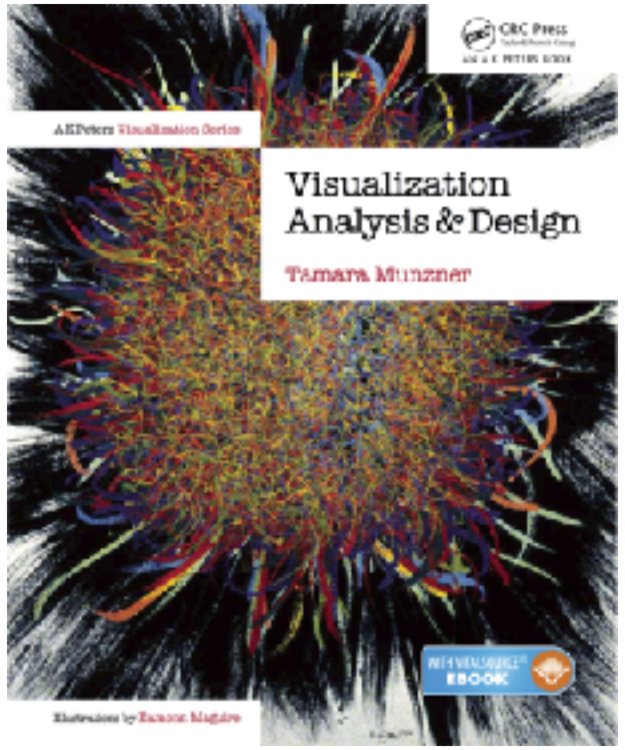
Visualization Analysis & Design



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University of British Columbia

DESIGNING for PEOPLE

CAIDA

UBC Data Science Institute

UBC Alumni/Industry Lecture
Feb 27 2020, Vancouver BC

http://www.cs.ubc.ca/~tmm/talks.html#vad20alum

@tamaramunzner

Visualization: definition & motivation

Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively.

Visualization is suitable when there is a need to augment human capabilities rather than replace people with computational decision-making methods.

- human in the loop needs the details & no trusted automatic solution exists
  - –doesn't know exactly what questions to ask in advance
  - –exploratory data analysis
    - ***speed up*** through human-in-the-loop visual data analysis
  - –present known results to others
  - –stepping stone towards automation
    - –before model creation to provide understanding
    - –during algorithm creation to refine, debug, set parameters
    - –before or during deployment to build trust and monitor

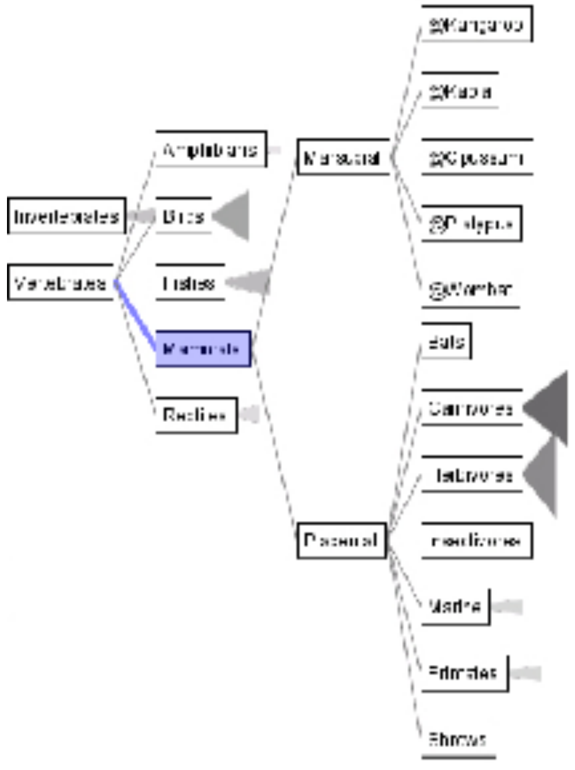
more at:
Visualization Analysis and Design.
Munzner. CRC Press, 2014.

<u>www.cs.ubc.ca/~tmm/talks.html#vad20alum</u>

Why analyze?

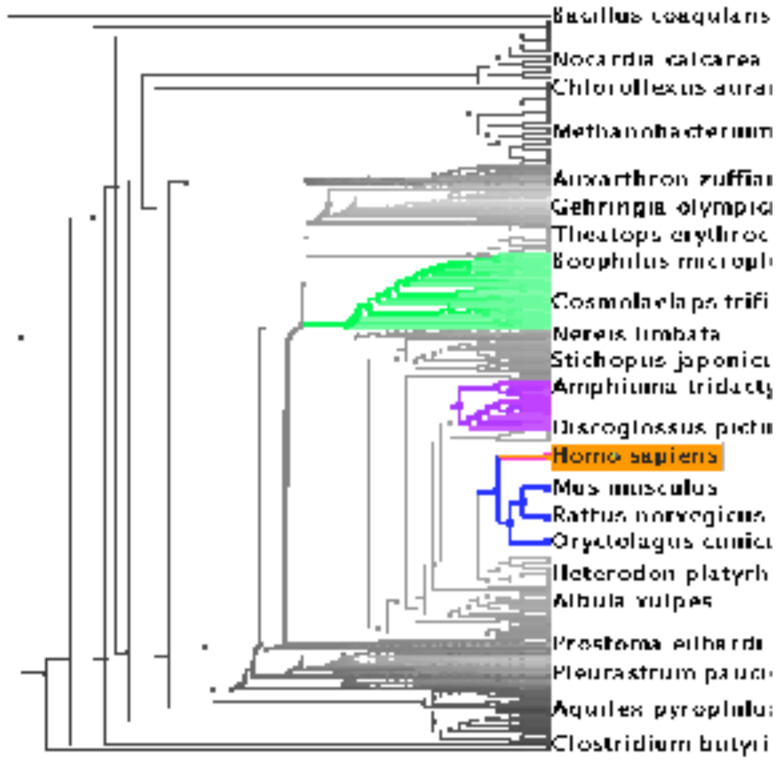
- imposes a structure on huge design space
  - scaffold to help you think systematically about choices
  - analyzing existing as stepping stone to designing new

SpaceTree

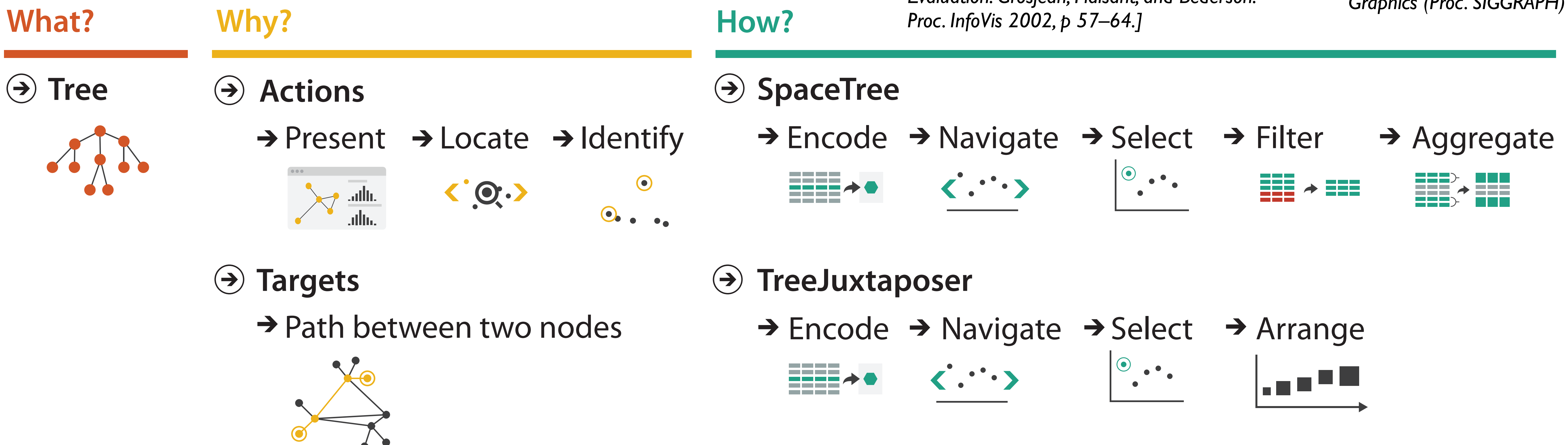


[SpaceTree: Supporting Exploration in Large Node Link Tree, Design Evolution and Empirical Evaluation. Grosjean, Plaisant, and Bederson. Proc. InfoVis 2002, p 57–64.]

TreeJuxtaposer



[TreeJuxtaposer: Scalable Tree Comparison Using Focus+Context With Guaranteed Visibility. ACM Trans. on Graphics (Proc. SIGGRAPH) 22:453– 462, 2003.]



What?

➔ Tree

Why?

➔ Actions

➔ Present ➔ Locate ➔ Identify

➔ Targets

➔ Path between two nodes

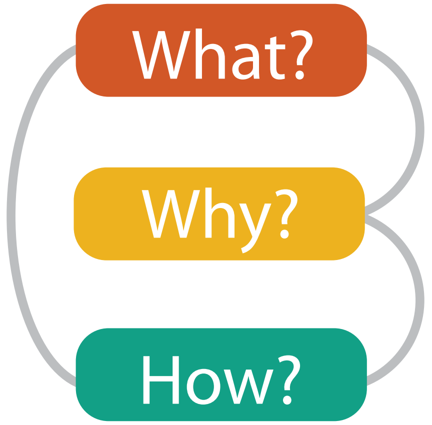
How?

➔ SpaceTree

➔ Encode ➔ Navigate ➔ Select ➔ Filter ➔ Aggregate

➔ TreeJuxtaposer

➔ Encode ➔ Navigate ➔ Select ➔ Arrange



What?

Why?

How?

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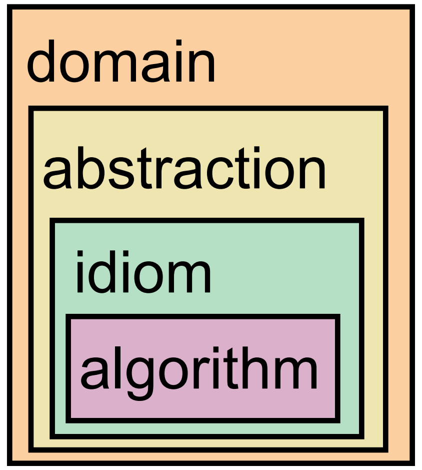
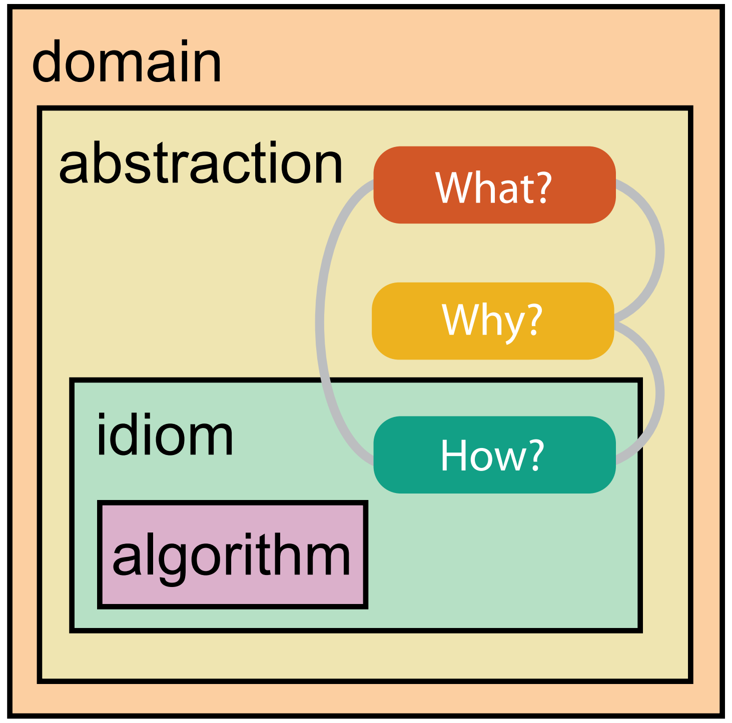
Analysis framework: Four levels, three questions

- *domain* situation
  - –who are the target users?
- *abstraction*
  - –translate from specifics of domain to vocabulary of vis
- **what** is shown? **data abstraction**
  - often don't just draw what you're given: transform to new form
- **why** is the user looking at it? **task abstraction**
- *idiom*
- **how** is it shown?
  - **visual encoding idiom**: how to draw
  - **interaction idiom**: how to manipulate
- *algorithm*
  - –efficient computation



[A Nested Model of Visualization Design and Validation.
Munzner. IEEE TVCG 15(6):921-928, 2009 (Proc. InfoVis 2009).]



[A Multi-Level Typology of Abstract Visualization Tasks
Brehmer and Munzner. IEEE TVCG 19(12):2376-2385, 2013 (Proc. InfoVis 2013).]

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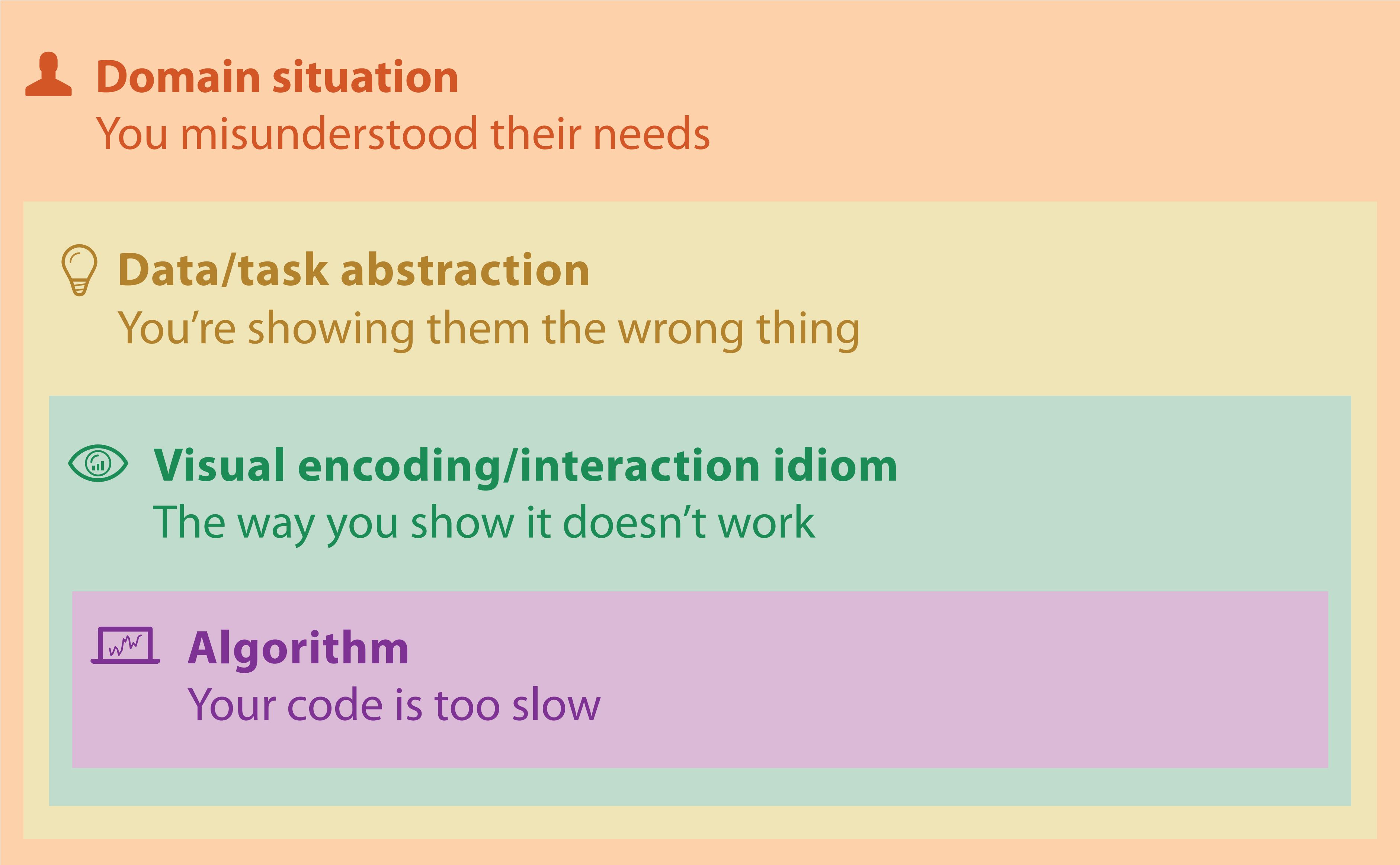
Why is validation difficult?

- different ways to get it wrong at each level



Domain situation
You misunderstood their needs

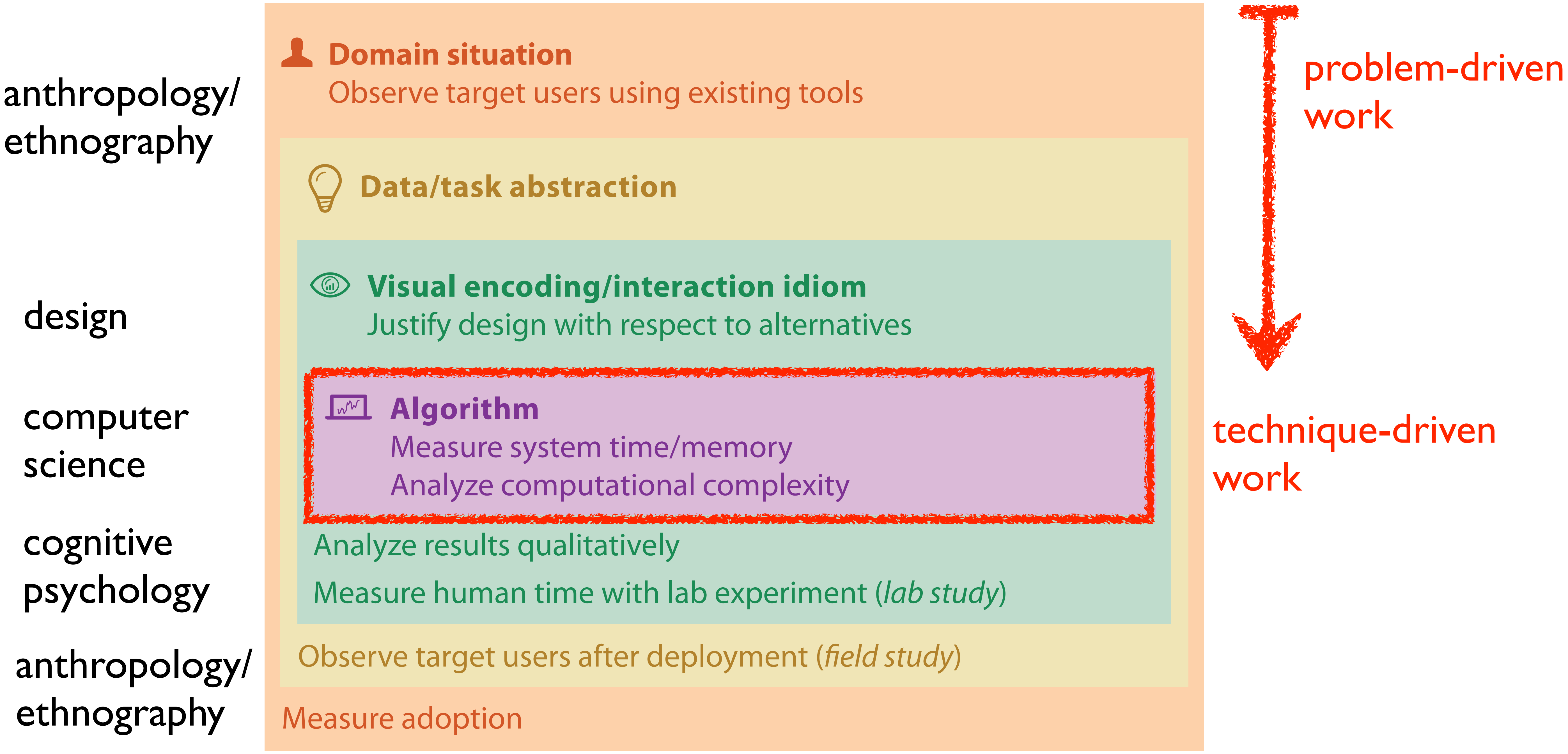
Data/task abstraction
You're showing them the wrong thing

Visual encoding/interaction idiom
The way you show it doesn't work

Algorithm
Your code is too slow

Why is validation difficult?

- solution: use methods from different fields at each level



anthropology/ ethnography

design

computer science

cognitive psychology

anthropology/ ethnography

Domain situation
Observe target users using existing tools

Data/task abstraction

Visual encoding/interaction idiom
Justify design with respect to alternatives

Algorithm
Measure system time/memory
Analyze computational complexity

Analyze results qualitatively

Measure human time with lab experiment (*lab study*)

Observe target users after deployment (*field study*)

Measure adoption

problem-driven work

technique-driven work

[A Nested Model of Visualization Design and Validation. Munzner. IEEE TVCG 15(6):921-928, 2009 (Proc. InfoVis 2009).]

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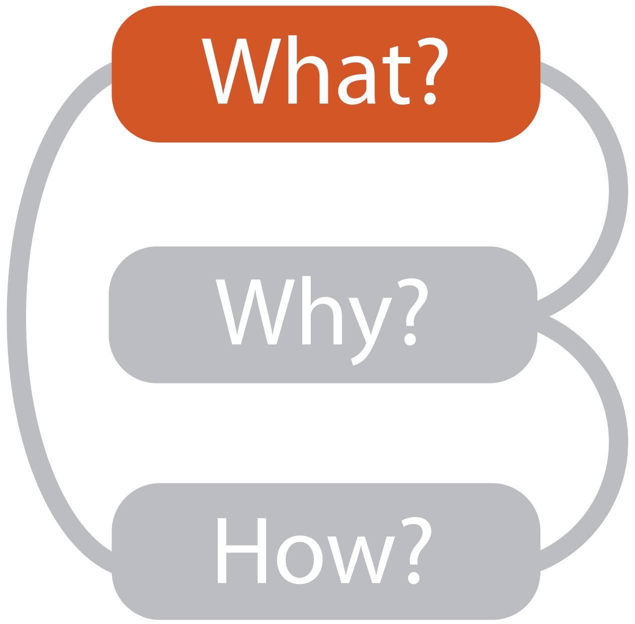


What?

Datasets

Data Types

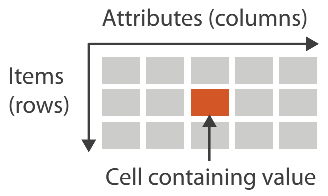
- Items
- Attributes
- Links
- Positions
- Grids

Data and Dataset Types

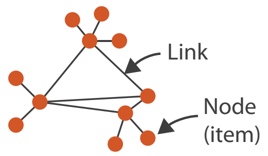
Tables	Networks & Trees	Fields	Geometry	Clusters, Sets, Lists
Items	Items (nodes)	Grids	Items	Items
Attributes	Links	Positions	Positions	
	Attributes	Attributes		

Dataset Types

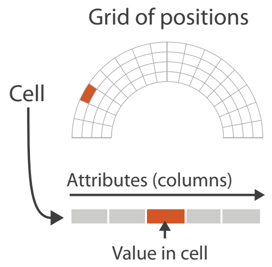
- Tables



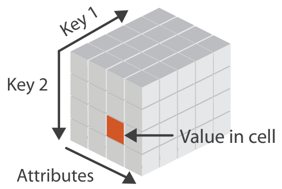
- Networks



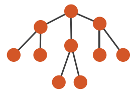
- Fields (Continuous)



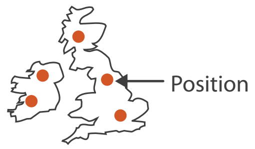
- *Multidimensional Table*



- *Trees*



- Geometry (Spatial)



Attributes

Attribute Types

- Categorical

✚ ● ■ ▲

- Ordered
  - *Ordinal*

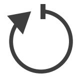
  - *Quantitative*

Ordering Direction

- Sequential

- Diverging

- Cyclic



Dataset Availability

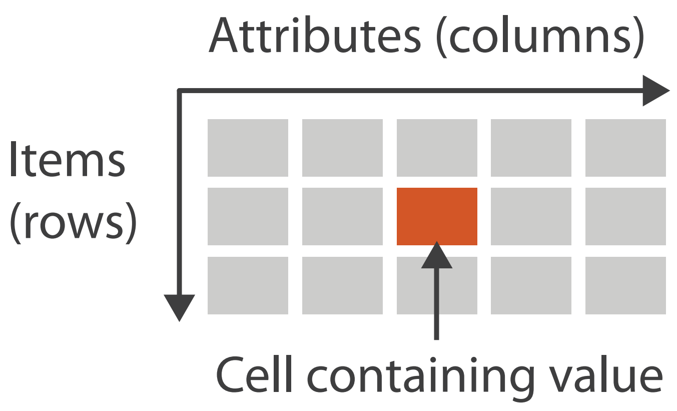
- Static

- Dynamic

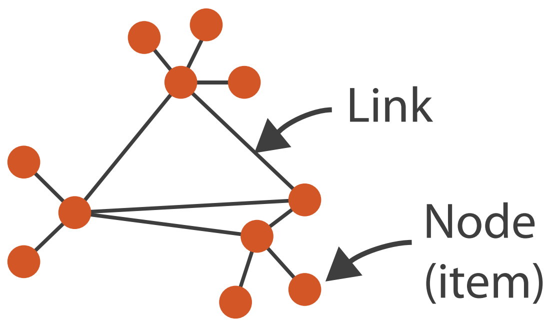
Types: Datasets and data

➔ Dataset Types

➔ Tables

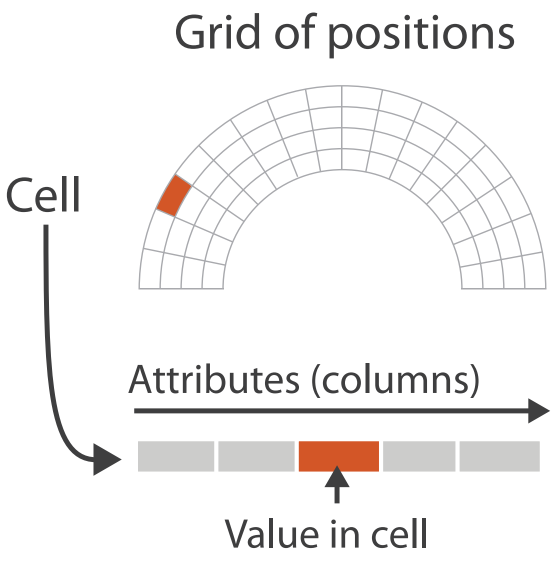


➔ Networks

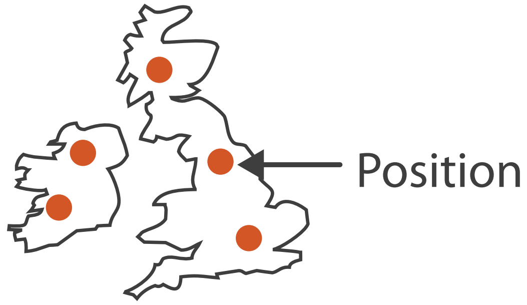


➔ Spatial

➔ Fields (Continuous)



➔ Geometry (Spatial)



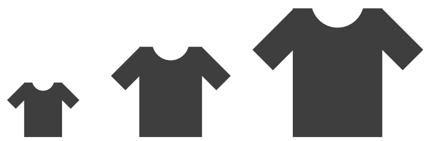
➔ Attribute Types

➔ Categorical

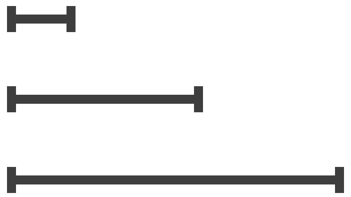
✚ ● ■ ▲

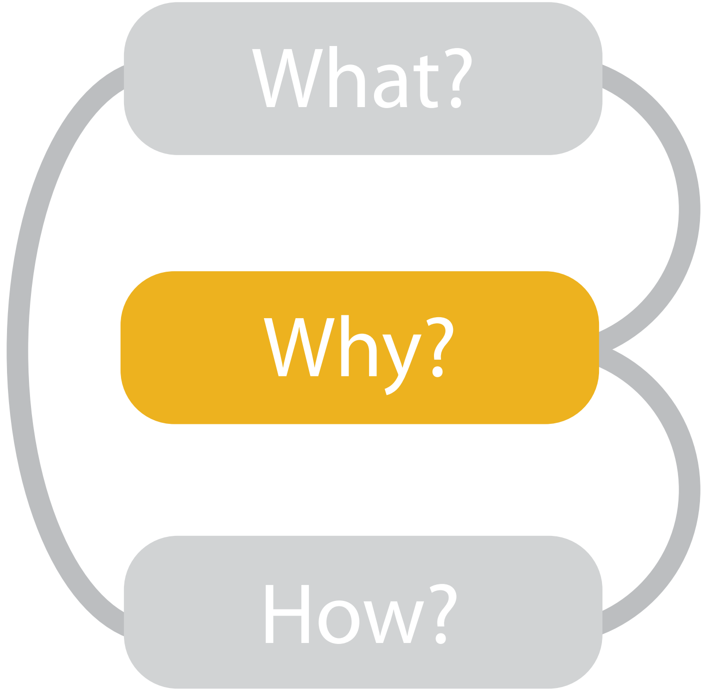
➔ Ordered

➔ *Ordinal*

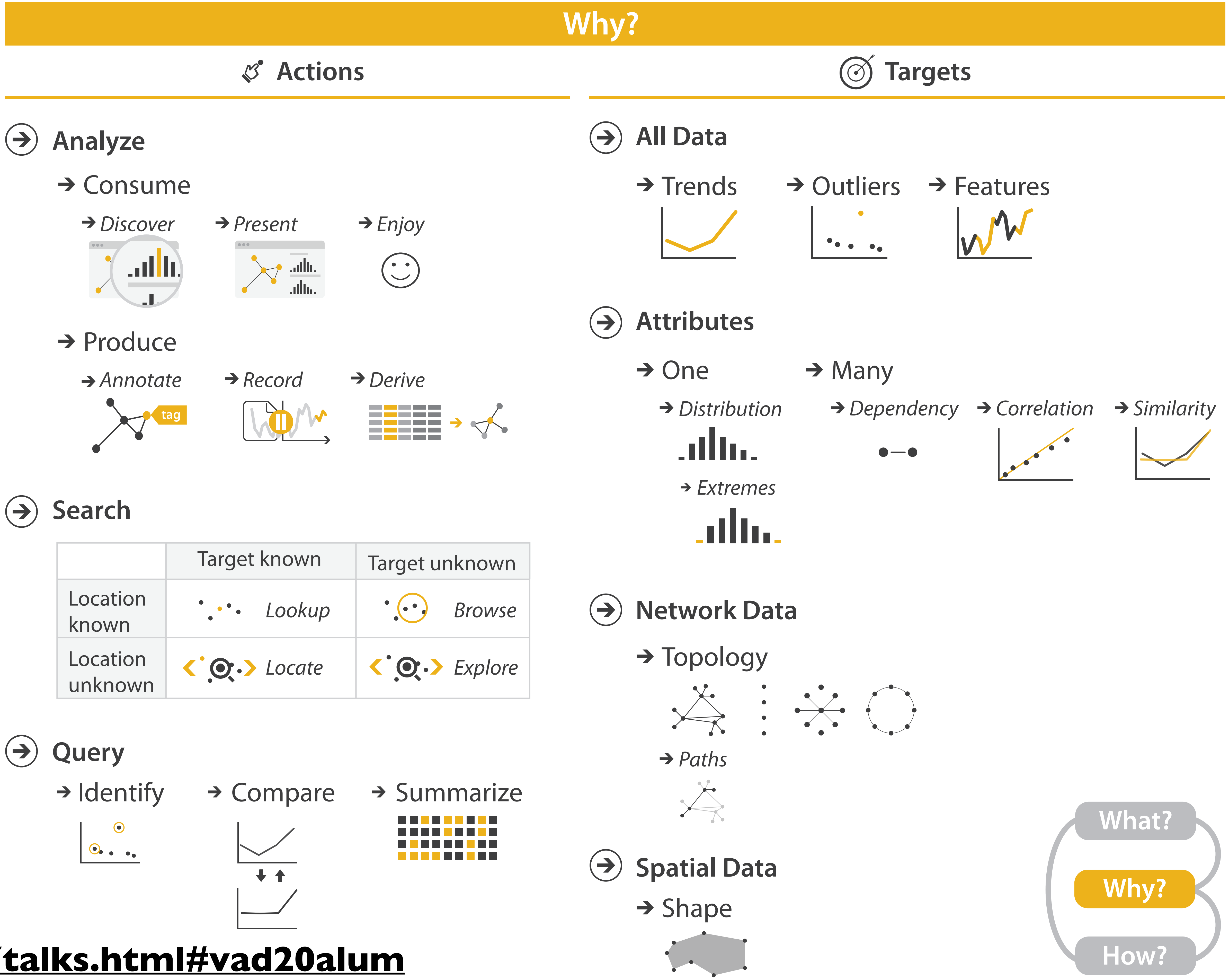


➔ *Quantitative*





- {action, target} pairs
  - *discover distribution*
  - *compare trends*
  - *locate outliers*
  - *browse topology*



Why?

Actions

Analyze

→ Consume

→ *Discover* → *Present* → *Enjoy*

→ Produce

→ *Annotate* → *Record* → *Derive*

Search

	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

Query

→ Identify → Compare → Summarize

Targets

All Data

→ Trends → Outliers → Features

Attributes

→ One

→ *Distribution*

→ *Extremes*

→ Many

→ *Dependency* → *Correlation* → *Similarity*

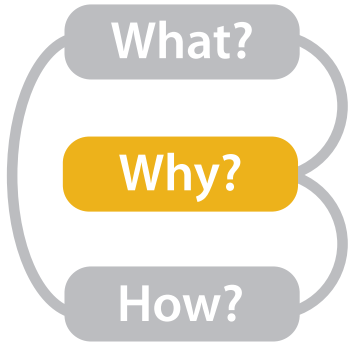
Network Data

→ Topology

→ *Paths*

Spatial Data

→ Shape



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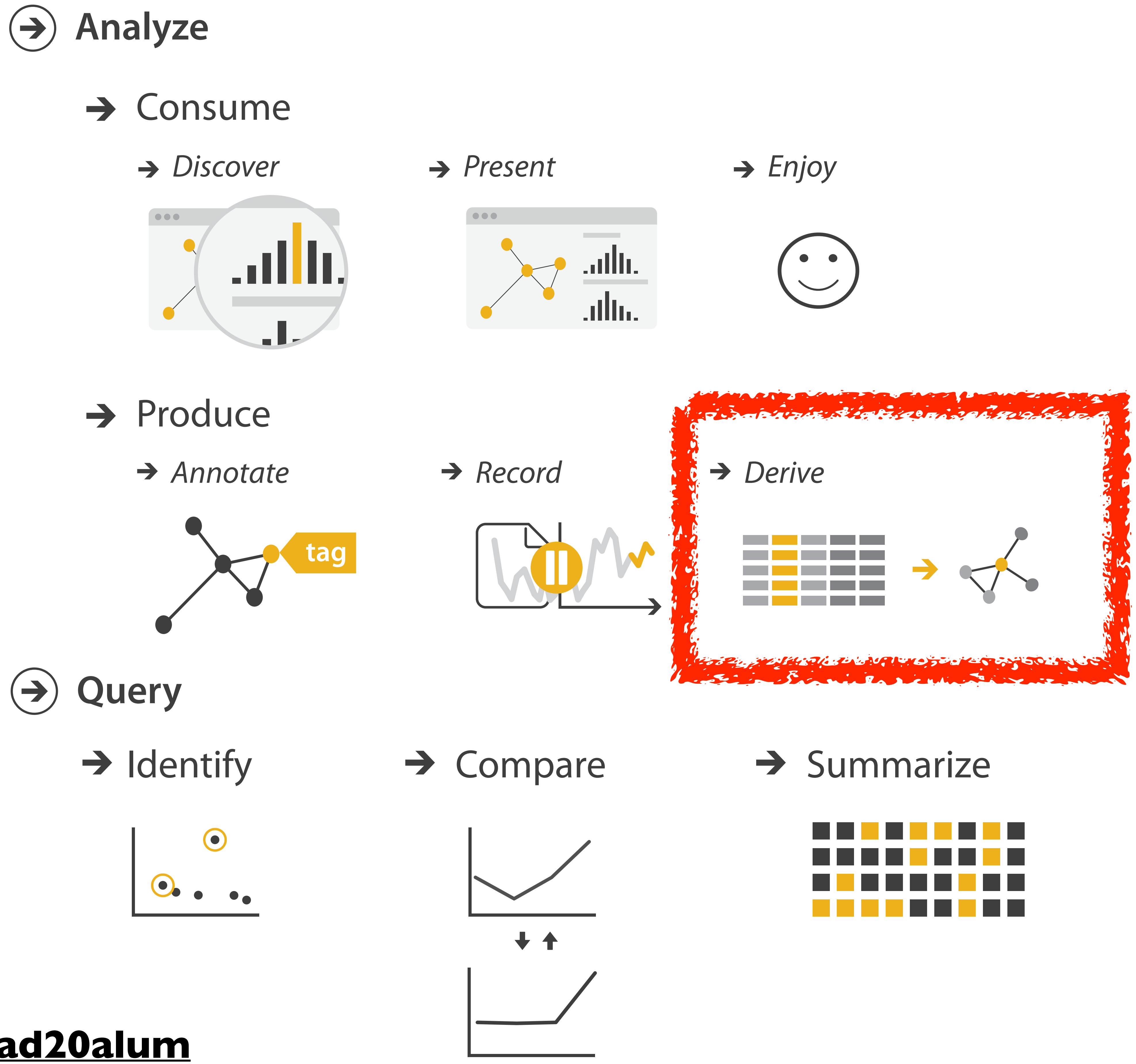
Actions: Analyze, Query

- analyze
  - consume
    - discover vs present
      - aka explore vs explain
    - enjoy
      - aka casual, social
  - produce
    - annotate, record, derive
- query
  - how much data matters?
    - one, some, all
- independent choices
  - analyze, query, (search)



Analyze

Consume

Discover *Present* *Enjoy*

Produce

Annotate *Record* *Derive*

Query

Identify Compare Summarize

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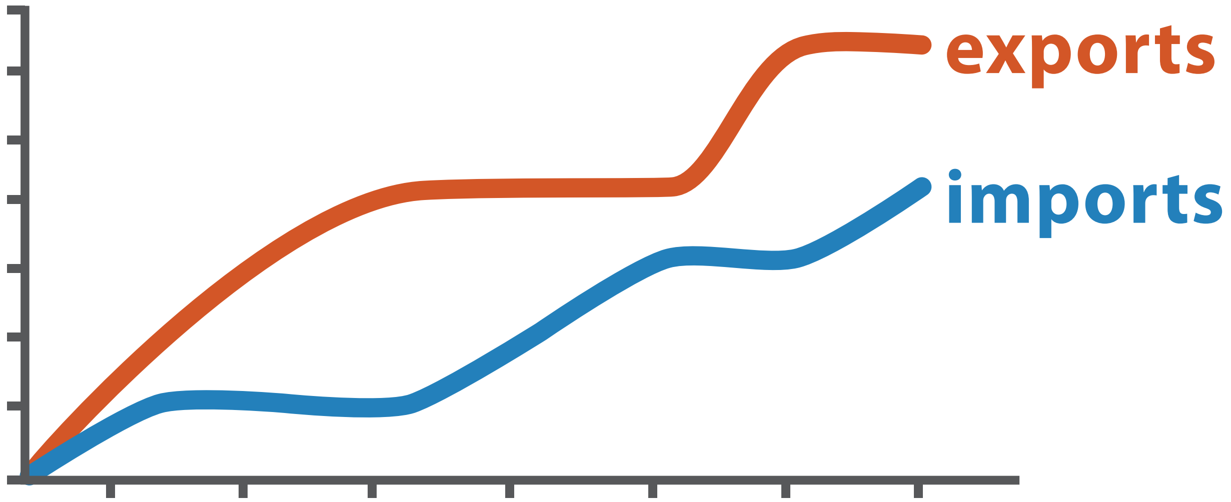
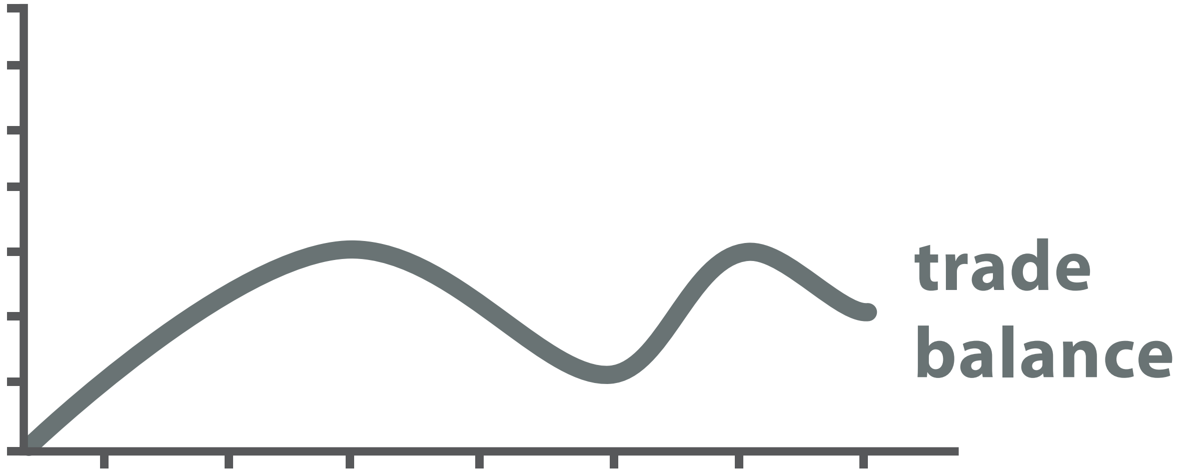
Derive: Crucial Design Choice

- don’t just draw what you’re given!
  - decide what the right thing to show is
  - create it with a series of transformations from the original dataset
  - draw that
- one of the four major strategies for handling complexity



Original Data



trade balance = exports − imports

Derived Data

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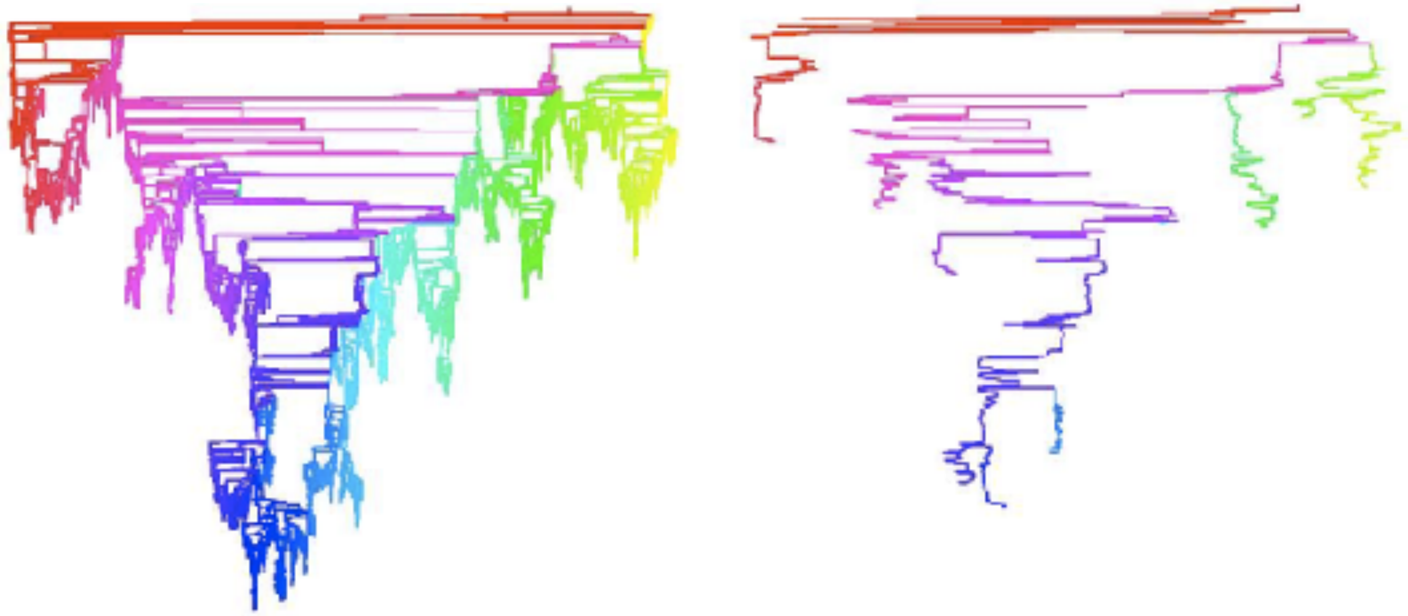
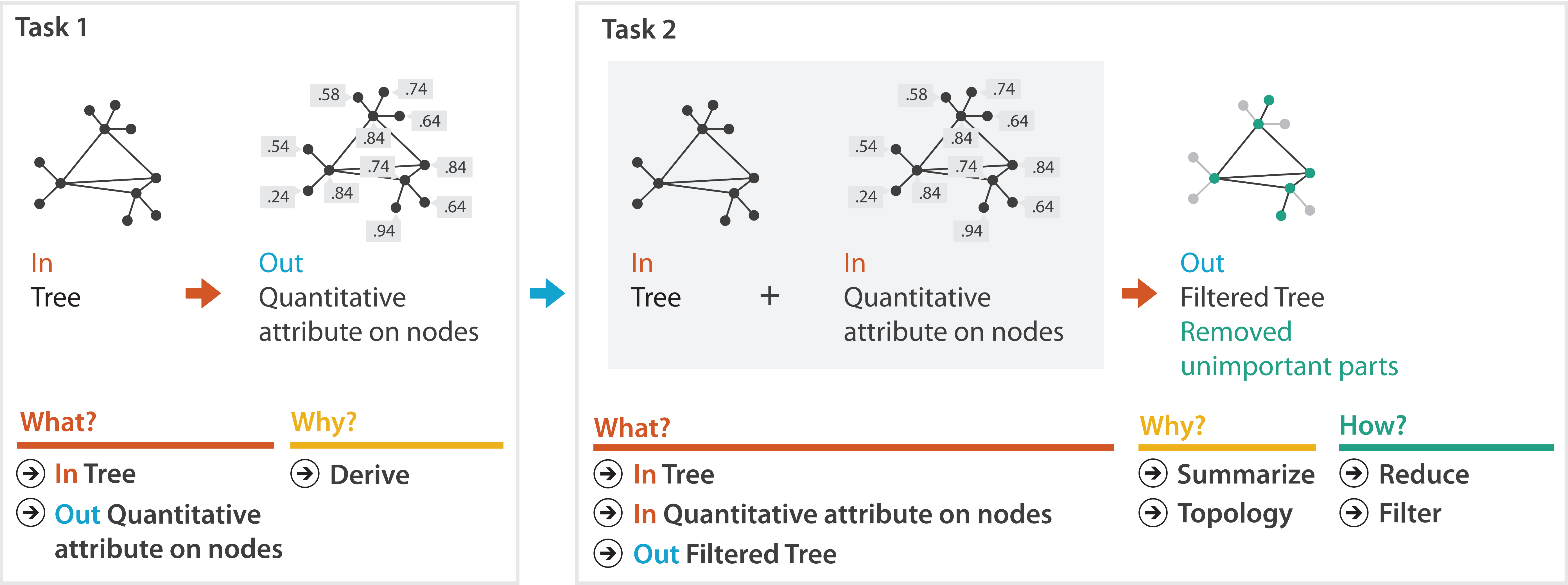
Analysis example: Derive one attribute

- Strahler number
  - centrality metric for trees/networks
  - derived quantitative attribute
  - draw top 5K of 500K for good skeleton

[Using Strahler numbers for real time visual exploration of huge graphs. Auber. Proc. Intl. Conf. Computer Vision and Graphics, pp. 56–69, 2002.]





Task 1

In
Tree

Out
Quantitative attribute on nodes

What?
- In Tree
- Out Quantitative attribute on nodes

Why?
- Derive

Task 2

In
Tree
+
In
Quantitative attribute on nodes

Out
Filtered Tree
Removed unimportant parts

What?
- In Tree
- In Quantitative attribute on nodes
- Out Filtered Tree

Why?
- Summarize
- Topology

How?
- Reduce
- Filter

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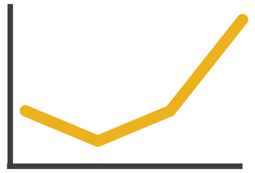
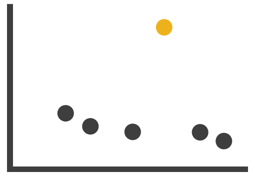
Targets

➔ All Data

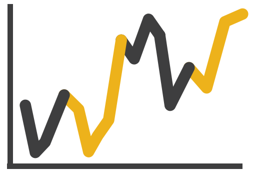
➔ Trends



➔ Outliers



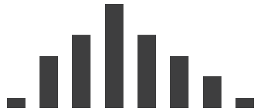
➔ Features



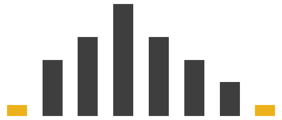
➔ Attributes

➔ One

➔ *Distribution*



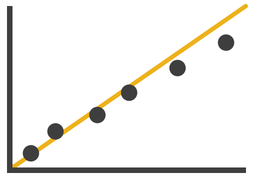
➔ *Extremes*



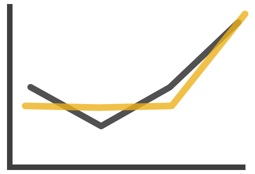
➔ Many

➔ *Dependency*

➔ *Correlation*

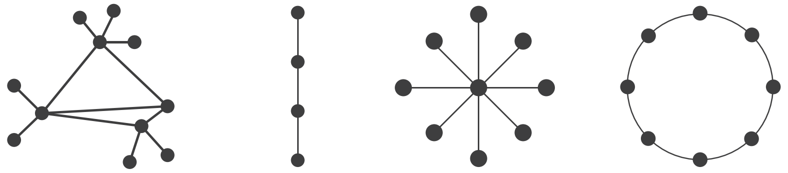


➔ *Similarity*

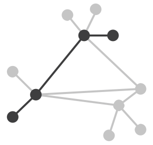


➔ Network Data

➔ Topology

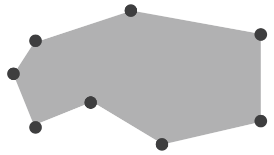


➔ *Paths*



➔ Spatial Data

➔ Shape



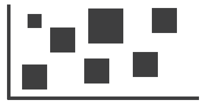
How?

Encode

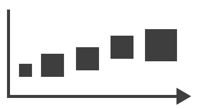
Arrange

→ Express

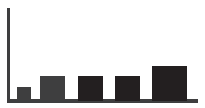
→ Separate



→ Order



→ Align



→ Use

Map

from categorical and ordered attributes

→ Color

→ *Hue*

→ *Saturation*

→ *Luminance*

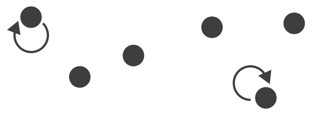
→ Size, Angle, Curvature, ...

→ Shape

✚ ● ■ ▲

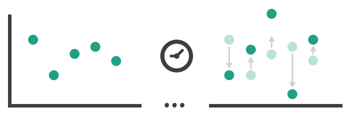
→ Motion

Direction, Rate, Frequency, ...

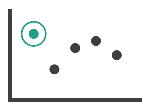


Manipulate

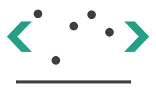
Change



Select

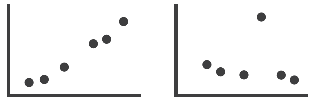


Navigate

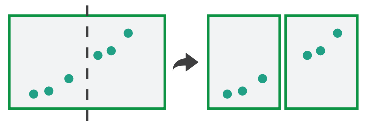


Facet

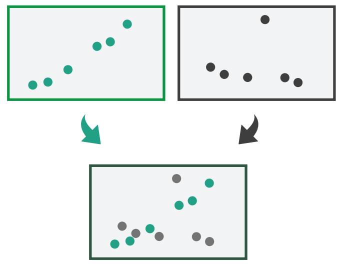
Juxtapose



Partition

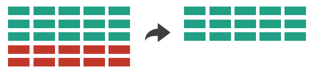


Superimpose

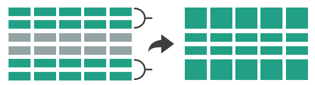


Reduce

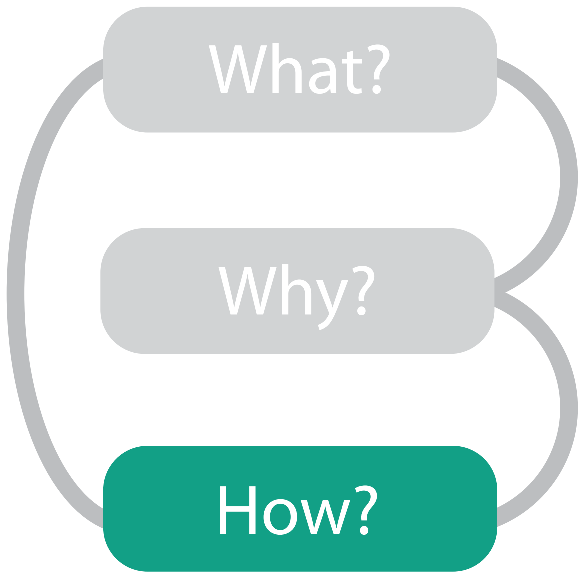
Filter



Aggregate



Embed



www.cs.ubc.ca/~tmm/talks.html#vad20alum

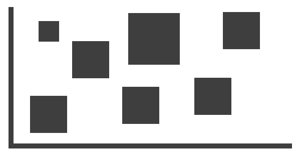
How to encode: Arrange space, map channels

Encode

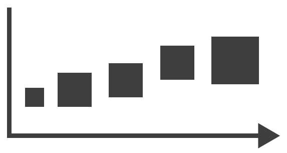
➔ Arrange

➔ Express

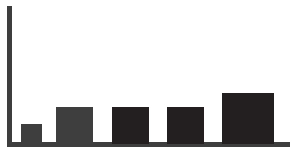
➔ Separate



➔ Order



➔ Align



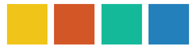
➔ Use

➔ Map

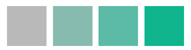
from categorical and ordered attributes

➔ Color

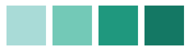
➔ *Hue*



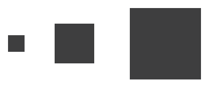
➔ *Saturation*

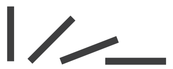


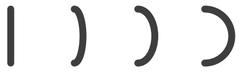
➔ *Luminance*



➔ Size, Angle, Curvature, ...





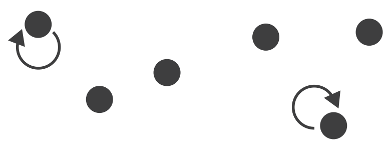


➔ Shape

+ ● ■ ▲

➔ Motion

Direction, Rate, Frequency, ...



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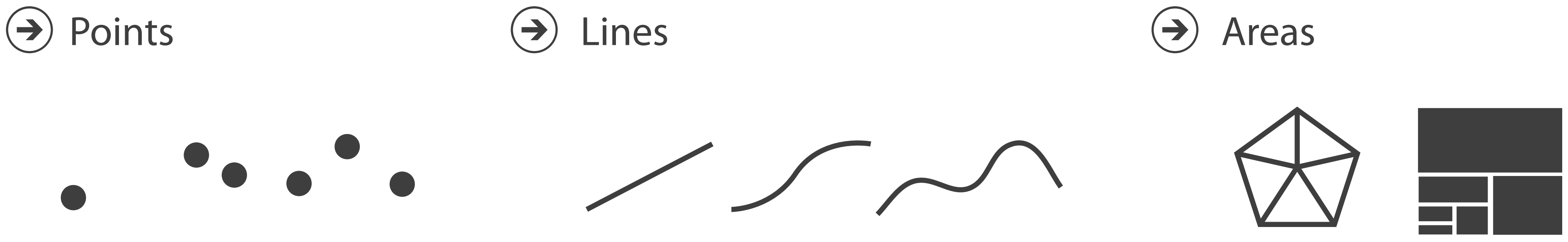
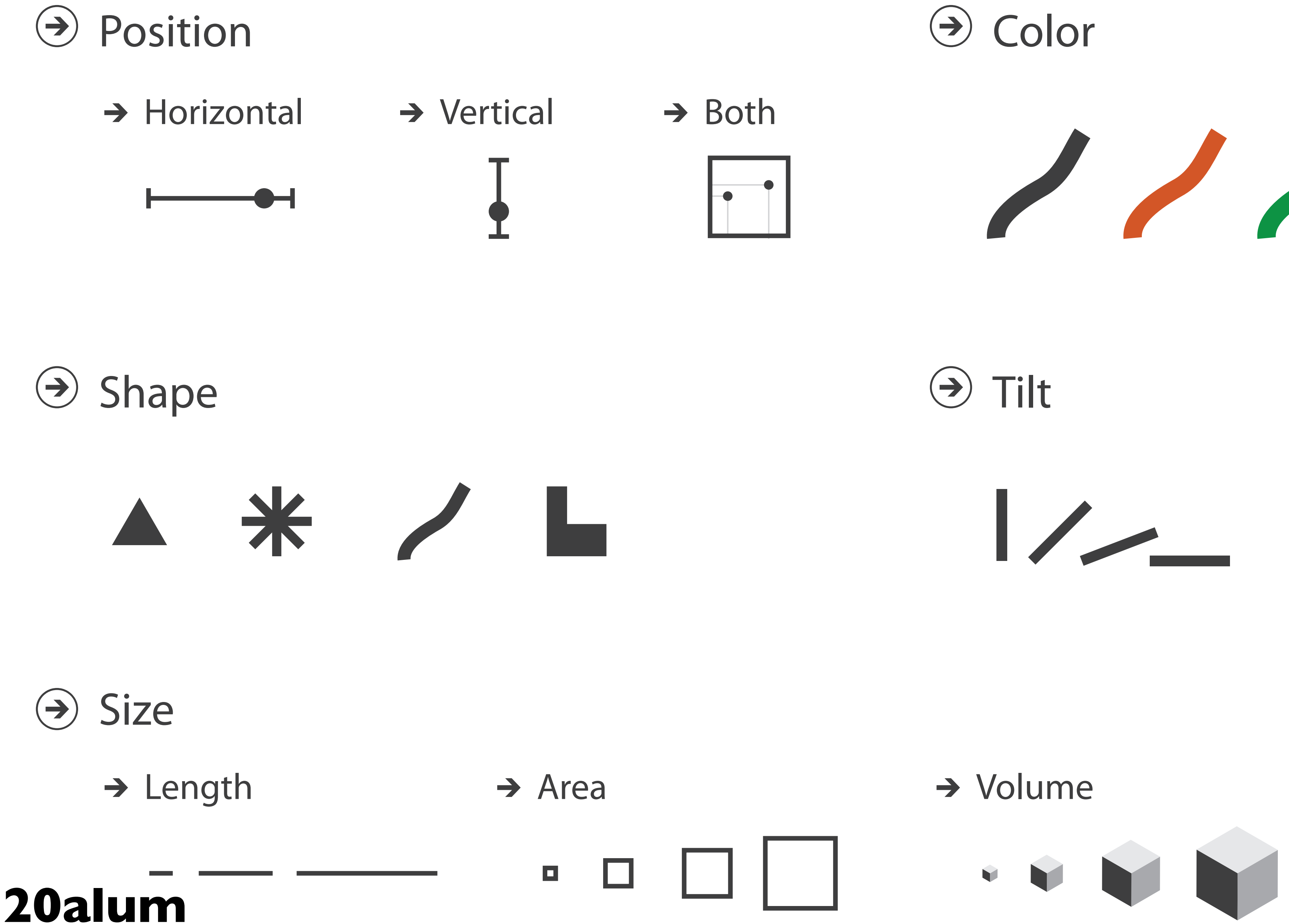
Definitions: Marks and channels

- marks
  - geometric primitives
  - one per item



- channels
  - control appearance of marks



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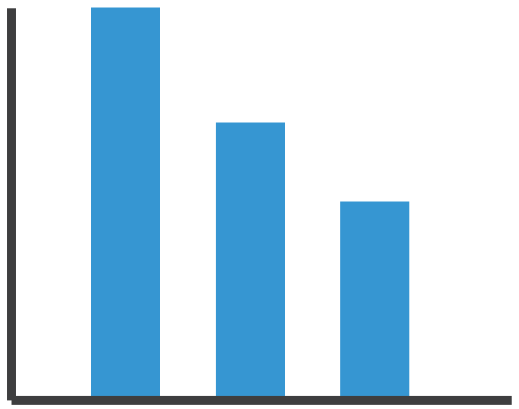
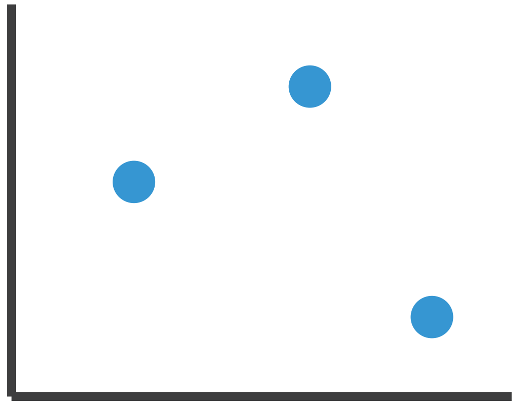
Encoding visually with marks and channels

- analyze idiom structure
  - as combination of marks and channels



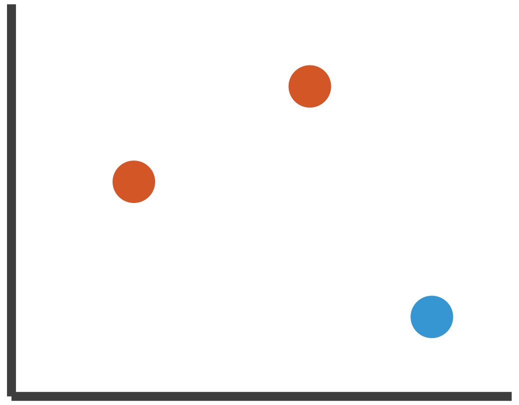
1:
vertical position

mark: line



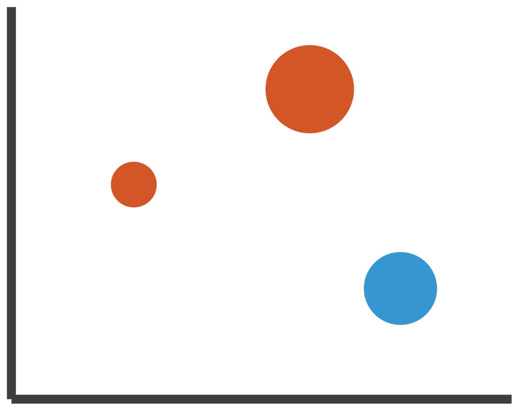
2:
vertical position
horizontal position

mark: point



3:
vertical position
horizontal position
color hue

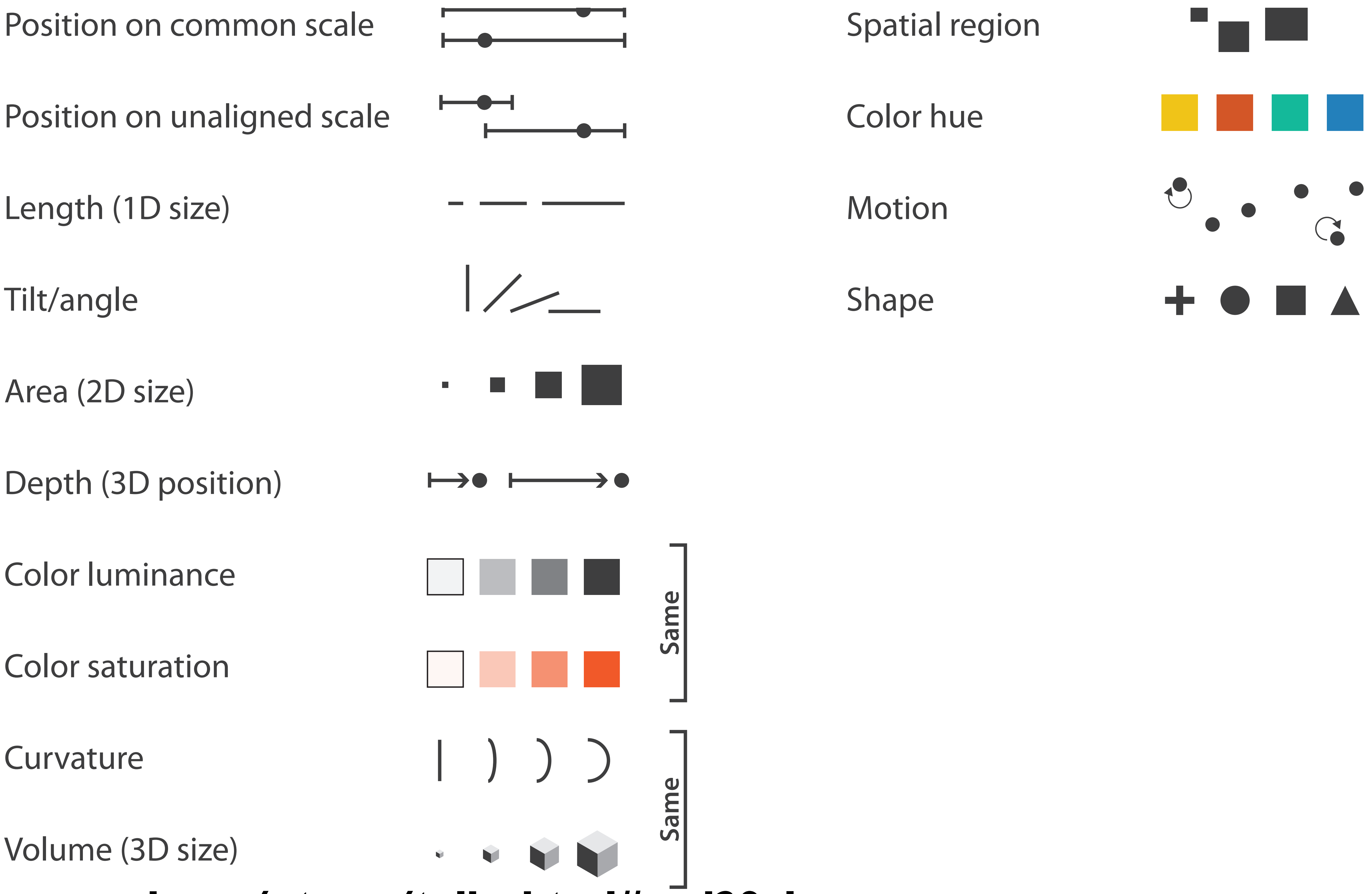
mark: point



4:
vertical position
horizontal position
color hue
size (area)

mark: point

Channels



Position on common scale

Position on unaligned scale

Length (1D size)

Tilt/angle

Area (2D size)

Depth (3D position)

Color luminance

Color saturation

Curvature

Volume (3D size)

Spatial region

Color hue

Motion

Shape

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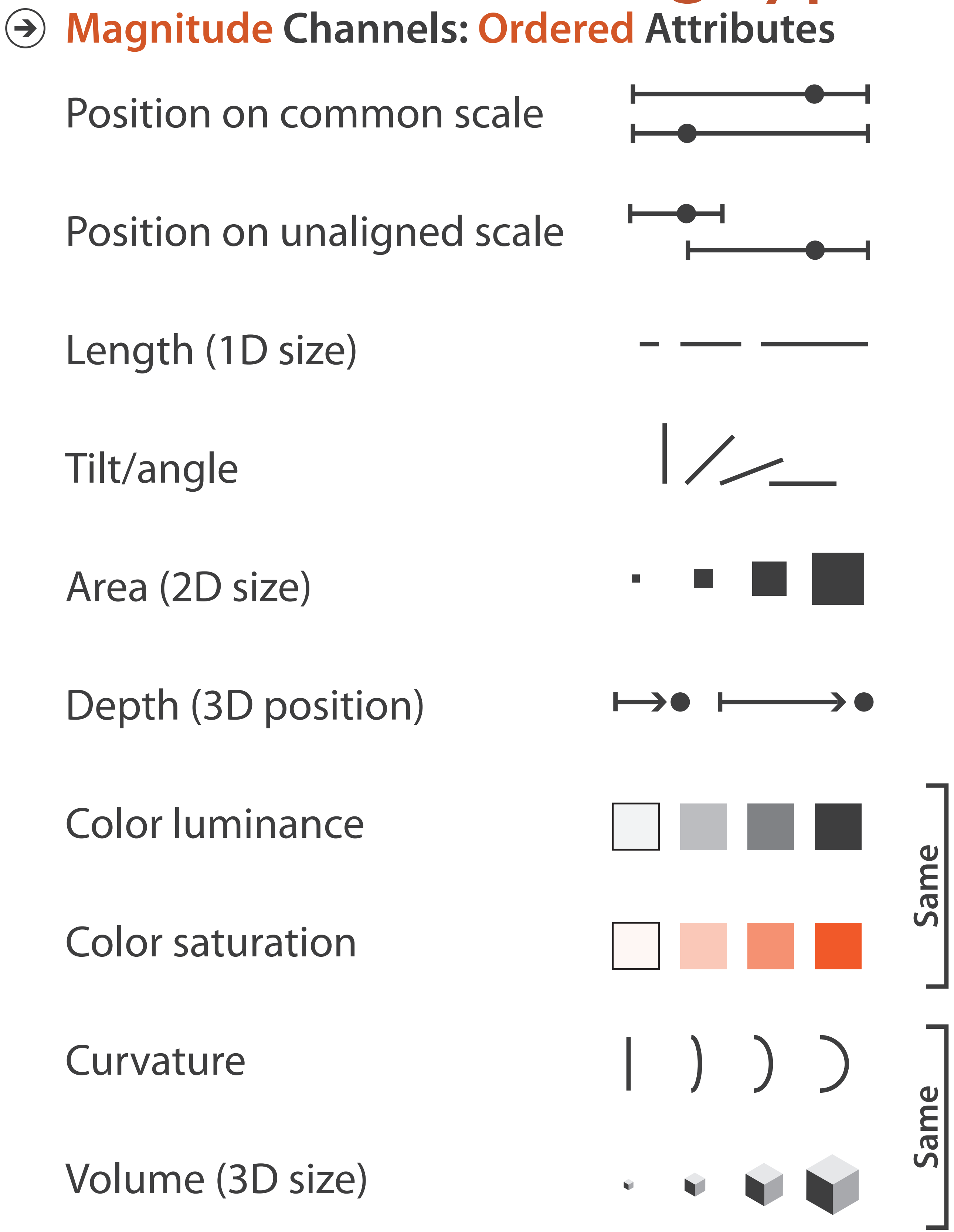
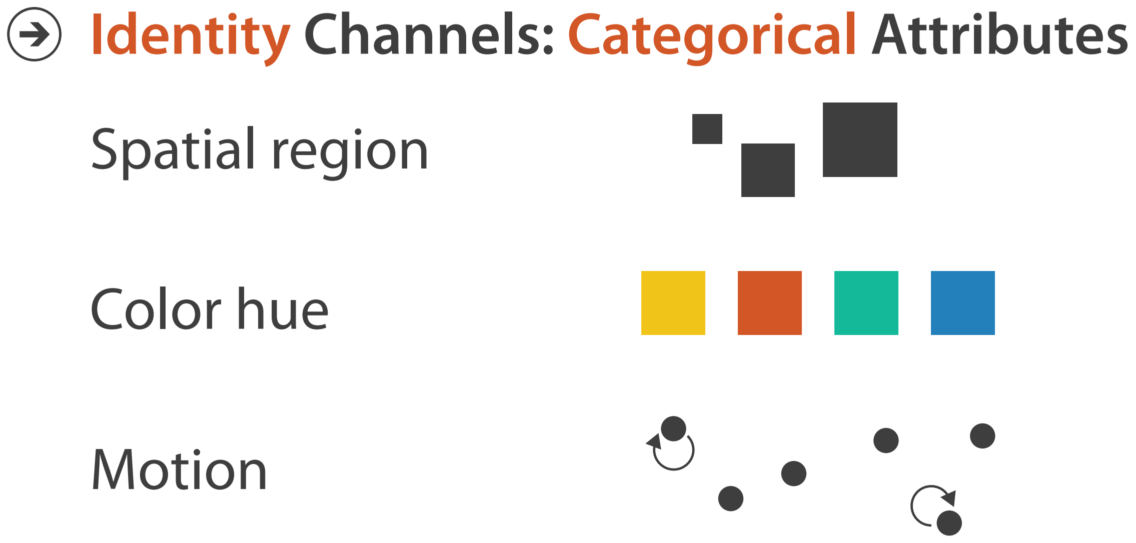
Channels: Matching Types





- expressiveness principle
  - match channel and data characteristics

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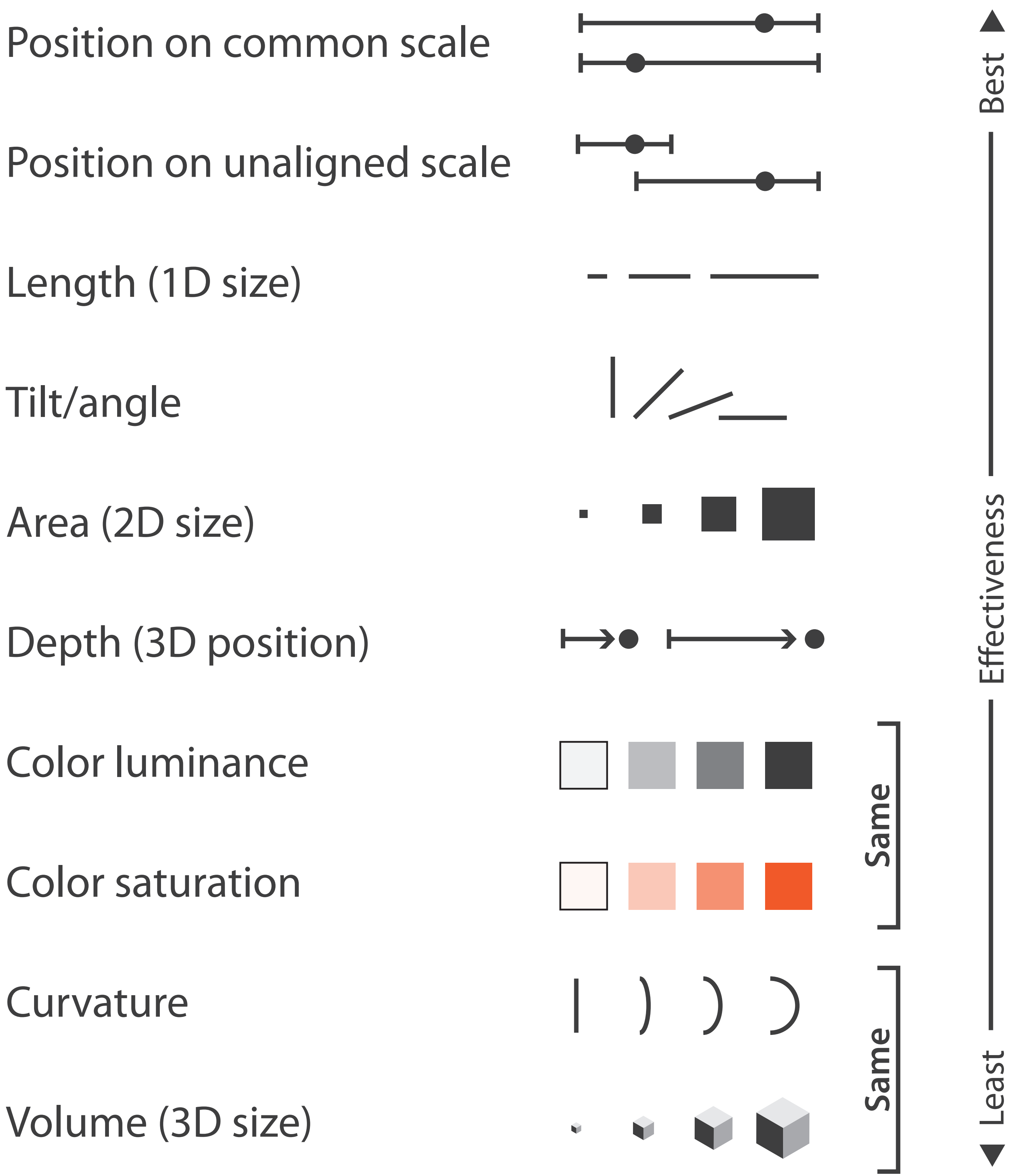
Channels: Rankings

➔ Magnitude Channels: Ordered Attributes



Position on common scale

Position on unaligned scale

Length (1D size)

Tilt/angle

Area (2D size)

Depth (3D position)

Color luminance

Color saturation

Curvature

Volume (3D size)

Best

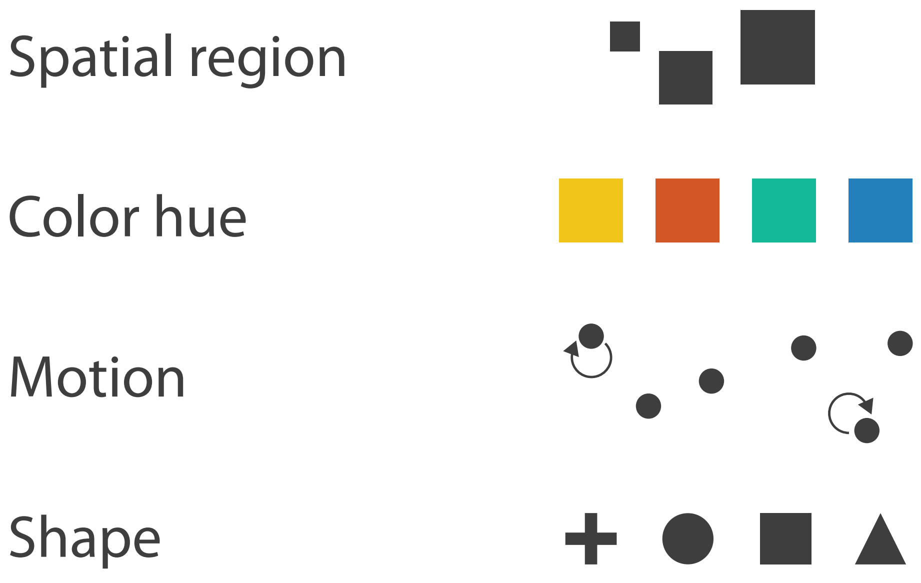
Effectiveness

Least

Same

Same

➔ Identity Channels: Categorical Attributes



Spatial region

Color hue

Motion

Shape

- expressiveness
  - match channel and data characteristics
- effectiveness
  - channels differ in accuracy of perception
- distinguishability
  - match available levels in channel w/ data

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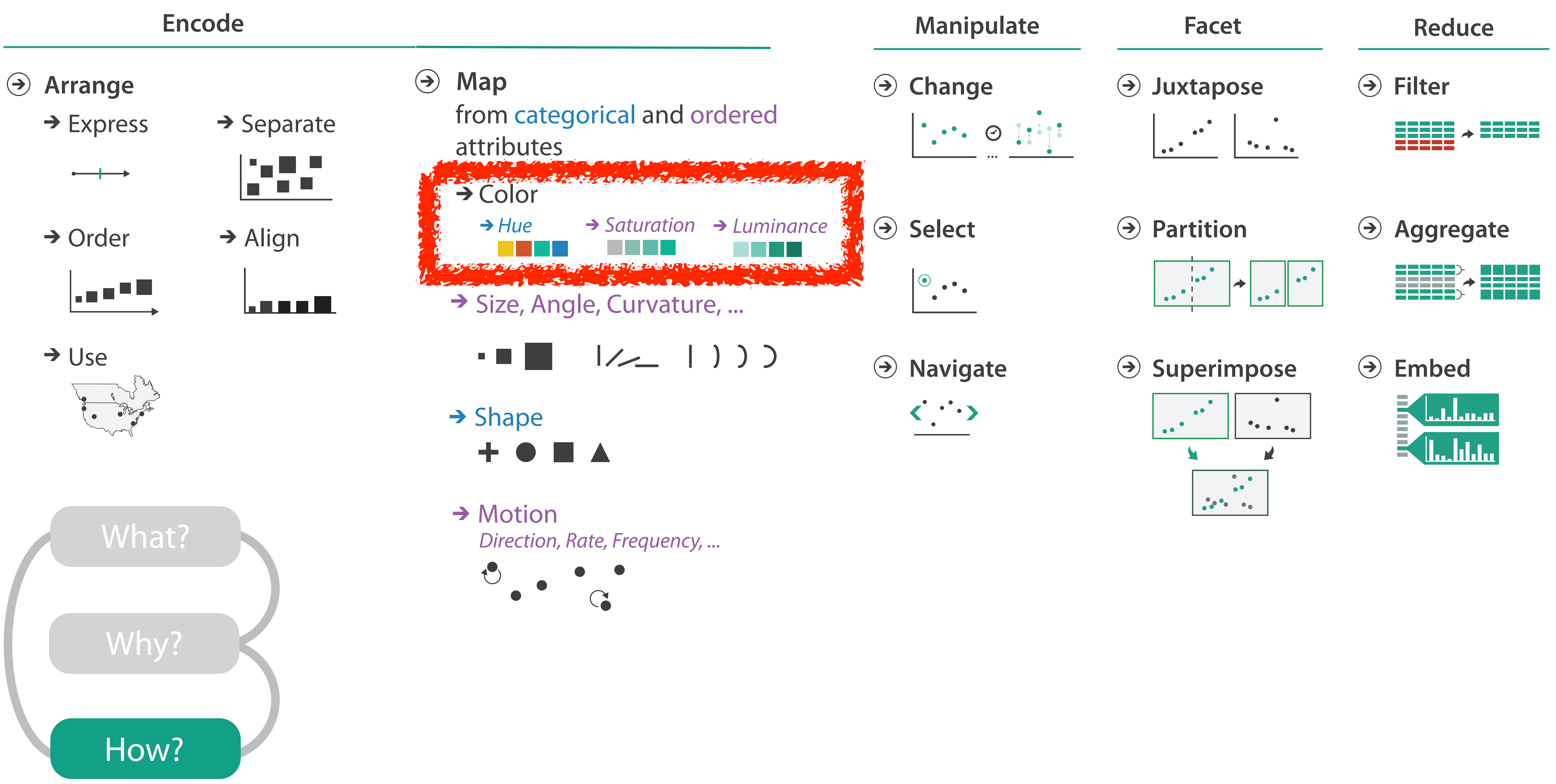
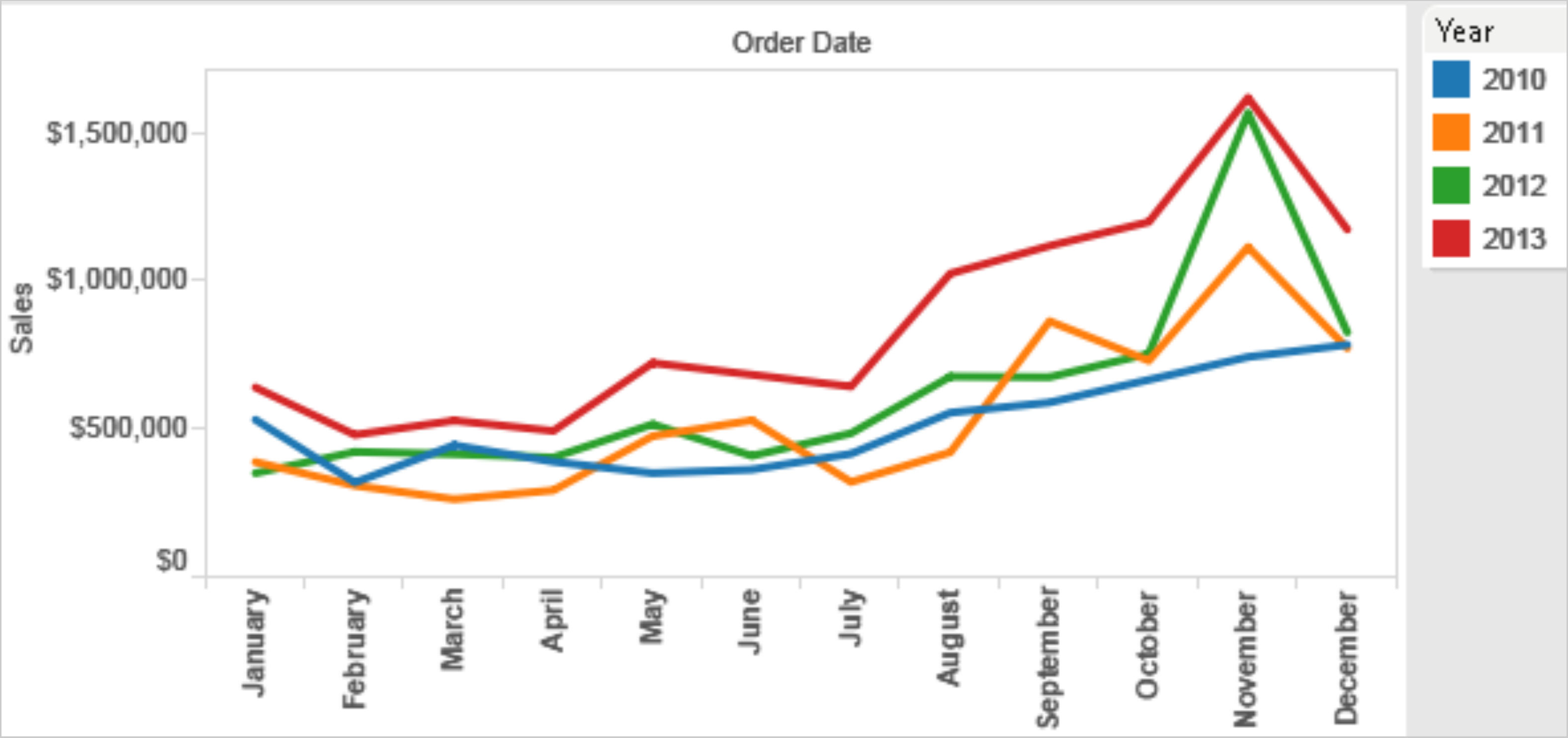
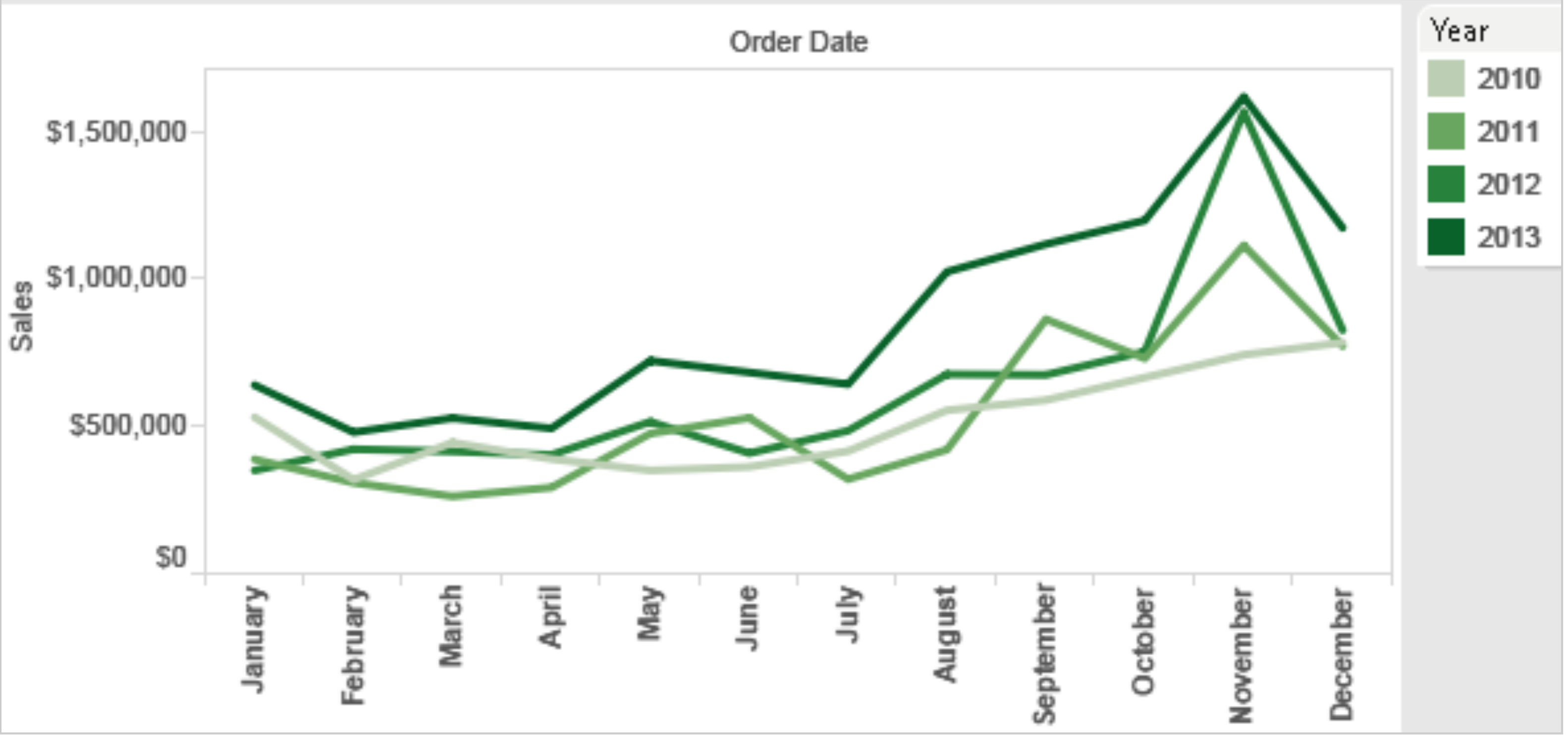
How?

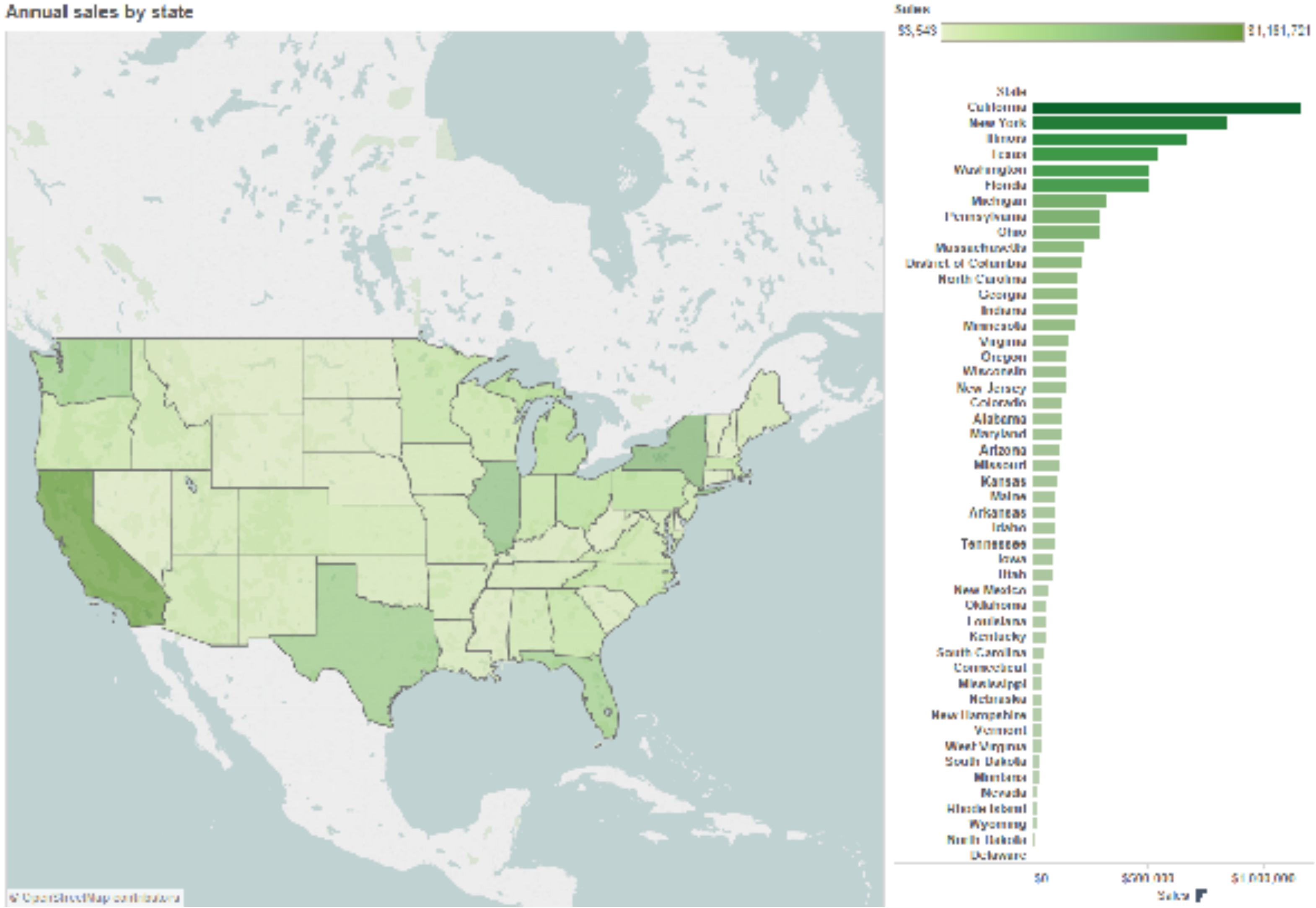


www.cs.ubc.ca/~tmm/talks.html#vad20alum

Categorical vs ordered color







[Seriously Colorful: Advanced Color Principles & Practices. Stone.Tableau Customer Conference 2014.]

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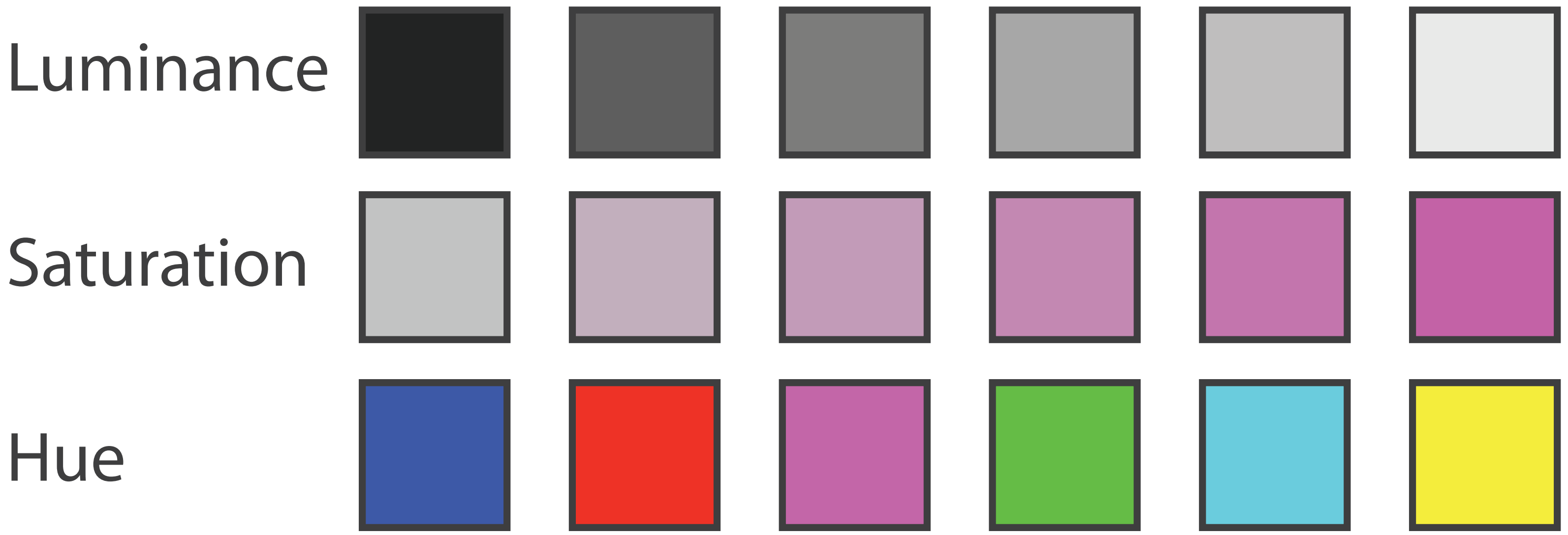
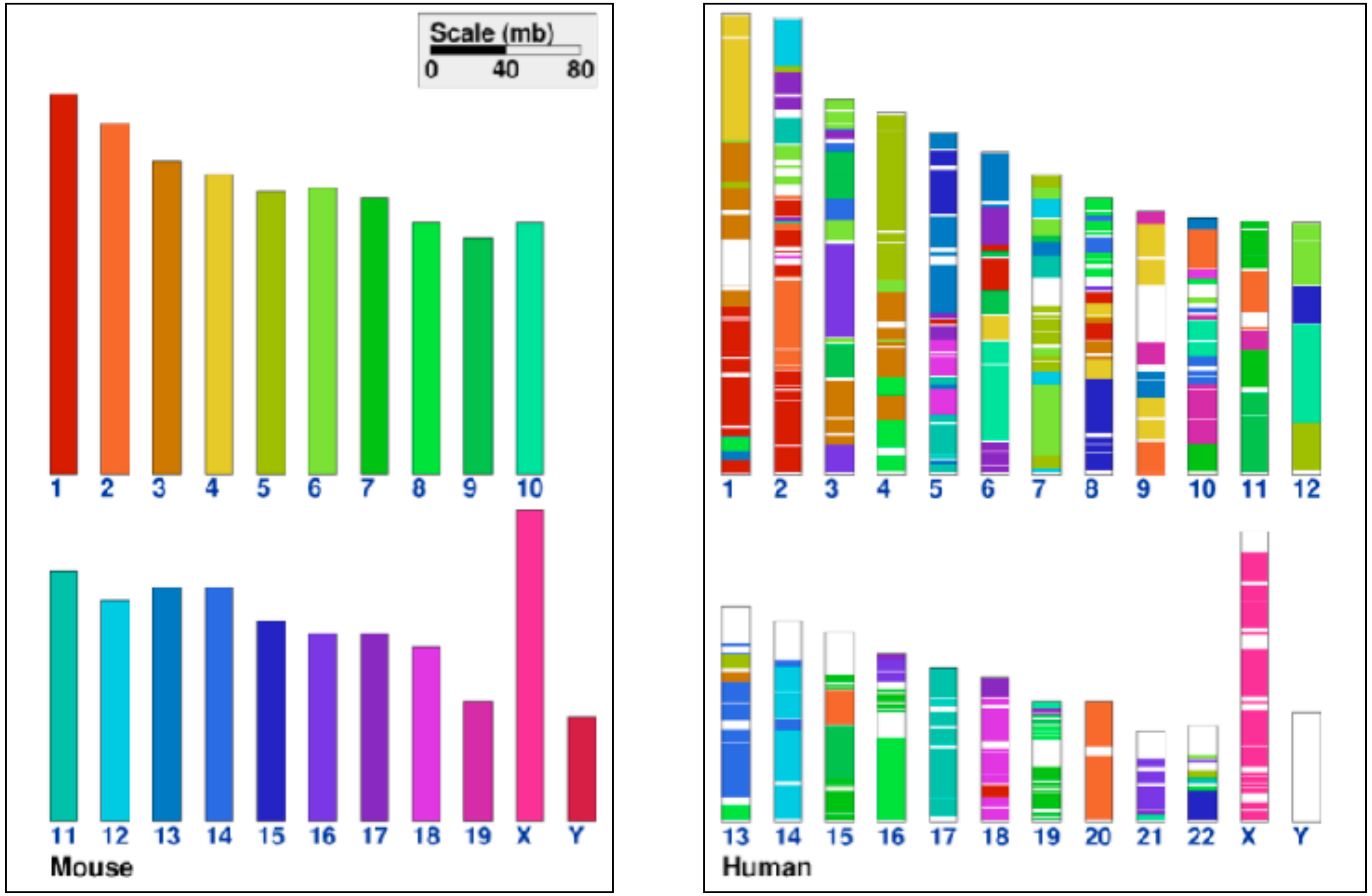
Decomposing color

- first rule of color: do not talk about color!
  - color is confusing if treated as monolithic
- decompose into three channels
  - ordered can show magnitude
    - luminance: how bright
    - saturation: how colorful
  - categorical can show identity
    - hue: what color
  - caveat: not well supported by current tools
- channels have different properties
  - what they convey directly to perceptual system
  - how much they can convey: how many discriminable bins can we use?



Categorical color: limited number of discriminable bins

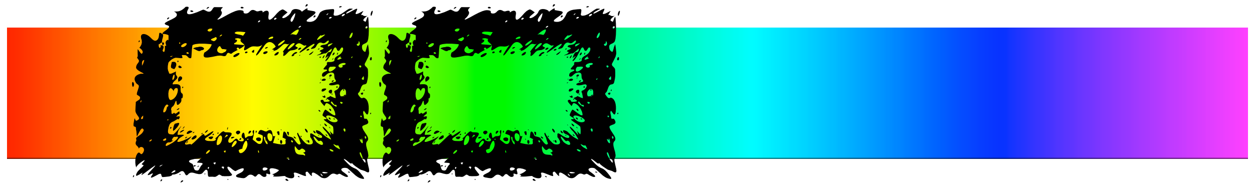
- human perception built on relative comparisons
  - great if color contiguous
  - surprisingly bad for absolute comparisons
- noncontiguous small regions of color
  - fewer bins than you want
  - rule of thumb: 6-12 bins, including background and highlights
- alternatives? other talks!

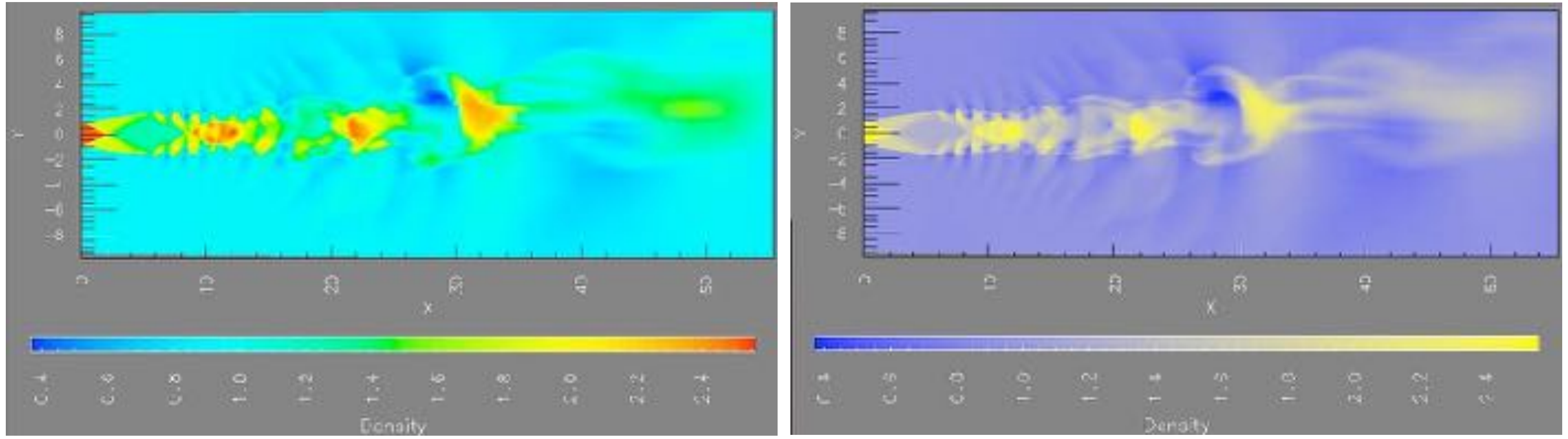


[Cinteny: flexible analysis and visualization of synteny and genome rearrangements in multiple organisms. Sinha and Meller. BMC Bioinformatics, 8:82, 2007.]

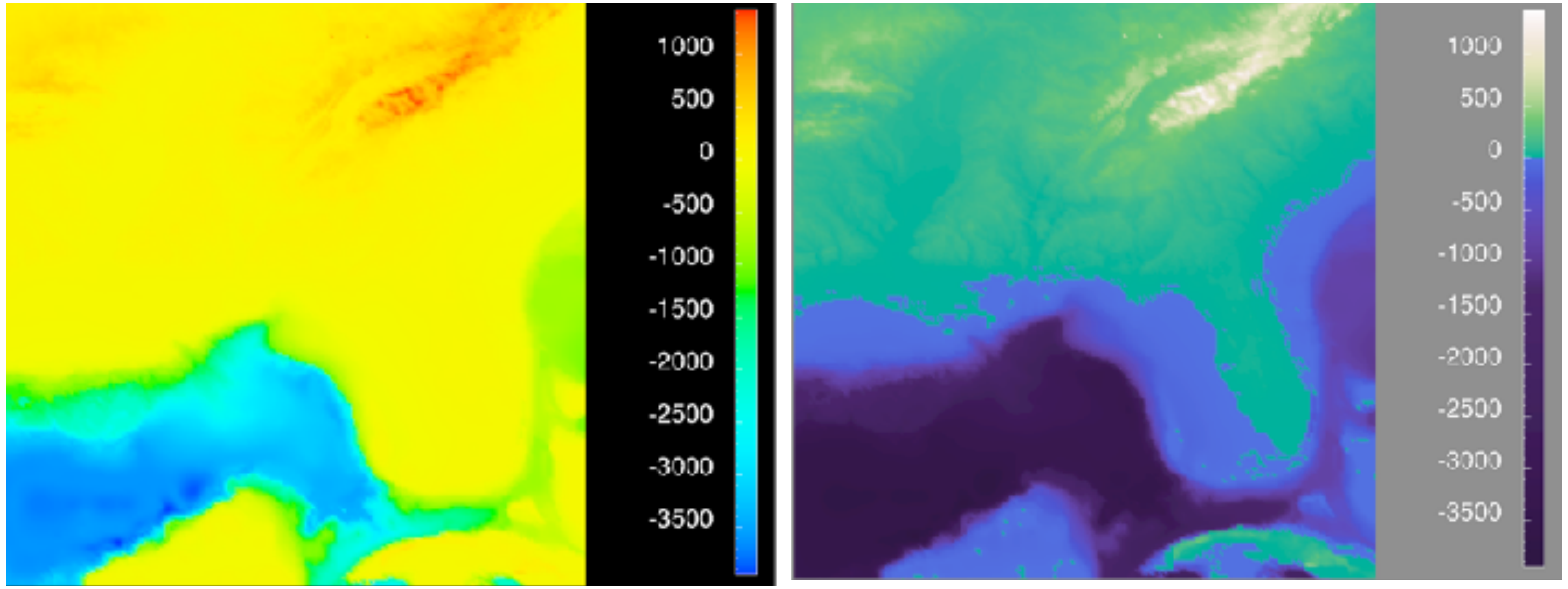
Ordered color: Rainbow is poor default

- problems
  - perceptually unordered
  - perceptually nonlinear
- benefits
  - small-scale structure: see & name
- alternatives
  - large-scale structure: fewer hues
  - known structure: segmented
  - have it both ways, small+large:
    - multiple hues
    - monotonically increasing luminance





[A Rule-based Tool for Assisting Colormap Selection. Bergman,. Rogowitz, and. Treinish. Proc. IEEE Visualization (Vis), pp. 118–125, 1995.]

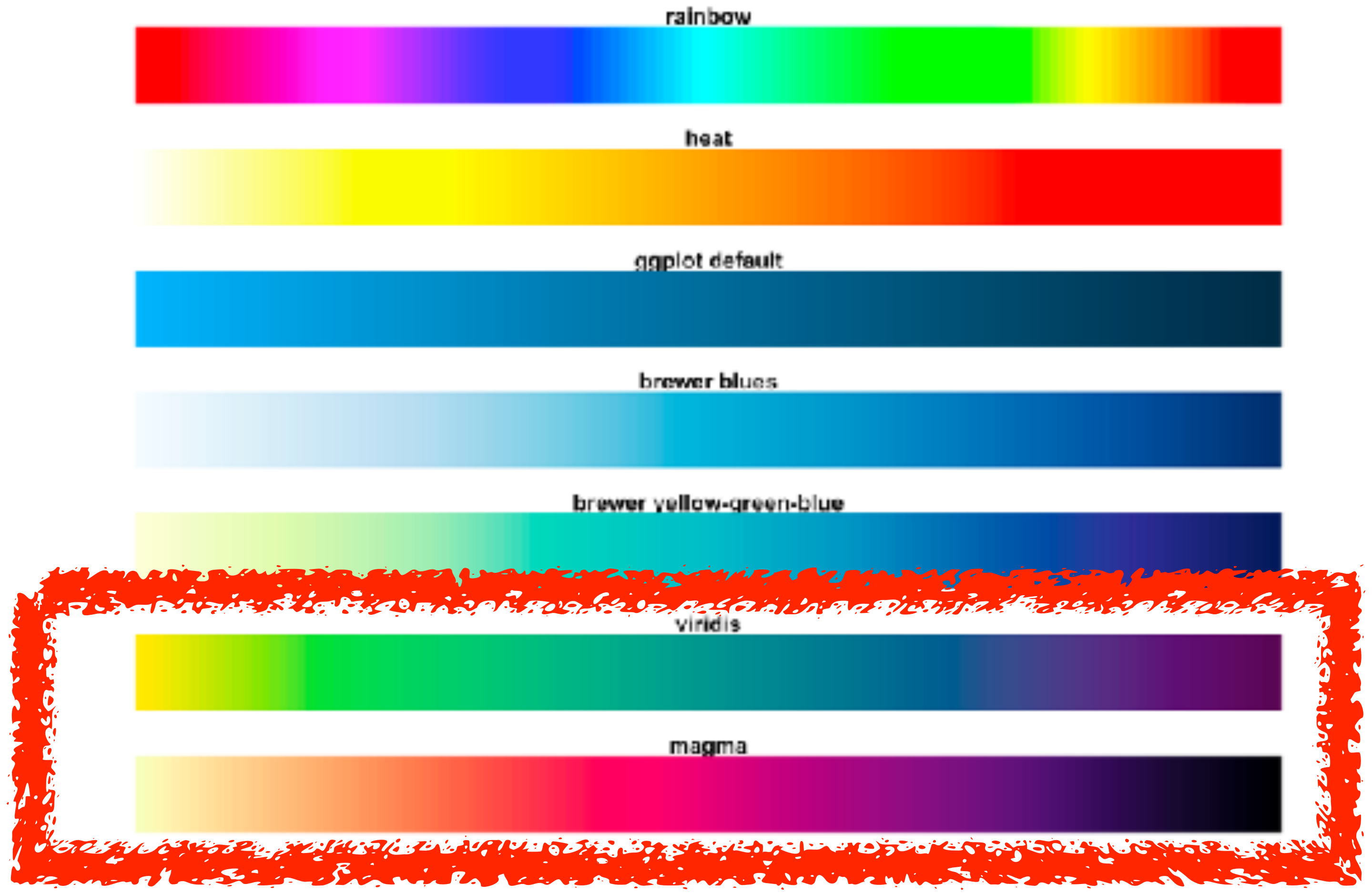


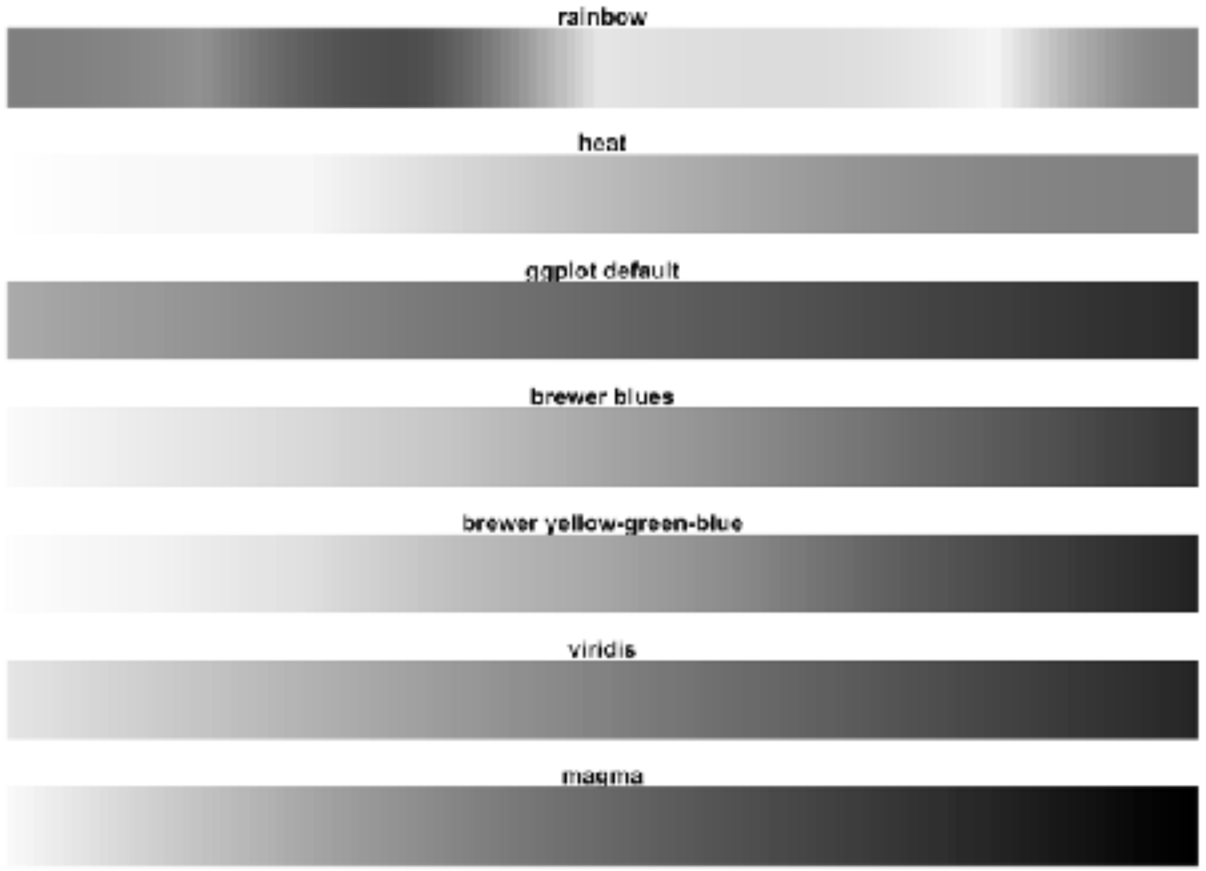
[Why Should Engineers Be Worried About Color? Treinish and Rogowitz 1998. http://www.research.ibm.com/people/l/lloydt/color/color.HTM]

Viridis / Magma

- colorful, perceptually uniform, colorblind-safe, monotonically increasing luminance

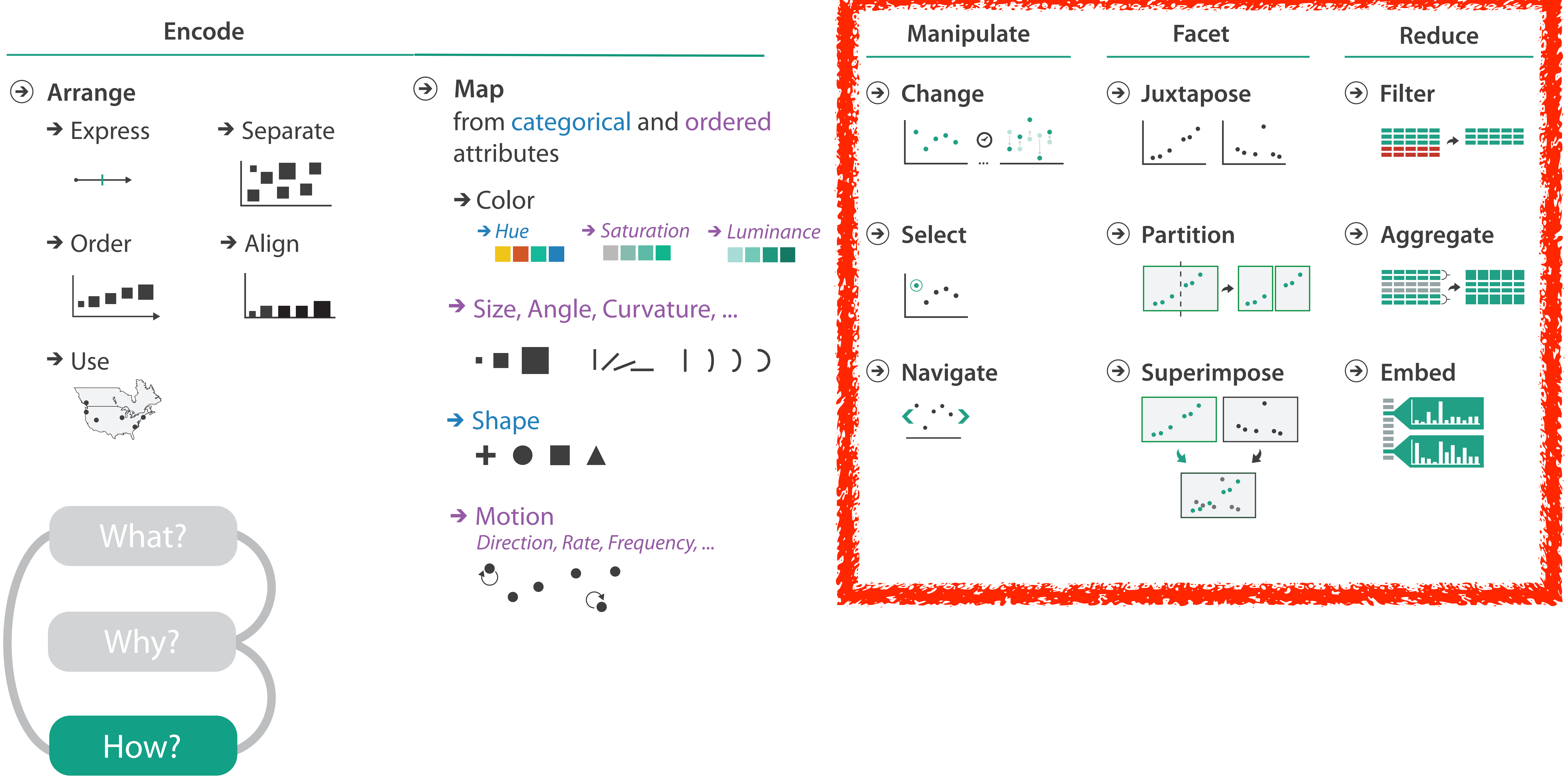
https://cran.r-project.org/web/packages/viridis/vignettes/intro-to-viridis.html





www.cs.ubc.ca/~tmm/talks.html#vad20alum

How?



Encode

Arrange

- Express
- Separate
- Order
- Align
- Use

Map

from categorical and ordered attributes

- Color
  - Hue
  - Saturation
  - Luminance
- Size, Angle, Curvature, ...
- Shape
- Motion
  Direction, Rate, Frequency, ...

Manipulate

- Change
- Select
- Navigate

Facet

- Juxtapose
- Partition
- Superimpose

Reduce

- Filter
- Aggregate
- Embed

What?

Why?

How?

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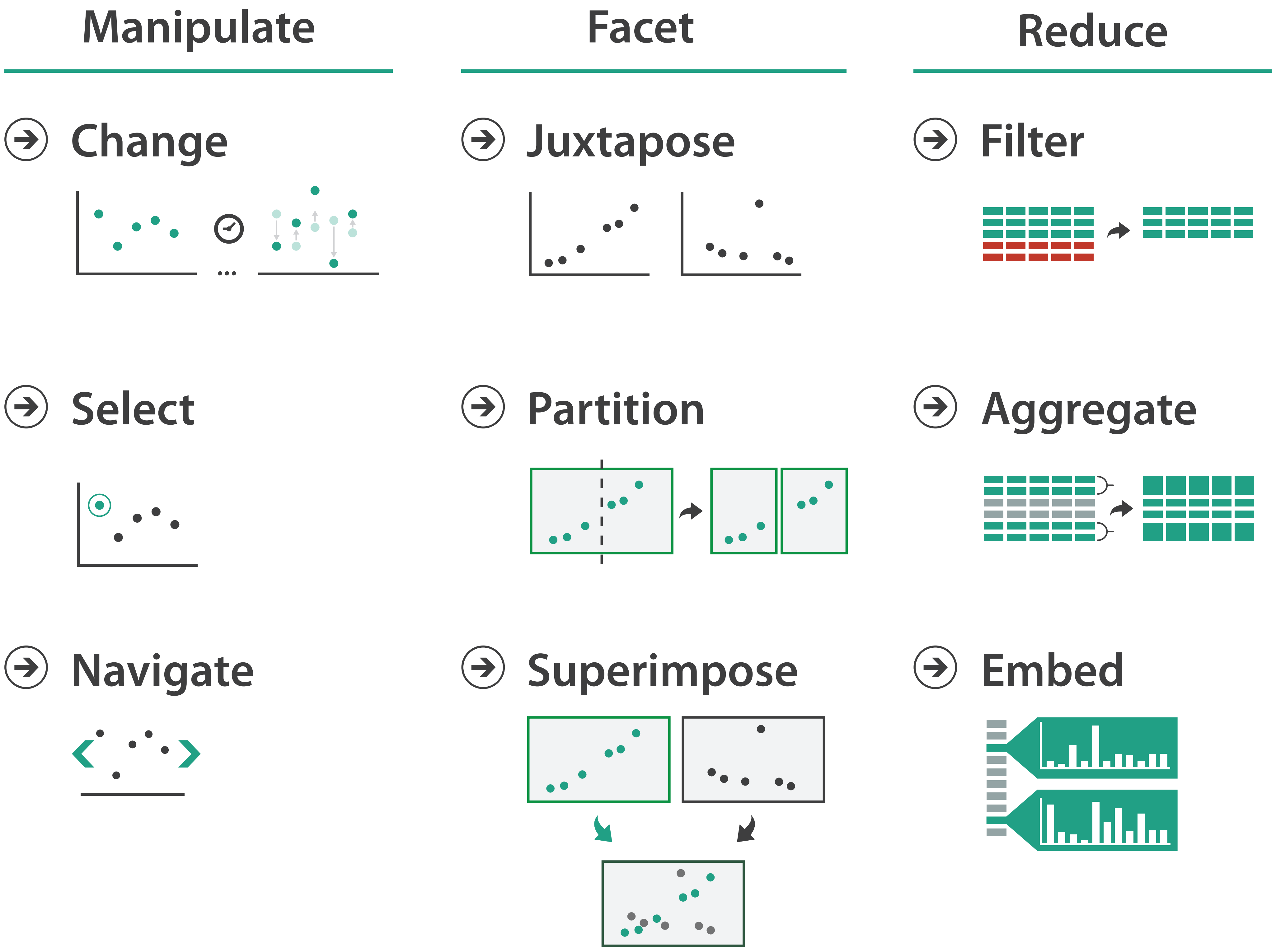
How to handle complexity: 3 more strategies + 1 previous



Manipulate

Change

Select

Navigate

Facet

Juxtapose

Partition

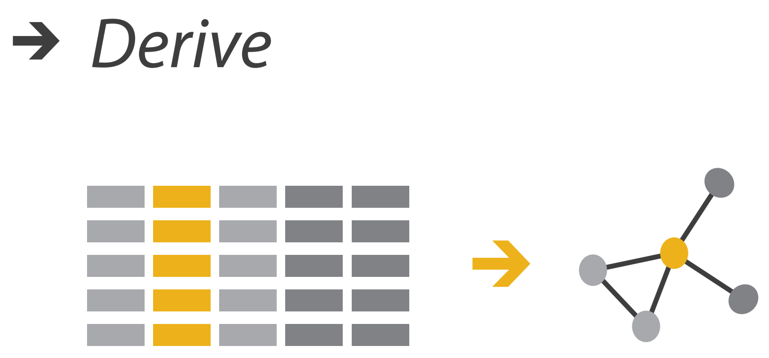
Superimpose

Reduce

Filter

Aggregate

Embed



→ *Derive*

- change view over time
- facet across multiple views
- reduce items/attributes within single view
- derive new data to show within view

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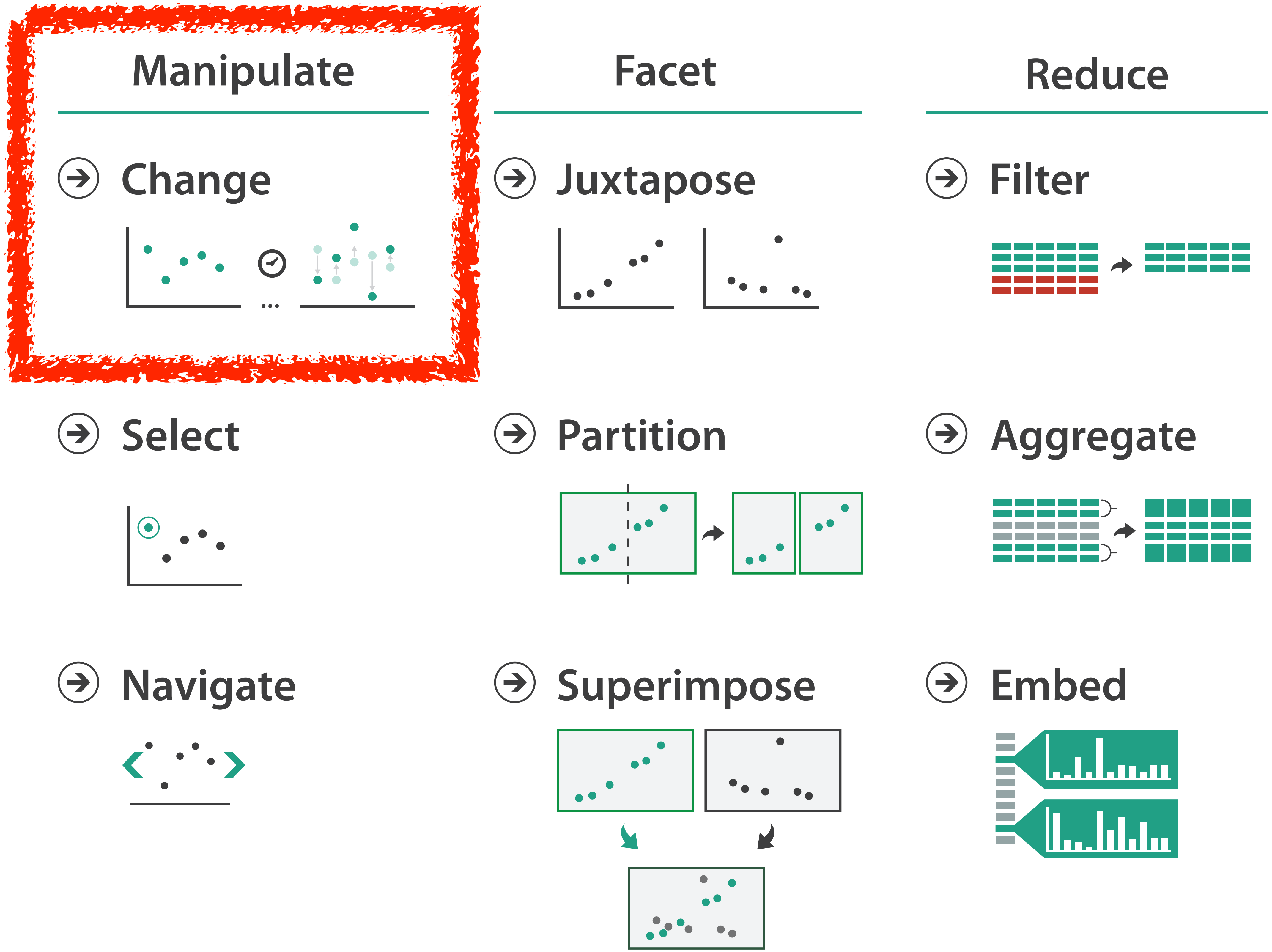
How to handle complexity: 3 more strategies + 1 previous



Manipulate

Change

Select

Navigate

Facet

Juxtapose

Partition

Superimpose

Reduce

Filter

Aggregate

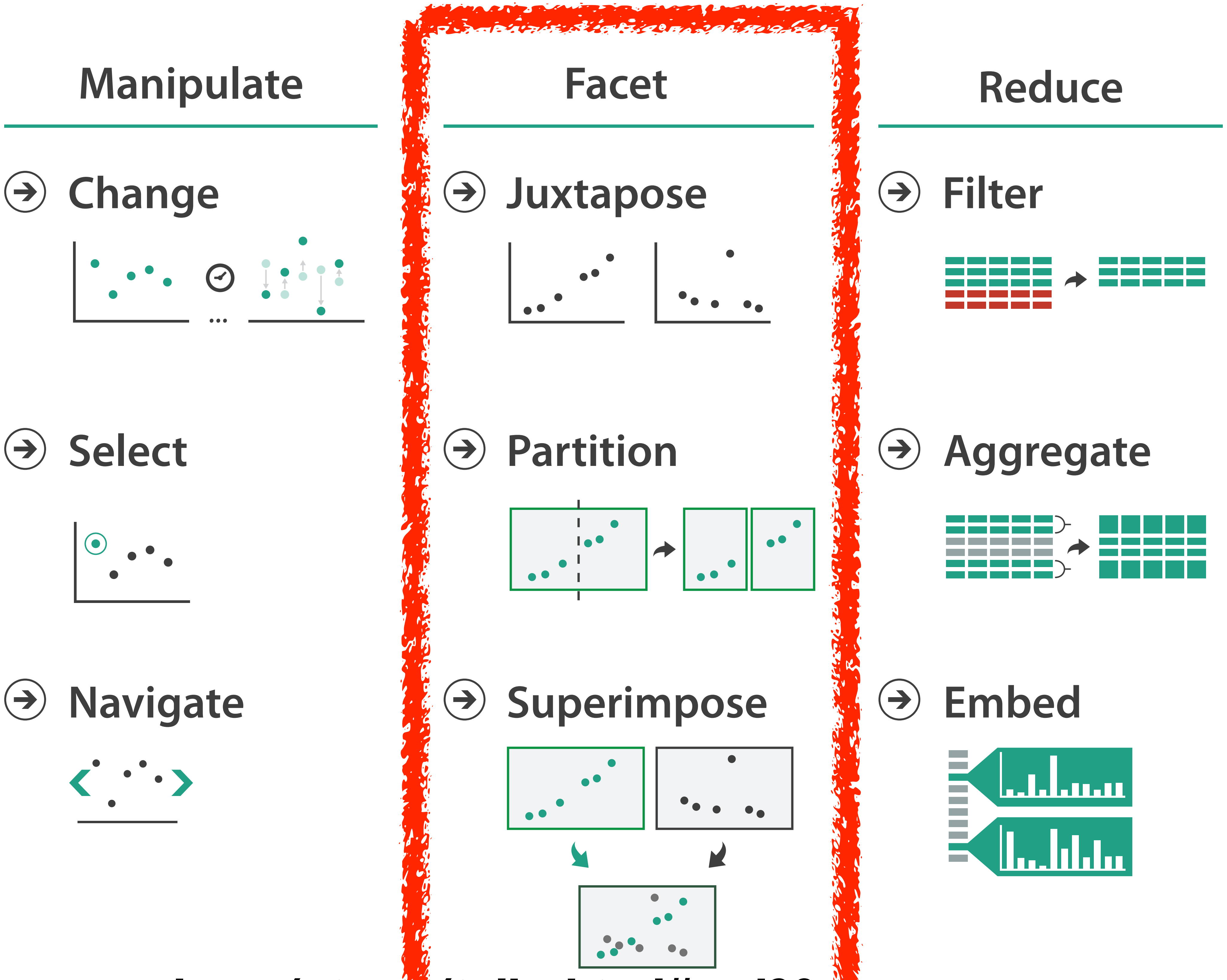
Embed

→ *Derive*

- change over time
  - most obvious & flexible of the 4 strategies

www.cs.ubc.ca/~tmm/talks.html#vad20alum

How to handle complexity: 3 more strategies + 1 previous



Manipulate

- Change
- Select
- Navigate

Facet

- Juxtapose
- Partition
- Superimpose

Reduce

- Filter
- Aggregate
- Embed

→ *Derive*

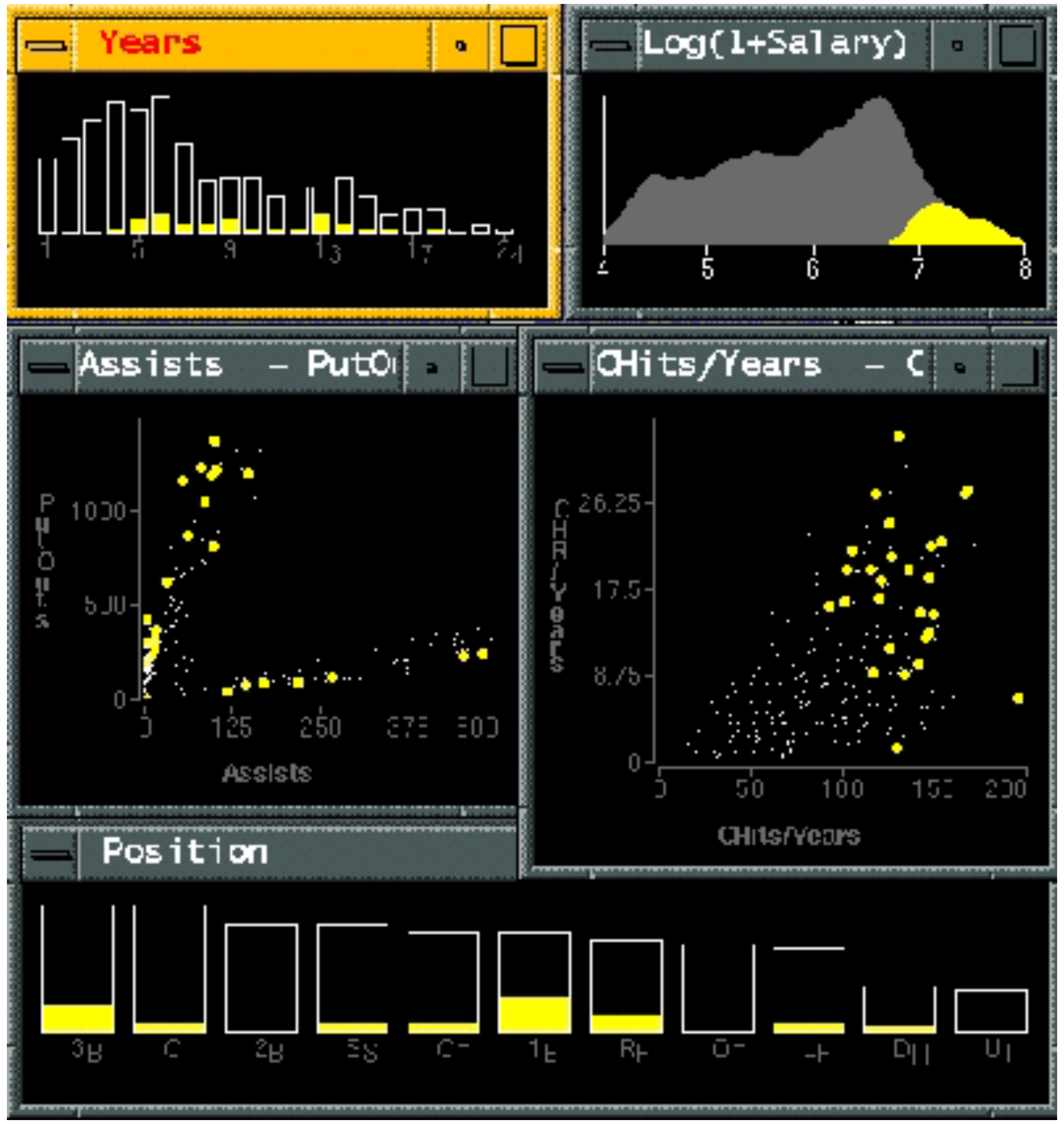
- facet data across multiple views

www.cs.ubc.ca/~tmm/talks.html#vad20alum

Idiom: **Linked highlighting** System: **EDV**

- see how regions contiguous in one view are distributed within another
  - –powerful and pervasive interaction idiom

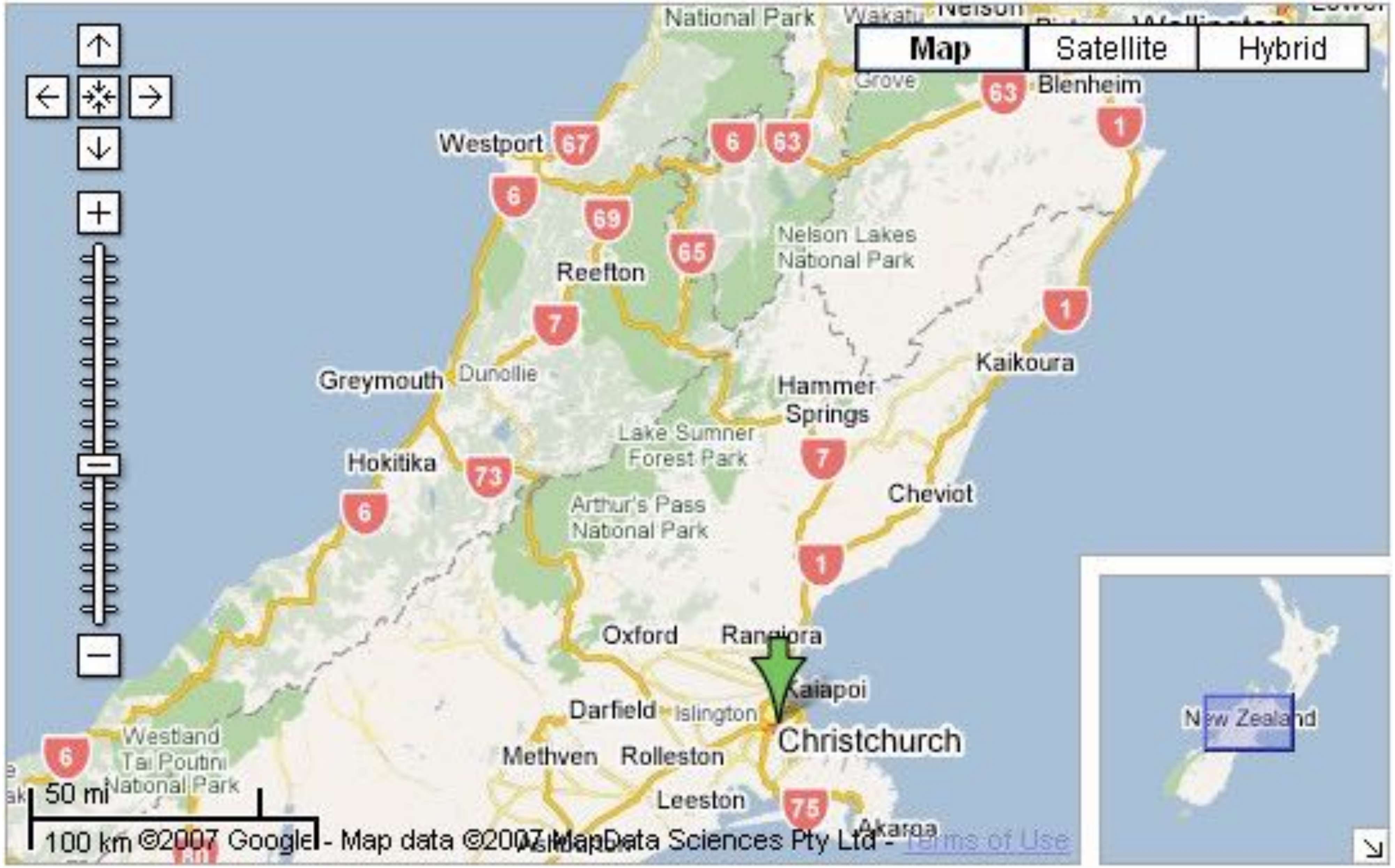
- encoding: different
- data: all shared



[Visual Exploration of Large Structured Datasets. Wills. Proc. New Techniques and Trends in Statistics (NTTS), pp. 237–246. IOS Press, 1995.]

Idiom: **bird's-eye maps** System: **Google Maps**

- encoding: same
- data: subset shared
- navigation: shared
  - bidirectional linking
- differences
  - viewpoint
  - (size)
- ***overview-detail***

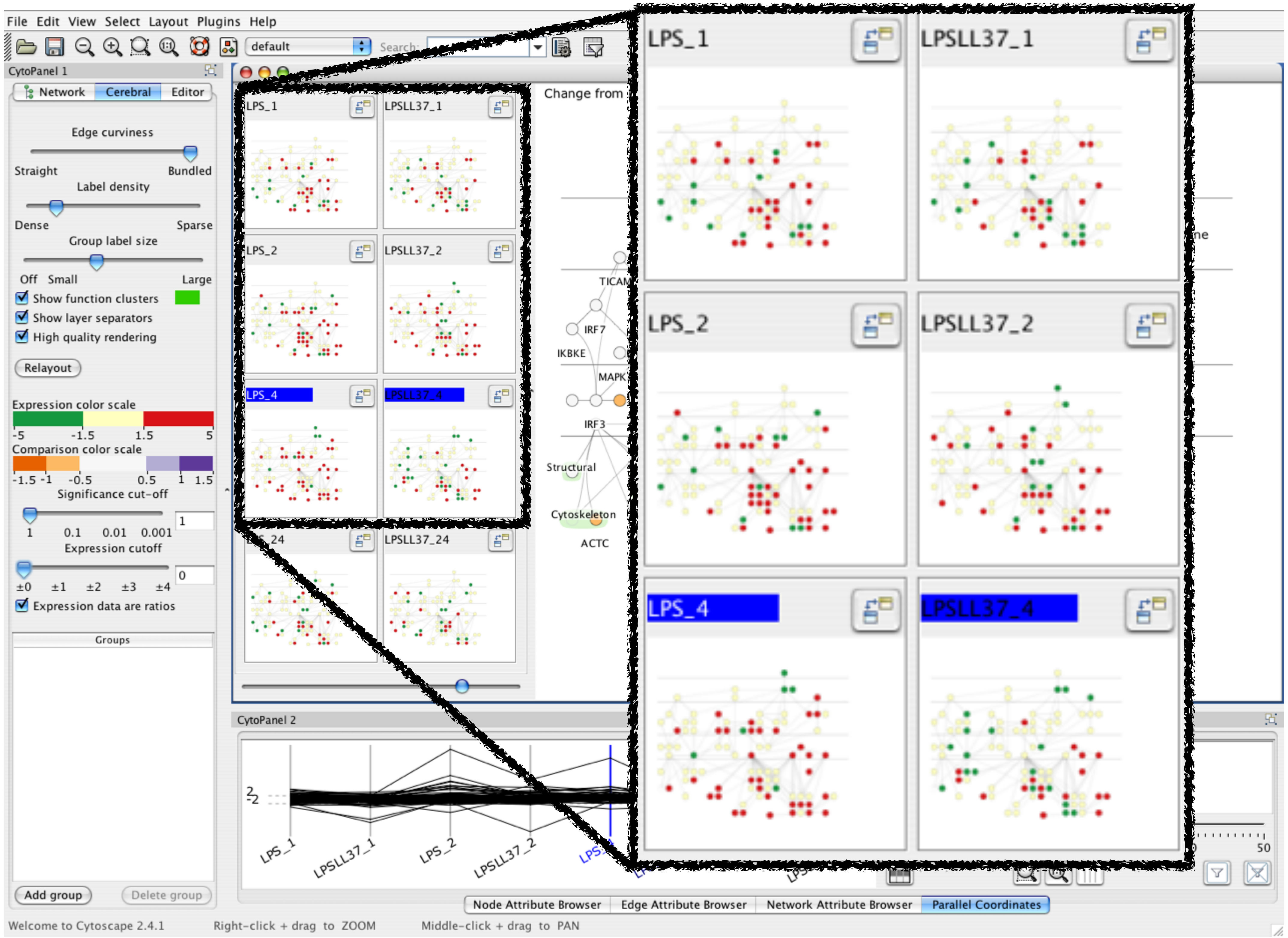


[A Review of Overview+Detail, Zooming, and Focus+Context Interfaces. Cockburn, Karlson, and Bederson. ACM Computing Surveys 41:1 (2008), 1–31.]

Idiom: **Small multiples**

System: **Cerebral**

- encoding: same
- data: none shared
  - nodes colored differently for each time/condition case
  - (same network layout)
- navigation: shared



[Cerebral: Visualizing Multiple Experimental Conditions on a Graph with Biological Context. Barsky, Munzner, Gardy, and Kincaid. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2008) 14:6 (2008), 1253–1260.]

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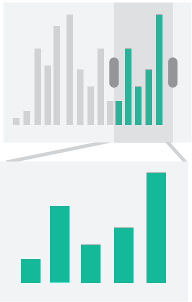
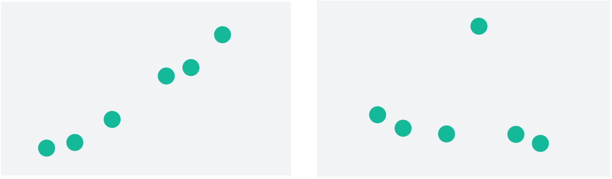
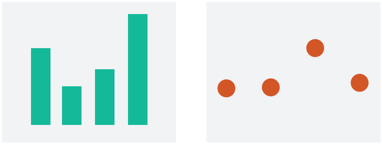
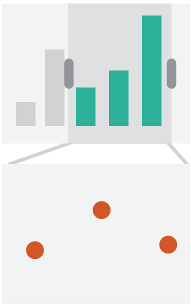
Coordinate views: Design choice interaction

		Data		
		All	Subset	None
Encoding	Same	Redundant	 Overview/ Detail	 Small Multiples
	Different	 Multiform	 Multiform, Overview/ Detail	No Linkage

- why juxtapose views?
  - –benefits: eyes vs memory
    - lower cognitive load to move eyes between 2 views than remembering previous state with single changing view
  - –costs: display area, 2 views side by side each have only half the area of one view

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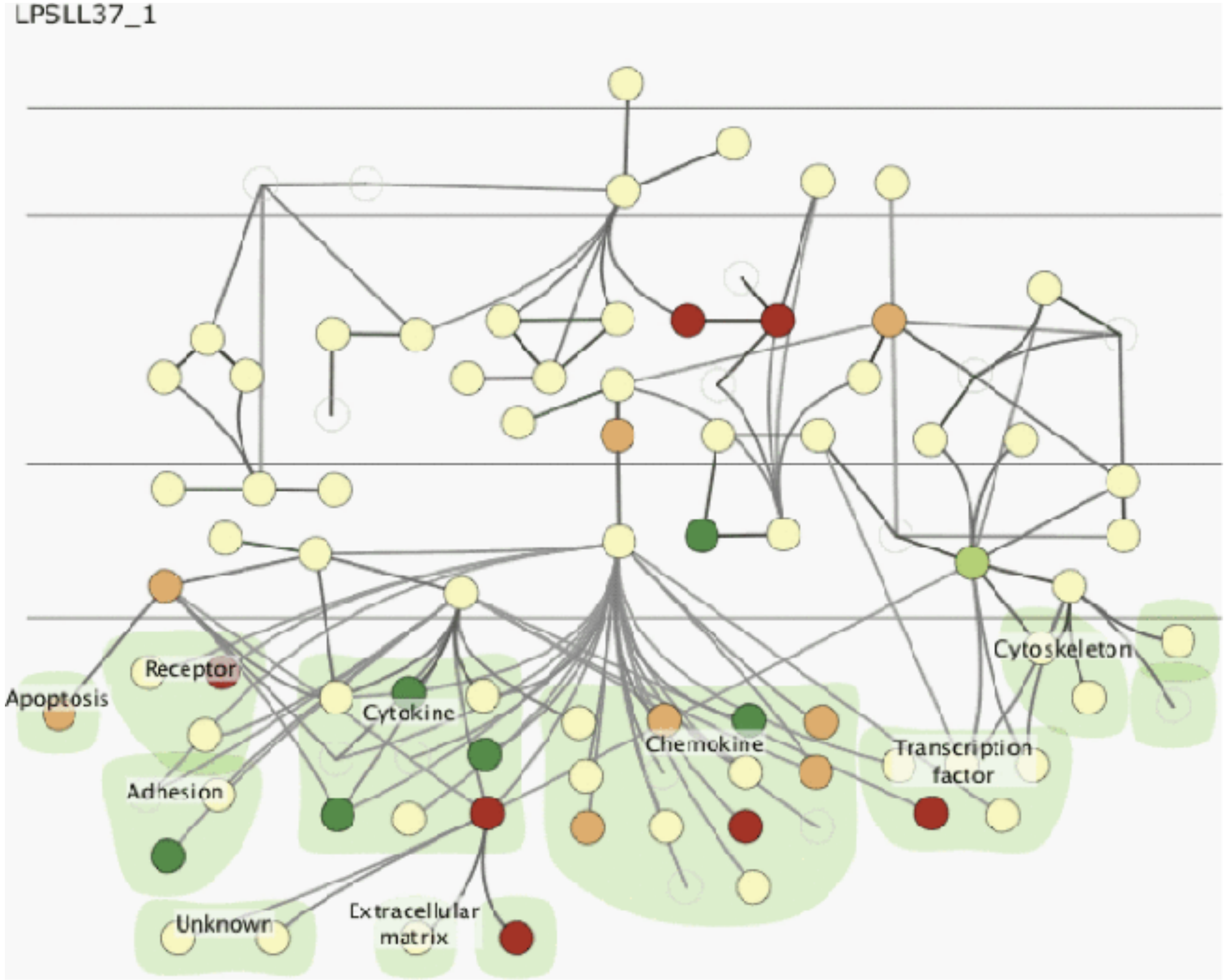
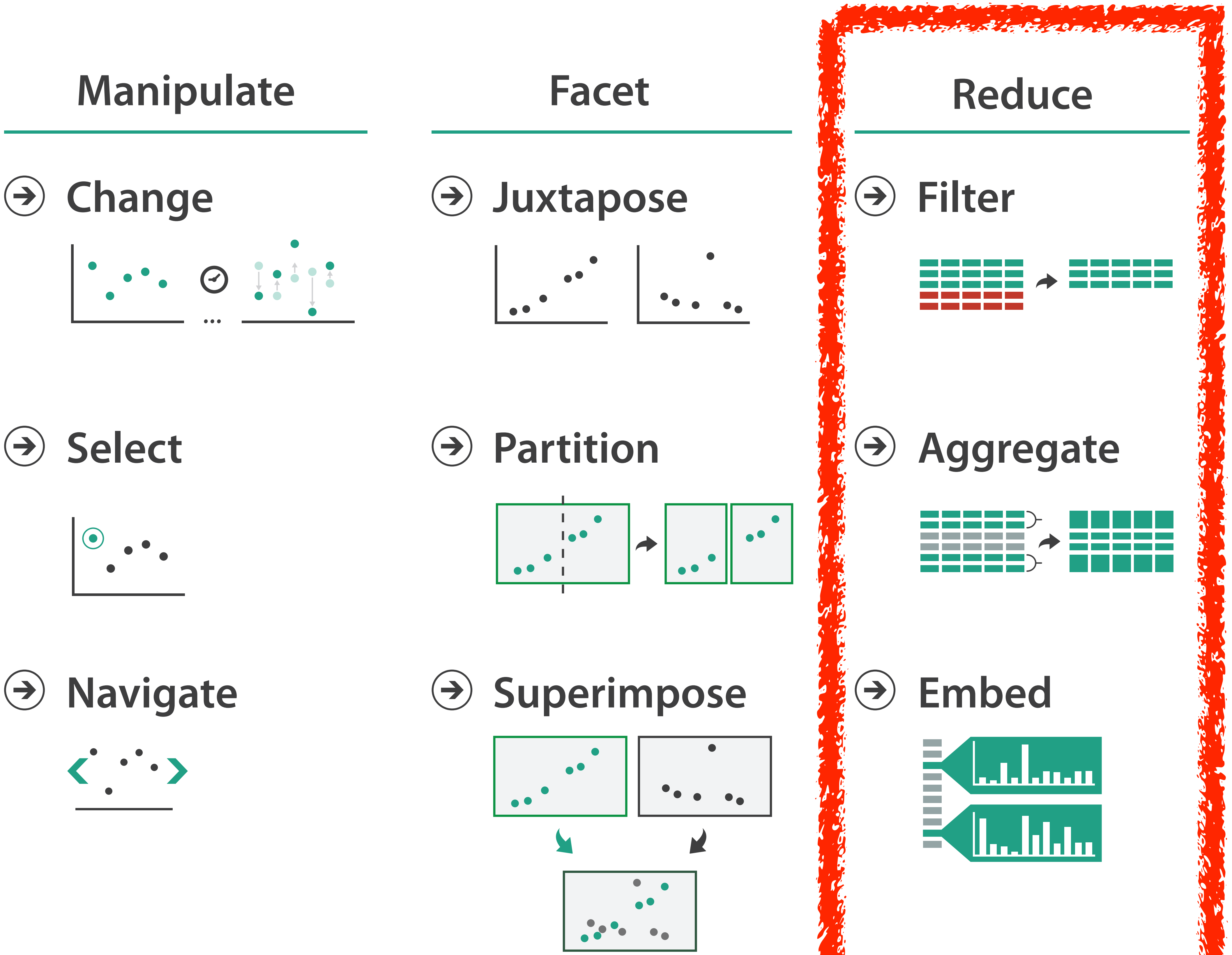
Idiom: Animation (change over time)

- weaknesses
  - –widespread changes
  - –disparate frames
- strengths
  - –choreographed storytelling
  - –localized differences between contiguous frames
  - –animated transitions between states



www.cs.ubc.ca/~tmm/talks.html#vad20alum

How to handle complexity: 3 more strategies + 1 previous



Manipulate

Change

Select

Navigate

Facet

Juxtapose

Partition

Superimpose

Reduce

Filter

Aggregate

Embed

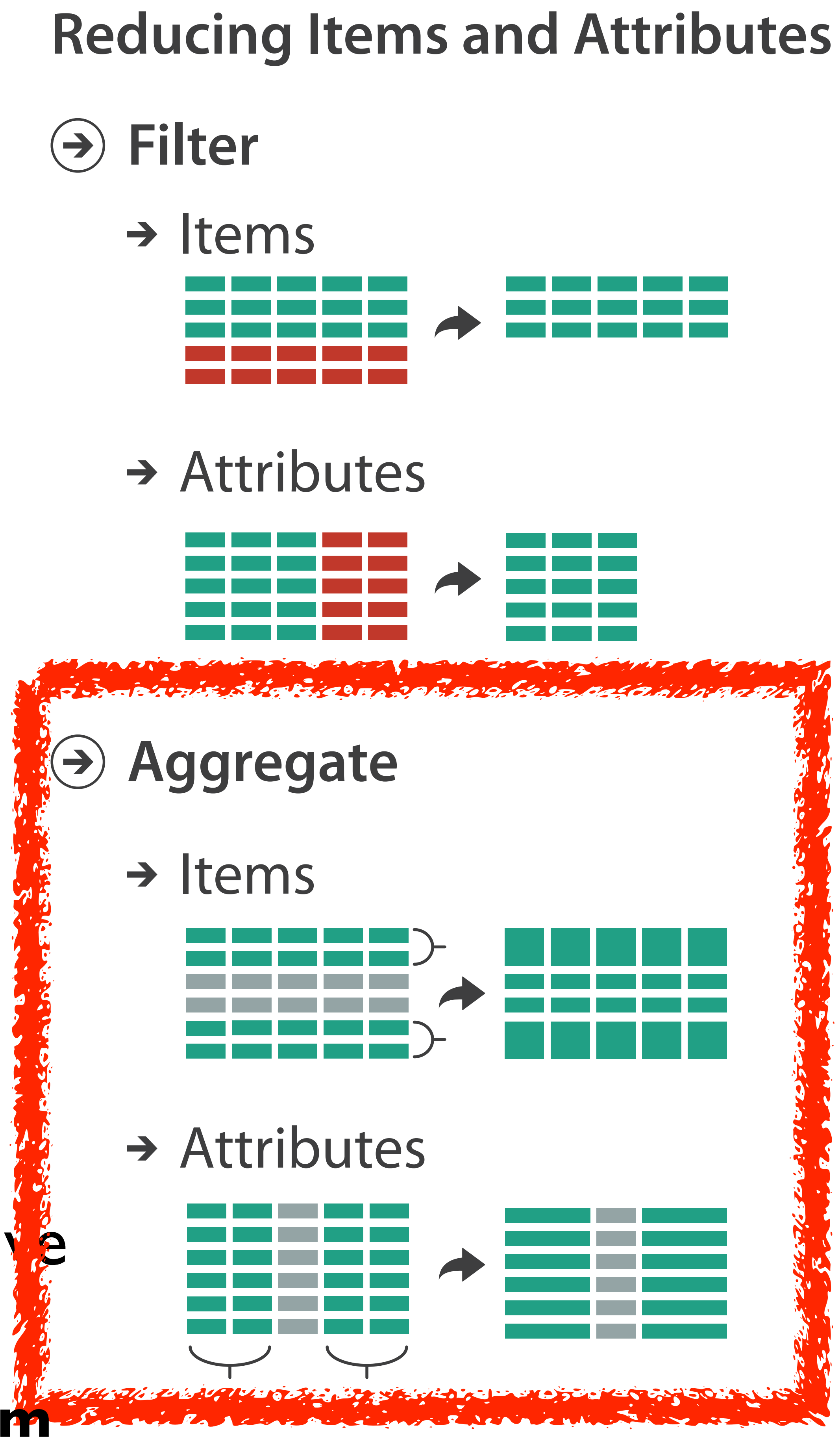
Derive

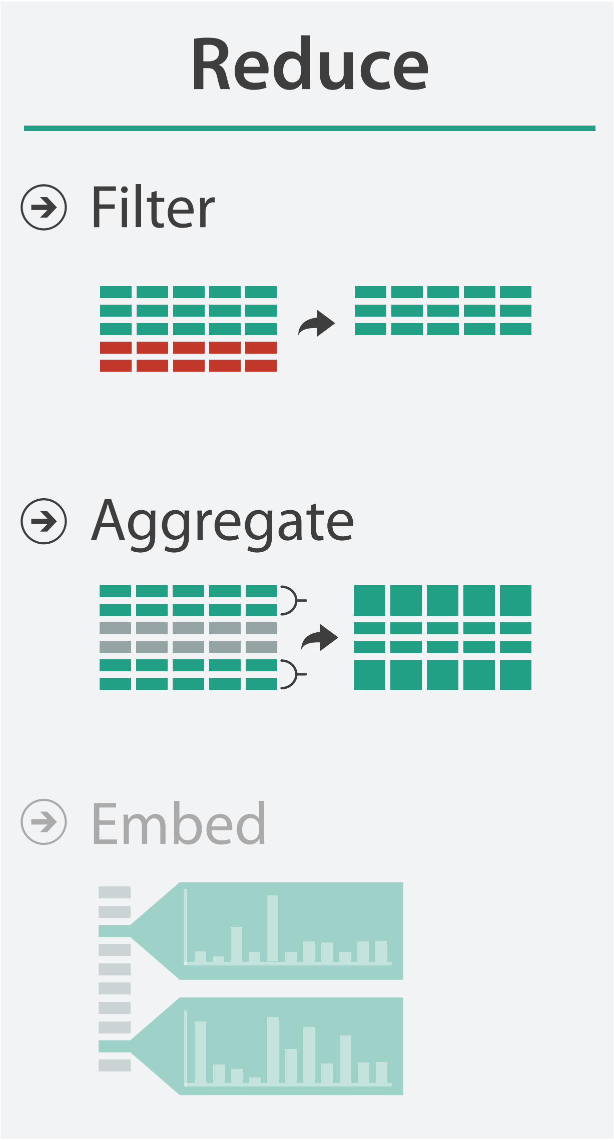
- reduce what is shown within single view

www.cs.ubc.ca/~tmm/talks.html#vad20a

Reduce items and attributes

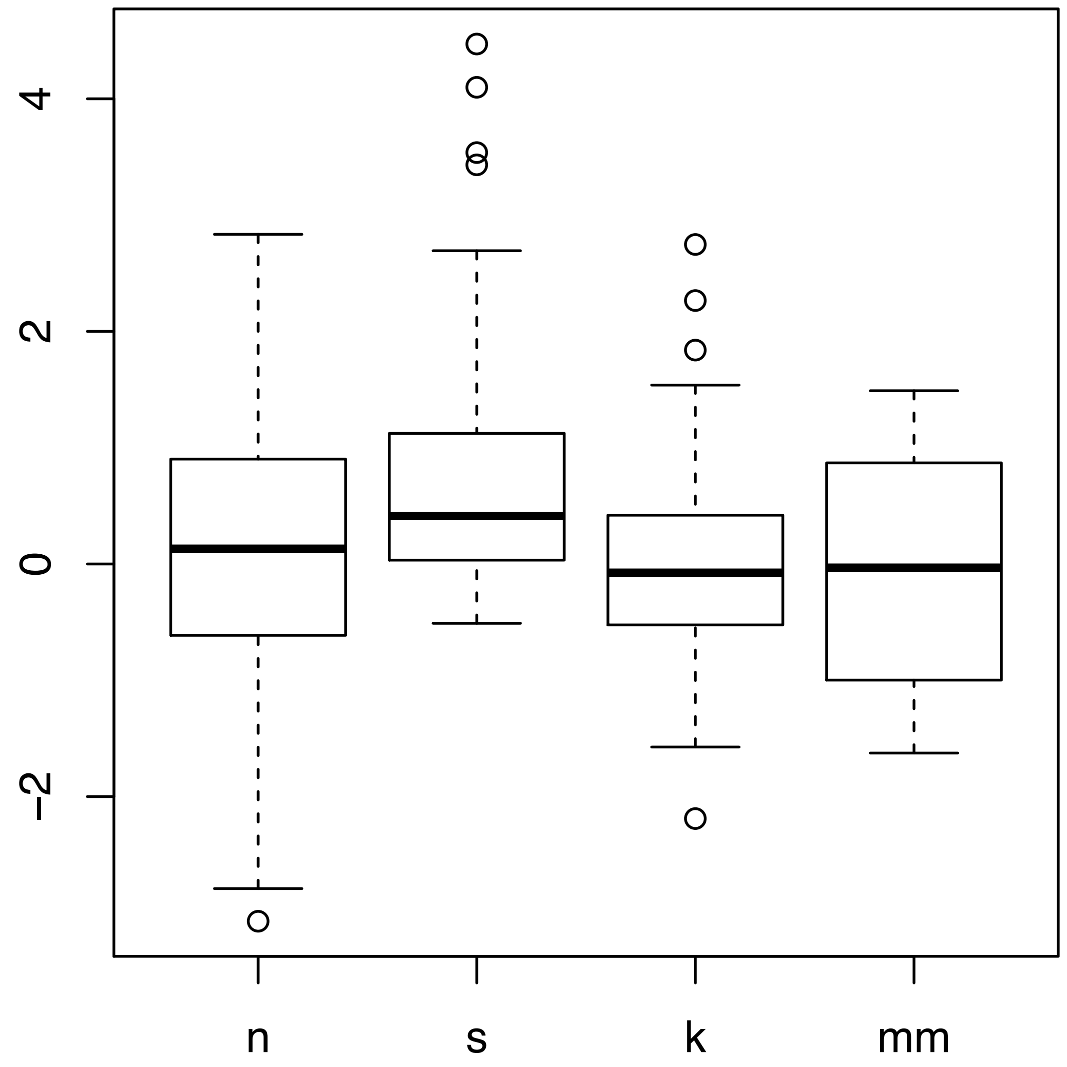
- reduce/increase: inverses
- filter
  - pro: straightforward and intuitive
    - to understand and compute
  - con: out of sight, out of mind
- aggregation
  - pro: inform about whole set
  - con: difficult to avoid losing signal
- not mutually exclusive
  - combine filter, aggregate
  - combine reduce, facet, change, derive





Idiom: **boxplot**

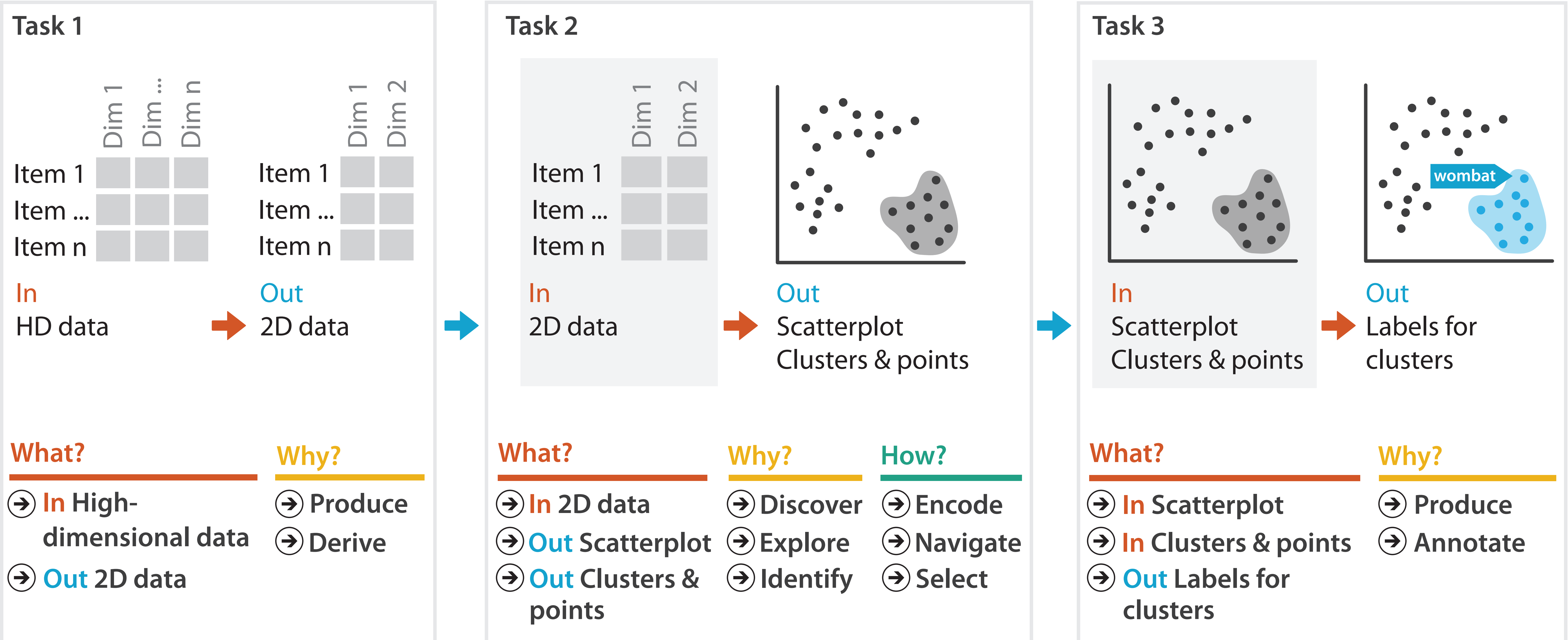
- static item aggregation
- task: find distribution
- data: table
- derived data
  - 5 quant attribs
    - median: central line
    - lower and upper quartile: boxes
    - lower upper fences: whiskers
      - values beyond which items are outliers
  - outliers beyond fence cutoffs explicitly shown



[40 years of boxplots. Wickham and Stryjewski. 2012. had.co.nz]

Idiom: **Dimensionality reduction for documents**

- attribute aggregation
  - –derive low-dimensional target space from high-dimensional measured space



Task 1

In
HD data

Out
2D data

What?
- In High-dimensional data
- Out 2D data

Why?
- Produce
- Derive

Task 2

In
2D data

Out
Scatterplot
Clusters & points

What?
- In 2D data
- Out Scatterplot
- Out Clusters & points

Why?
- Discover
- Explore
- Identify

How?
- Encode
- Navigate
- Select

Task 3

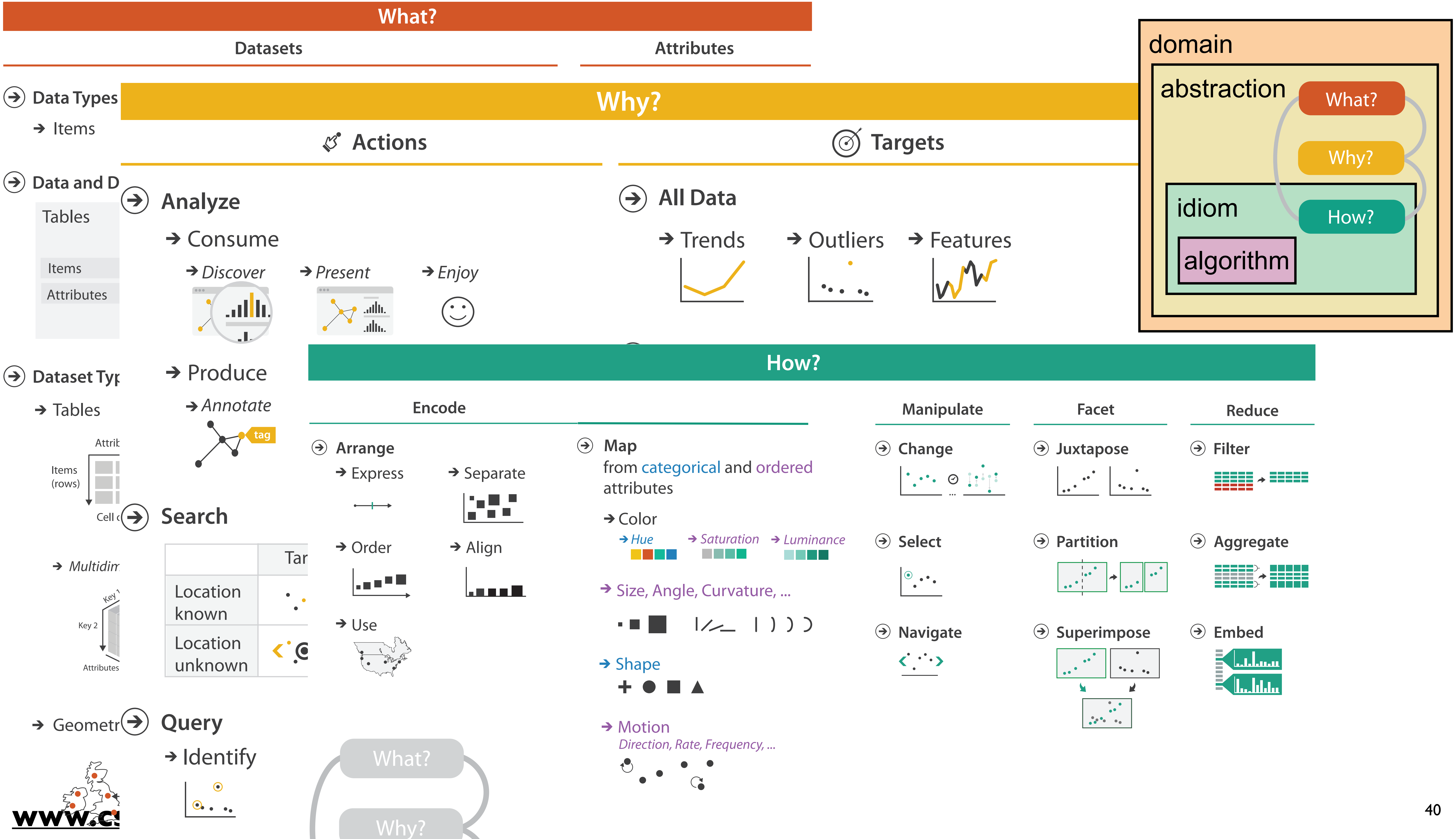
In
Scatterplot
Clusters & points

Out
Labels for
clusters

What?
- In Scatterplot
- In Clusters & points
- Out Labels for clusters

Why?
- Produce
- Annotate

www.cs.ubc.ca/~tmm/talks.html#vad20alum



What?

Datasets

Attributes

Data Types

→ Items

Data and D

Tables

Items

Attributes

Dataset Typ

→ Tables

Attrib

Items (rows)

Cell c

→ Multidim

Key 1

Key 2

Attributes

→ Geometr

www.c

Why?

Actions

Analyze

→ Consume

→ *Discover*

→ *Present*

→ *Enjoy*

→ Produce

→ *Annotate*

tag

Search

	Tar
Location known	
Location unknown	

Query

→ Identify

What?

Why?

Targets

All Data

→ Trends

→ Outliers

→ Features

How?

Encode

Arrange

→ Express

→ Separate

→ Order

→ Align

→ Use

Map

from categorical and ordered attributes

→ Color

→ *Hue*

→ *Saturation*

→ *Luminance*

→ Size, Angle, Curvature, ...

→ Shape

→ Motion

Direction, Rate, Frequency, ...

Manipulate

Change

Select

Navigate

Facet

Juxtapose

Partition

Superimpose

Reduce

Filter

Aggregate

Embed

domain

abstraction

What?

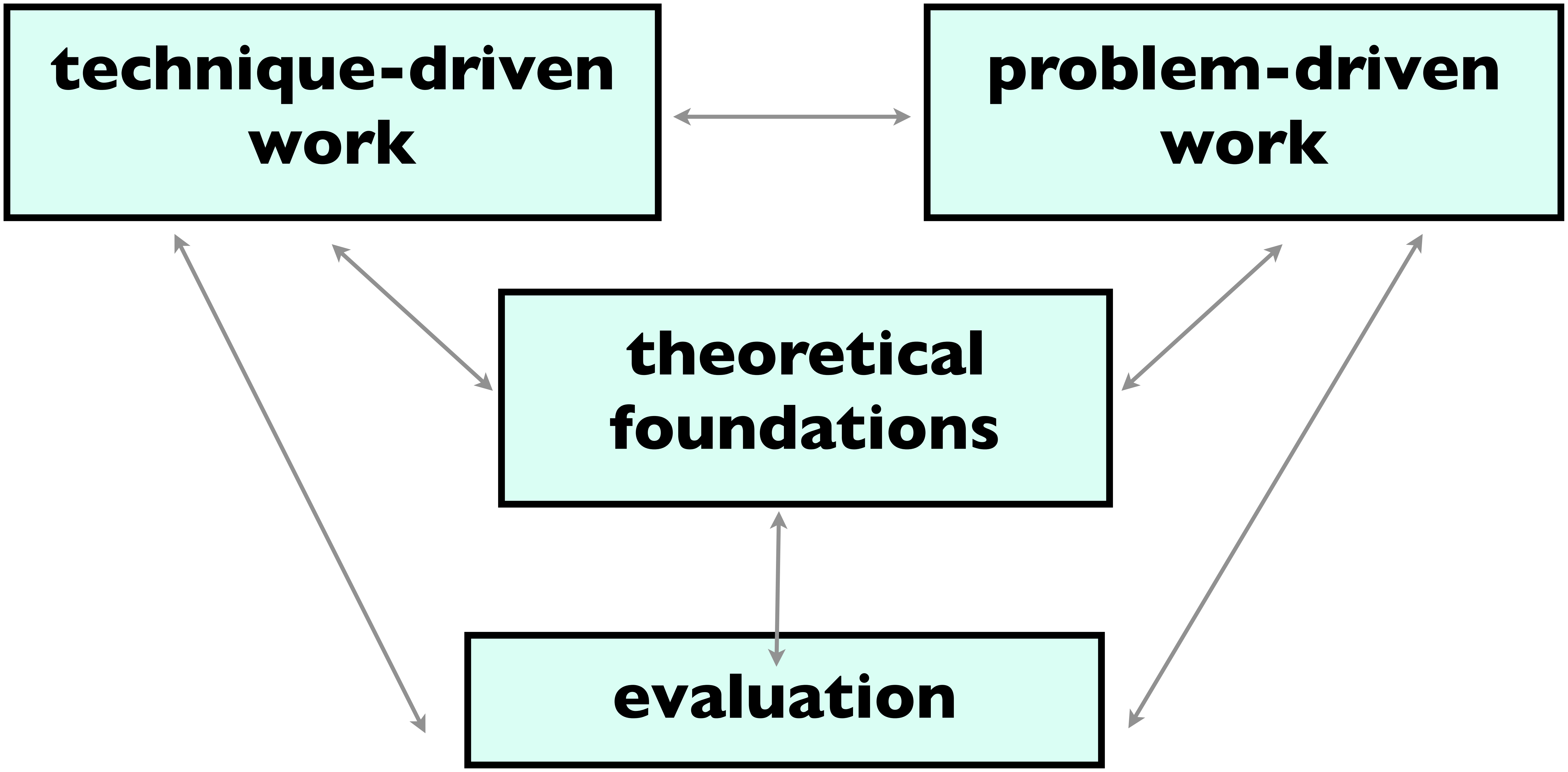
Why?

idiom

How?

algorithm

A quick taste of my own work!



technique-driven work

problem-driven work

theoretical foundations

evaluation

www.cs.ubc.ca/~tmm/talks.html#vad20alum

Technique-driven: Graph/network drawing

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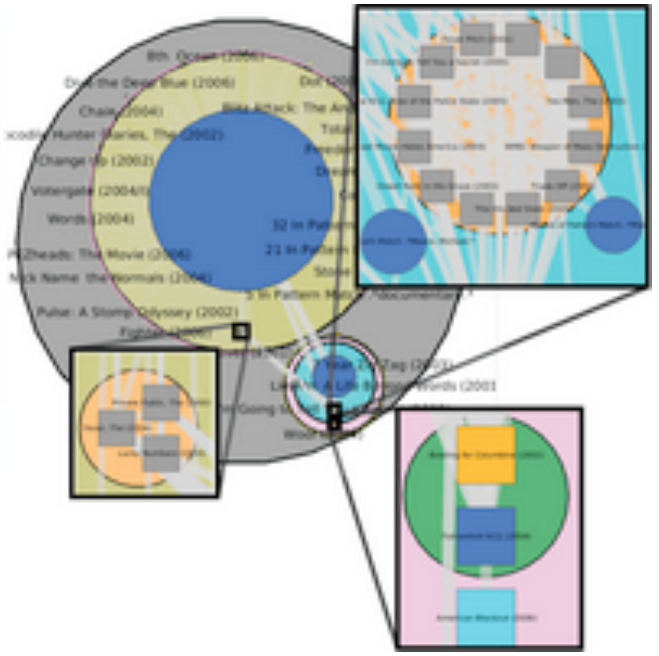
Daniel Archambault

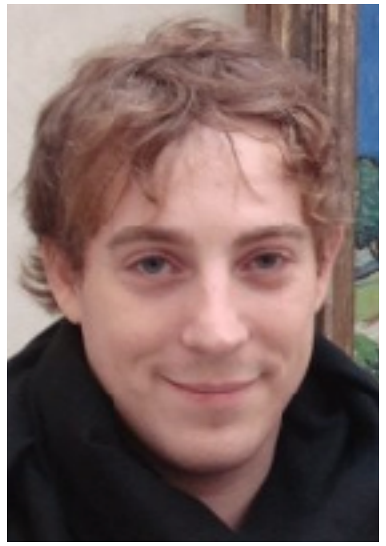
David Auber (Bordeaux)



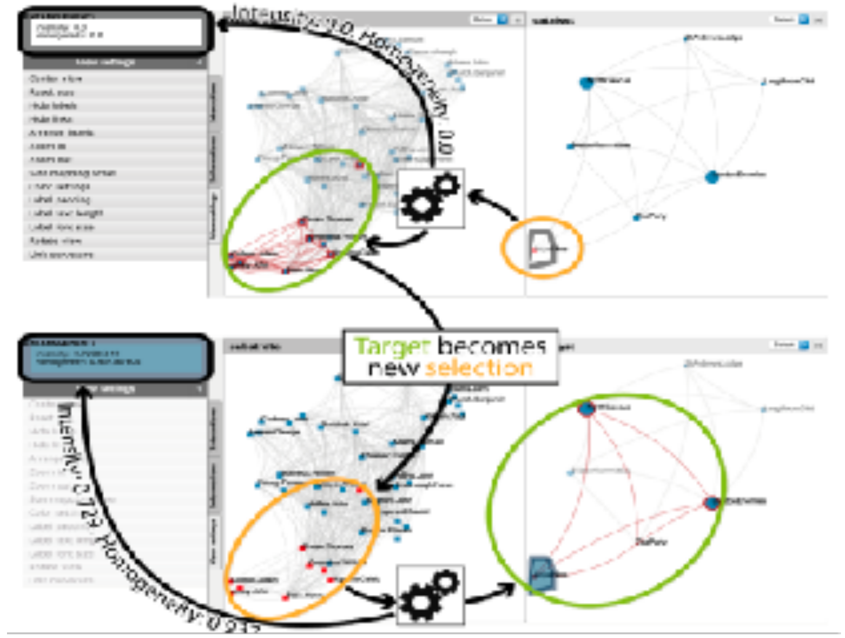
https://youtu.be/AWXAe8zvkt8

TopoLayout
SPF
Grouse
GrouseFlocks
TugGraph

Benjamin Renoust



Guy Melançon (Bordeaux)


Intensity 0.0 Homogeneity 0.01
Target becomes new selection
Intensity 0.23 Homogeneity 0.23

Detangler

https://youtu.be/QOtnHSsUV6k

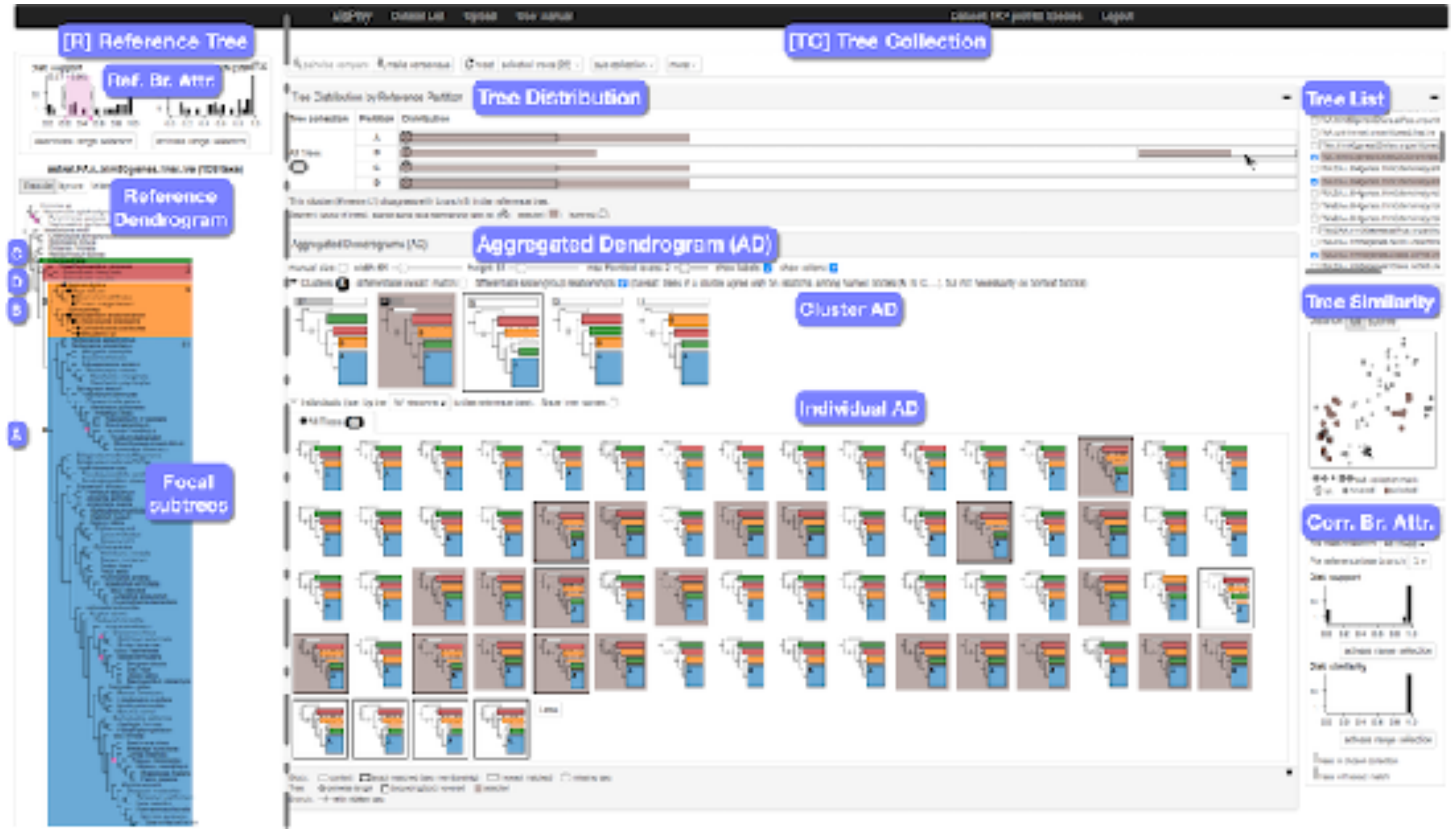
www.cs.ubc.ca/~tmm/talks.html#vad20alum

Technique-driven: Tree drawing

T F P E

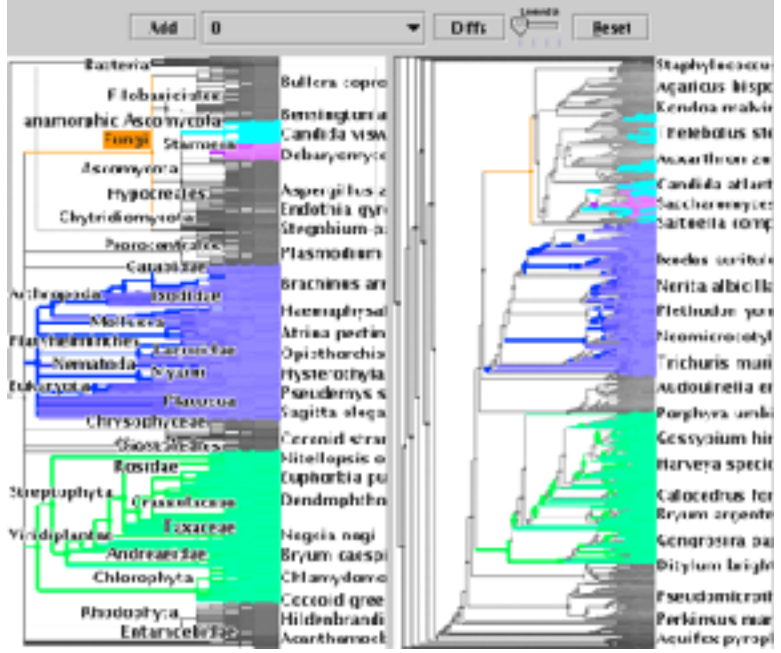
Zipeng Liu

Shing Hei Zhan



Aggregated Dendrograms

https://youtu.be/2SLcz7KNLJw



TreeJuxtaposer

https://youtu.be/GdaPj8a9QEo

Evaluation experiments: Graph/tree drawing

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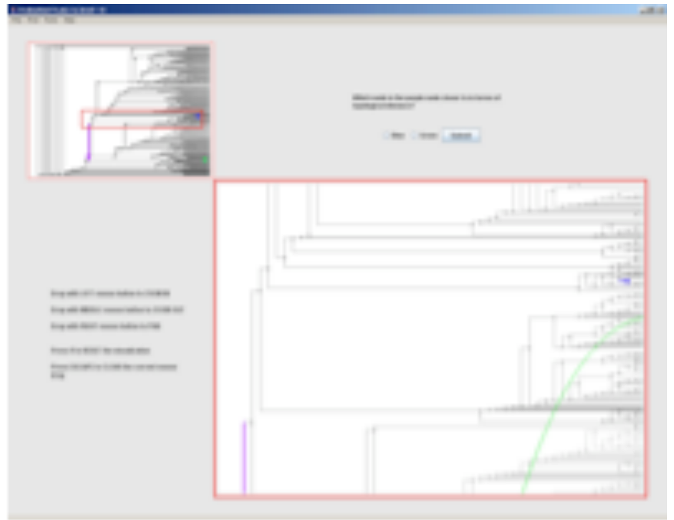
E

Dmitry Nekrasovski

Adam Bodnar

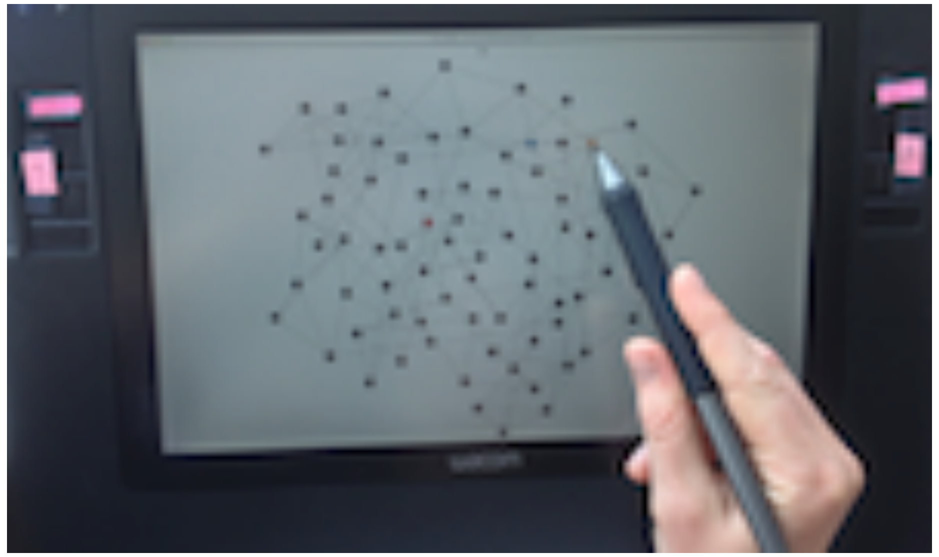
Joanna McGrenere



Stretch and squish navigation

Jessica Dawson

Joanna McGrenere



Search set model of path tracing

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Technique-driven: Dimensionality reduction

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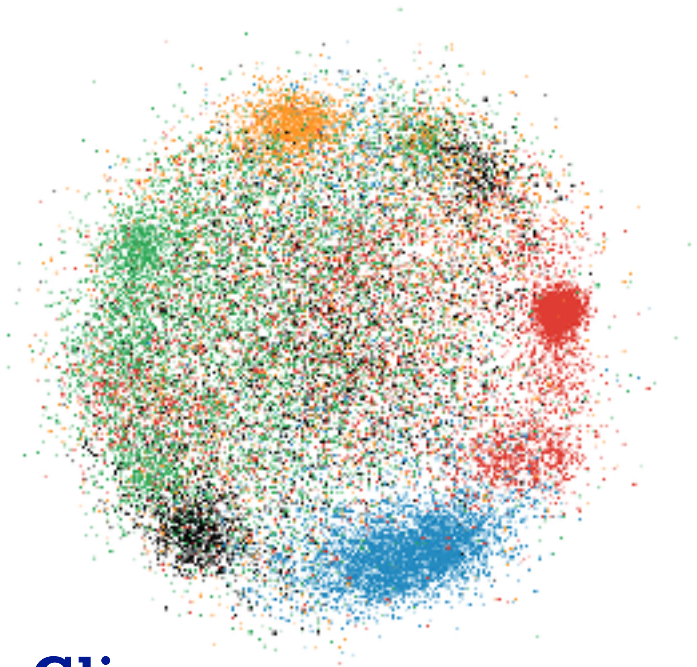
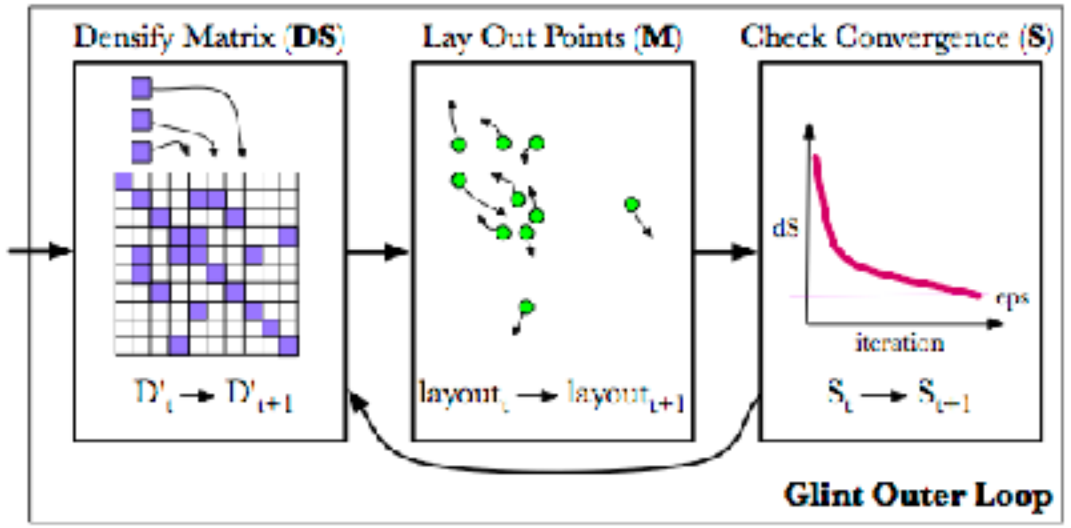
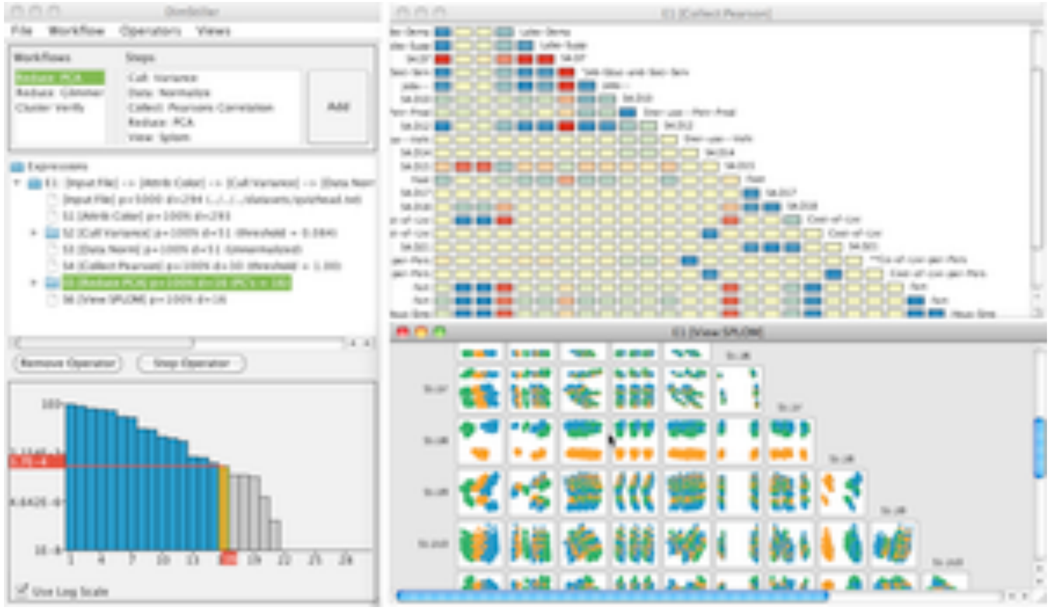
Stephen Ingram



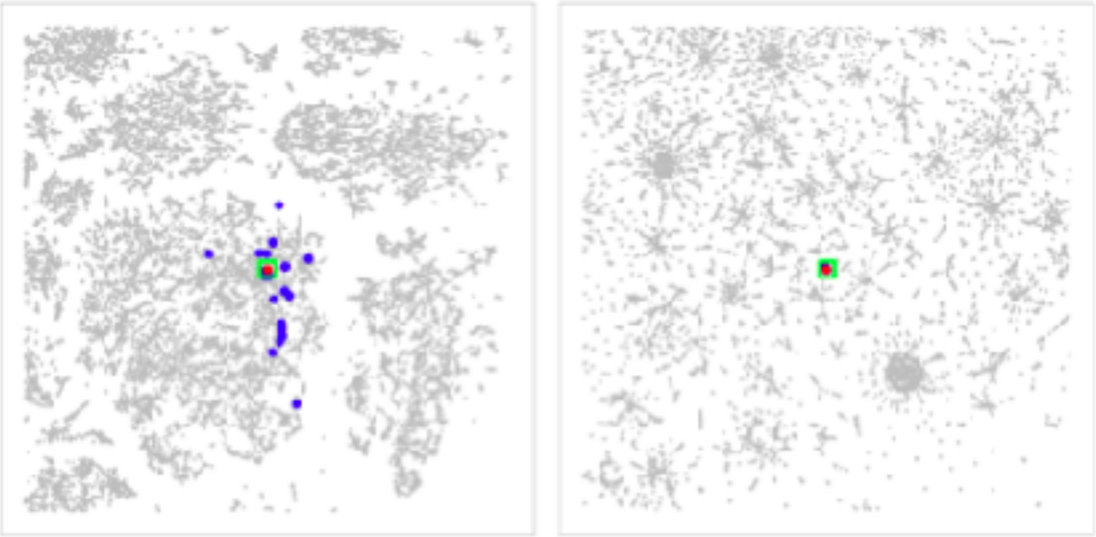
Glimmer



Glint



DimStiller



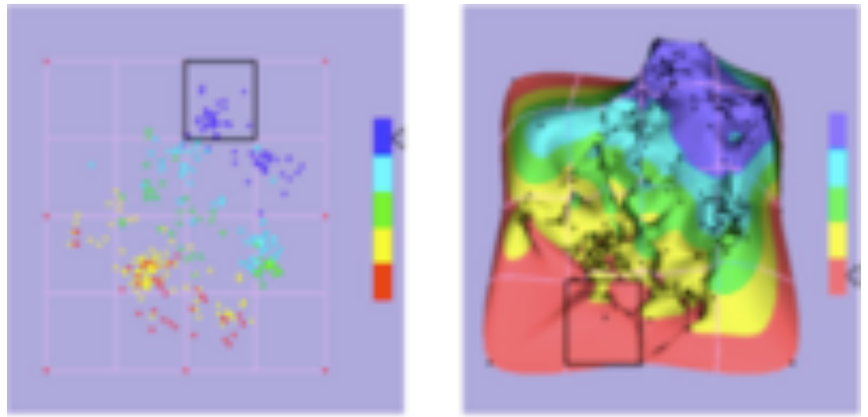
QSNE

www.cs.ubc.ca/~tmm/talks.html#vad20alum

Evaluation experiments: Dimensionality reduction

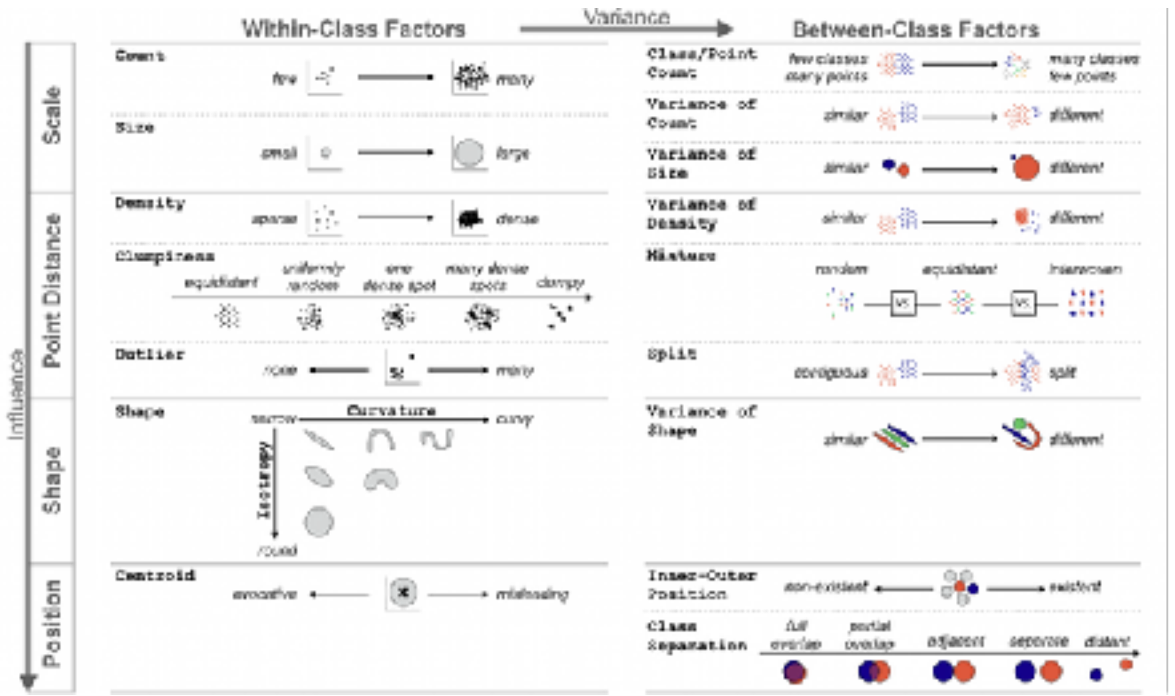
T P F E

Melanie Tory

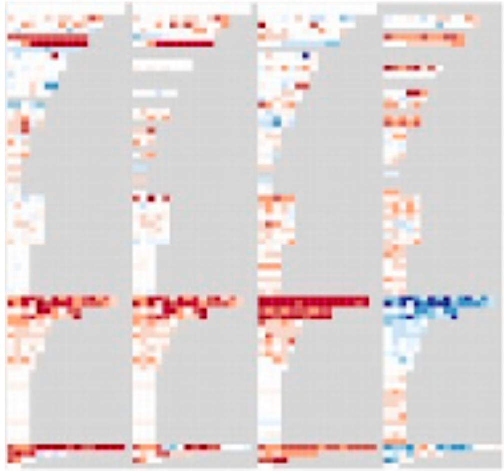


Points vs landscapes for dimensionally reduced data

Michael Sedlmair Melanie Tory



Taxonomy of cluster separation factors



Guidance on DR & scatterplot choices

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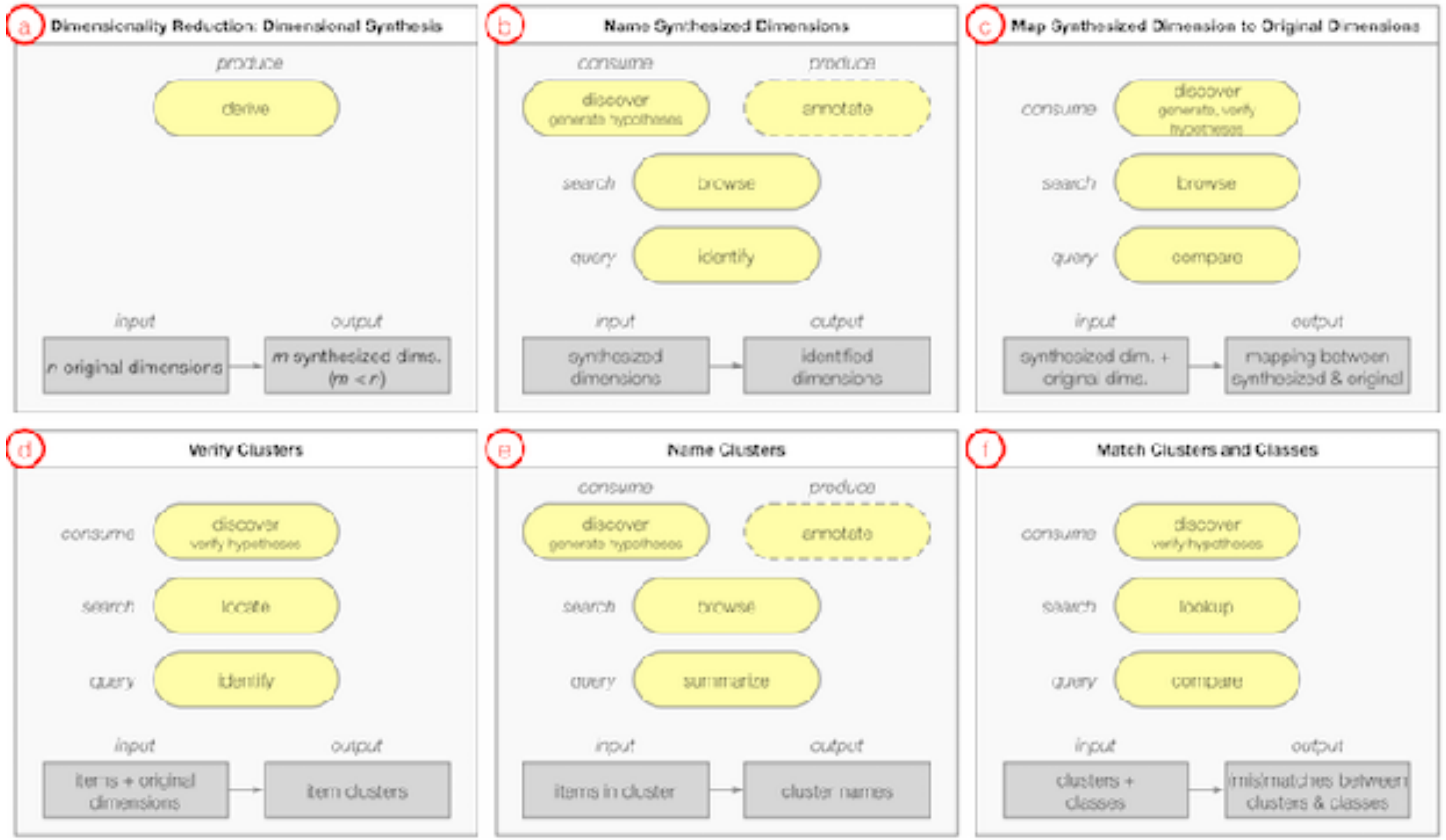
Evaluation in the field: Dimensionality reduction

T F P E



DR in the Wild

Matt Brehmer Michael Sedlmair Melanie Tory Stephen Ingram

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Problem-driven: Genomics

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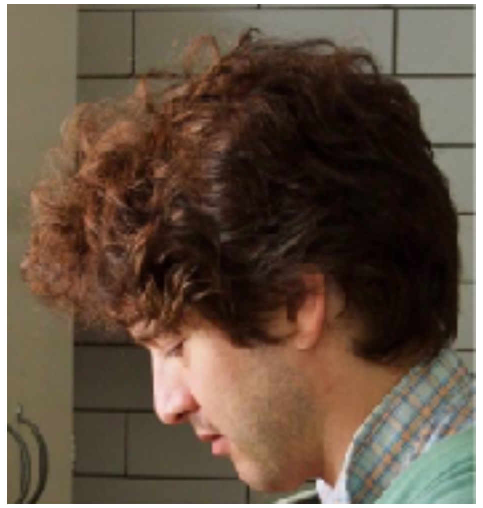
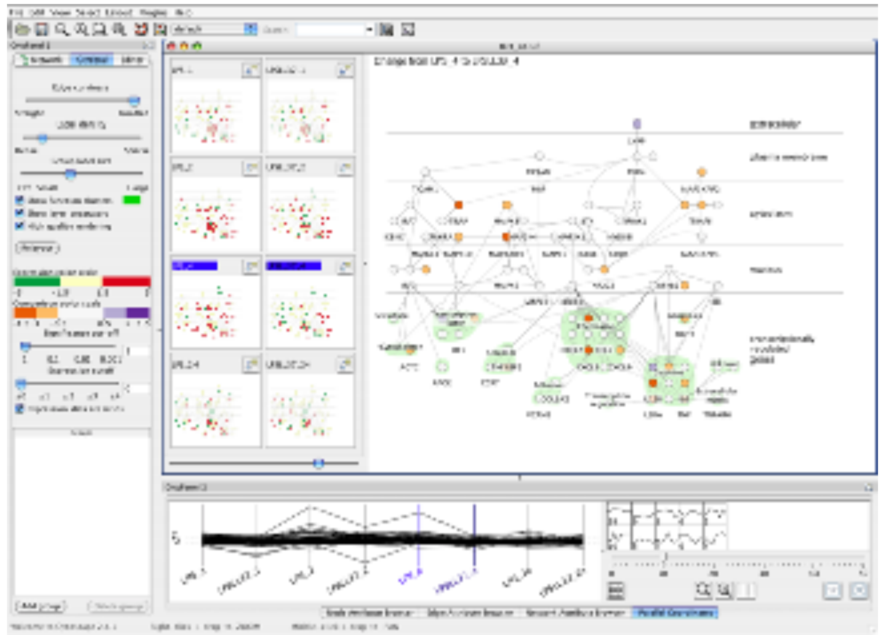
Aaron Barsky



Jenn Gardy (Microbio)

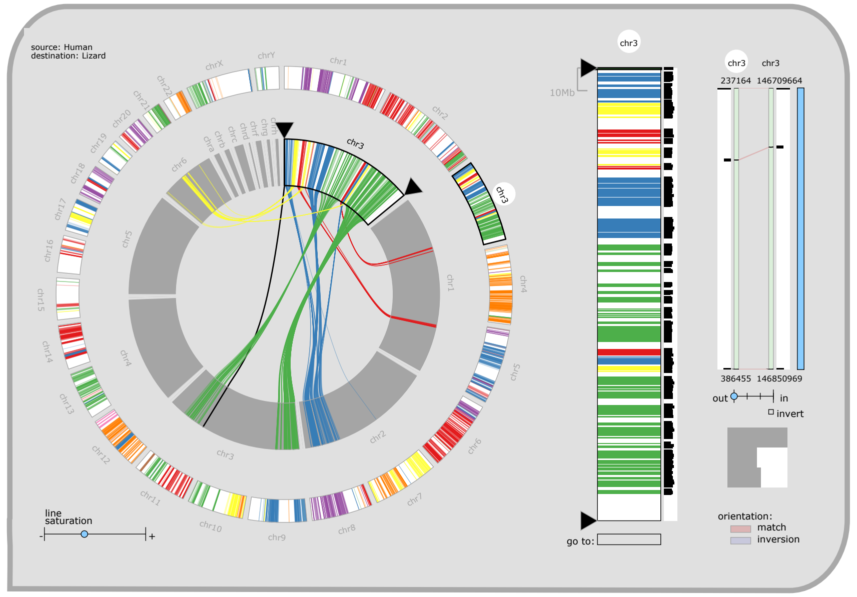
Robert Kincaid (Agilent)



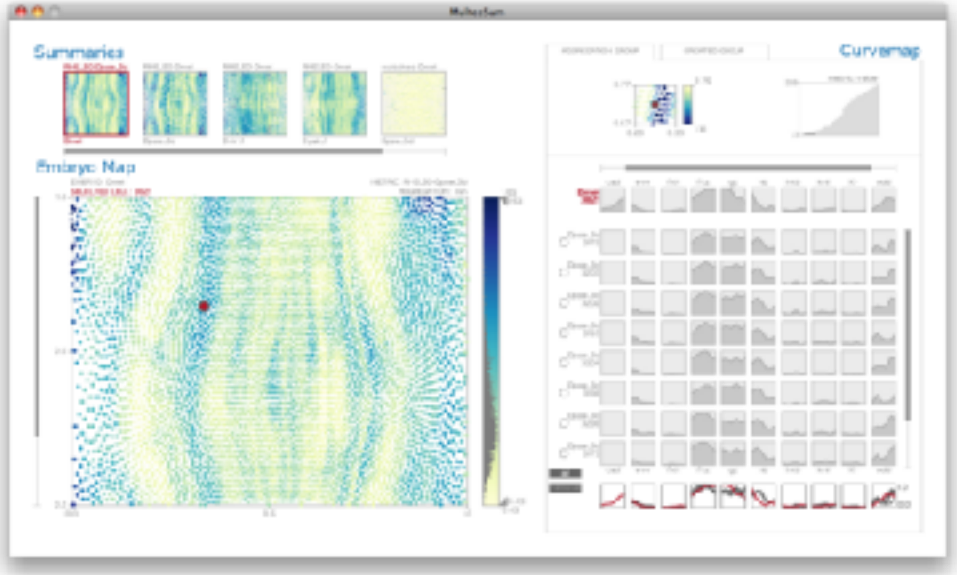
Cerebral
https://youtu.be/76HhG1FQngI

Miriah Meyer

Hanspeter Pfister (Harvard)



MizBee
https://youtu.be/86p7brwuz2g



MulteeSum, Pathline

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Problem-driven: Genomics, fisheries

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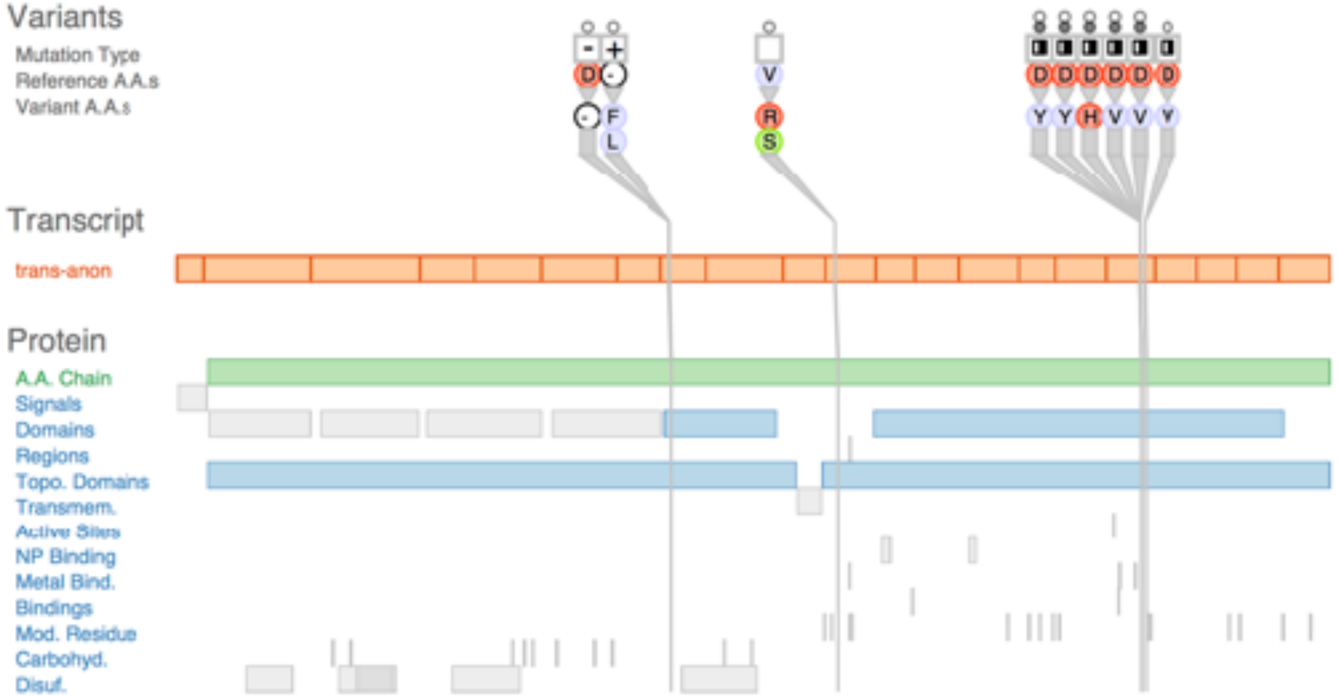
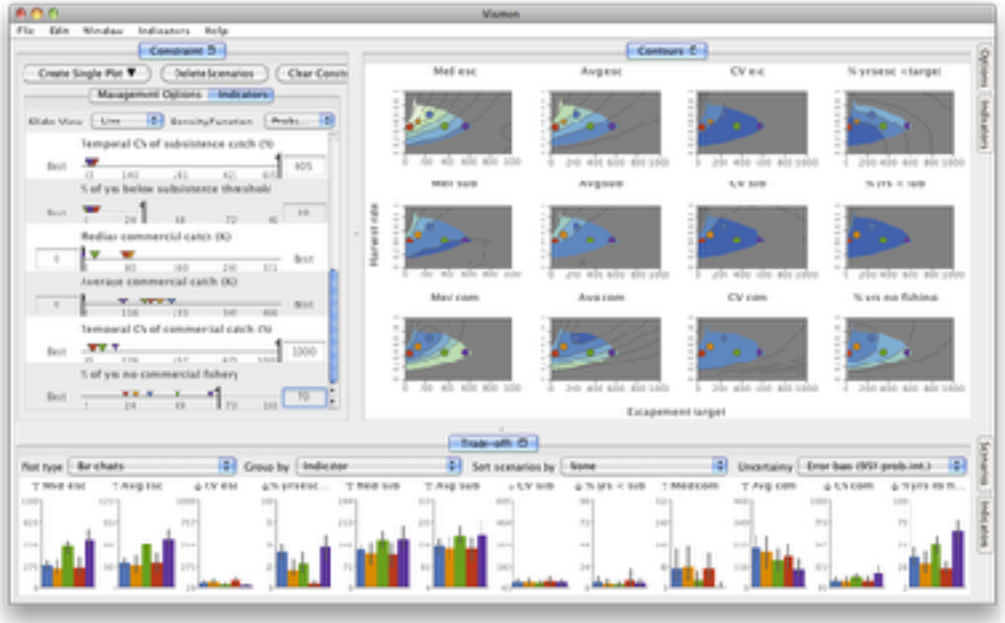
Joel Ferstay

Cydney Nielsen (BC Cancer)



Variant View https://youtu.be/AHDnv_qMXxQ



Vismon https://youtu.be/h0kHoS4VYmk

Maryam Booshehrian

Torsten Moeller (SFU)

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Problem-driven: Tech industry

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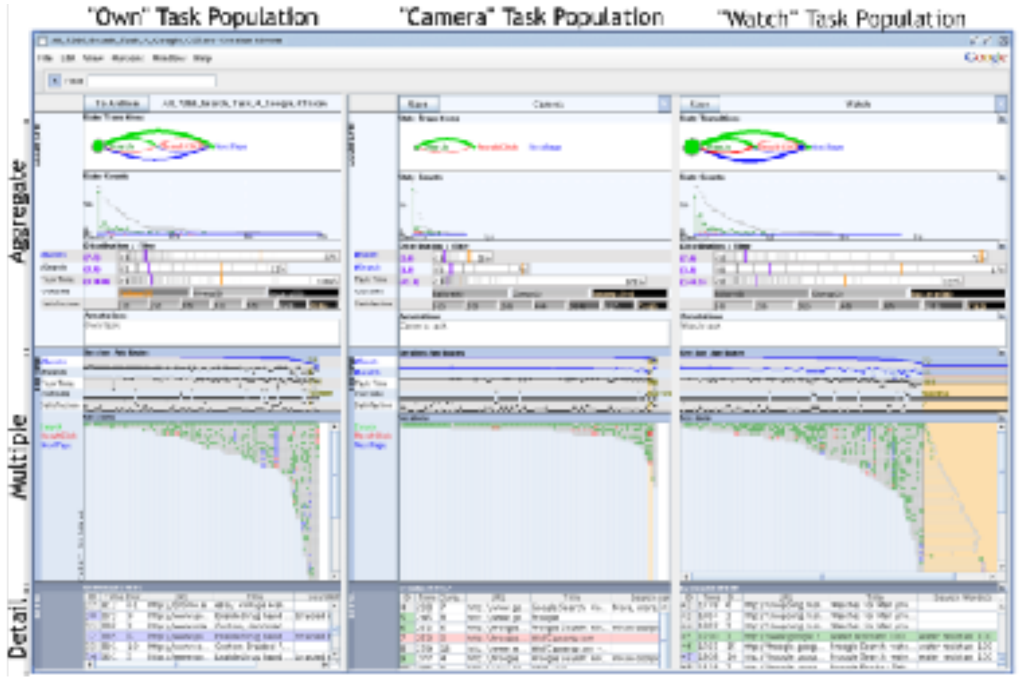
Heidi Lam

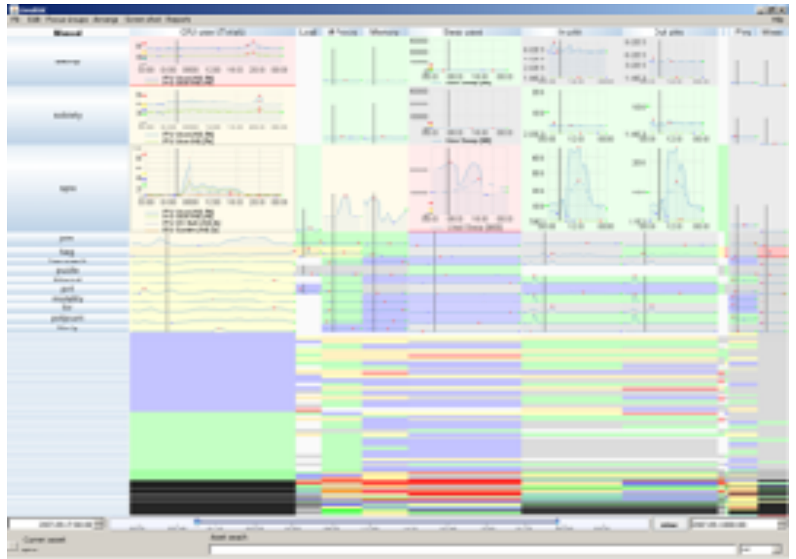
Diane Tang
(Google)



SessionViewer: web log analysis
https://youtu.be/T4MaTZd56G4

Peter McLachlan

Stephen North
(AT&T Research)



LiveRAC: systems time-series https://youtu.be/ld0c3H0VSkw

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Problem-driven: Building energy mgmt, journalism

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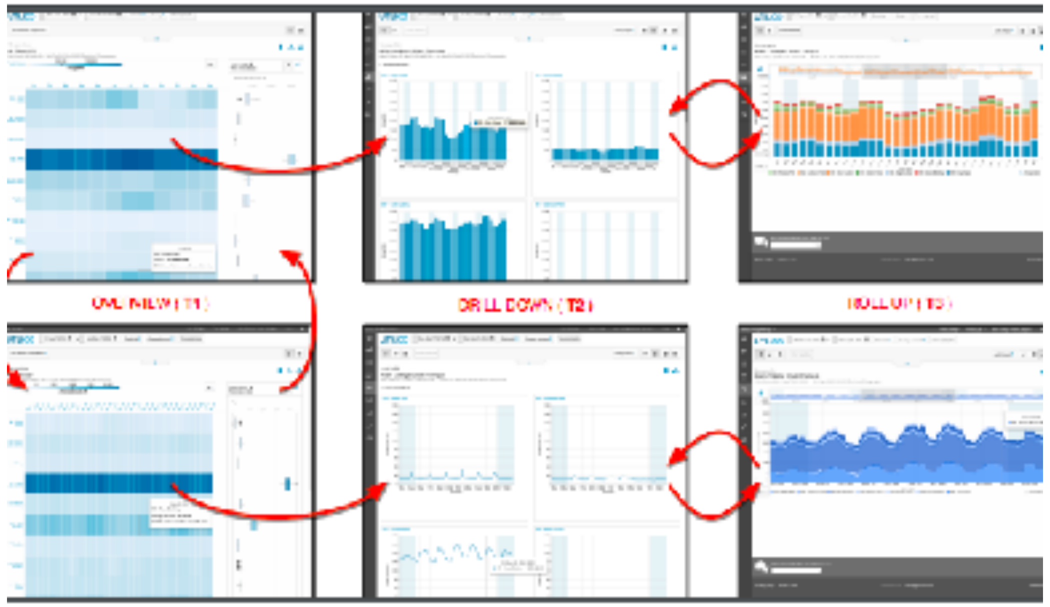
Matt Brehmer

Kevin Tate

(Pulse/EnerNOC)



Energy Manager

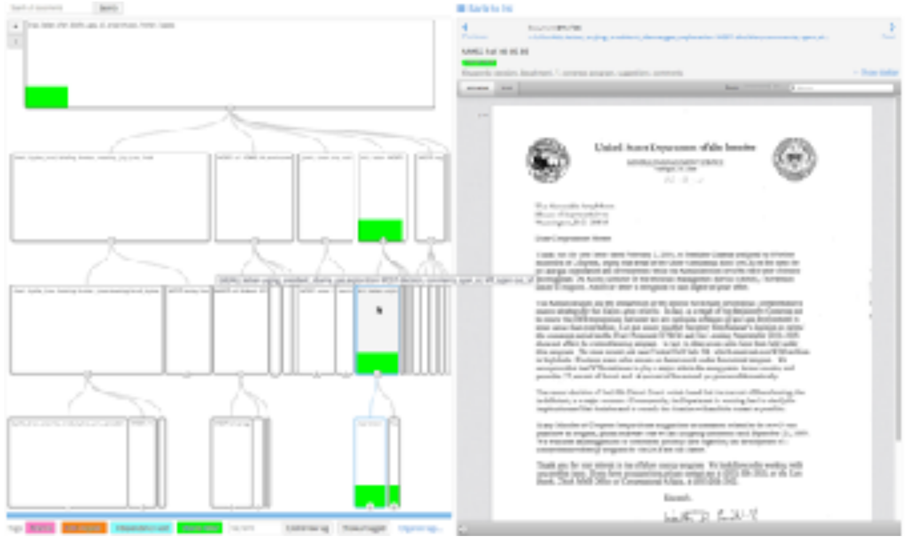
redesign success:
industrial swdev
resources committed

Matt Brehmer

Stephen Ingram

Jonathan Stray

(Assoc Press)



Overview

https://vimeo.com/71483614

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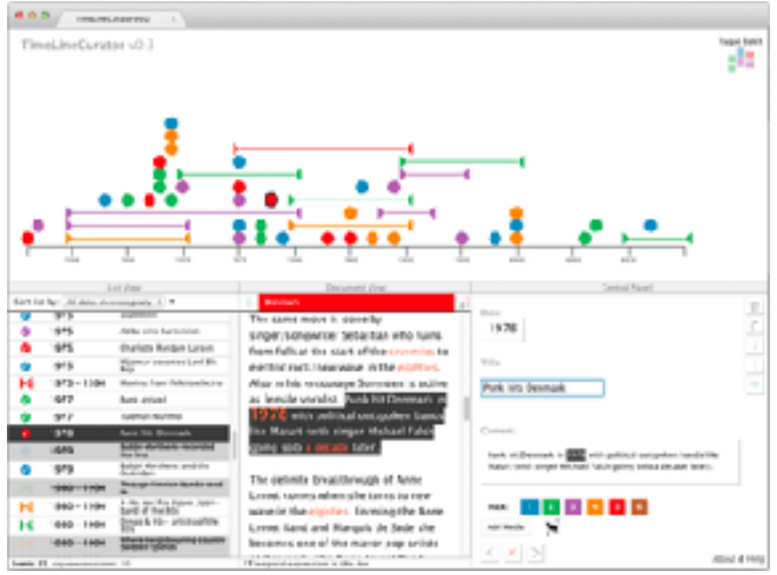
Curation & Presentation: Timelines

T F P
E



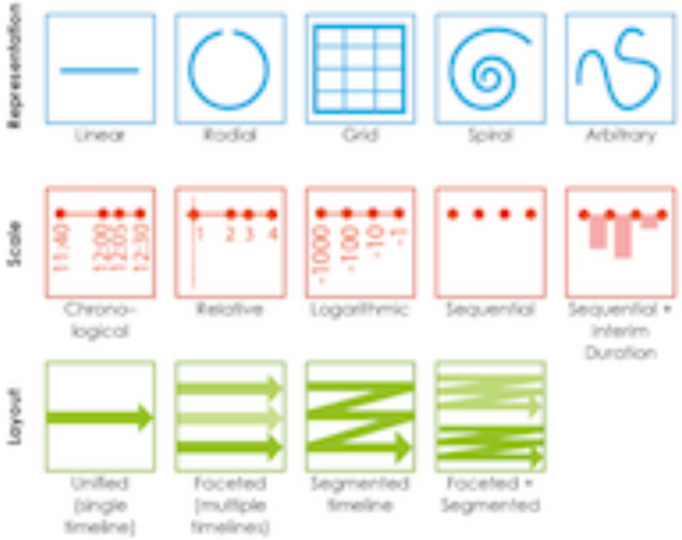
TimeLineCurator

https://vimeo.com/123246662

Matt Brehmer

Johanna Fulda

(Sud. Zeitung)



Timelines Revisited

timelinesrevisited.github.io/

Matt Brehmer

Bongshin Lee

(Microsoft)

Benjamin Bach

(Microsoft)

Nathalie Henry-Riche

www.cs.ubc.ca/~tmm/talks.html#vad20alum

Problem-driven: Current data science

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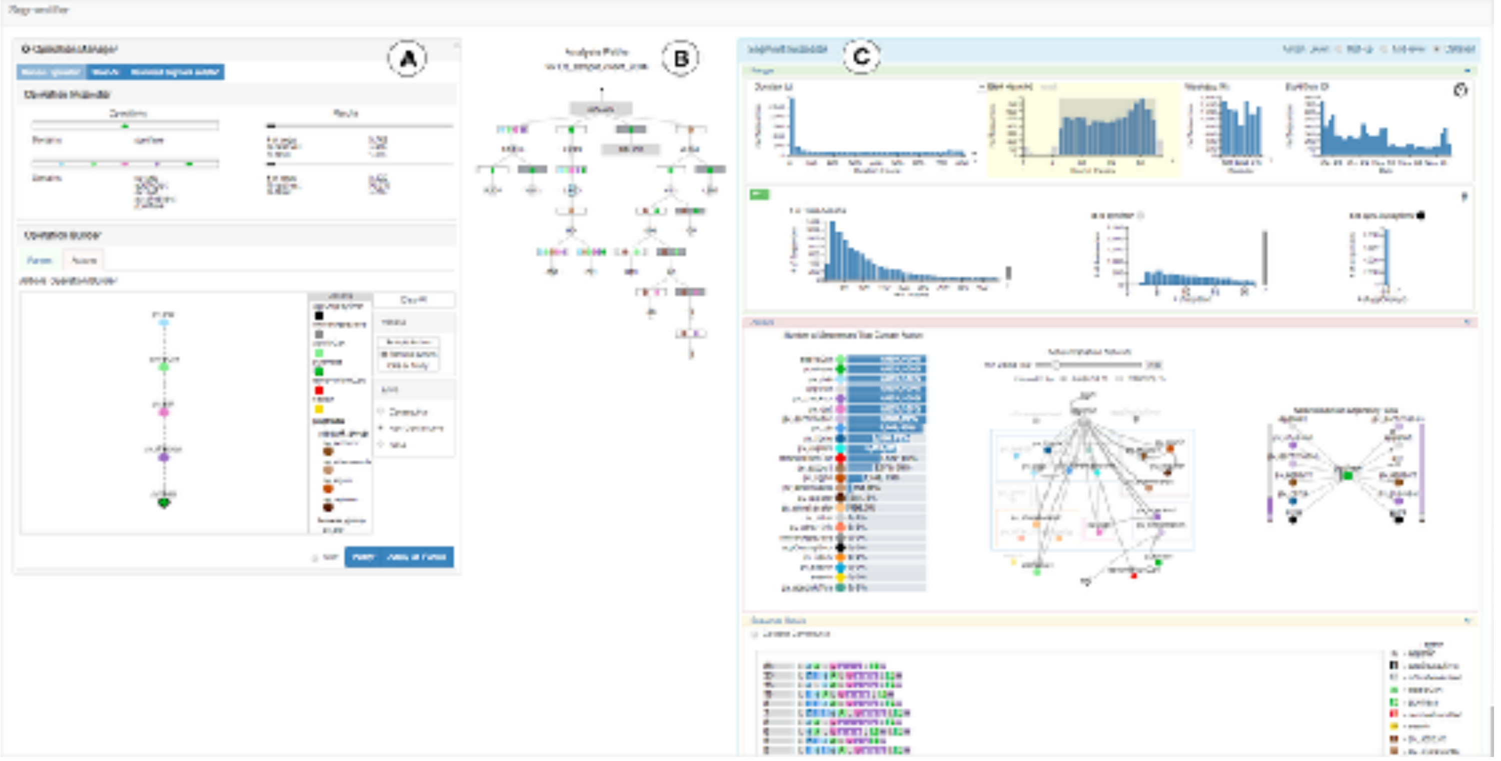
Kimberly Dextras-Romagnino

recent work:
Segmentifier
(Mobify)

e-commerce clickstreams

build tools for human-in-the-loop visual data analysis



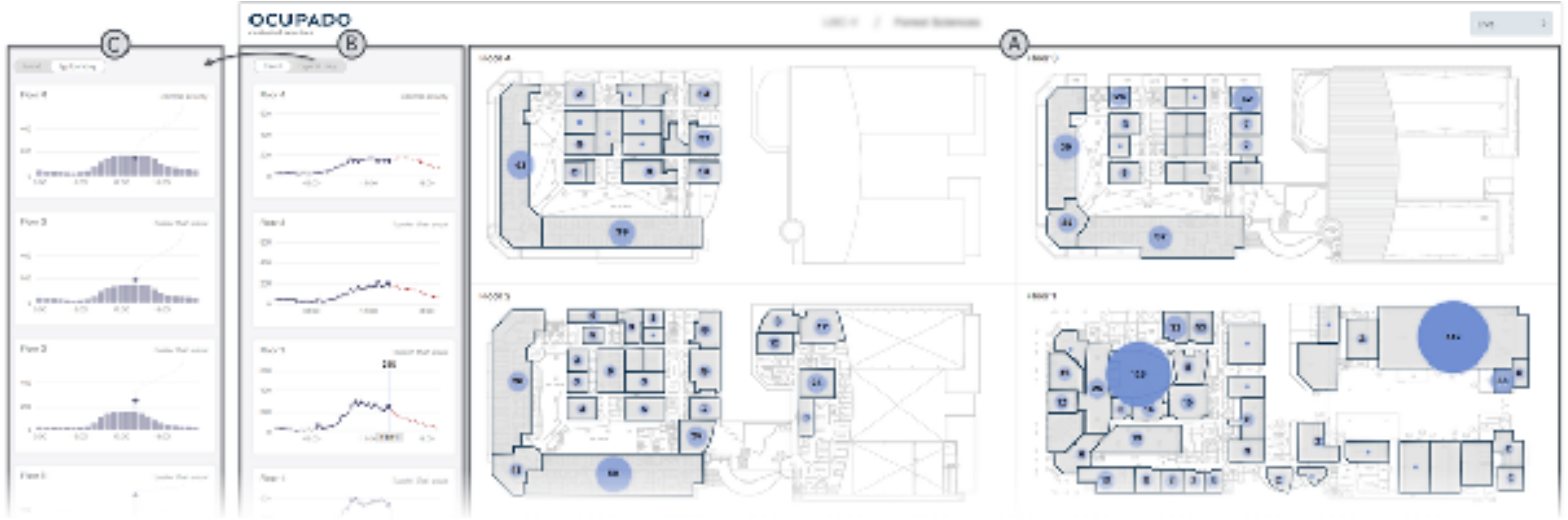
https://youtu.be/TobYDFelSOg

Michael Oppermann

recent work:
Ocupado
(Sensible Building Science)

wifi proxy for real-time building occupancy

visual analytics for facilities management



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Theoretical foundations: Typologies

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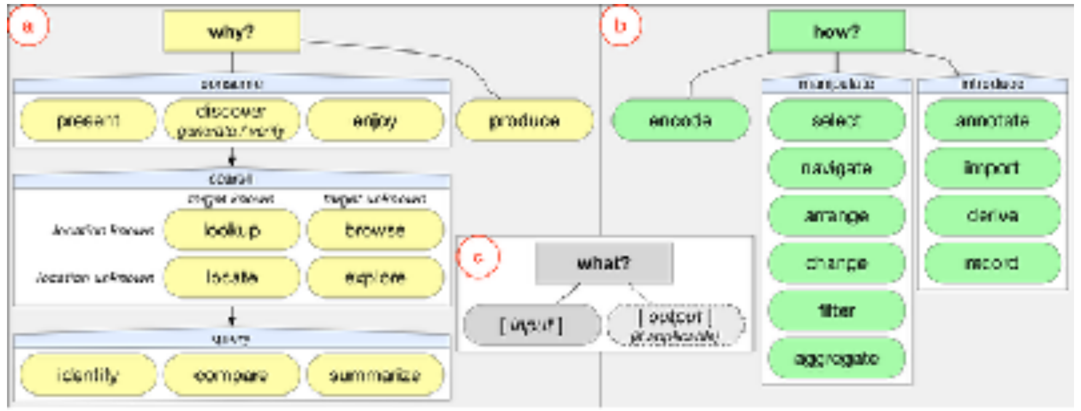
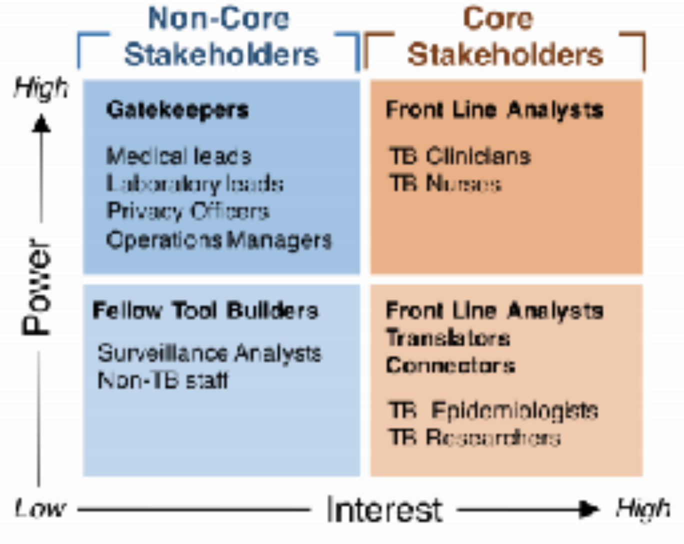
Matt Brehmer



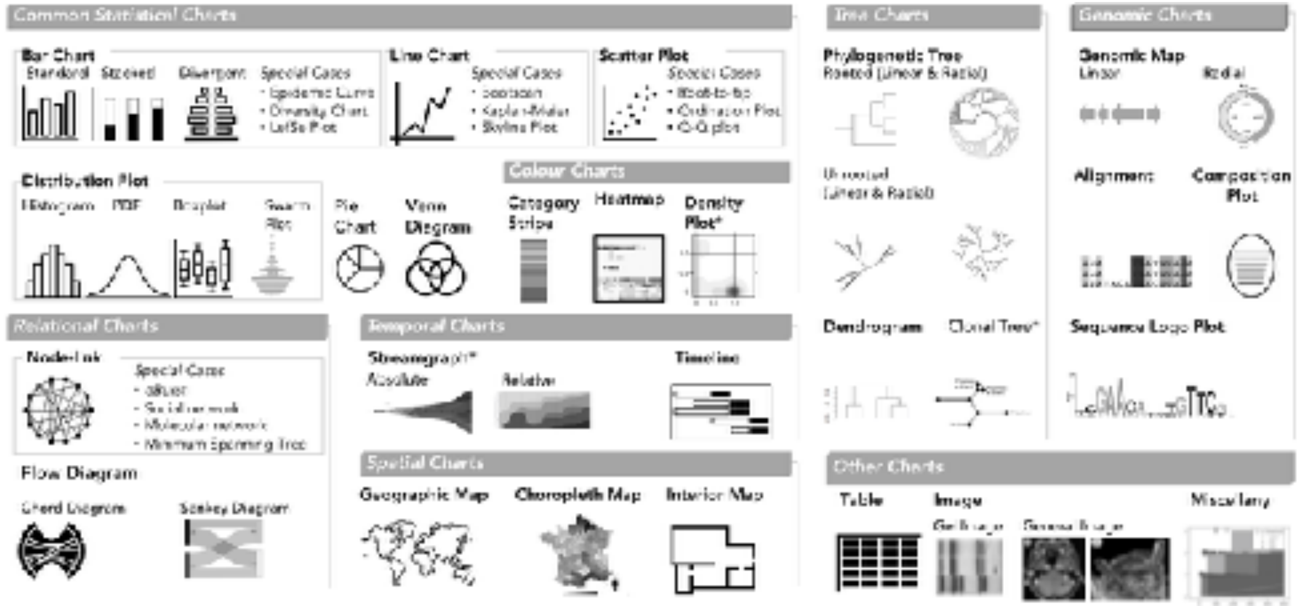
Abstract Tasks

Anamaria Crisan



Non-Core Stakeholders	Core Stakeholders
Gatekeepers Medical leads Laboratory leads Privacy Officers Operations Managers	**Front Line Analysts** TB Clinicians TB Nurses
Fellow Tool Builders Surveillance Analysts Non-TB staff	**Front Line Analysts** **Translators** **Connectors** TB Epidemiologists TB Researchers

Regulatory & Organizational Constraints



GEViT: Genomic Epidemiology Visualization Typology

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Theoretical foundations

T

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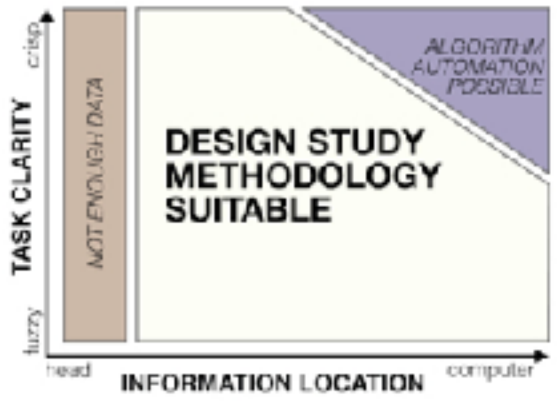
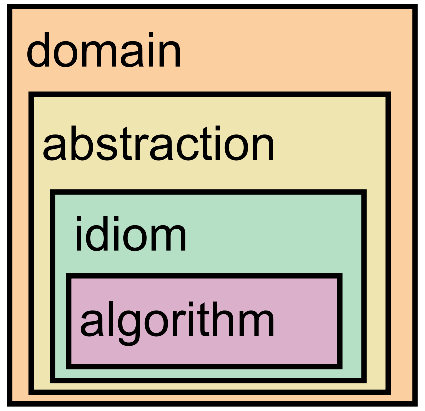
- Visual Encoding Pitfalls
  - Unjustified Visual Encoding
  - Hammer In Search Of Nail
  - 2D Good, 3D Better
  - Color Cacophony
  - Rainbows Just Like In The Sky
- Strategy Pitfalls
  - What I Did Over My Summer
  - Least Publishable Unit
  - Dense As Plutonium
  - Bad Slice and Dice

Papers Process & Pitfalls



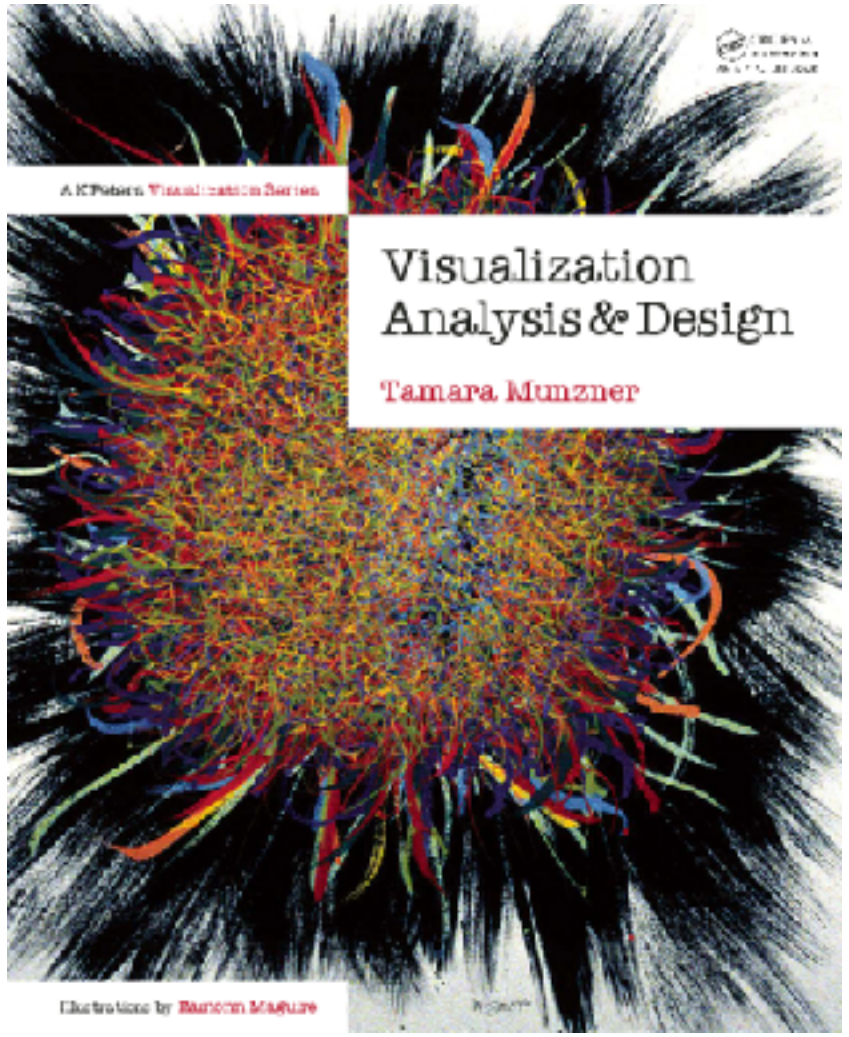
Design Study Methodology



Nested Model

Michael Sedlmair

Miriah Meyer


A K Peters Visualization Series
Visualization Analysis & Design
Tamara Munzner
Illustrations by Eamonn Maguire

Visualization Analysis & Design

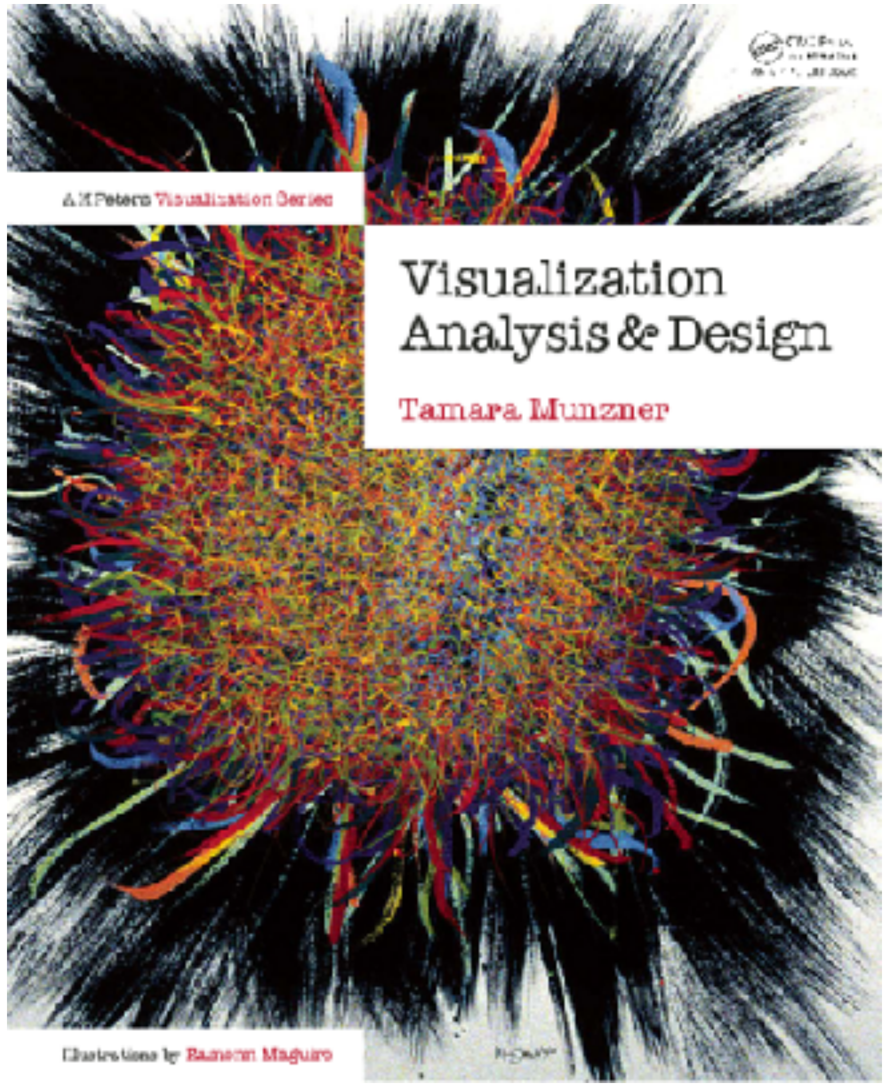
www.cs.ubc.ca/~tmm/talks.html#vad20alum

More Information

- this talk
  http://www.cs.ubc.ca/~tmm/talks.html#vad20alum

- book page (including tutorial lecture slides)
  http://www.cs.ubc.ca/~tmm/vadbook
  - 20% promo code for book+ebook combo: HVN17
  - http://www.crcpress.com/product/isbn/9781466508910
  - illustrations: Eamonn Maguire

- papers, videos, software, talks, courses
  http://www.cs.ubc.ca/group/infovis
  http://www.cs.ubc.ca/~tmm


A K Peters Visualization Series
Visualization Analysis & Design
Tamara Munzner
Illustrations by Eamonn Maguire

Visualization Analysis and Design.
Munzner. A K Peters Visualization Series, CRC Press, Visualization Series, 2014.