**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 analyze
- This tool helps us examine these patterns, and how they change
- Takes a novel approach, using animation as a key visual channel

### Data

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

### 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
- Animation shows direction

### Alternatives

- **Animated textures**
- Doesn't work for thin trajectories
- Color maps
  - Low resolution, can't overlap
  - Arrows: height, 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

*Challenging – but not intractable*
Selection/Filtering

- Different modes of selection can be combined
- Compound selections use set-like logic:
  \[ S = \bigoplus S_{\downarrow i} \setminus \bigcup R_{\downarrow i} \]

- Where \( \bigoplus \) can be either \( \bigcup \) or \( \bigcap \) (union or intersection), and \( \setminus \) is set subtraction
- Extremely powerful
- User can add, intersect, and subtract (inverses) selections

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

Comparison

- Different windows are also linked
- 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

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

Use-Case: Air Traffic

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

Thanks!

Questions?