

Features vs Prototypes

Amplifying cognition with common data graphics

Gosia Migut and Marcel Worrying
 Informatics Institute, University of Amsterdam, The Netherlands

Abstract

The most common and important data visualizations, such as barcharts or scatterplots are typically feature-based. In this paper we question whether feature-based representations are favorable from the cognition point of view. We show through examples how the notion of prototypes can be introduced and discuss based on Card's taxonomy how feature- and prototype based representations amplify cognition.

Motivation

- Effective visualisations of information support cognition
- Data representation contributes to the effectiveness of the visualisation
- Common way to represent data is with features measurements
- Alternatively, prototypes can be used: they represent data well and are proven to support cognitive abilities of humans
- Comparing prototypes vs feature representations on offloading cognition (Card): (1) increased resources, (2) reduced search, (3) enhanced recognition of patterns, (4)perceptual inference, (5) perceptual monitoring, (6) manipulable medium.

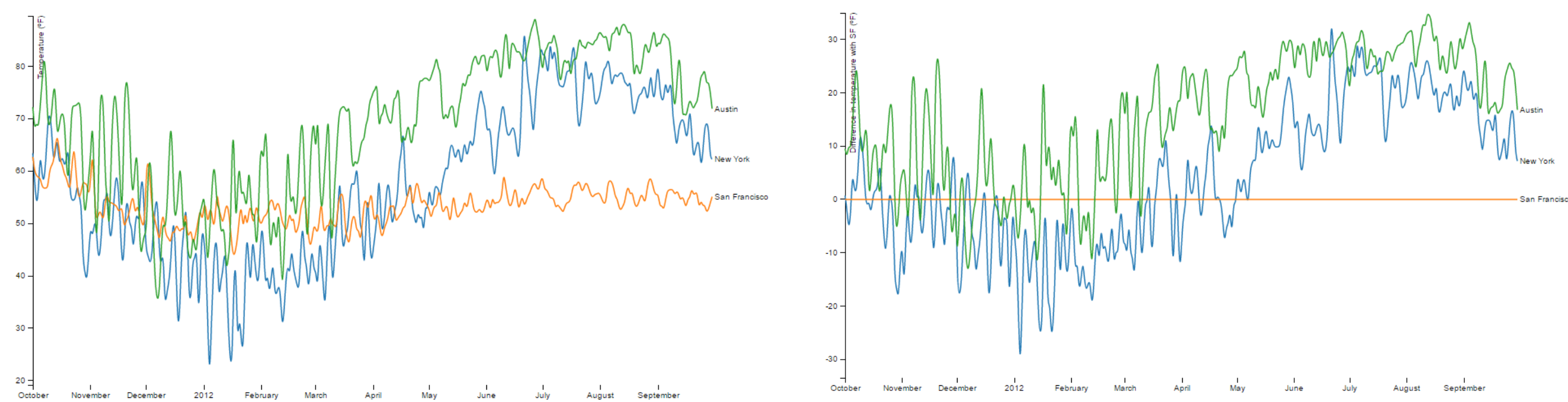
From features to prototypes

Reference to prototype

Visualizations that excel in heterogeneous or continues data such as a lineplot, heatmap, or barchart reveal individual feature dimensions.

Such visualizations can be transformed to a prototype representation by comparing each individual feature value to the reference feature value of the prototype.

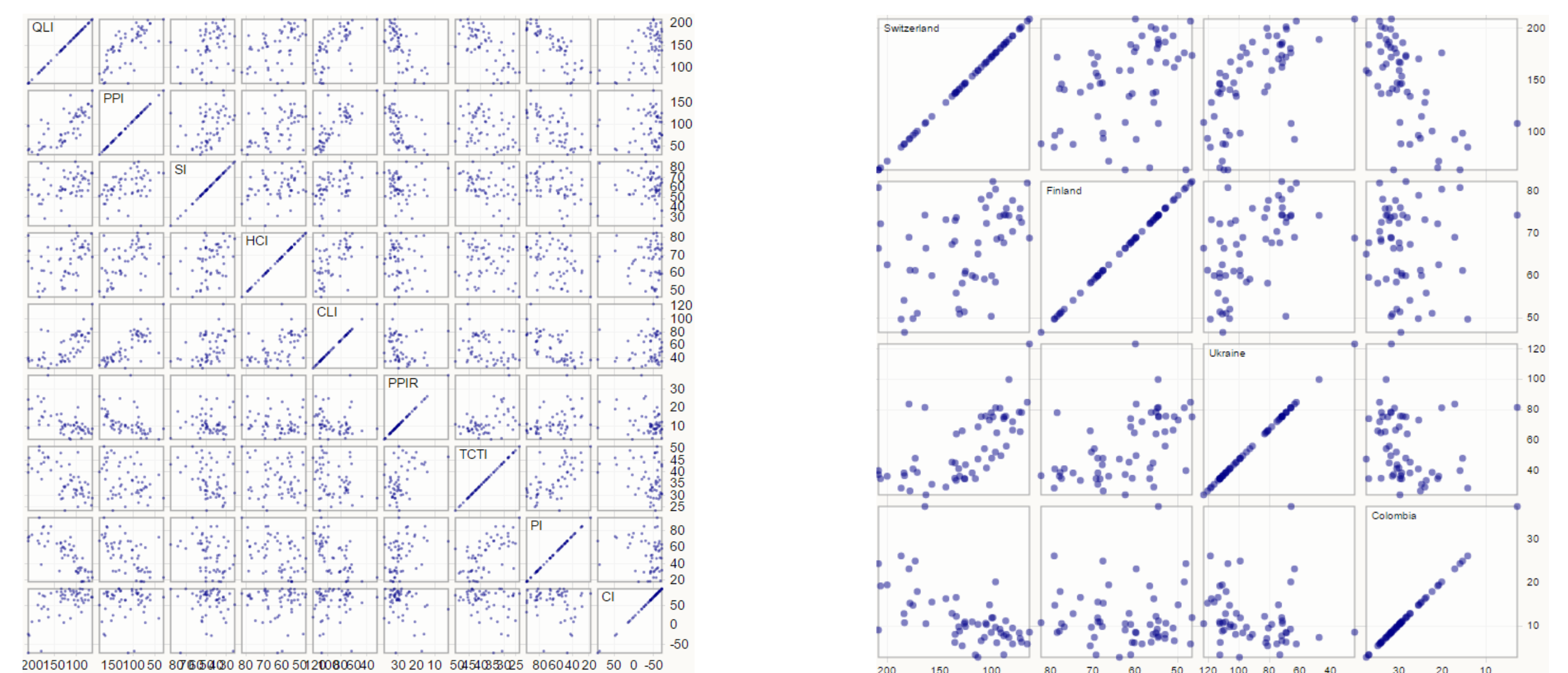
The reference prototype can be interactively selected by the user



Dissimilarity to prototype

Several visualizations are suitable for uniform feature measurements including a scatterplot, parallel coordinates, radarplot, etc.

A transformation to a prototype-based representation uses prototypes instead of features and visualize the rest of the data in terms of similarities to those prototypes



Amplify or diminish cognition?

How feature-based and prototype-based common data visualizations amplify (✓) and diminish (✗) cognition according to Card's taxonomy: (1) increased resources, (2) reduced search, (3) enhanced recognition of patterns, (4) perceptual inference, (5) perceptual monitoring, (6) manipulable medium.

Transformation approach	Property	Features	Prototypes
Reference to prototype e.g. lineplot & barchart	Individual feature patterns visible Easy comparison between data instances Scales to many dimensions Interactive selection	✓ (3) ✗ (4) ✗ (1) (2) ✗ (6)	✗ (1) (2) ✓ (2) (3) (4) ✗ (1) (2) ✓ (3) (6)
Similarity to prototype e.g. scatterplot & radarplot	Individual feature patterns visible Easy comparison between data instance Scales to many dimensions Interactive selection	✓ (3) ✗ (3) (4) ✗ (1) (2) ✗ (6)	✗ (4) ✓ (1) (3) (4) ✓ (1) (2) ✓ (3) (6)

Conclusions

- Combination of the choice of data representation and the choice of the visualization technique influences cognitive abilities
- Feature-based representation amplifies cognition when comparison of feature values is required
- Prototype-based reference representation could be useful where multiple values are to be compared
- Prototype-based representation scales better and is more suitable for high-dimensional datasets
- Prototype-based representation is homogeneous and suitable for visualizations that use linked views