Visualization, Selection, and Analysis of Traffic Flows

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Overview

Visualize Traffic flows

Select Traffic flows

Analyze Dynamics
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
Data

• Trajectories over time

10s of thousands of journeys

100s of thousands of sample points
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
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!
Approach

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

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

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

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
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
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*Challenging – but not intractable
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:
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
• Selections can be refined in other dimensions
• Here, the user filters by altitude:
Selection/Filtering

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

\[ S = \oplus S \downarrow i \setminus \bigcup R \downarrow i \]

• 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
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
Examination

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

Fig. 6 (page 6)
Examination

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

- Different windows are also linked
Comparison

• Windows can be combined for more direct comparison
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)
Use-Case: Infographics

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

Fig. 11 (page 9)
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)
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)
Thanks!
Questions?