Software Visualization

Mircea Lungu

Roadmap

- Information Visualization
- Designing Visualizations
- Visualizing Software
  - Structure
  - Evolution
  - Behavior
- Discussion

Roadmap

- **Information Visualization**
- Visualization Design
- Visualizing Software
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Deciduous shrub, glabrous or nearly so, with weak, trailing sub-glaucous, often purple-tinted stems, either decumbent and forming low bushes 50 - 100 cm high, or climbing over other shrubs, rarely more erect and reaching 2 m. Prickles hooked, all +- equal. L'flets 2-3 pairs, 1-3.5 cm, ovate or ovate-elliptic, simply, rarely double serrate, glabrous on both sides or pubescent on the veins (rarely all over) beneath, rather thin; petiole usually with some stalked glands; stipules narrow, auricles straight. Flowers 1-6, white 3-5 cm diam.; pedicels 2-4 cm with stalked glands, rarely smooth; buds short... etc. etc.

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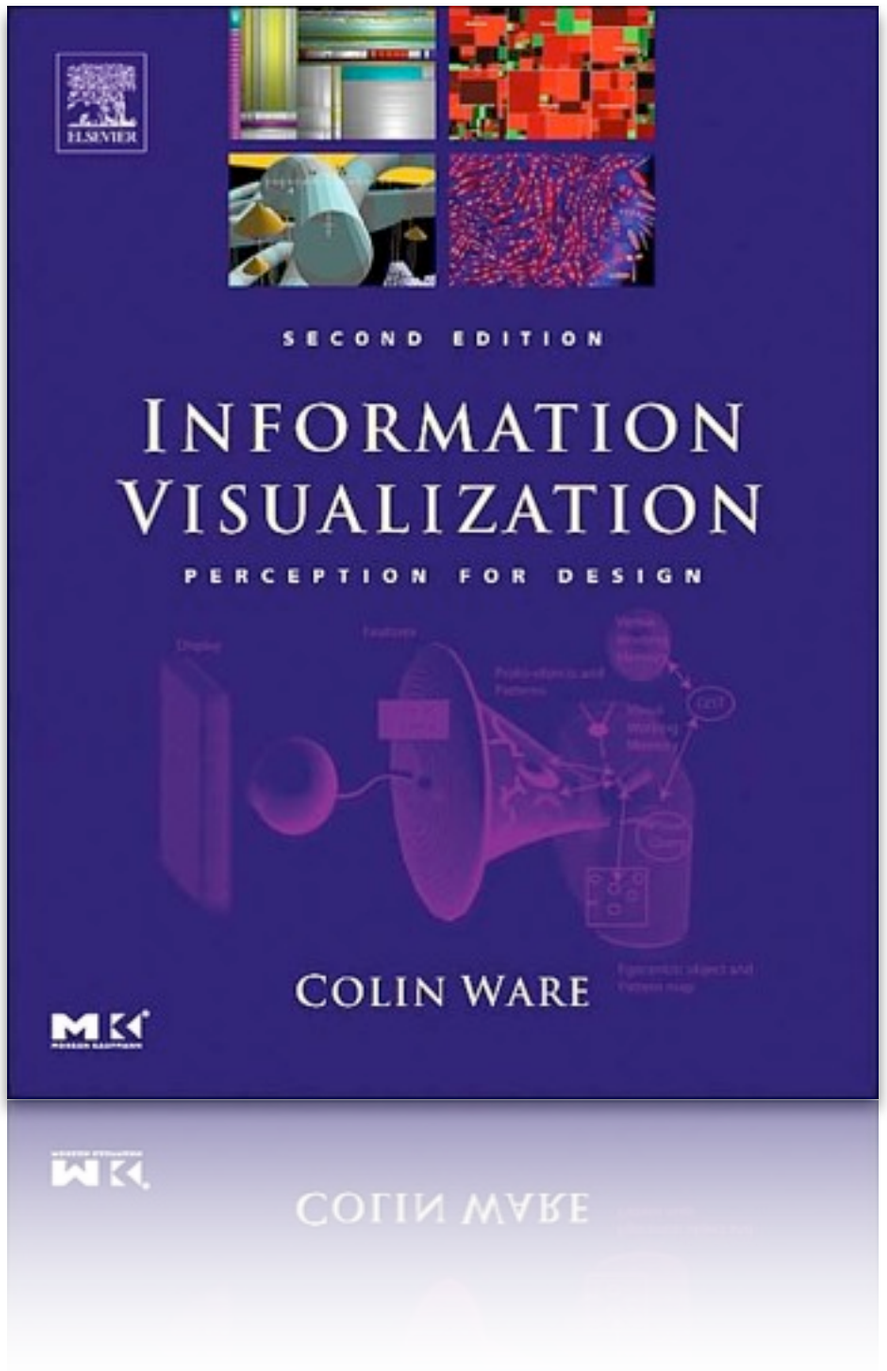
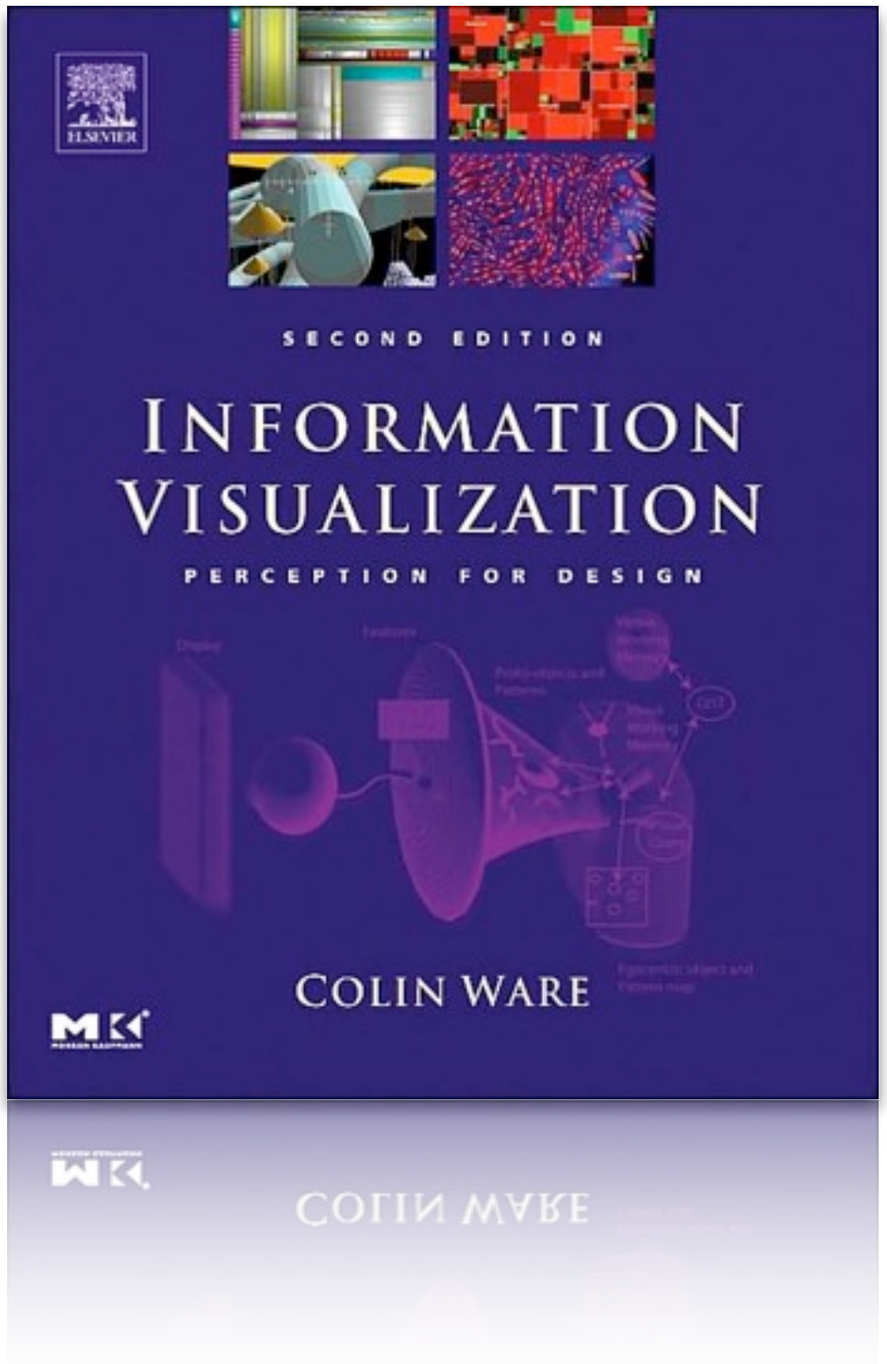

ELSEVIER
SECOND EDITION
INFORMATION VISUALIZATION
PERCEPTION FOR DESIGN
COLIN WARE
MK

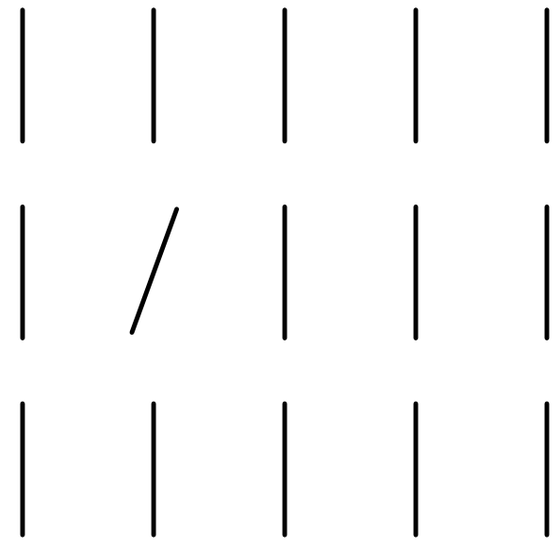
We aquire **more information through vision** than all the other senses combined



Preattentive Processing

Orientation	Line Length	Line Width	Size
Shape	Curvature	Added Marks	Enclosure

Preattentive Processing



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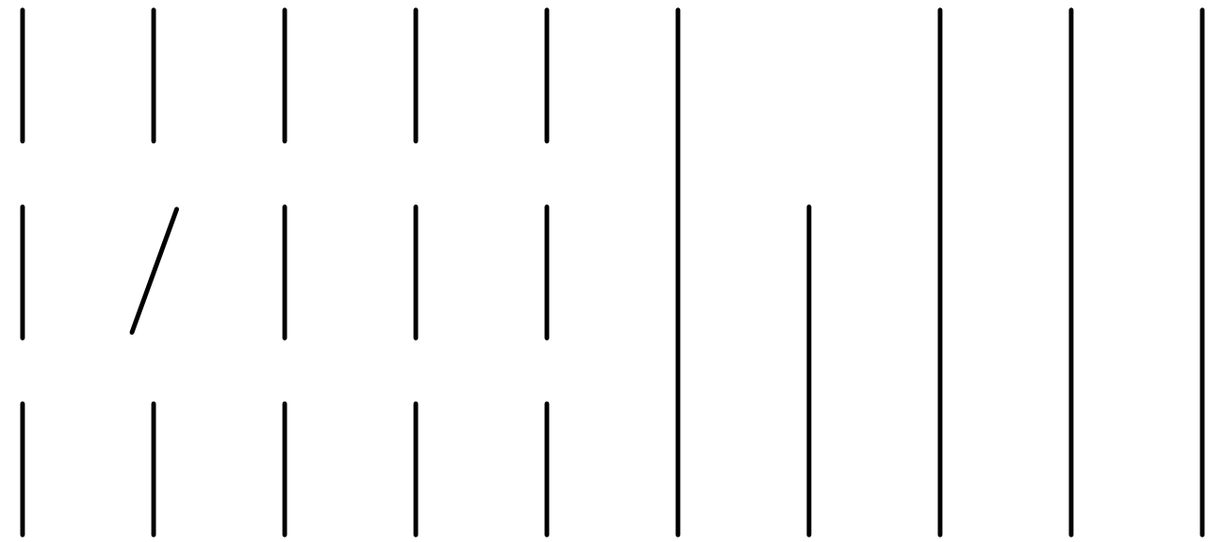

Line Width	Size

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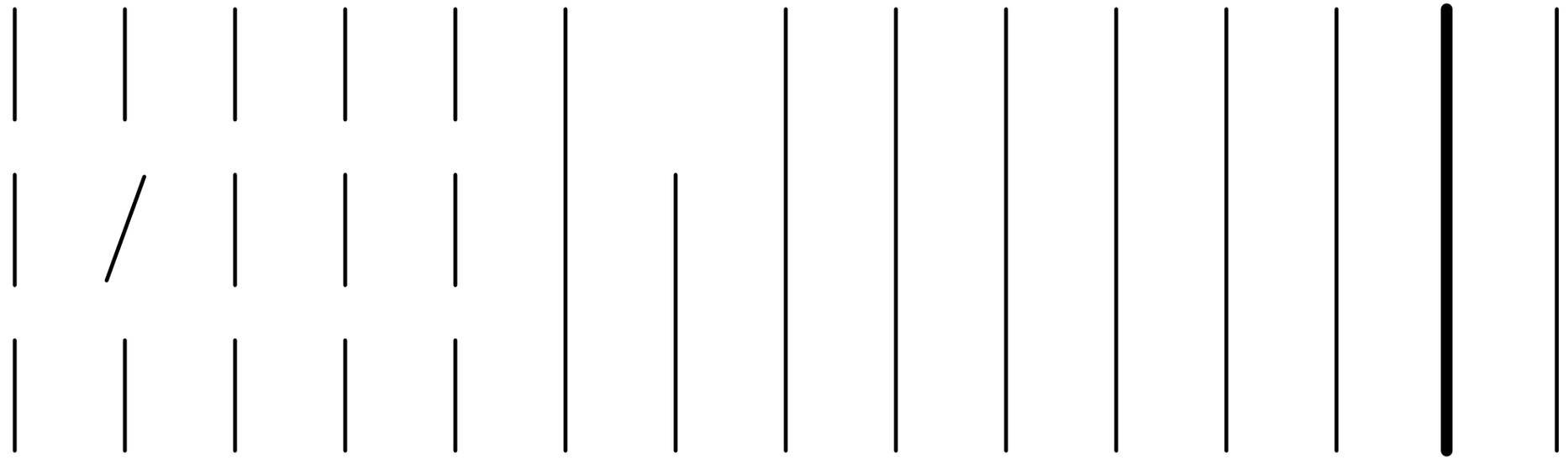

Size

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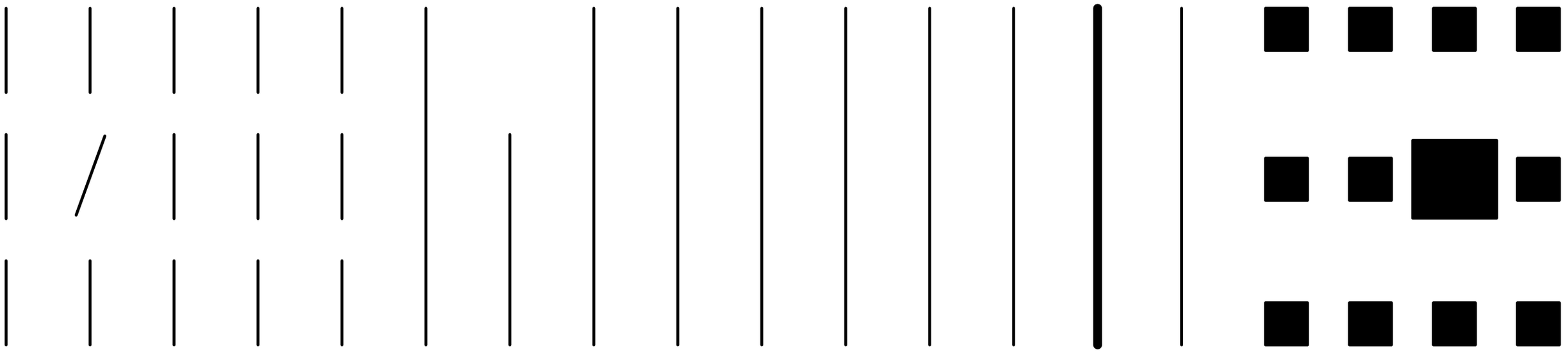

Shape	Curvature	Added Marks	Enclosure

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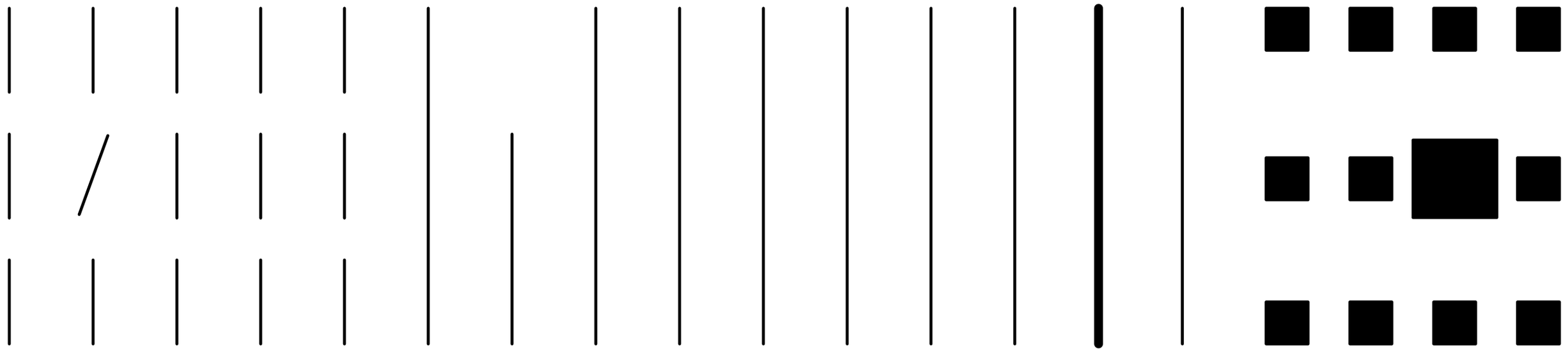

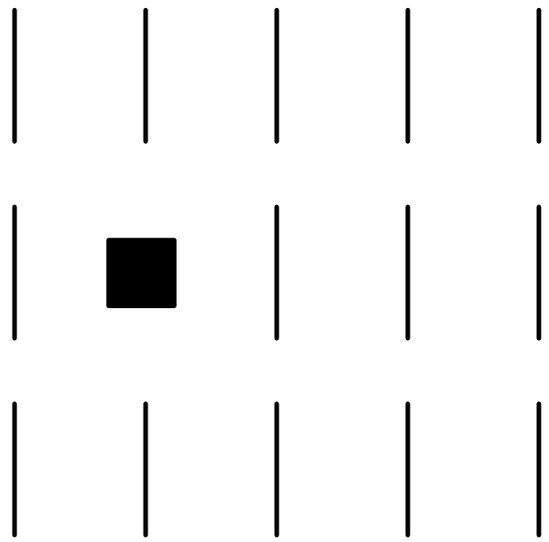

Curvature	Added Marks	Enclosure

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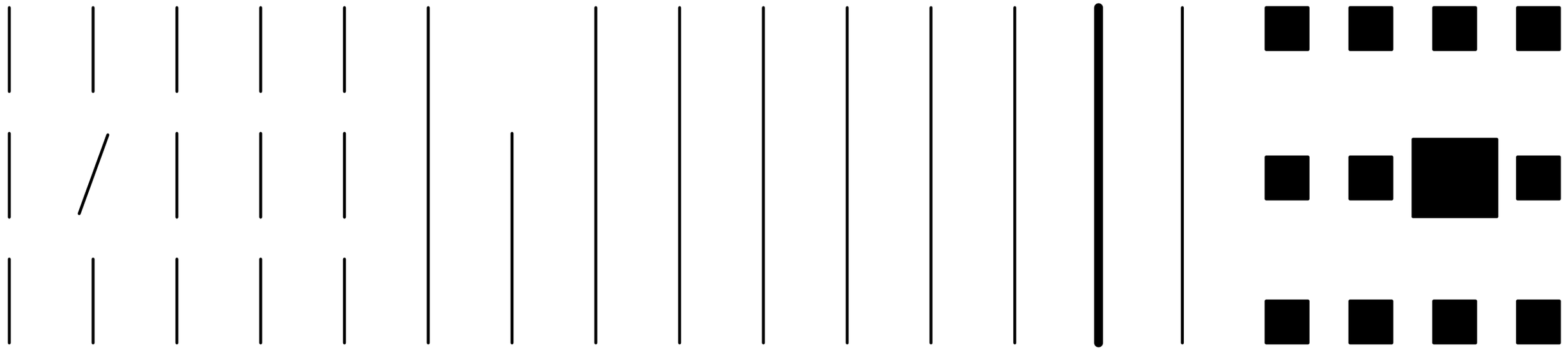

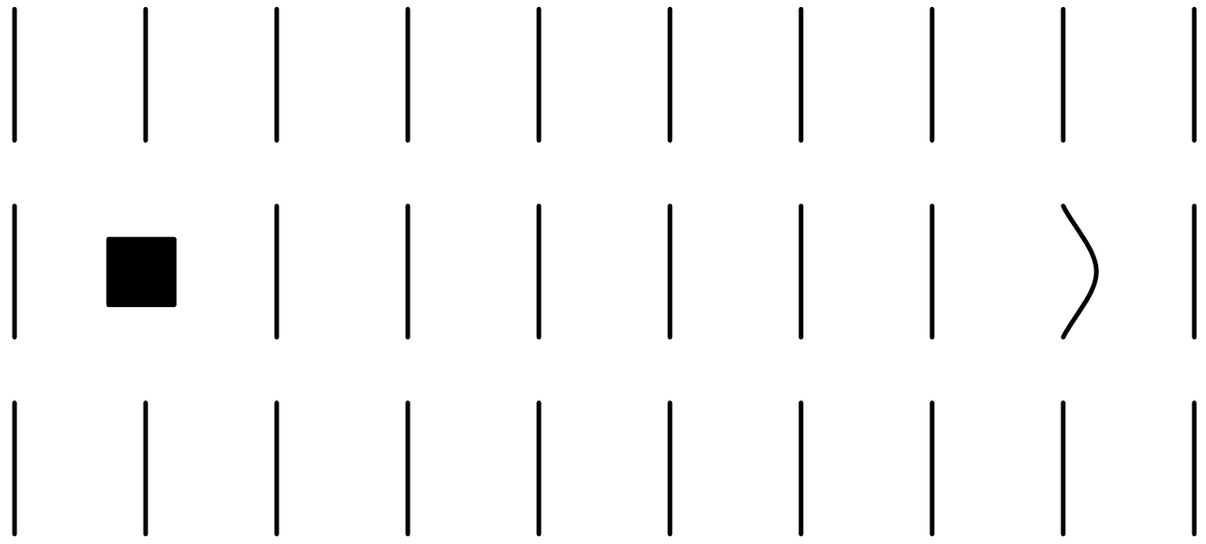

Added Marks	Enclosure

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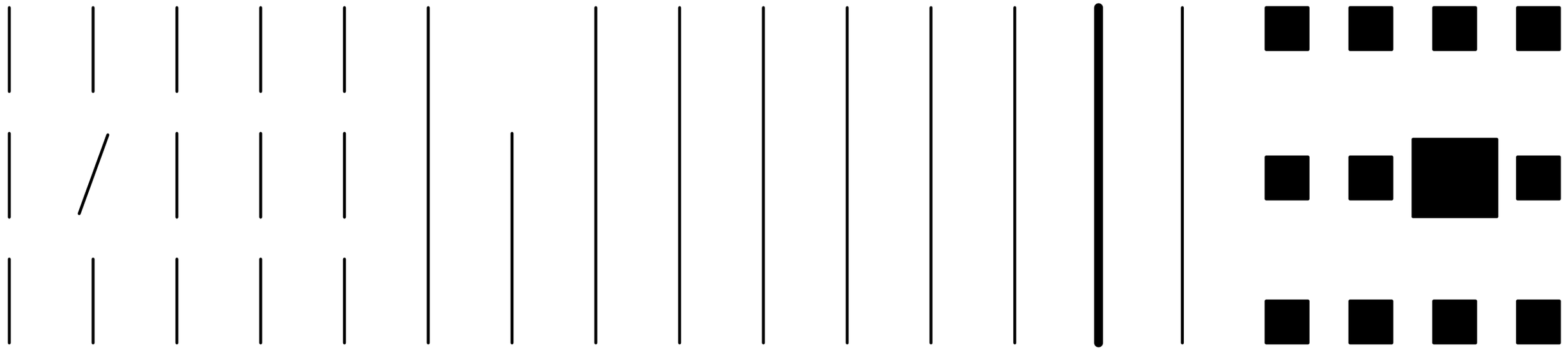
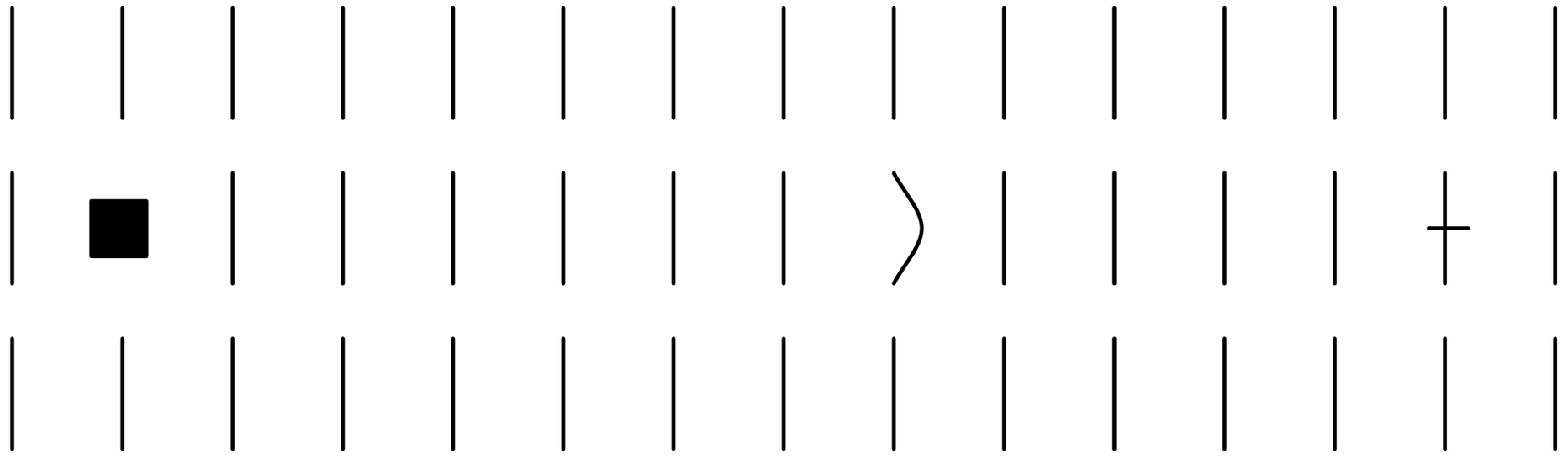
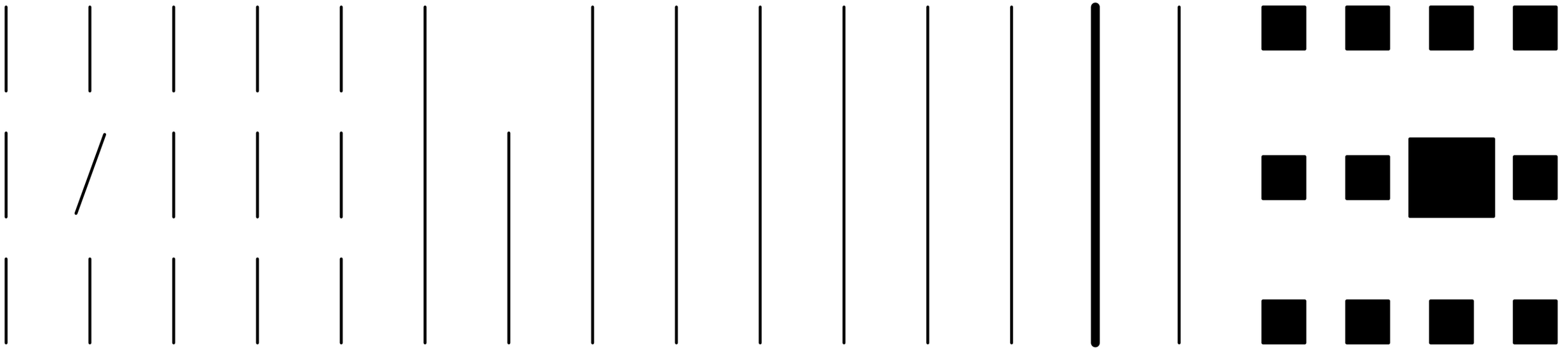
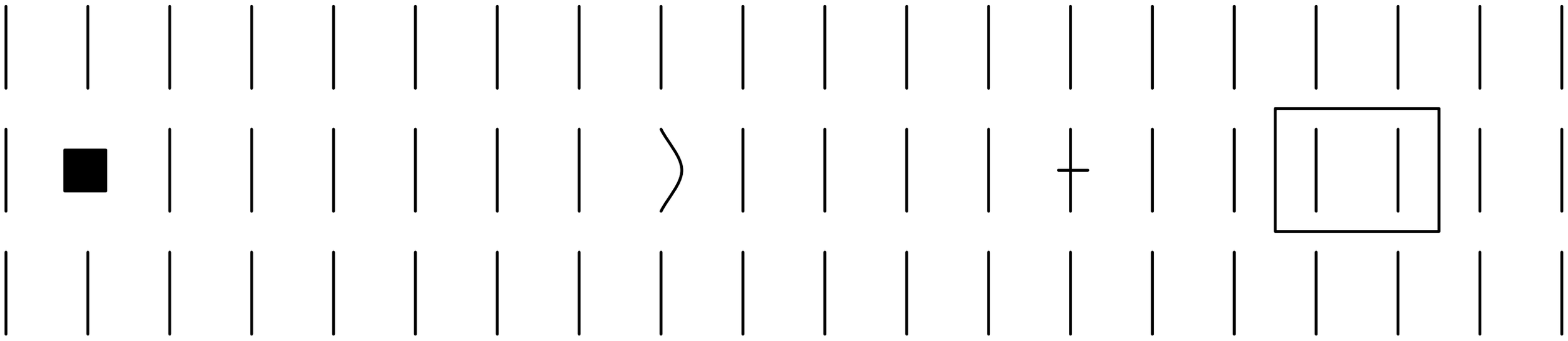




Enclosure

Preattentive Processing





Preattentive Processing: Color

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Preattentive Processing: Color

8789364082376403128764532984732984732094873290845 3
89274-0329874-32874-2319847509834098340983240983204
9823-0984903281453209481-0839393947896587436598

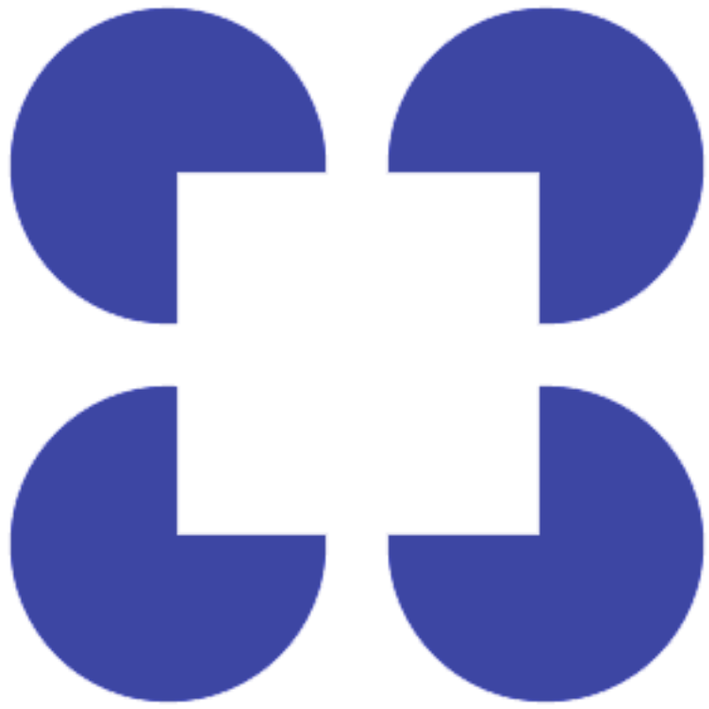
Gestalt Psychology

- The law of simplicity
- The Gestalt Laws
  - Closure
  - Similarity
  - Proximity
  - Continuity

“Reality is organized and reduced to the simplest form possible”

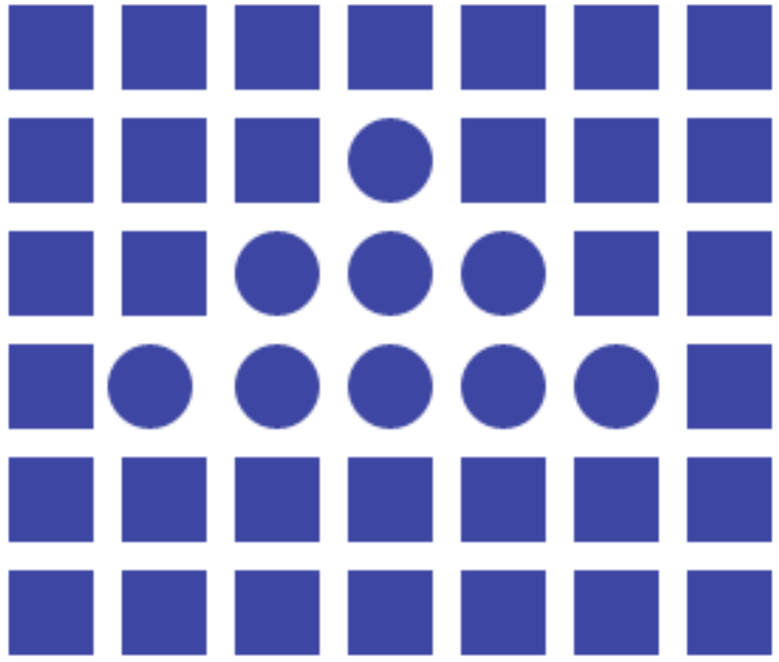
Law of Closure

- The mind completes missing parts so it can see a simple image



Similarity

- The mind groups similar elements together

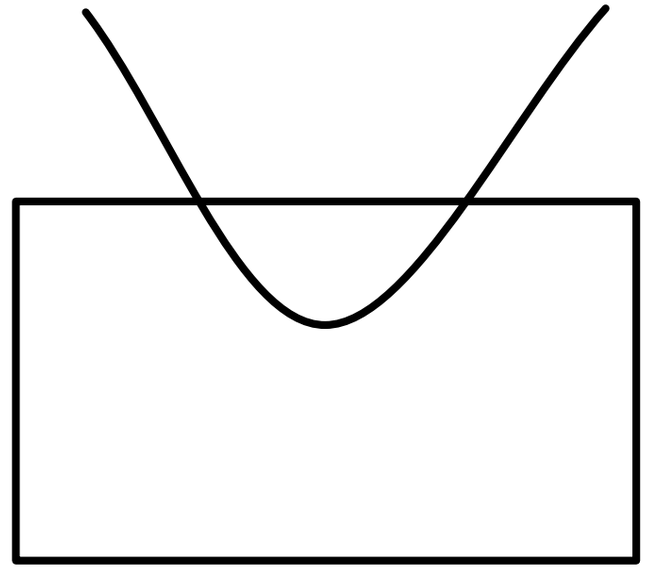


Proximity

- Spatial (or temporal) proximity induces the mind to see a totality

Law of contiuity

- Lines follow the smoothest and simplest path.



Why Use Information Visualization?

- Supports analysis
- Allows discovering emergent properties that one didn't think about
- Allows problems with the data set to become aparent
- Allows communication
- Supports thinking

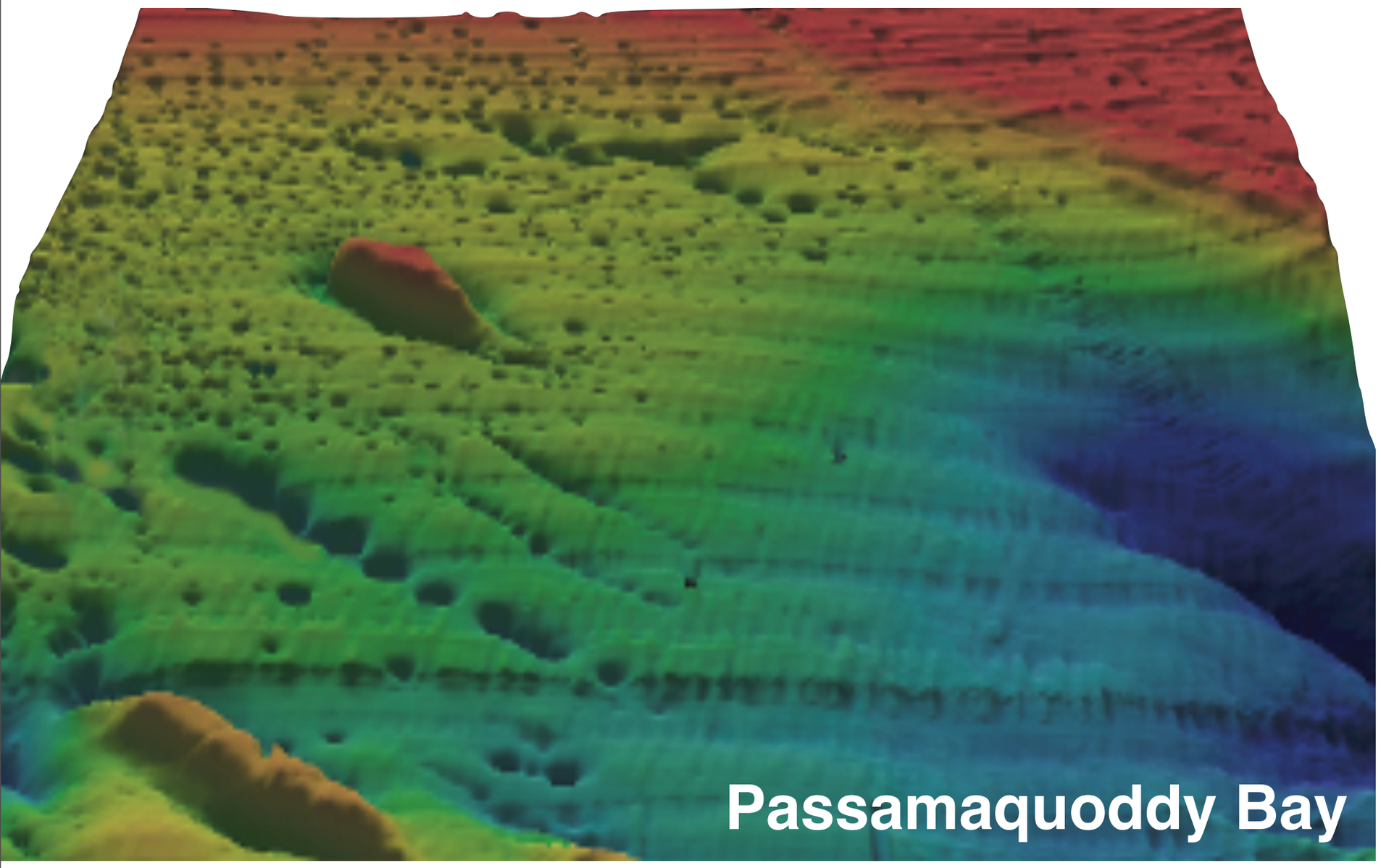
Visualization supports analysis

John Snow

The lines on the buildings are proportional to the number of deaths due to cholera from those buildings.

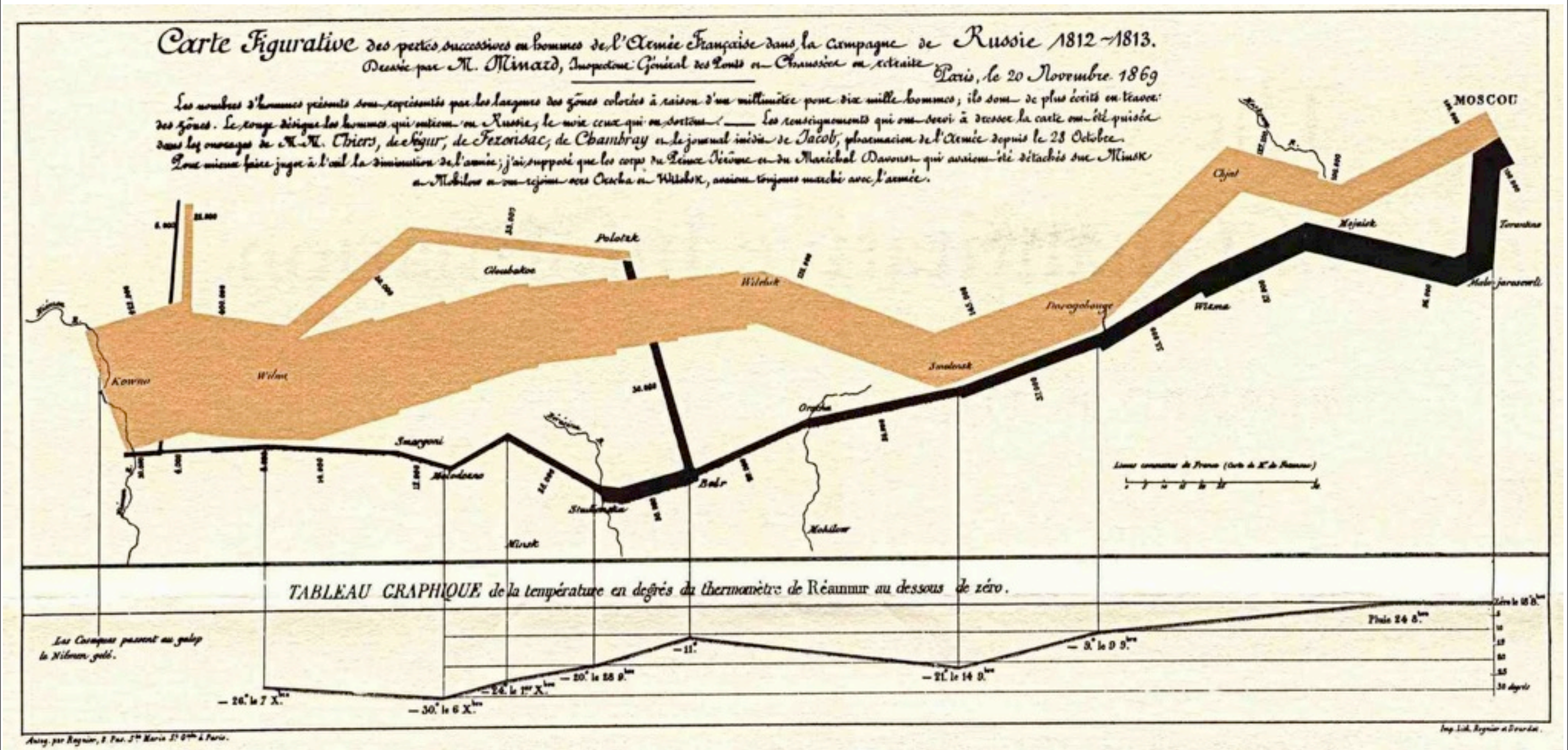
Do you know how did Snow realize which was the cause of cholera by looking at this map?

Visualization allows discovering emergent properties that one did not think about

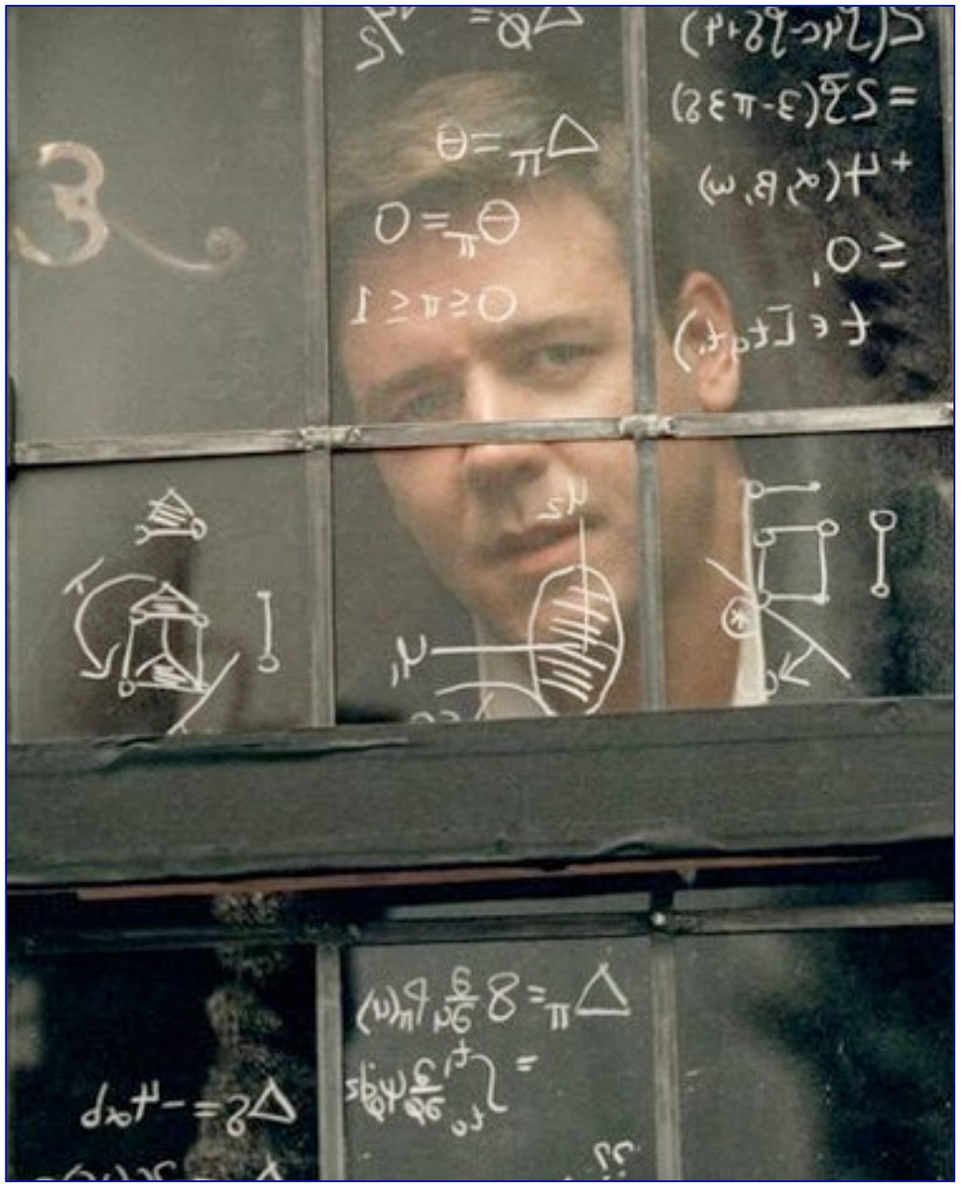


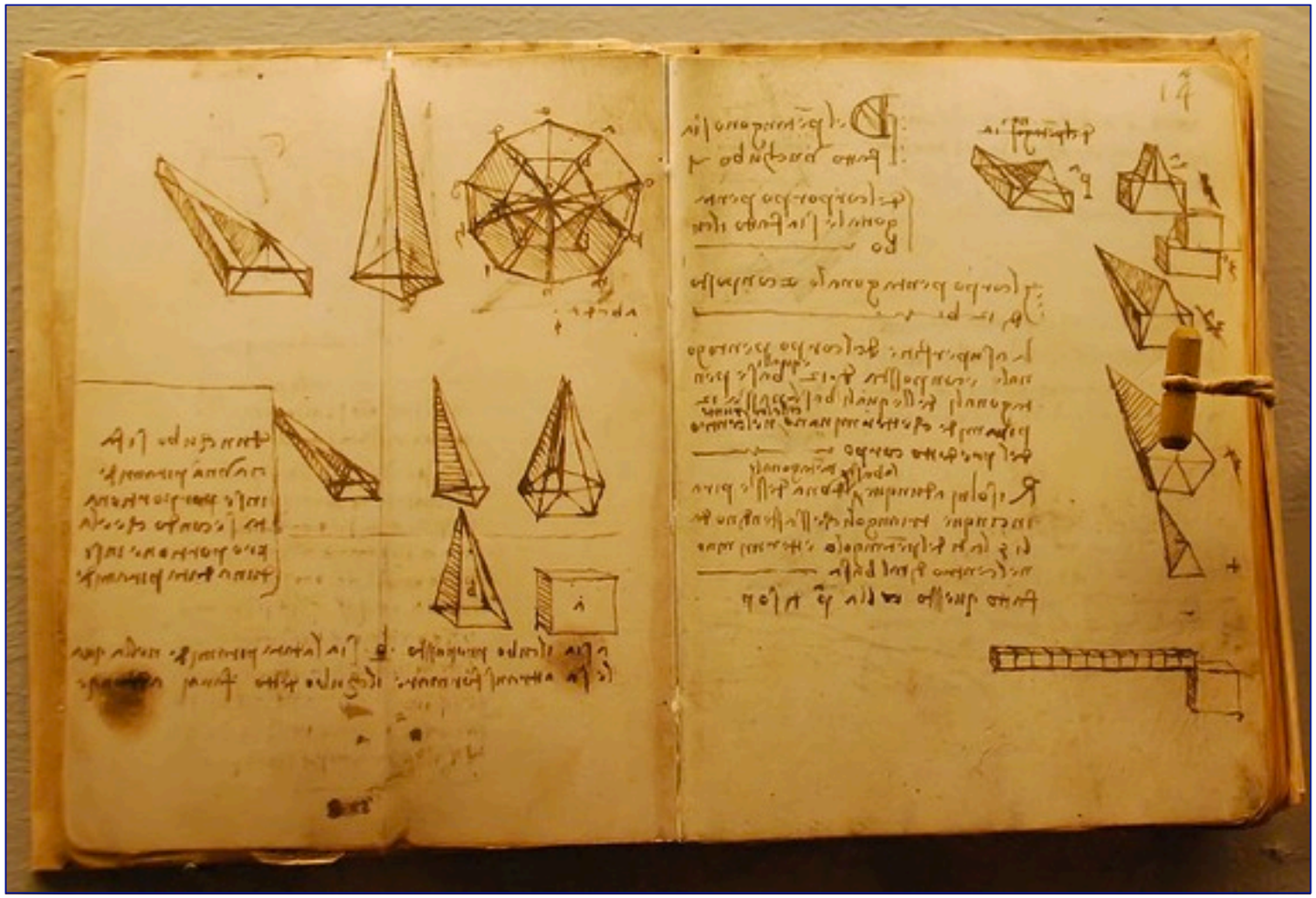
* pockmarks
* linear ripples

Visualization allows communication



Visualization supports thinking





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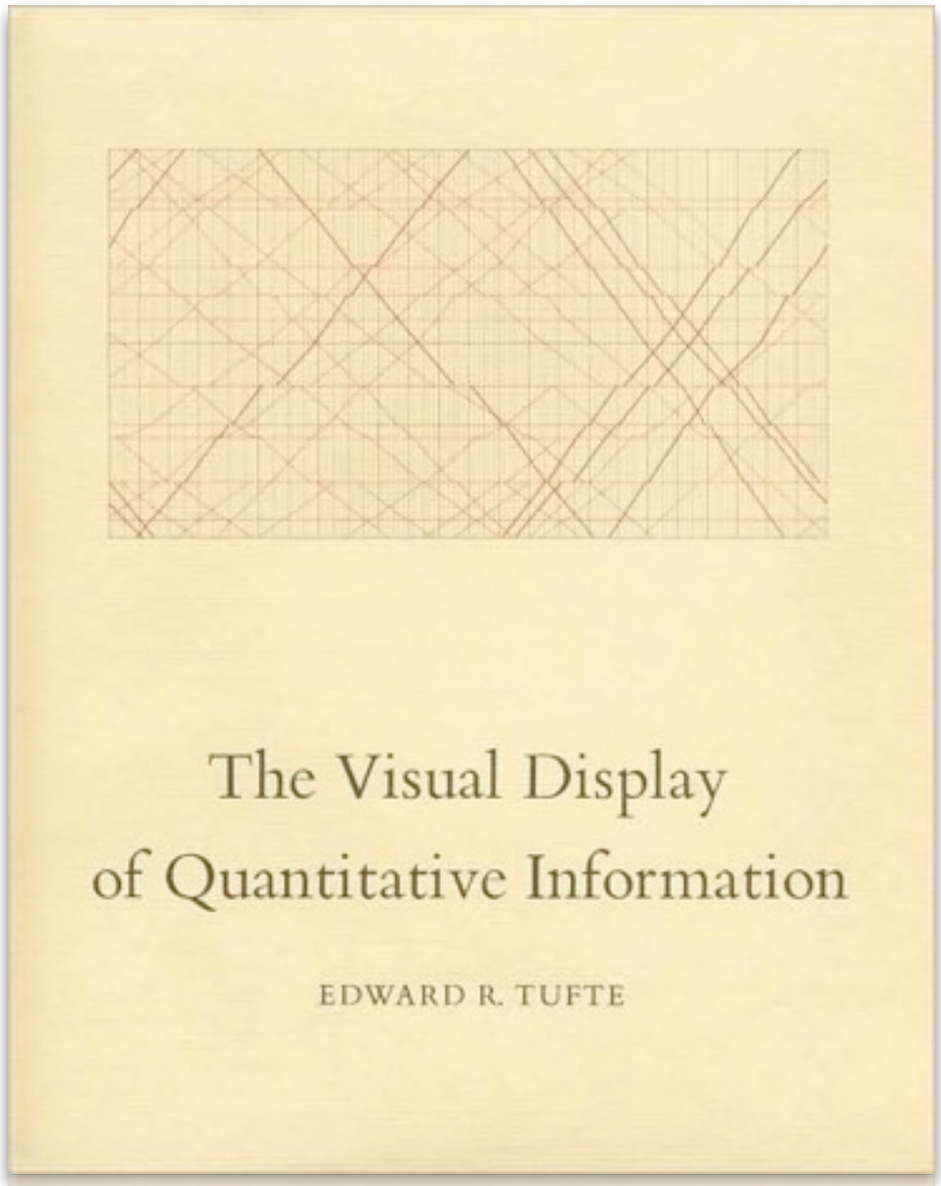
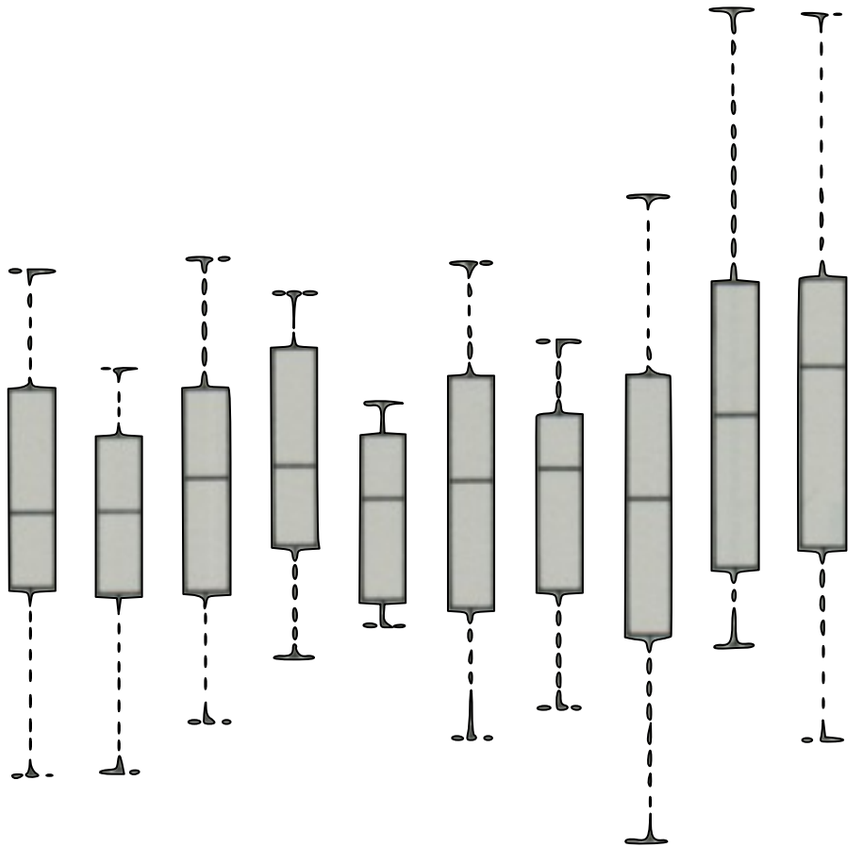
Good information visualization is based on thinking, style, and respect.



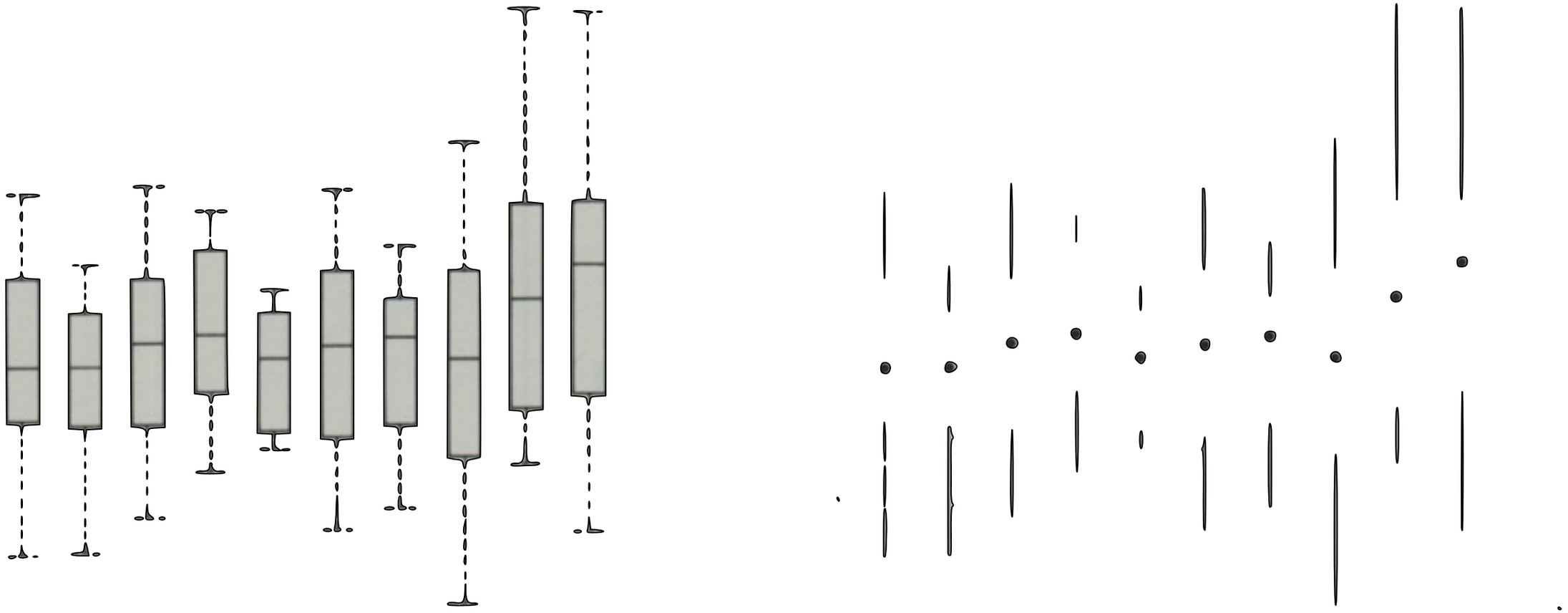
- Principles
  - Minimize Non-Data Ink
  - Have Integrity
  - Design Counts

Minimize Non-Data Ink



Removing ink from your graph should remove meaning from it.

Minimize Non-Data Ink



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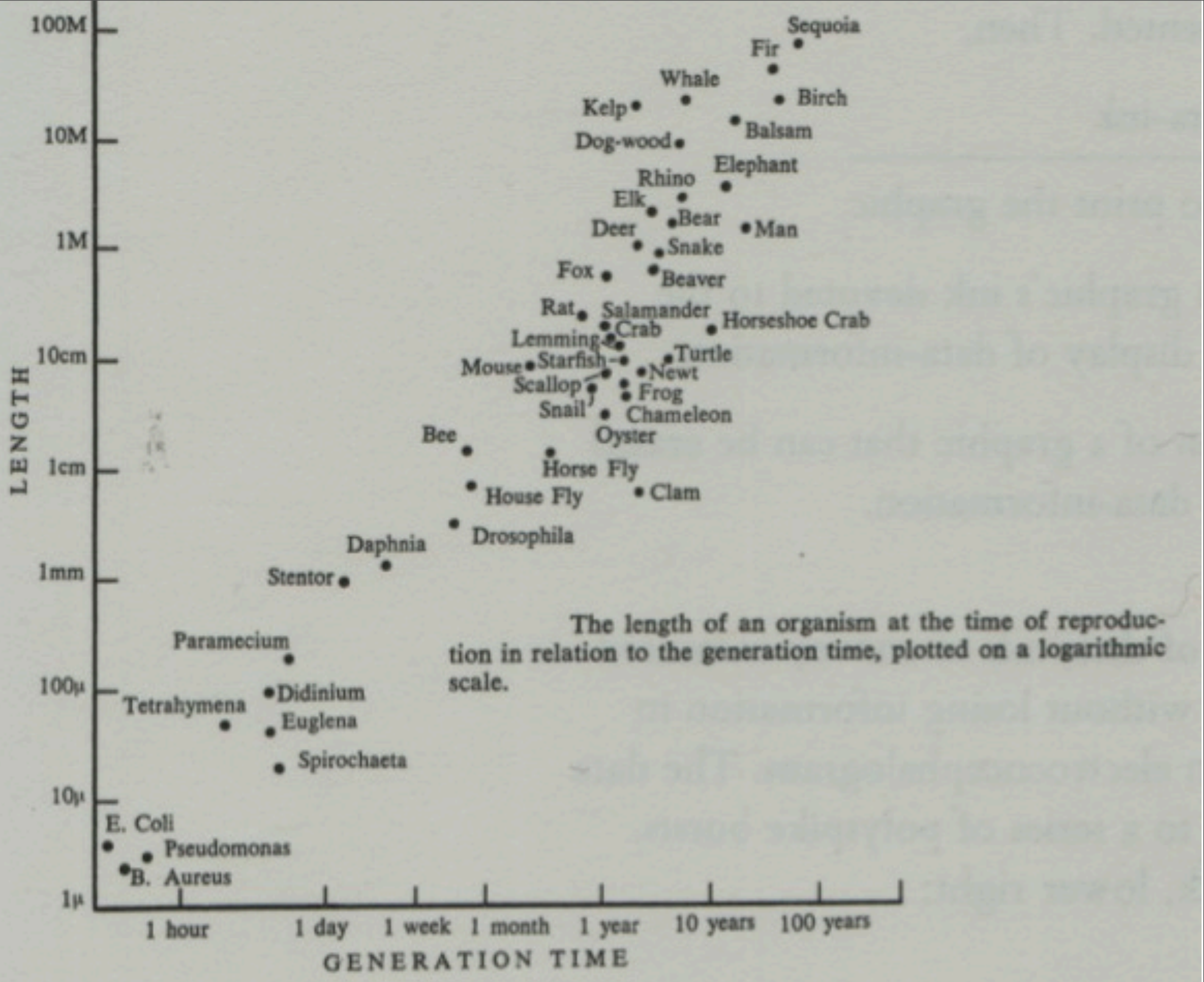
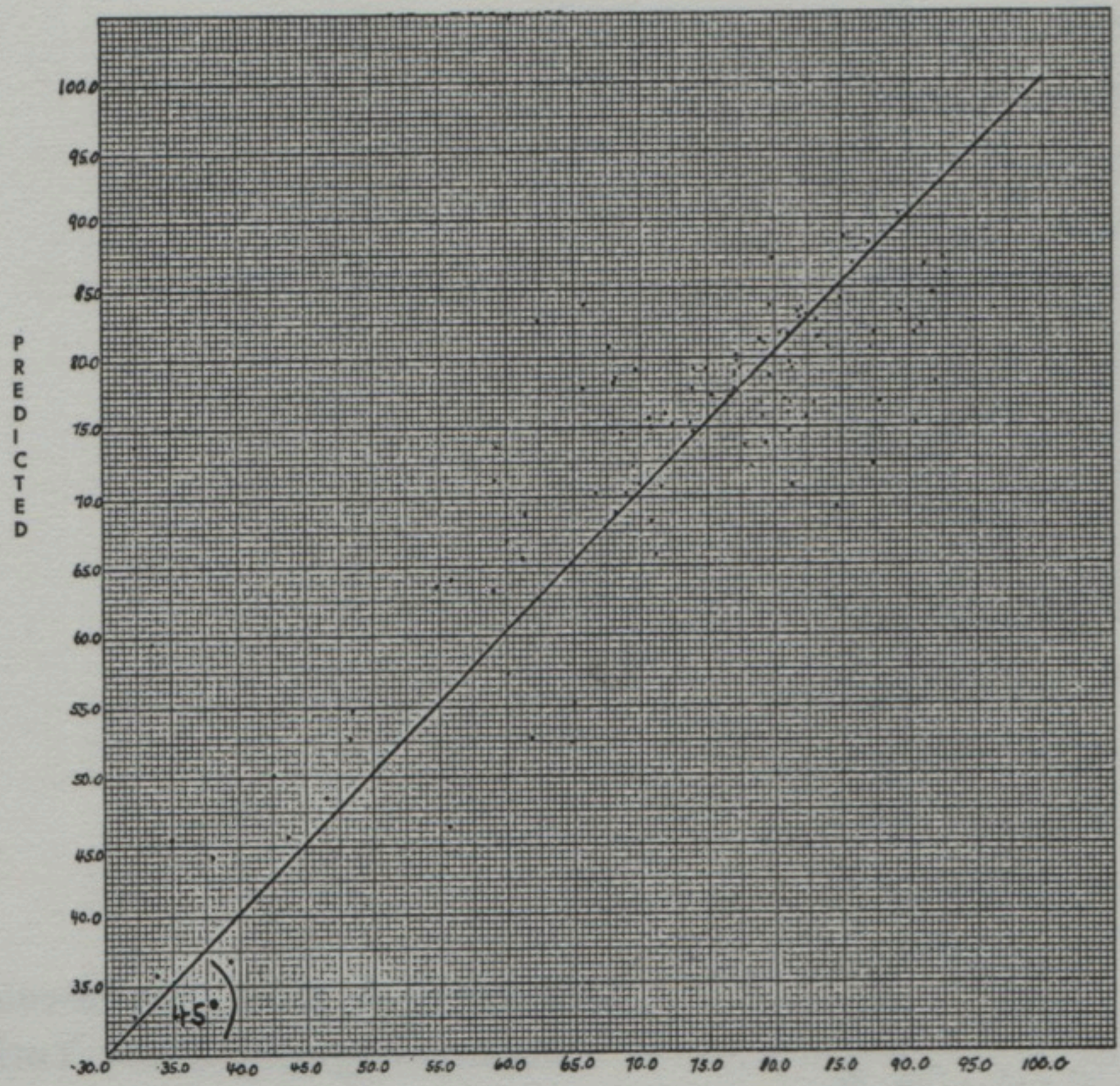


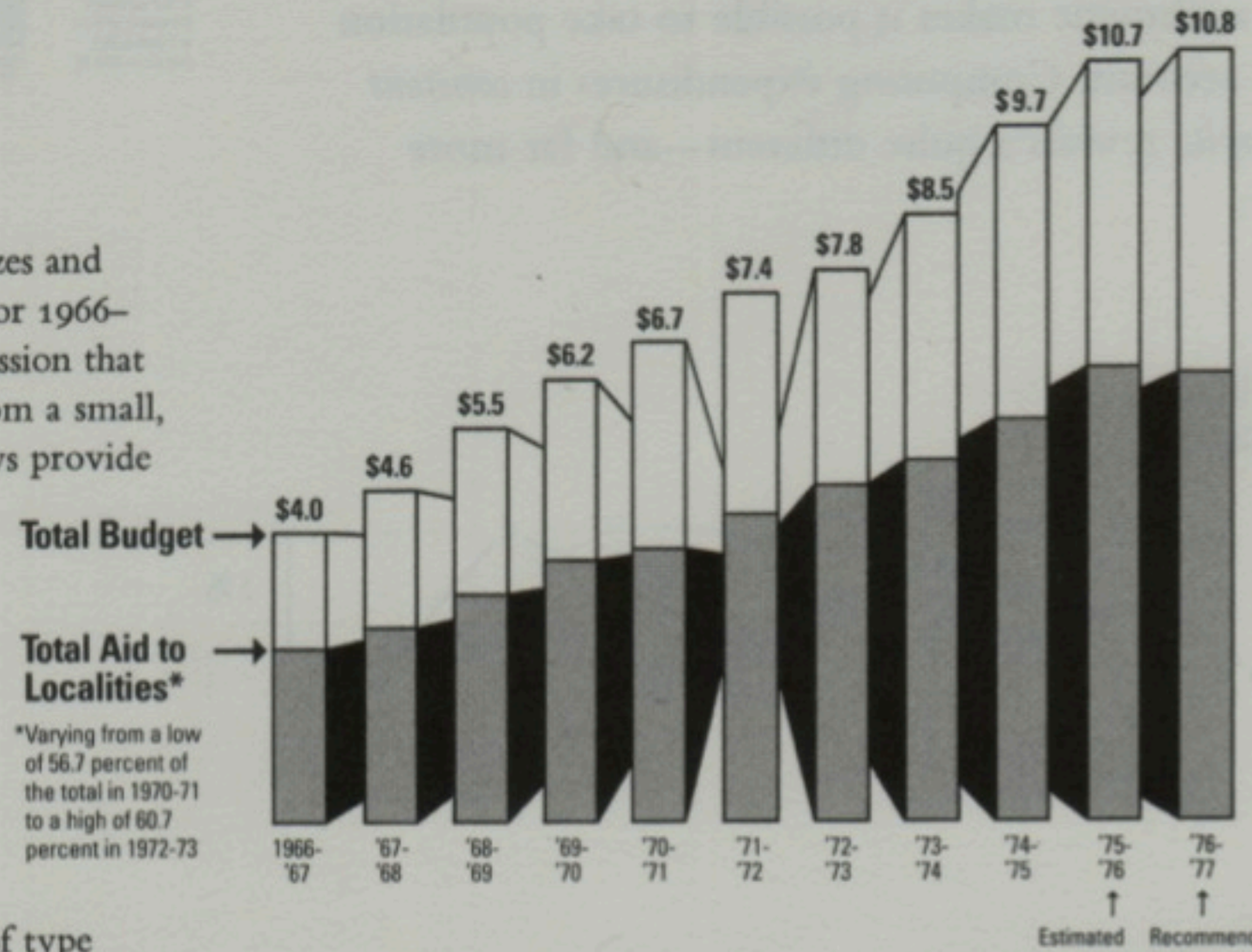
The length of an organism at the time of reproduction in relation to the generation time, plotted on a logarithmic scale.

Relationship of Actual Rates of Registration to Predicted Rates
(104 cities 1960).



Have Integrity

This cluster of type emphasizes and stretches out the low value for 1966–1967, encouraging the impression that recent years have shot up from a small, stable base. Horizontal arrows provide similar emphasis.

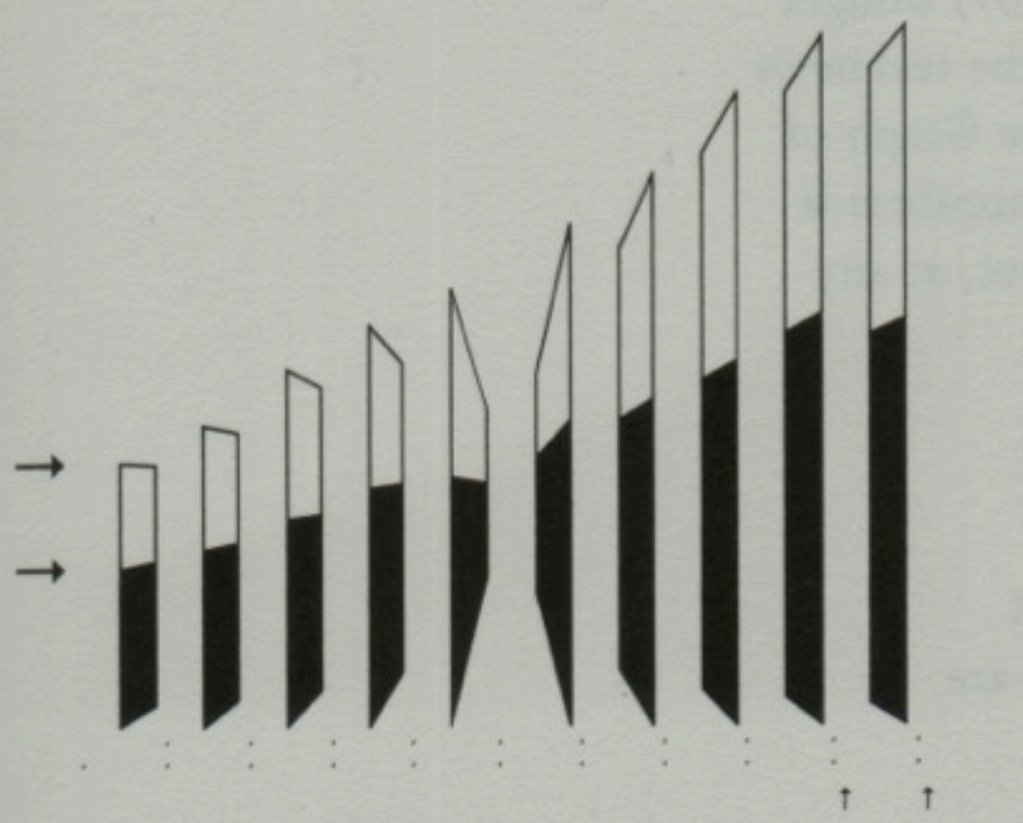


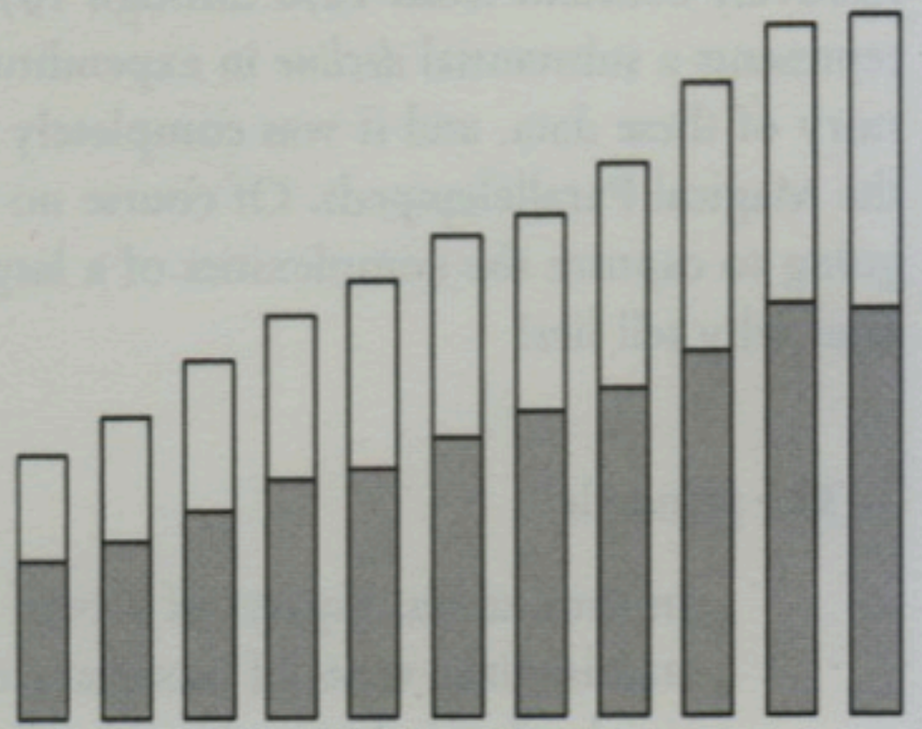
This squeezed-down block of type contributes to an image of small, squeezed-down budgets back in the good old days.

Arrows pointing straight up emphasize recent growth. Compare with horizontal arrows at left.

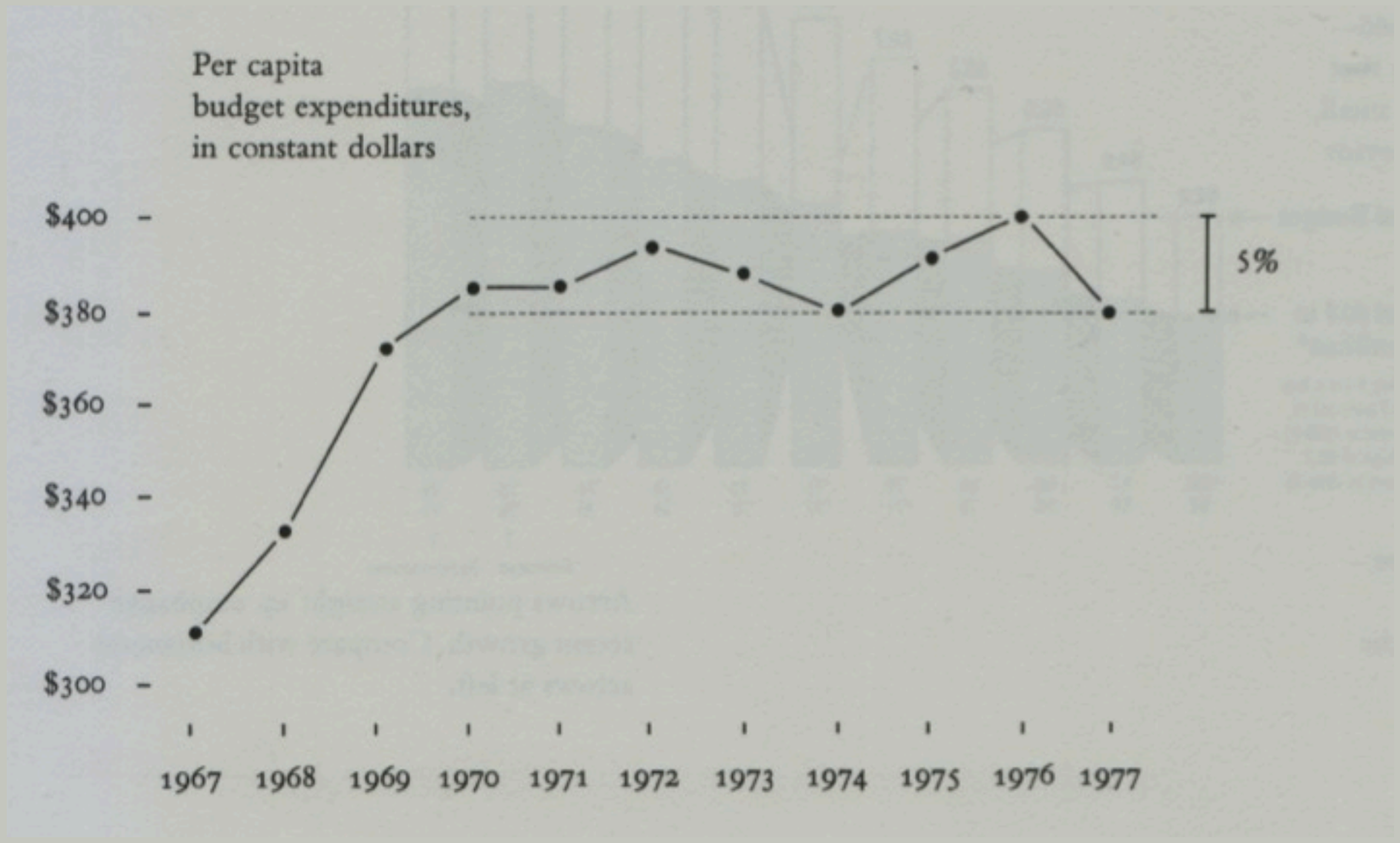
Step 1: Eliminate Chart Junk

Leaving behind the distortion in the chartjunk heap at the left yields a calmer view:





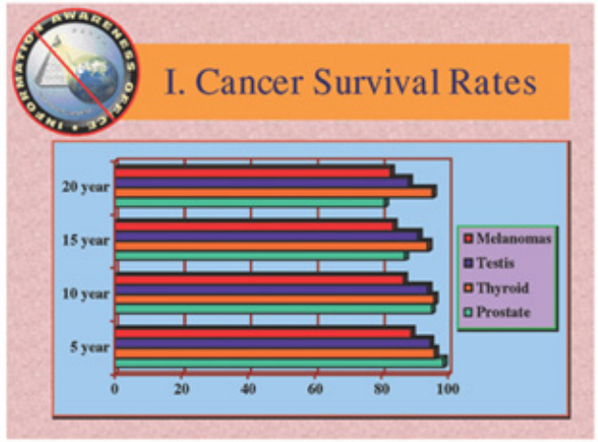
Step #2: Adjust for inflation...

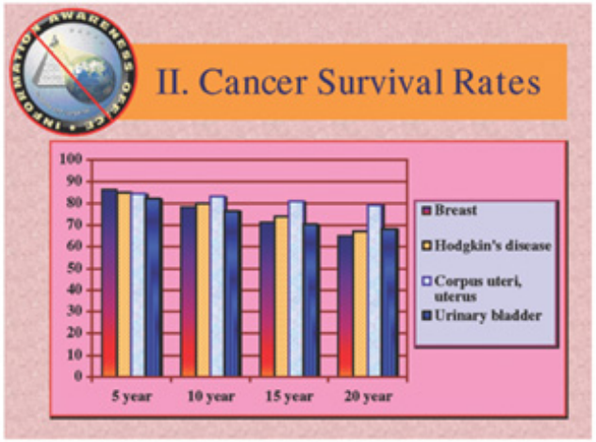


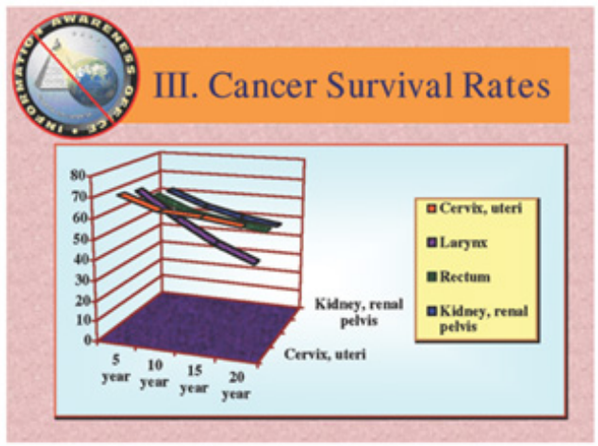
Design Counts

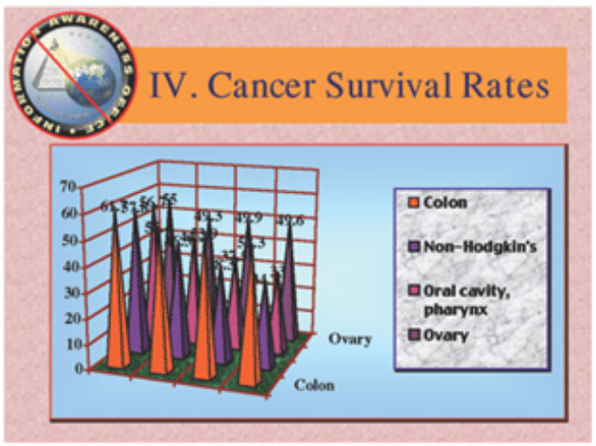
Estimates of relative survival rates, by cancer site

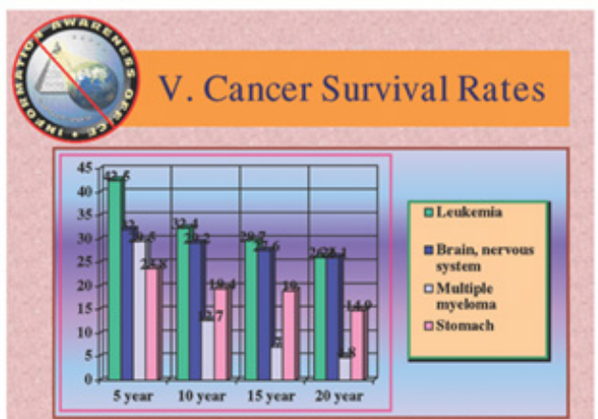
	% survival rates and standard errors							
	5 year		10 year		15 year		20 year	
Prostate	98.8	0.4	95.2	0.9	87.1	1.7	81.1	3.0
Thyroid	96.0	0.8	95.8	1.2	94.0	1.6	95.4	2.1
Testis	94.7	1.1	94.0	1.3	91.1	1.8	88.2	2.3
Melanomas	89.0	0.8	86.7	1.1	83.5	1.5	82.8	1.9
Breast	86.4	0.4	78.3	0.6	71.3	0.7	65.0	1.0
Hodgkin's disease	85.1	1.7	79.8	2.0	73.8	2.4	67.1	2.8
Corpus uteri, uterus	84.3	1.0	83.2	1.3	80.8	1.7	79.2	2.0
Urinary, bladder	82.1	1.0	76.2	1.4	70.3	1.9	67.9	2.4
Cervix, uteri	70.5	1.6	64.1	1.8	62.8	2.1	60.0	2.4
Larynx	68.8	2.1	56.7	2.5	45.8	2.8	37.8	3.1
Rectum	62.6	1.2	55.2	1.4	51.8	1.8	49.2	2.3
Kidney, renal pelvis	61.8	1.3	54.4	1.6	49.8	2.0	47.3	2.6
Colon	61.7	0.8	55.4	1.0	53.9	1.2	52.3	1.6
Non-Hodgkin's	57.8	1.0	46.3	1.2	38.3	1.4	34.3	1.7
Oral cavity, pharynx	56.7	1.3	44.2	1.4	37.5	1.6	33.0	1.8
Ovary	55.0	1.3	49.3	1.6	49.9	1.9	49.6	2.4
Leukemia	42.5	1.2	32.4	1.3	29.7	1.5	26.2	1.7
Brain, nervous system	32.0	1.4	29.2	1.5	27.6	1.6	26.1	1.9
Multiple myeloma	29.5	1.6	12.7	1.5	7.0	1.3	4.8	1.5
Stomach	23.8	1.3	19.4	1.4	19.0	1.7	14.9	1.9
Lung and bronchus	15.0	0.4	10.6	0.4	8.1	0.4	6.5	0.4
Esophagus	14.2	1.4	7.9	1.3	7.7	1.6	5.4	2.0
Liver, bile duct	7.5	1.1	5.8	1.2	6.3	1.5	7.6	2.0
Pancreas	4.0	0.5	3.0	1.5	2.7	0.6	2.7	0.8

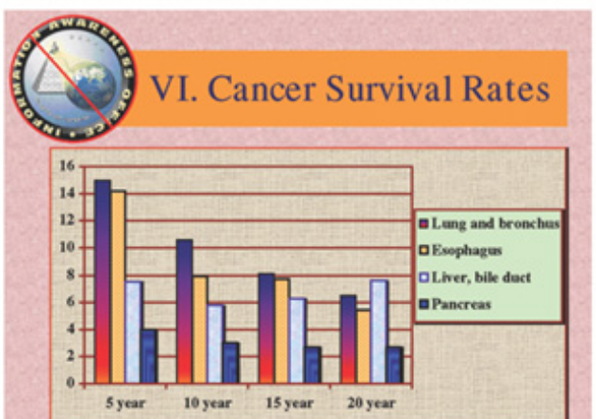






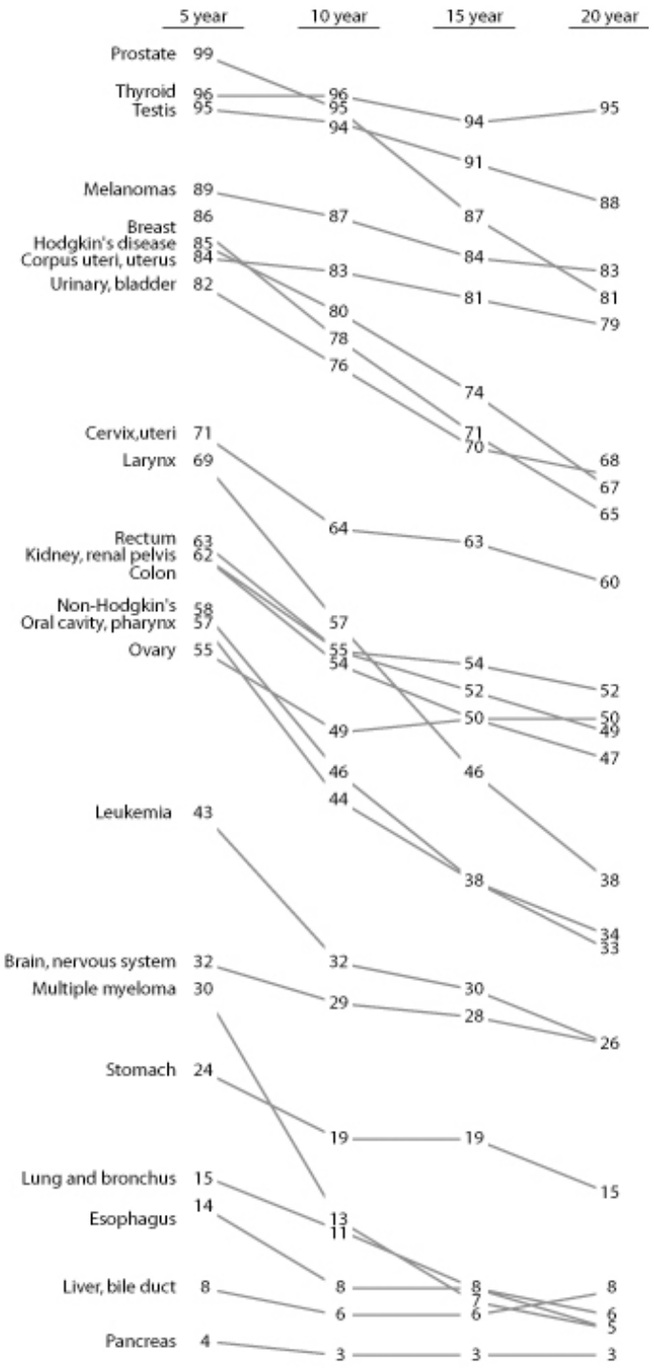






Design Counts

Estimates of relative survival rates, by cancer site



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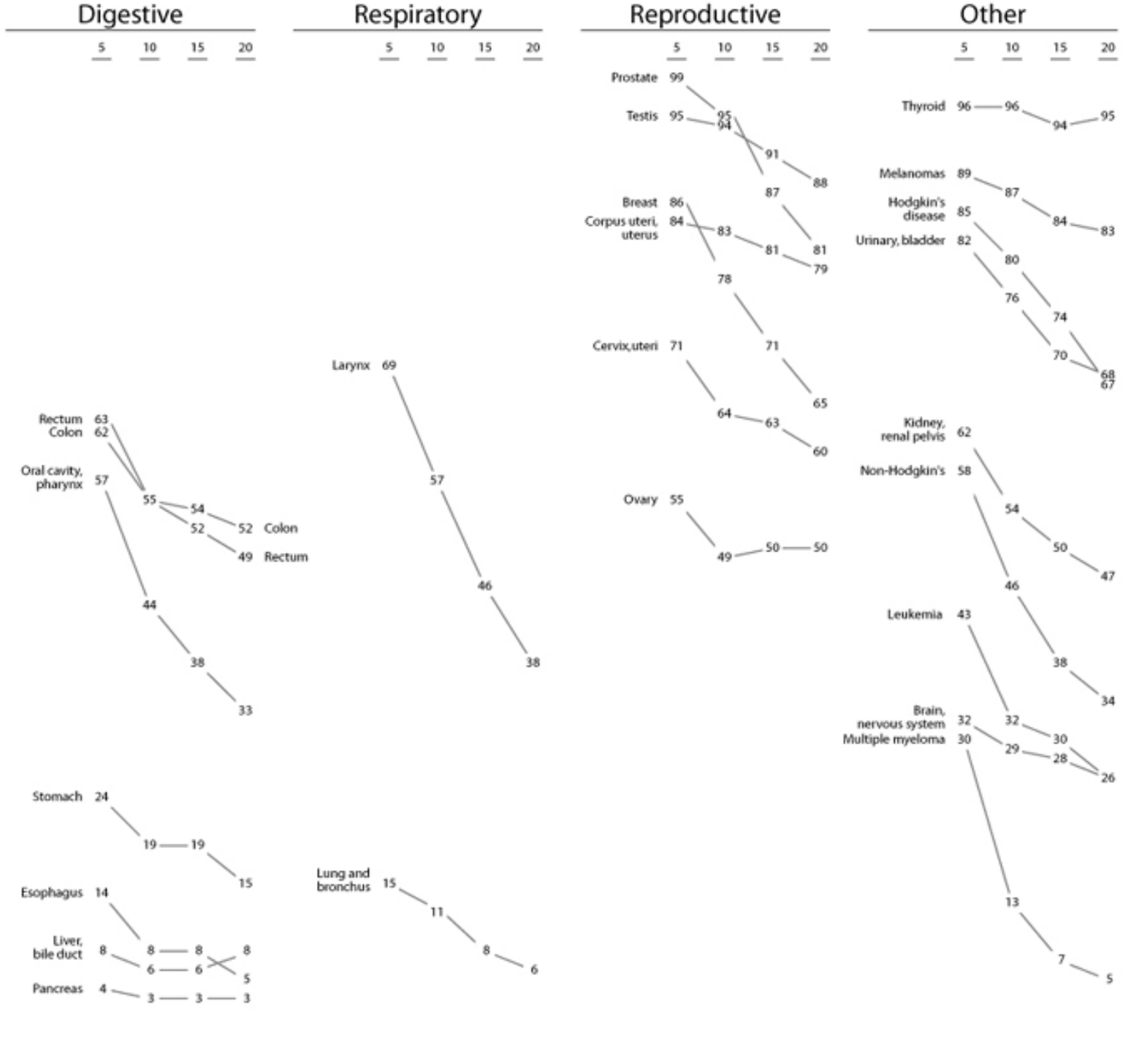

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Why Software Visualization?

- To communicate
- To analyze the “as is” as opposed to “as designed” system
- To support in debugging

- When reading all the source code is not an option

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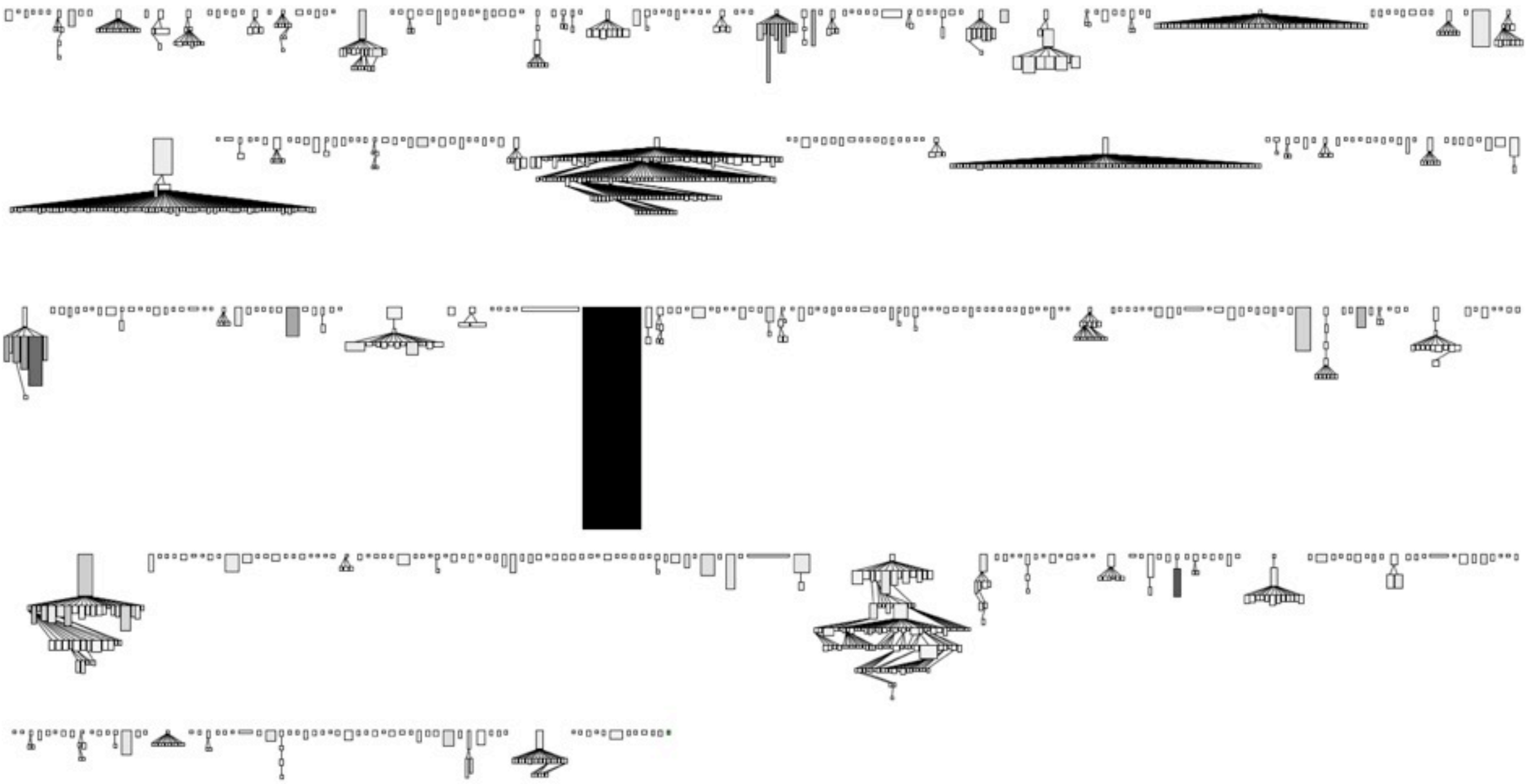
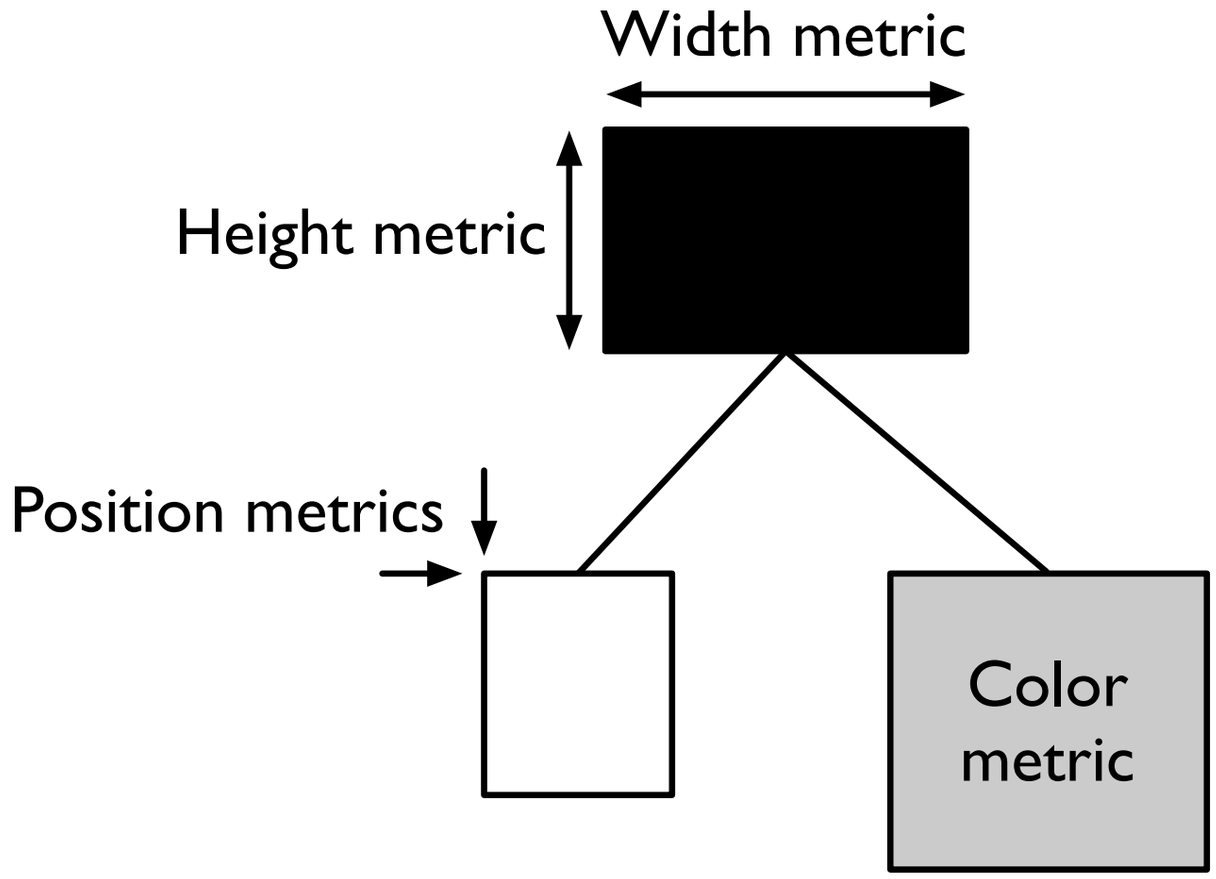
Inheritance in ArgoUML with Polymetric Views



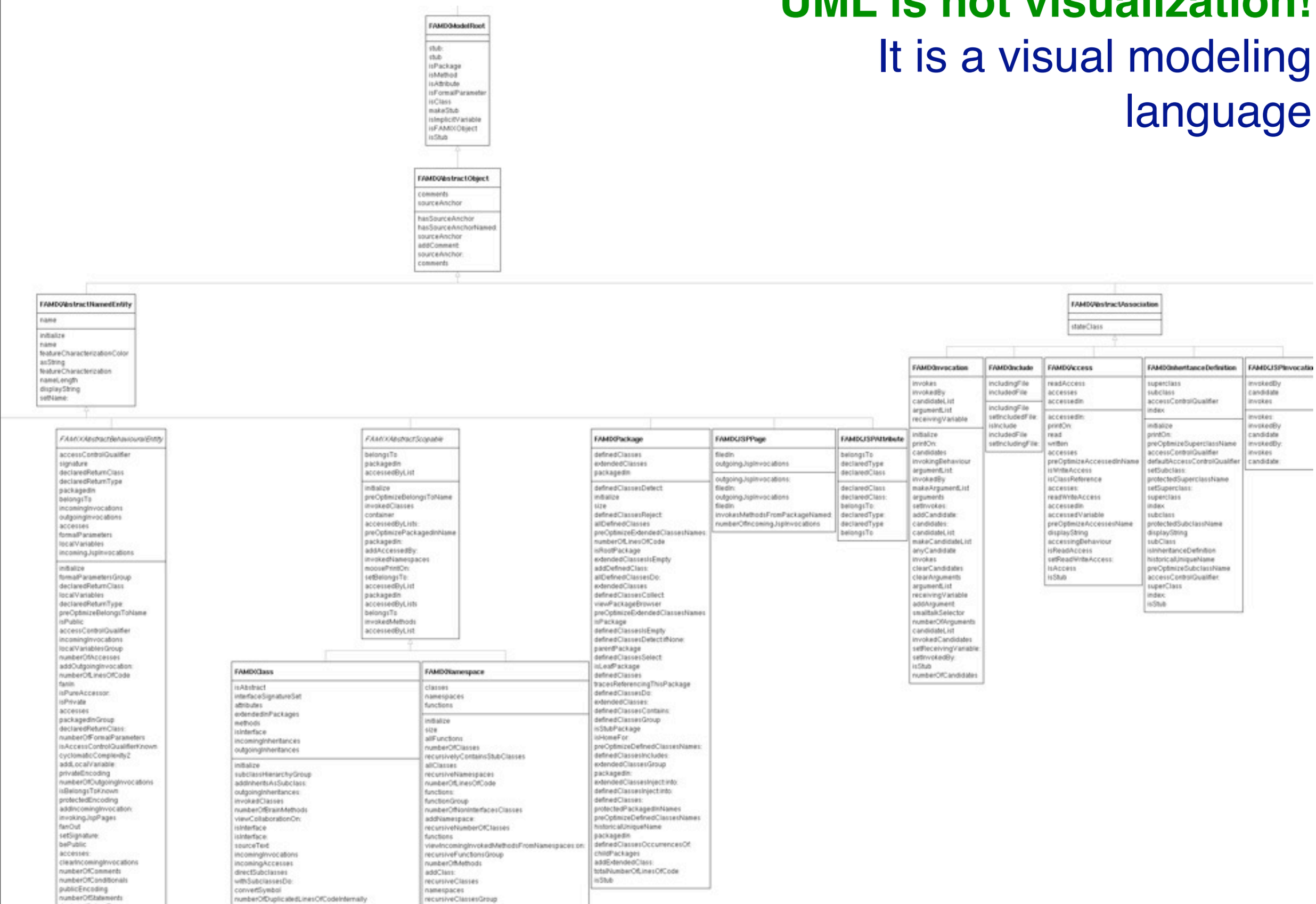
Polymetric Views

- Make use of the preattentive processing features
  - Size
  - Color
  - Connectedness
- Implemented in various tools
  - Mondrian
  - XRay, Plugin for Eclipse

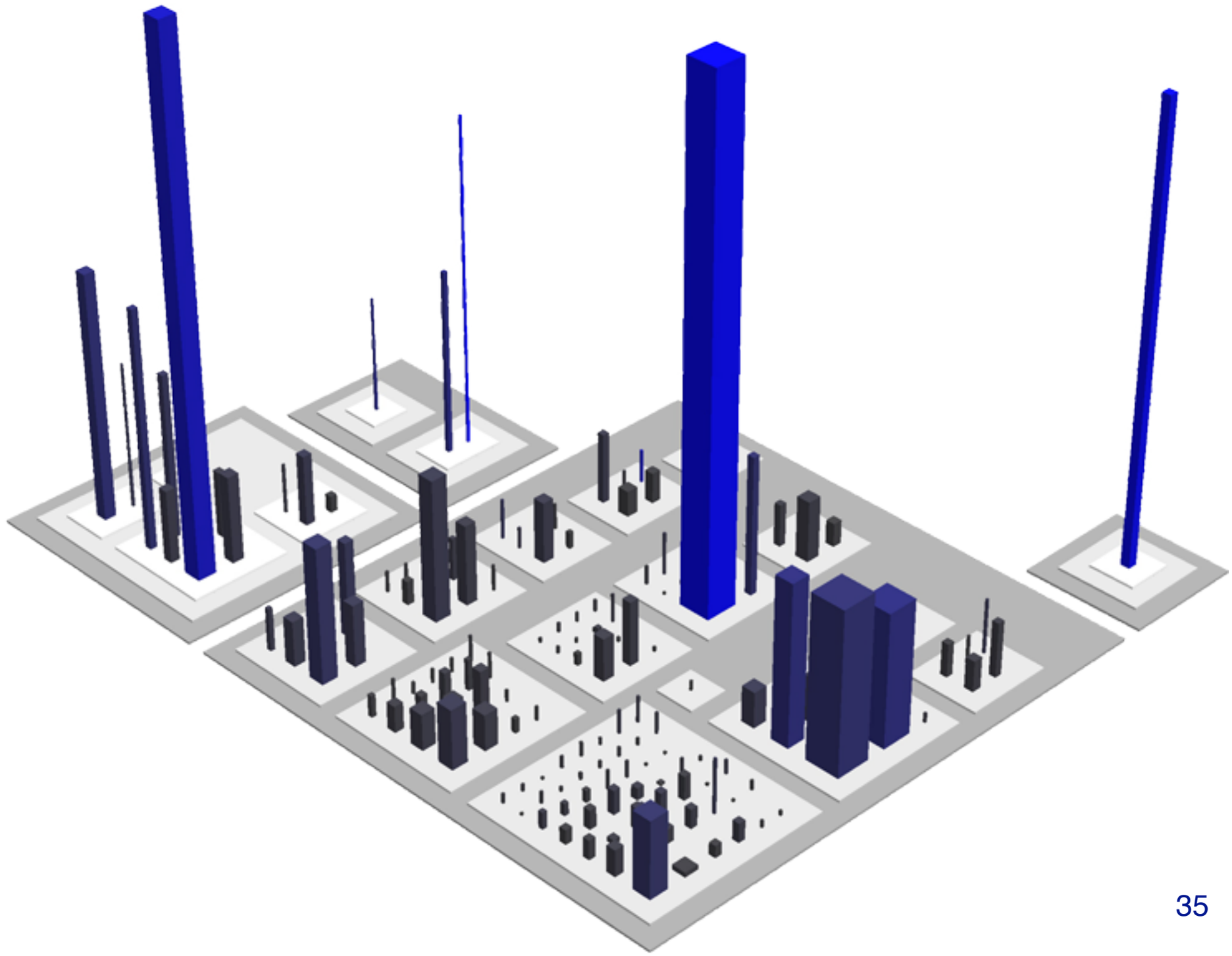


UML is not visualization!

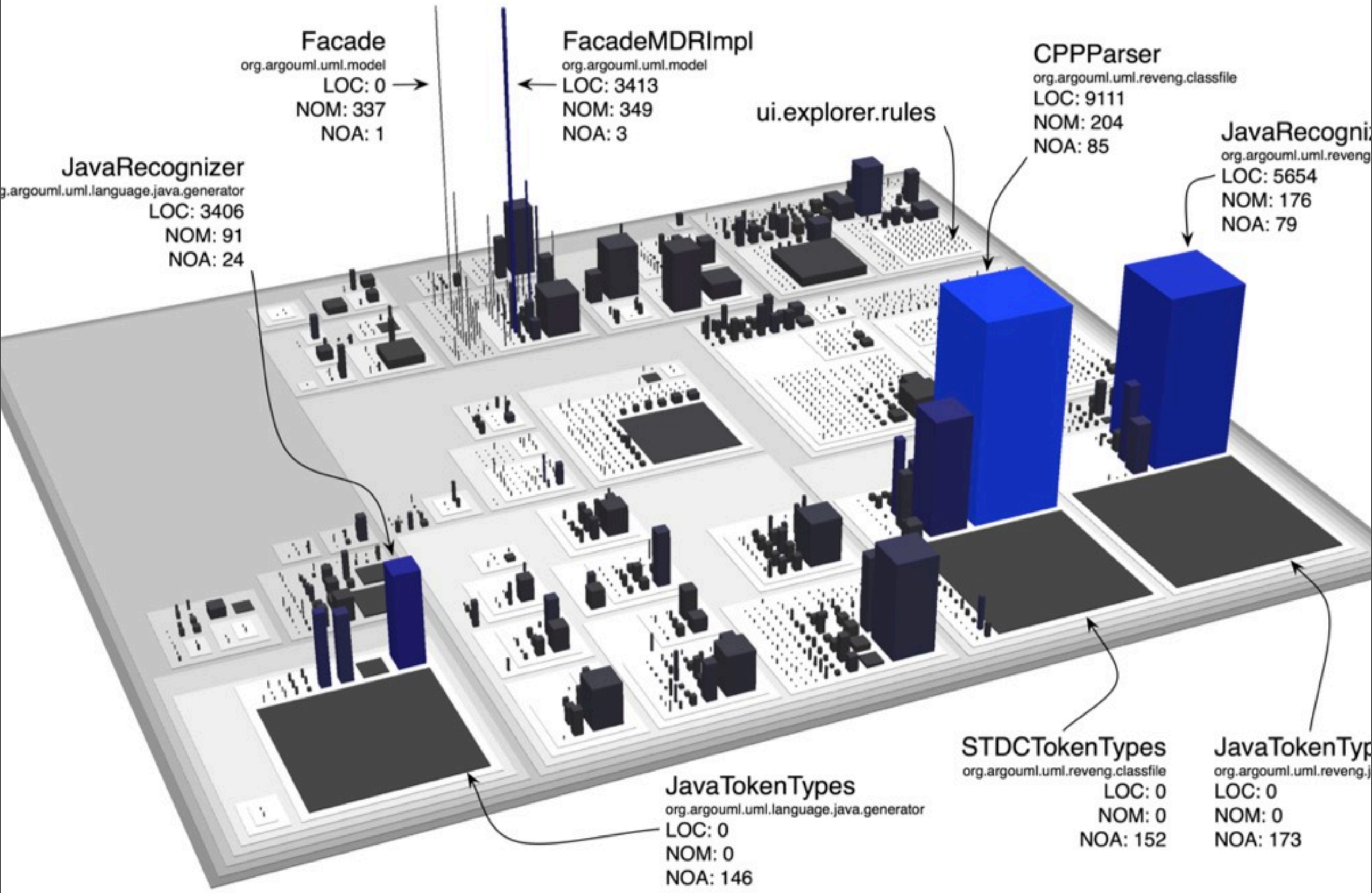
It is a visual modeling language



3D “city” metaphor showing CodeCity

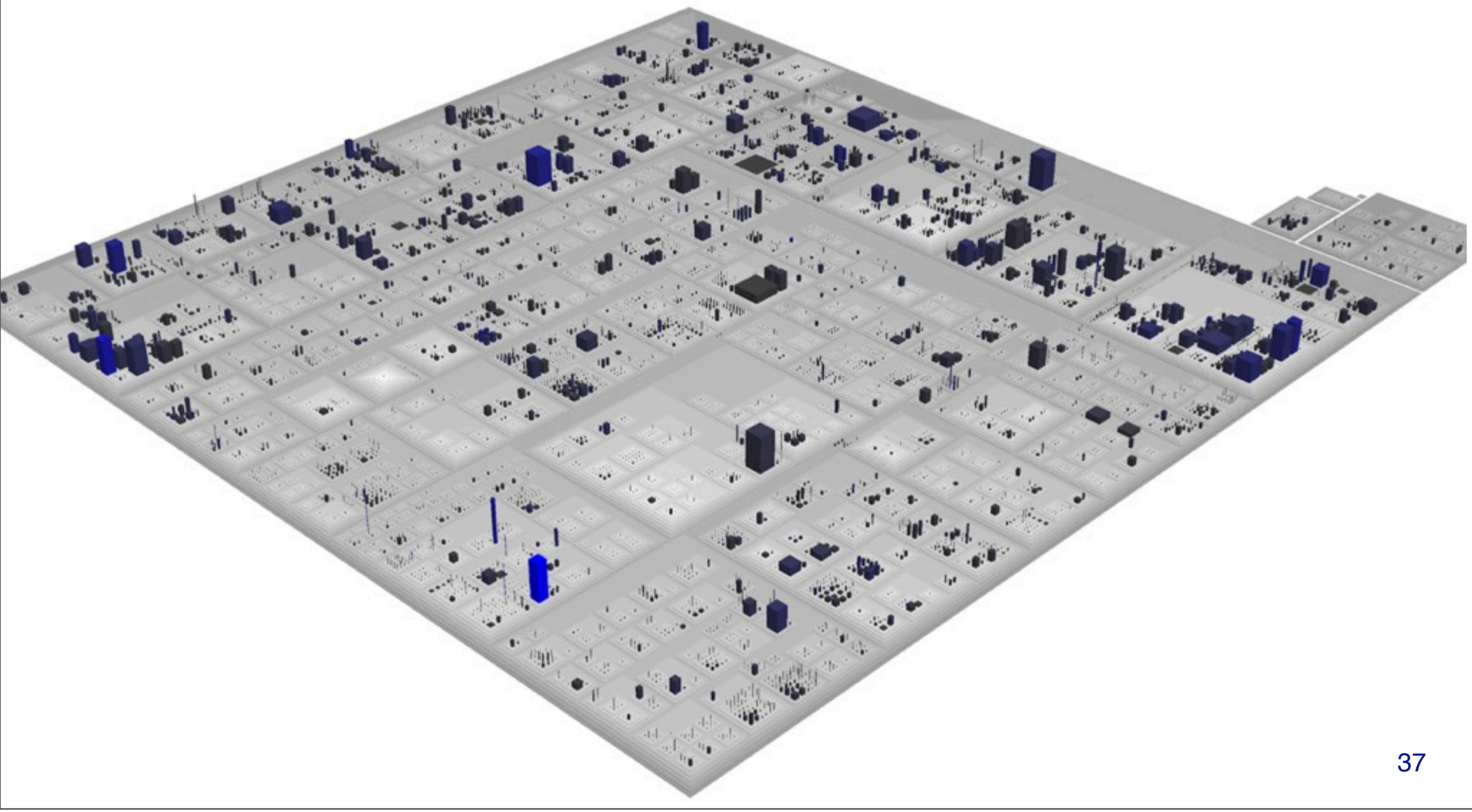


LOC -> Color
NOM -> Height
NOA -> Area

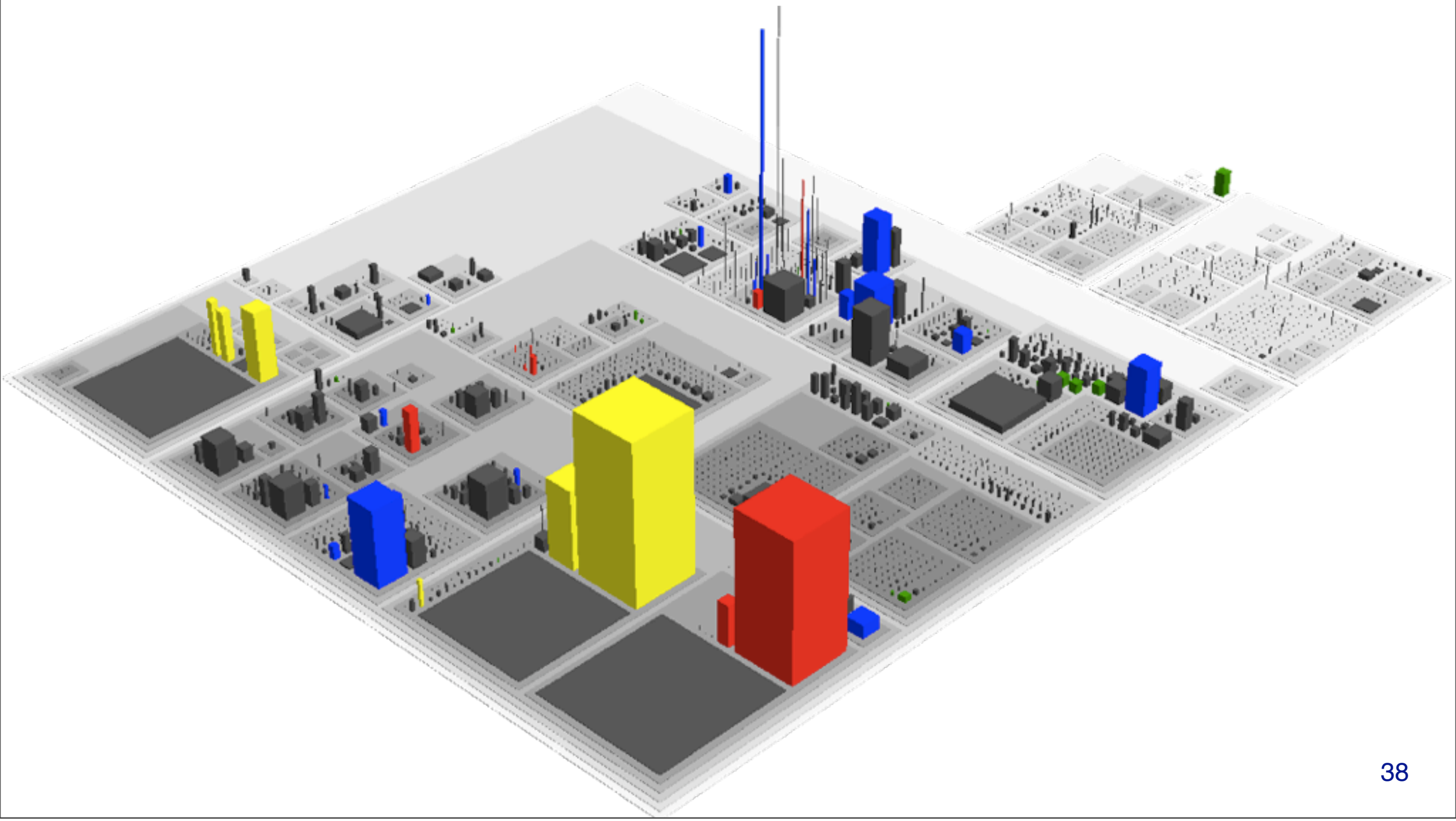

Facade
org.argouml.uml.model
LOC: 0
NOM: 337
NOA: 1
FacadeMDRImpl
org.argouml.uml.model
LOC: 3413
NOM: 349
NOA: 3
ui.explorer.rules
CPPParser
org.argouml.uml.reveng.classfile
LOC: 9111
NOM: 204
NOA: 85
JavaRecogni
org.argouml.uml.reveng
LOC: 5654
NOM: 176
NOA: 79
JavaRecognizer
g.argouml.uml.language.java.generator
LOC: 3406
NOM: 91
NOA: 24
JavaTokenTypes
org.argouml.uml.language.java.generator
LOC: 0
NOM: 0
NOA: 146
STDCTokenTypes
org.argouml.uml.reveng.classfile
LOC: 0
NOM: 0
NOA: 152
JavaTokenTyp
org.argouml.uml.reveng.j
LOC: 0
NOM: 0
NOA: 173

ArgoUML

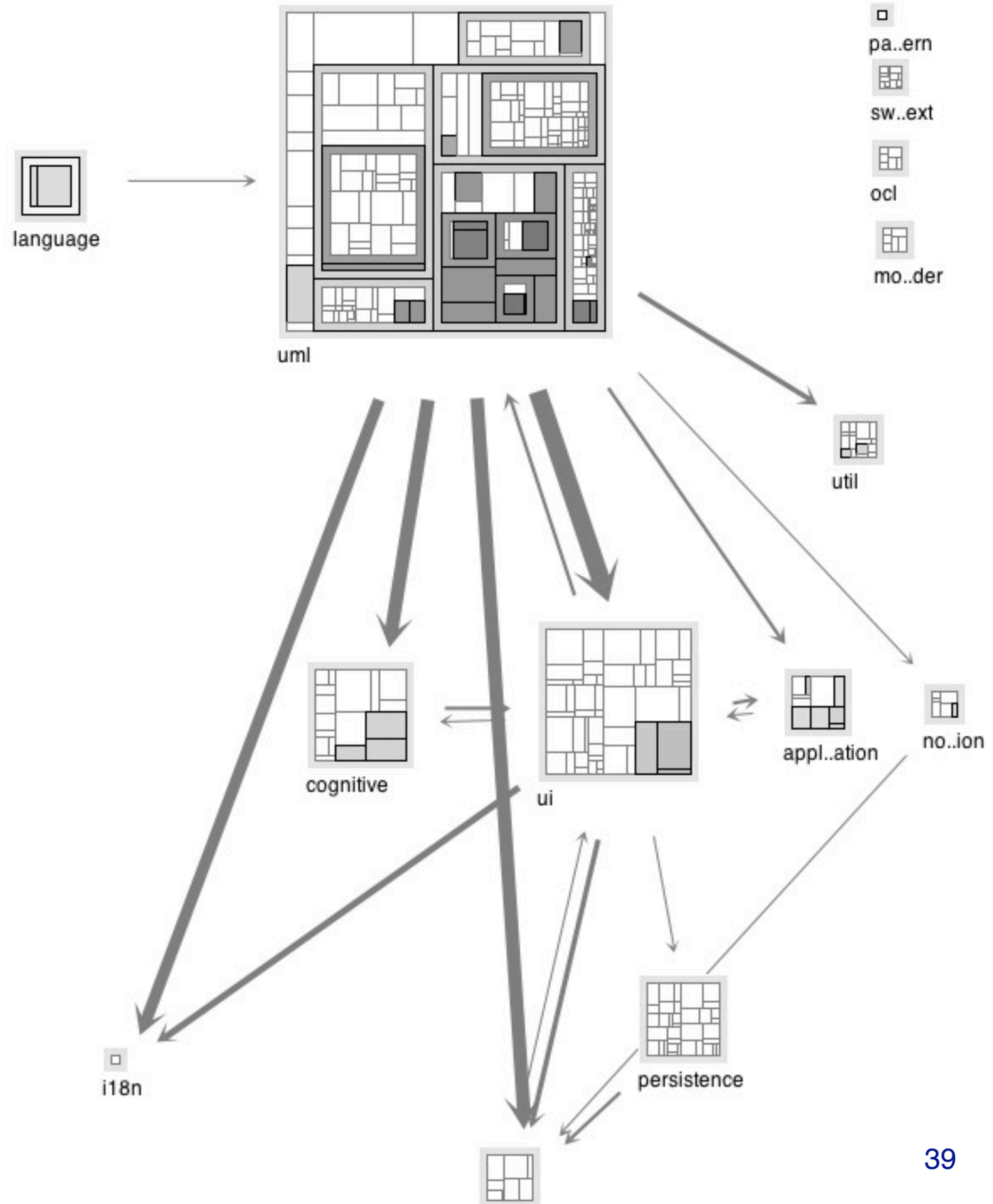
JBoss Application Server 500KLOC



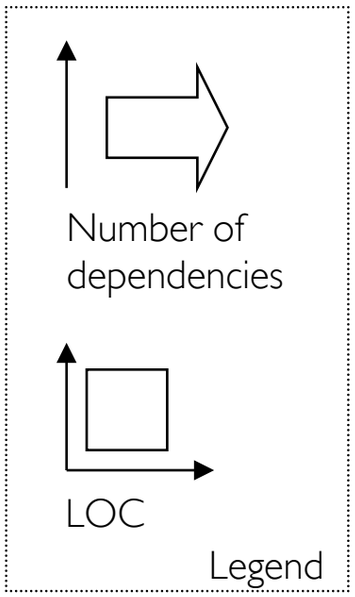
CodeCity allows communicating information about the locality of design problems

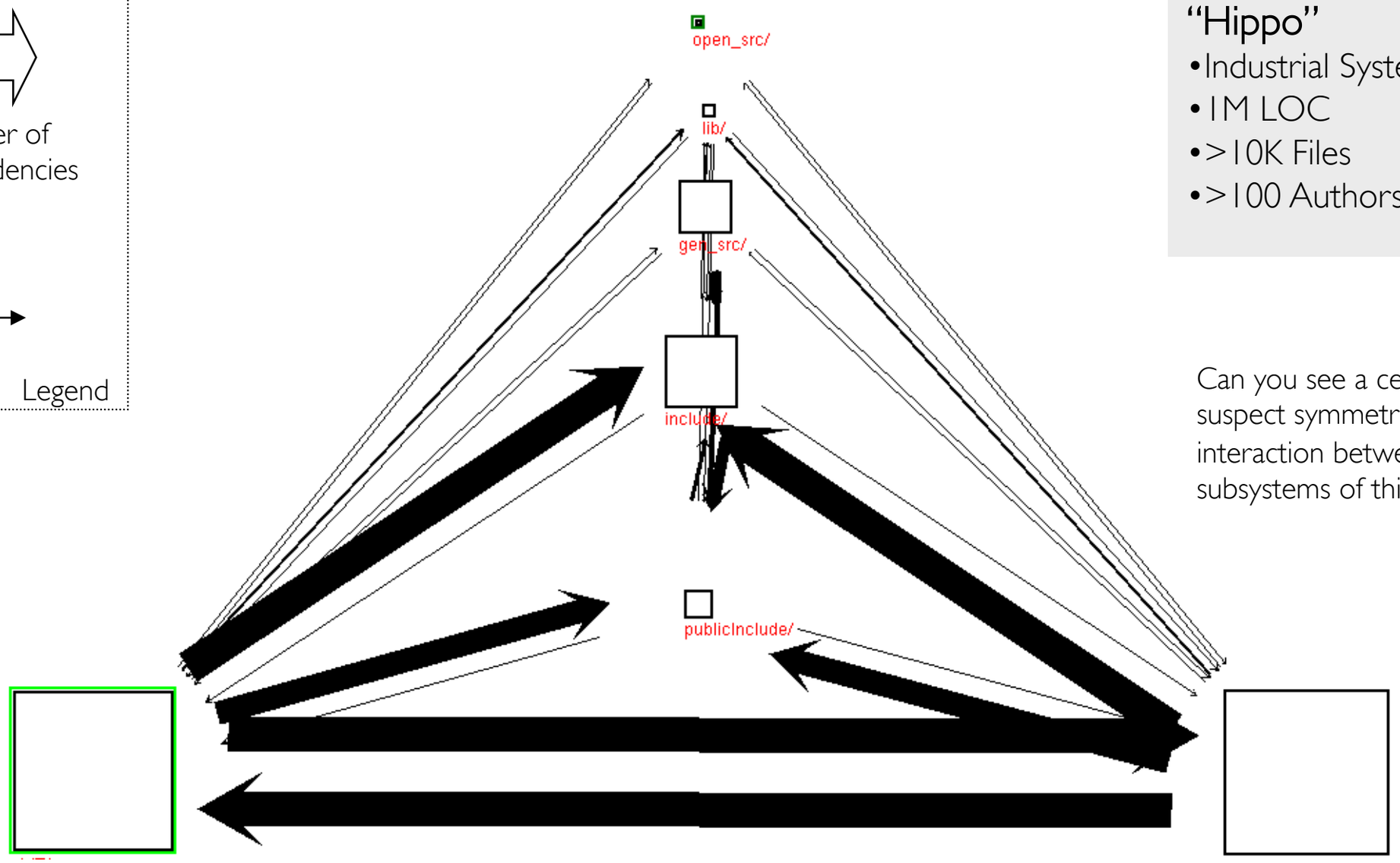


Showing Containment with Treemaps and Relationships



Relationship visualization supports pattern detection

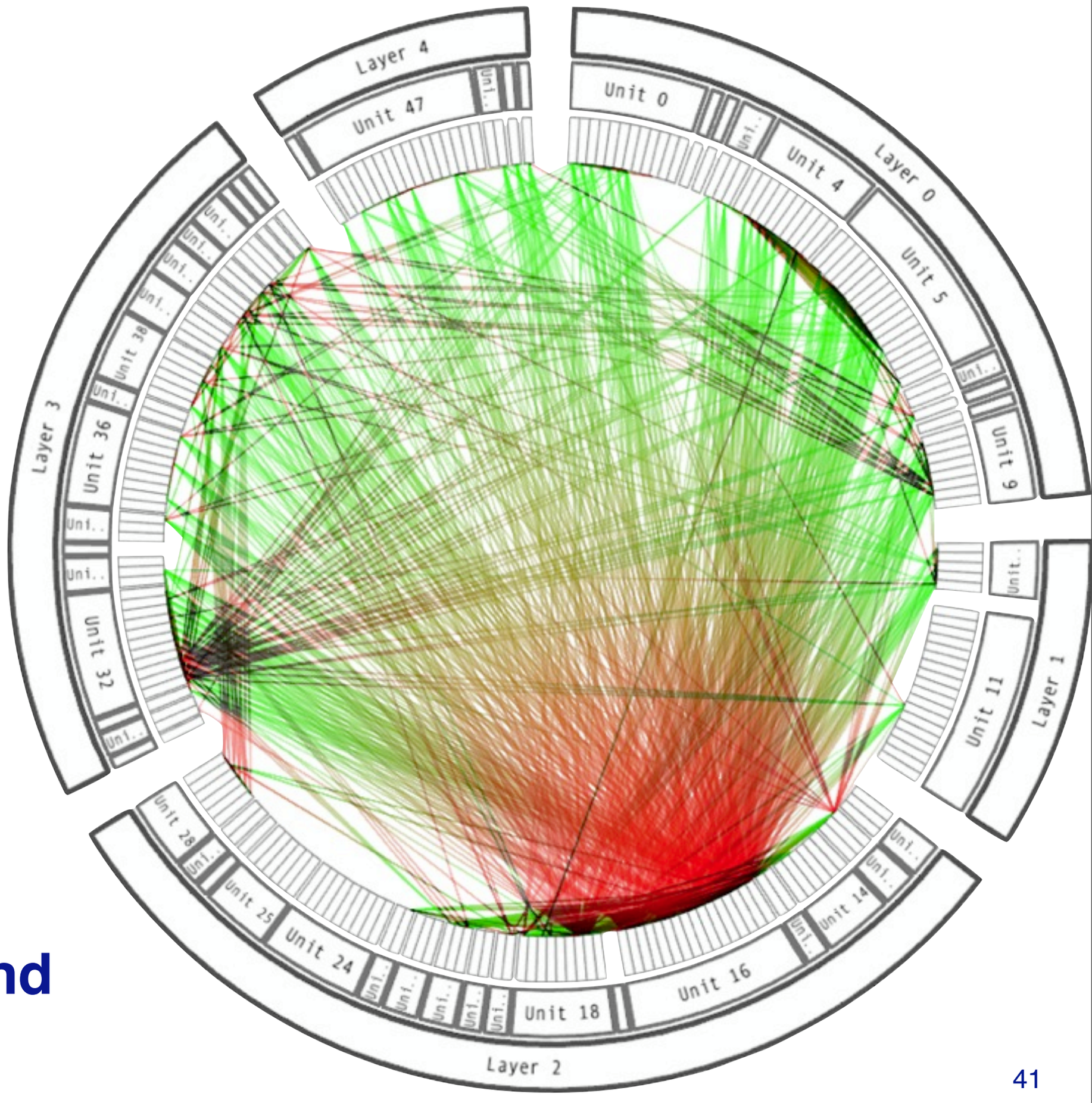




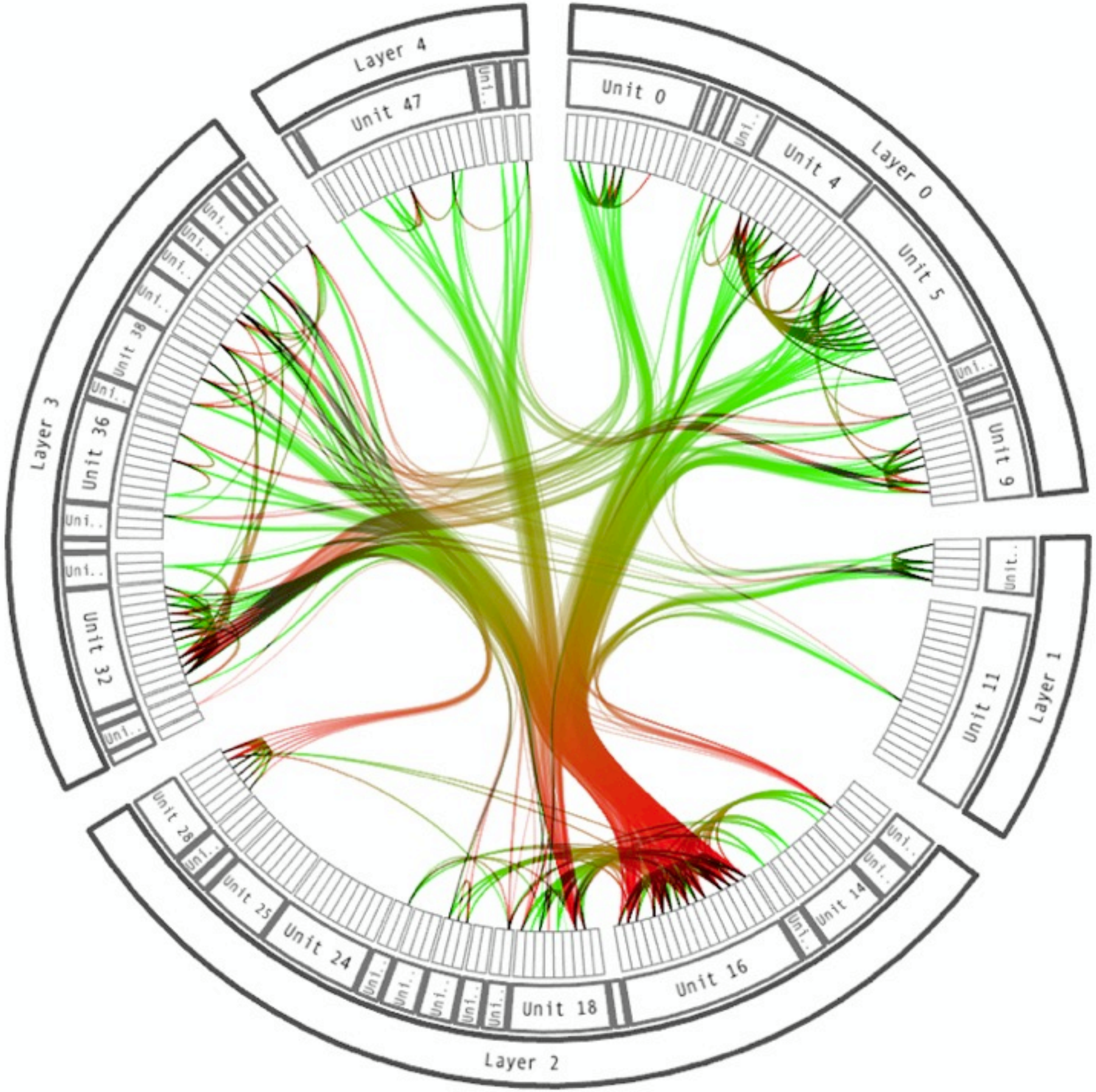
"Hippo"
- Industrial System
- 1M LOC
- >10K Files
- >100 Authors

Can you see a certain suspect symmetry in the interaction between the subsystems of this project?

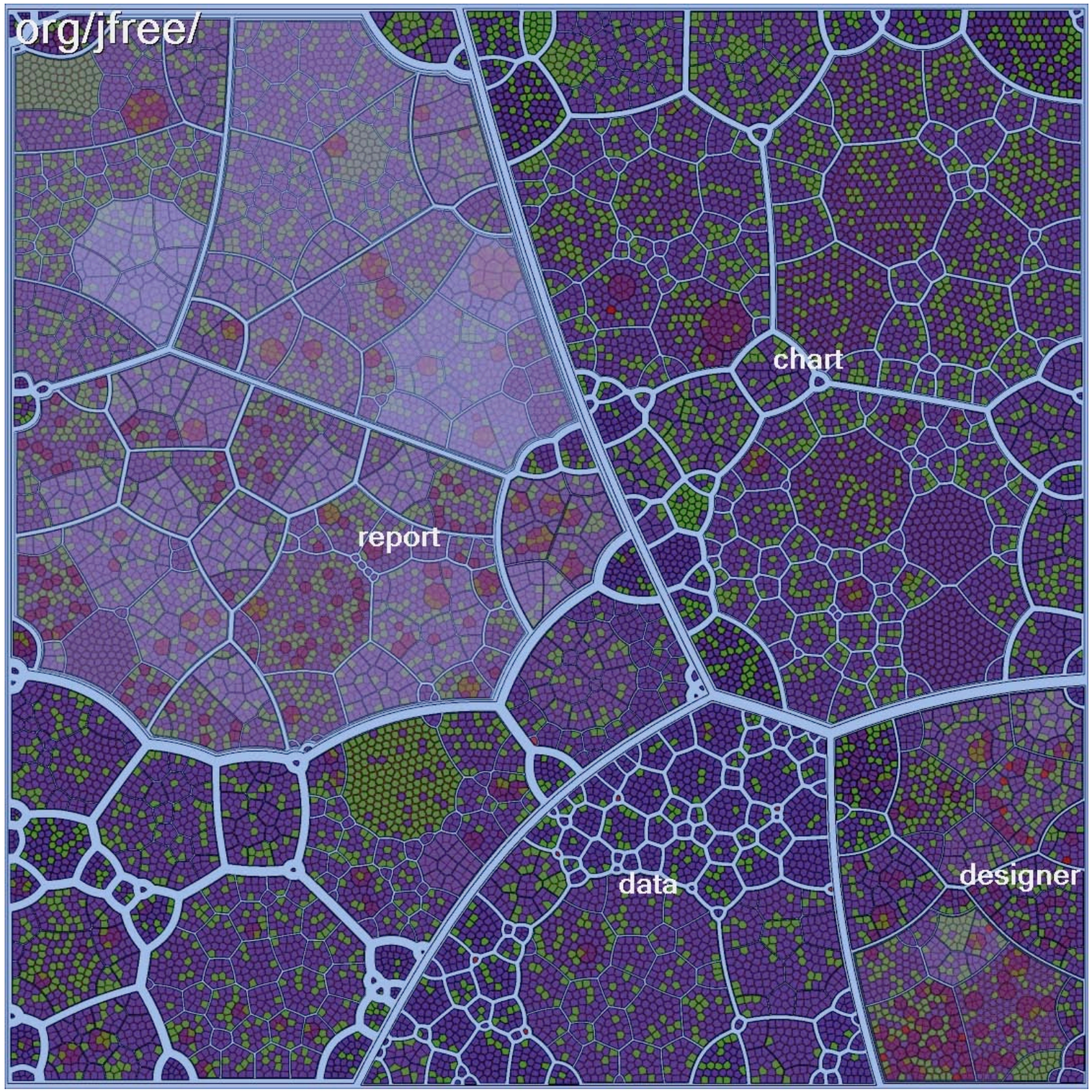
Circular Containment and Dependencies



Circular Containment and Hierarchical Edge Bundles



Voronoi Treemaps are just awesome



But do they support visual analysis?

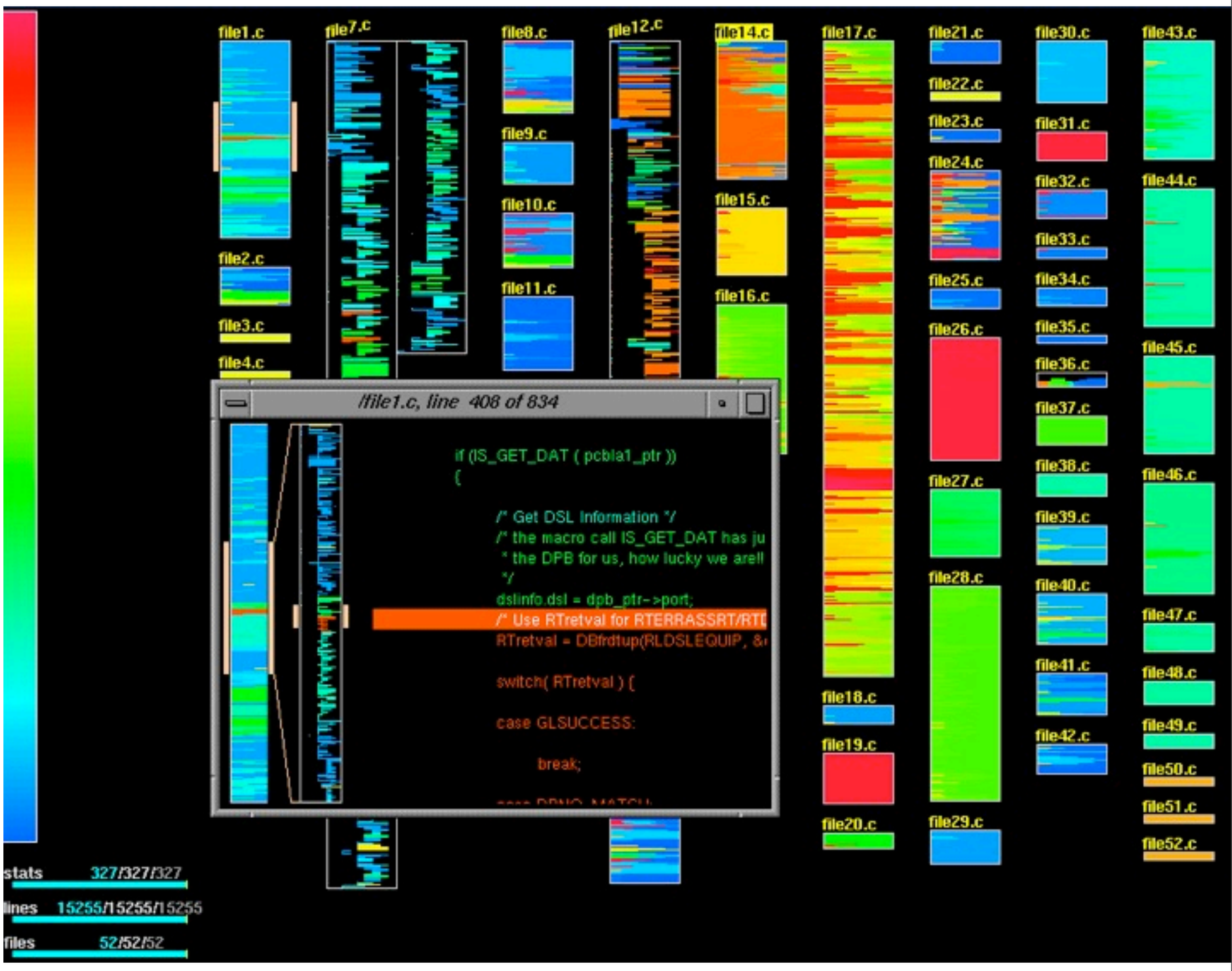
Structure

- Visualized Aspects
  - Inheritance
  - Containment
  - Calls
- Challenges
  - Displaying both structure and containment
- Techniques
  - Space filling techniques
  - Circular Containment Layout

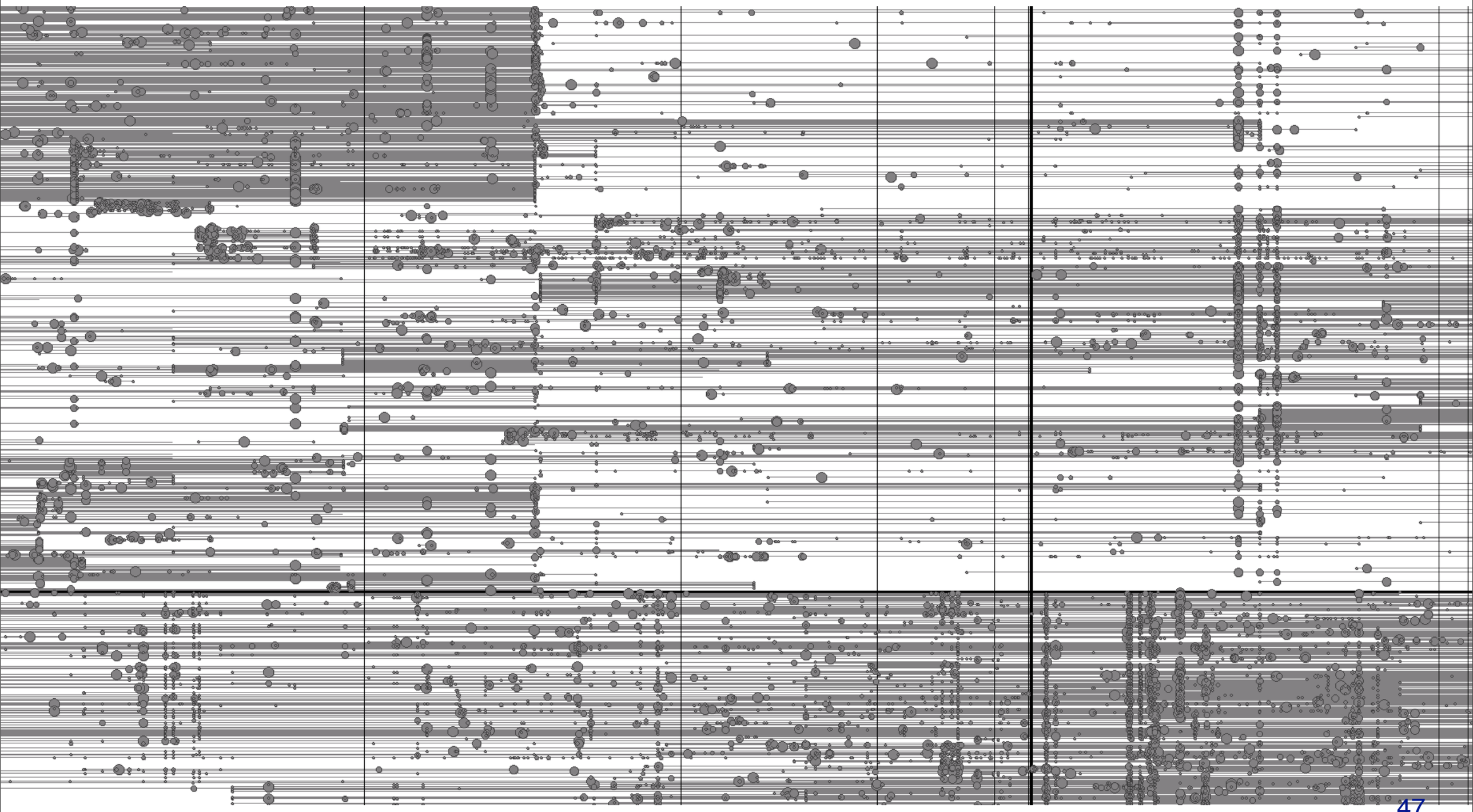
Roadmap

- Information Visualization
- Visualization Design
- **Visualizing Software Systems**
  - Structure
  - **Evolution**
  - Behavior
- Discussion

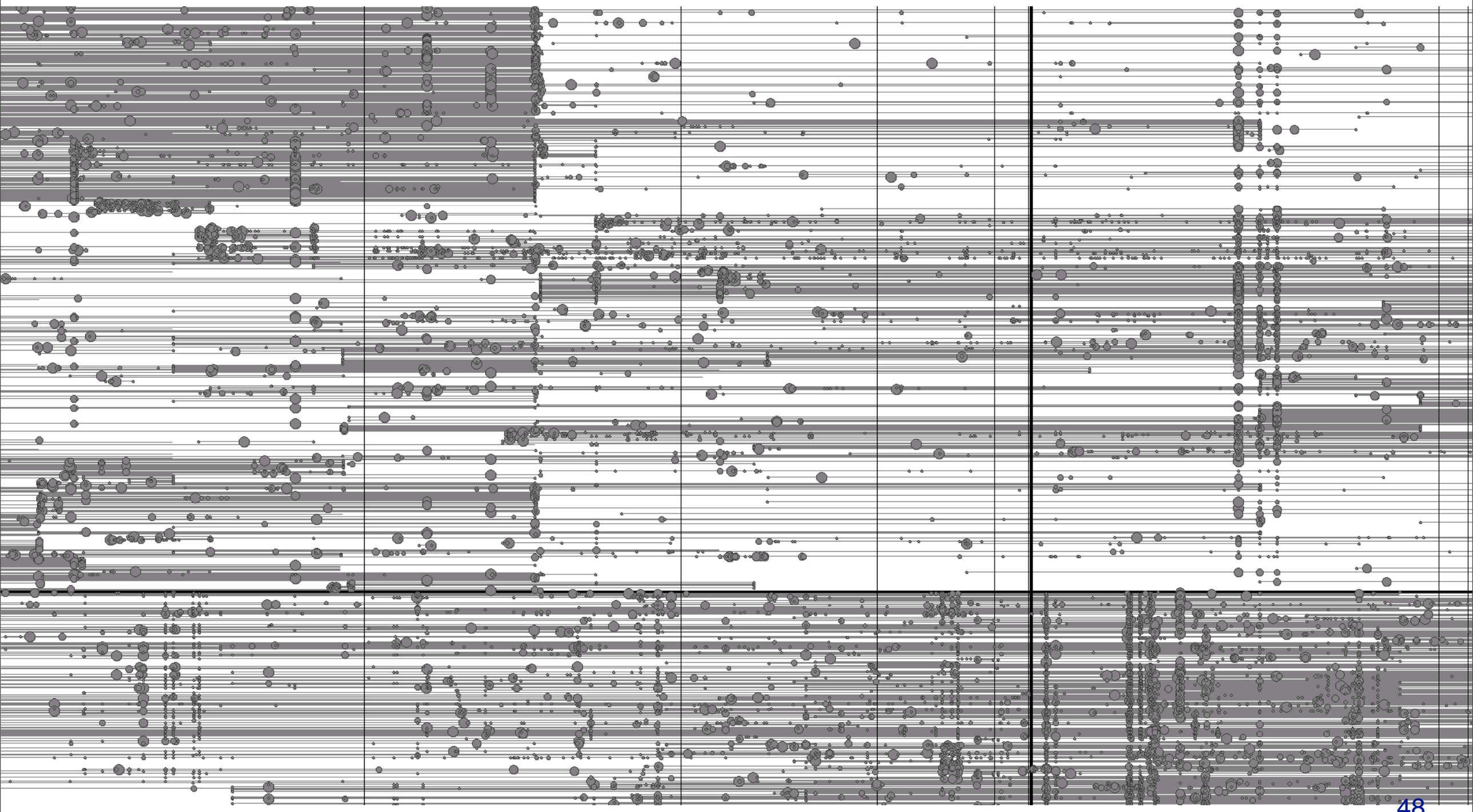
SeeSoft was the first visualization to present evolutionary information



Example: CVS shows activity

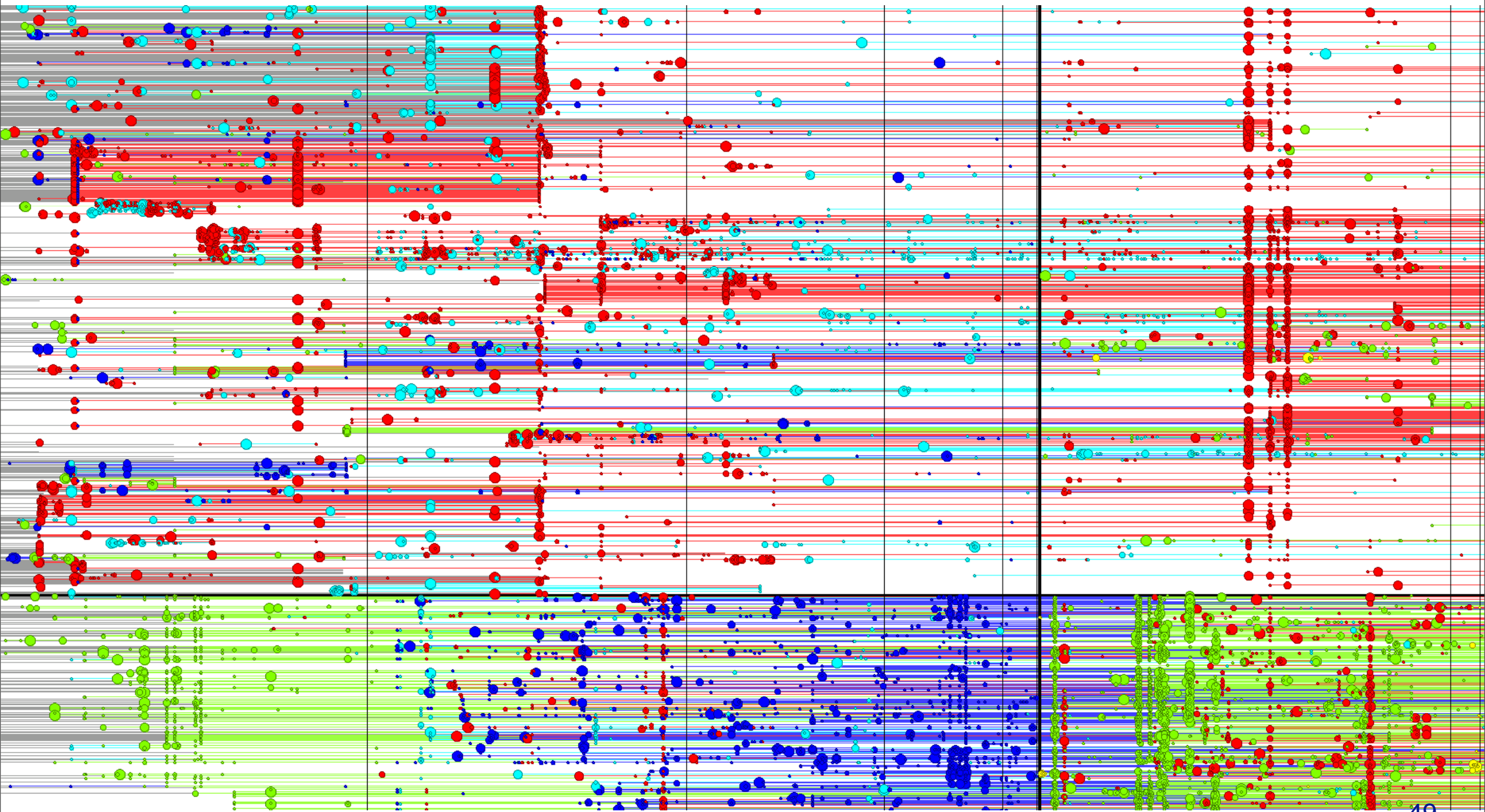


Who did this?



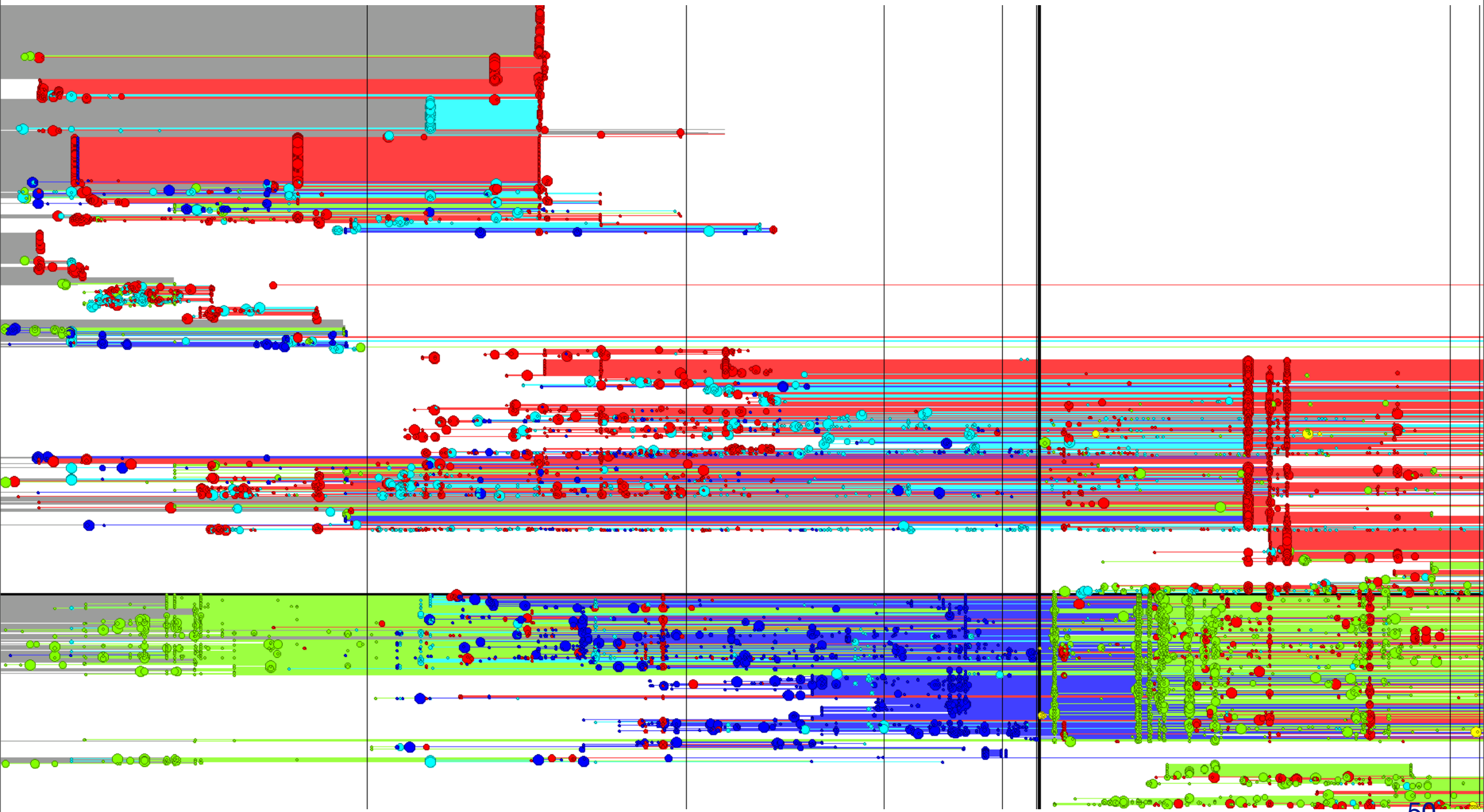
Alphabetical order is no order

Kuhn



Ownership Map orders histories

Girba etal, 2006



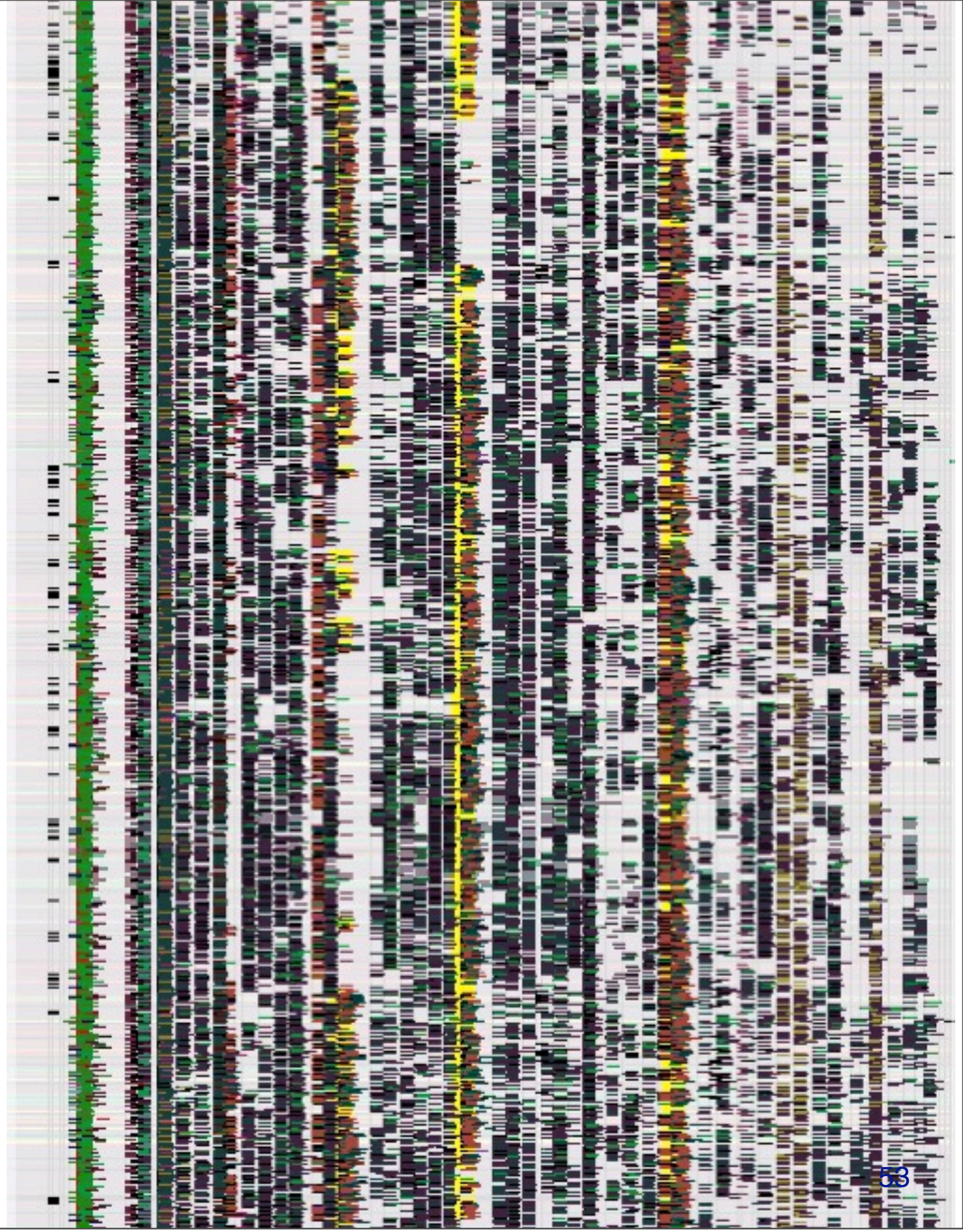
Evolution

- Time can be mapped on
  - color
  - an axis
  - time (not recommended)

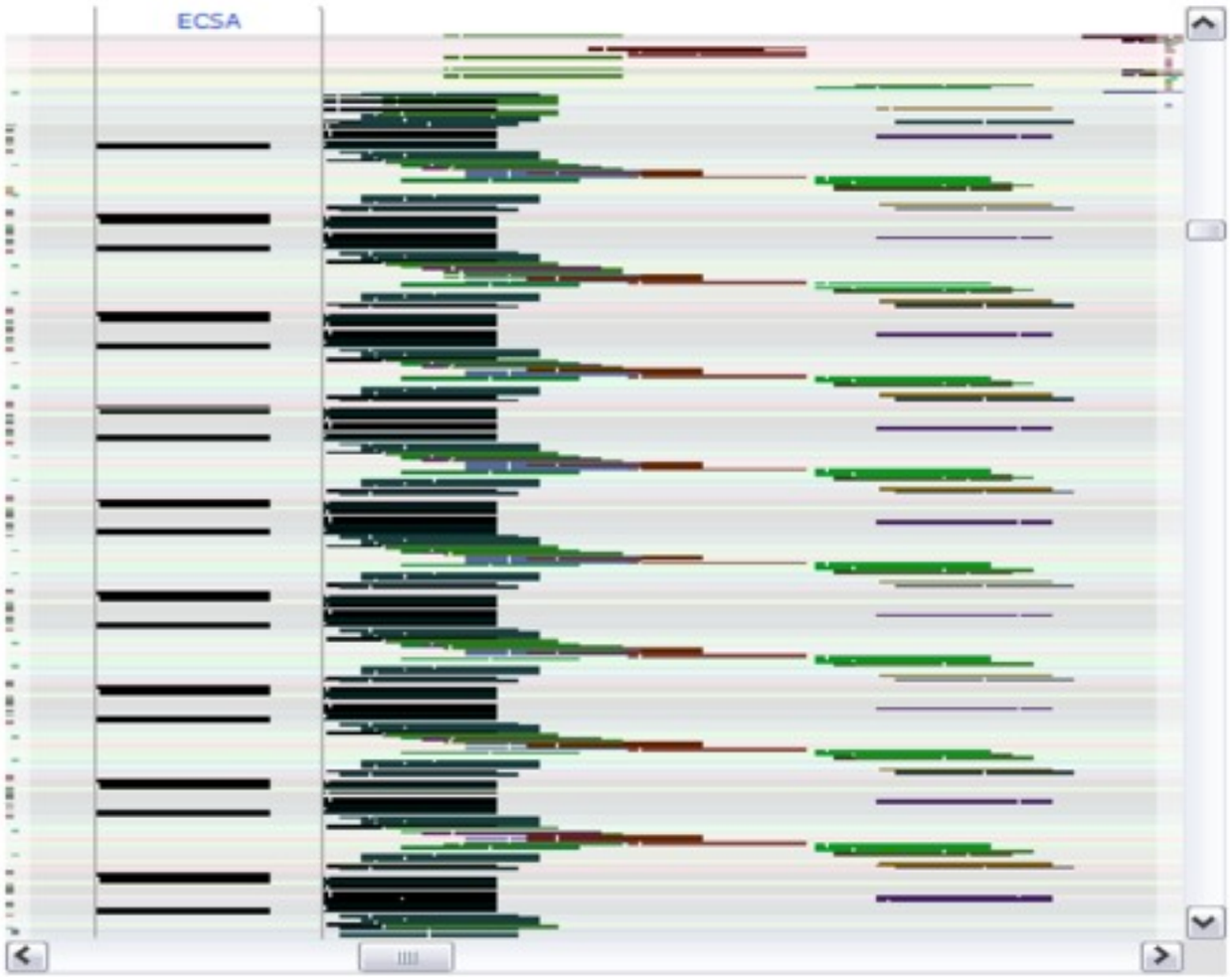
Roadmap

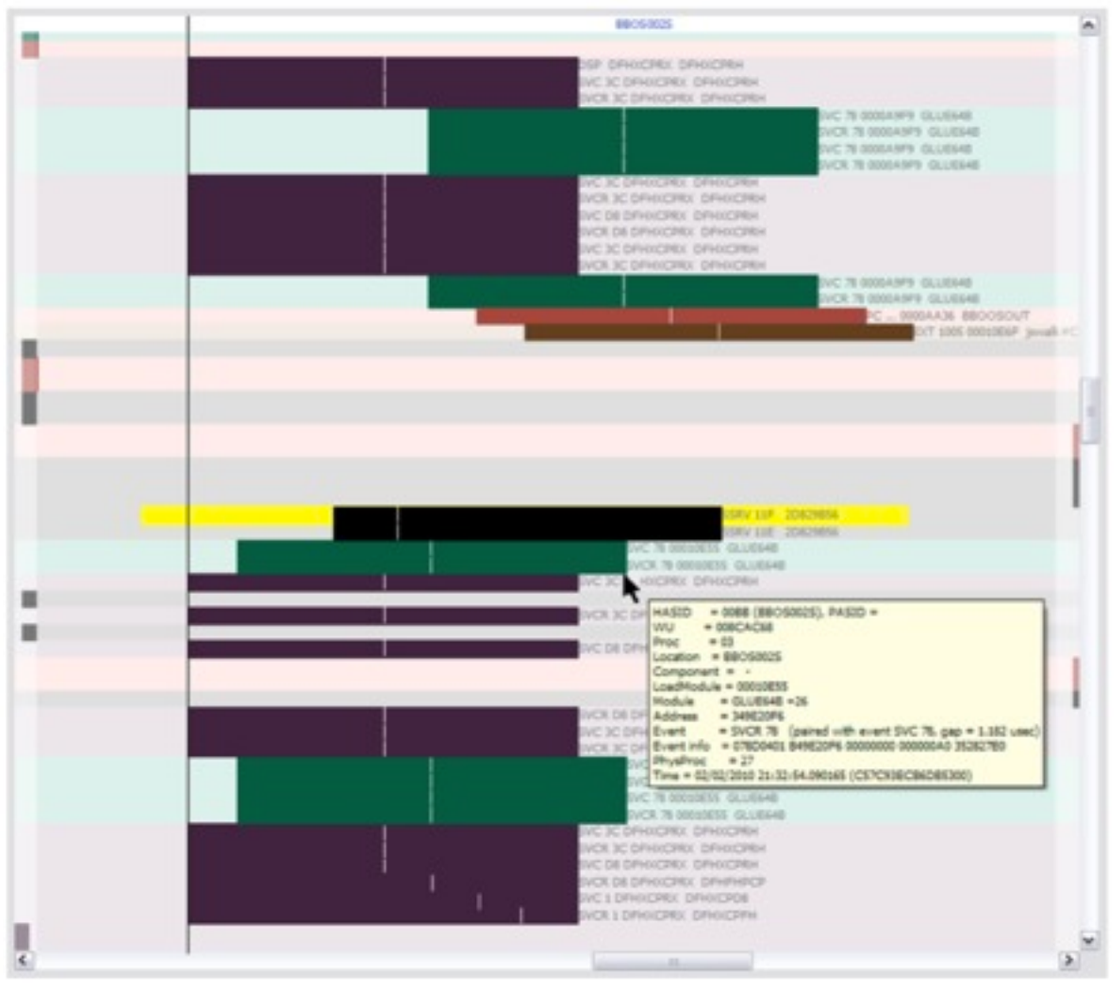
- Information Visualization
- Visualization Design
- **Visualizing Software Systems**
  - Structure
  - Evolution
  - **Behavior**
- Discussion

Zinsight visualization is targeted at analyzing large event traces



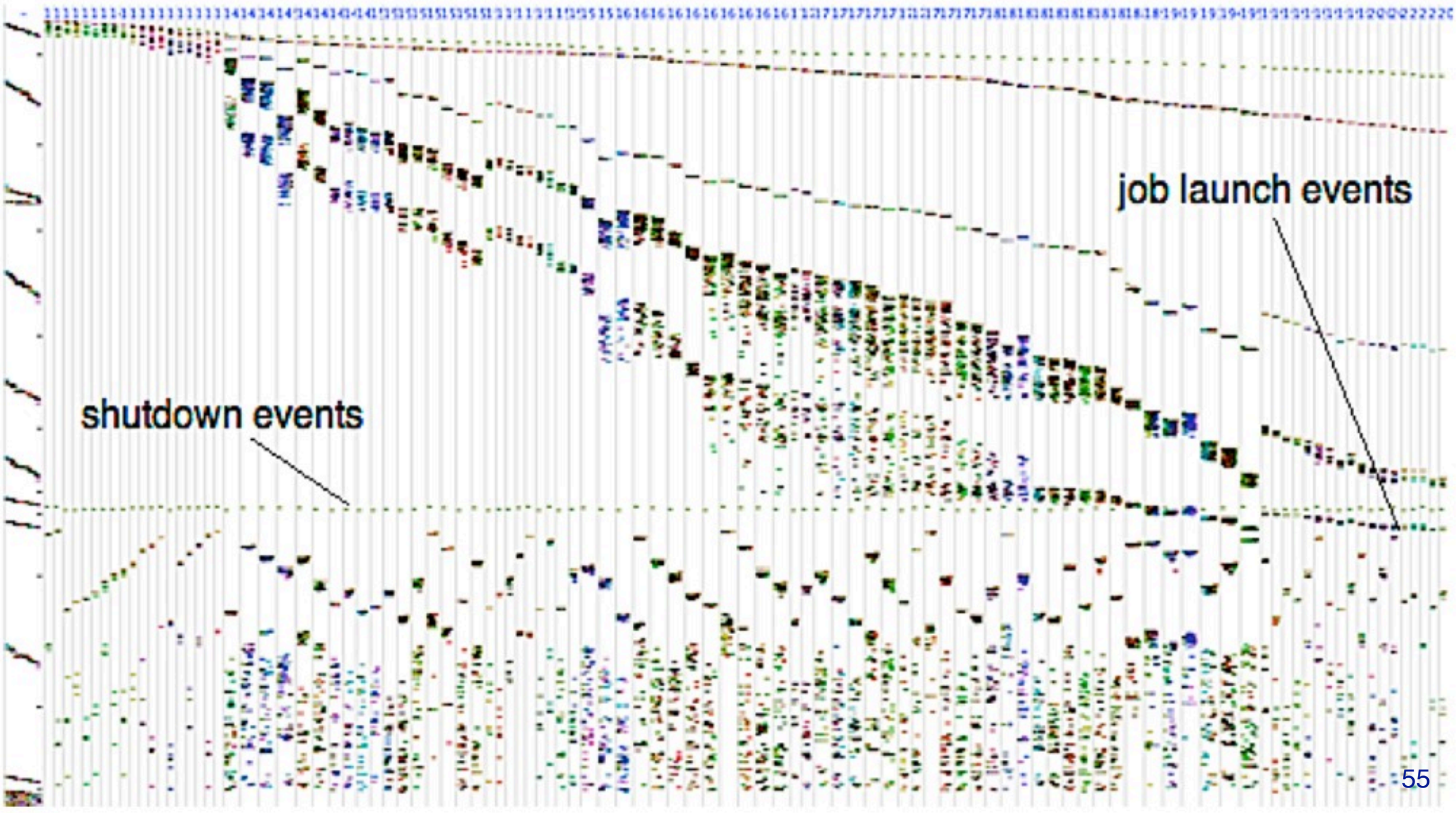
Massively reliant on visual pattern recognition





Semantic Zooming

Visual detection of bugs



Algorithm Animation

- The first software visualization were algorithm animations
- The transilvanian dances
- Animation is usually inferior to static visualization

Roadmap

- Information Visualization
- Visualization Design
- Visualizing Software
  - Structure
  - Evolution
  - Behavior
- **Discussion**

Some successfull visualization techniques will make themselves obsolete.

Besides every successful visualization there is a **tool**.

Besides every successful visualization there is a **use case**.

Further Reading

http://scg.unibe.ch/scgbib?query=sde-visualization

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