

# Lesson 3: Interactivity in Visual Analytics

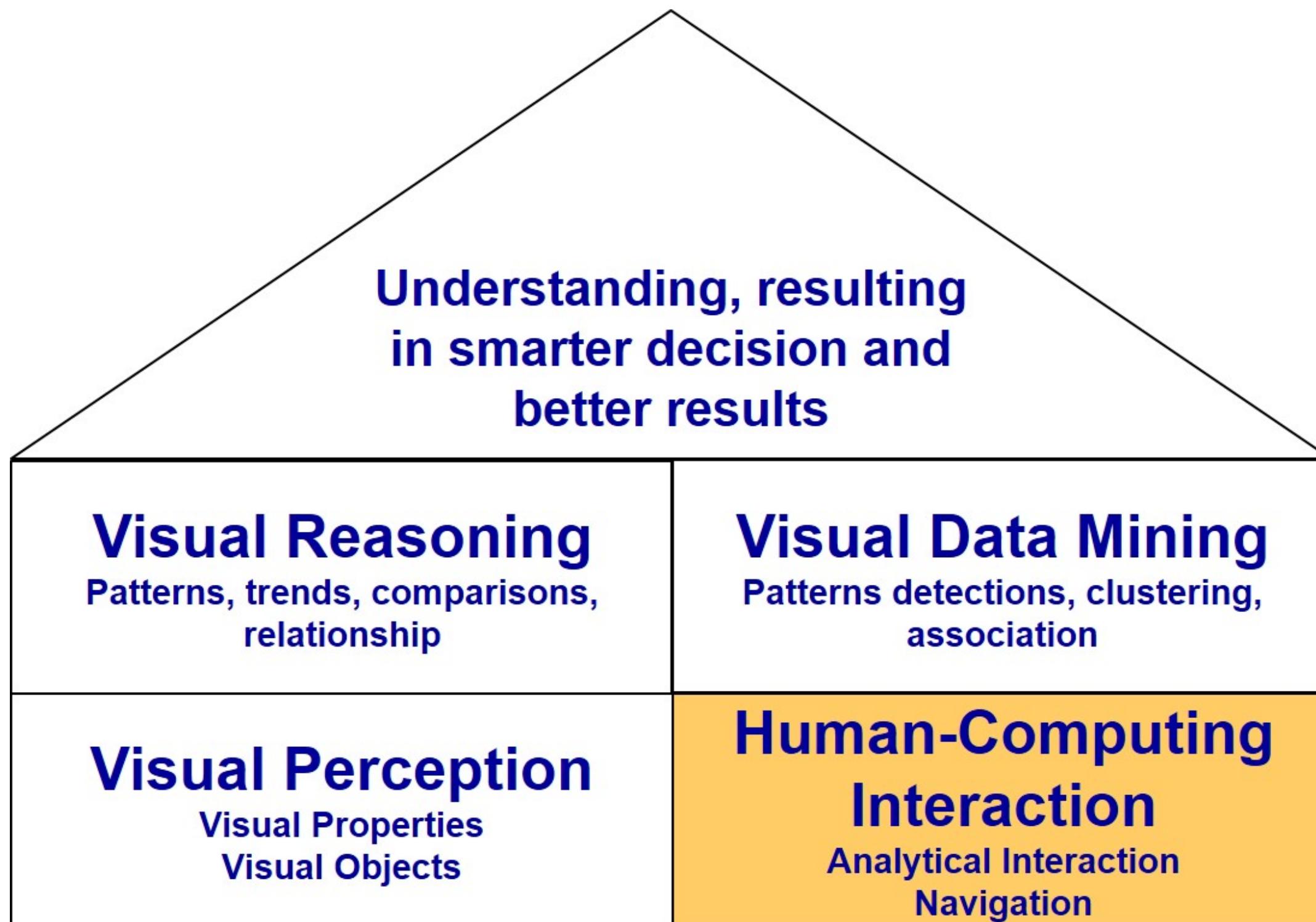
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23 Jan 2023

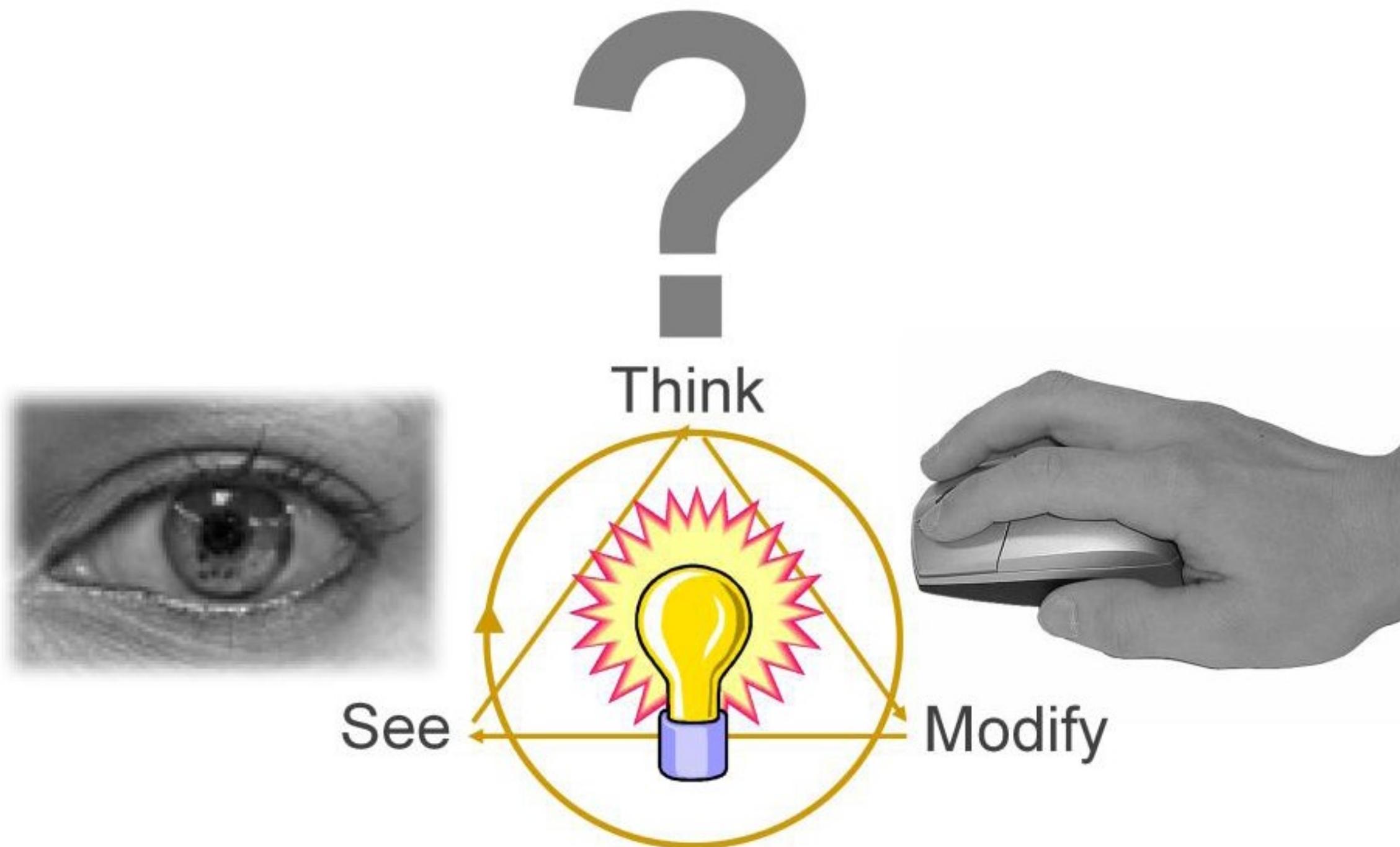
# What will you learn from this lesson?

- Typology of Interactive Techniques
  - Data & view specification
  - View Manipulation
  - Process and Provenance
- Interactive Design Primitive
- Animation: Principles and Best Practices

# Building Block of Visual Analytics



# Revisiting Visual Analytics Framework



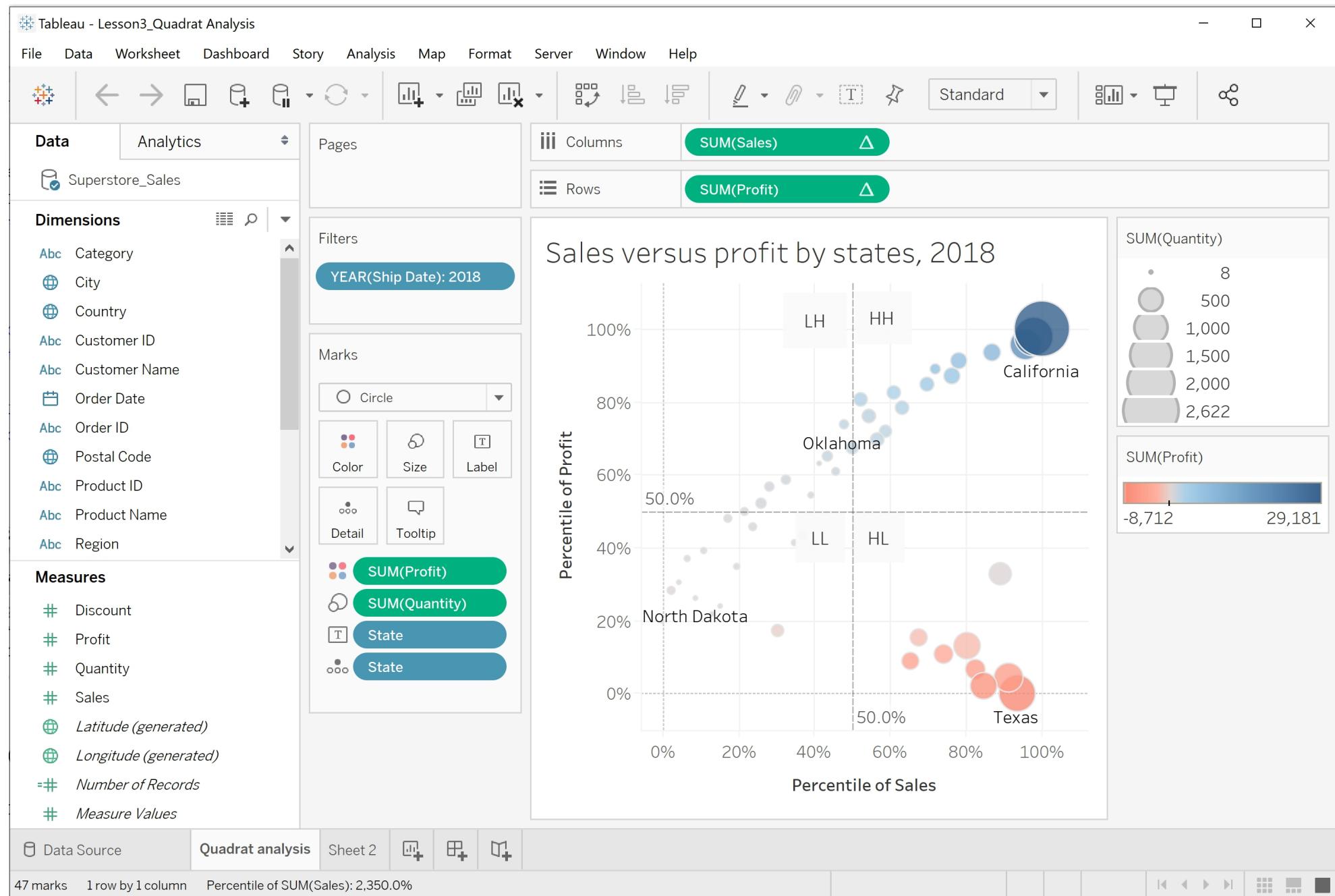
# Taxonomy of Interactive Dynamics

<b>Data and View Specification</b>	<b>Visualize</b> data by choosing visual encodings. <b>Filter</b> out data to focus on relevant items. <b>Sort</b> items to expose patterns. <b>Derive</b> values or models from source data.
<b>View Manipulation</b>	<b>Select</b> items to highlight, filter, or manipulate them. <b>Navigate</b> to examine high-level patterns and low-level detail. <b>Coordinate</b> views for linked, multidimensional exploration. <b>Organize</b> multiple windows and workspaces.
<b>Process and Provenance</b>	<b>Record</b> analysis histories for revisit, review, and sharing. <b>Annotate</b> patterns to document findings. <b>Share</b> views and annotations to enable collaboration. <b>Guide</b> users through analysis tasks or stories.

Source: Heer, J. & Shneiderman, B. (2012) “Interactive Dynamics for Visual Analytics” *ACM Queue*, Vol. 55, No. 4, pp 45-54.

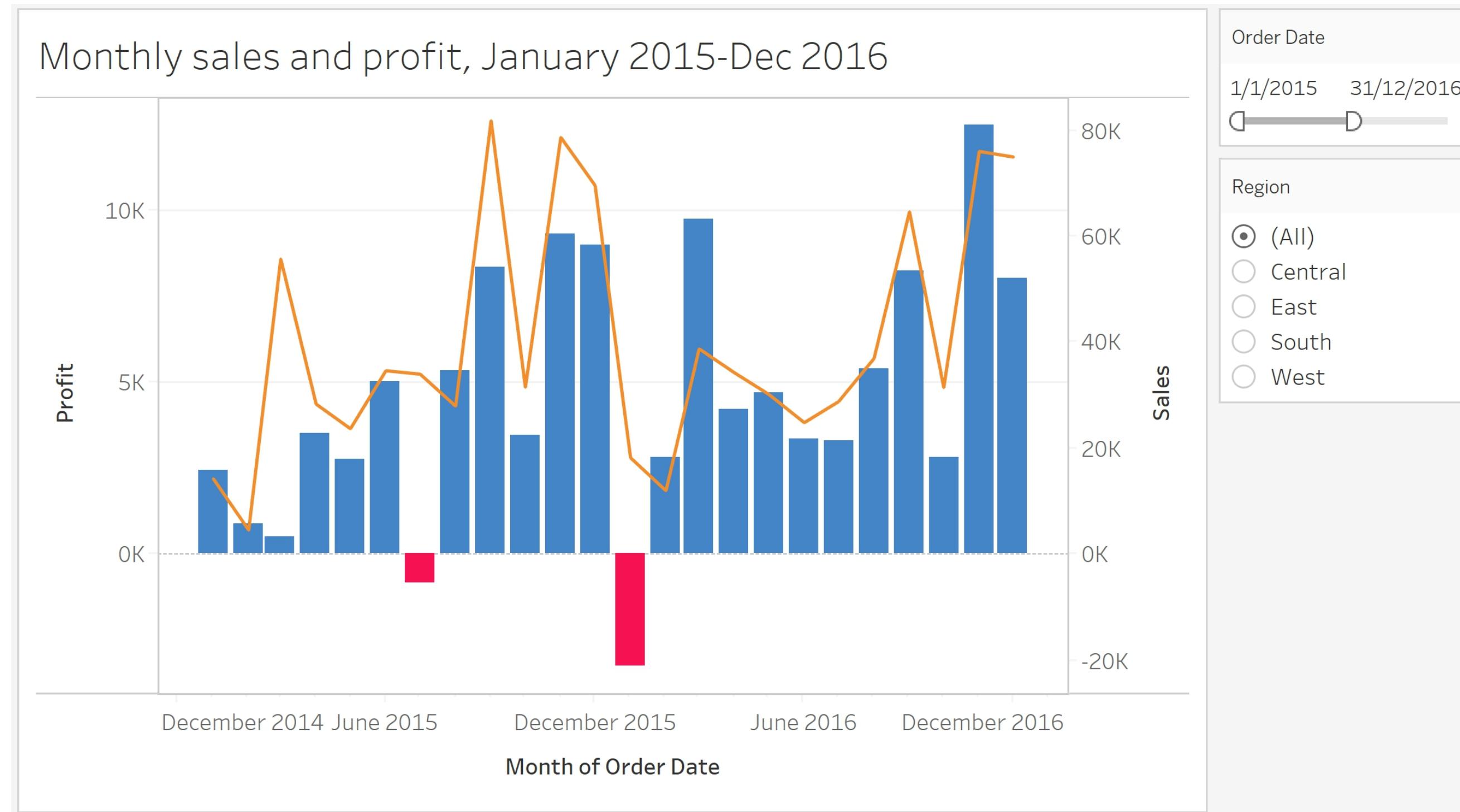
# Data & view specification

- Visualise data by choosing visual encodings.
- Polaris of Tableau



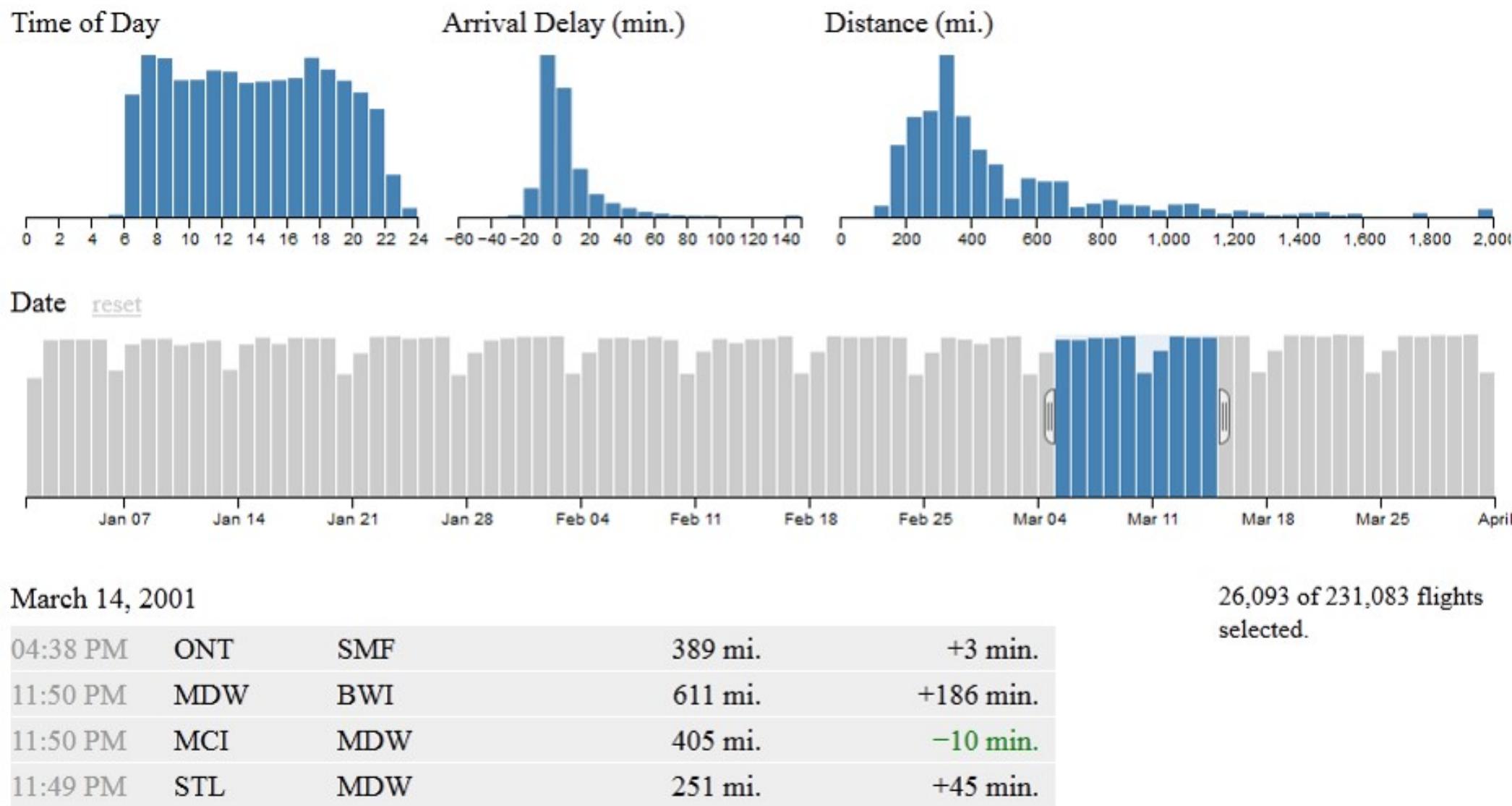
# Data & view specification

- Filter out data to focus on relevant items.



# Data & view specification

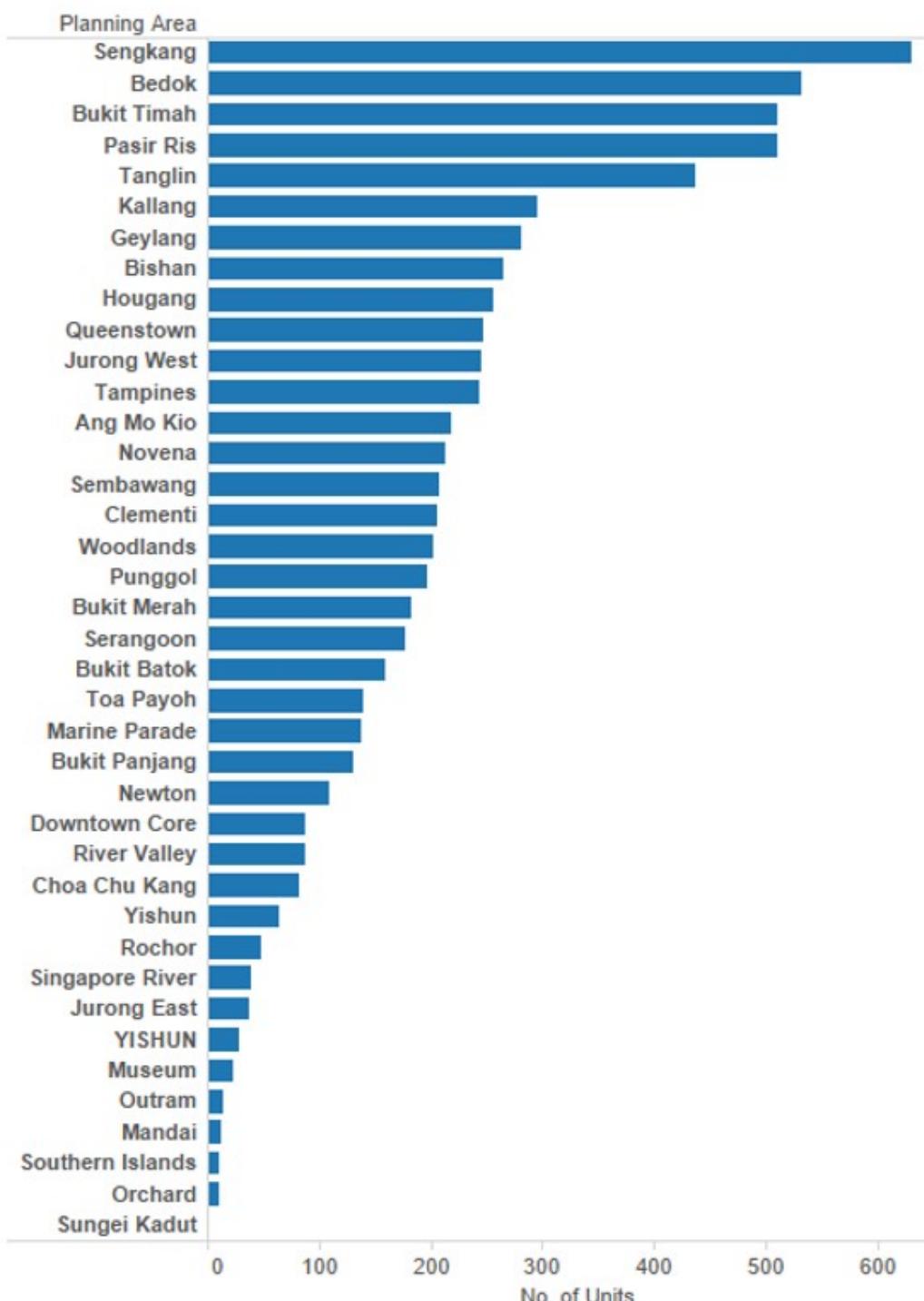
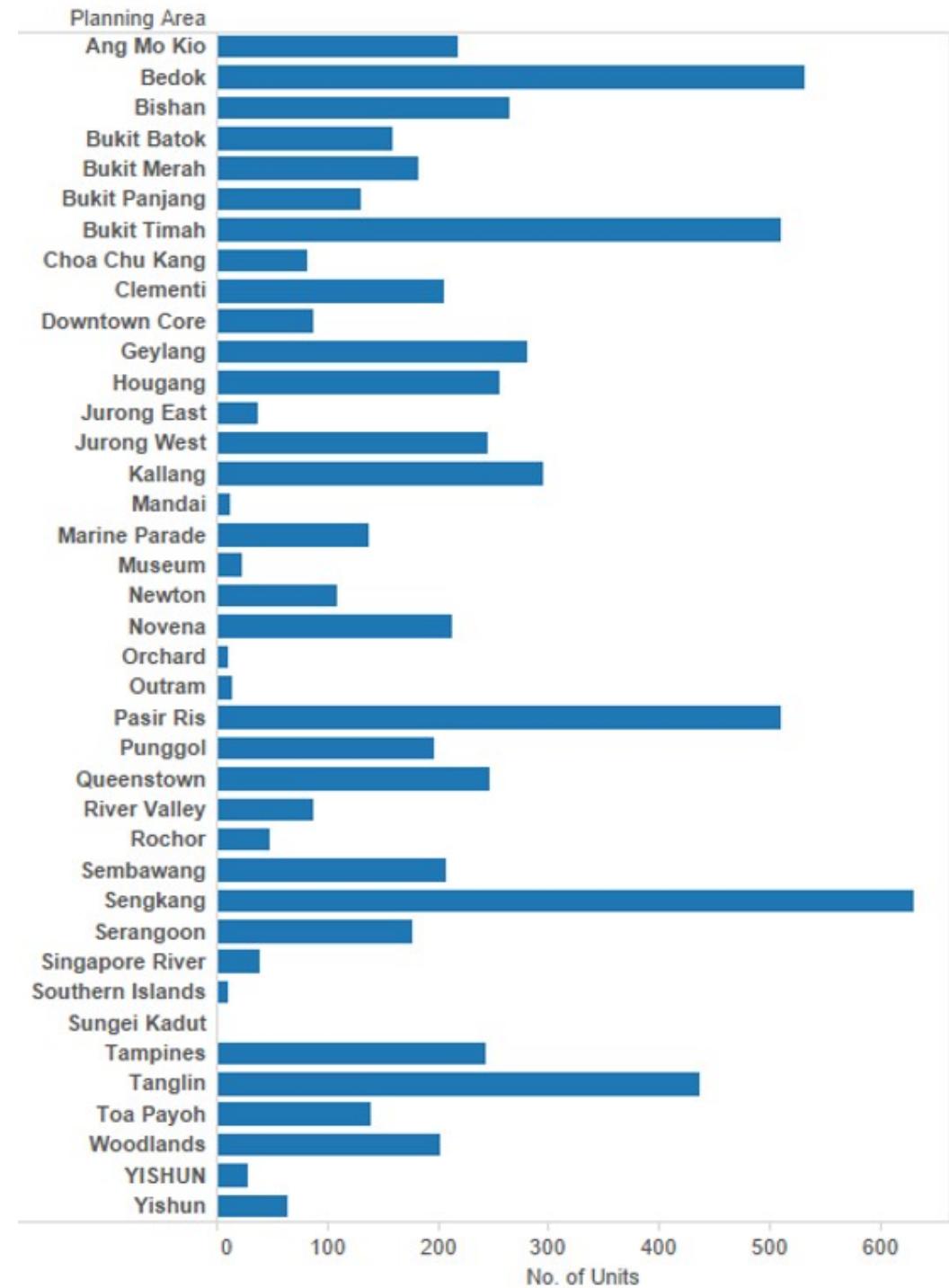
- **Slicer** is an axis-parallel selection tool, which selects a range along an axis, where the end-point of the interval can be modified dynamically.



Source: [crossfilter](#)

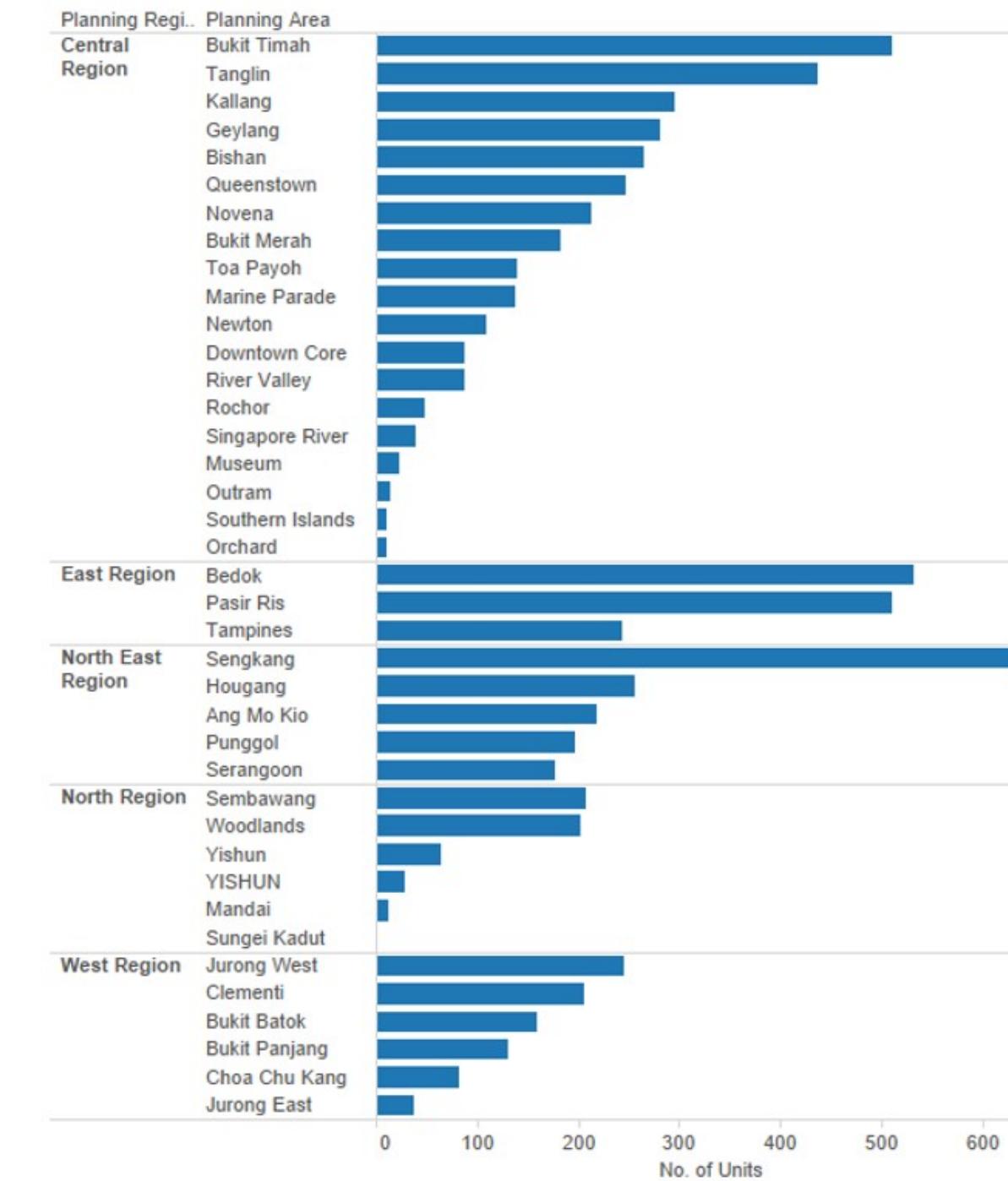
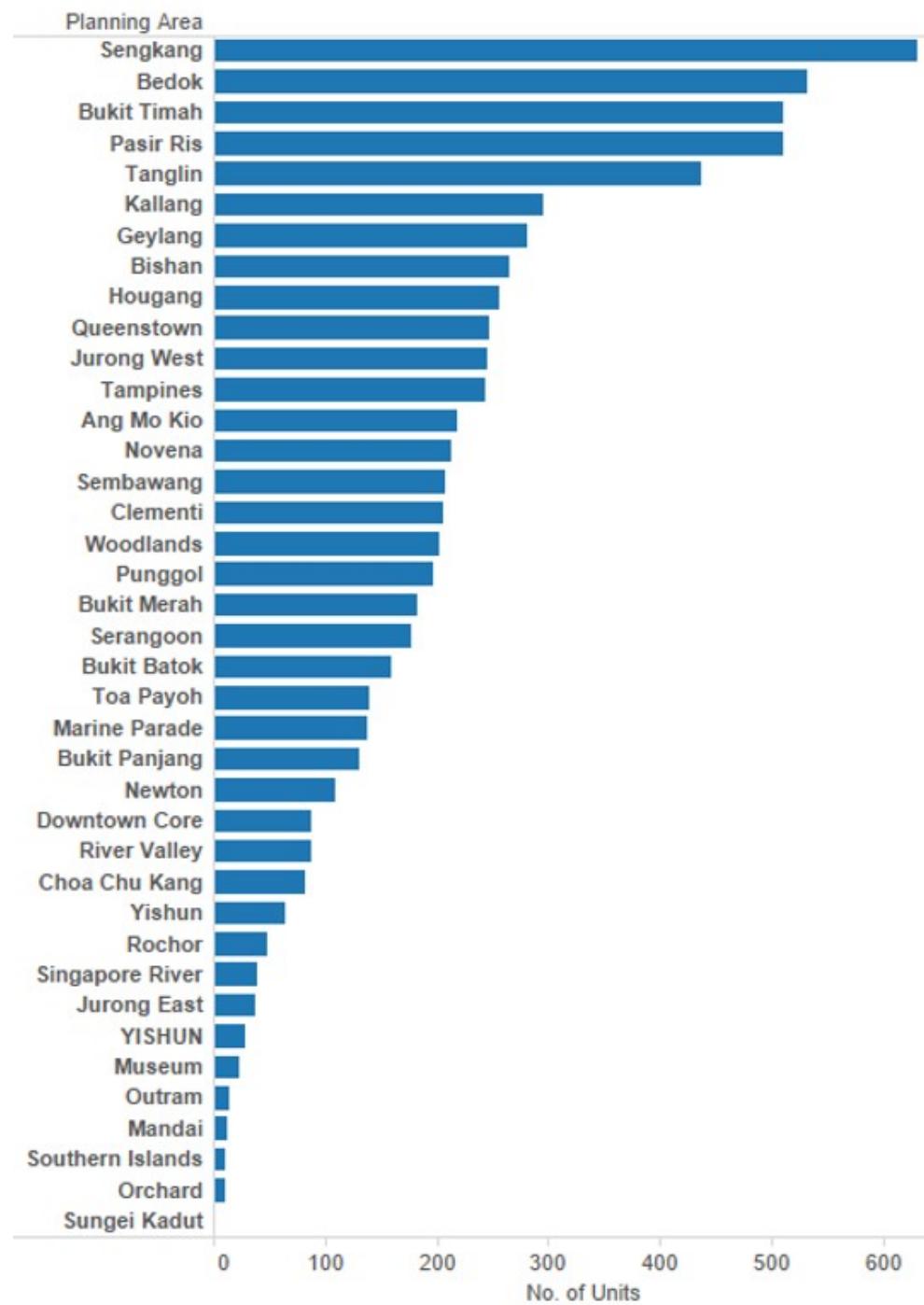
# Data & view specification

- Sort items to expose patterns.



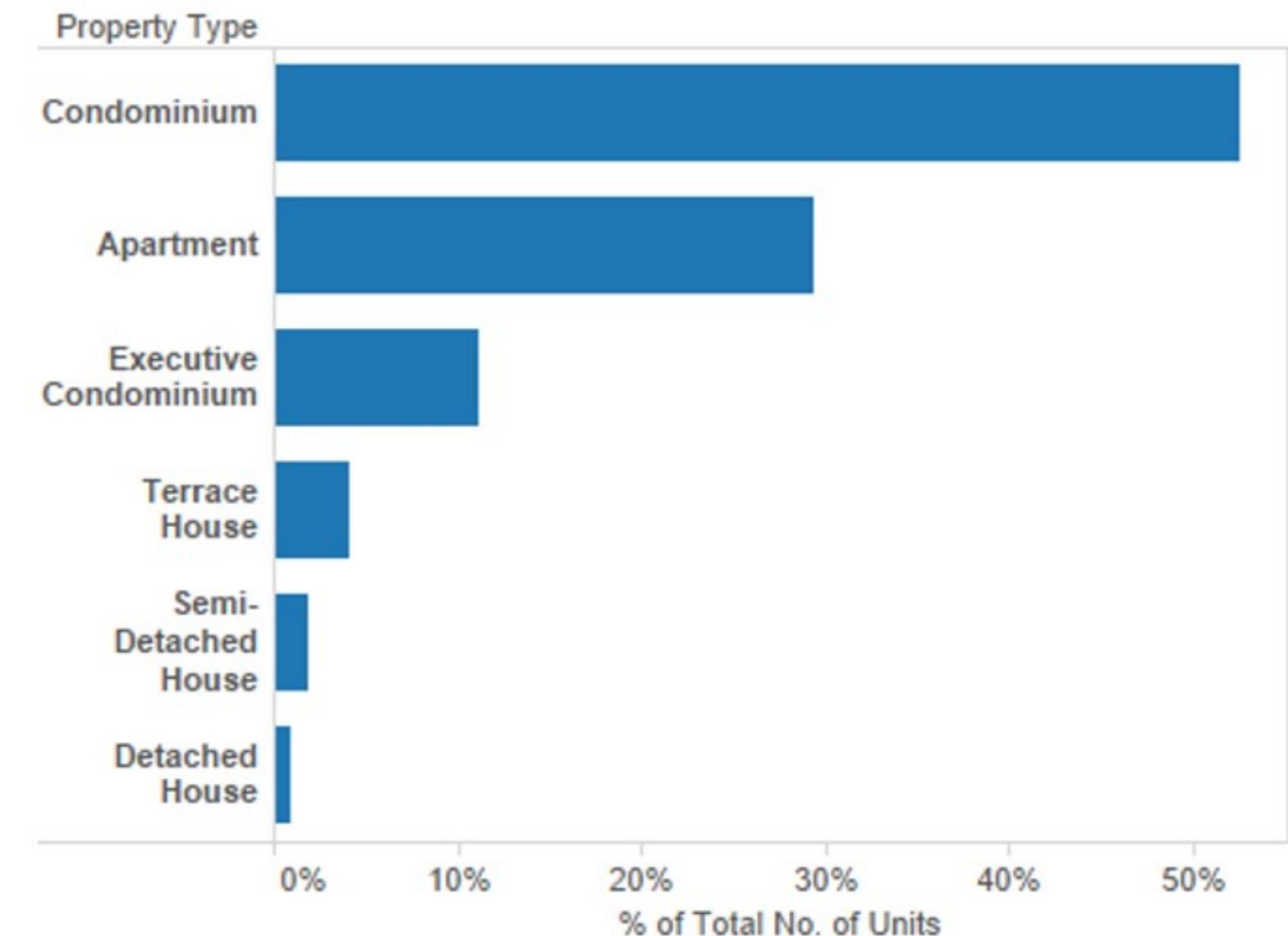
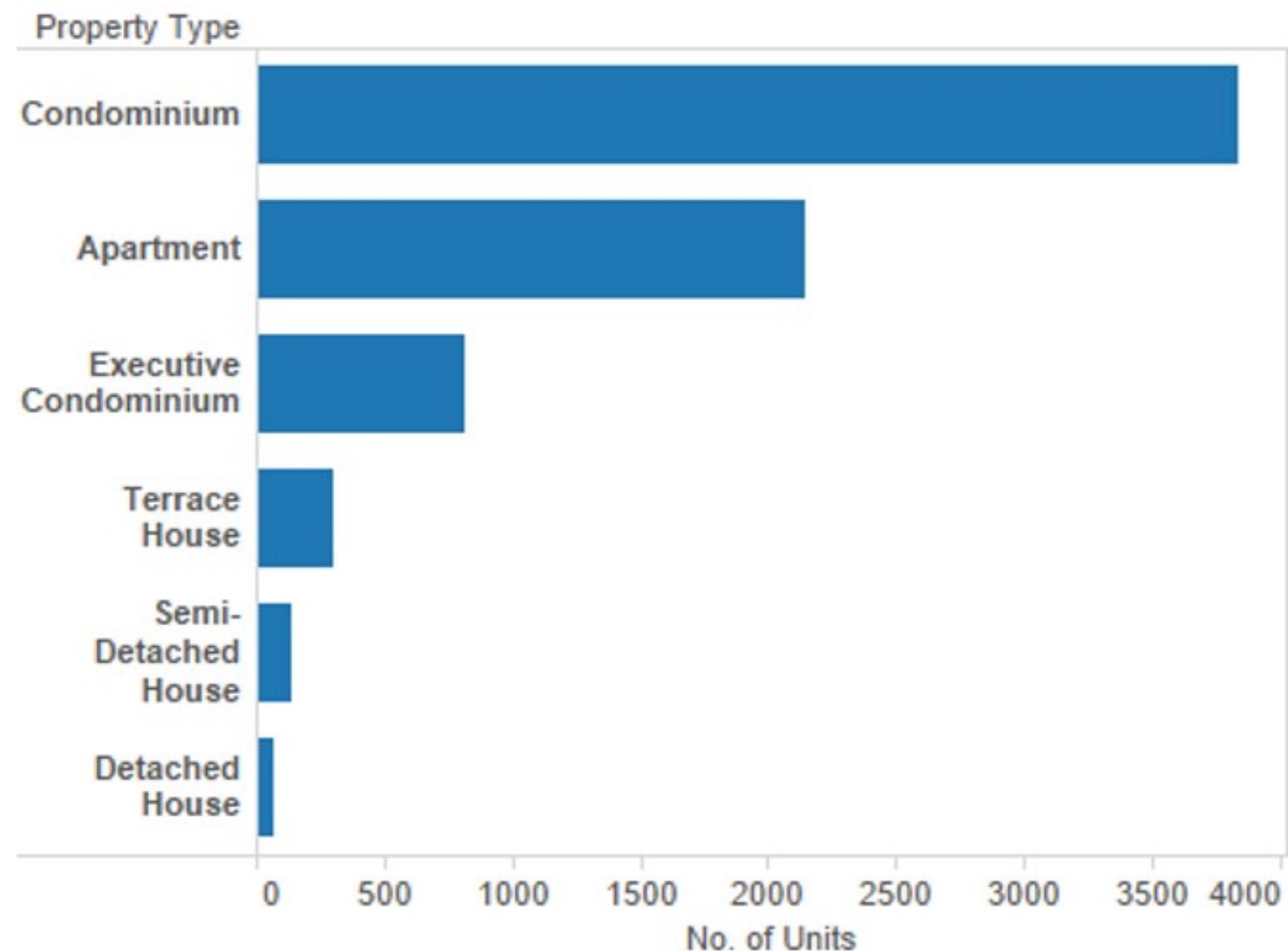
# Data & view specification

- Hierarchical sorting



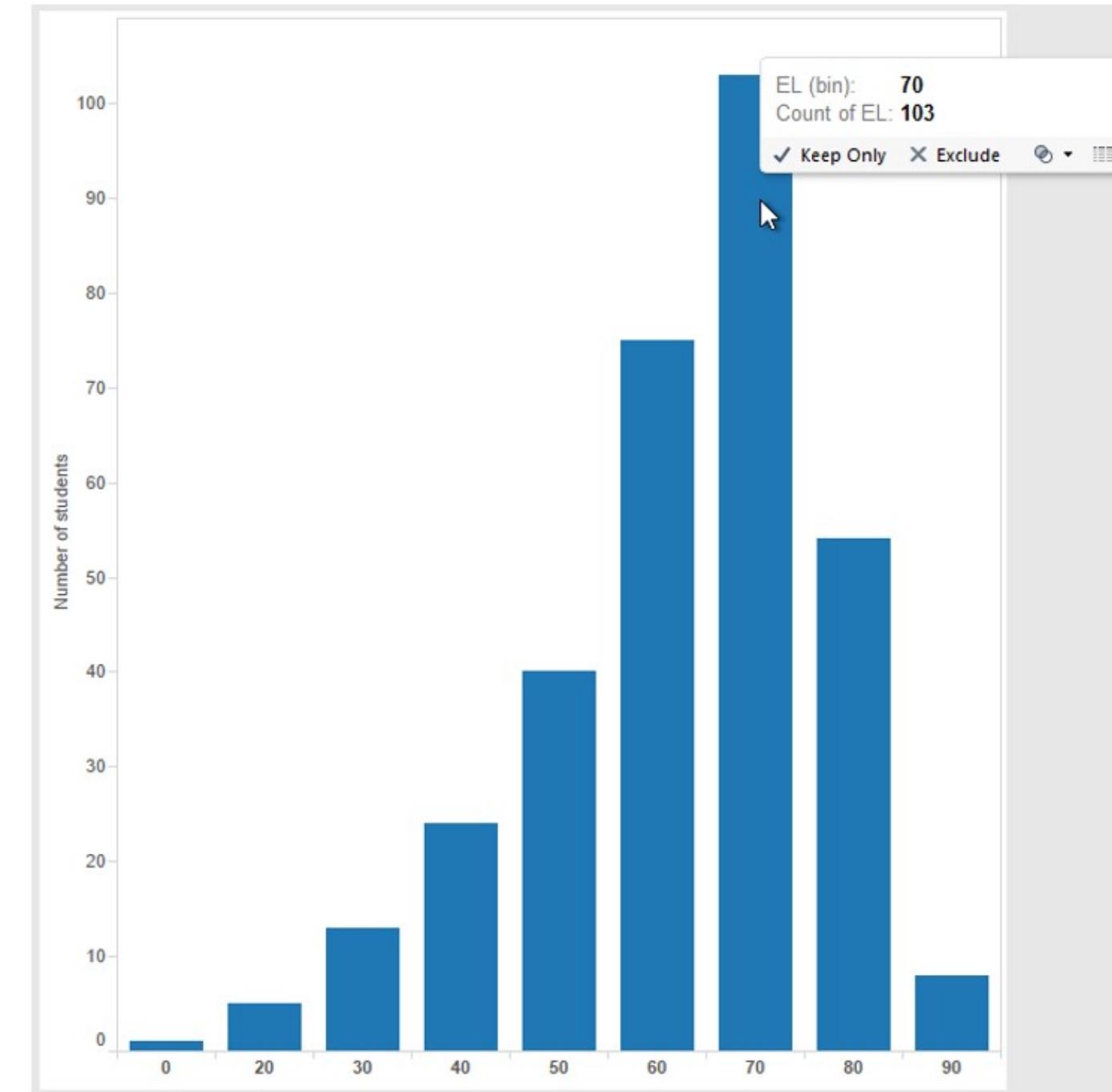
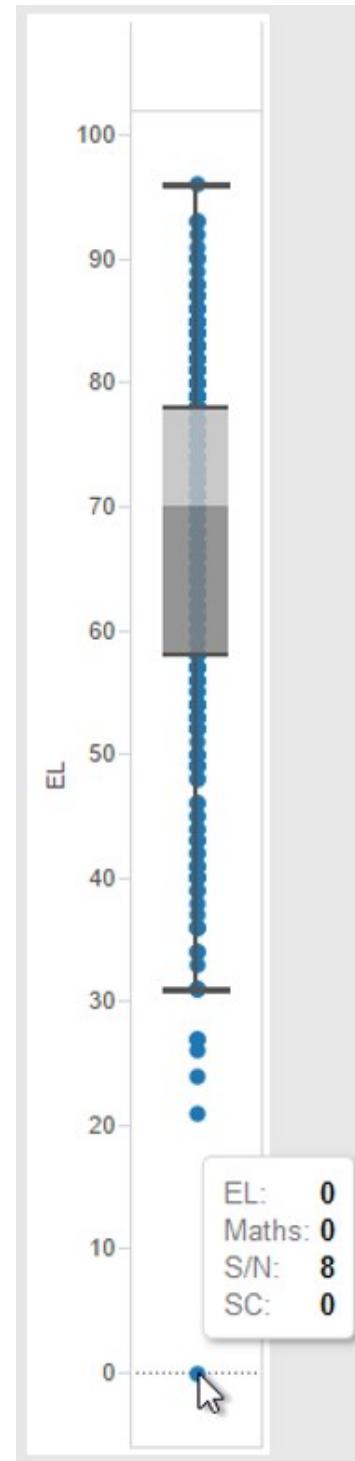
# Data & view specification

- Derive values or models from source data.



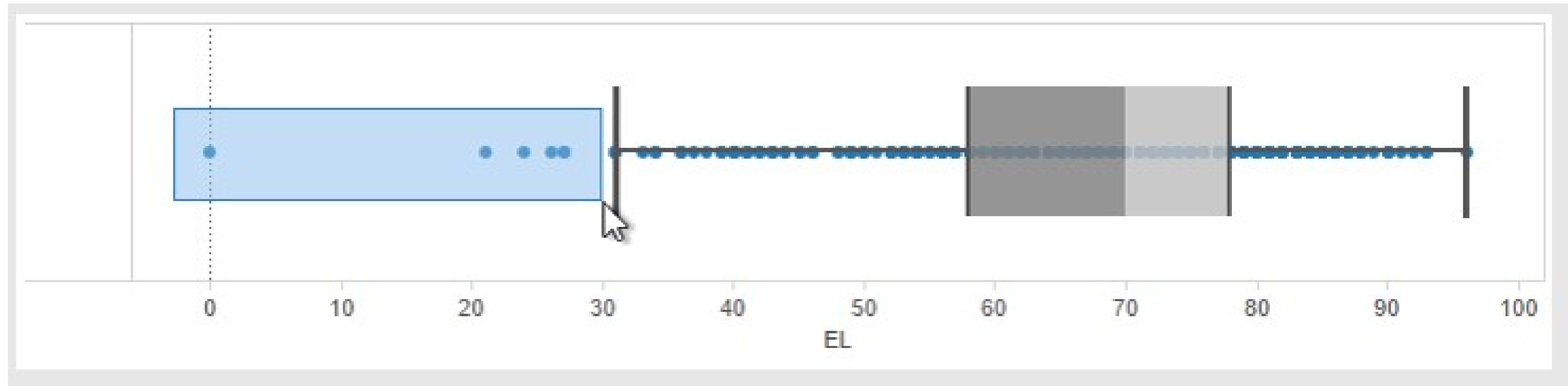
# View Manipulation: Selection functions

- Pointer selects a single object in a plot.



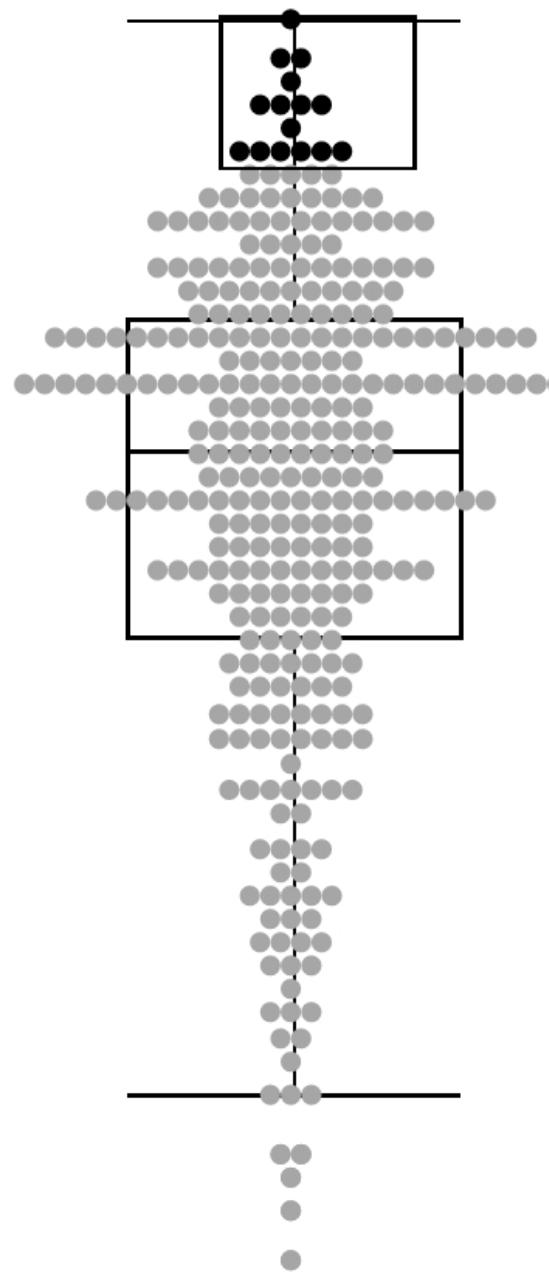
# View Manipulation: Selection functions

- Drag-box selects a rectangular region in a box.



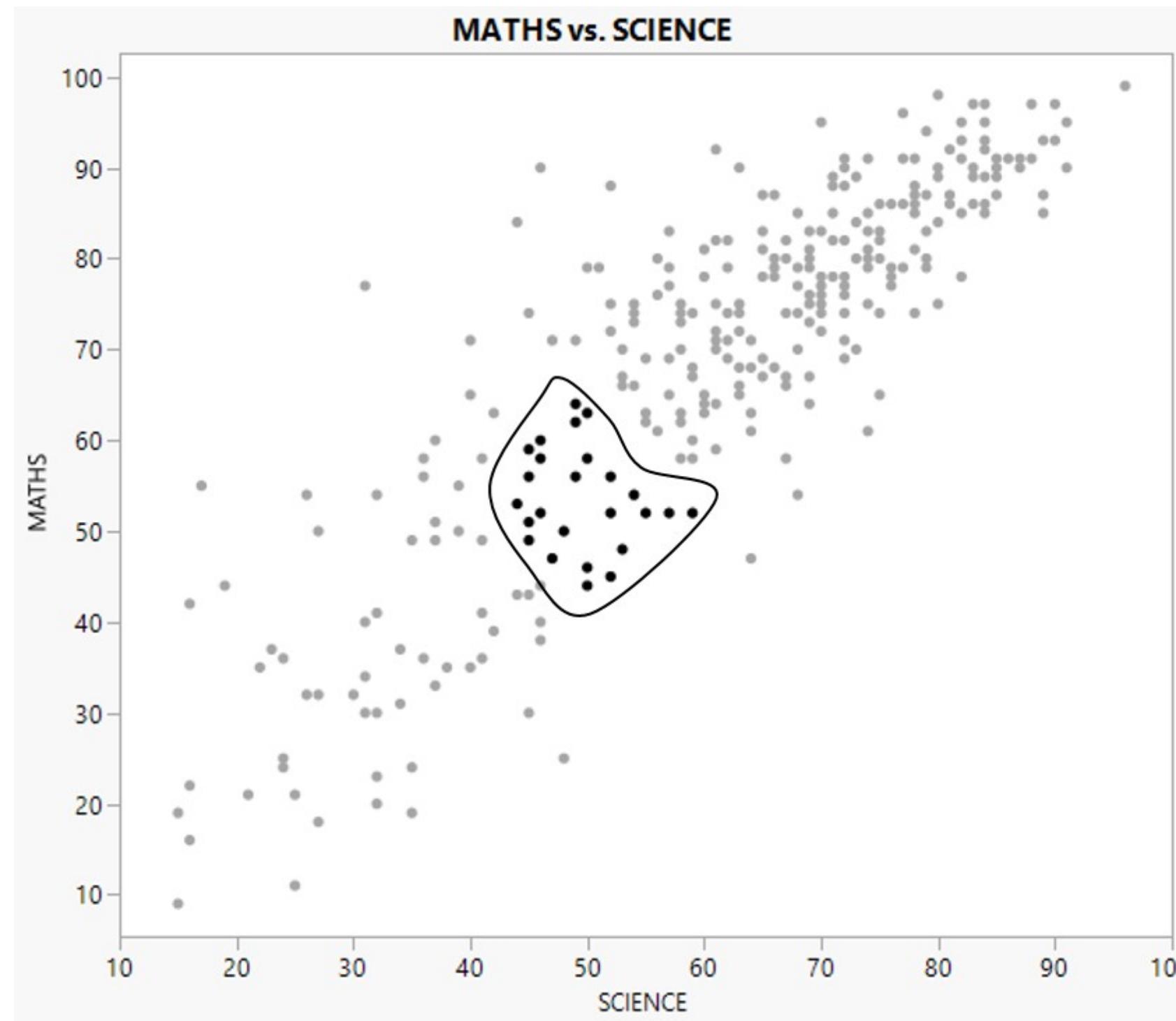
# View Manipulation: Selection functions

- **Brush** is a generalisation of the drag-box.  
Once a rectangular region is define, the brush allows users to move that region across a plot and thus dynamically change the selected subset.

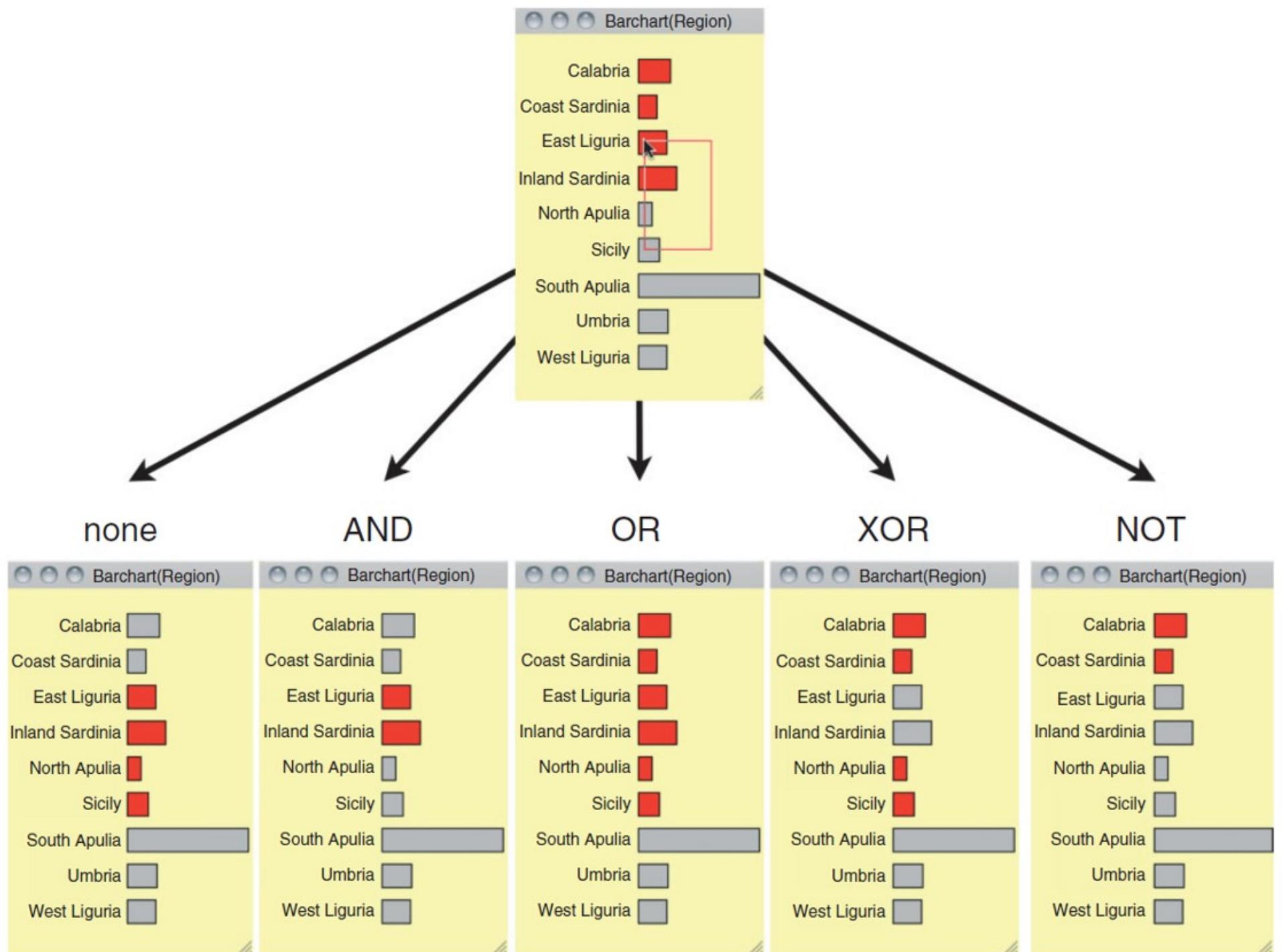


# View Manipulation: Selection functions

- Lasso allows users to define an arbitrary contiguous shape to select data.



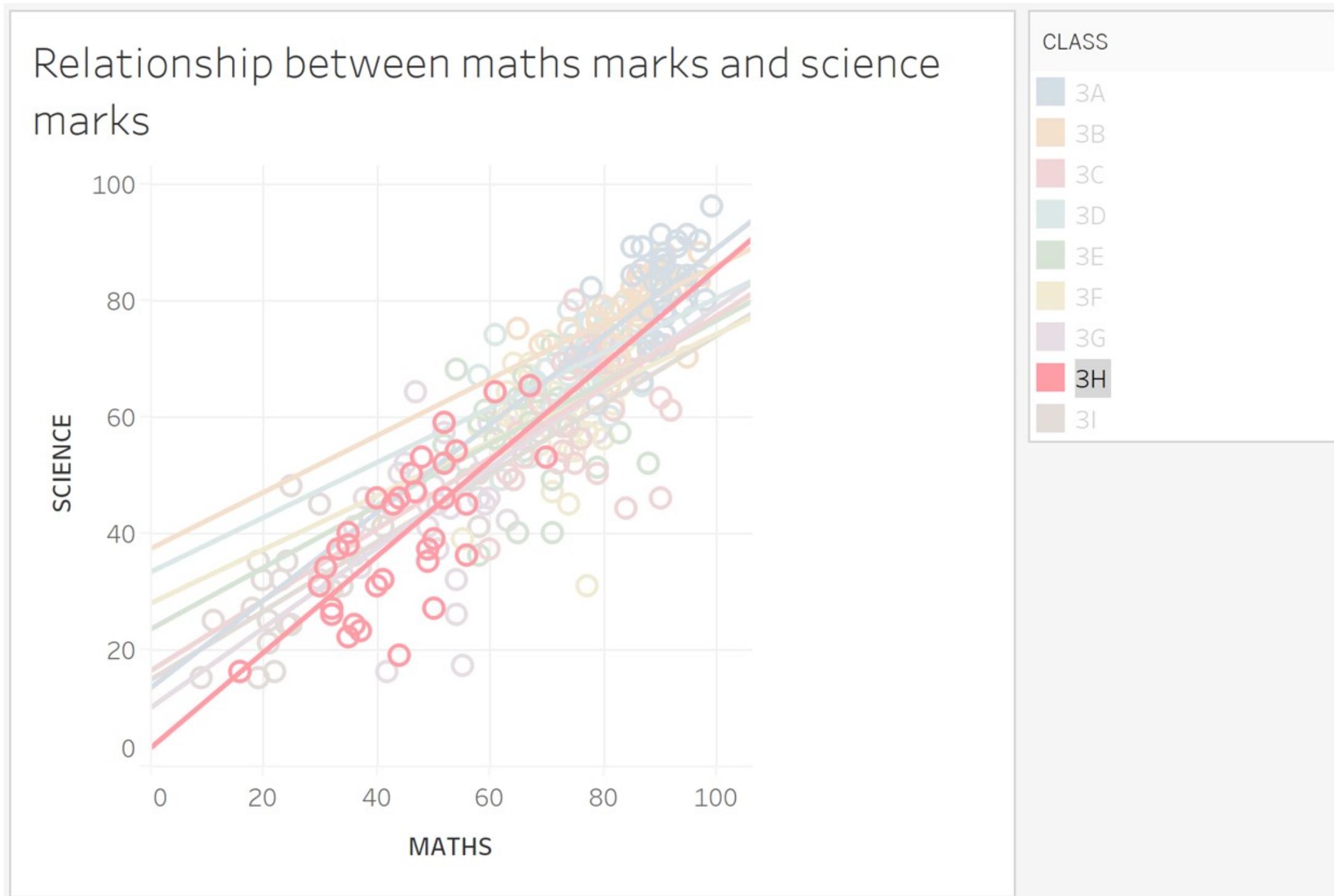
# View Manipulation: Selection modes



Reference: [Mondrian](#)

# View Manipulation: Highlighting

- Selected records are highlighted.



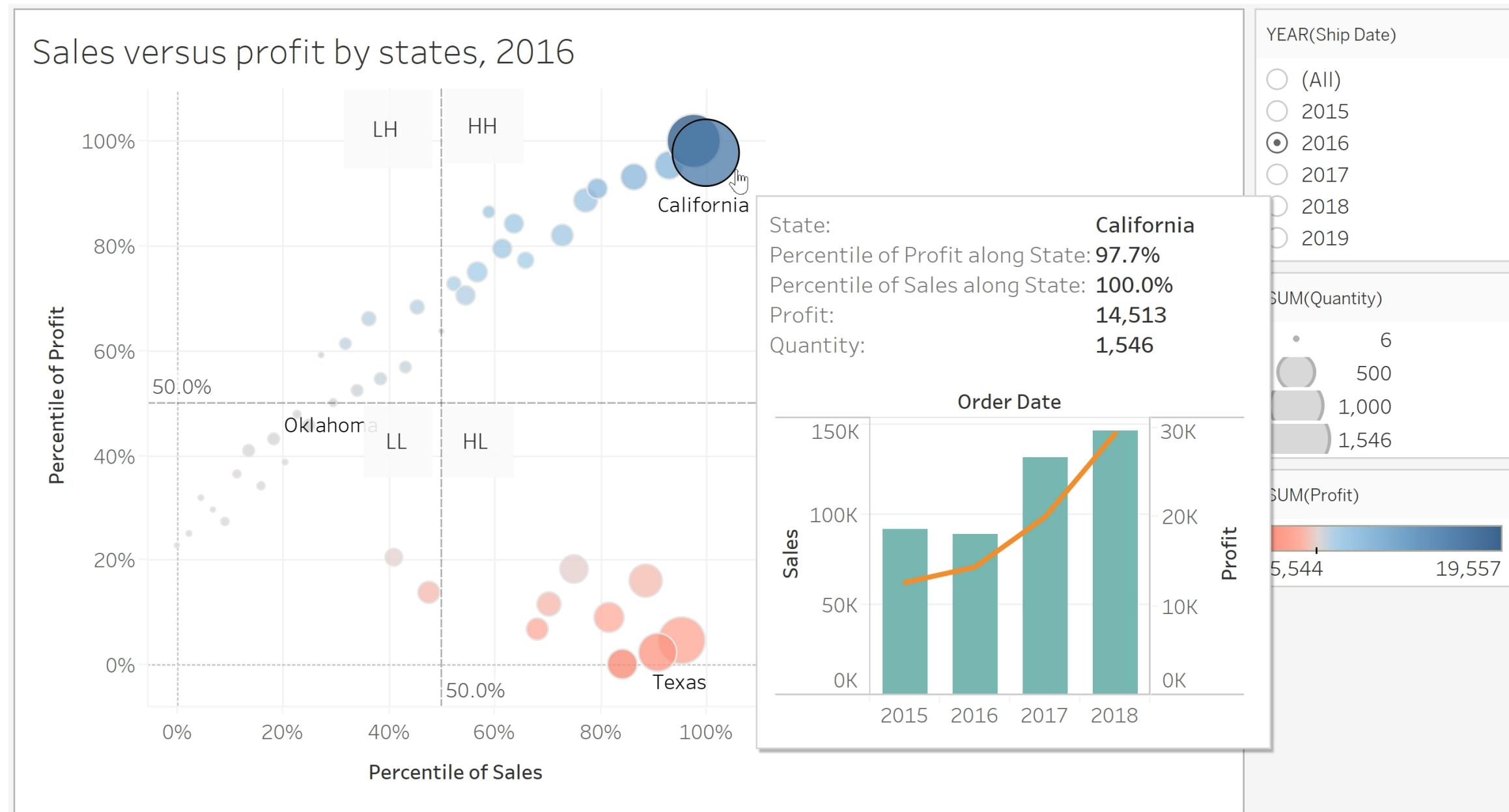
## View Manipulation

- Navigate to examine high-level patterns and low-level detail.
- Shneiderman's mantra

**“Overview first,  
zoom and filter,  
then details-on-demand”**

# View Manipulation

- The scatter plot provides an overview and the bar and line graphs provide detail sales and profits trends overtime.

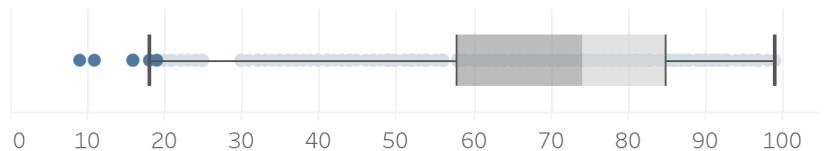


# View Manipulation

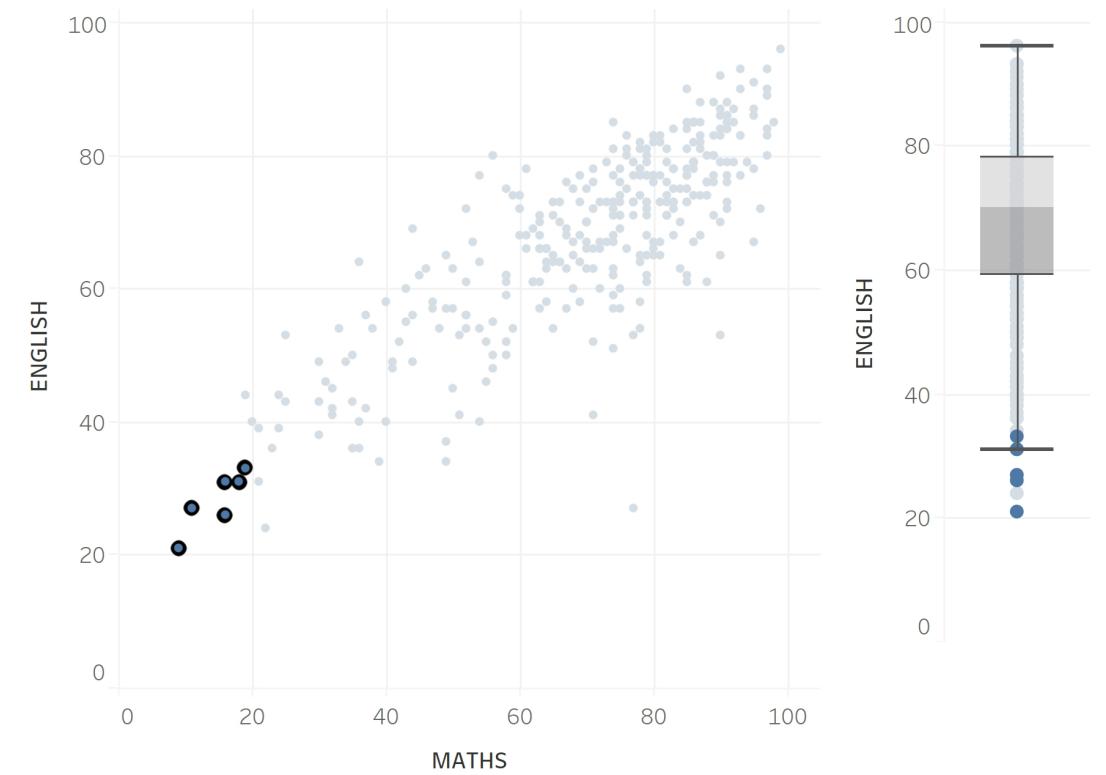
- Coordinate views for linked, multi-dimensional exploration

Scatterplot with marginal boxplot

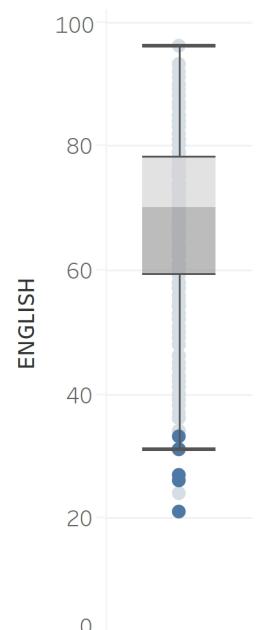
Maths



English versus Maths



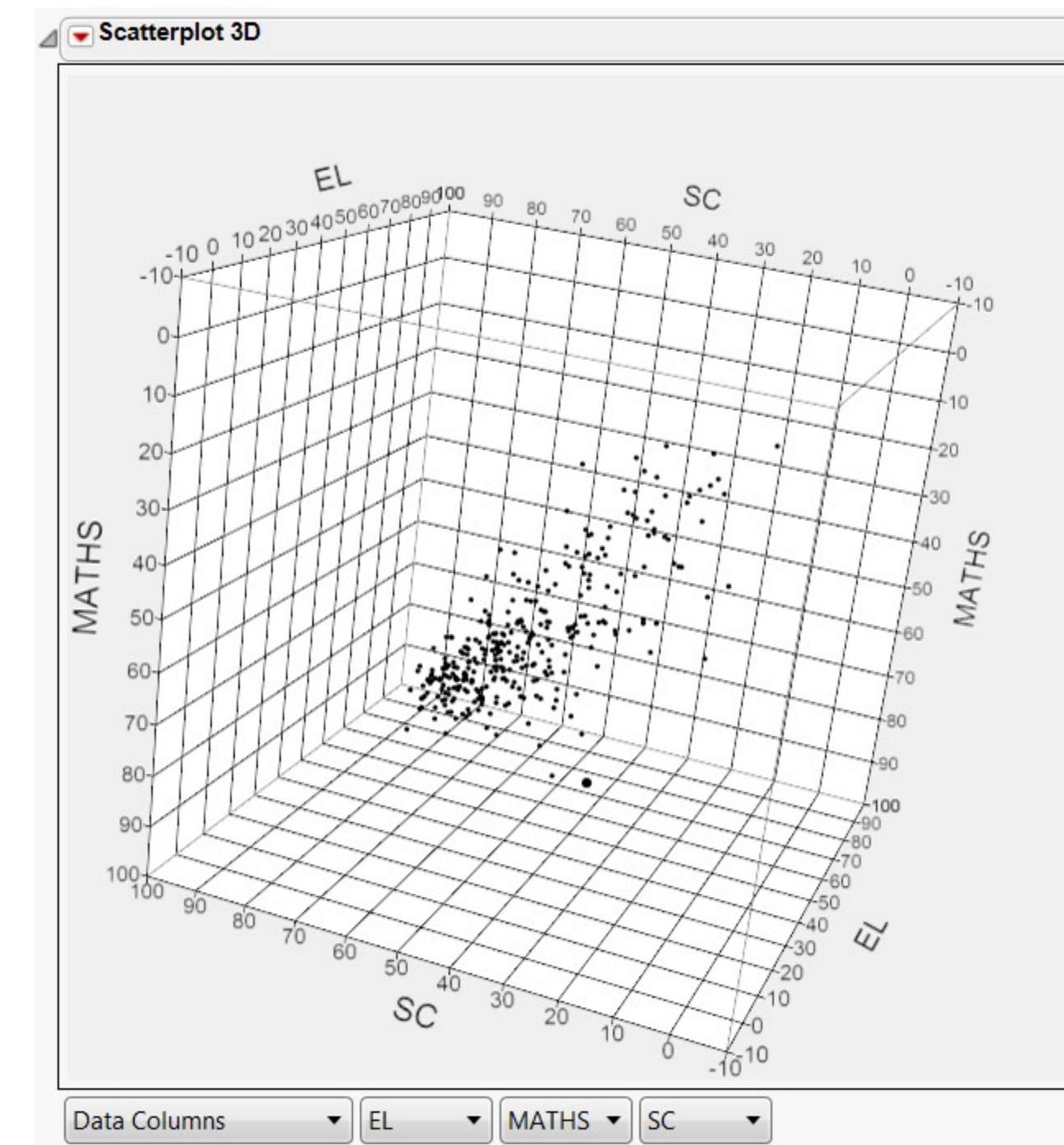
English



# View Manipulation

# View Manipulation: Rotating

- Touring view with JMP's 3D scatterplot

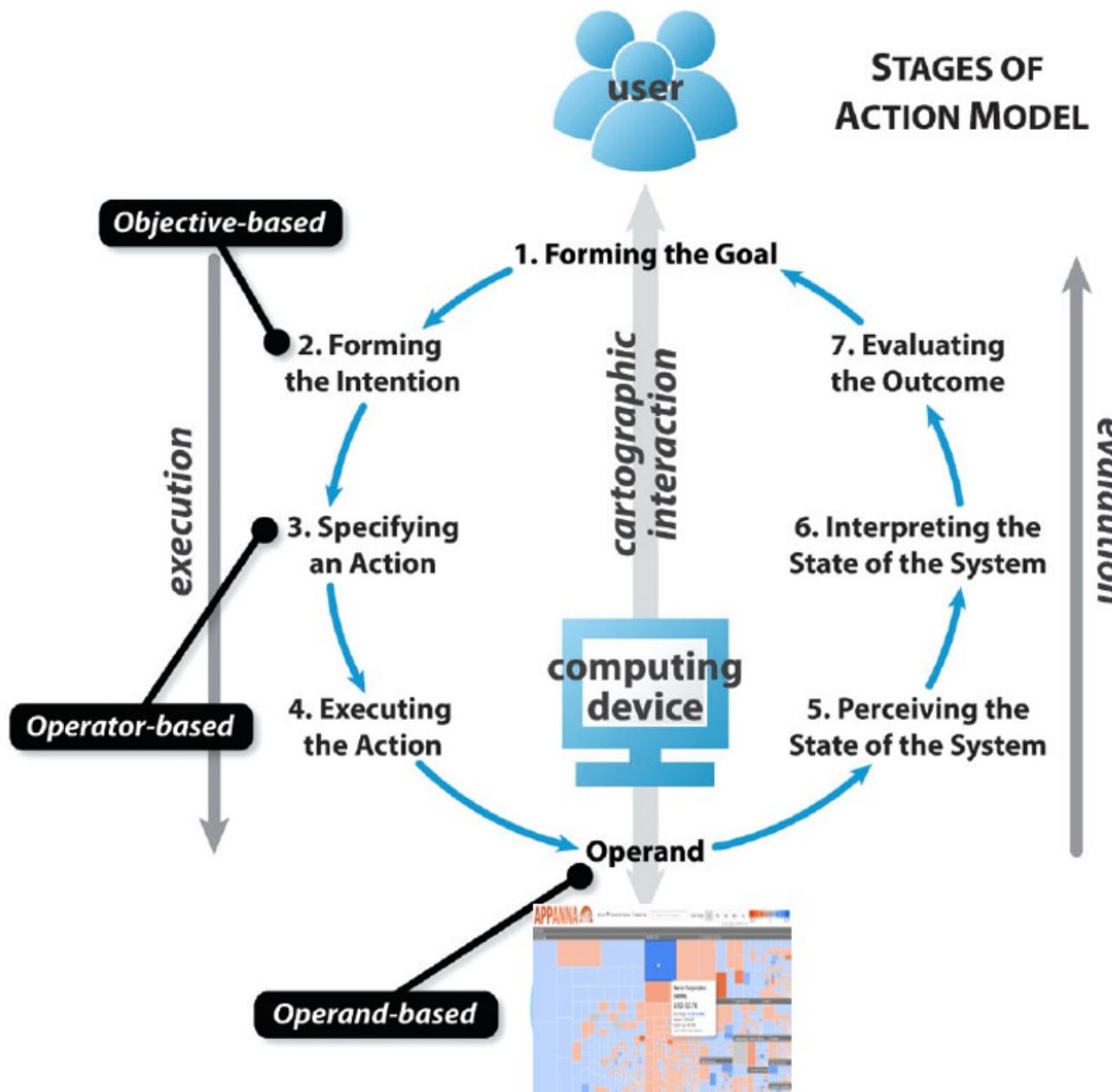


# Process and Provenance

- Record analysis histories for revisit, review and sharing.
- Annotate patterns to determine findings.
- Share views and annotations to enable collaboration.
- Guide users through analysis tasks or stories.

# Interactive Design Primitive

A framework for effective interactive design in visual analytics application.



Source: Roth, R.E. (2012) "Cartographic Interaction Primitive: Framework and Synthesis". The Cartographic Journal, Vol. 49, No. 4 pp. 376-395.

# Interactive Design Primitive

## Visual Analytics Objective Primitives

### objectives | geographic insight

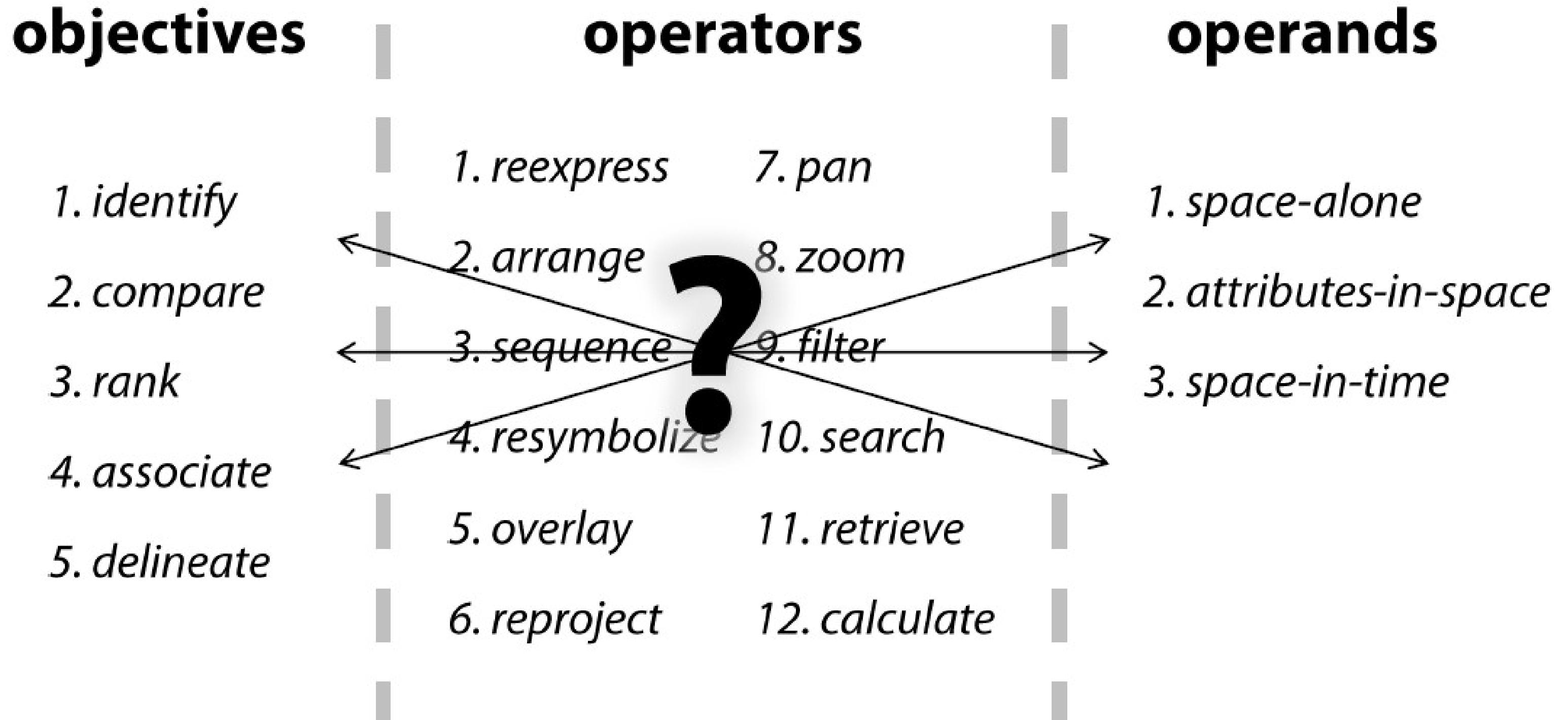
1. identify → e.g., ID, locate
2. compare → e.g., difference, change
3. rank → e.g., anomaly, outlier
4. associate → e.g., correlation, trend, cause-effect
5. delineate → e.g., cluster, hotspot, spike

### Interactive Analytics Operator Primitives

### operators

- |                     |                     |
|---------------------|---------------------|
| <b>1. reexpress</b> | <b>7. pan</b>       |
| 2. arrange          | 8. zoom             |
| <b>3. sequence</b>  | <b>9. filter</b>    |
| 4. resymbolize      | <b>10. search</b>   |
| <b>5. overlay</b>   | <b>11. retrieve</b> |
| 6. reproject        | 12. calculate       |

# Interactive Design Primitive

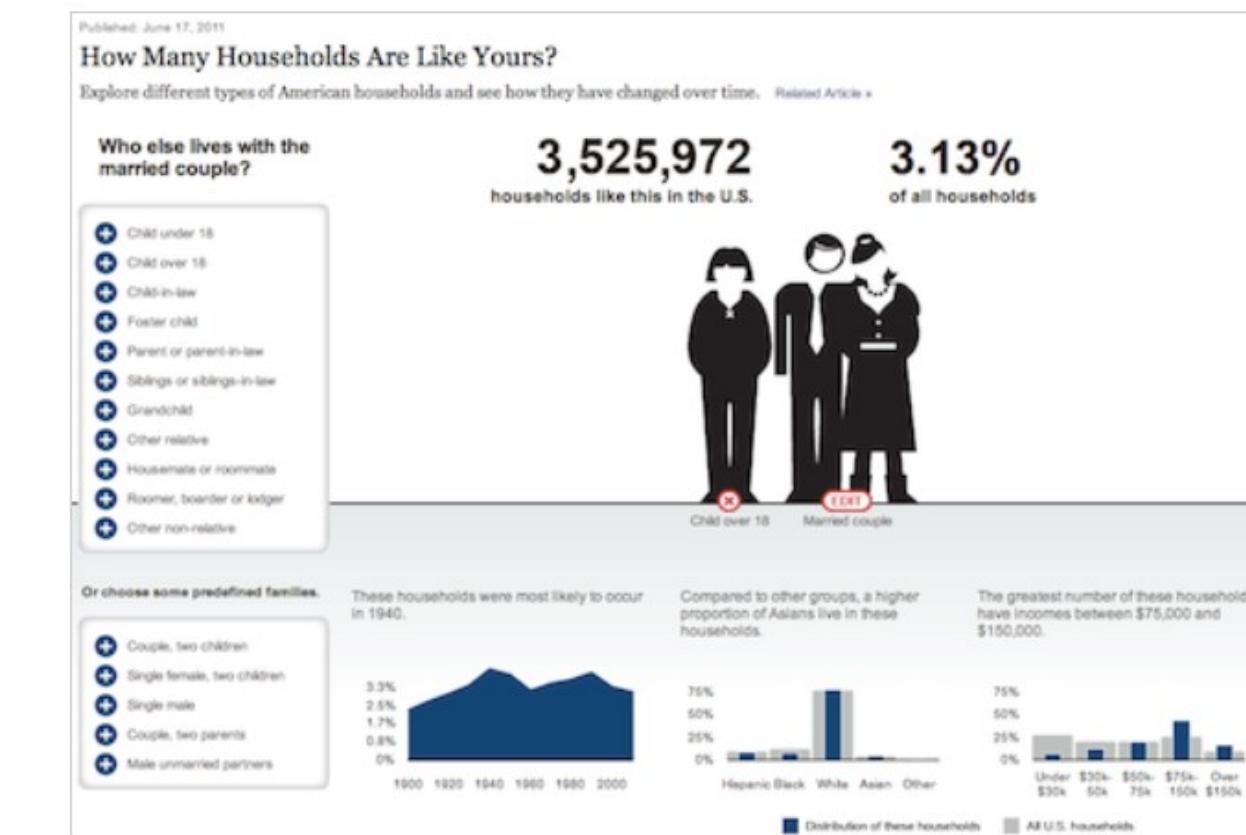


# Animation in Visual Analytics

- The purpose of animation is to facilitate perception of changes when transitioning between related data graphics
- Do not confine to time-series data only

## The Original Design

The New York Times recently published an interactive graphic for exploring different types of American households. [Go check it out.](#)



Source: [How Many Households](#)

# Why using Animation in Visual Analytics

- Motion is highly effective at attracting attention.
- Animation facilitates object constancy for changing objects.
- Animated behaviours can give rise to perceptions of causality and intentionality, communicating cause-and-effect relationships and establishing narrative.
- Animation can be emotionally engaging, engendering increased interest or enjoyment.

# Principles of Animation

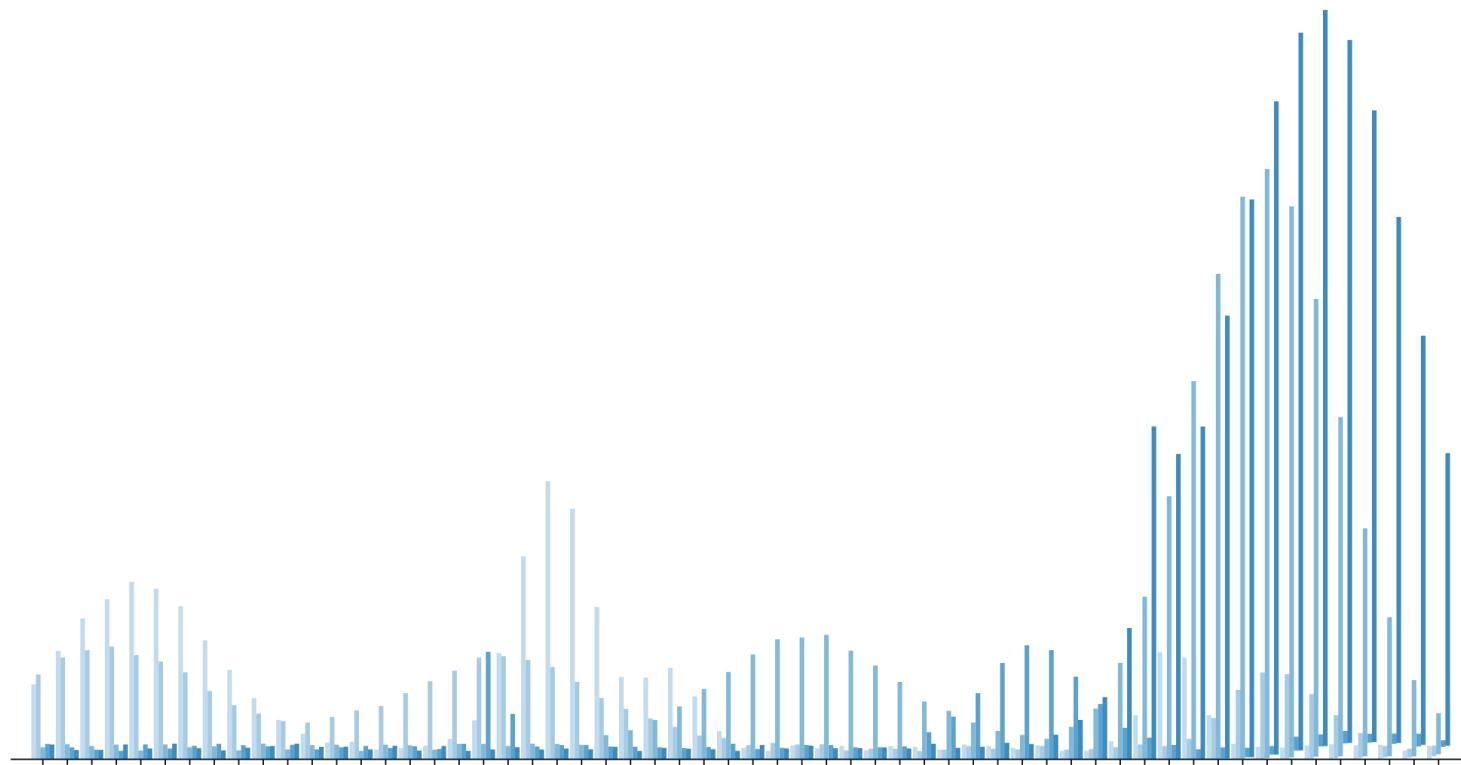
- *Congruence* principle states that the structure and content of the external representation should correspond to the desired and content of the internal representation.
- Maintain valid data graphics during transitions
- Use consistent semantic-syntactic mappings
- Respect semantic correspondence
- Avoid ambiguity
- *Apprehension* principle states that the structure and content of the external representation should be readily and accurately perceived and comprehended.
  - Group similar transitions
  - Minimise occlusion
  - Maximise predictability
  - Use simple transitions
  - Use staging for complex transitions
  - Make transitions as long as needed, but no longer

Source: Heer, J and Robertson G. (2007) [Animated Transitions in Statistical data Graphics](#), IEEE Transactions on Visualization and Computer Graphics, Vol. 13, No. 6, 1240-1247 and the [video](#).

# Animation in Action

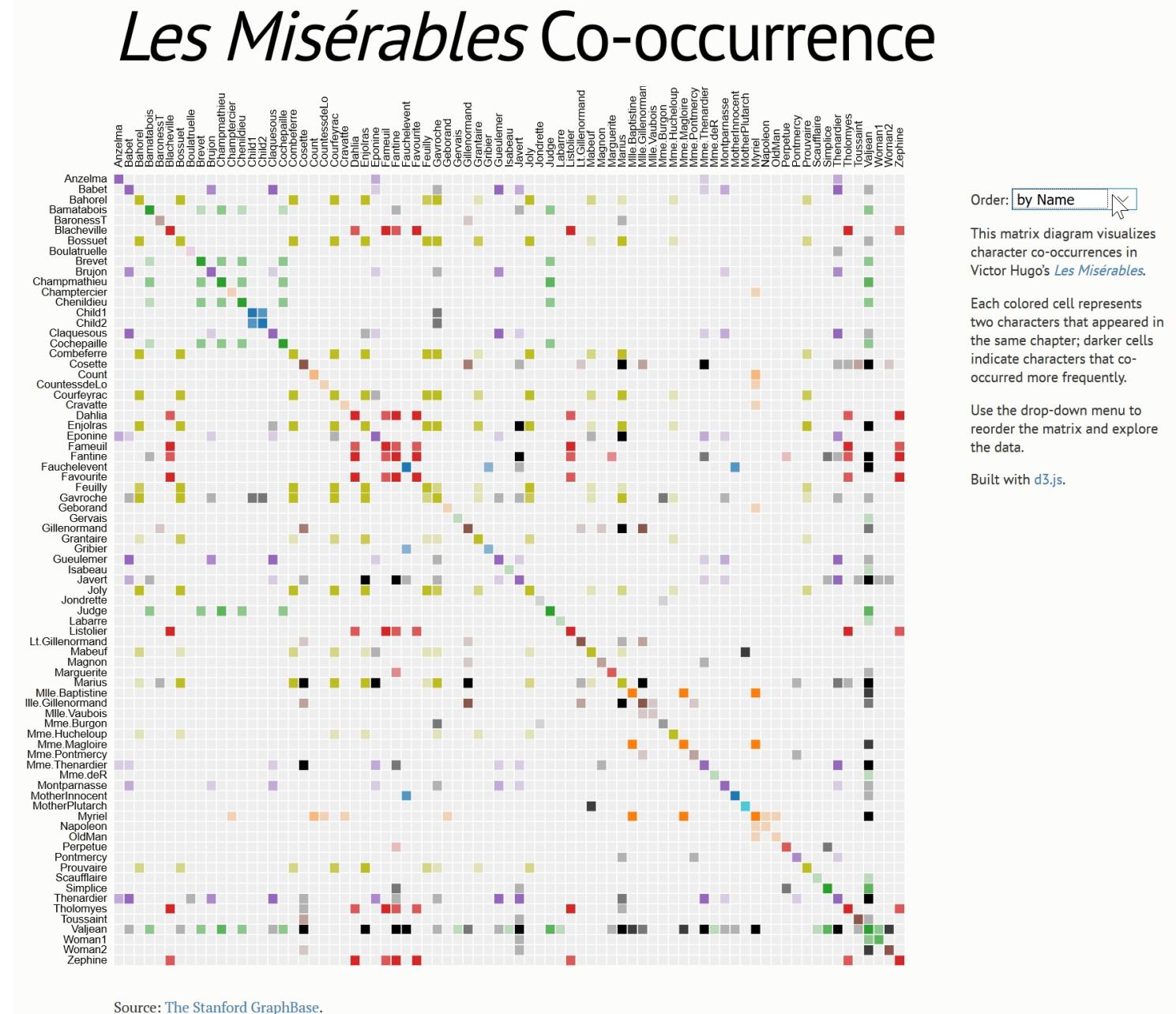
## Stacked-to-Grouped Bars

○ Stacked   ● Grouped



Source: [Stacked to Grouped Bars](#)

# Animated Co-occurrence matrix



Source: [Miserables](#)

# References

- Dynamics for Visual Analysis
- Animated Transitions in Statistical Data Graphics, IEEE Transactions on Visualization and Computer Graphics, Vol. 13, No. 6, 1240-1247 and the [video](#)
- Coordinated Highlighting in Context
- Cartographic Interaction Primitive: Framework and Synthesis

