Lecture 2: Design Studies

Information Visualization
CPSC 533C, Fall 2007

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News

- questions
  - one question per reading, up to max of 5
  - plain (ASCII) text not Word/PDF/etc
- reserve books
  - in CS reading room (ICICS/CS 2nd floor)
  - www.cs.ubc.ca/local/reading/about
  - 24-hr fob access possible
- proxy server
  - note instructions on web page for accessing IEEE DL material

Papers Covered

Ware, Chapter 1: Foundation for a Science of Data Visualization

Cluster and Calendar based Visualization of Time Series Data.
Jarke J. van Wijk and Edward R. van Selow
Proc. InfoVis 99, pp 4-9
http://www.win.tue.nl/~vanwijk/clv.pdf

Using Multilevel Call Matrices in Large Software Projects.
Frank van Ham
Proc. InfoVis 2003, pp 227-232
http://www.win.tue.nl/~fvham/DL/callmatrix.pdf

Constellation: Linguistic Semantic Networks
Tamara Munzner
Interactive Visualization of Large Graphs and Networks (PhD thesis) Chapter 5, Stanford University, 2000, pp 87-122
http://graphics.stanford.edu/papers/munzner_thesis

Design Study

- describe task
- justify solution
- refine until satisfied

Design Study Definition

Design study papers explore the choices made when applying infovis techniques in an application area, for example relating the visual encodings and interaction techniques to the requirements of the target task. Although a limited amount of application domain background information can be useful to provide a framing context in which to discuss the specifics of the target task, the primary focus of the case study must be the infovis content. Describing new techniques and algorithms developed to solve the target problem will strengthen a design study paper, but the requirements for novelty are less stringent than in a Technique paper.

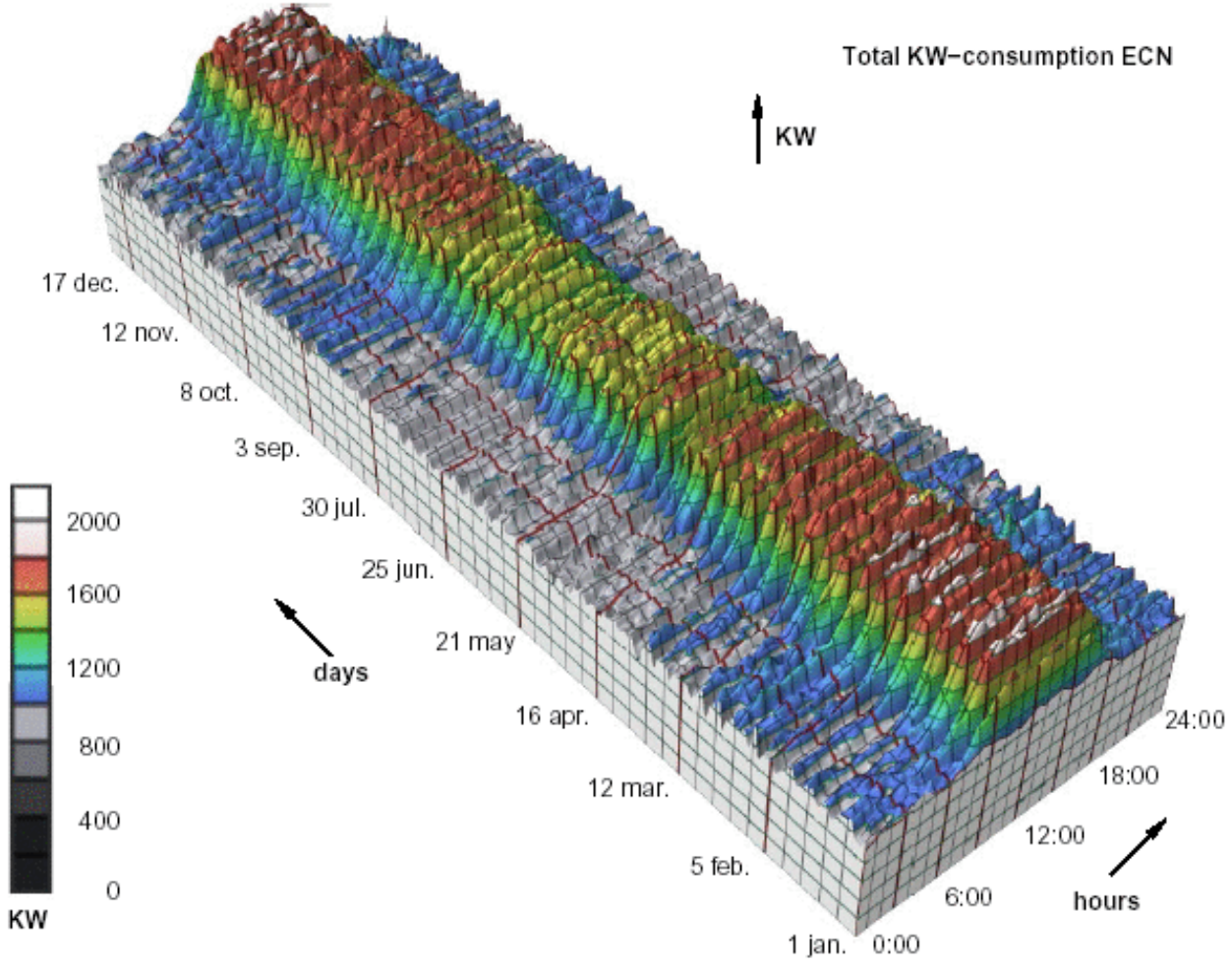
[InfoVis03 CFP, infovis.org/infovis2003/CFP]

Cluster-Calendar, van Wijk

- data: N pairs of (value, time)
  - N large: 50K
- tasks
  - find standard day patterns
  - find how patterns distributed over year, week, season
  - find outliers from standard daily patterns
  - want overview first, then detail on demand
- possibilities
  - predictive mathematical models
    - details lost, multiscale not addressed
  - scale-space approaches (wavelet, fourier, fractal)
    - hard to interpret, known scales lost
  - 3D mountain: x hours, y value, z days
- excellent example, emulate for project writeups!

3D Time-series Data

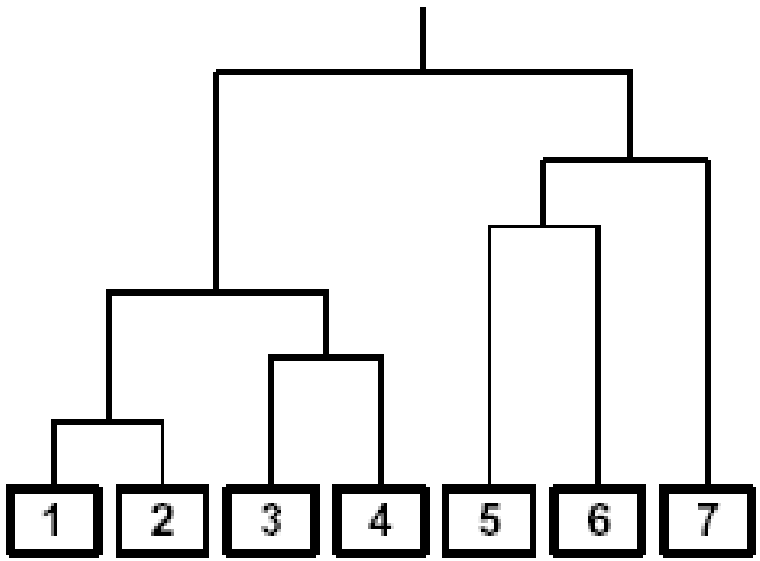
- 3D extrusion pretty but not useful
  - daily, weekly patterns hard to see

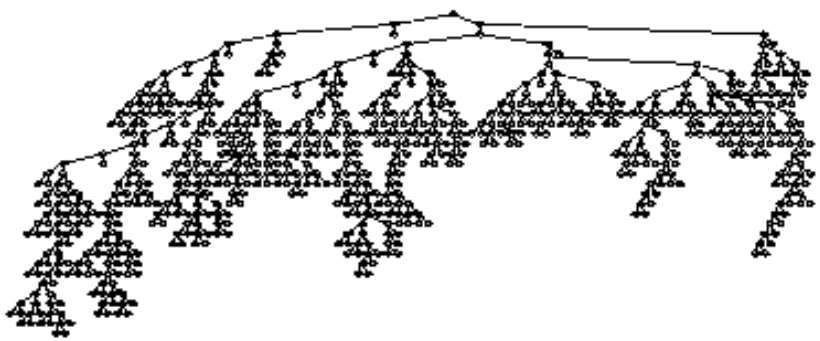


[van Wijk and van Selow, Cluster and Calender based Visualization of Time Series Data, InfoVis99, http://www.win.tue.nl/~vanwijk/clv.pdf]

Hierarchical Clustering

- start with all M day patterns
  - compute mutual differences, merge most similar: M-1
  - continue up to 1 root cluster
- result: binary hierarchy of clusters
- choice of distance metrics
- dendrogram display common
  - but shows structure of hierarchy, not time distribution

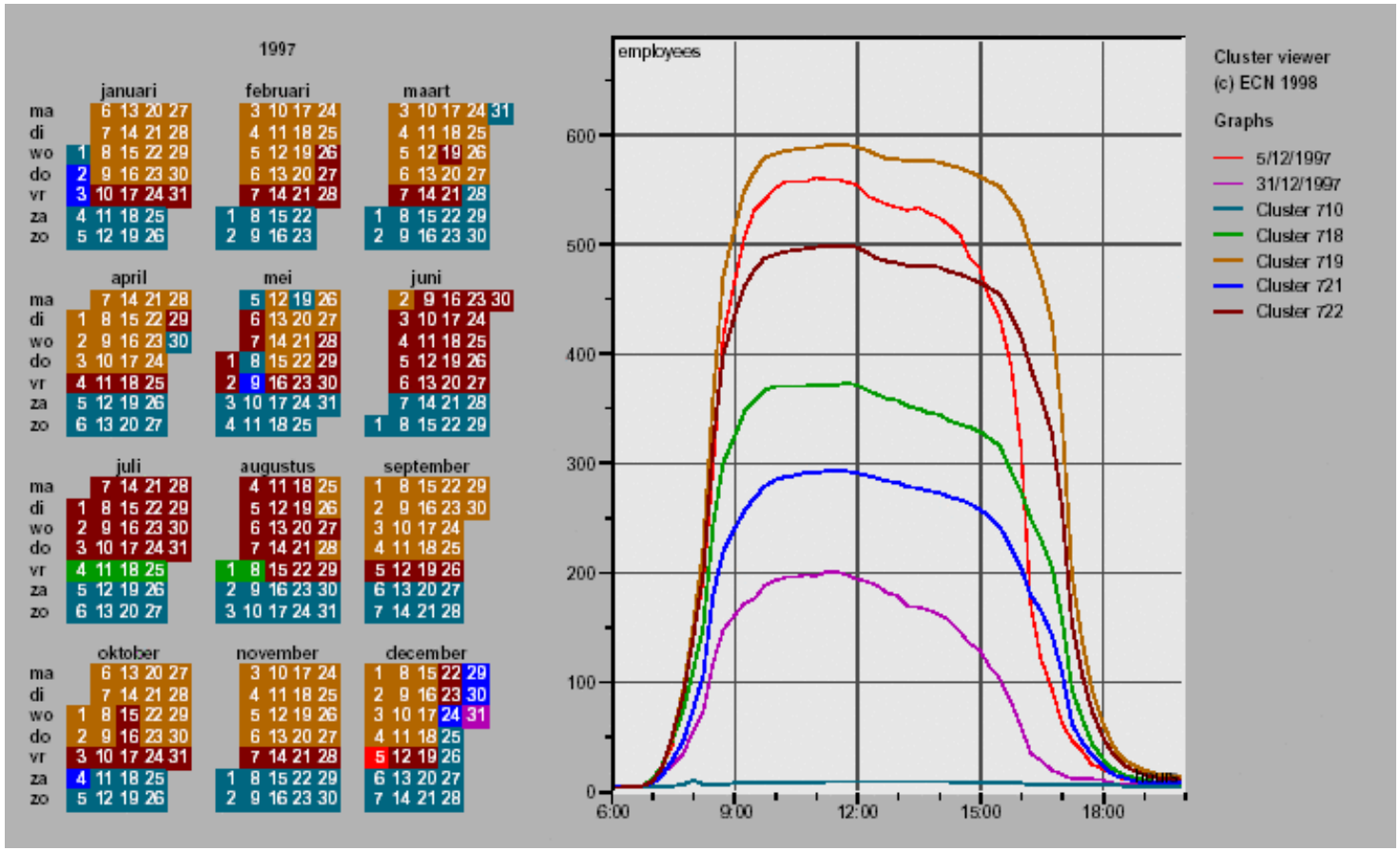




[van Wijk and van Selow, Cluster and Calender based Visualization of Time Series Data, InfoVis99, http://www.win.tue.nl/~vanwijk/clv.pdf]

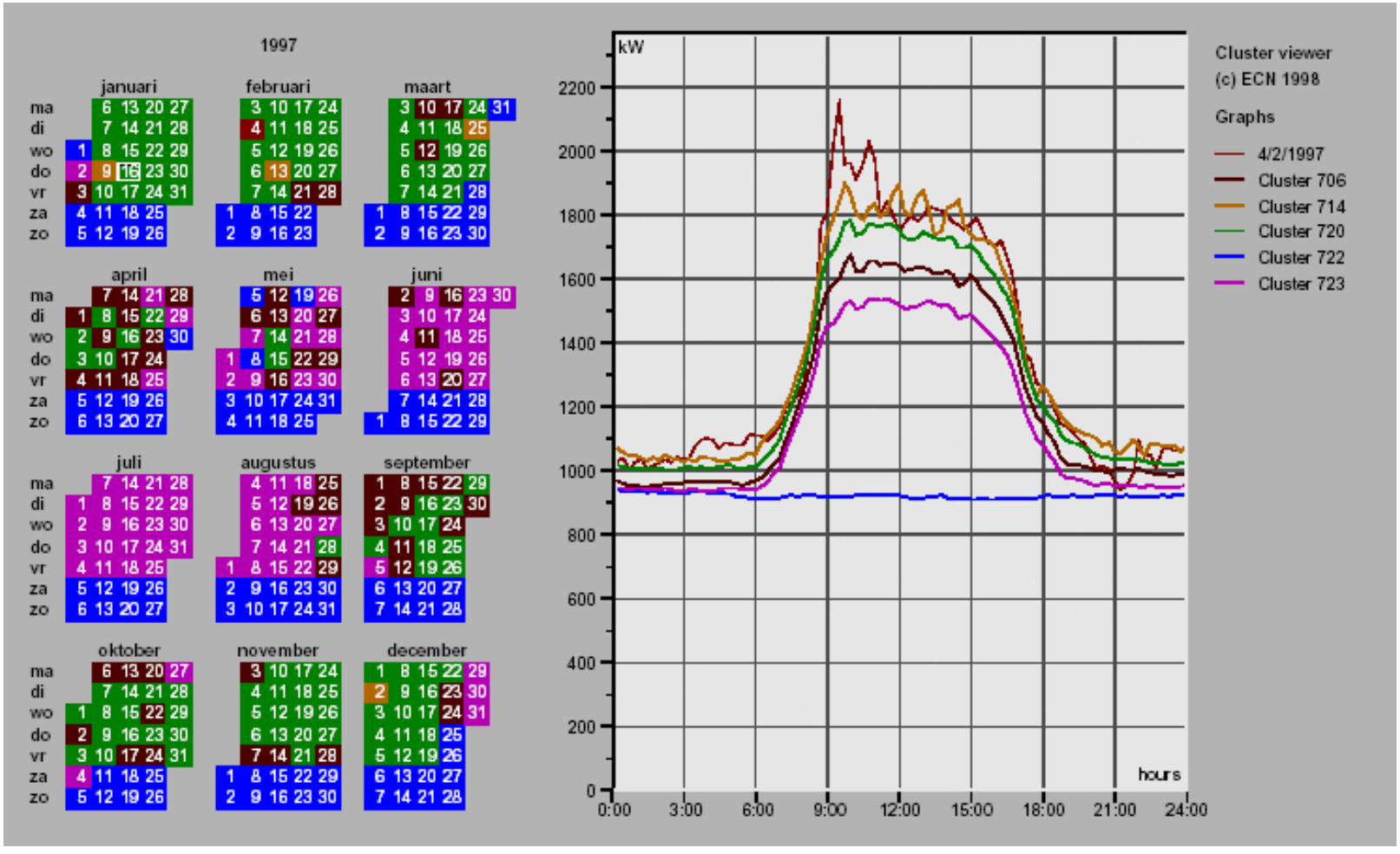
Link Clusters and Calendar

- 2D linked clusters-calendars shows patterns
  - number of employees:
  - office hours, fridays in/and summer, school break
  - weekend/holidays, post-holiday, santa claus



[van Wijk and van Selow, Cluster and Calender based Visualization of Time Series Data, InfoVis99, http://www.win.tue.nl/~vanwijk/clv.pdf]

Power Consumption



[van Wijk and van Selow, Cluster and Calender based Visualization of Time Series Data, InfoVis99, http://www.win.tue.nl/~vanwijk/clv.pdf]

Lessons

- derived space: clusters
- visual representation of time: calendar
  - linked display
  - interactive exploration
- clear task analysis guided choices
  - reject standard 3D extrusion
  - reject standard dendrogram
- critique

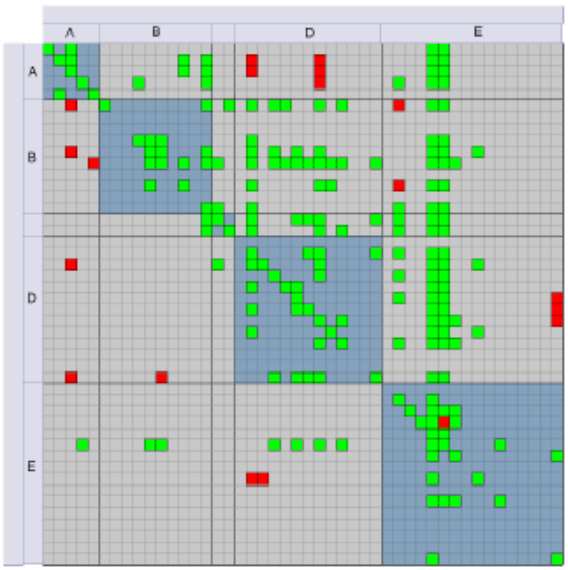
Lessons

- derived space: clusters
- visual representation of time: calendar
  - linked display
  - interactive exploration
- clear task analysis guided choices
  - reject standard 3D extrusion
  - reject standard dendrogram
- critique
  - color choice not so discriminable
  - especially legend

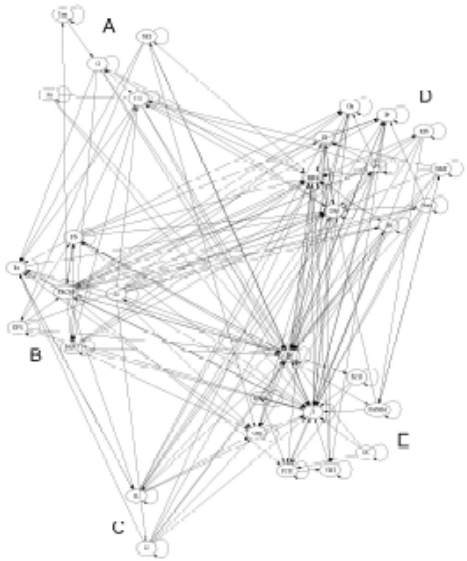
Multilevel Call Matrices, van Ham

- large software project, implementation vs. spec
- link matrix vs. node network

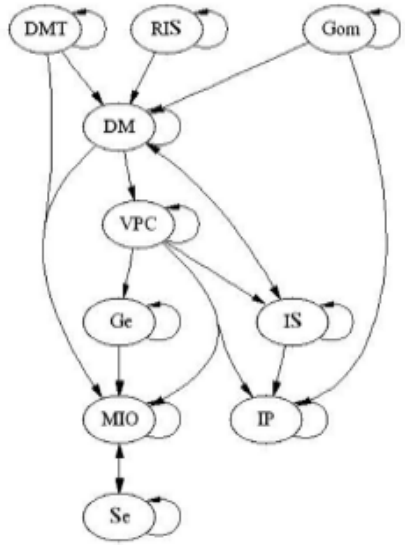
matrix



force-directed



layered subset

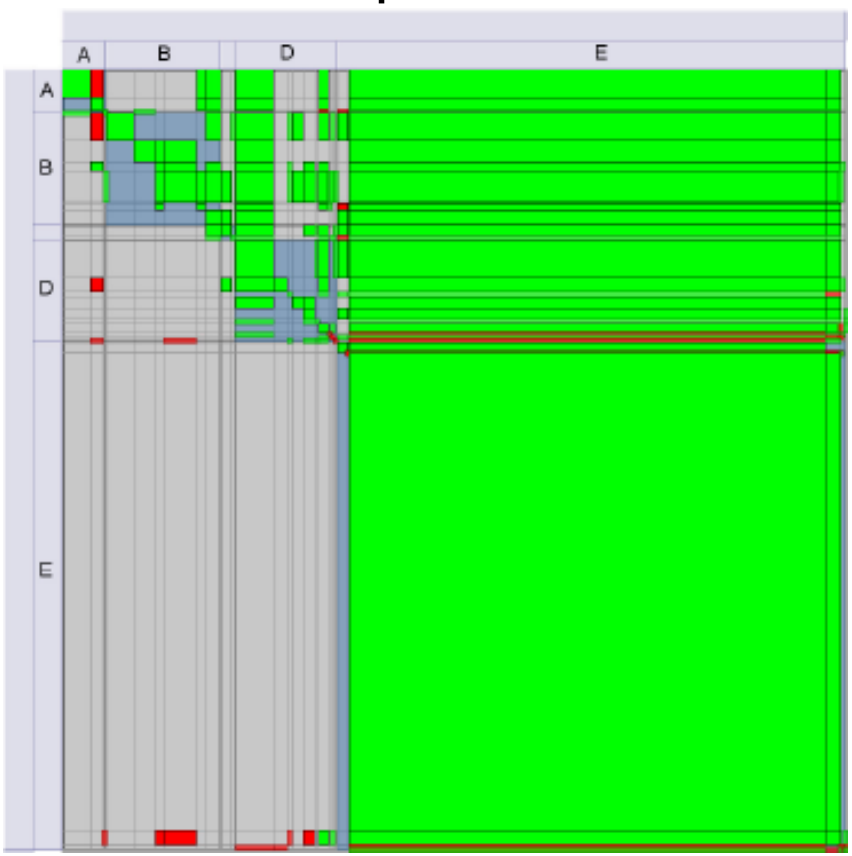


[van Ham, Using Multilevel Call Matrices in Large Software Projects. InfoVis03 http://www.win.tue.nl/~fvham/DL/callmatrix.pdf]

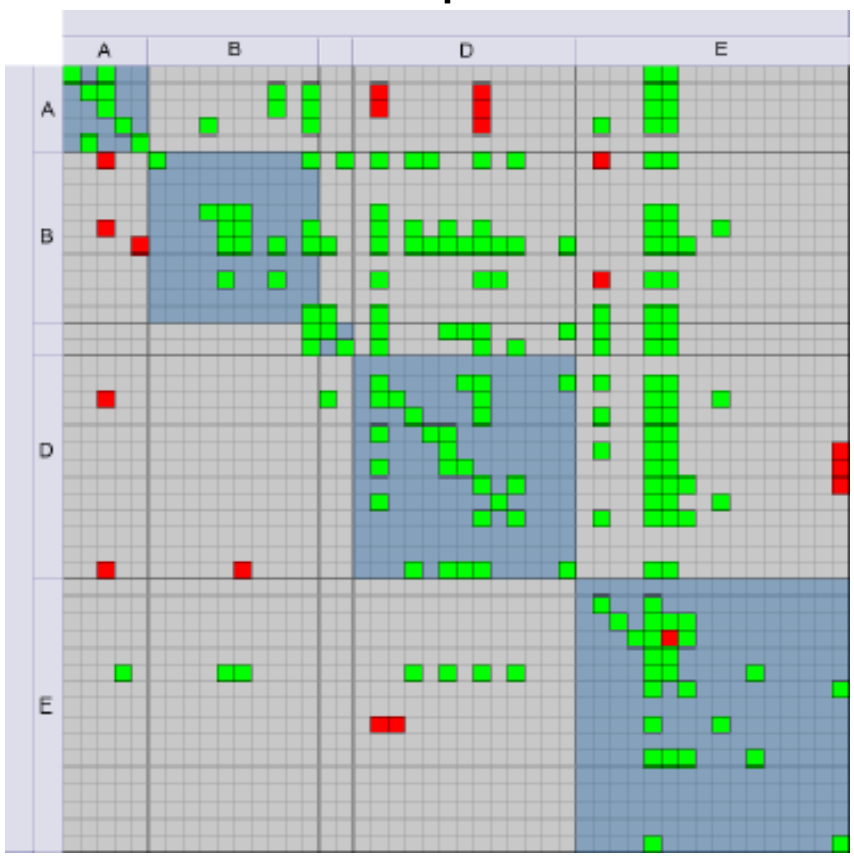
Matrices

- uniform, recursive, stable
- subdivide by

total component count



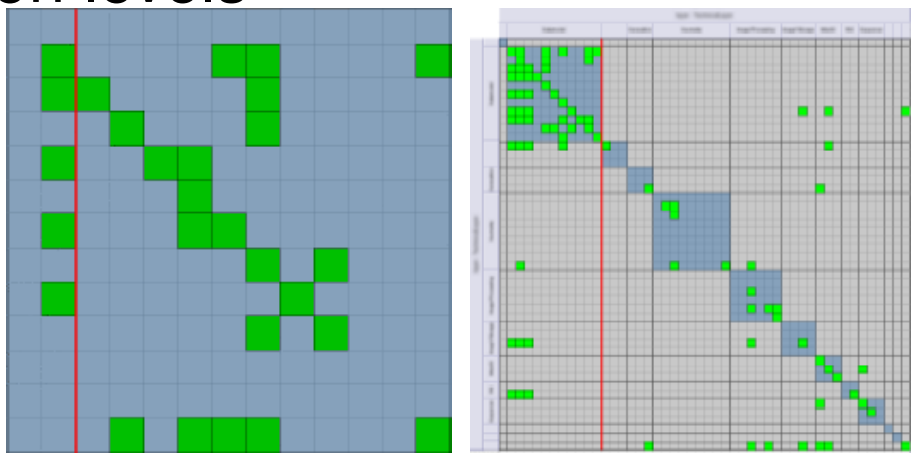
visible subcomponent count



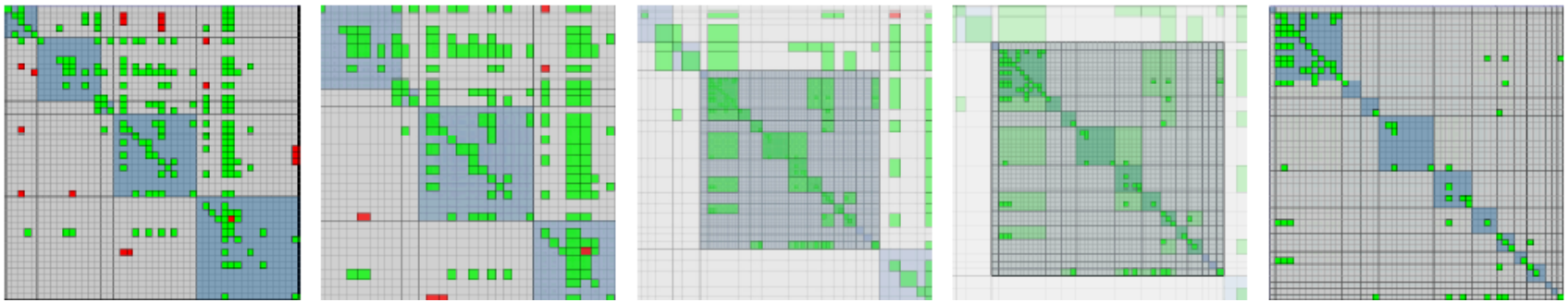
[van Ham, Using Multilevel Call Matrices in Large Software Projects. InfoVis03
http://www.win.tue.nl/~fvham/DL/callmatrix.pdf]

Zooming

- abstraction levels



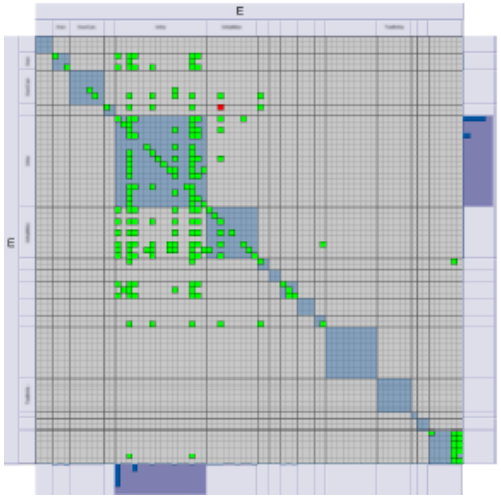
- linear interpolation plus crossfade
- trajectories: will read van Wijk 03 in nav lecture



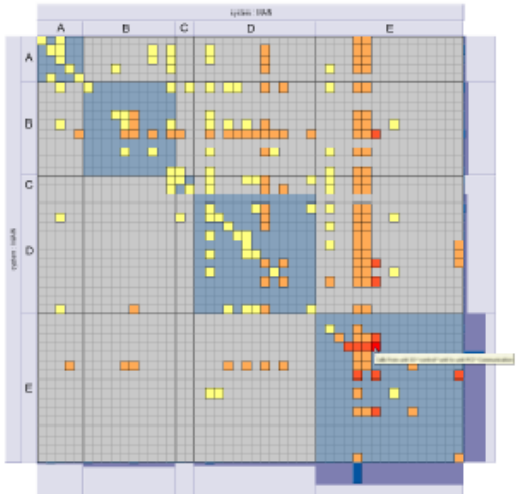
[van Ham, Using Multilevel Call Matrices in Large Software Projects. InfoVis03 http://www.win.tue.nl/~fvham/DL/callmatrix.pdf]

Additional Encoding

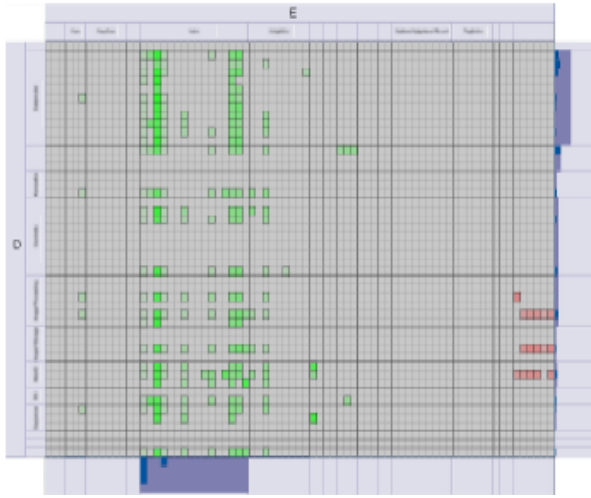
color:
call allowed
by spec



color:
local region
closest red



transparency:
call density



- histograms: size distribution

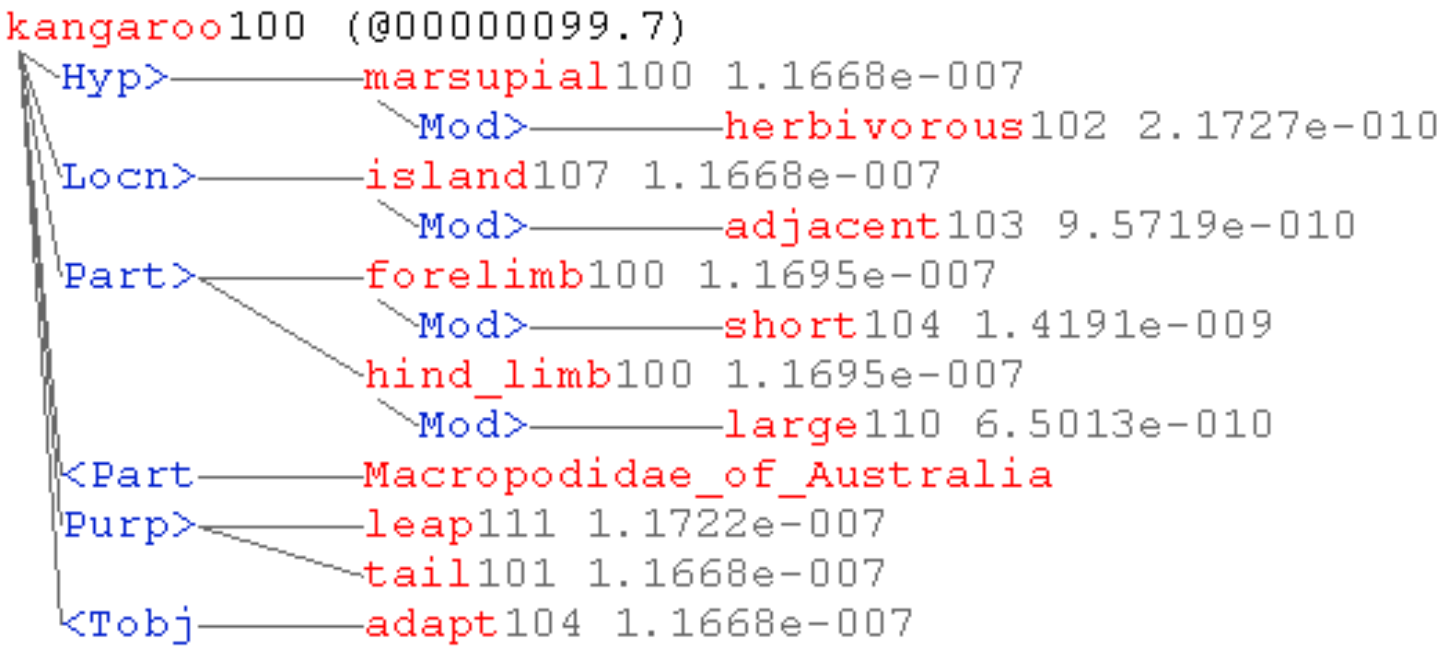
[van Ham, Using Multilevel Call Matrices in Large Software Projects. InfoVis03
http://www.win.tue.nl/~fvham/DL/callmatrix.pdf]

Critique

- tasks succesfully supported
  - visual categorization
    - i.e. libraries with mostly incoming calls
  - previous summary shown to be incomplete
  - spotting unwanted calls
  - determining component dependencies
- limitations
  - ordering unsolved
  - strict layering, not true in many apps

Linguistic Networks, Munzner

- data: MindNet query results
- definition graph
  - dictionary entry sentence
  - nodes: word senses
  - links: relation types



[Munzner, Interactive Visualization of Large Graphs and Networks (PhD thesis), Stanford University, 2000, http://graphics.stanford.edu/papers/munzner_thesis]

Semantic Network

- definition graphs used as building blocks
- unify shared words
- large network
  - millions of nodes
  - grammar checking now, translation future
  - global structure known: dense
- probes return local info

Path Query

- best N paths between two words
- words on path itself

```
kangaroo100—Part→forelimb100—Mod→short104—Join→short←Mod—tail100
```

- definition graphs used in computation

```
kangaroo100  (vole101 tapir100 s
sharp-tailed_grouse100 scut100 r
pitta100 partridge104 lynx100 lo
kingfisher100 horned_toad100 haw
bobtail101 bobtail100 bobcat100
Scottish_terrier100)
```

Task: Plausibility Checking

- paths ordered by computed plausibility
- researcher hand-checks results
  - high-ranking paths believable?
  - believable paths high-ranked?
  - are stop words all filtered out?

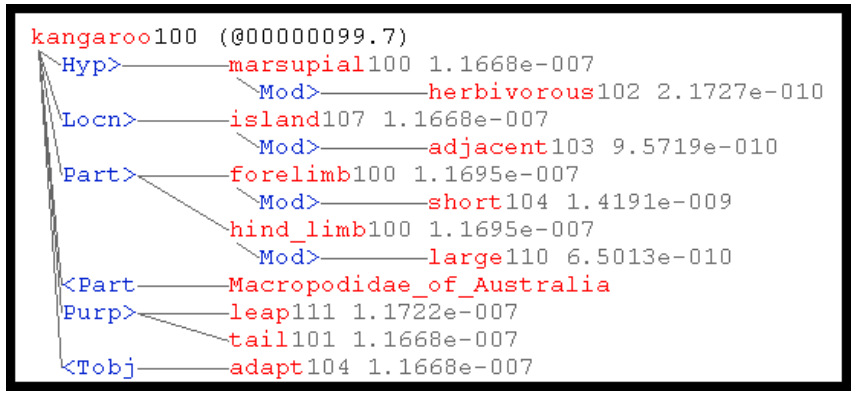
Top 10 Paths Kangaroo→ Tail

Natural Language Processor [Ansi, Debug, BigSys]

File Analyze... Command... Display Choose Explain Tools Options Window Help

Graph - Path - "kangaroo" "tail"

```
Number of paths: 10


Similarity score: 0.00068368 ( < 0.0015 - the words are not similar)

1       1.1668e-007  kangaroo100—Purp→tail101  kangaroo100

2       6.4417e-014  kangaroo100—Hyp→marsupial100←Hyp—Tasmanian_devil100—Part→tail101  kangaroo100  Tasmanian_devil100

3       4.9545e-014  kangaroo103—Hyp→animal109—Part→tail101  kangaroo103  (taper103 tail127 tail111
                                                             tag114 switch115 dock111 chipmunk102)

4       4.2954e-014  kangaroo100—Hyp→marsupial100←Hyp—cuscus100—Part→tail101  kangaroo100  cuscus100

5       1.2972e-014  kangaroo100—Part→forelimb100—Mod→short104—Join→short←Mod—tail100  kangaroo100  (vole101 tapir100 s
                                                                                        sharp-tailed_grouse100 scut100 r
                                                                                        pitta100 partridge104 lynx100 lo
                                                                                        kingfisher100 horned_toad100 haw
                                                                                        bobtail101 bobtail100 bobcat100
                                                                                        Scottish_terrier100)

6       5.6234e-015  kangaroo103←Hyp—wallaroo100—Part→fur112—Join→fur113—Mod→tail132  wallaroo100  (phalanger100 ermine

7       2.4774e-015  kangaroo103←Hyp—joey100—Hyp→animal109—Part→tail101  joey100  (taper103 tail127 tail111
                                                                         tag114 switch115 dock111 chipmunk102)

8       1.5560e-015  kangaroo103←Hyp—wallaroo100—Part→fur112—Join→fur113←Part—tail101  wallaroo100  Old_English_sheepdo

9       1.5488e-015  kangaroo103←Hyp—wallaroo100—Part→fur112—Join→fur113—Part→tail100  wallaroo100  wolverine100

10      1.1220e-015  kangaroo103←Hyp—wallaby100←Hyp—rock_wallaby100←Tsub—sole110—Tobj→tail101  wallaby100  rock_wallaby
```



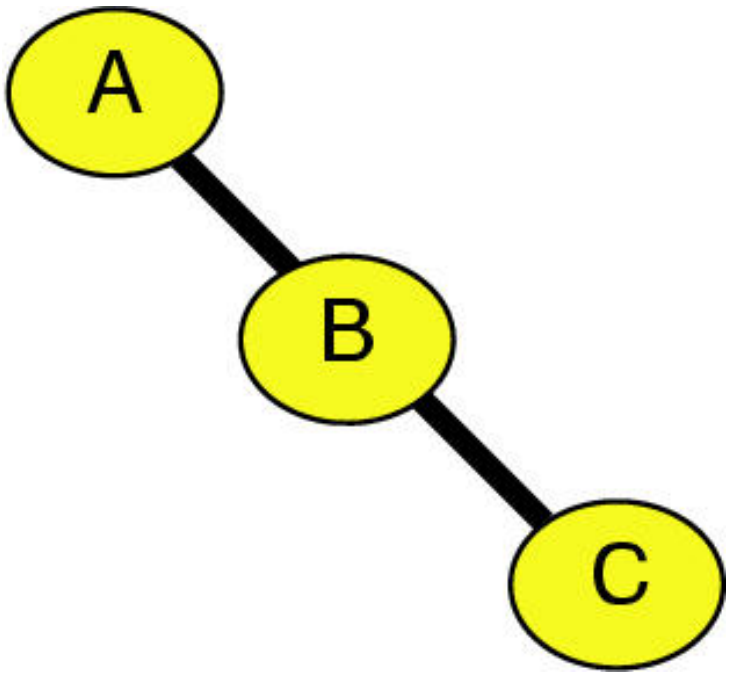
Goal

- create a unified view of relationships between paths and definition graphs
  - shared words are key
  - thousands of words (not millions)
- special purpose algorithm debugging tools
  - not understand structure of English

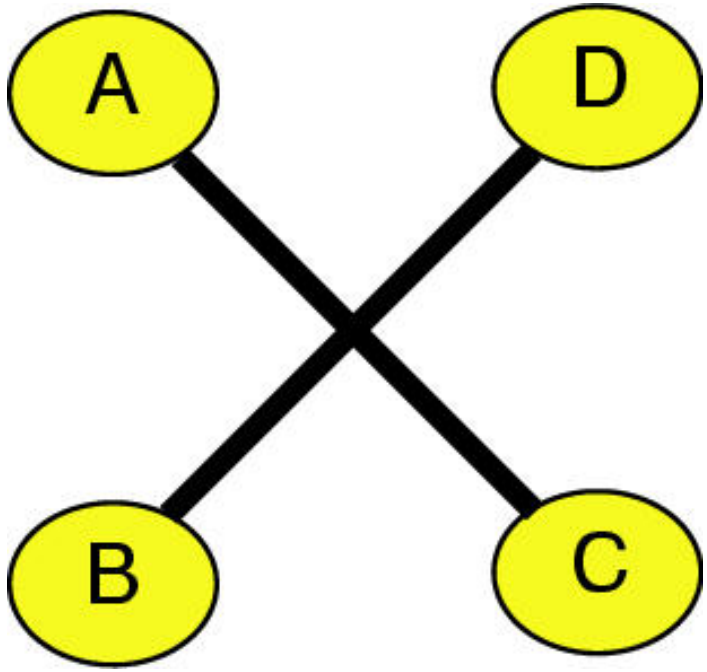
Constellation Video

Traditional Layout

- avoid crossings
- reason: avoid false attachments



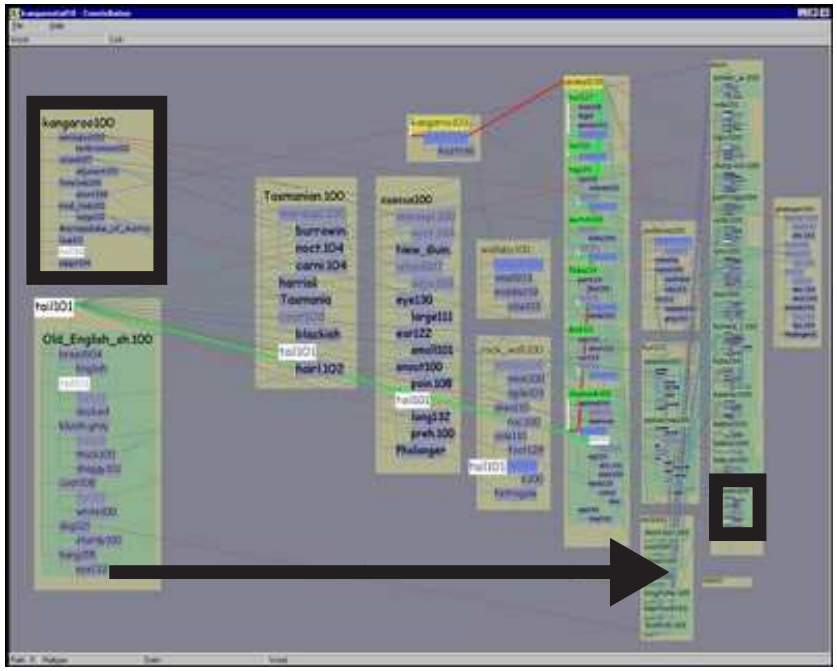
ambiguity



artifact salience

Information Visualization Approach

- spatial position is strongest perceptual cue
  - encode domain specific attribute
  - plausibility gradient

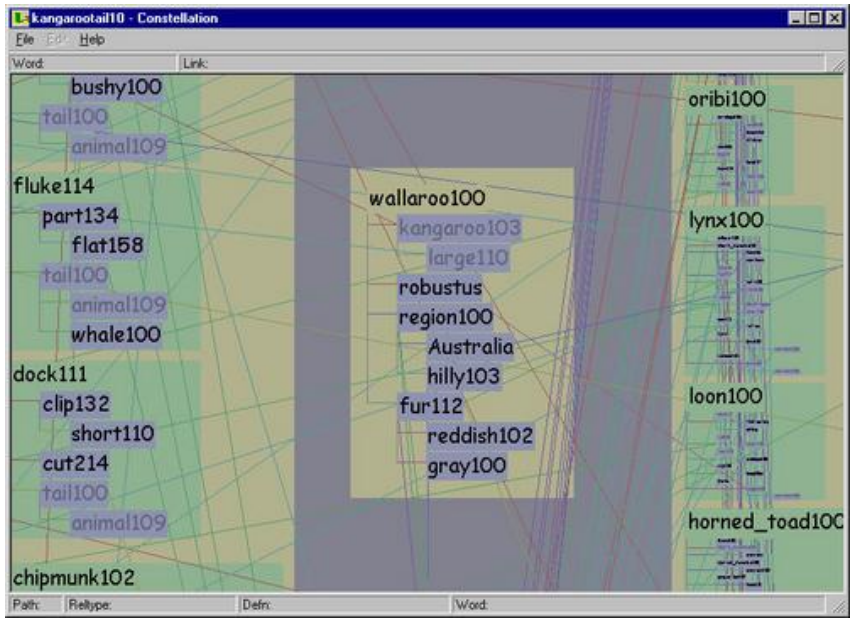


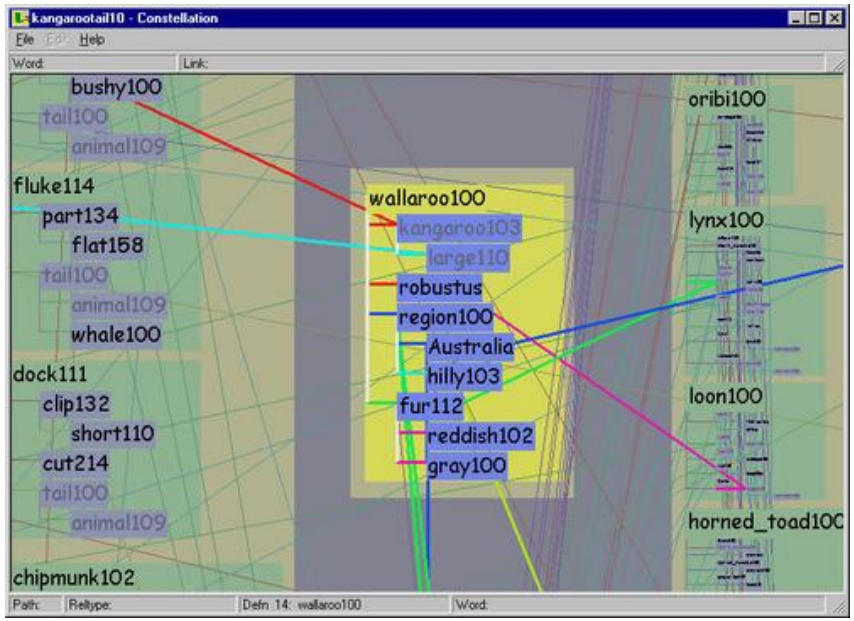
Constellation Semantic Layout

- novel layout algorithm
  - paths as backbone, definition graphs attached
  - curvilinear grid
  - iterative design for maximum semantics with reasonable information density
- allow crossings for long-distance proxy links

Selective Emphasis

- highlight sets of boxes and edges
  - interaction
  - additional perceptual channels
- avoid perception of false attachments

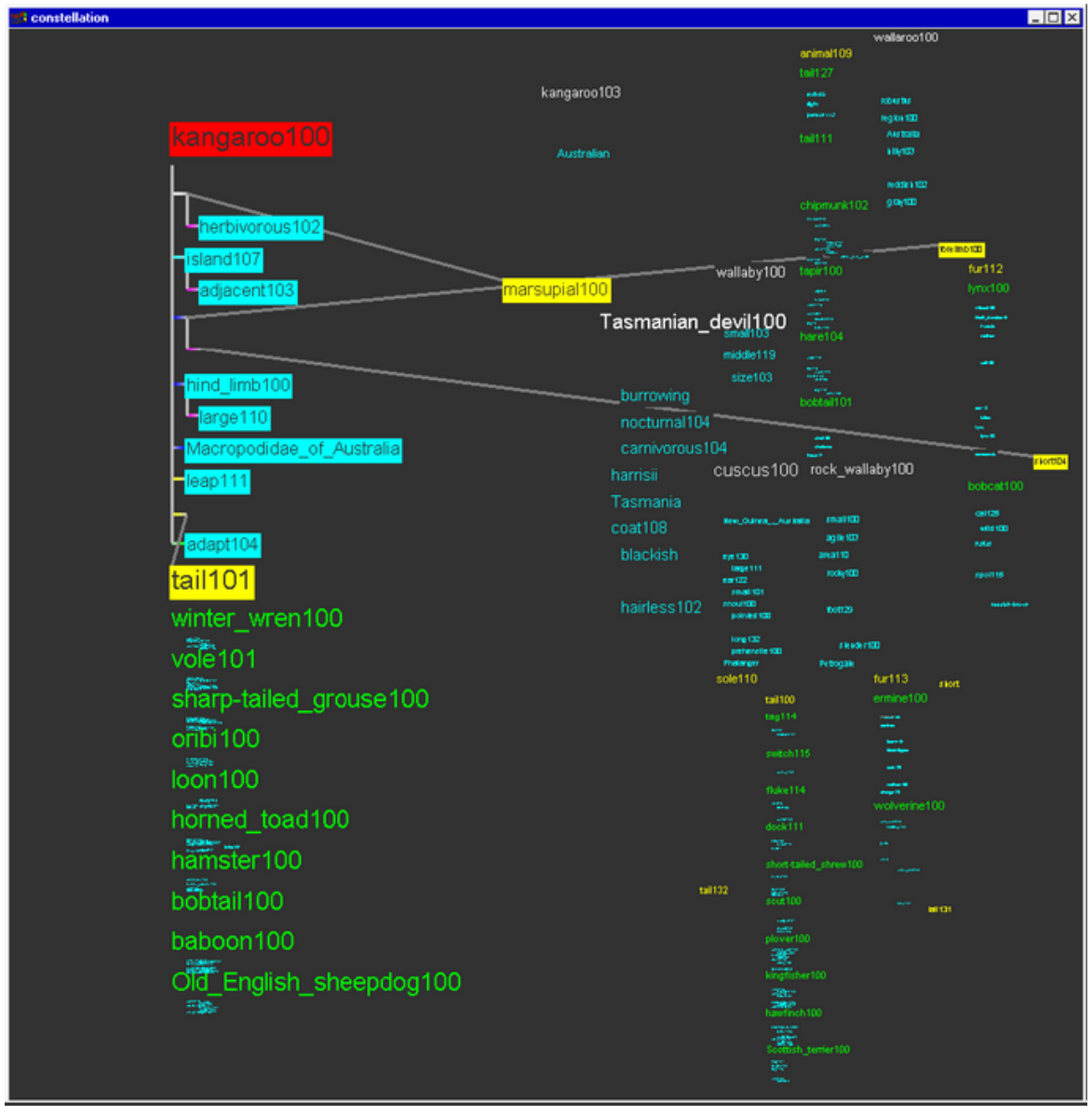




Hidden State

- avoid hidden state
  - change salience instead of toggle drawing
- why? closed world assumption
  - implicit assumption: if not visible, doesn't exist
  - easy to forget previous actions
    - draw false negative conclusions

Single vs. Multiple Word Instances

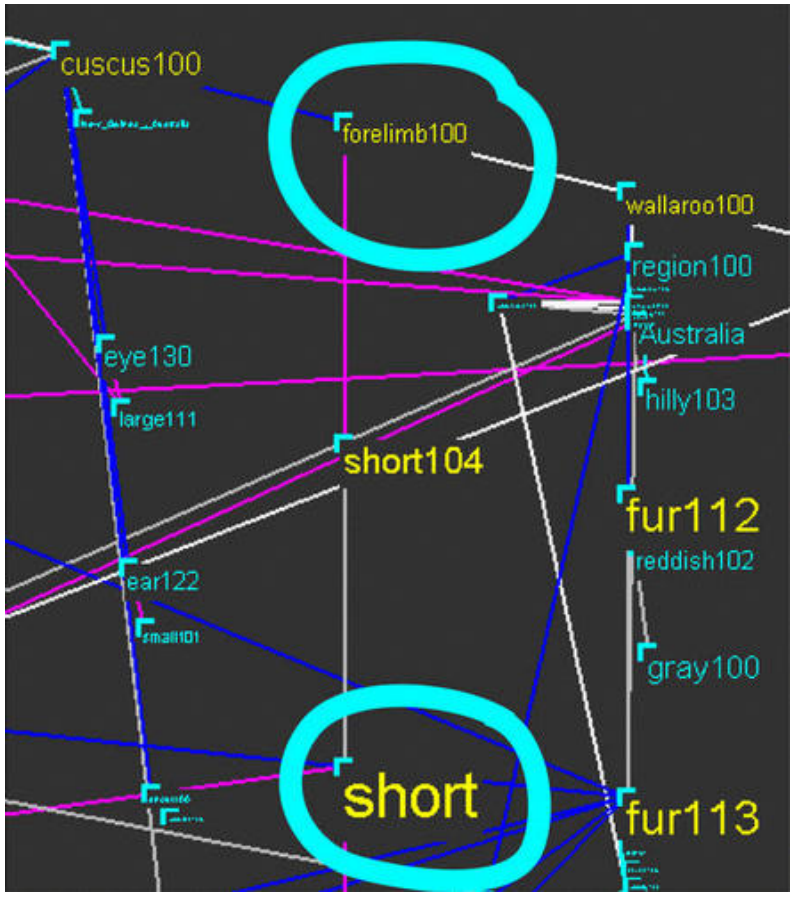


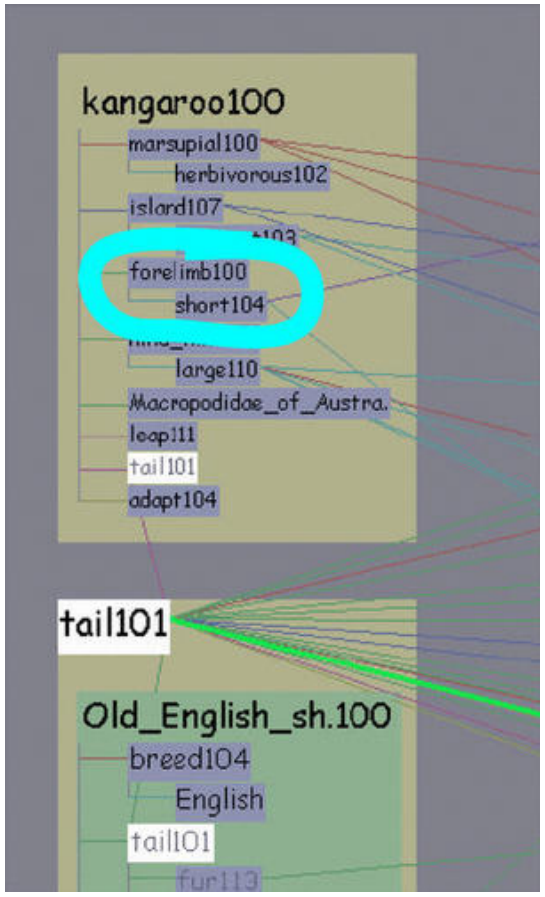
Information Density

- early prototype: poor

Information Density

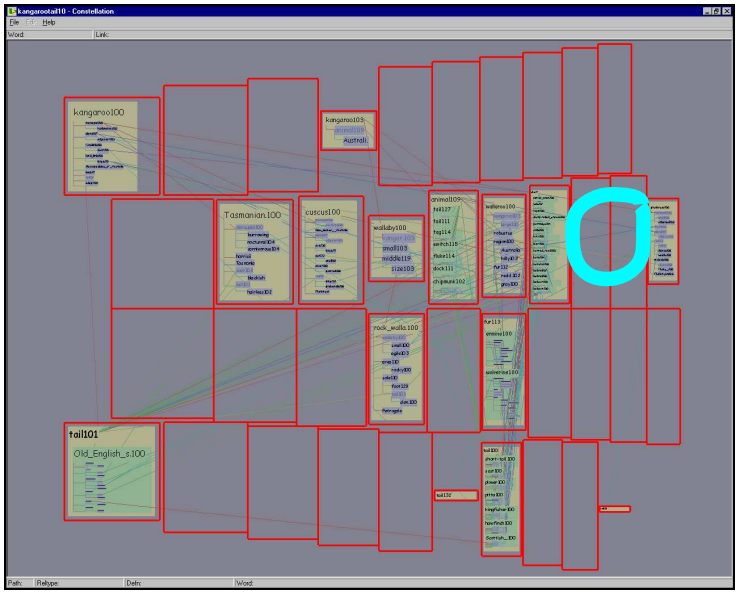
- design tradeoff with visual salience

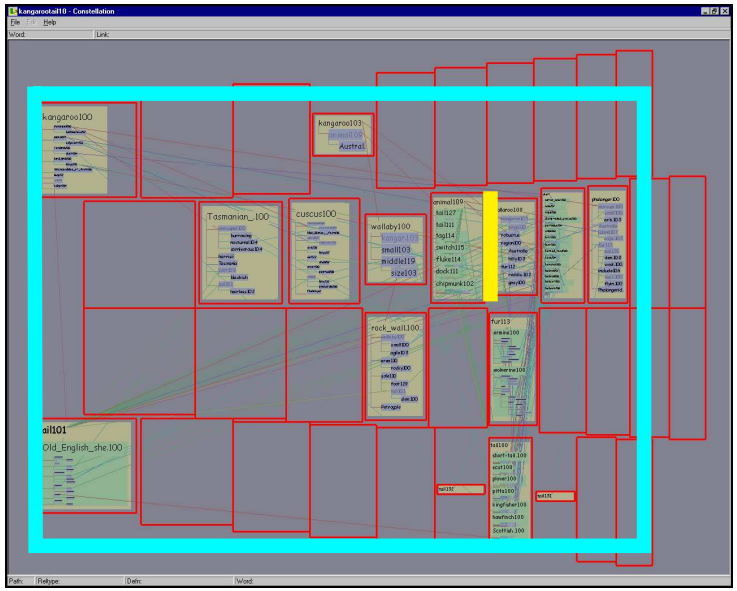


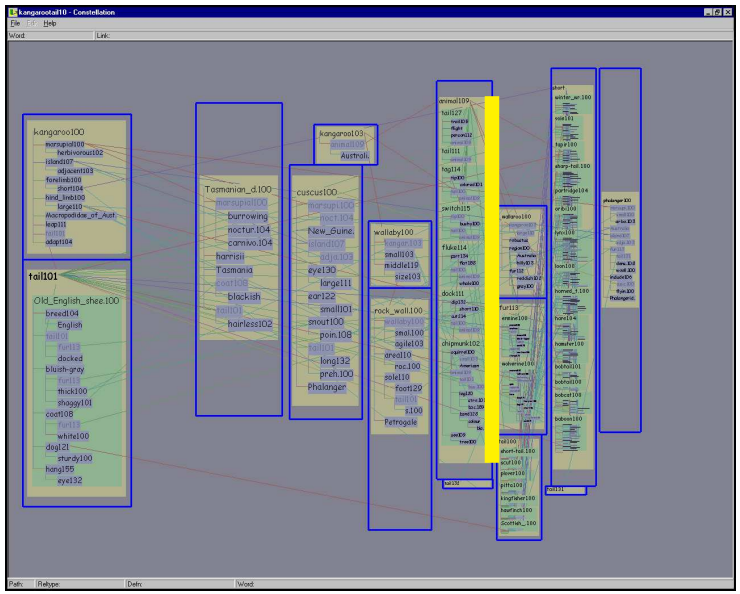


Information Density

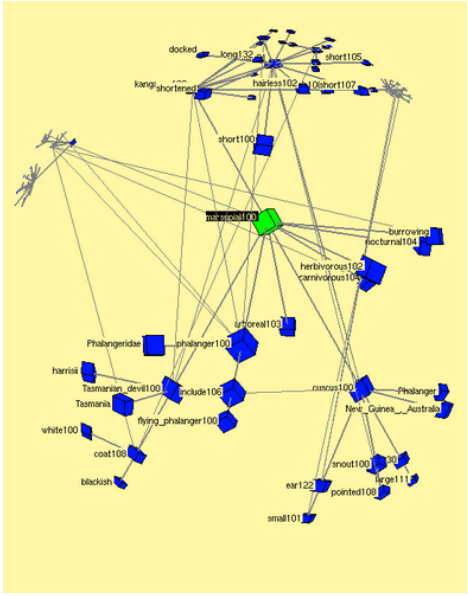
- grid adjustment

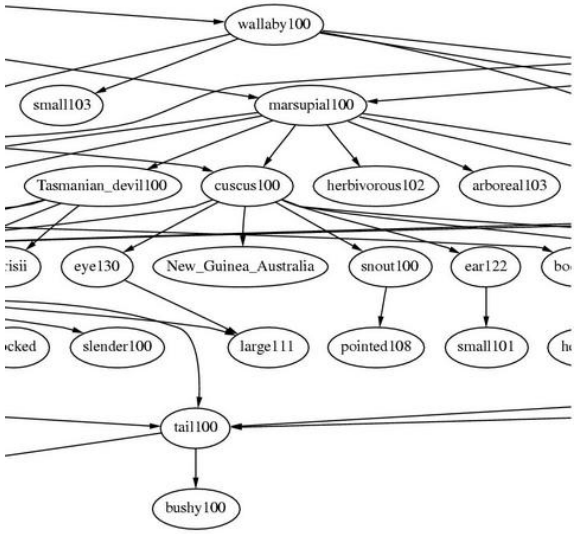




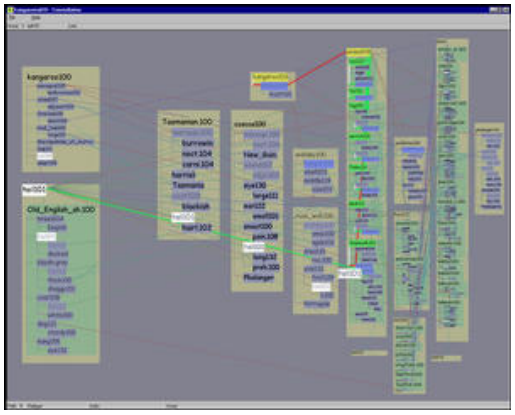


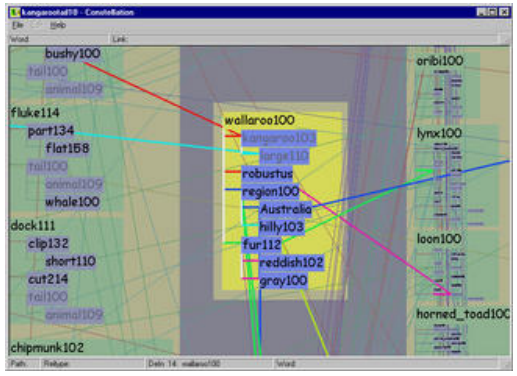
Task-Oriented Design





- task-specific methods





Readings For Next Time

A Review and Taxonomy of Distortion-Oriented Presentation Techniques. Y.K. Leung and M.D. Apperley, ACM Transactions on Computer-Human Interaction, Vol. 1, No. 2, June 1994, pp. 126-160. [http://www.ai.mit.edu/people/jimmylin/papers/Leung94.pdf]

A Fisheye Follow-up: Further Reflection on Focus + Context. George W. Furnas. SIGCHI 2006.

The Hyperbolic Browser: A Focus + Context Technique for Visualizing Large Hierarchies. John Lamping and Ramana Rao, Proc SIGCHI '95. [http://citeseer.nj.nec.com/lamping95focuscontext.html]

TreeJuxtaposer: Scalable Tree Comparison using Focus+Context with Guaranteed Visibility. Munzner, Guimbretiere, Tasiran, Zhang, and Zhou. SIGGRAPH 2003. [http://www.cs.ubc.ca/~tmm/papers/tj/]

SpaceTree: Supporting Exploration in Large Node Link Tree, Design Evolution and Empirical Evaluation. Catherine Plaisant, Jesse Grosjean, and Ben B. Bederson. Proc. InfoVis 2002. ftp://ftp.cs.umd.edu/pub/hcil/Reports-Abstracts-Bibliography/2002-05html/2002-05.pdf