

## Visual Encoding and Design Choices

The visualization uses a **Parallel Coordinates Plot** to represent each house in the dataset. Each data point is shown as a polyline that intersects a series of vertical axes, where each axis corresponds to one of these attributes: price, area, bedrooms, bathrooms, stories, and parking.

Continuous attributes are mapped to scaled numeric axes, allowing direct comparison of magnitude across houses. Color and opacity are used to guide attention:

- All lines are shown in blue by default.
- The selected or hovered line becomes red and increases in thickness.
- Non-selected lines fade to 0.3 opacity, reducing visual noise and helping highlight patterns in the focus subset.

This encoding makes it possible to view all houses simultaneously, while still letting the user isolate and inspect individual data objects when needed.

## Interaction Design and Data–Task Fit

The interactions are designed to support exploratory analysis and pattern discovery across multiple attributes:

- **1D Brushing:** Users can drag vertically on any axis to filter data within a specific value range. Multiple brushes can be active simultaneously, enabling multi-attribute filtering. This interaction supports *range-based exploration* and *constraint-based filtering*.
- **Hover Interaction:** Hovering over a polyline temporarily highlights it and increases its thickness, providing immediate visual feedback and helping users trace individual data objects across axes.

- **Click Selection:** Clicking a line selects that data point and synchronizes the selection with the linked scatterplot (via shared React state). This supports comparison across different visualization.
- **Double-Click Detail View (Modal):** Double-clicking a line opens a modal displaying the full set of attribute values for that specific house. This provides a clear, readable summary without requiring users to manually trace the polyline across axes.

These interactions directly support the intended user tasks: identifying similar houses, exploring attribute relationships, and narrowing down options based on user-defined constraints. The visualization allows users to move easily between global patterns and detailed inspection.

## Evaluation of Design Choices

### Advantages

- **Comprehensive Overview:** Displays all data points simultaneously, making it easier to detect correlations and shared trends.
- **Good for similarity search:** Houses with similar characteristics produce lines with similar trajectories.
- **Flexible filtering:** 1D brushing supports targeted exploration of subsets.
- **Integrates well with linked visualizations:** Selection updates consistently across views.
- **Instance-level inspection:** The double-click modal allows users to retrieve complete data about a specific house without visual ambiguity.

### Limitations

- **Overplotting:** With 500+ data points, overlapping lines create visual clutter, reducing readability.

- **Difficult density assessment:** The plot shows general trends, but it is hard to judge how densely values are clustered without additional techniques (e.g., transparency gradients).
- **Learning Curve:** Users unfamiliar with parallel coordinates may find interpretation challenging at first.
- **Scalability:** Beyond ~10 dimensions, the plot becomes harder to read and navigate.

## Summary

The parallel coordinates visualization provides a strong foundation for exploring the housing dataset, supporting both *global pattern recognition* and *detailed inspection*. The combination of brushing, hover and click interactions, and the double-click detail modal creates a workflow where users can easily identify patterns, filter the dataset, and view complete attribute information for specific data points. While challenges such as overplotting and interpretability remain, the design effectively balances full-data visibility with focused exploration.