
Motivation

- Individuals move, but groups make *traffic*
- Traffic is unpredictable, but not random – it forms patterns
- These patterns are important, but difficult to analyse
- This tool helps us examine these patterns, and how they change
- Takes a novel approach, using animation as a key visual channel

3

Data

- Trajectories over time



10s of thousands of journeys

100s of thousands of sample points

4

Data

Case Studies

- One day over Paris: 17,841 flights, 424,546 samples
- Vessel data near Dutch coast: 16,421 vessels, 420,335 samples



10s of thousands of journeys

100s of thousands of sample points

5

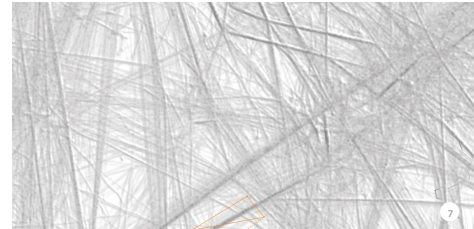
Data

- Large numbers of overlapping trajectories
- High density variation
- At a minimum, data includes:
 - Position
 - Heading
 - Velocity
- May also include:
 - Vehicle type
 - Altitude for aircraft
- Approach is designed for ordered traffic, *not* random movements!

6

Approach

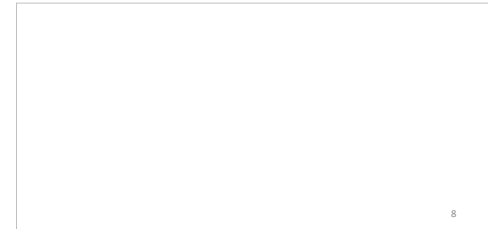
- Density map shows *where* the trajectories lie
 - Like a high-resolution heatmap, simple lightness encoding
 - High-level overview of the paths taken



7

Approach

- Animated particle flow shows direction
 - Low clutter (unlike glyphs, arrows)
 - Leaves a wide range of visual channels for other uses



8

Approach

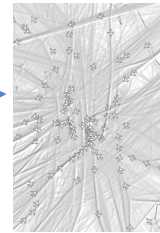
- Important to realise the particles are *not* marking individual vehicles
- They are a visual aid to show direction of flow
- Not part of the data: vis layer added by the application
- Uses some form of edge bundling (may be optional) on trajectories



9

Alternatives

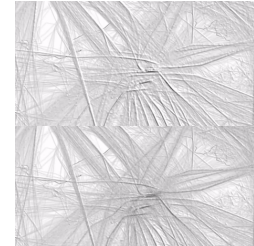
- Animated textures
 - Doesn't work for thin trajectories
- Color maps
 - Low resolution, can't overlap
- Arrows/Glyphs
 - Cluttered; obscure the view
- Could just show the vehicle locations?
 - Terrible for identifying distinct trajectories



10

Particle Display Method

- Incorporated to density map
 - Hard to combine with color
 - Imprecise

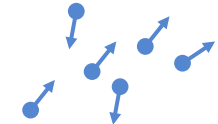


11

- Gaussian Bells
 - Alpha-blended on top of map
 - Easy to color
 - High visibility

Particle Flow - Pros

- Can resolve opposing directions
- Low clutter
- Intuitive; motion encodes motion
- Low-priority channel – color channels remain free



12

Particle Flow - Cons

- (Very) high overhead
- Requires guaranteed performance
- Real-time rendering at high resolution and framerate
- Thousands or millions of particles with constant turnover

13

Particle Flow - Cons

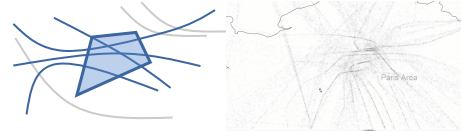
- (Very) high overhead
- Requires guaranteed performance
- Real-time rendering at high resolution and framerate
- Thousands or millions of particles with constant turnover

*Challenging – but not intractable

14

Selection/Filtering

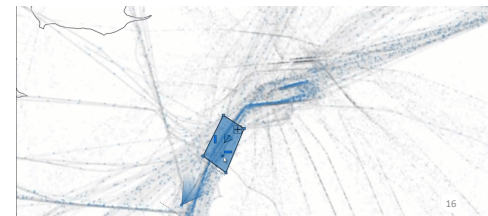
- Both representations respond to selection
- This is how the user explores the data
- Selections are localized and filter all paths passing through them:



15

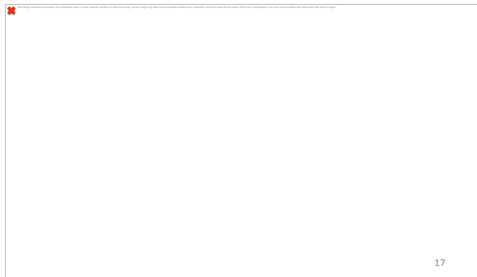
Selection/Filtering

- Selections are also *directional*
- The user picks a direction range to filter – paths which match the range within the selection area are selected



16

- Selections can be refined in other dimensions
- Here, the user filters by altitude:



17

Selection/Filtering

- Different modes of selection can be combined
- Compound selections use set-like logic:

$$S = \oplus S_i \setminus U R_i$$

- Where \oplus can be either \cup or \cap (union or intersection), and \setminus is set subtraction
- Extremely powerful
- User can add, intersect, and subtract (inverse) selections

18

Selection/Filtering

Summary:

- Polygonal selection areas
 - Selects trajectories passing through area
- Select for heading/altitude ranges
 - Custom selection widget
- Powerful compound selections
- User can enable/disable specific selections
- Can hide the unselected trajectories
- Parametric – selections can be modified at any time

19

Examination

- Detail windows can be displayed on-demand for any selection

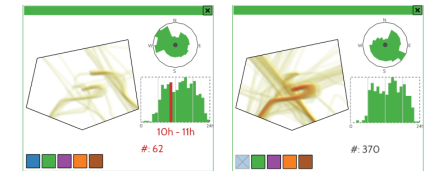
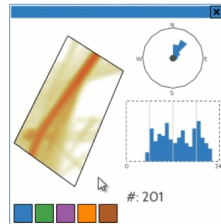


Fig. 6 (page 6)

20

Examination

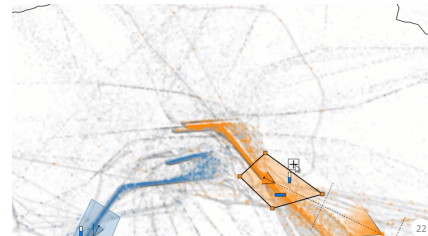
- Zoomed view of selection area
- Histogram of trajectories over time
- Polar area histogram of directions
- All sub-plots are linked
- Pickable selection color



21

Comparison

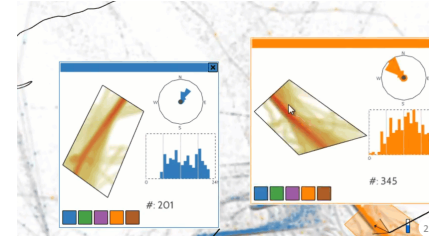
- Different windows are also linked



22

Comparison

- Windows can be combined for more direct comparison



23

Use-Case: Infographics

- Multiple selections create a faceted view suitable for infographics
- Here a static view contains all the information needed

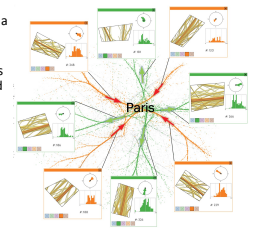
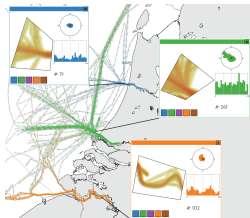


Fig. 10 (page 8)

24

Use-Case: Infographics

- Boat traffic on the Dutch coast
- Antwerp (bottom) histogram shows wave pattern – tides coming in and out!



25

Use-Case: Air Traffic

- Flights in and out of Charles de Gaulle airport
- Take-off in blue
- Landing in green
- Part of evaluation with 2 professional flight controllers

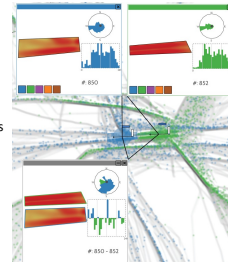


Fig. 9 (page 8)

26

Use-Case: Air Traffic

- Same view rotated to show altitude
- Alternating incoming/outgoing flows
- Different flows can be selected and compared

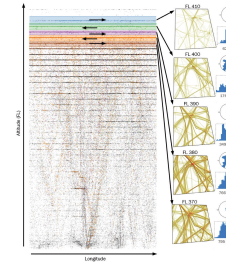


Fig. 9 (page 8)

27

Thanks!
Questions?

28