Use Vega with trame to create interactive plots from selected VTK data

Course: COSC 6344 - Visualization
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Team Members

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1. Project Overview

Understanding population trends across geographic regions and over time is critical for demographic studies, policy making, and regional planning. However, static maps or plots often fail to capture the spatio-temporal relationships and variations in the data.

Our goal is to create an interactive visualization system that integrates VTK (for data processing and rendering), Trame (for web-based interactive applications), and Vega (for declarative data visualization) to allow users to explore derived data attributes interactively.

To demonstrate this pipeline, we will use the Virginia Population dataset (virginia_population.csv) along with a VTK data file constructed from public Shapefile. This allows users to explore Virginia's county-level population data (2010 - 2019) dynamically.

We will use VTK for geometric data representation and processing, Trame for building an interactive web-based interface, and Vega for declarative 2D data visualizations (e.g., scatter plots, bar charts, and trend lines).

The resulting system will enable users to:

- Visually explore population growth or decline by county and over time.
- Select or highlight specific counties to view temporal population trends.
- Link between geographic and attribute-based visualizations.

2. Tentative Plan

2.1. Language & Tools:

- Python
- VTK (data loading, processing, and geometry extraction)
- Trame (interactive web-based visualization framework)
- Vega / Vega-Lite (for declarative charting and interactive linked plots)

2.2. Data Sources:

- Virginia Population CSV: contains population values from 2010 to 2019 by county.
- Geometry Data: we will first attempt to find a VTK dataset for Virginia county boundaries. If not available, we will use Shapefile data from public sources and convert it into VTK PolyData.

2.3. Tentative Workflow:

- **Data Processing:**
    - Load and preprocess the Virginia population dataset

- Load or construct geometry for Virginia counties (VTK or Shapefile to VTK conversion)

- **Data Abstraction:**
  - Merge population attributes into VTK data structures
  - Prepare JSON format compatible with Vega specifications

- **Visualization (Trame + Vega):**
  - Visualize county-level population data in Trame with a choropleth-style map
  - Integrate Vega charts to show attribute relationships and temporal trends
  - Enable interactive brushing/selection that highlights corresponding elements

3. Tentative Timeline

Week	Plan	Expected Outcomes
Week 1	Finalize dataset and team roles. Set up environment (VTK + Trame + Vega). Perform initial data exploration.	Clean dataset, determine target attributes, initial data summary plots.
Week 2	Load geometry data into VTK and visualize static county map. Link population attributes to geometry.	VTK view showing Virginia counties with color-coded population.
Week 3	Integrate Vega into Trame interface. Add secondary plots like time-series of selected county.	Working Trame app with embedded Vega plot.
Week 4	Implement interactive linking and brushing between map and Vega plots. Add tooltips and highlight behavior.	Bi-directional selection between map and chart views.
Week 5	Refine design with color maps, legends, filters, etc.	Polished interactive visualization and evaluation results.
Week 6	Prepare final report, presentation slides, and live demo.	Completed system and final presentation.

4. Work distributions

Team member	Contribution
Anjani Kumar Avadhanam	Implement of Trame-Vega integration, develop visualization logic. Assist with data tranformation and interface design.
Jayachandra Sarika	Implement Trame layout, interactive linking and brushing between map and Vega plots. Assist with data mapping.
Minh Nguyen	Handle dataset preprocessing, geometry data preparation, and population data transformation into a format suitable for visualization. Assist with Trame-Vega integration.