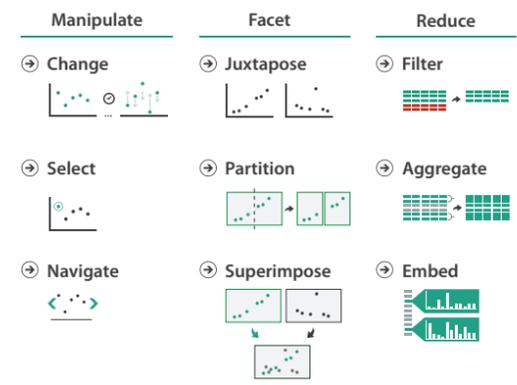# Chap 12: Facet Into Multiple Views
Paper: Multiform Matrices and Small Multiples

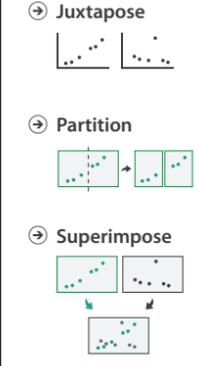**Tamara Munzner**
Department of Computer Science
University of British Columbia

CPSC 547: Information Visualization
Mon Oct 27 2014

http://www.cs.ubc.ca/~tmm/courses/547-14/l1#chap12

Idiom design choices: Part 2

Manipulate	Facet	Reduce
Change	Juxtapose	Filter
Select	Partition	Aggregate
Navigate	Superimpose	Embed

2

Facet

- Juxtapose
- Partition
- Superimpose

3

Juxtapose and coordinate views

- → Share Encoding: Same/Different
  - → *Linked Highlighting*
- → Share Data: All/Subset/None
- → Share Navigation
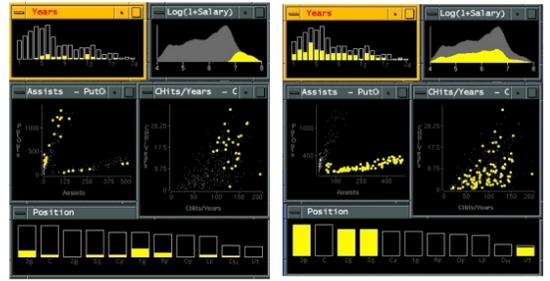

4

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

- see how regions contiguous in one view are distributed within another
  - powerful and pervasive interaction idiom
- encoding: different
  - *multiform*
- data: all shared

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

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

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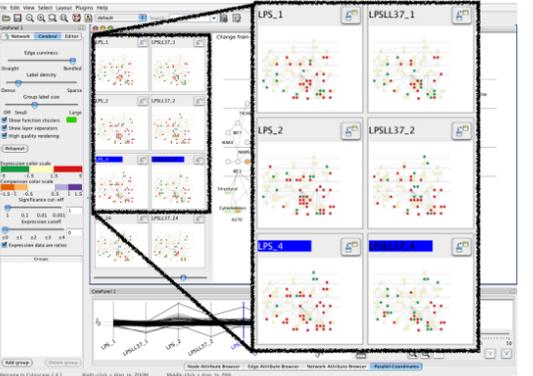 - (size)
- *overview–detail*

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

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Idiom: **Small multiples**   System: **Cerebral**

- encoding: same
- data: none shared
  - different attributes for node colors
  - (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

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Juxtapose design choices

- design choices
  - view count
    - few vs many
      - how many is too many? open research question
  - view visibility
    - always side by side vs temporary popups
  - view arrangement
    - user managed vs system arranges/aligns
- why juxtapose views?
  - benefits: eyes vs memory
    - lower cognitive load to move eyes between 2 views than remembering previous state with 1
  - costs: display area
    - 2 views side by side each have only half the area of 1 view

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System: **Improvise**

- investigate power of multiple views
  - pushing limits on view count, interaction complexity
  - reorderable lists
    - easy lookup
    - useful when linked to other encodings
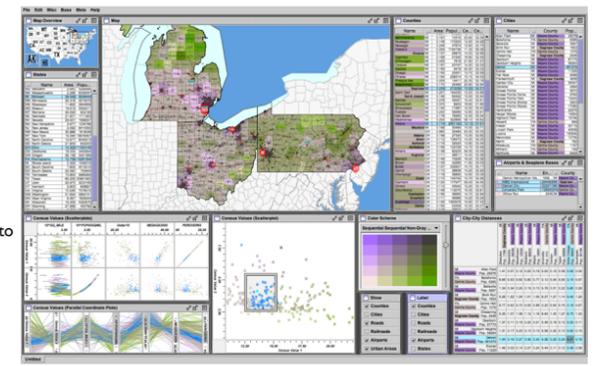
[Building Highly-Coordinated Visualizations In Improvise. Weaver. Proc. IEEE Symp. Information Visualization (InfoVis), pp. 159–166, 2004.]

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Partition into views

- how to divide data between views
  - encodes association between items using spatial proximity
  - major implications for what patterns are visible
  - split according to attributes
- design choices
  - how many splits
    - all the way down: one mark per region?
    - stop earlier, for more complex structure within region?
  - order in which attribs used to split
  - how many views

→ **Partition into Side-by-Side Views**
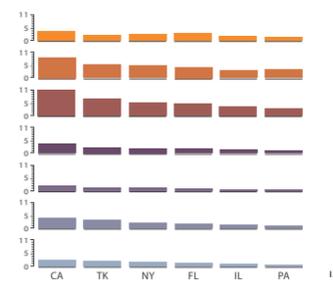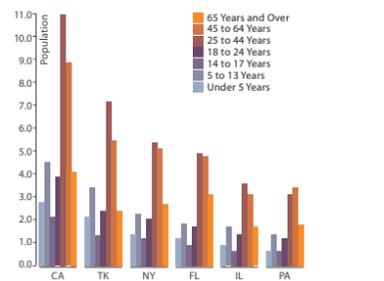

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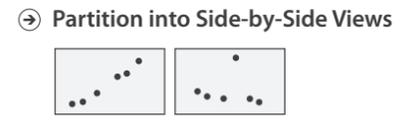
Views and glyphs

- *view*
  - contiguous region in which visually encoded data is shown on the display
- *glyph*
  - object with internal structure that arises from multiple marks
- no strict dividing line
  - view: big/detailed
  - glyph: small/iconic

→ **Partition into Side-by-Side Views**

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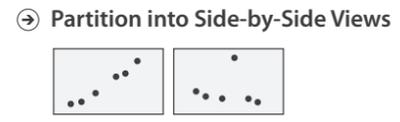
Partitioning: List alignment

- single bar chart with grouped bars
  - split by state into regions
  - complex glyph within each region showing all ages
  - compare: easy within state, hard across ages
- small-multiple bar charts
  - split by age into regions
    - one chart per region
  - compare: easy within age, harder across states

65 Years and Over
45 to 64 Years
25 to 44 Years
18 to 24 Years
14 to 17 Years
5 to 13 Years
Under 5 Years

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Partitioning: Recursive subdivision   System: **HIVE**

- split by type
- then by neighborhood
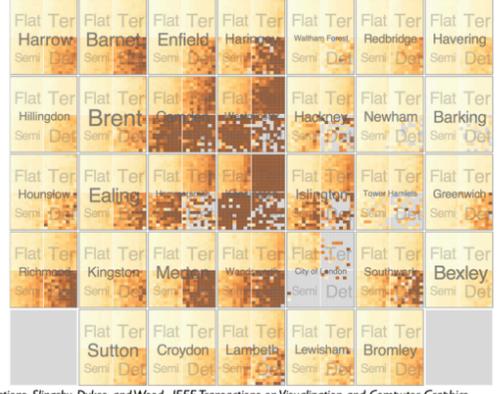- then time
  - years as rows
  - months as columns

[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

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Partitioning: Recursive subdivision   System: **HIVE**

- switch order of splits
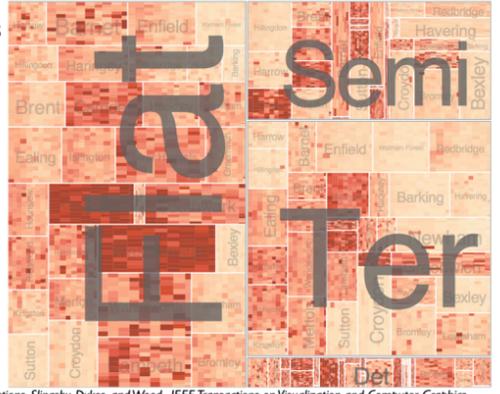 - neighborhood then type
- very different patterns

[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

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Partitioning: Recursive subdivision   System: **HIVE**

- size regions by sale counts
  - not uniformly
- result: treemap

[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

Partitioning: Recursive subdivision — System: **HIVE**

- different encoding for second-level regions
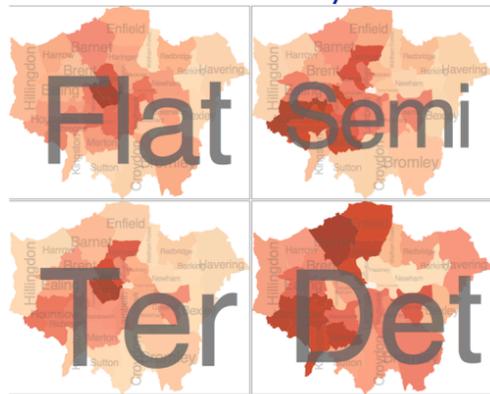 - choropleth maps

Flat Semi
Ter Det

[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

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Superimpose layers

- **layer**: set of objects spread out over region
  - each set is visually distinguishable group
  - extent: whole view
- design choices
  - how many layers?
  - how are layers distinguished?
  - small static set or dynamic from many possible?
  - how partitioned?
    - heavyweight with attribs vs lightweight with selection
- distinguishable layers
  - encode with different, nonoverlapping channels
    - two layers achieveable, three with careful design

→ Superimpose Layers

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Static visual layering

- foreground layer: roads
  - hue, size distinguishing main from minor
  - high luminance contrast from background
- background layer: regions
  - desaturated colors for water, parks, land areas
- user can selectively focus attention
- "get it right in black and white"
  - check luminance contrast with greyscale view

[Get it right in black and white. Stone. 2010.
http://www.stonesc.com/wordpress/2010/03/get-it-right-in-black-and-white]

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Superimposing limits

- few layers, but many lines
  - up to a few dozen
  - but not hundreds
- superimpose vs juxtapose: empirical study
  - superimposed for local visual, multiple for global
  - same screen space for all multiples, single superimposed
  - tasks
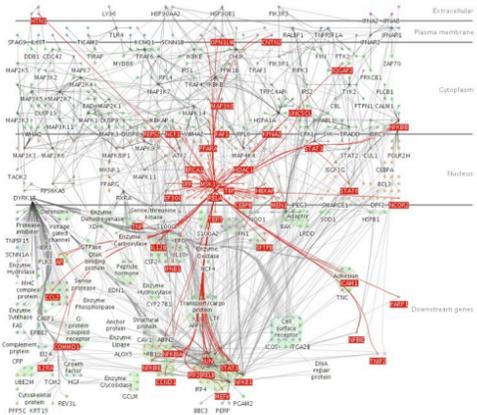   - local: maximum, global: slope, discrimination
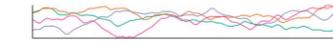
[Graphical Perception of Multiple Time Series. Javed, McDonnel, and Elmqvist. IEEE Transactions on Visualization and Computer Graphics (Proc. IEEE InfoVis 2010) 16:6 (2010), 927–934.]

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Dynamic visual layering — System: **Cerebral**

- interactive, from selection
  - lightweight: click
  - very lightweight: hover

- ex: 1-hop neighbors

[Cerebral: a Cytoscape plugin for layout of and interaction with biological networks using subcellular localization annotation. Barsky, Gardy, Hancock, and Munzner. Bioinformatics 23:8 (2007), 1040–1042.]

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Further reading

- Visualization Analysis and Design. Munzner. AK Peters / CRC Press, Oct 2014.
  - Chap 12: Facet Into Multiple Views
- A Review of Overview+Detail, Zooming, and Focus+Context Interfaces. Cockburn, Karlson, and Bederson. ACM Computing Surveys 41:1 (2008), 1–31.
- A Guide to Visual Multi-Level Interface Design From Synthesis of Empirical Study Evidence. Lam and Munzner. Synthesis Lectures on Visualization Series, Morgan Claypool, 2010.
- Zooming versus multiple window interfaces: Cognitive costs of visual comparisons. Plumlee and Ware. ACM Trans. on Computer-Human Interaction (ToCHI) 13:2 (2006), 179–209.
- Exploring the Design Space of Composite Visualization. Javed and Elmqvist. Proc. Pacific Visualization Symp. (PacificVis), pp. 1–9, 2012.
- Visual Comparison for Information Visualization. Gleicher, Albers, Walker, Jusufi, Hansen, and Roberts. Information Visualization 10:4 (2011), 289–309.
- Guidelines for Using Multiple Views in Information Visualizations. Baldonado, Woodruff, and Kuchinsky. In Proc. ACM Advanced Visual Interfaces (AVI), pp. 110–119, 2000.
- Cross-Filtered Views for Multidimensional Visual Analysis. Weaver. IEEE Trans. Visualization and Computer Graphics 16:2 (Proc. InfoVis 2010), 192–204, 2010.
- Linked Data Views. Wills. In Handbook of Data Visualization, Computational Statistics, edited by Unwin, Chen, and Härdle, pp. 216–241. Springer-Verlag, 2008.
- Glyph-based Visualization: Foundations, Design Guidelines, Techniques and Applications. Borgo, Kehrer, Chung, Maguire, Laramee, Hauser, Ward, and Chen. In Eurographics State of the Art Reports, pp. 39–63, 2013.

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Multiform matrices and small multiples

- matrices for bivariate exploration (SPLOM and other)
  - vs small multiples for univariate
- uniform vs multiform multiples
- idioms
  - juxtapose
  - sort/order
  - manipulate
  - linked multiple bivariate views

[Exploring High-D Spaces with Multiform Matrices and Smal Multiples. MacEachren, Dai, Hardisty, Guo, and Lengerich. Proc. InfoVis 2003.]

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Multiform bivariate small multiple

- common attribute: per capita income
- per-column attributes: type of cancer mortality
- per-row views: scatterplot, choropleth map
- top left bright green
  - high income, low cervical cancer
    - hypothesis: not screened
- top right dark green
  - low income, high breast cancer
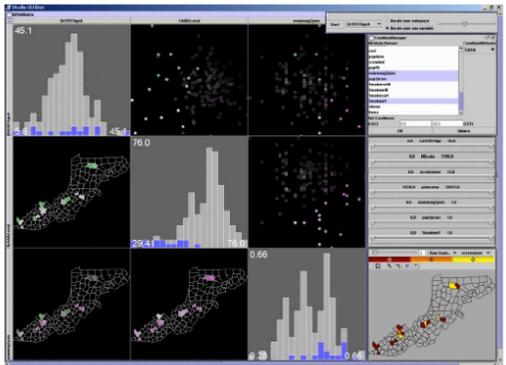   - hypothesis: late childbearing
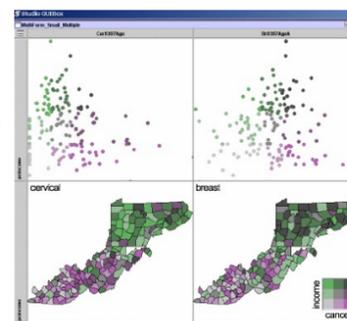
[Exploring High-D Spaces with Multiform Matrices and Small Multiples. MacEachren, Dai, Hardisty, Guo, and Lengerich. Proc. InfoVis 2003.]

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Multiform bivariate matrix

- scatterplots/maps
- histograms along diagonal
  - per-column attribs: mortality, early detection, recent screening
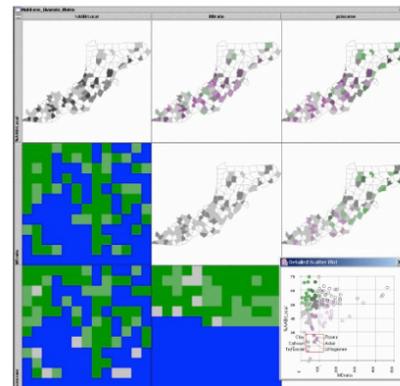- univariate map attrib: screening facility availability

[Exploring High-D Spaces with Multiform Matrices and Small Multiples. MacEachren, Dai, Hardisty, Guo, and Lengerich. Proc. InfoVis 2003.]

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Spacefill form

- linked highlight of low doctor ratio counties from scatterplot
- spacefill shows it's roughly half the items

[Exploring High-D Spaces with Multiform Matrices and Small Multiples. MacEachren, Dai, Hardisty, Guo, and Lengerich. Proc. InfoVis 2003.]

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Sorting and Linking

- sorting
  - manual: direct manipulation from user
  - automatic: conditional entropy metric
  - automatic: hierarchical clustering to find interesting
- linking
  - highlighting
  - many others
    - background color, subspace, conditioning
  - conditioning: filter in/out of given range on another attribute
  -

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