iVisDesigner: Expressive Interactive Design of Information Visualizations

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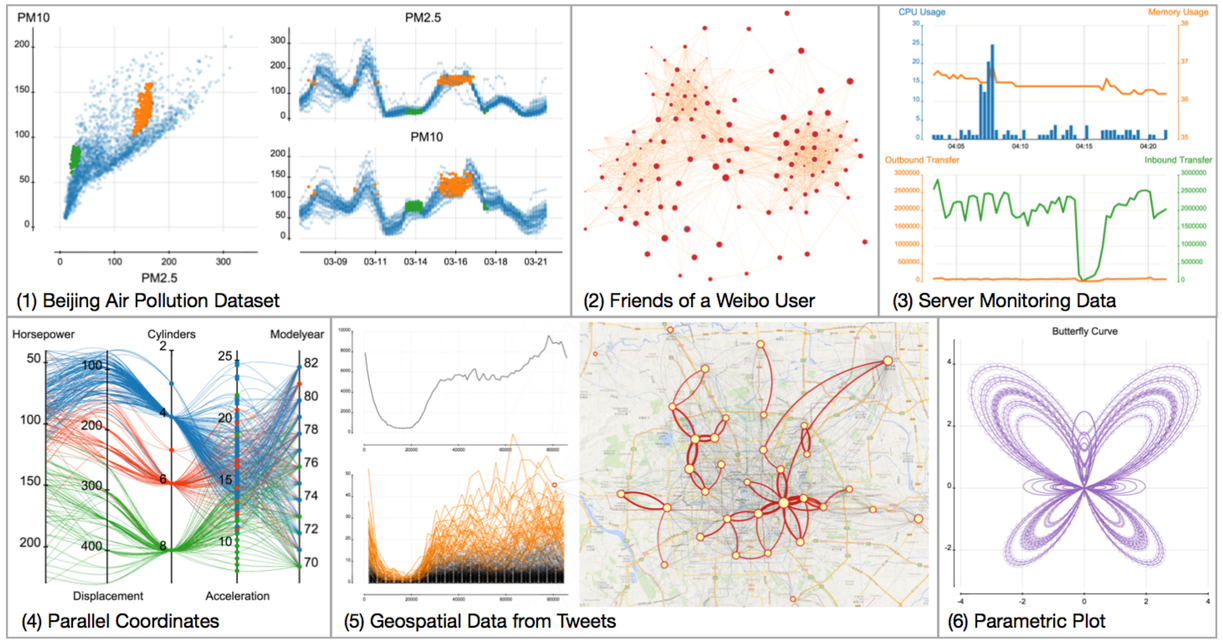
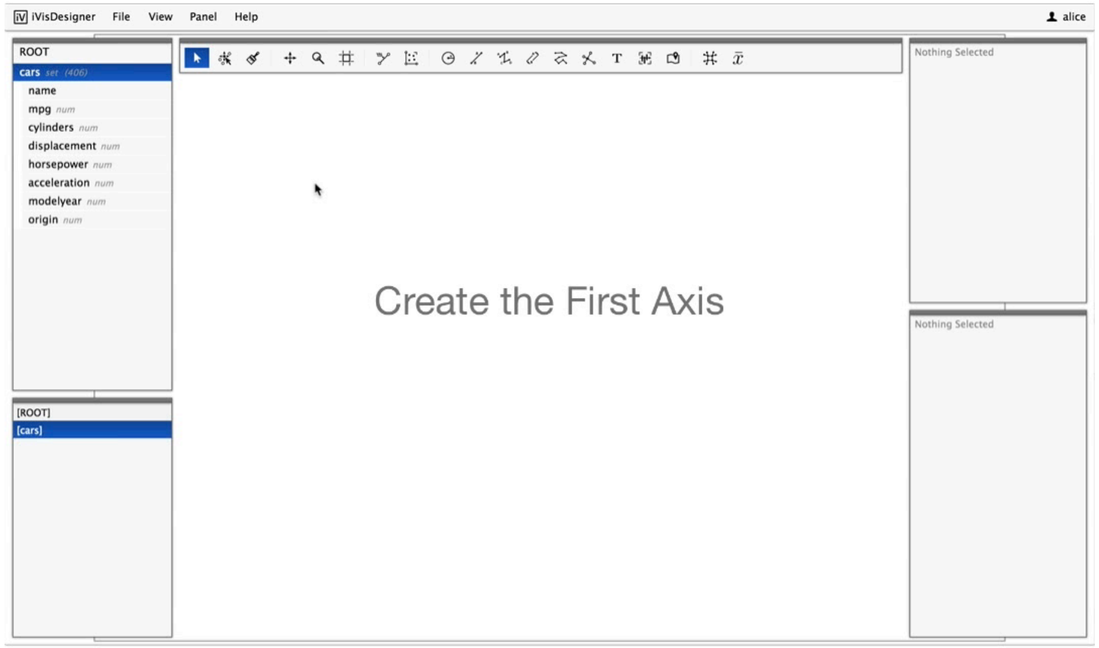
VisPKU

Motivation

- Design Information Visualizations without the need for Textual Programming or Templates.
- Incorporate Data into Vector Graphics Design Paradigm.





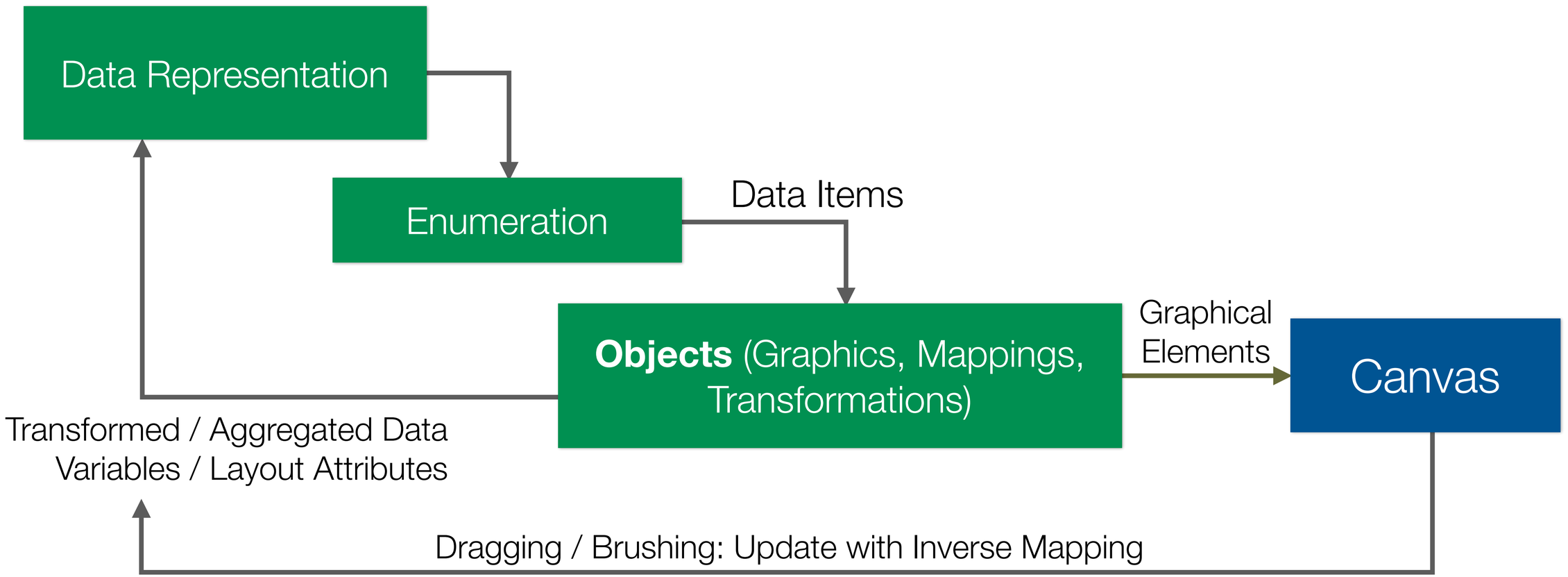
Live Demo

… Live Demo …

Related Work

- **Data Flow Systems**
  - Iris Explorer, AVS, VisTrails.
- **Programming Frameworks and Declarative Languages**
  - Prefuse, ProtoVis, D3.js, Vega.
- **Interactive Design Tools**
  - Tableau.
  - SketchStory.
  - Flexible Linked Axes.
  - Lyra.

System Design: Framework



System Design: Data Representation

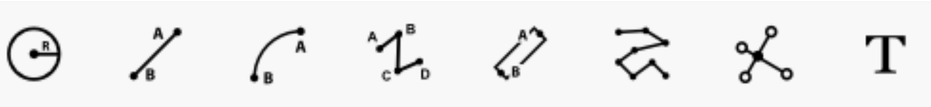
- **JSON-style Dataset:**
  - Object := { key: Value, key: Value, … }
  - Value := Primitive | Object | **Reference** | Array of Objects
  - **Fixed Schema**
- **Examples:**
  - Tabular datasets.
  - Nested Lists.
  - Graphs: edges as references to nodes.

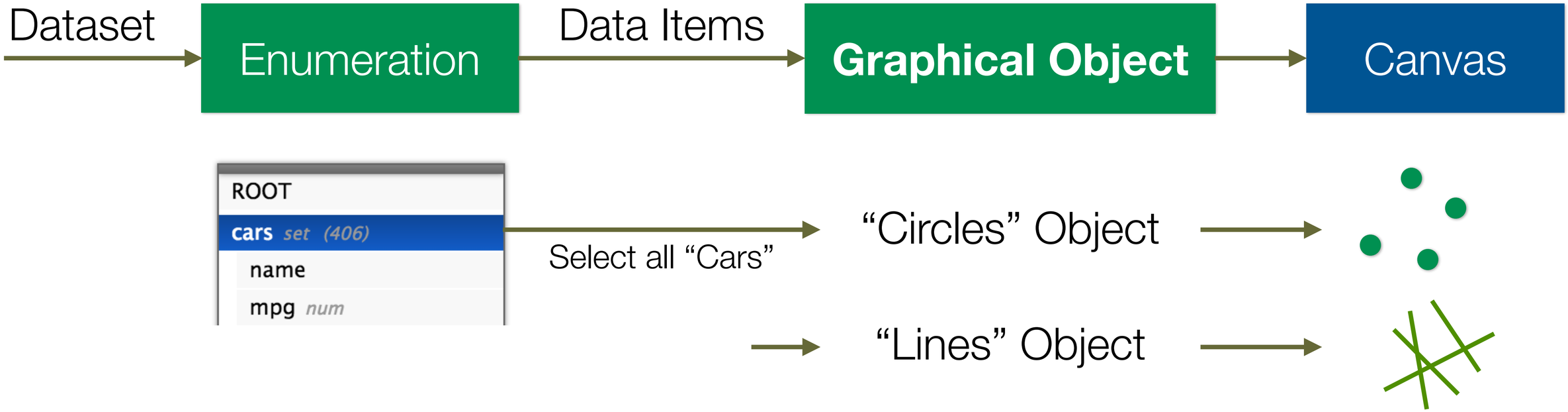
System Design: Visualization Representation

- **Object-oriented Framework.**
- Object Classes:
  - **Graphical Objects**: Map data items to graphical elements.
    - Circles, Lines, Arcs, Polylines, etc.
  - **Guide Objects**: Provide Information for Graphical Objects.
    - Axes, Scatters, Maps, Linear Mapping, etc.
  - **Generator Objects**: Attach derived data back to the dataset.
    - Statistics, Range, Expression, Brushing, ForceLayout, etc.
  - **Components**: Nest objects inside (for example, glyphs).

System Design: Graphical Objects

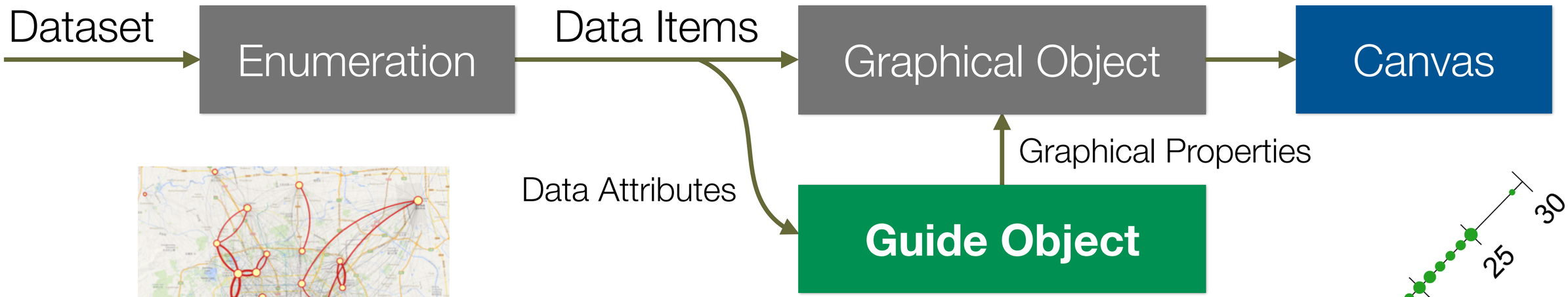
- Object Classes:
  - **Graphical Objects**: Map data items to graphical elements.
    - Circles, Lines, Arcs, Polylines, etc.

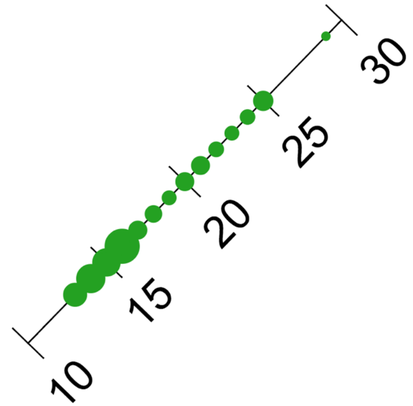




System Design: Guide Objects

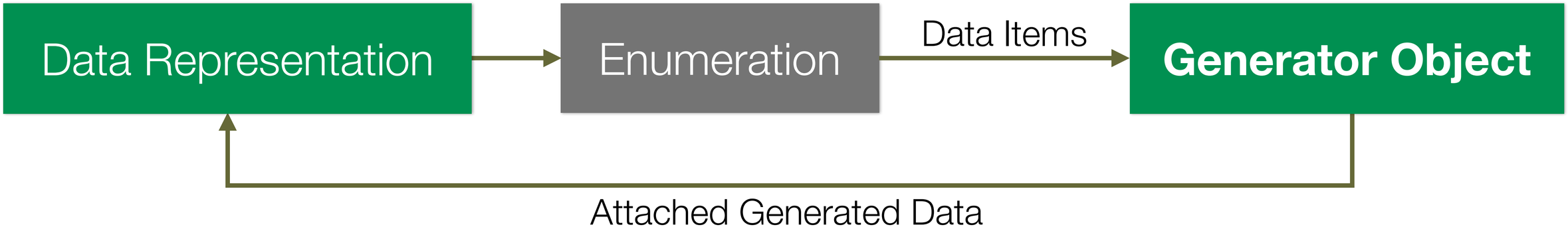
- Object Classes:
  - **Guide Objects**: Provide Information for Graphical Objects.
    - Axes, Scatters, Maps, Linear Mapping, etc.





System Design: Generator Objects

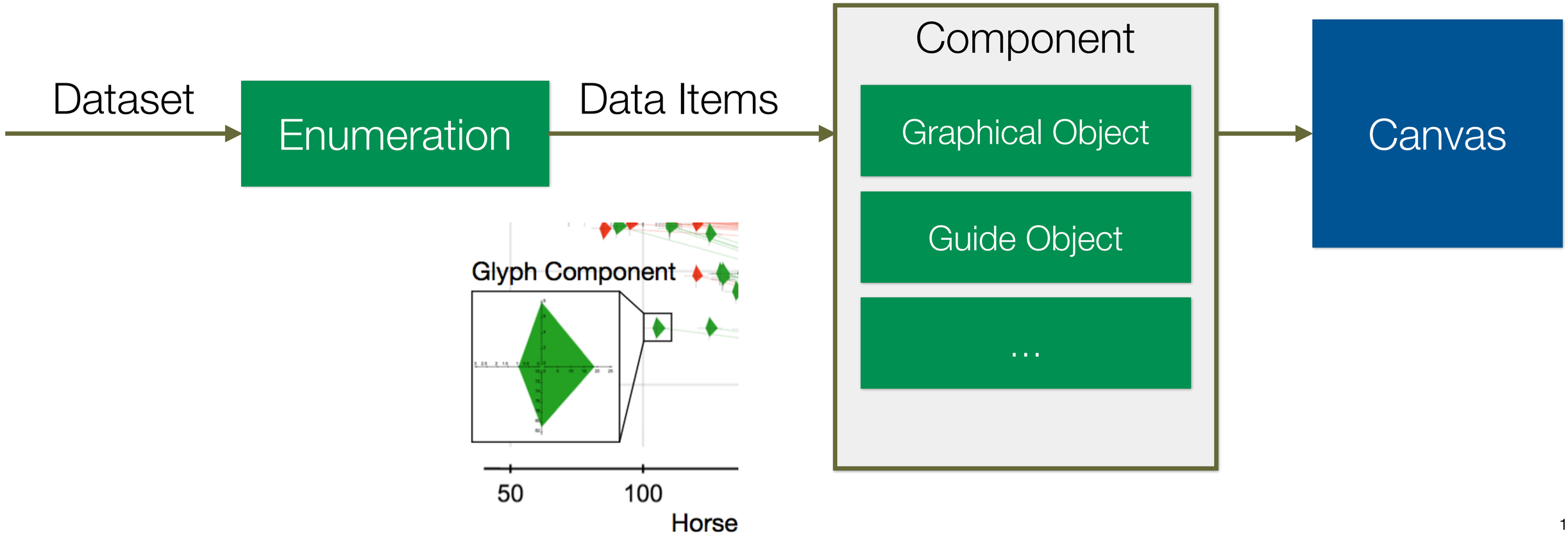
- Object Classes:
  - **Generator Objects**: Attach derived data back to the dataset.
    - Statistics, Range, Expression, Brushing, ForceLayout, etc.



Example: Cars → PCA → Coordinates for Each Car

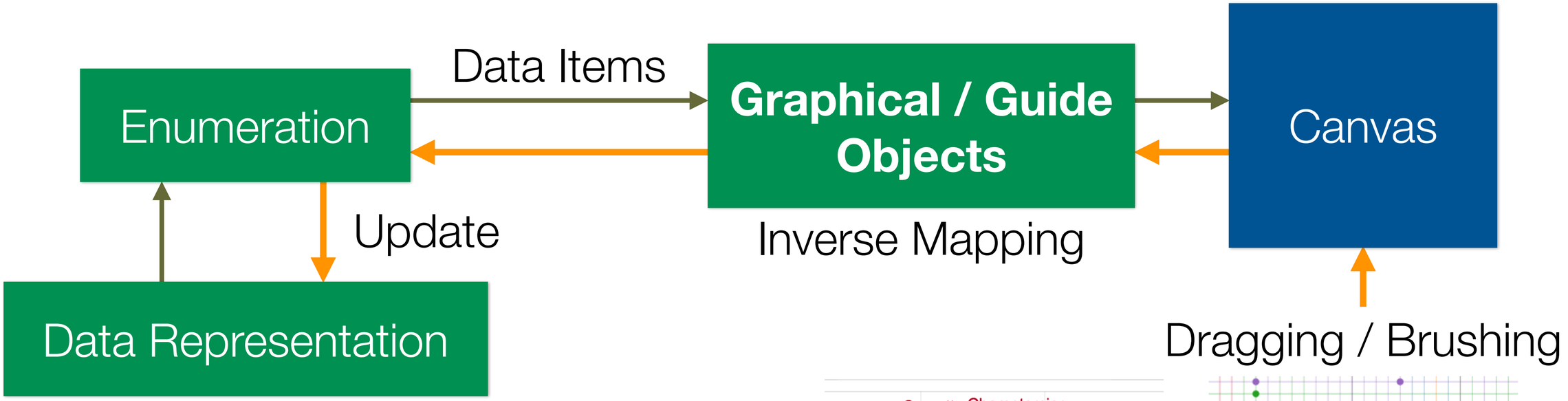
System Design: Components

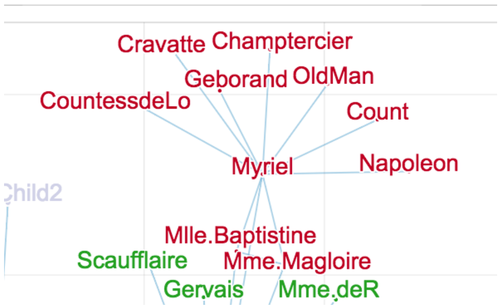
- Object Classes:
  - **Components**: Nest Objects Inside.

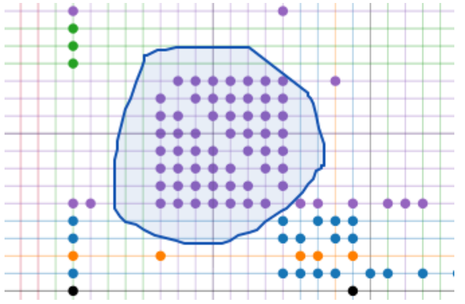


System Design: End-User Interactions

- Designing (Provisioning) for End-User Interactions:
  - **Dragging** and **Brushing**

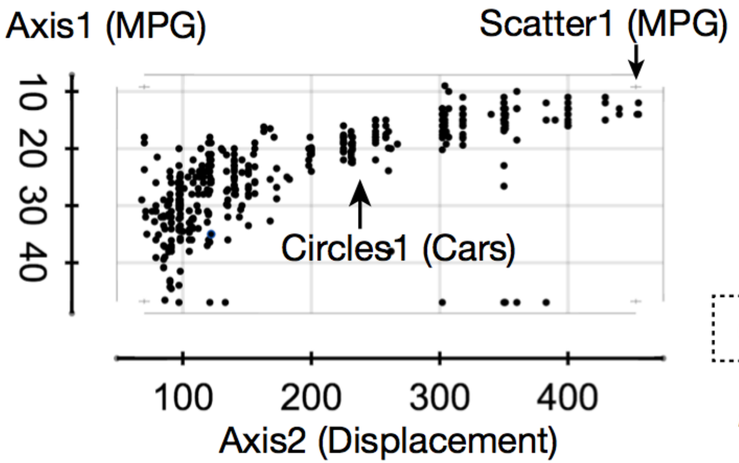


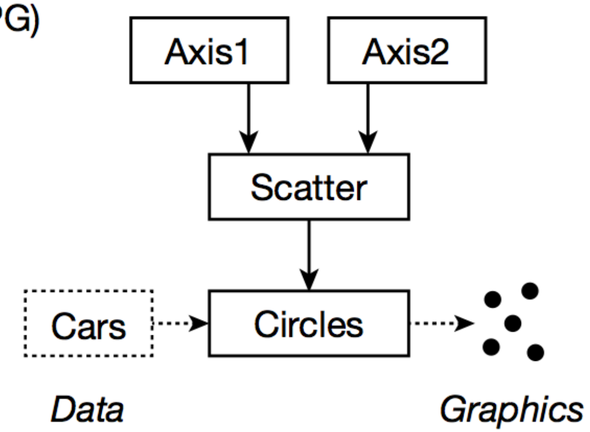




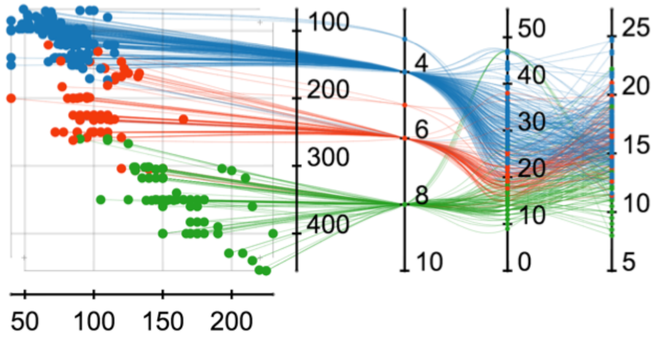
System Design: Example

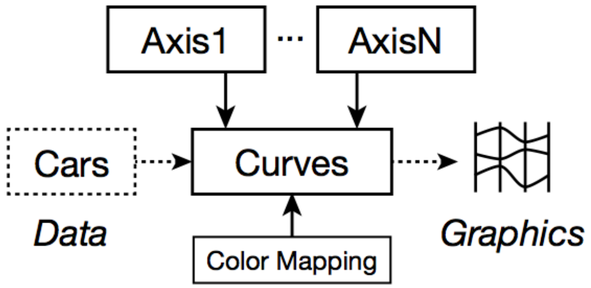
(1) Basic Scatterplot





(2) Scatterplot with Parallel Coordinates



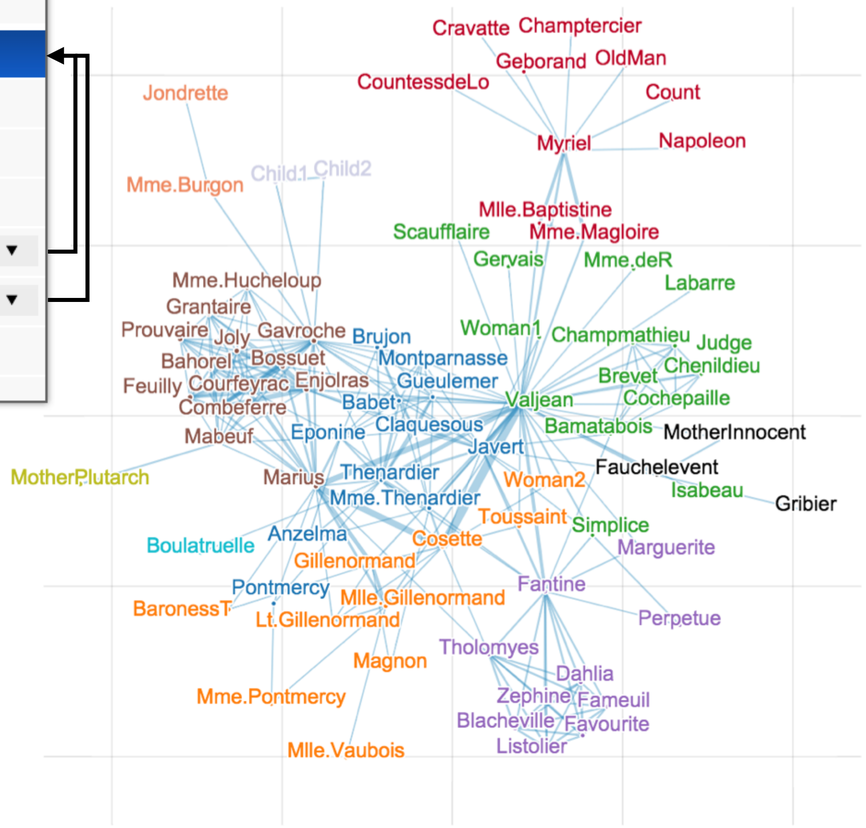


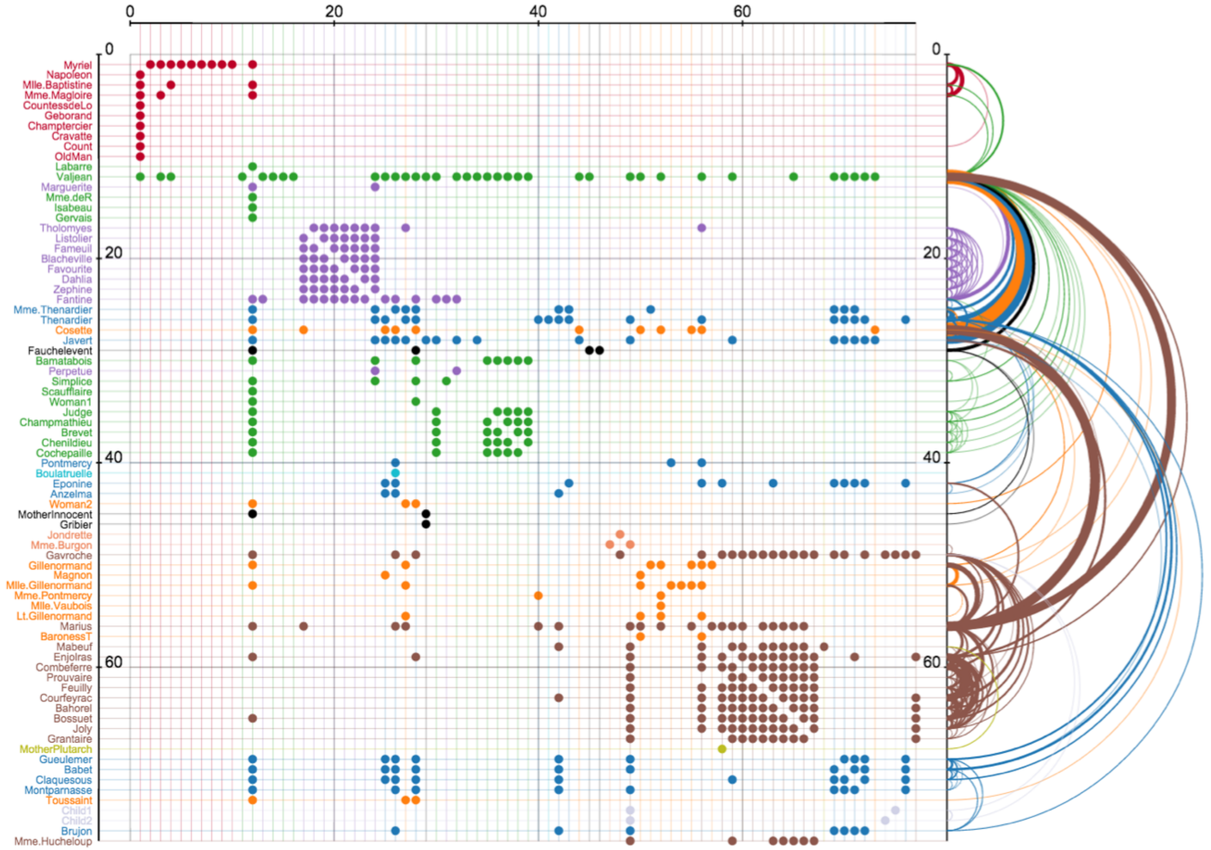
- Scatterplot Anatomy:
  - **Axis**: Define 1D positions.
  - **Scatter**: Define 2D positions using two axes.
  - **Circles**: Draw a circle for each element on the data selection, using the location provided by the Scatter object.

Design Examples: Graph Data

- Data: Character Co-occurrence Graph in *Les Misérables*.

ROOT
- nodes *set (77)*
  - name
  - group *num*
- links *set (254)*
  - -ref- source
  - -ref- target
  - value *num*





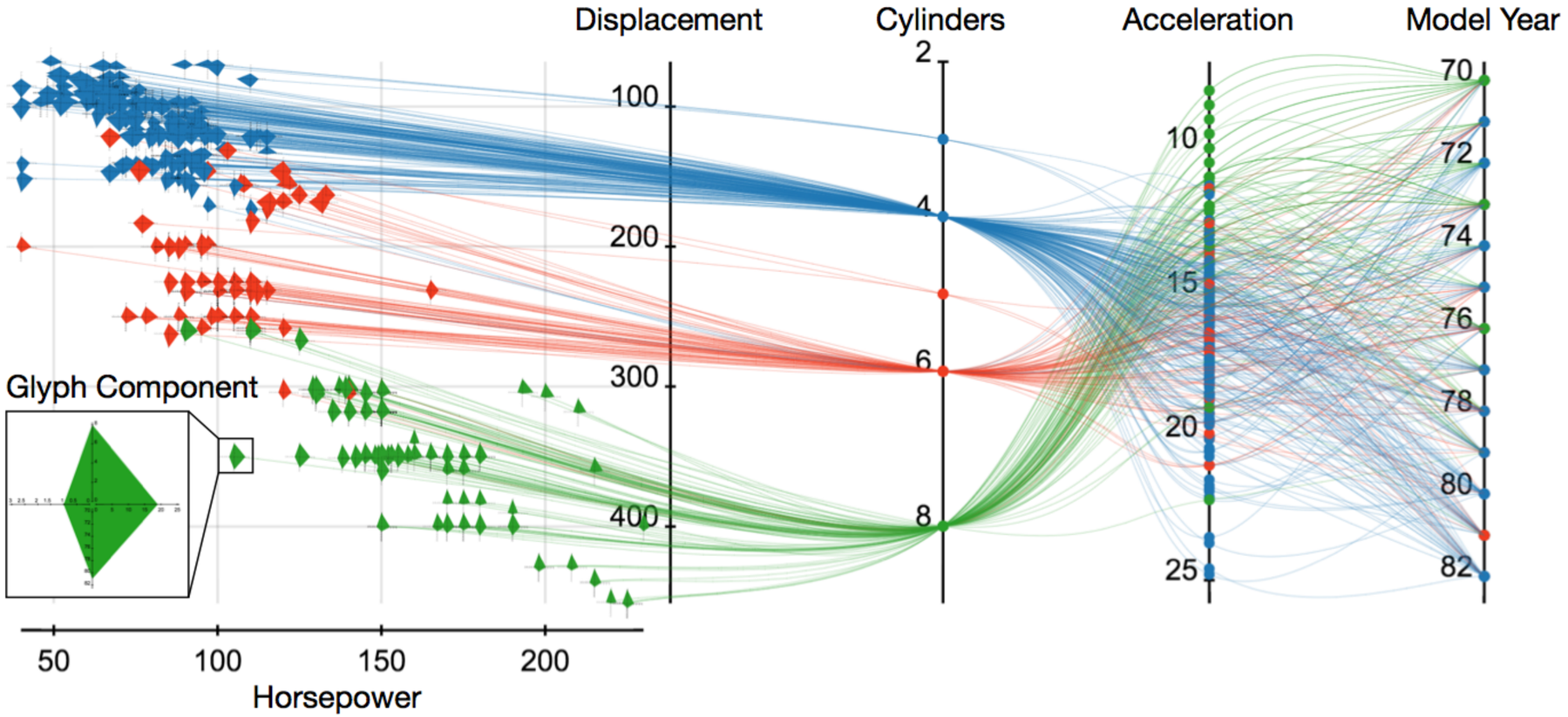
Node Link

Adjacency Matrix

Arc Diagram

Design Examples: Scatterplot with Glyphs

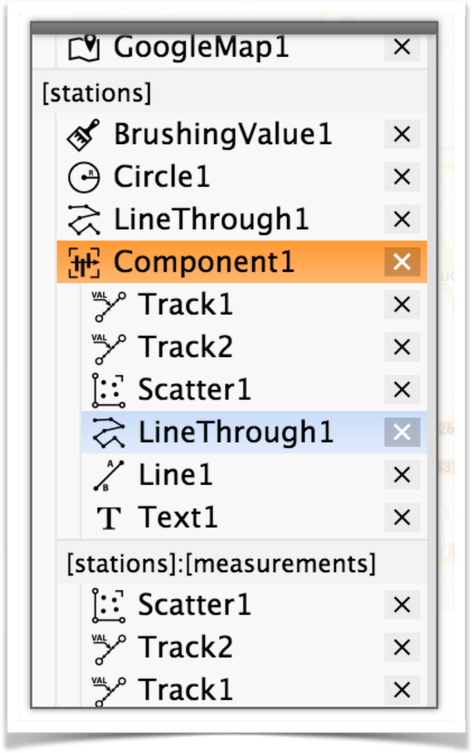
- SPPC with Star Glyph for Cars Dataset.



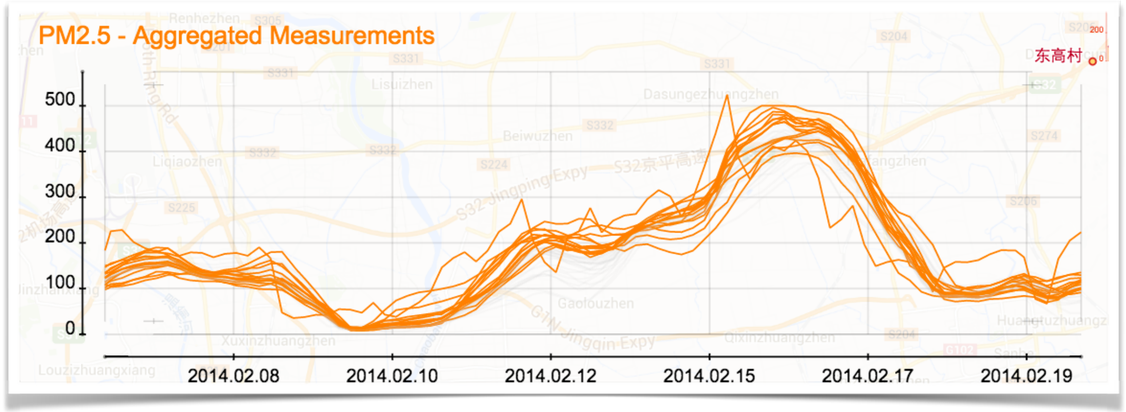
Component Object: Design Glyphs (Sub-Visualizations).

Design Examples: Map with Timelines

- Beijing Air Pollution Dataset (PM2.5).
- Component: Timeline Glyph for Each Station.

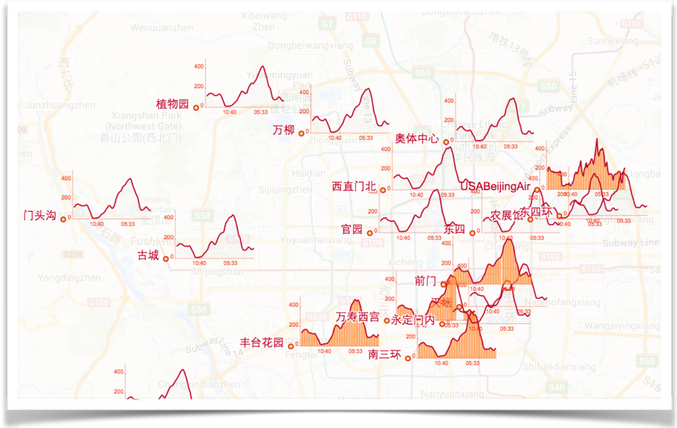


Nested Objects



Aggregated Plot (All Timelines Together)

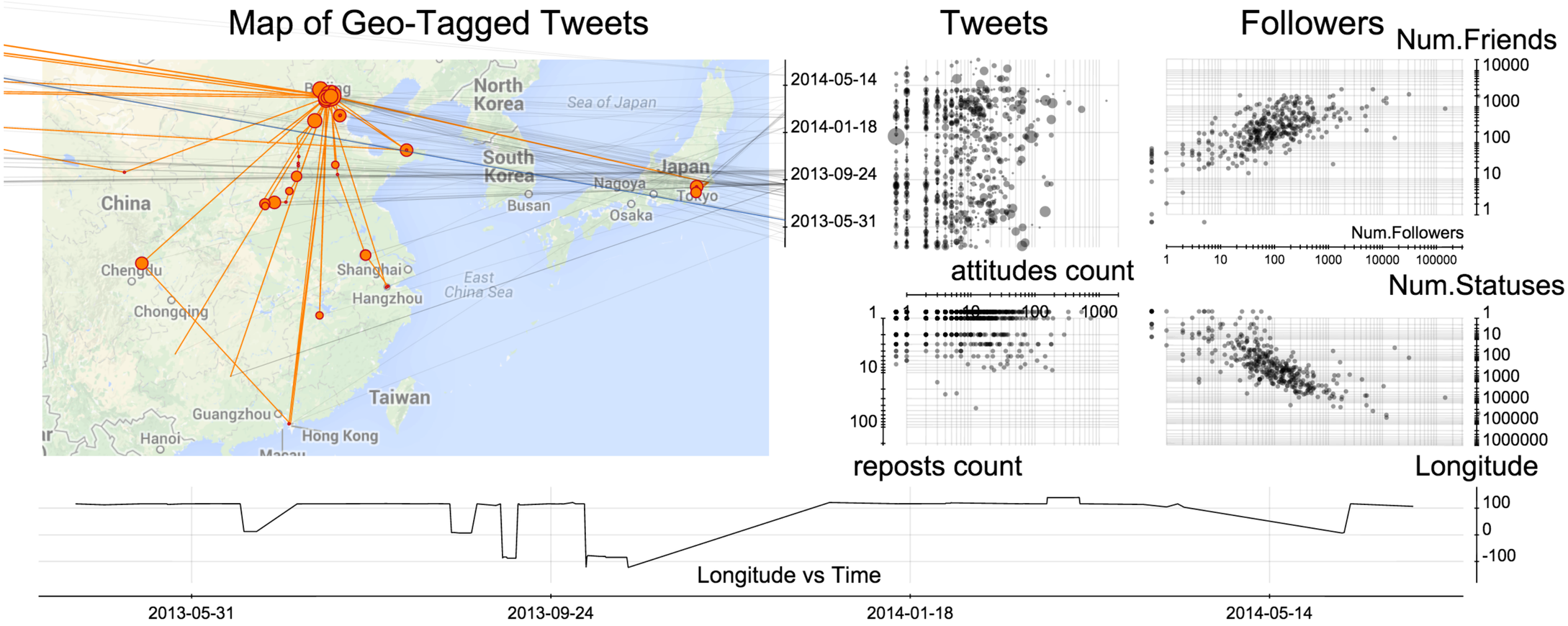
Individual Timeline Plot



Timeline Plots on a Map

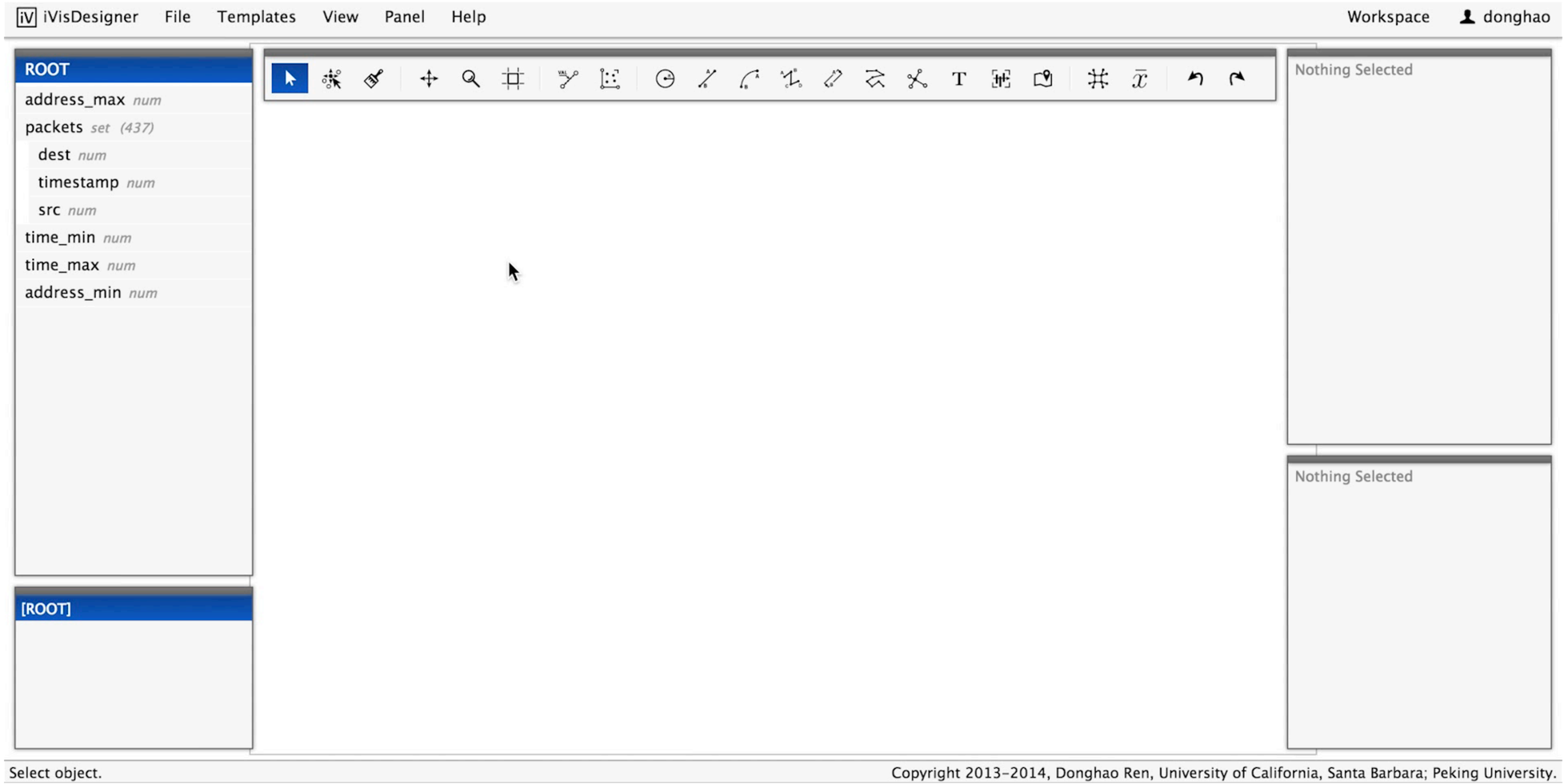
Design Examples: Microblog Data

- Weibo User Data: Friends, Followers, Tweets.
- Design: Map + Scatterplots, with links.

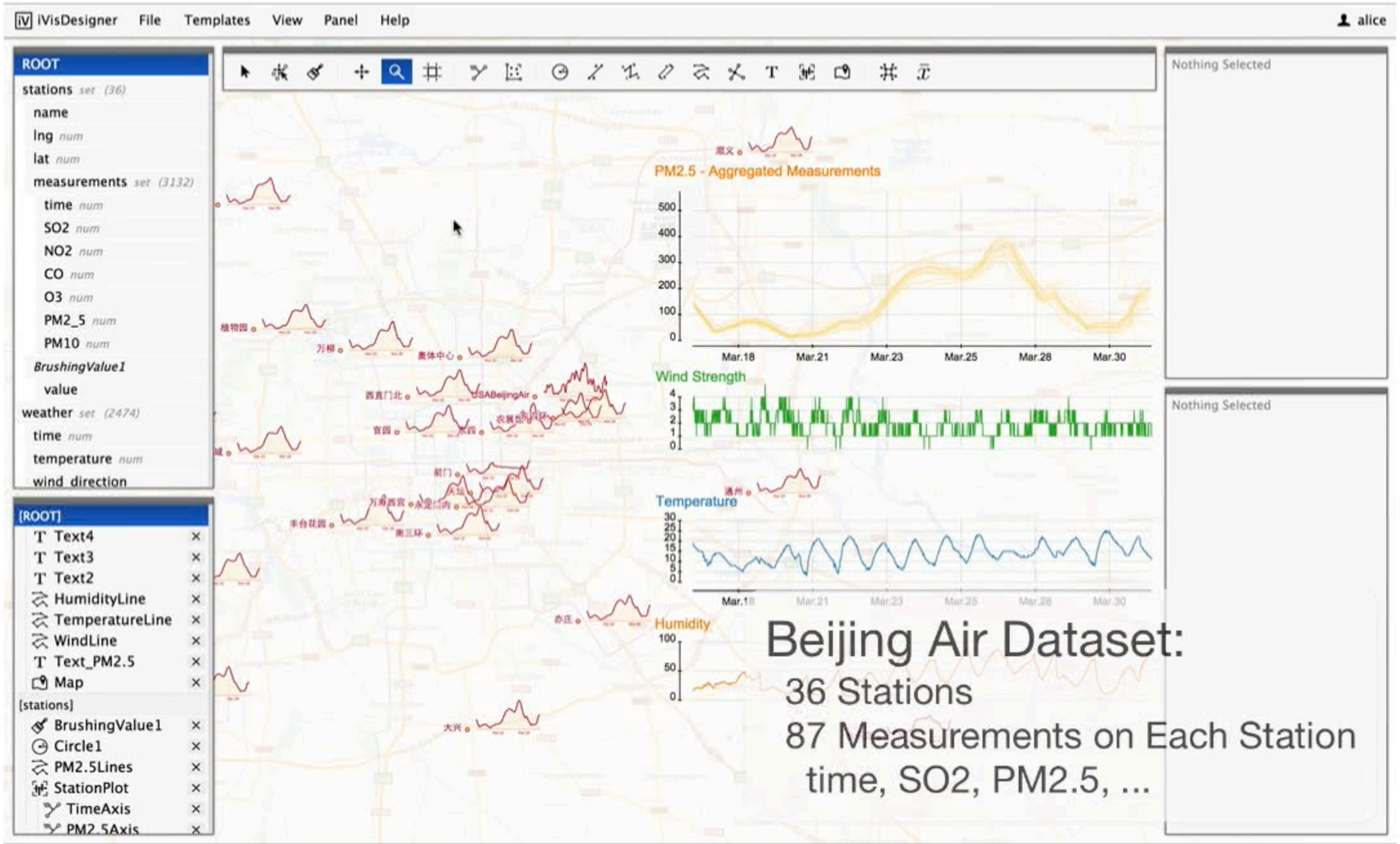


Design Examples: Dynamic Datasets

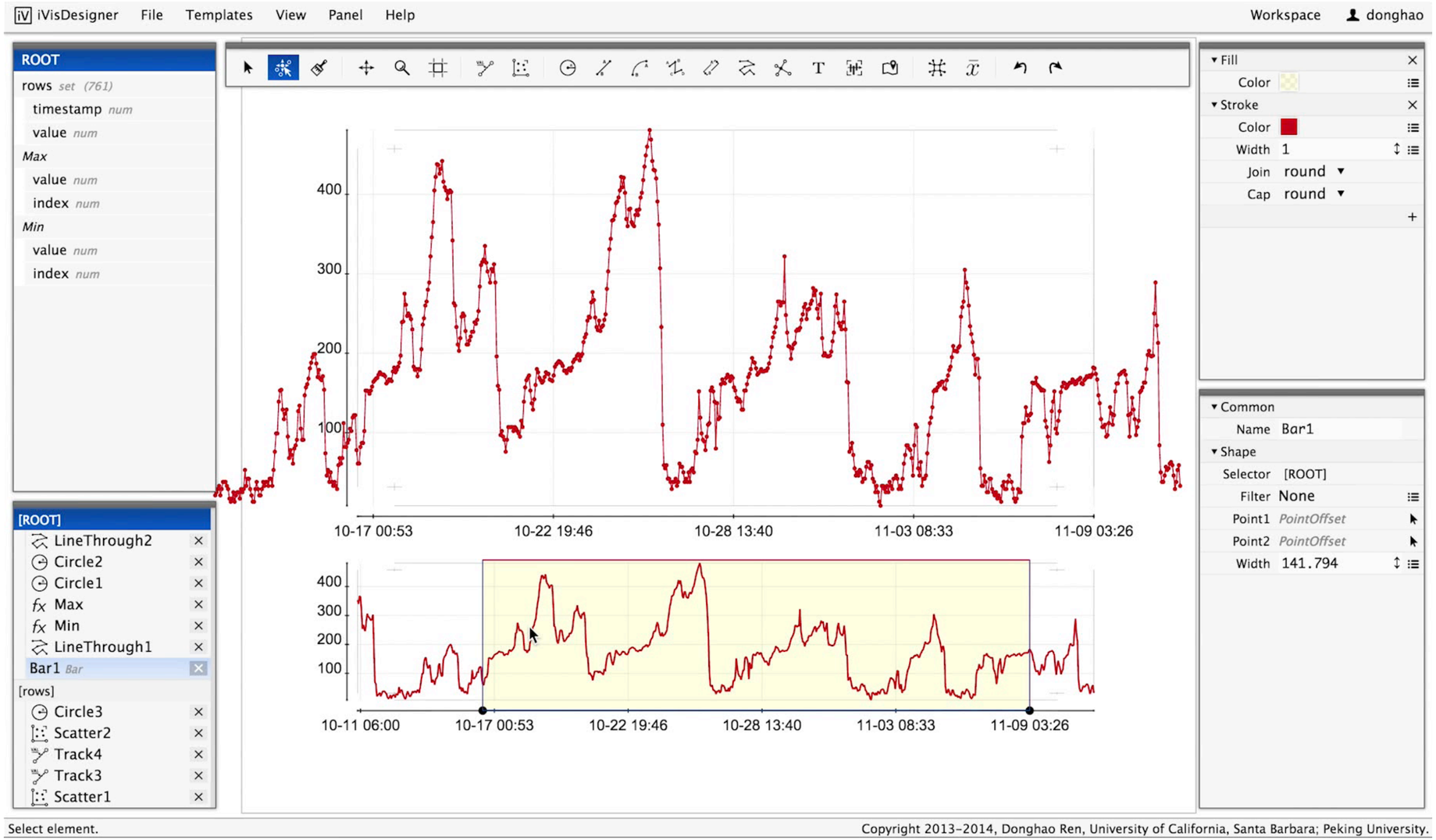
- Packet Flow Streaming Dataset



Design Examples: End-User Interaction / Brushing and Dragging



Design Examples: End-User Interaction / Level of Detail



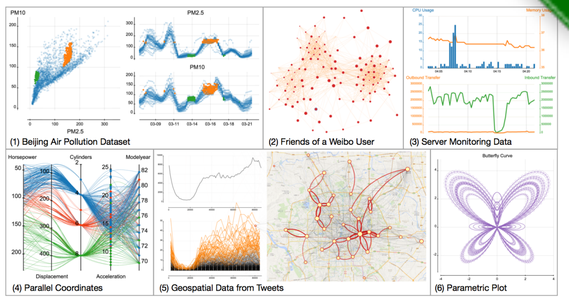
Performance and User Feedback

- **Rendering Performance**
  - Handle ~2000 data items at an interactive rate in a web browser.
  - Further optimizations are possible.
- **Feedback from User Survey**
  - **High scores on:**
    - Expressive, flexible and useful, and good for designing visualizations for different types of data.
  - **Lower scores on:**
    - Easy to use, easy to understand.

Discussion & Conclusion

- **Goals:**
  - Interactively Design Information Visualizations.
  - Provision for End-User Interactions.
- **Approach:**
  - Data-driven Vector Graphics Editing Paradigm.
  - Represent designs with Graphical, Guide, Generator and Component objects.

Discussion & Conclusion



- **Pros:**
  - Expressive: Able to construct a variety of different designs.
  - Extensible: Templates / New Objects.
  - Web-based: Easily embed designs into websites or web applications.
- **Open Source:**
  - https://github.com/donghaoren/iVisDesigner
- **Still Improving:**
  - Send your feedbacks!
  - Refer to https://donghaoren.org/ivisdesigner/ for future updates.

Future Work

- **More object types, and support for:**
  - Scale Indicators.
  - Coordinate Spaces (Cartesian, Polar, etc).
  - Recursive Layouts (TreeMaps, etc).
- **Usability Improvements:**
  - Hints & Error Reporting.
  - Additional Higher-level Templates.
  - Automatic Design Recommendations.
- **Ongoing Work:**
  - Integration into an immersive Situation Room (UCSB Allosphere).

iVisDesigner in the Allosphere

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Questions?

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