

# Multidimensional Data

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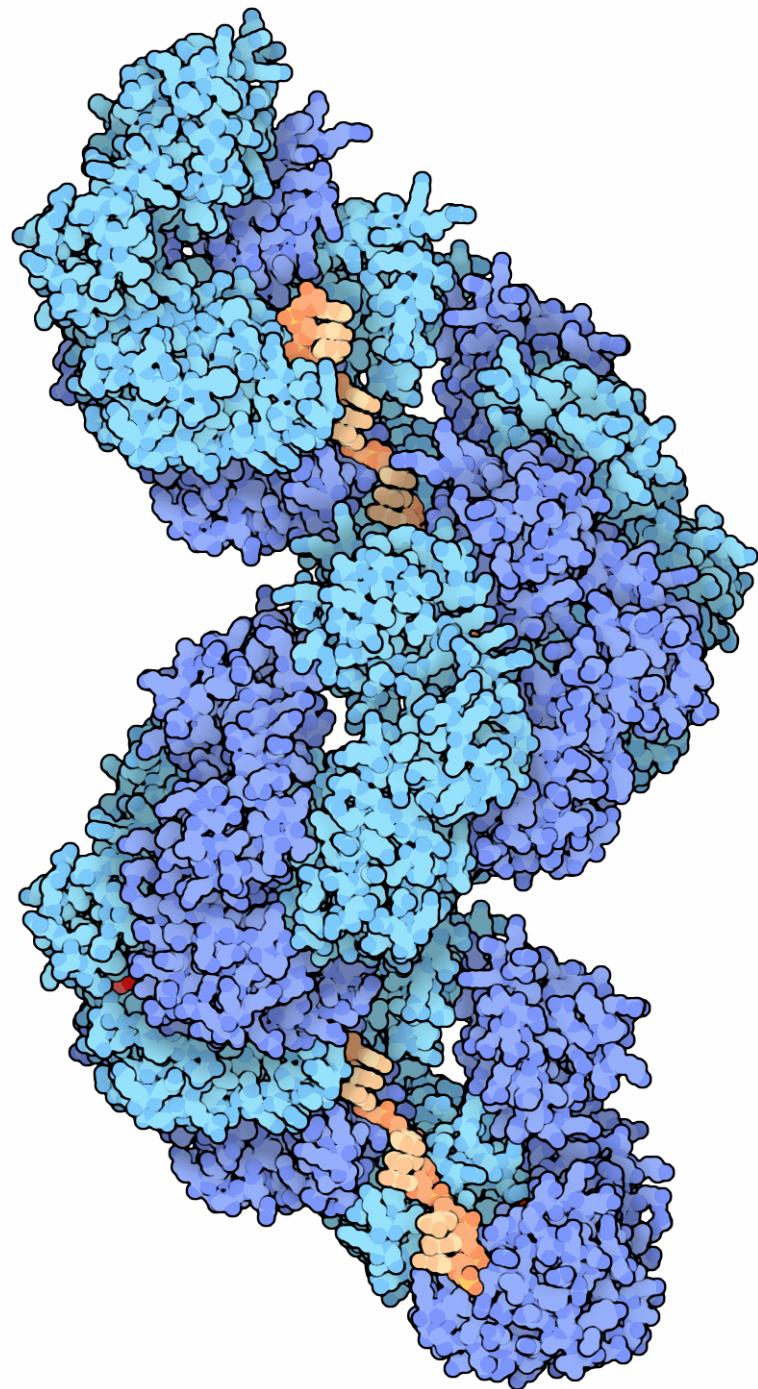
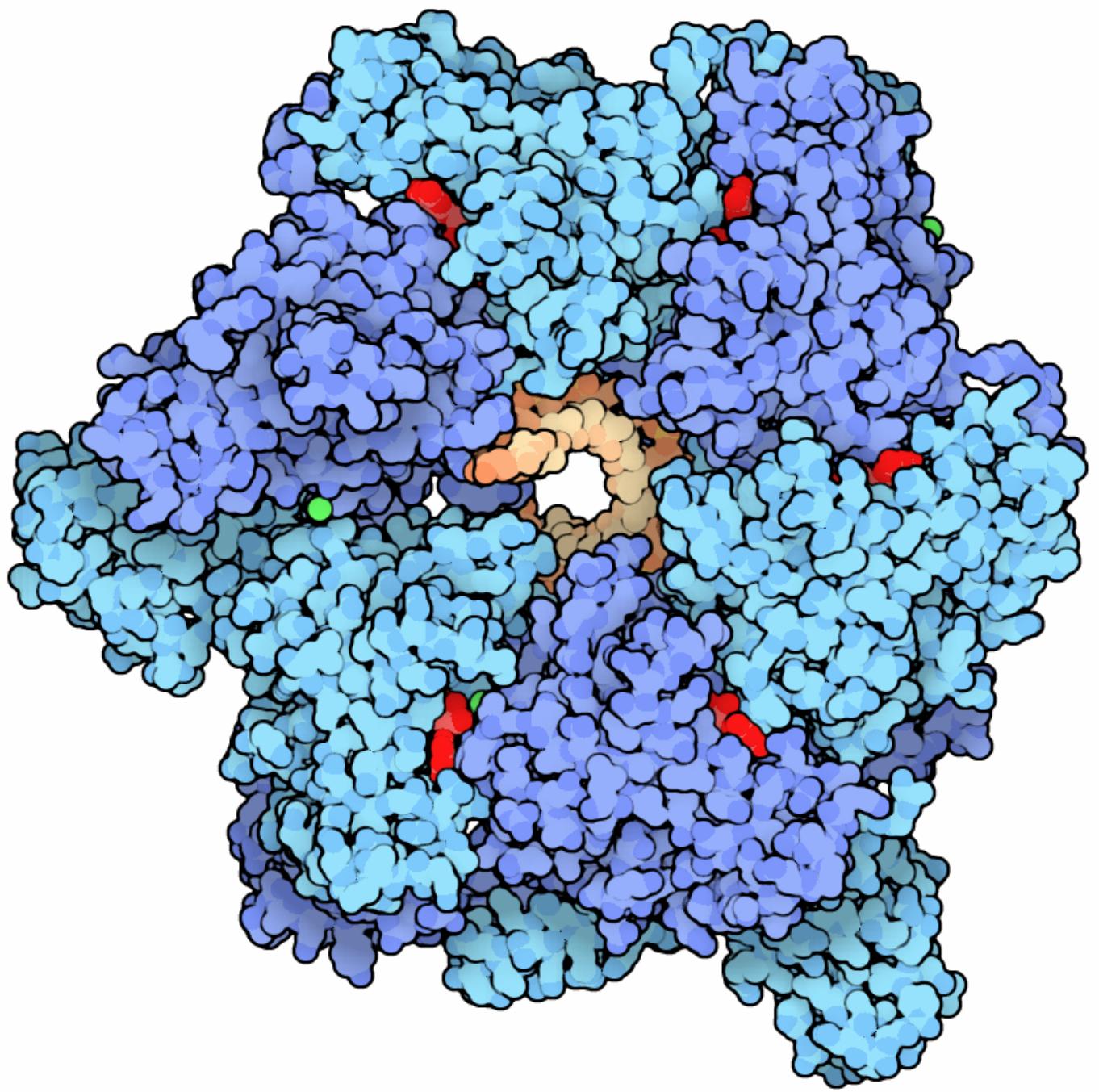
May 9, 2017

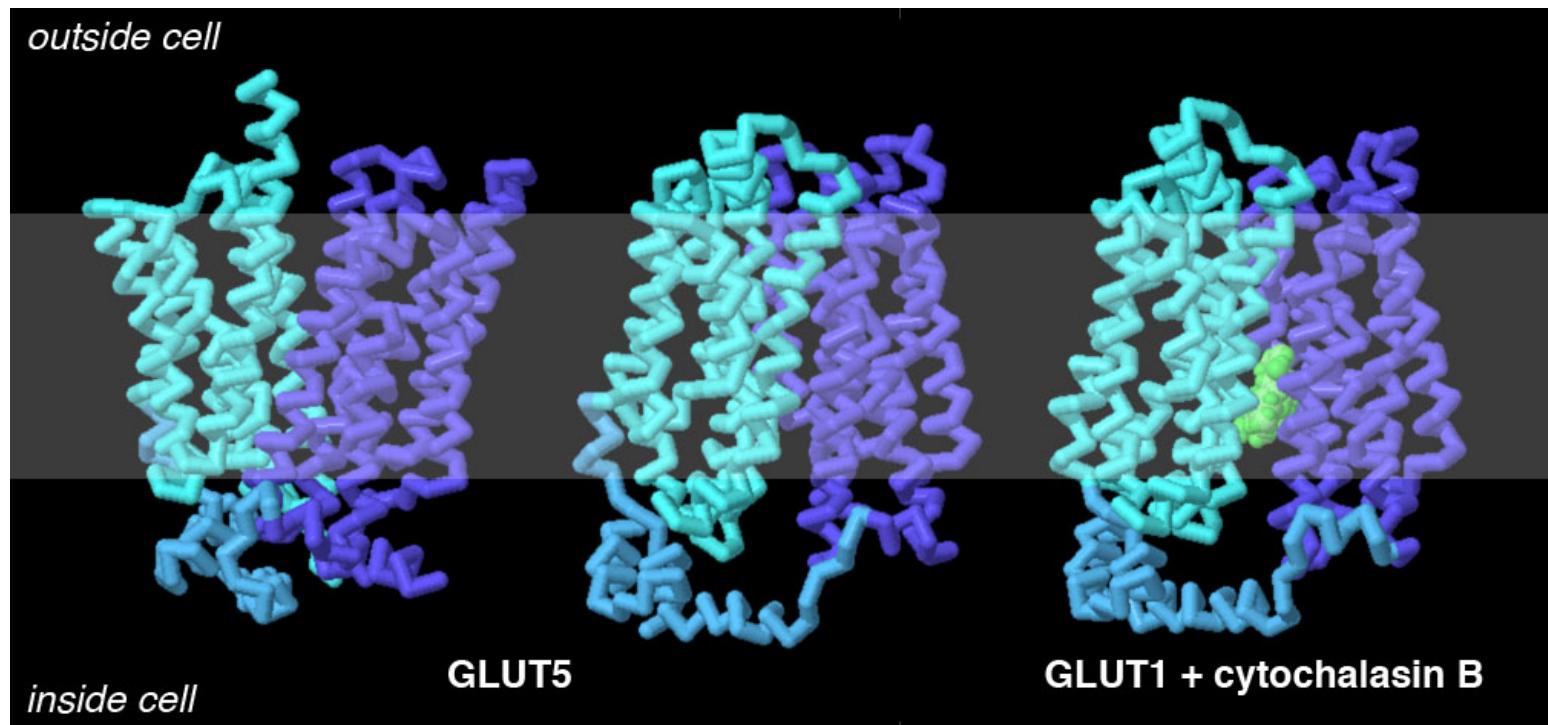
When working with multidimensional  
data, we can use principles of  
**storytelling** to guide the focus of our  
audience

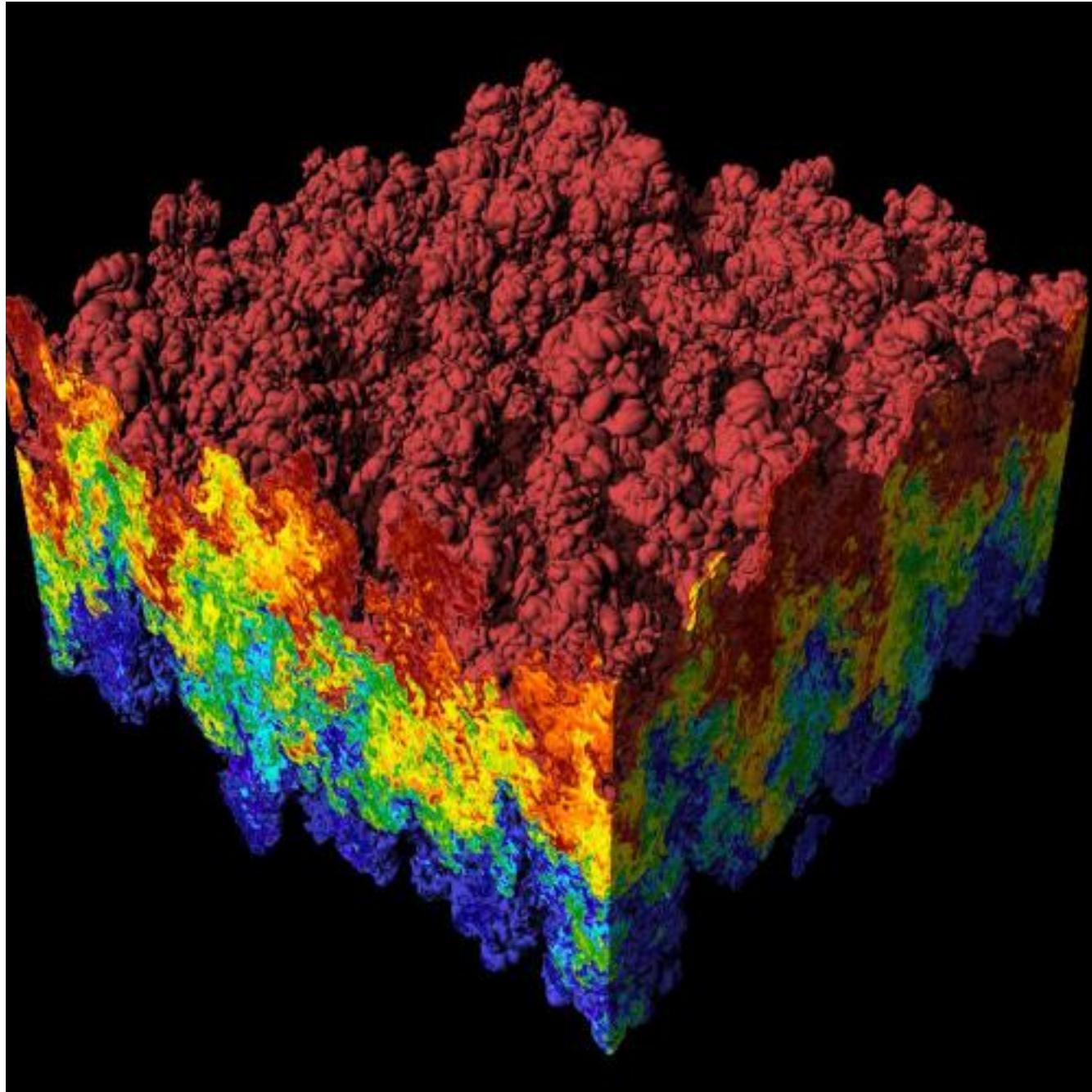
When is it appropriate to create a  
visualization in 3D?

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visualization in 3D?

Only when the 3<sup>rd</sup> dimension is inherently spatial  
(rarely ever)







# Visualizing Multidimensional Data

In small groups, identify all the independent dimensions in the data set provided.

How many different visual arrangements of those dimensions are possible?

Two-dimensional representations of  
multidimensional data use

visual depth cues

to represent higher dimensions

When plotting data in 3D space,  
visual cues for indicating depth

**can interfere**

with other common visual encodings

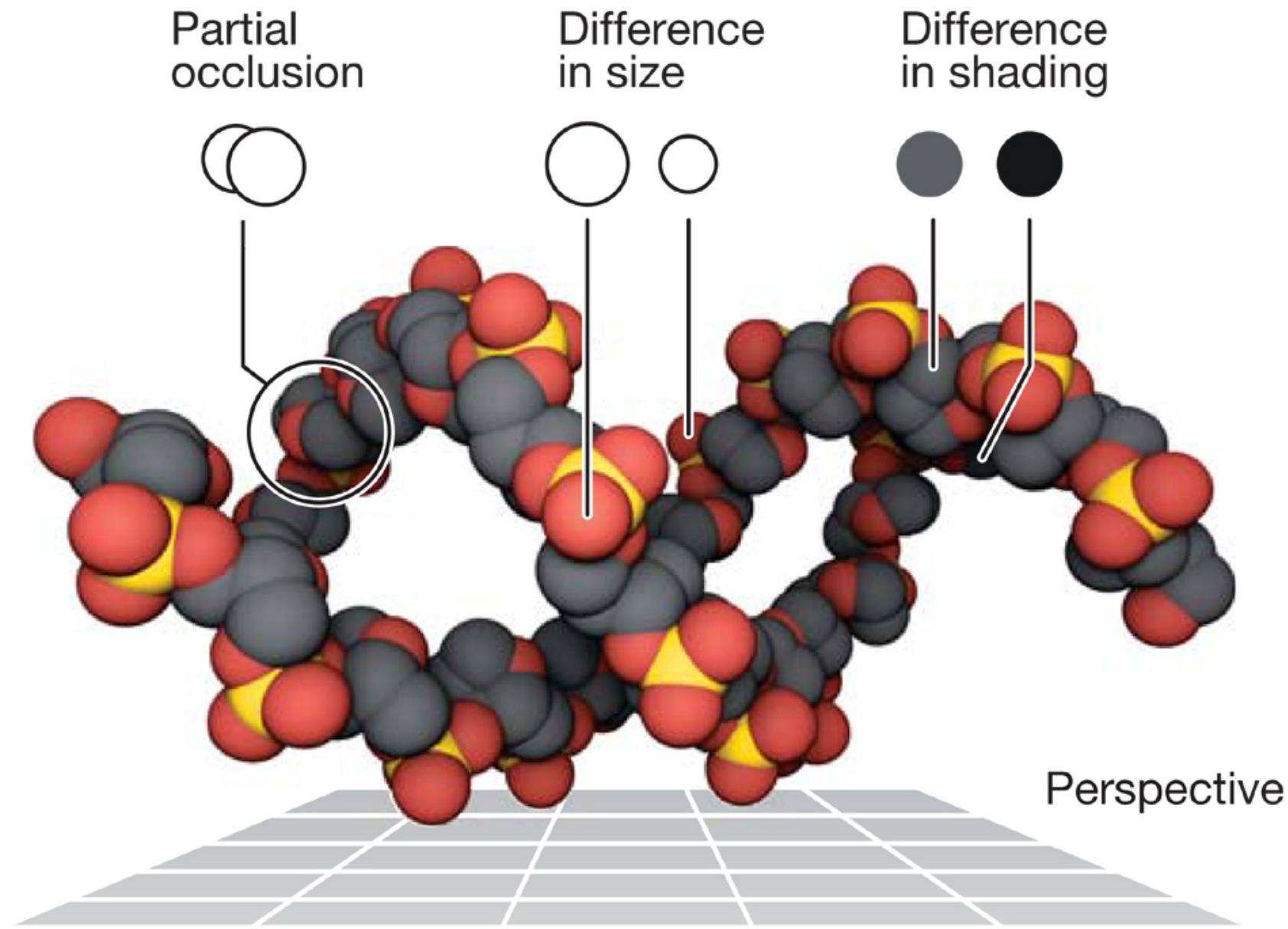
## VISUAL DEPTH CUES

Partial Occlusion

Shading

Color

Size



## EXAMPLES OF MULTIDIMENSIONAL PLANE VISUALIZATIONS

Heatmap

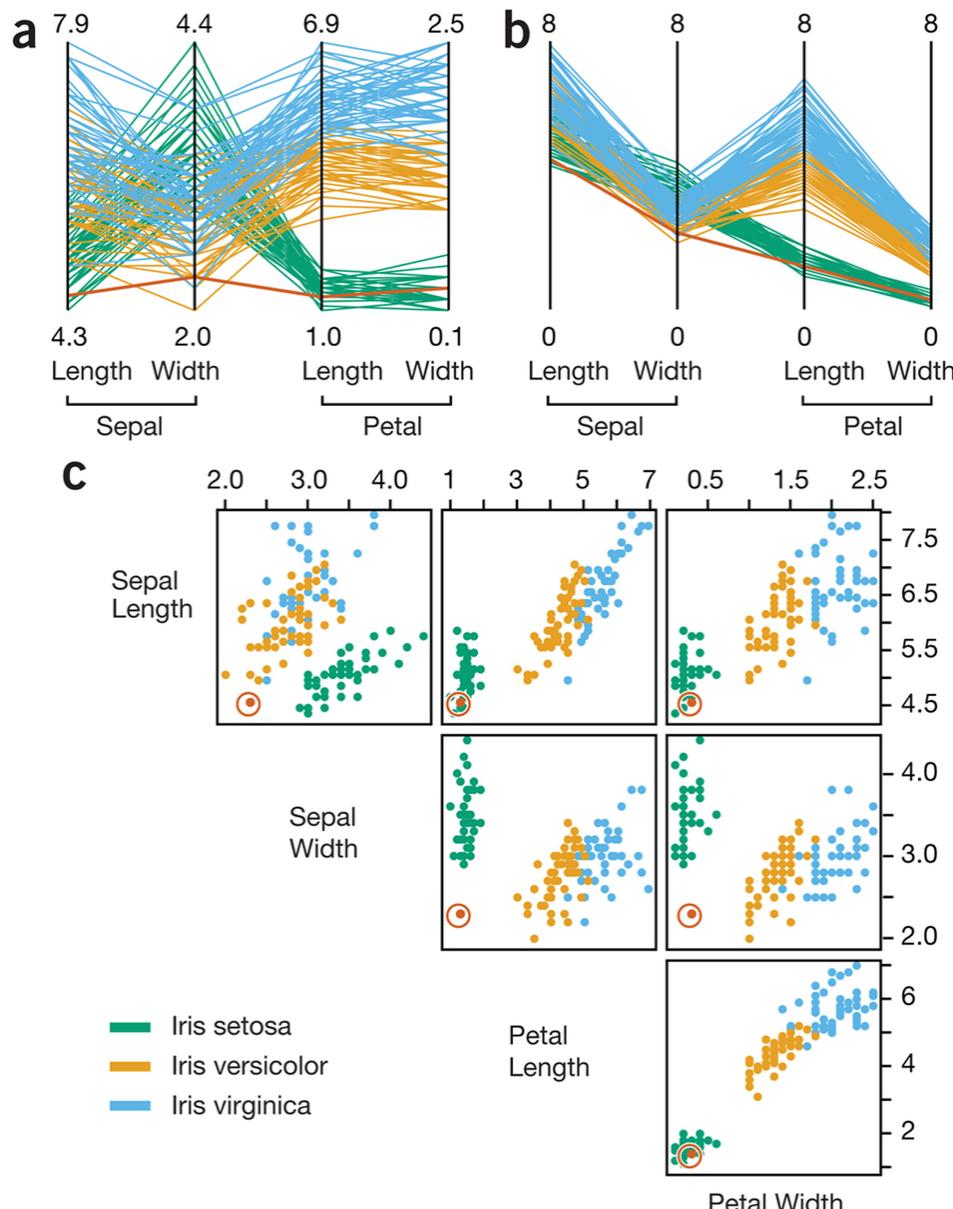
Scatter plot matrix

Parallel coordinates

Network

Trellis

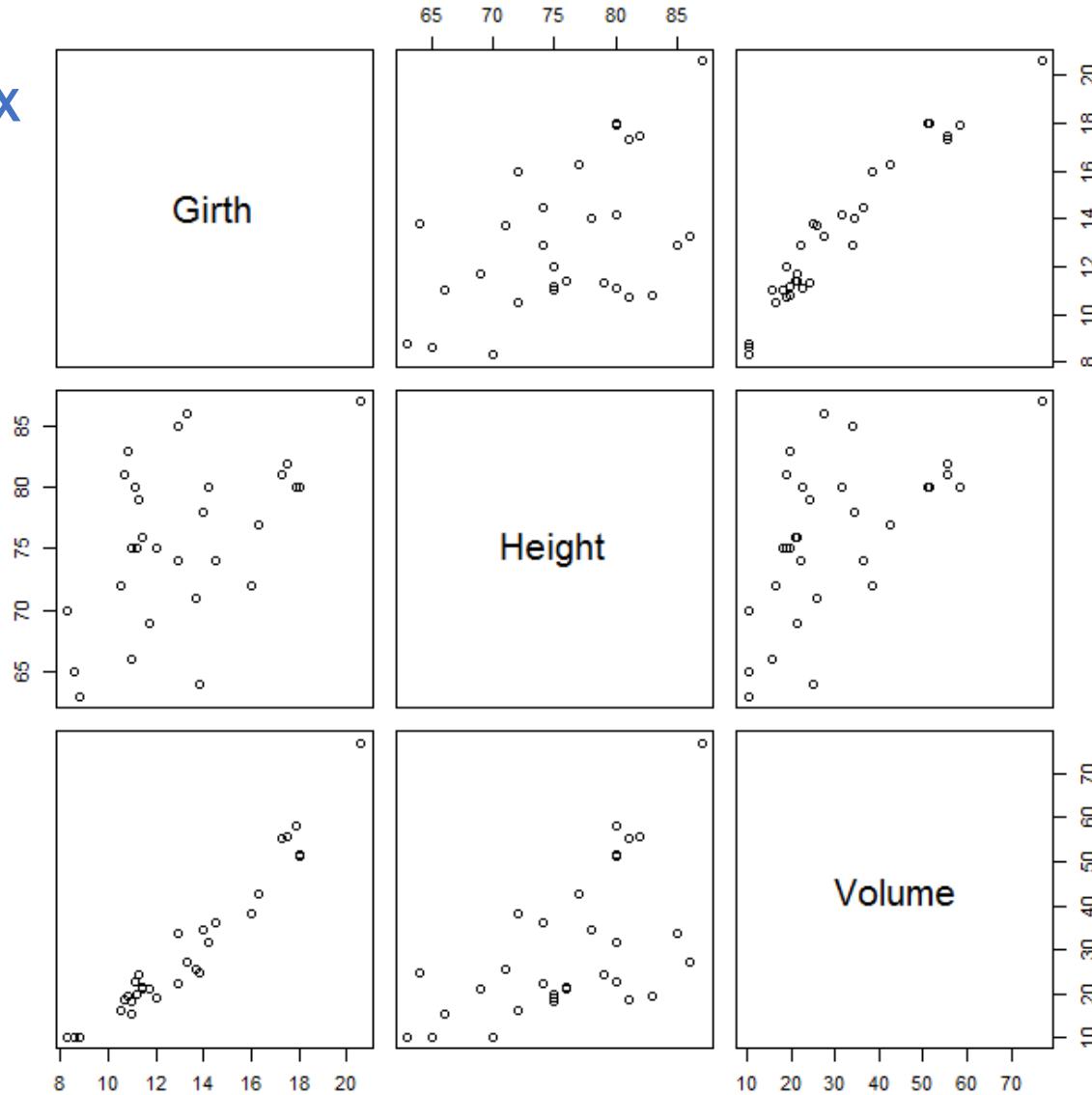
Small multiples



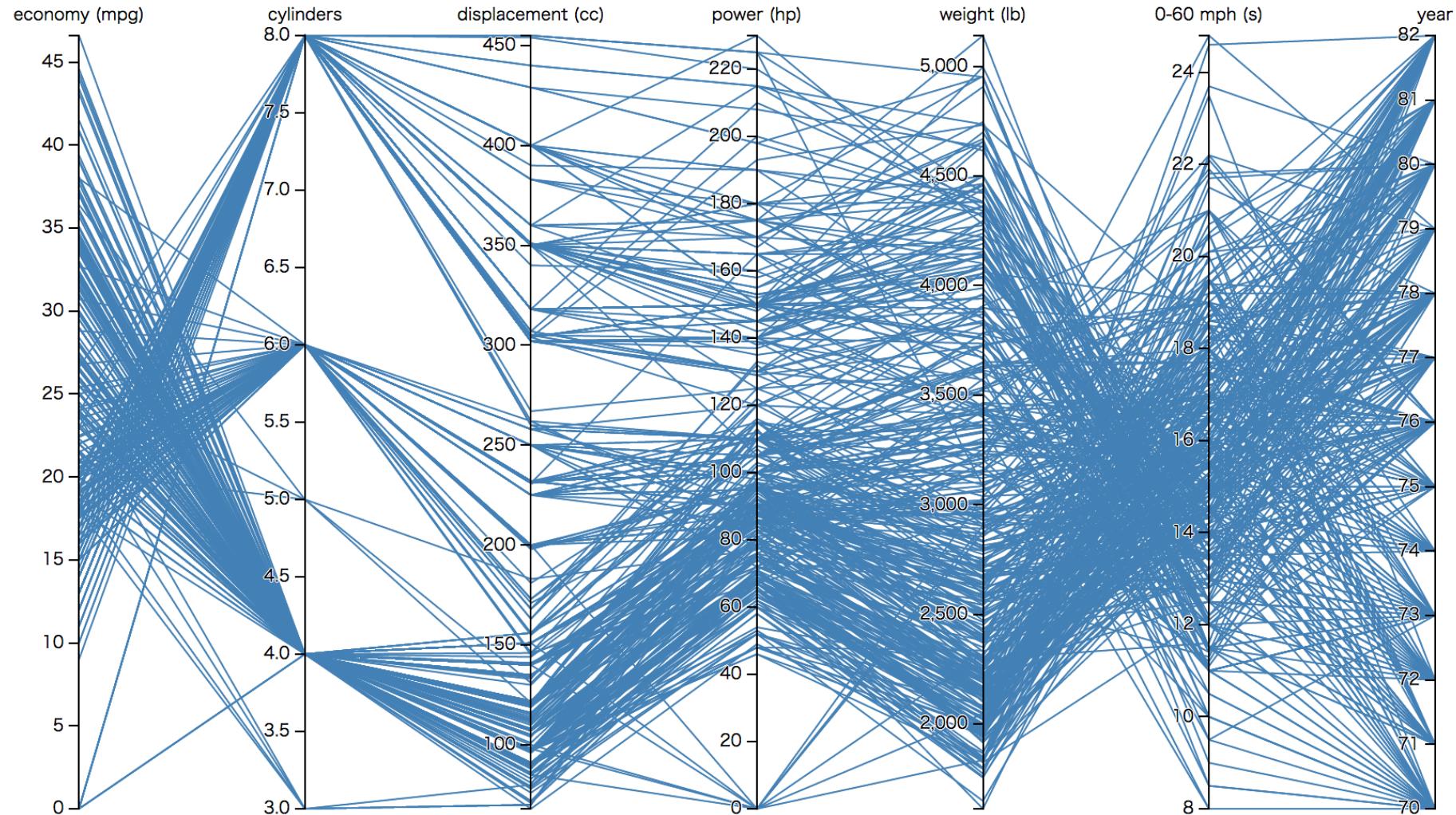
**Parallel coordinate plots** split out dimensions across several axes joined together by paths

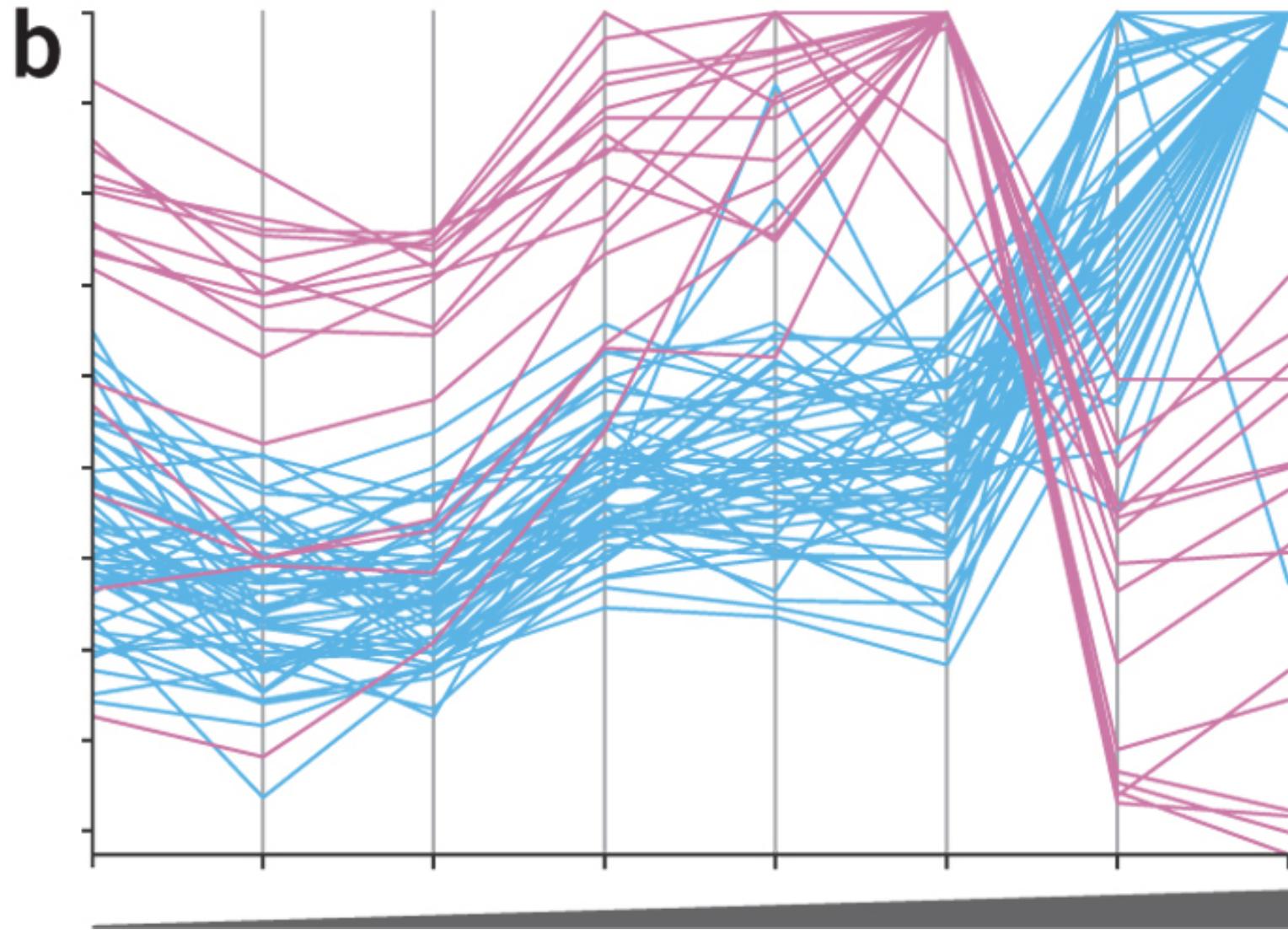
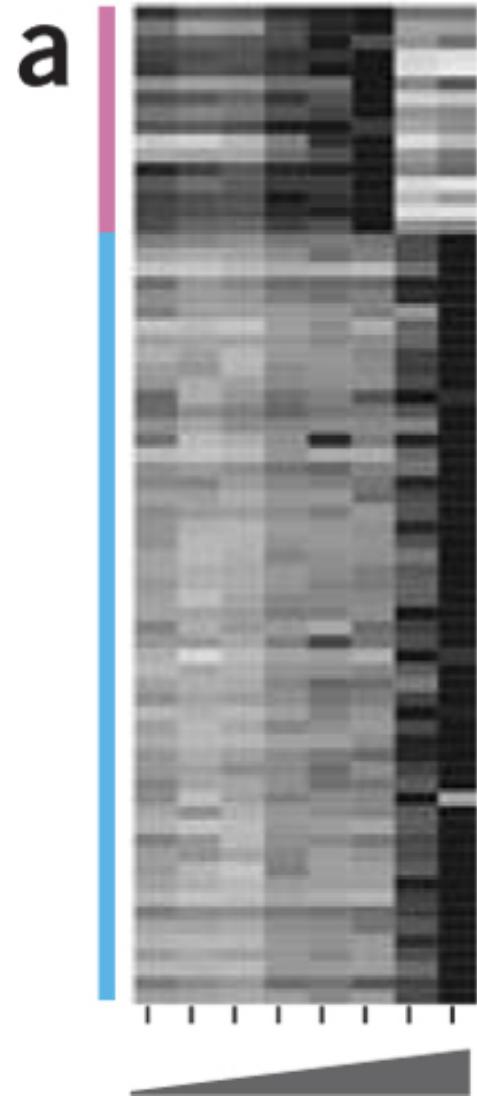
**Scatter plot matrices** arrange multiple scatter plots to enable cross-comparison across many dimensions

## Scatter plot matrix

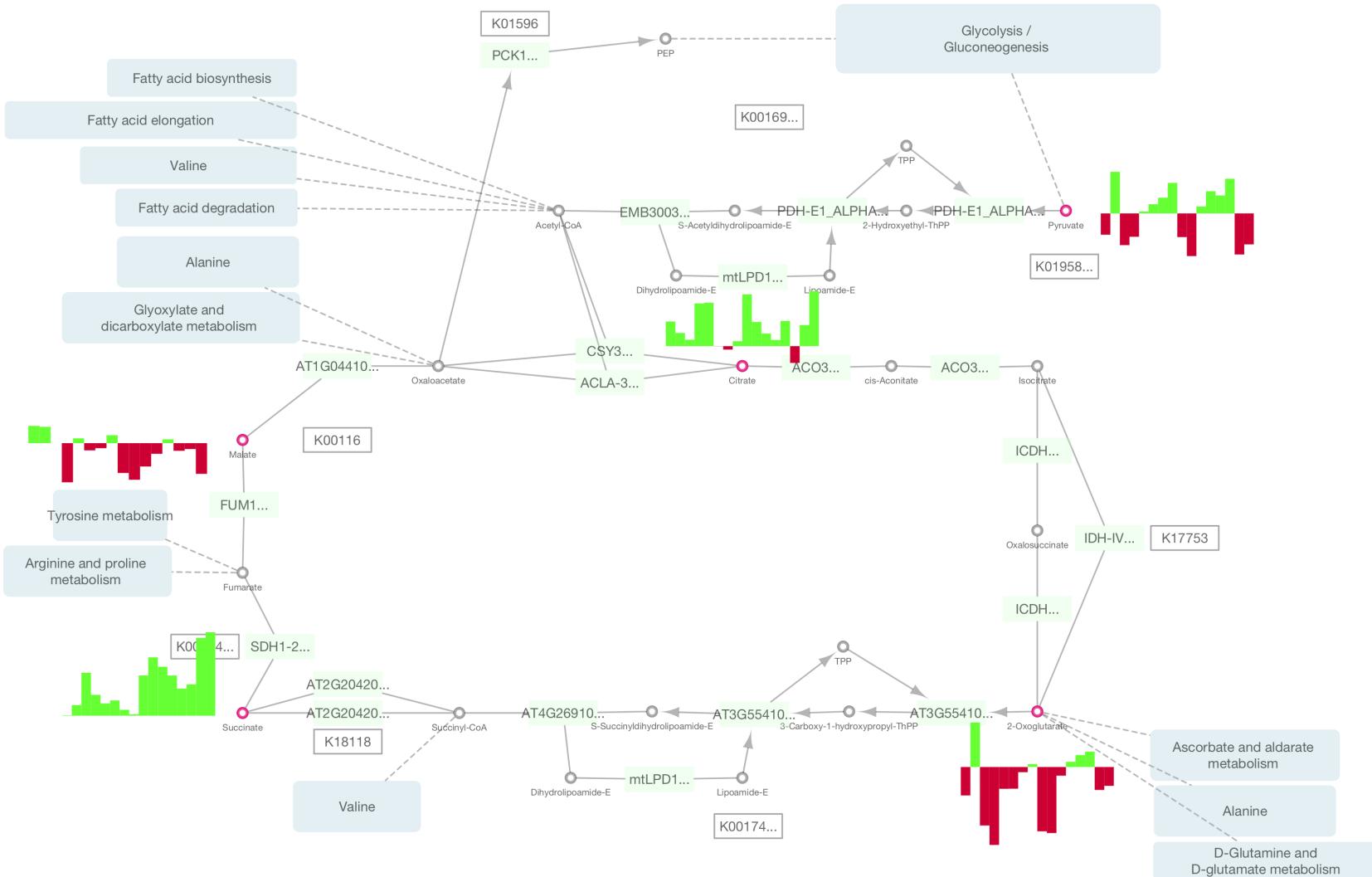


# Parallel Coordinates

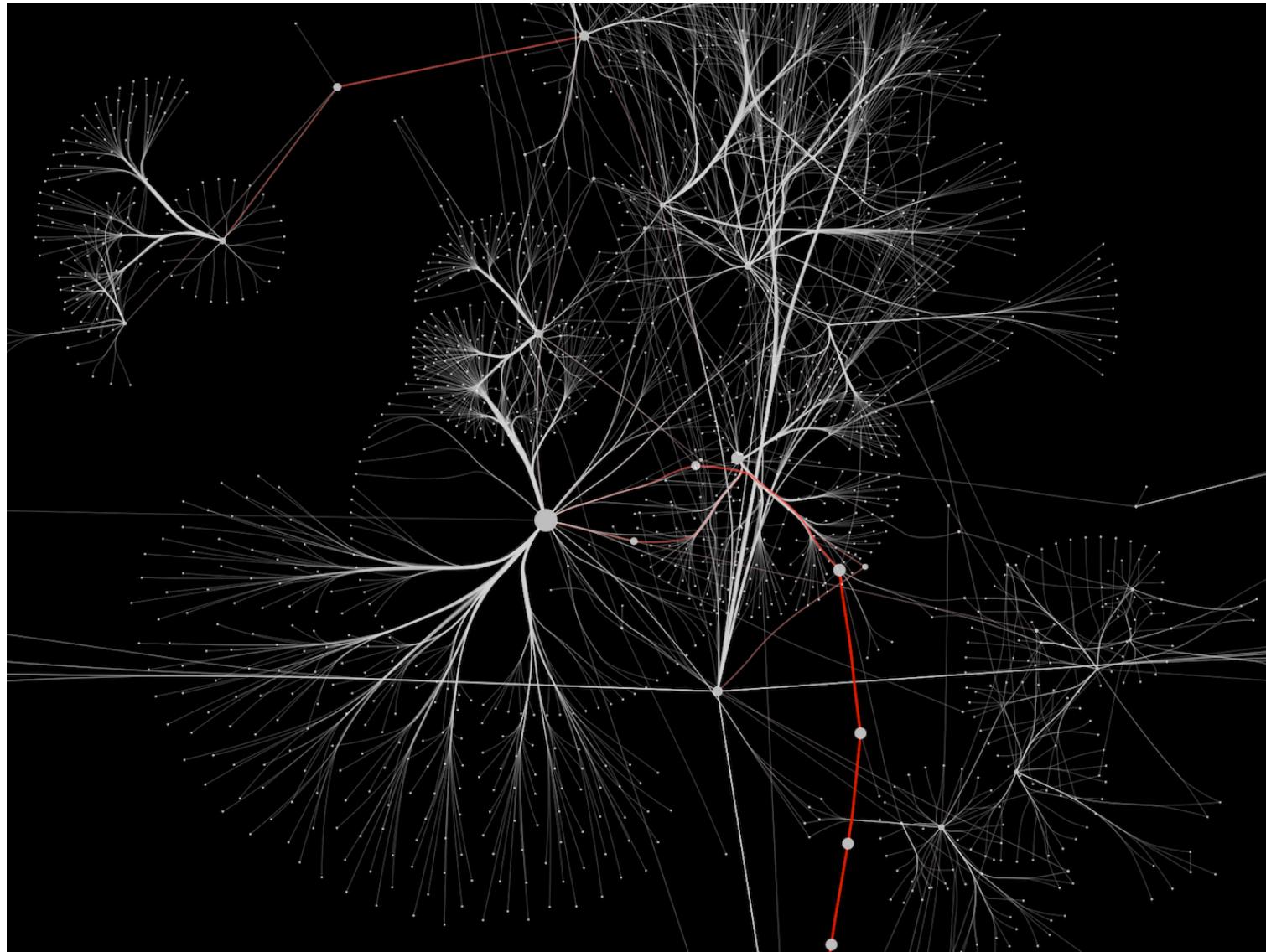




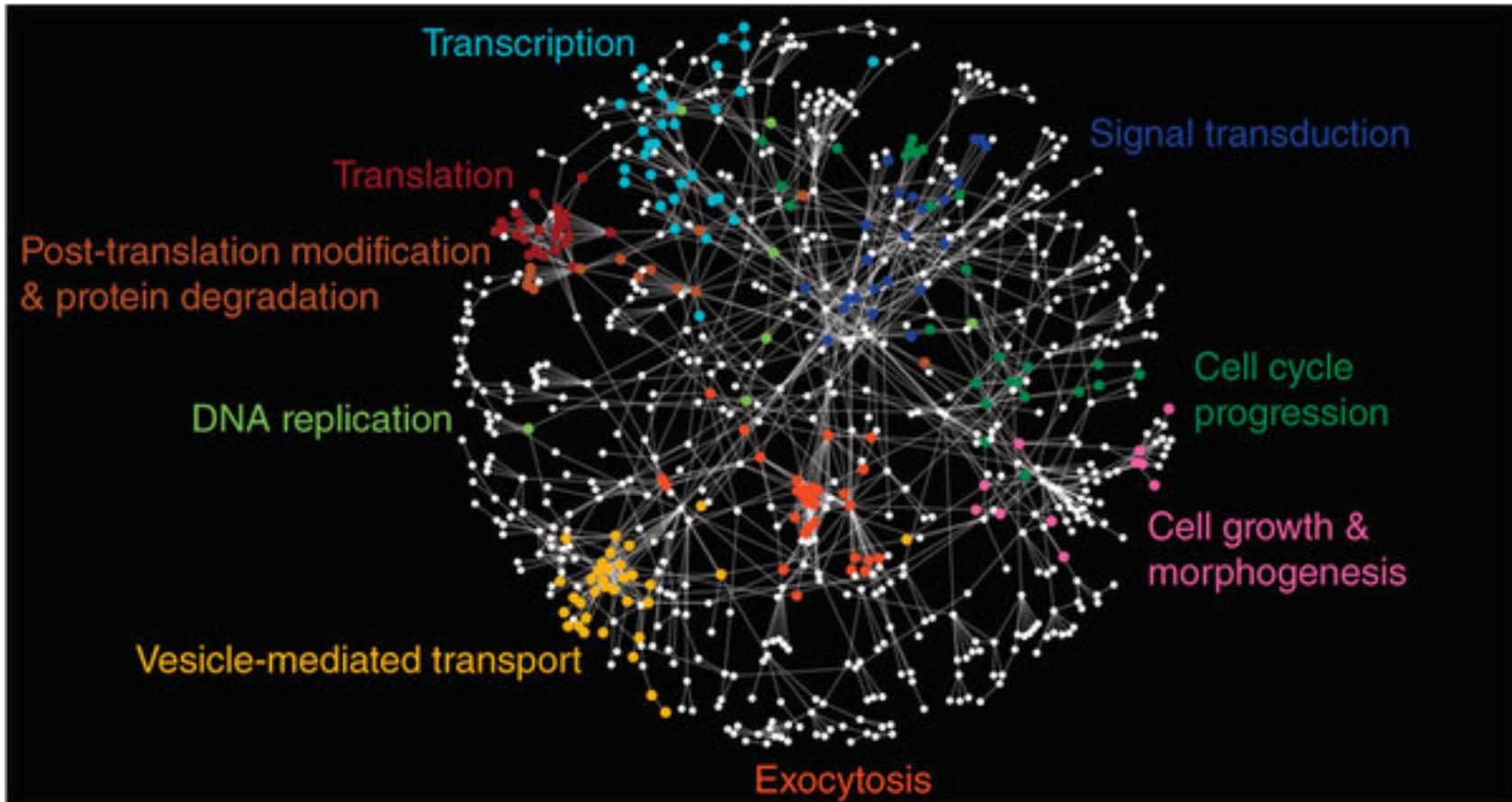
# Cytoscape



# Cytoscape

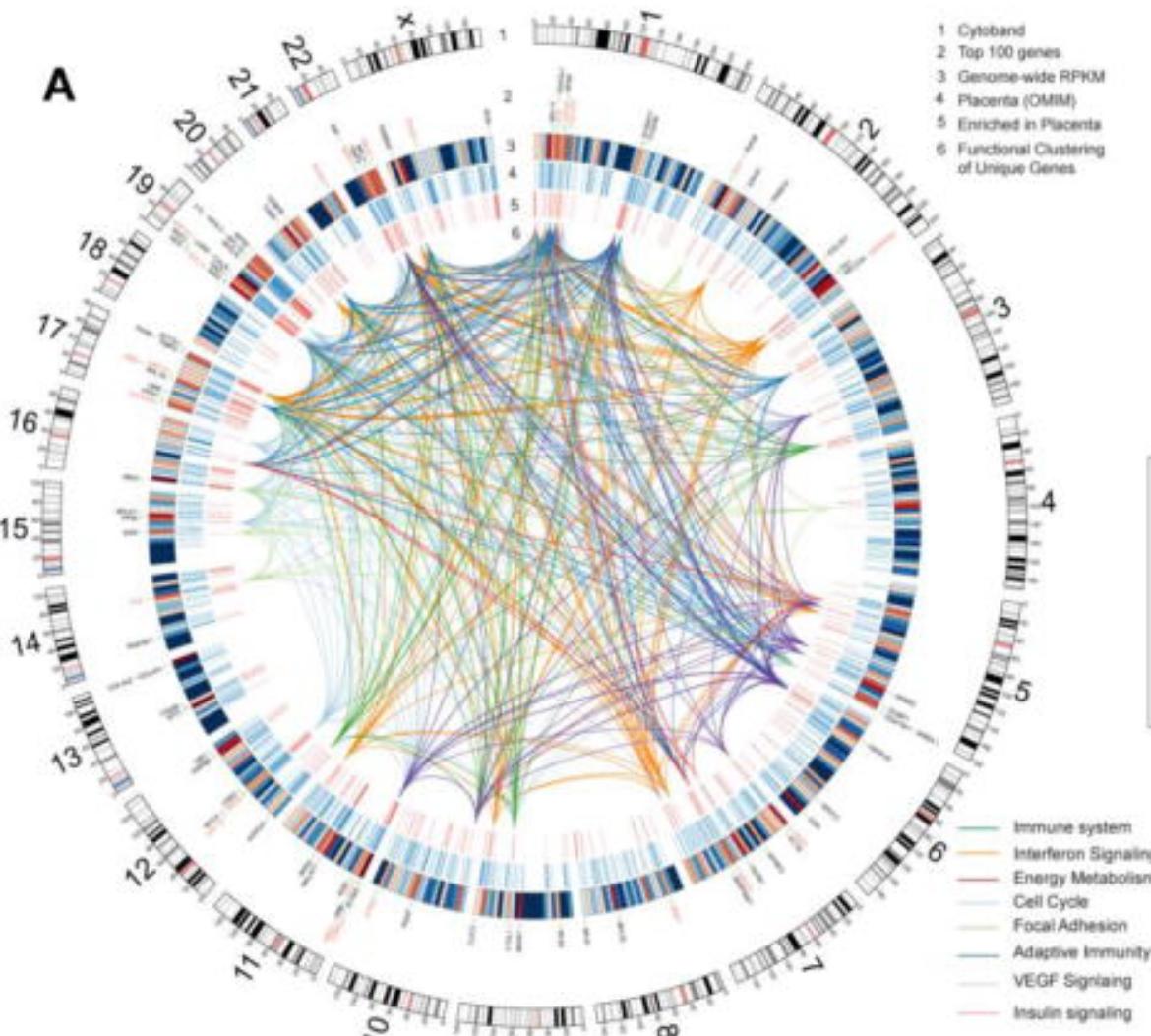


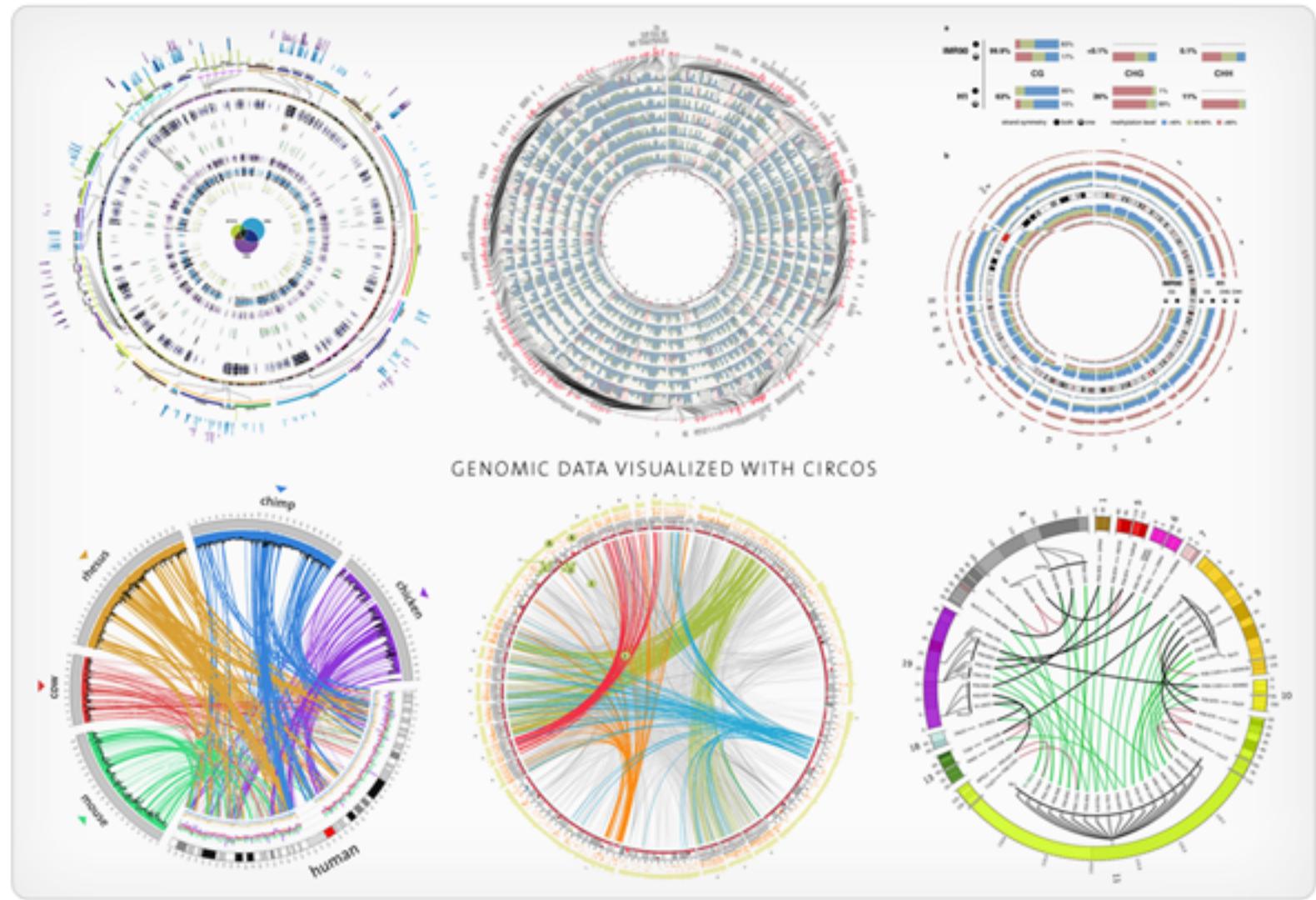
# Network



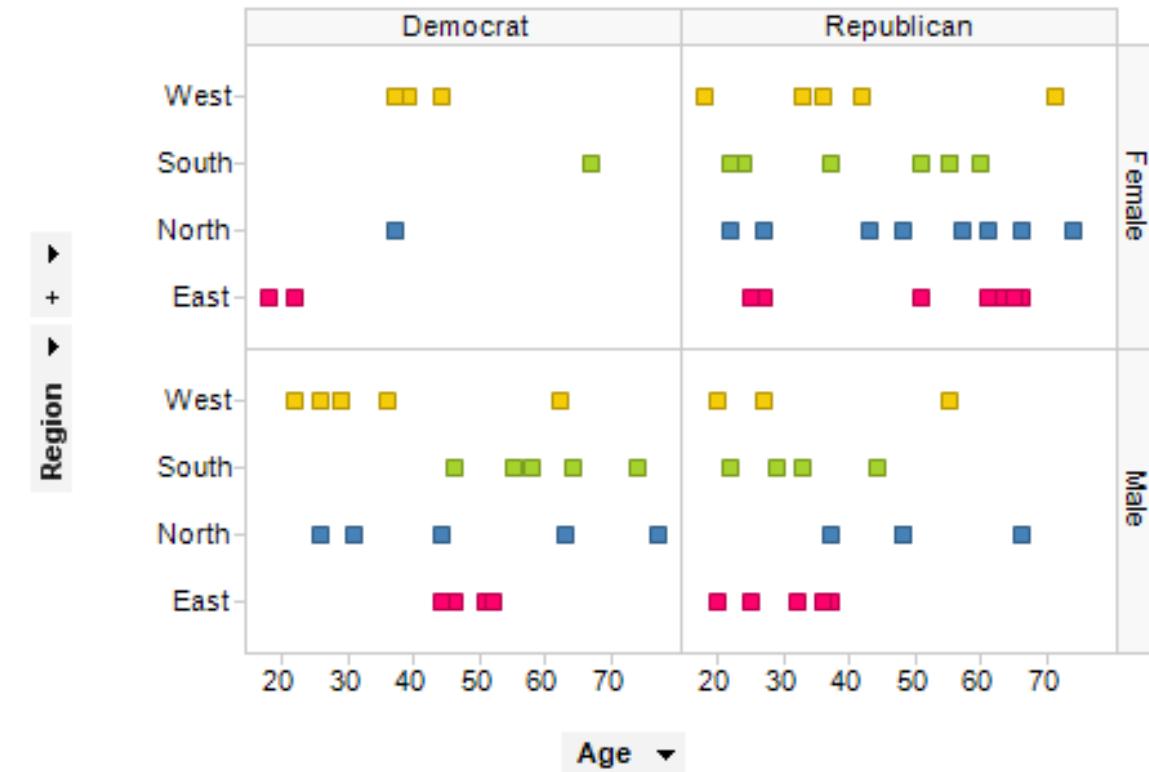
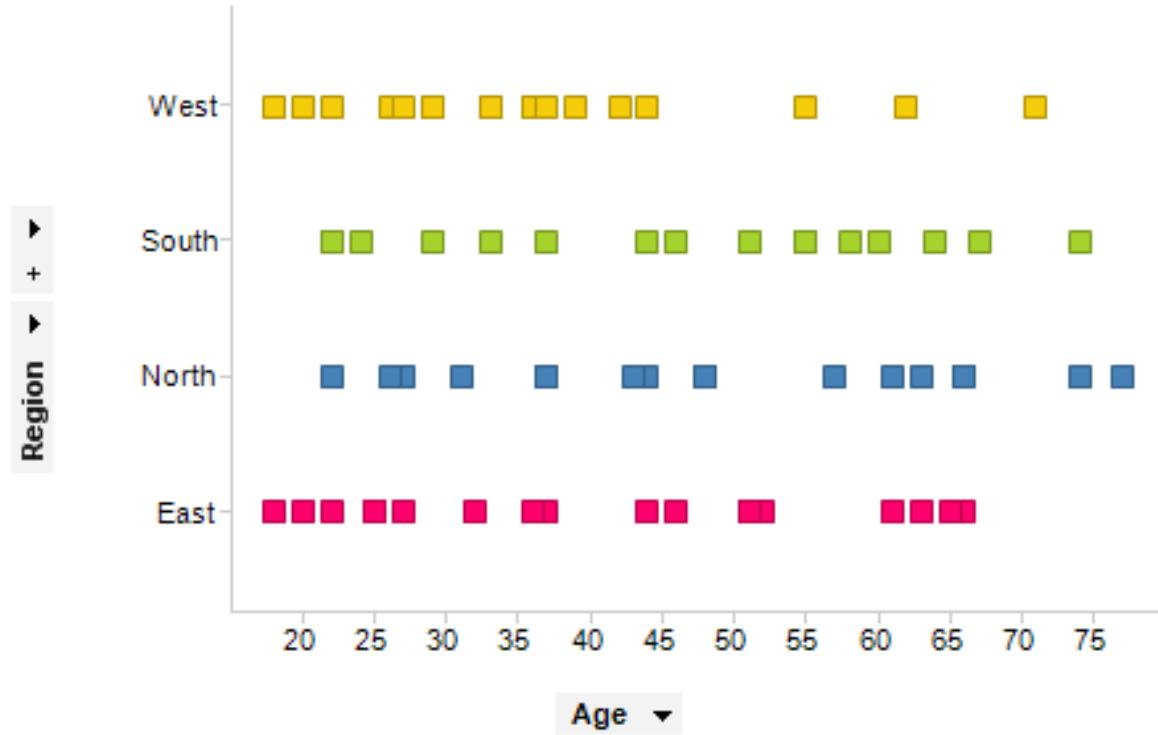
Magtanong et al. Dosage suppression genetic interaction networks enhance functional wiring diagrams of the cell. *Nature Biotechnology* 29, 505–511 (2011)

# Chord Diagram





# Trellis Display



## **TECHNIQUES FOR DIMENSIONAL REDUCTION**

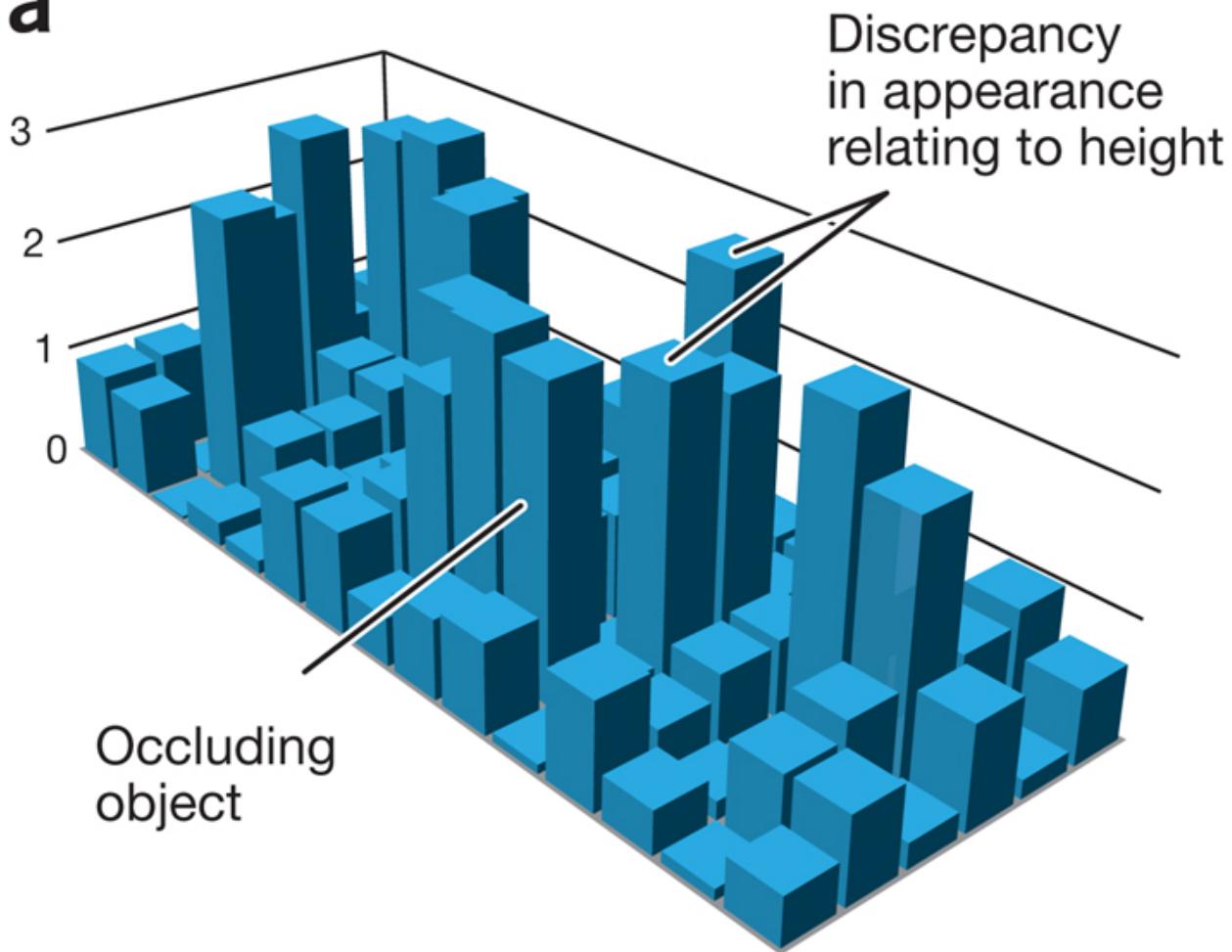
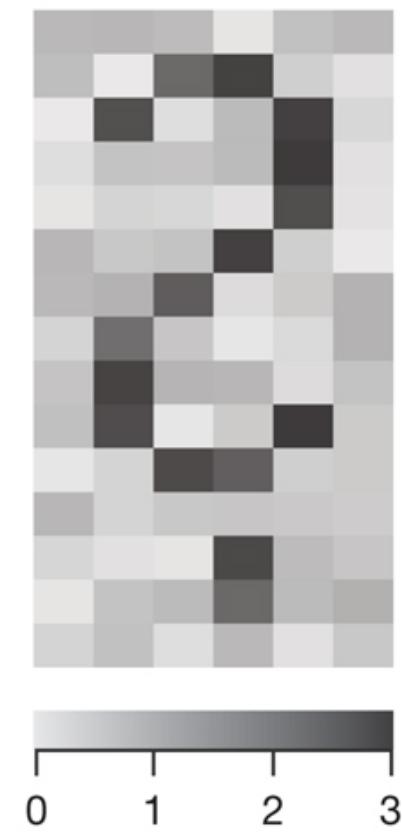
Principle Component Analysis (PCA)

Clustering

Sometimes, visual depth cues can  
produce unwanted

**perceptual artifacts**

if not used carefully

**a****b**

## Unequal Encodings

Our visual acuity for distinguishing differences varies across encodings like length, area, brightness, and saturation

4



4



4



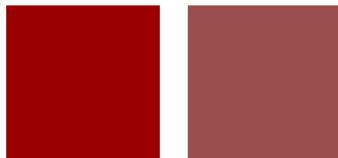
4



4



4



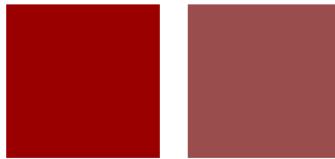
4



4

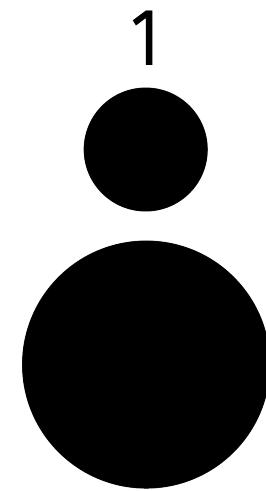
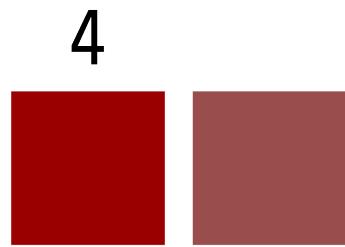


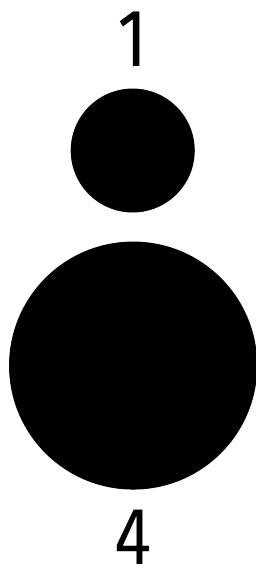
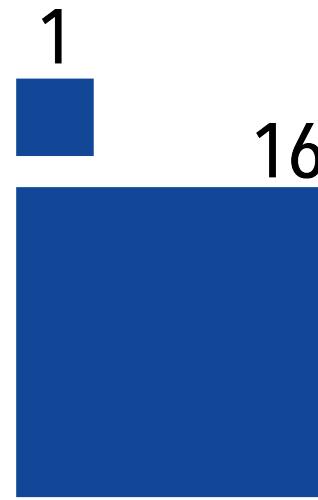
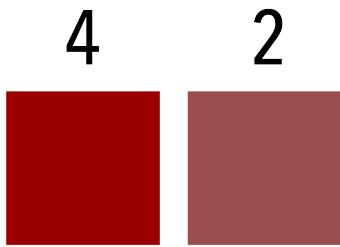
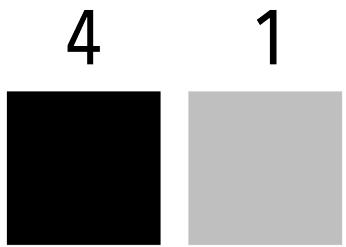
4



1







## WEBER'S LAW

The perceived change in a stimulus is proportional  
to the initial stimulus

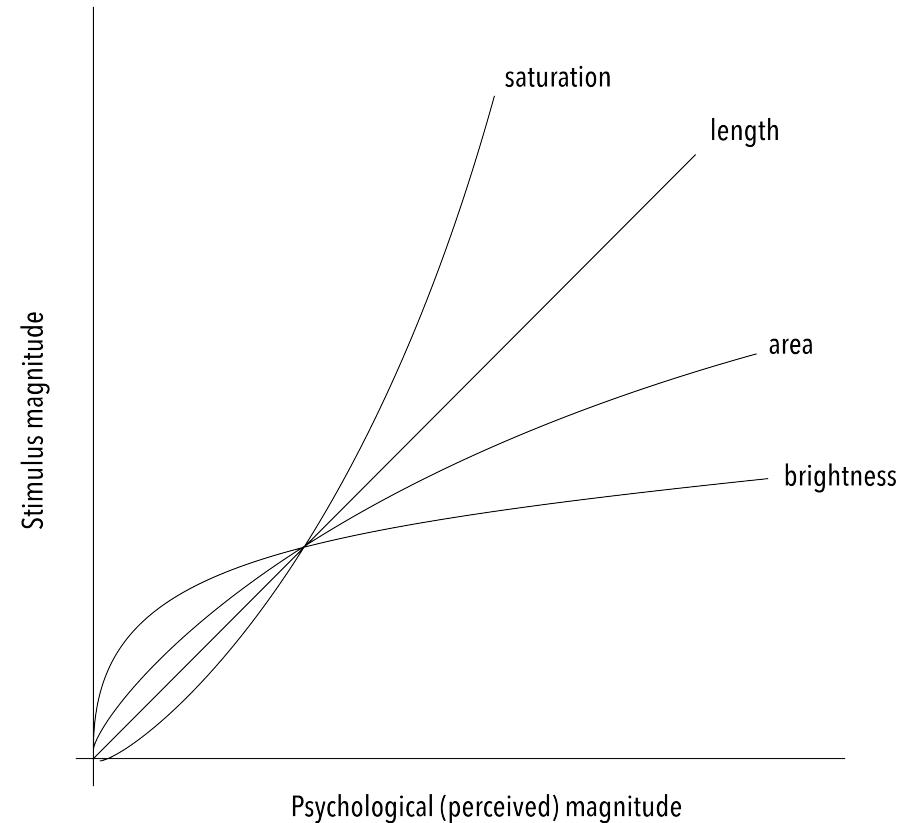
Also known as the **Just Noticeable Difference**,  
the amount something must be changed in order for a  
difference to be detectable

## STEVEN'S POWER LAW

The perceived magnitude or intensity of a stimulus

is related to the actual stimulus intensity

by a power law



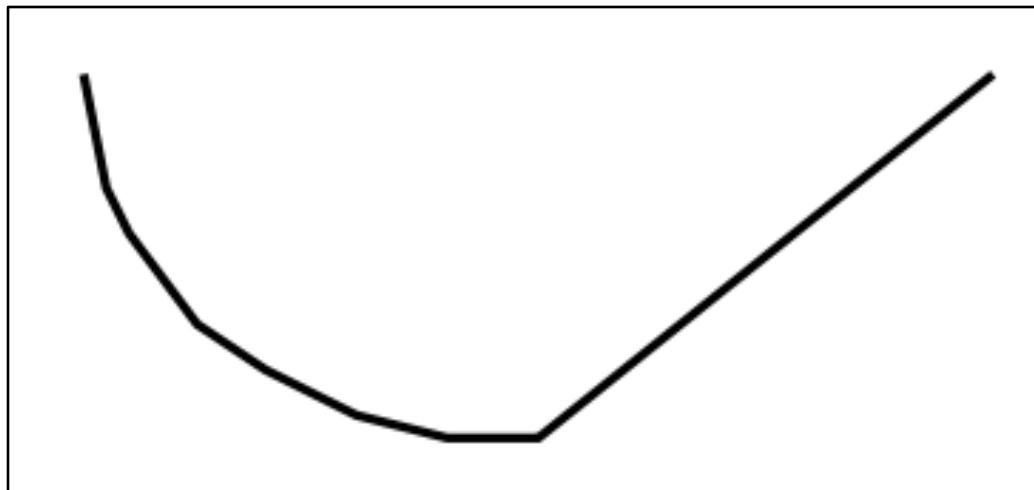
## VISUAL ENCODINGS

Color		Sequence		Length	
Value/Gradation		Size + Scale		Area	
Texture		Orientation		Proportion	
Symbol		Proximity/Density		Count	

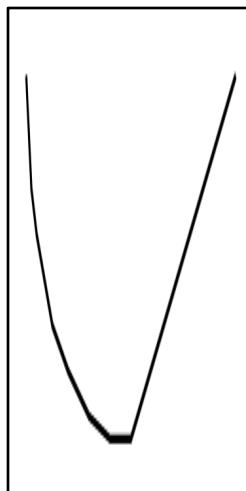
For two-dimensional representations,  
the aspect ratio should be chosen to  
bank line segments to **45° angles**

**ASPECT RATIO**  
*height / width*

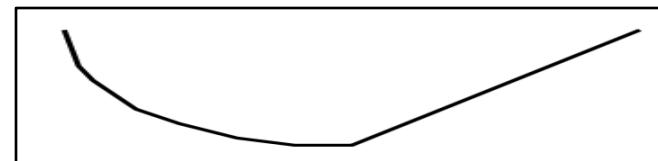
**1:2**



**2:1**

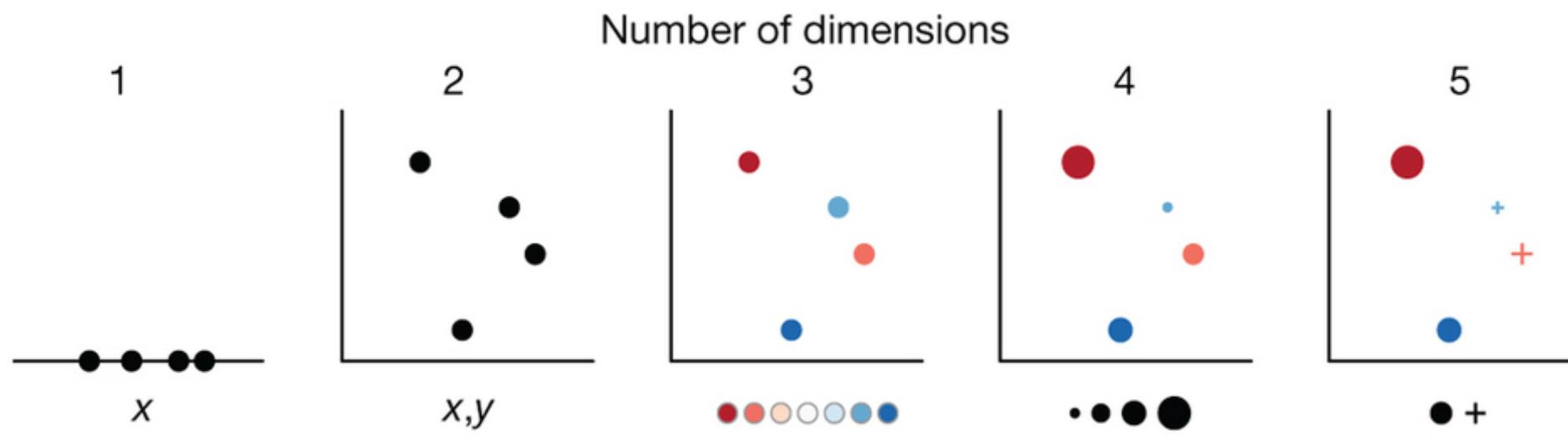


**1:4**



## Remember:

Visualizations of multidimensional  
data require more effort and training  
to be read and understood



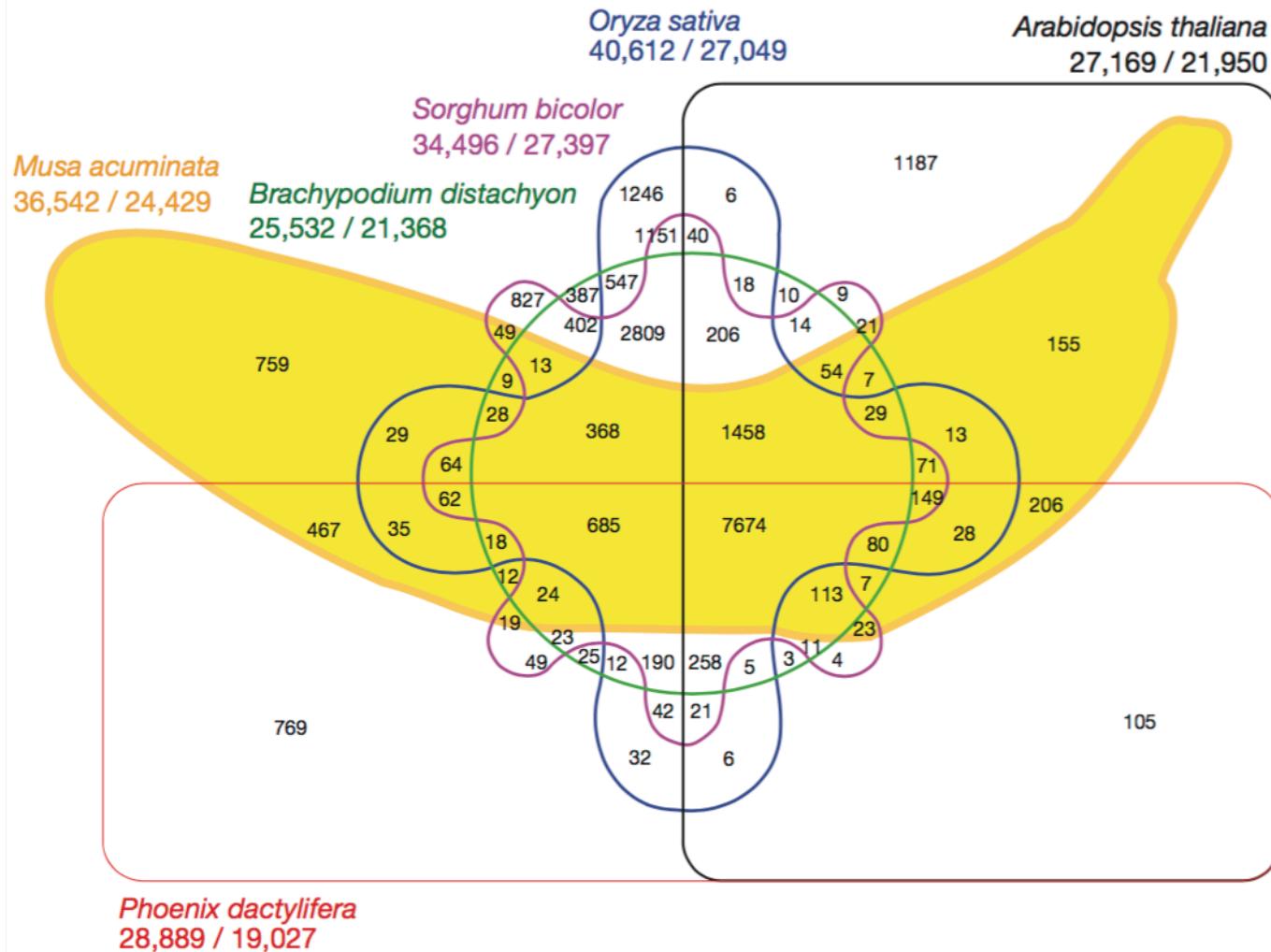
# UpSetR

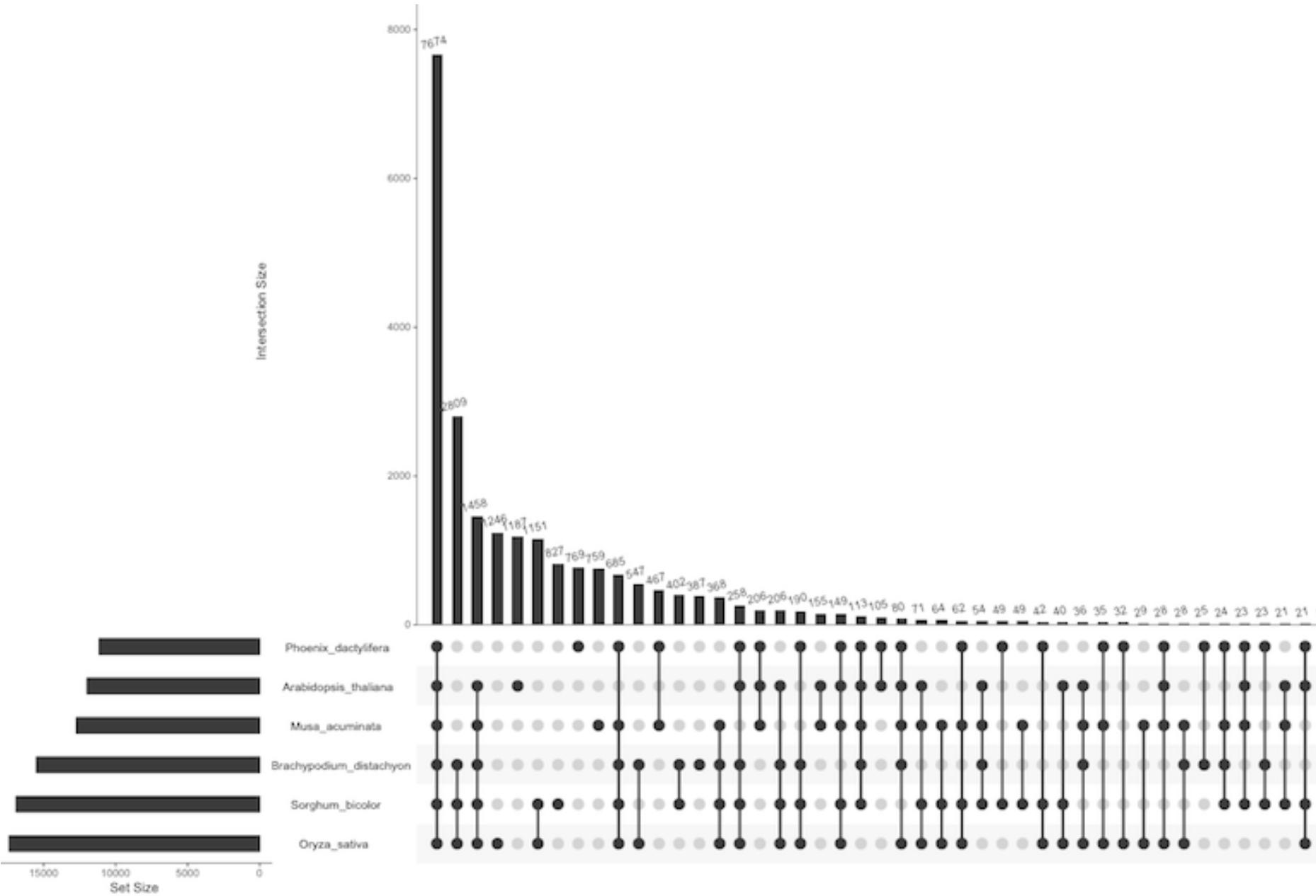
R package for quantitative analysis of sets,  
intersections of sets, and aggregates of  
intersections

<http://caleydo.org/tools/upset/>

<https://gehlenborglab.shinyapps.io/upsetr>



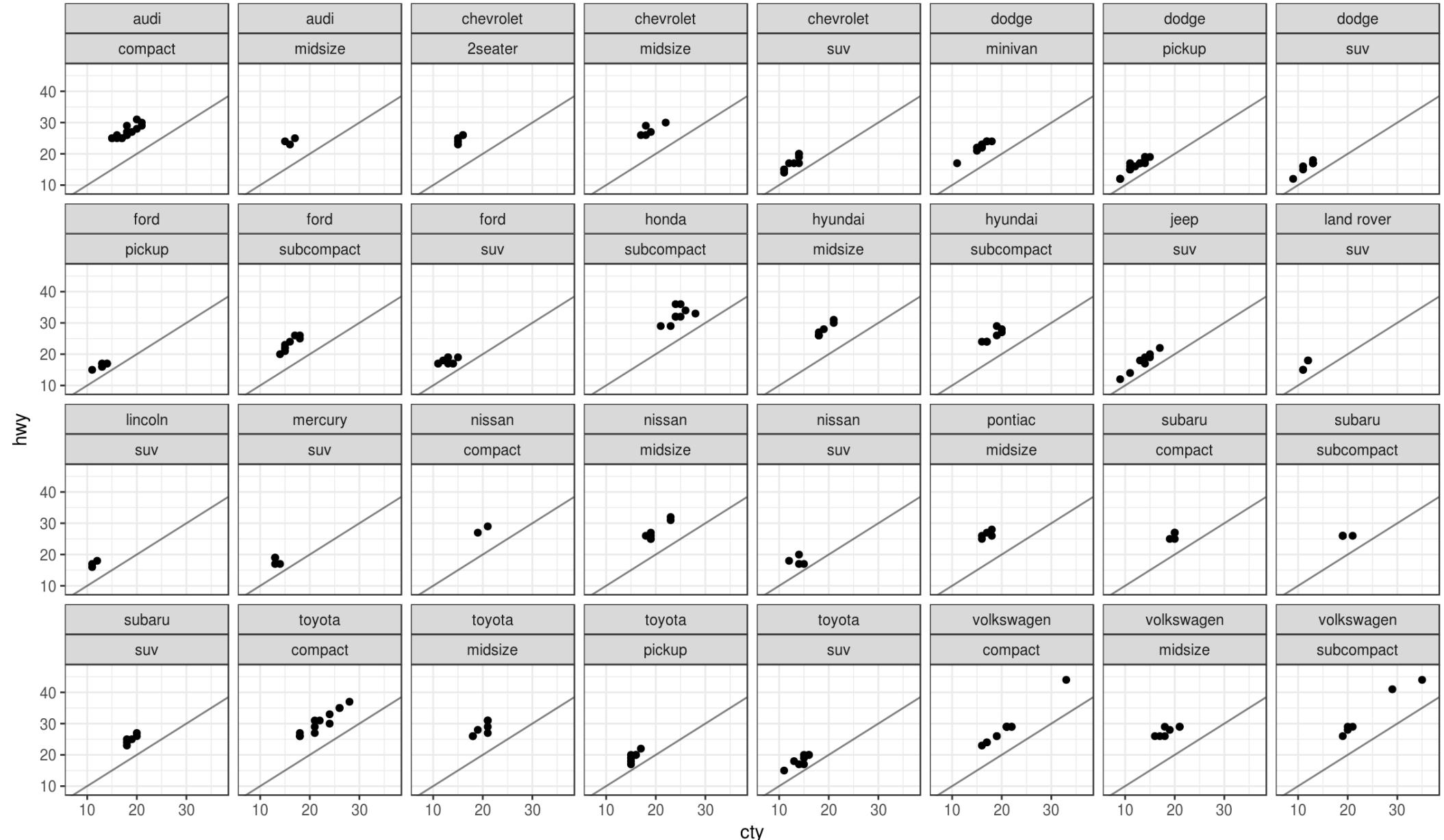


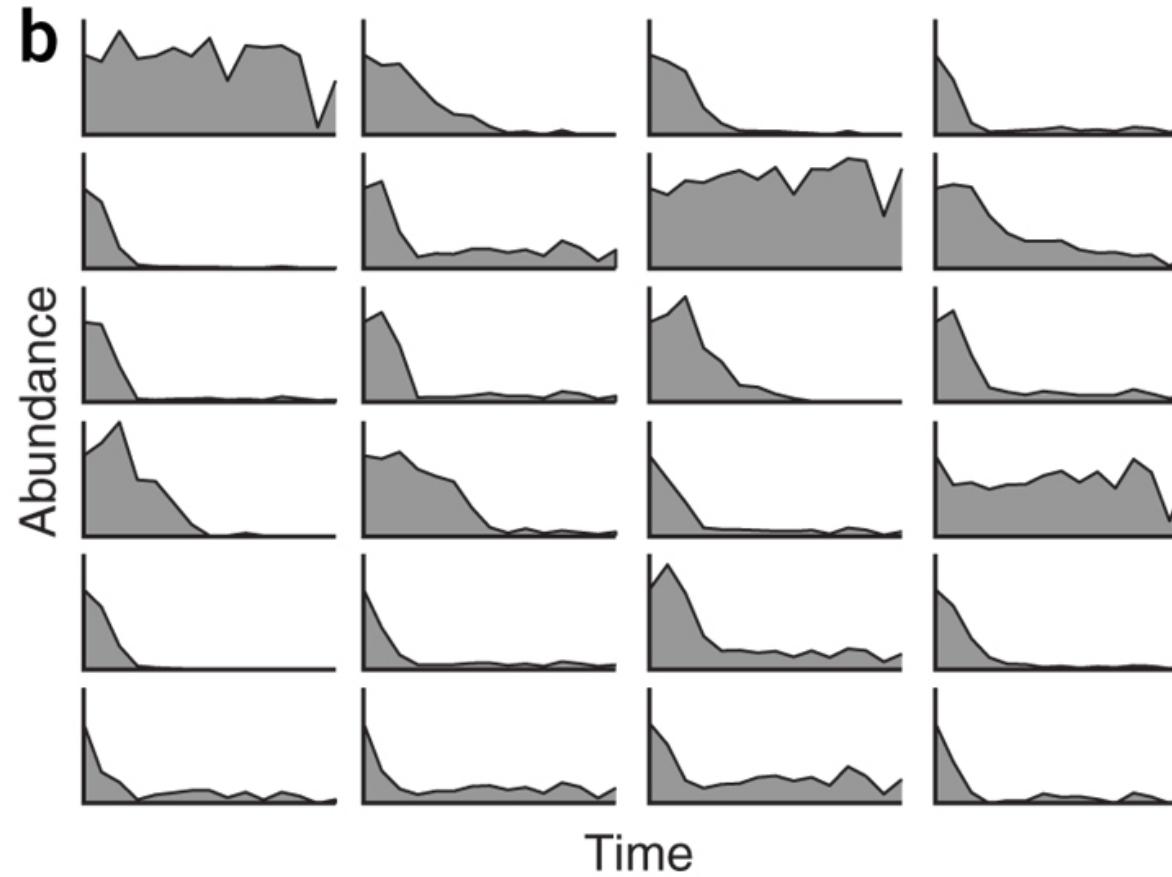


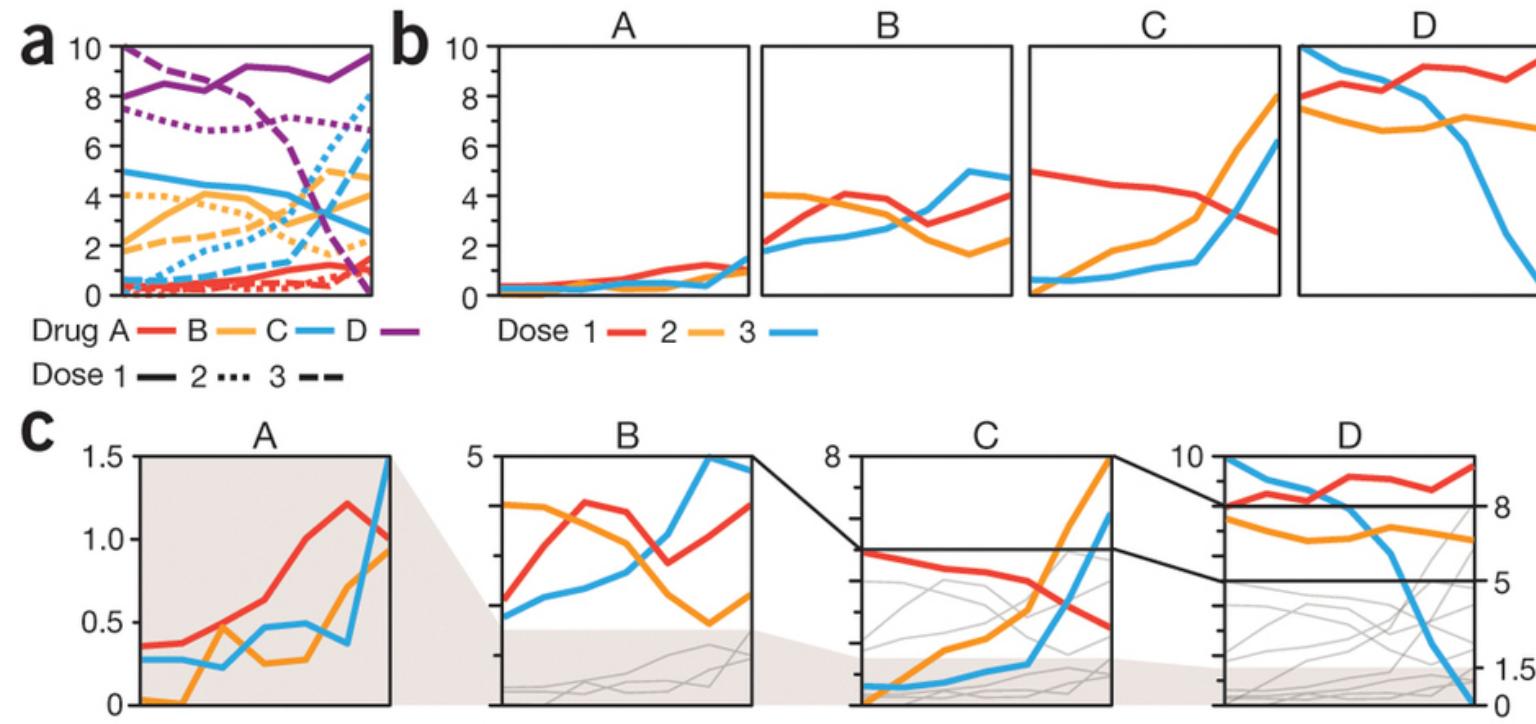
# trelliscopejs

An R package for creating interactive  
trellis displays of data

<https://hafen.github.io/trelliscopejs/>







Multidimensional data  
benefit from being represented in

**linked views**