Design Studies

Lecture 3 CPSC 533C, Fall 2004

Mon Sep 20 2004

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Papers Covered

Cluster and Calendar based Visualization of Time Series Data.
Jarke J. van Wijk and Edward R. van Selow, pp 4–9
Proc. InfoVis 99.

Using Multilevel Call Matrices in Large Software Projects.
Frank van Ham,
Proc. InfoVis 2003, pp 227–232

Constellation: Linguistic Semantic Networks
Tamara Munzner,
Interactive Visualization of Large Graphs and Networks (PhD thesis) Chapter 5, Stanford University, 2000, pp 87–122

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]

Time-series Data Analysis

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

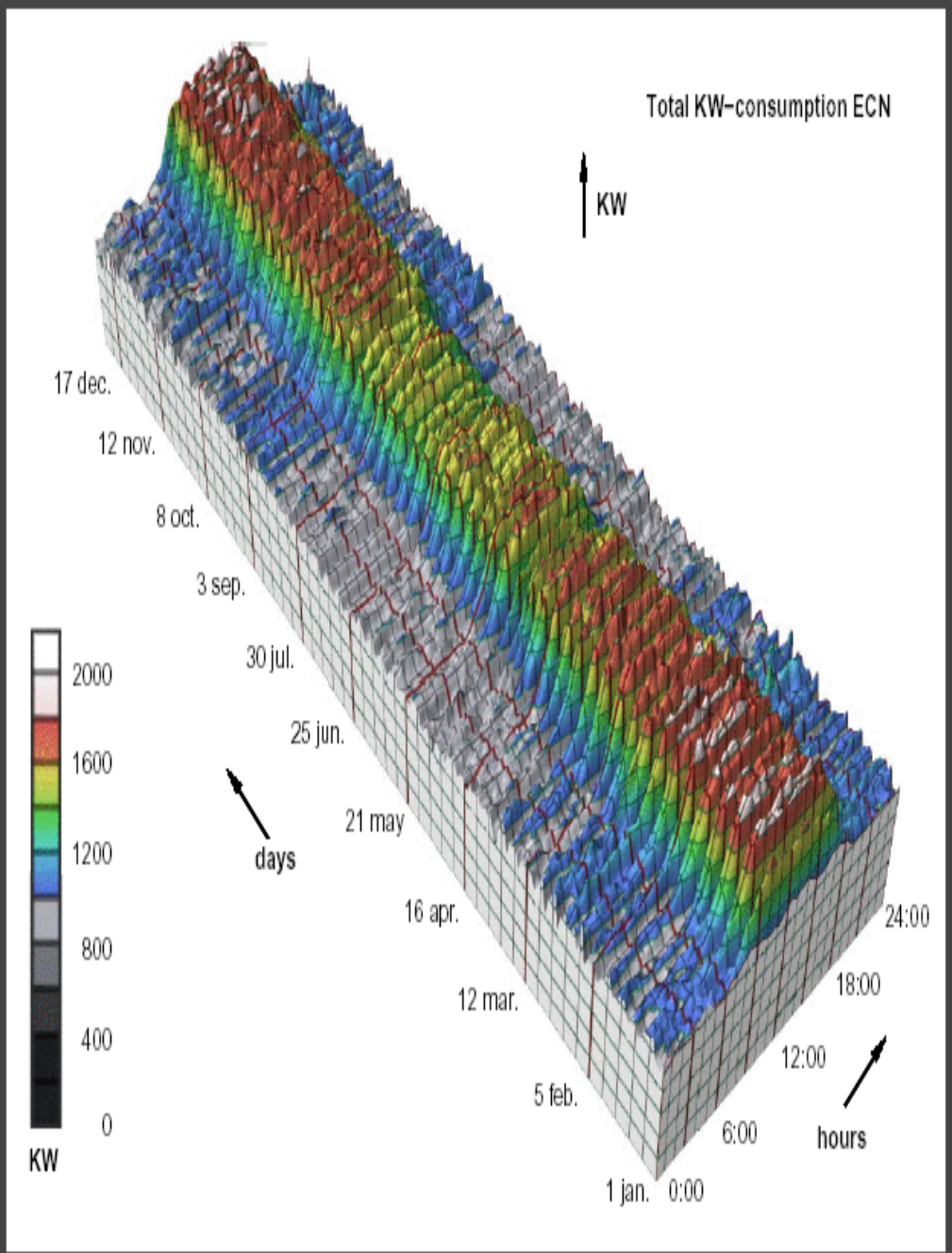
- predictive mathematical models
  - details lost, multiscale not addressed
- scale-space approaches (wavelet, fourier, fractal)
  - hard to interpret, known scales lost
- 3D mountain: x hours, y value, z days

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, citeseer.nj.nec.com/vanwijk99cluster.html]

Hierarchical Clustering

start with all M day patterns

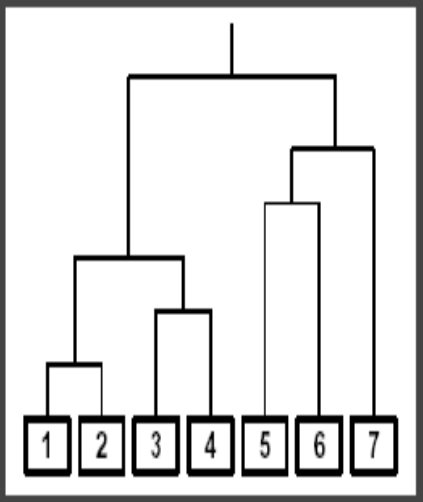
- compute mutual differences, merge most similar: M–1
- continue up to 1 root cluster

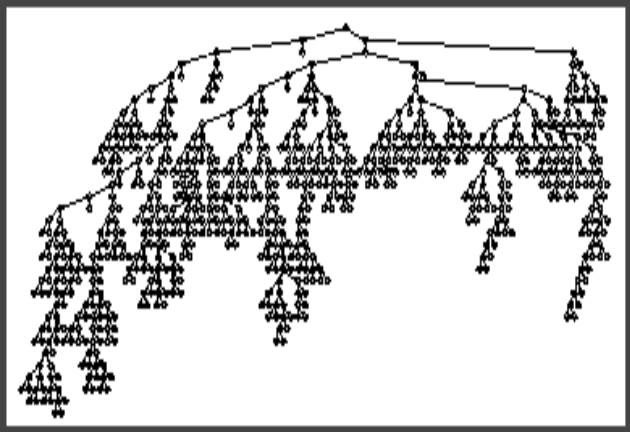
result: binary hierarchy of clusters

choice of distance metrics

dendrogram display common

- but shows structure of hierarchy, not time distribution

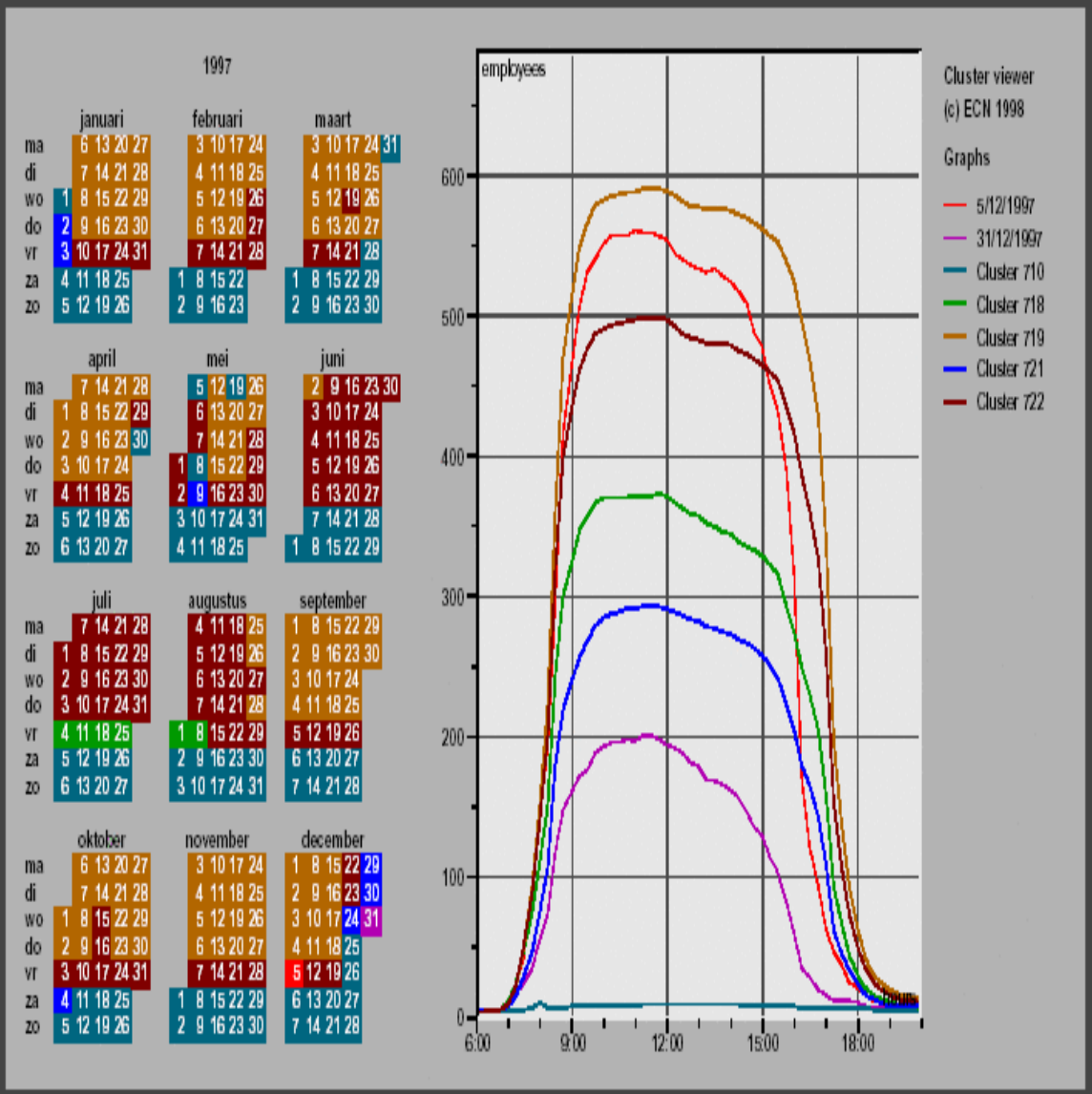




Link Clusters and Calendar

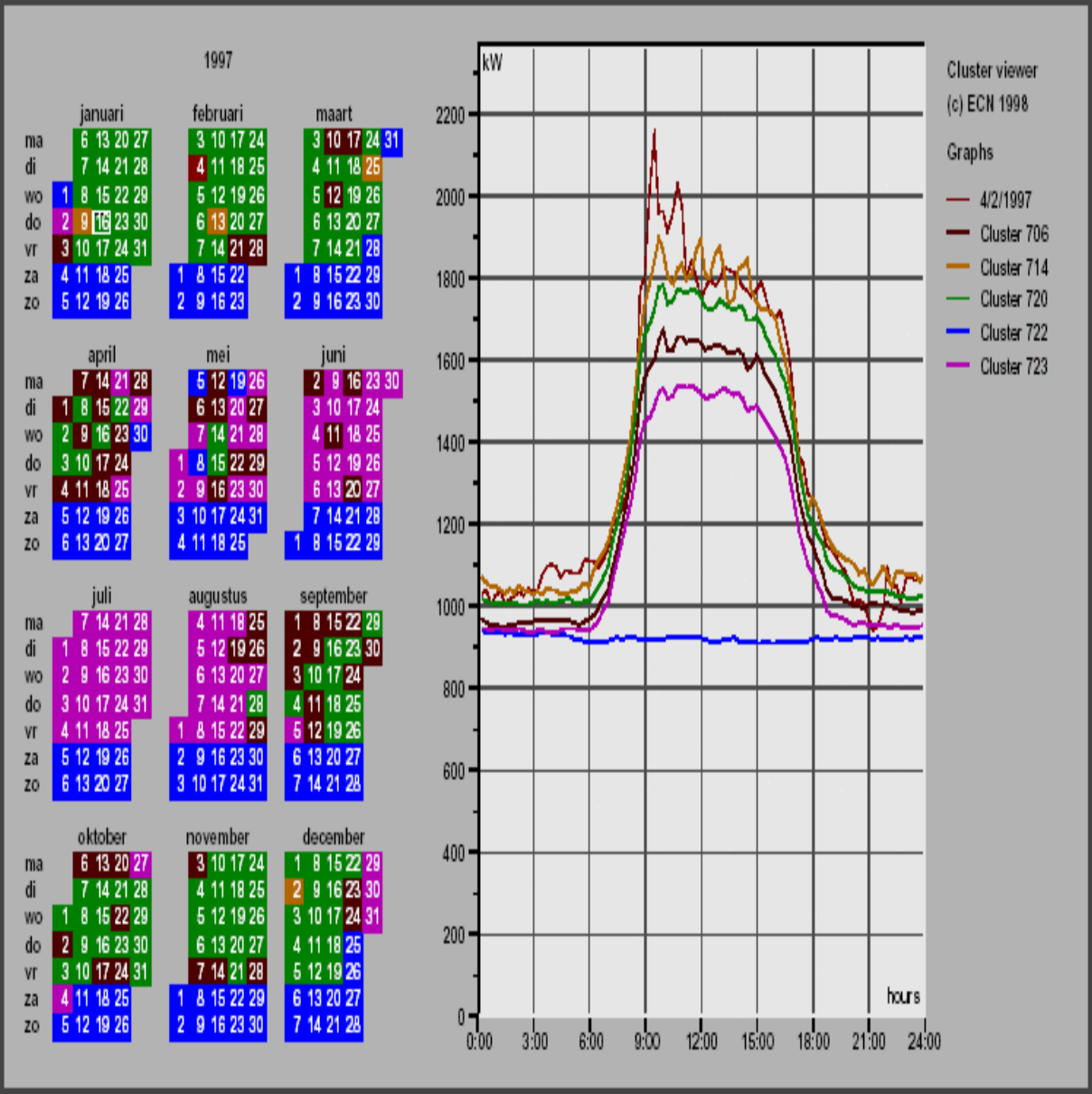
2D linked clusters–calendars shows patterns

- 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, Figure 4, citeseer.nj.nec.com/vanwijk99cluster.html]

Power Consumption



[van Wijk and van Selow, Cluster and Calender based Visualization of Time Series Data, InfoVis99, Figure 5, citeseer.nj.nec.com/vanwijk99cluster.html]

van Wijk 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

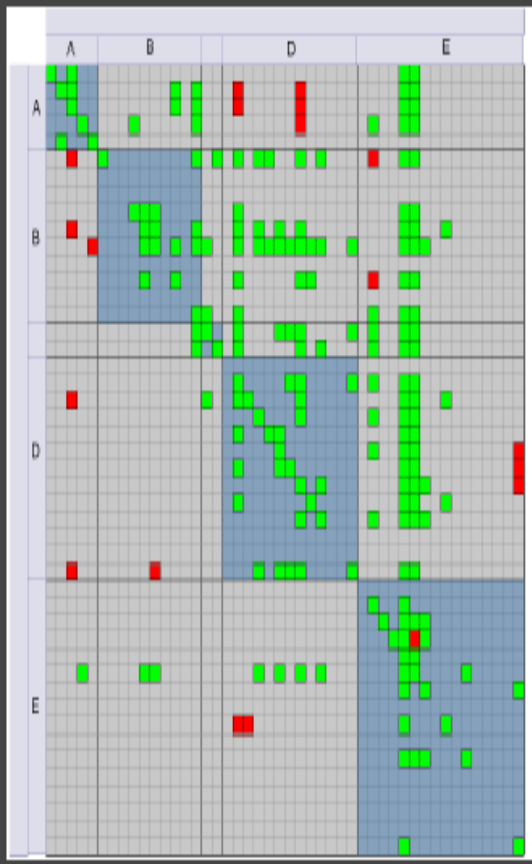
- color choice not so discriminable
  especially legend

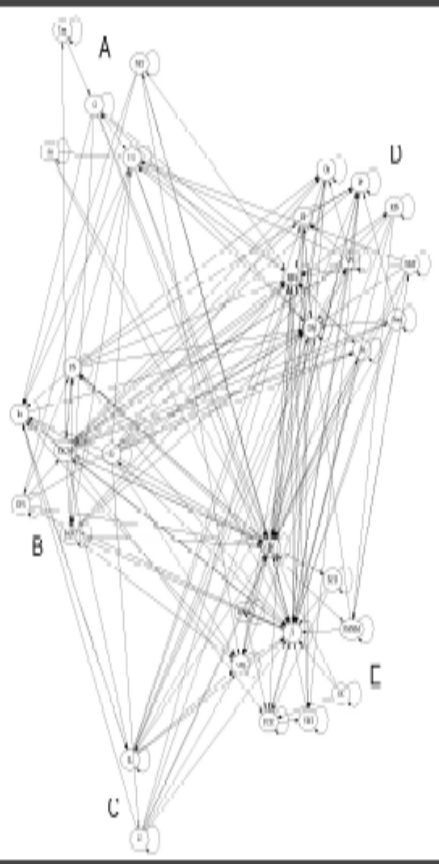
Multilevel Call Matrices, van Ham

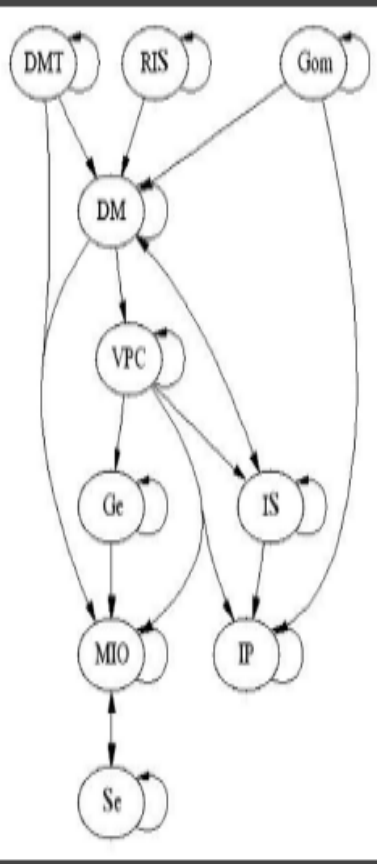
large software project, implementation vs. spec

link matrix vs. node network

matrix force-directed layered subset







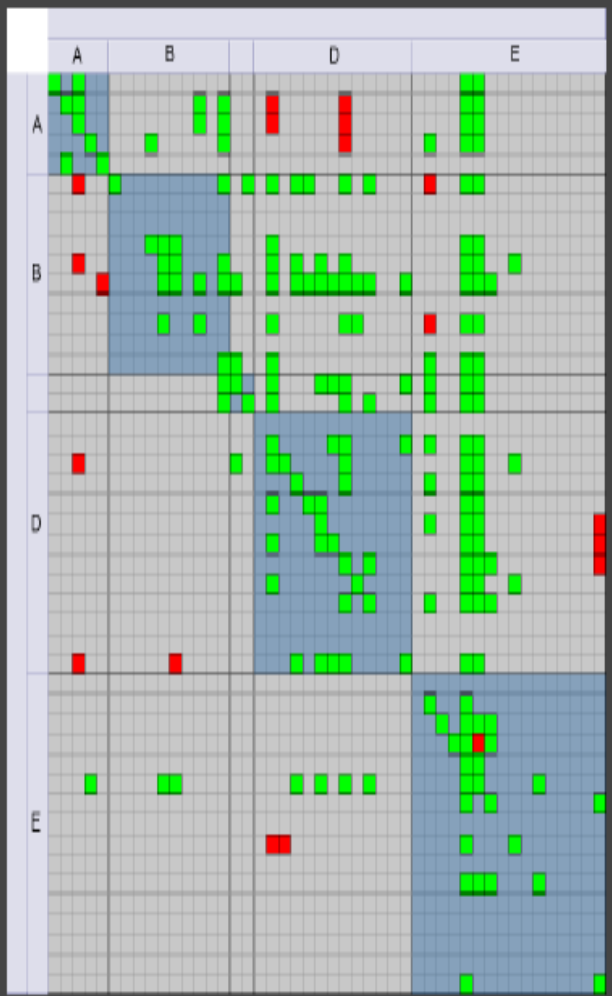
Matrices

uniform, recursive, stable

subdivide by

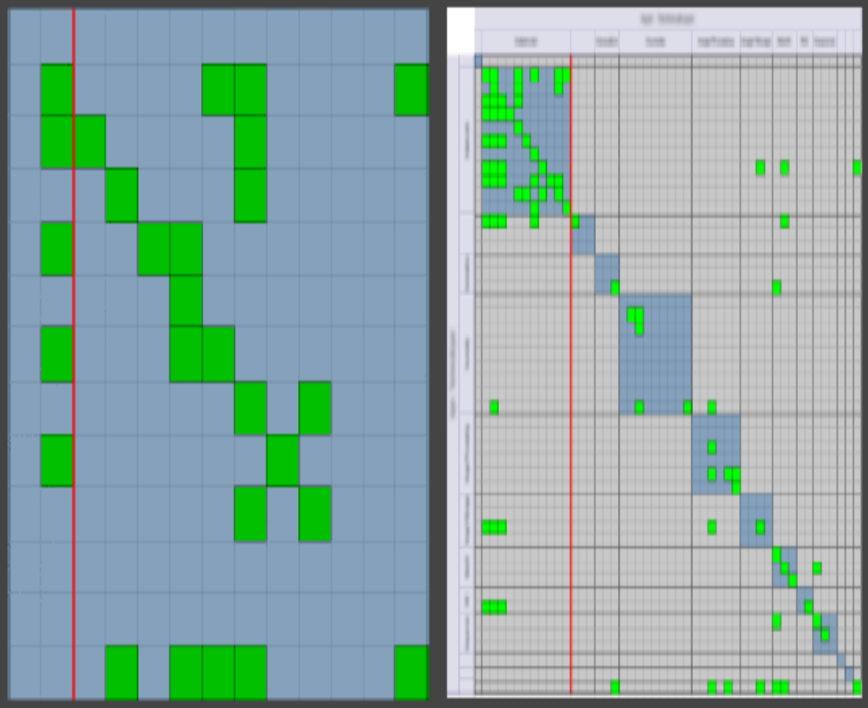
total component count

visible subcomponent count



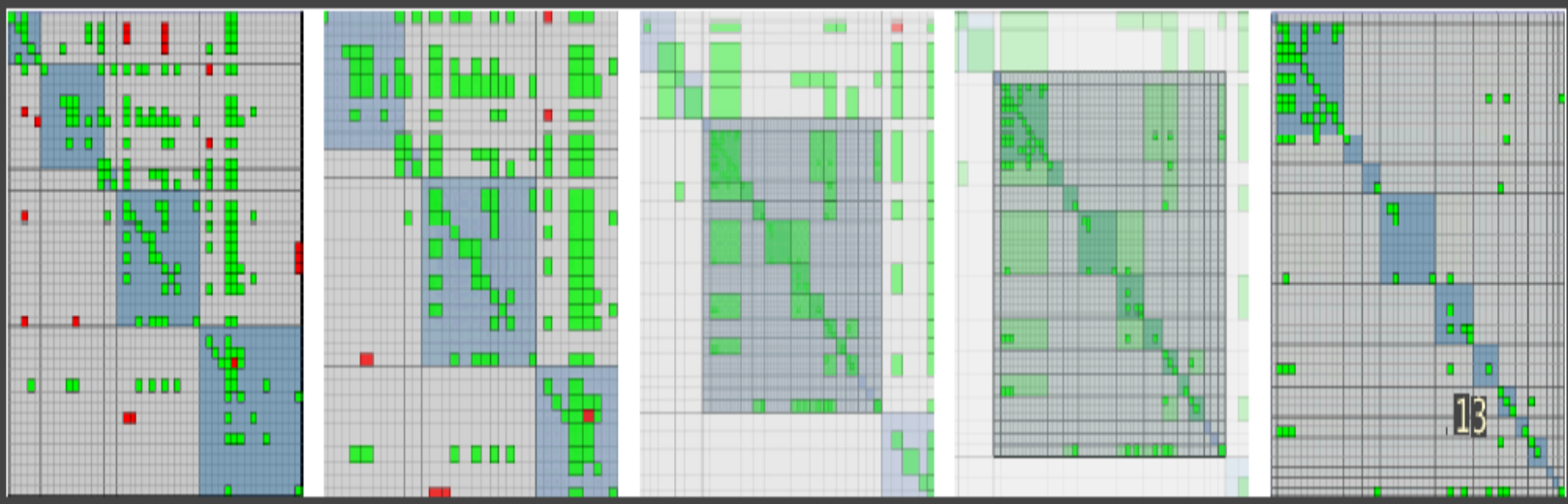
Zooming

abstraction levels



linear interpolation plus crossfade

trajectories: will read van Wijk 03 in week 6

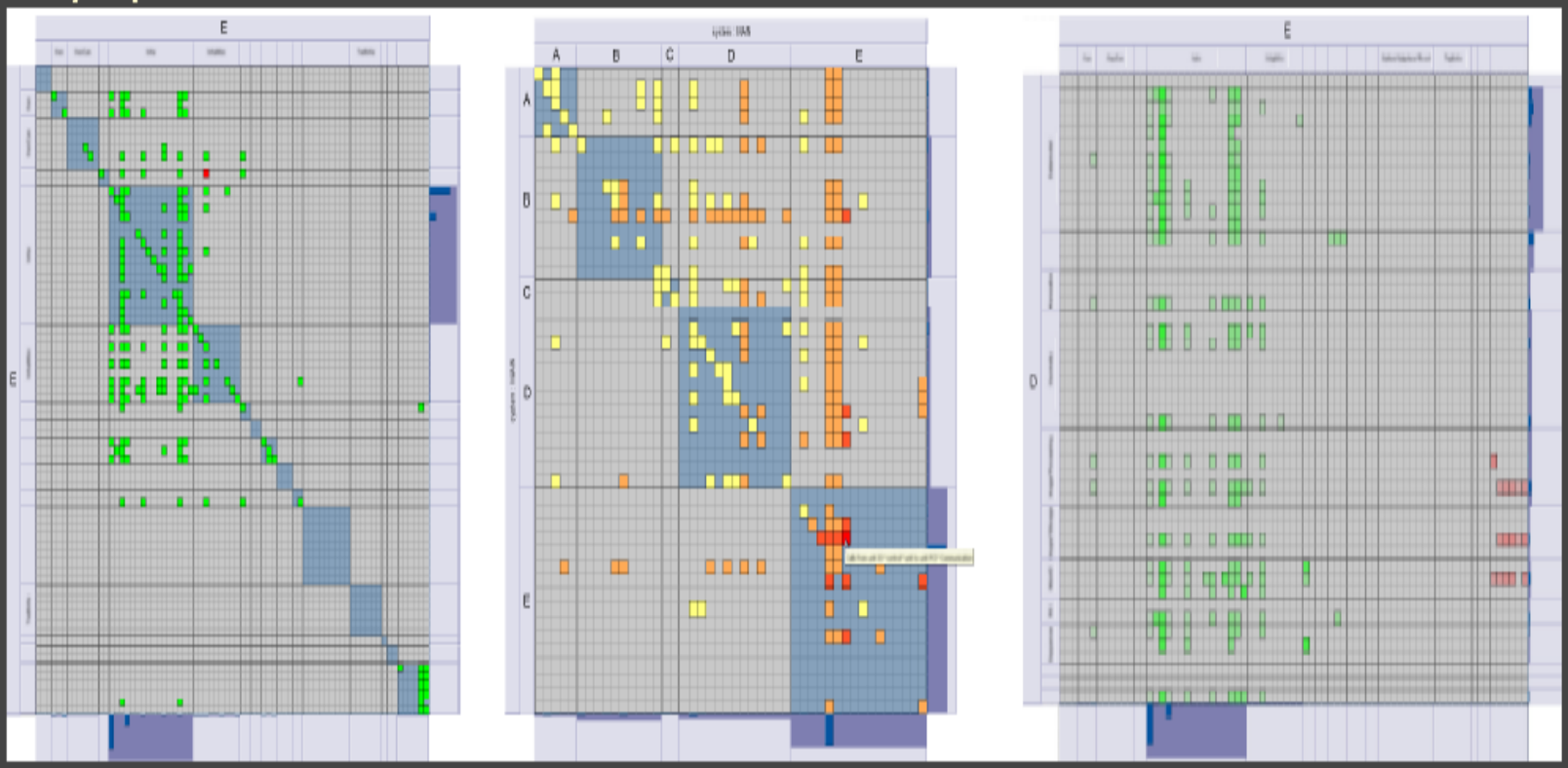


Additional Encoding

color:
call allowed
by spec

color:
local region
closest red

transparency:
call density



histograms: size distribution

Tasks Succesfully Supported

visual categorization

- i.e. libraries with mostly incoming calls

previous summary shown to be incomplete

spotting unwanted calls

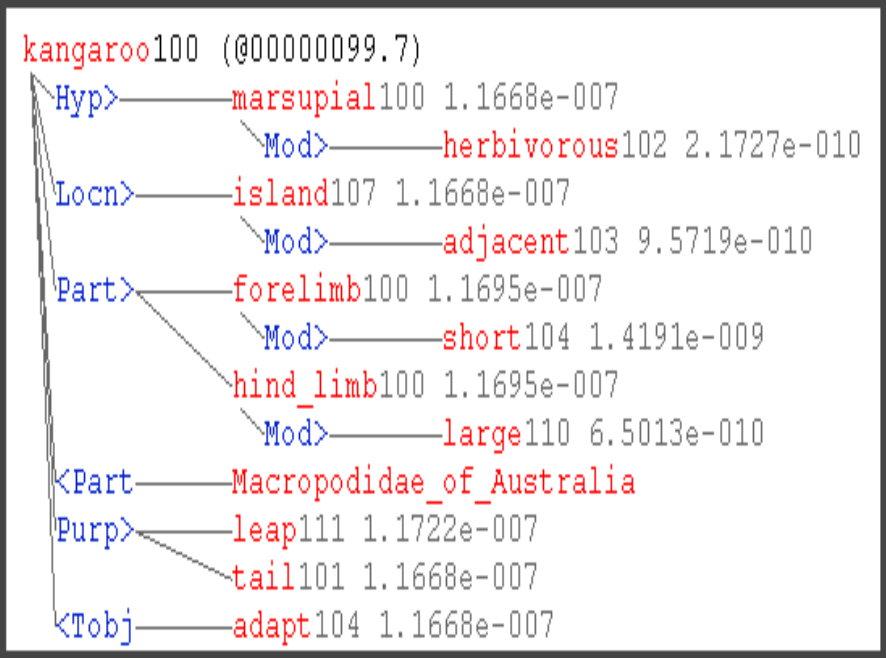
determining component dependencies

Linguistic Networks, Munzner

data: MindNet query results

definition graph

- dictionary entry sentence
- nodes: word senses
- links: relation types



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 (phalanger100 ermine

7 2.4774e-015 ail111 munk102)

8 1.5560e-015 Old_English_sheepdo

9 1.5488e-015 wolverine100

10 1.1220e-015 aby100 rock_wallaby

kangaroo100 (@00000099.7)
- Hyp> marsupial100 1.1668e-007
  - Mod> herbivorous102 2.1727e-010
- Locn> island107 1.1668e-007
  - Mod> adjacent103 9.5719e-010
- Part> forelimb100 1.1695e-007
  - Mod> short104 1.4191e-009
- hind_limb100 1.1695e-007
  - Mod> large110 6.5013e-010
- <Part Macropodidae_of_Australia
- Purp> leap111 1.1722e-007
- tail101 1.1668e-007
- <Tobj adapt104 1.1668e-007

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

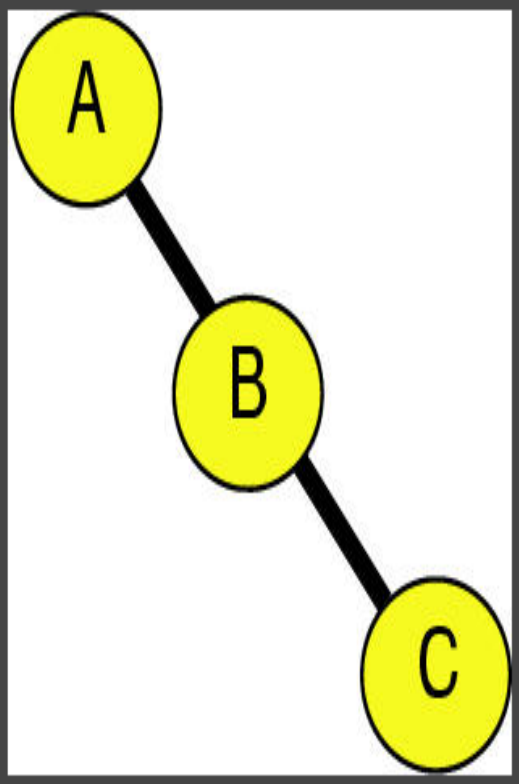
- not understand structure of English

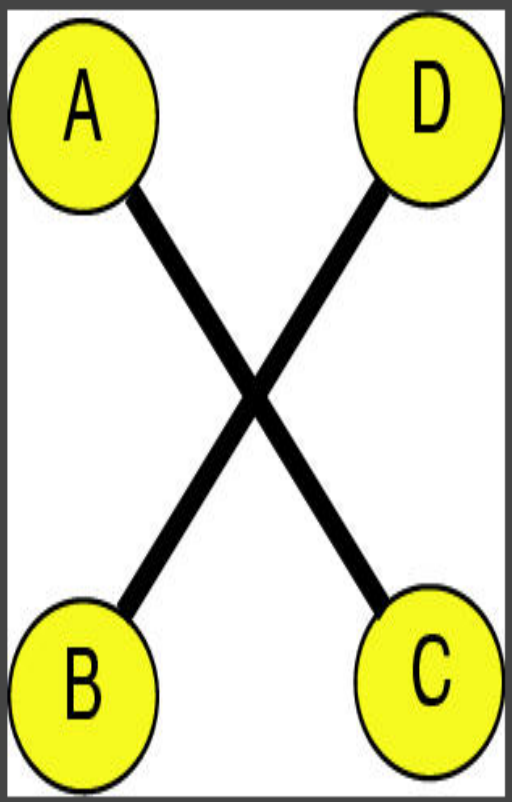
Constellation Video

Traditional Layout

avoid crossings

reason: avoid false attachments





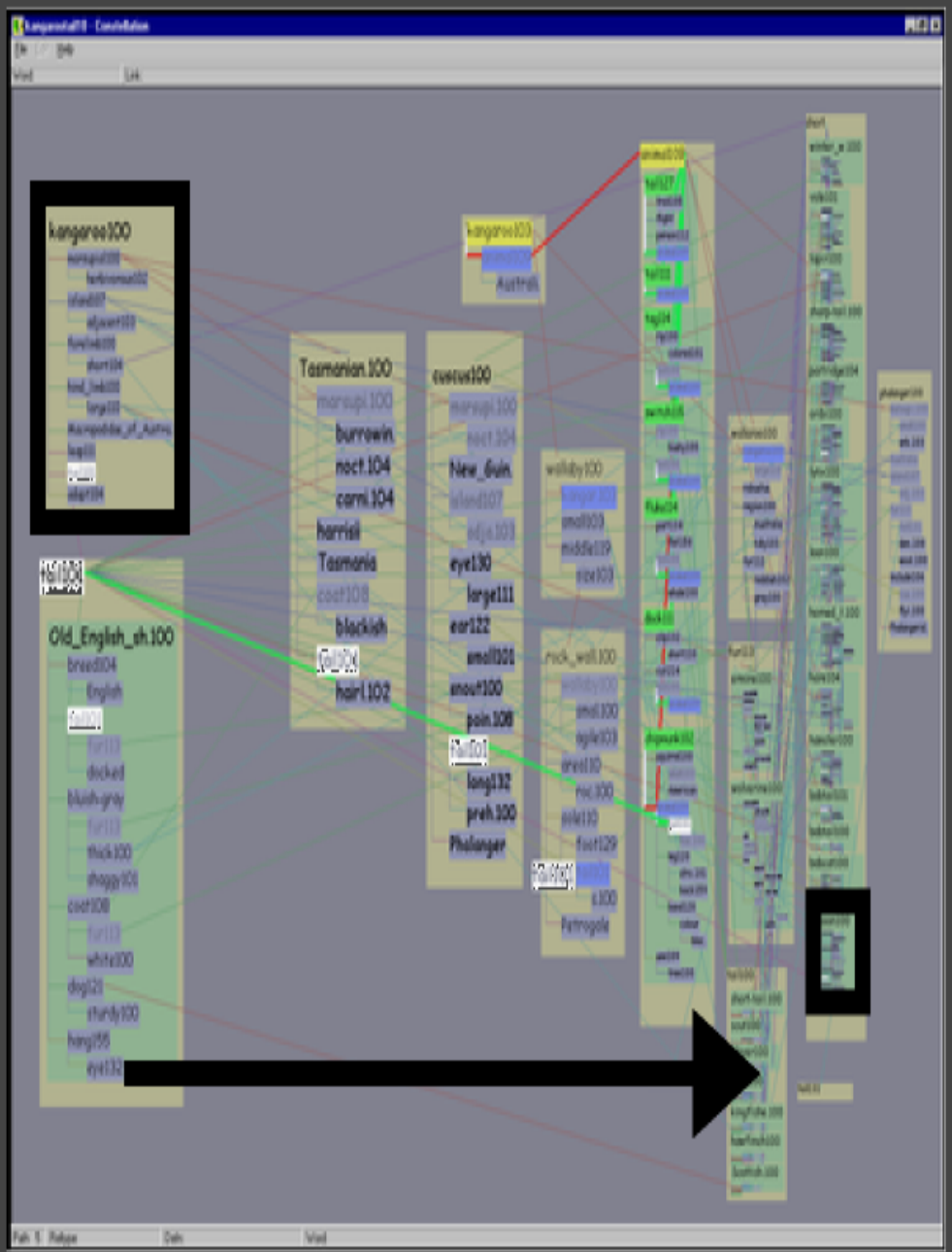
ambiguity

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

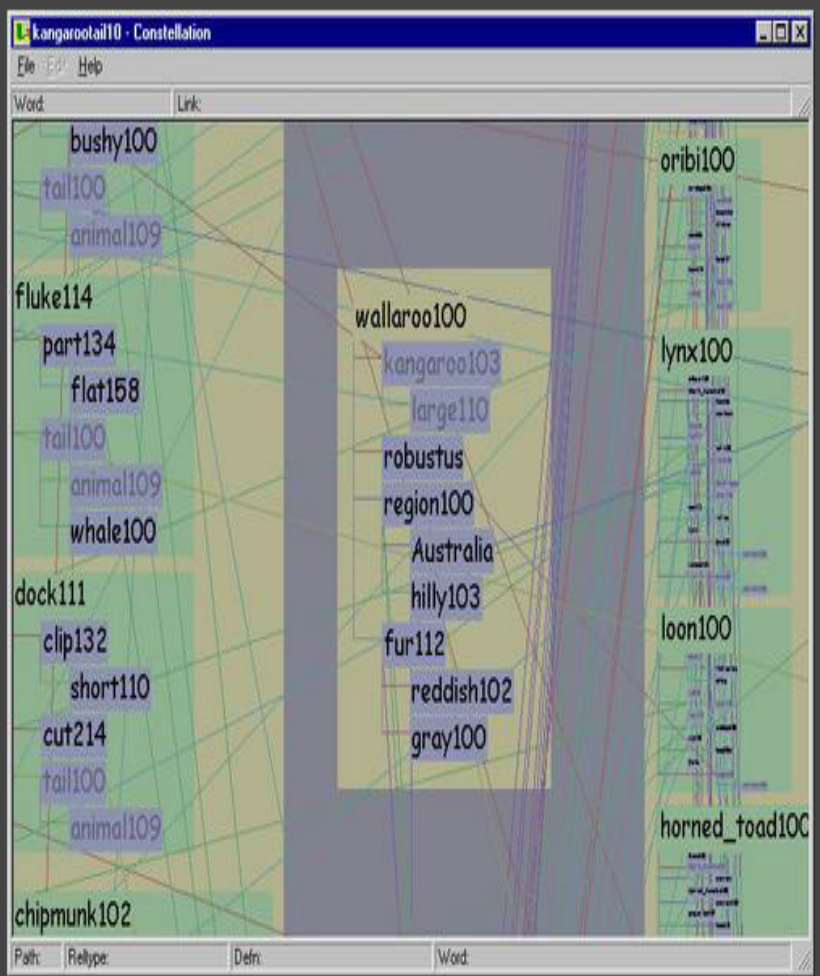
allow crossings for long-distance proxy links

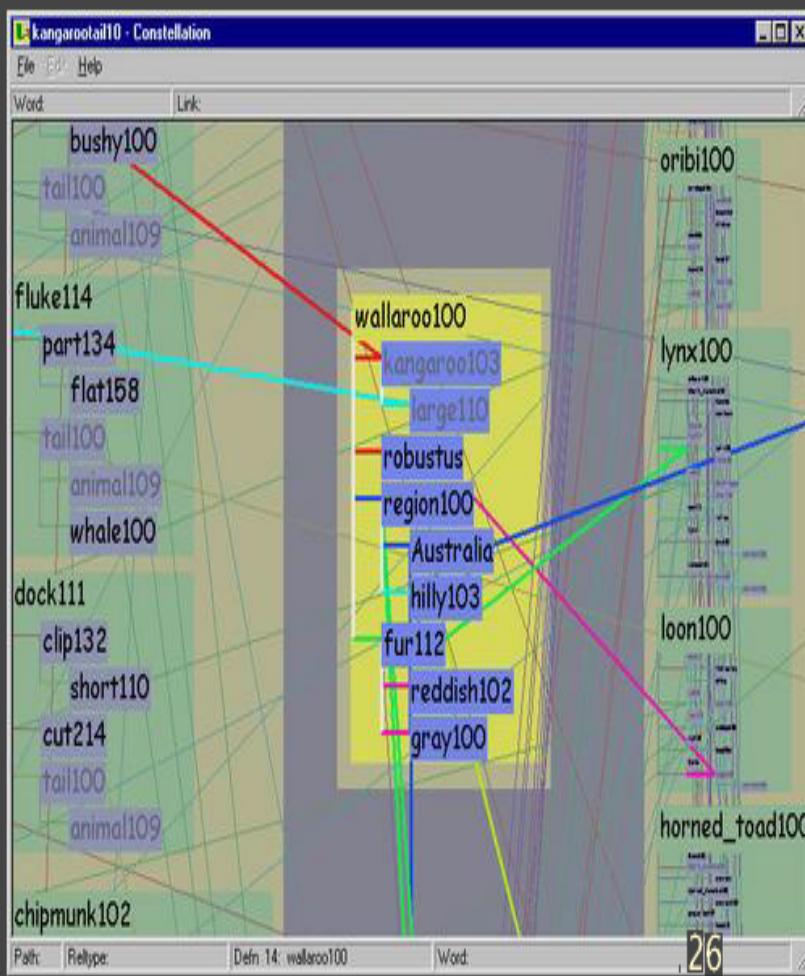
Selective Emphasis

highlight sets of boxes and edges

- interaction
- additional perceptual channels

avoid perception of false attachments





Hidden State

avoid hidden state

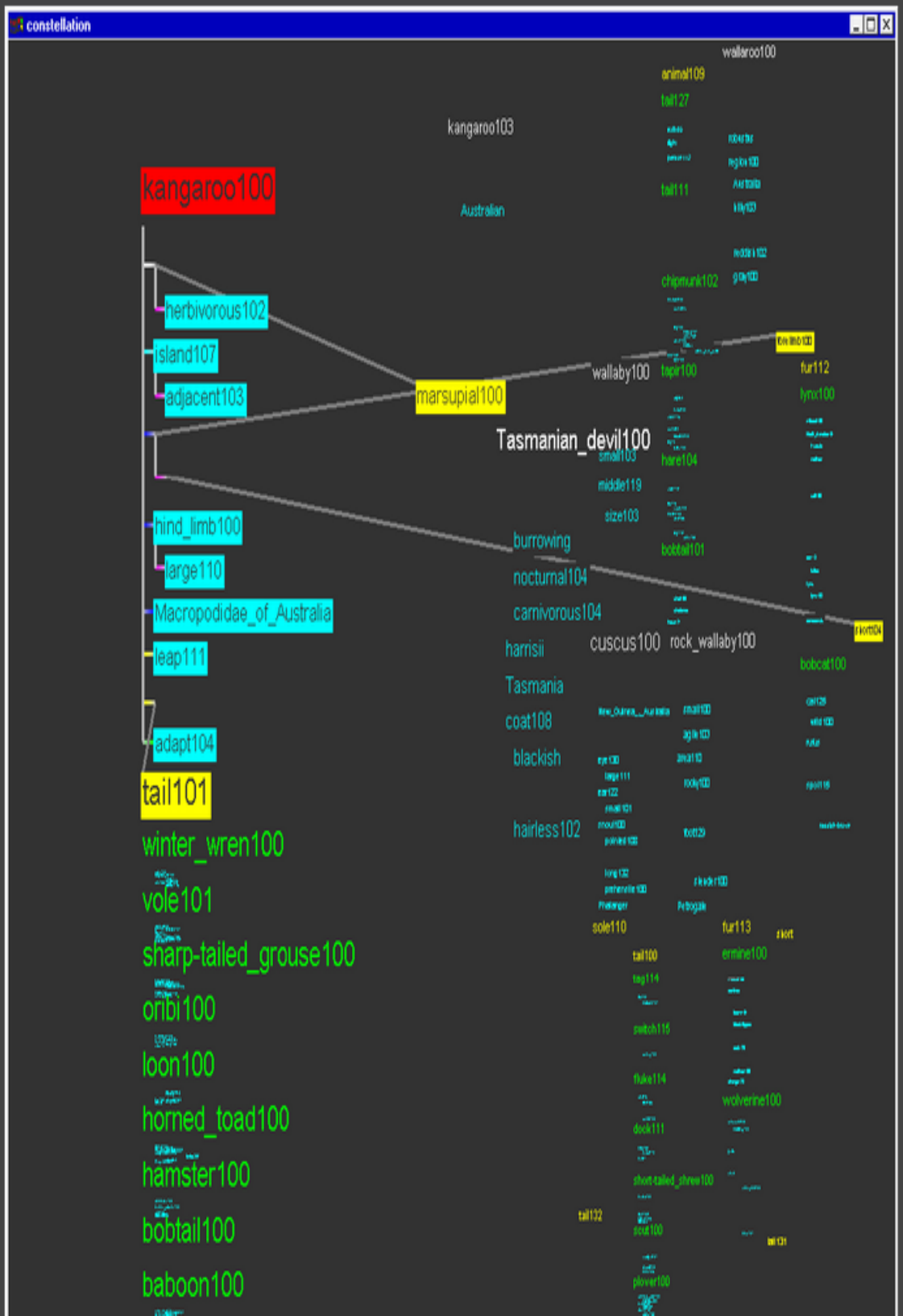
- change salience instead of toggle drawing

why? closed world assumption

- implicit assumption: if not visible, doesn't exist
- easy to forget previous actions

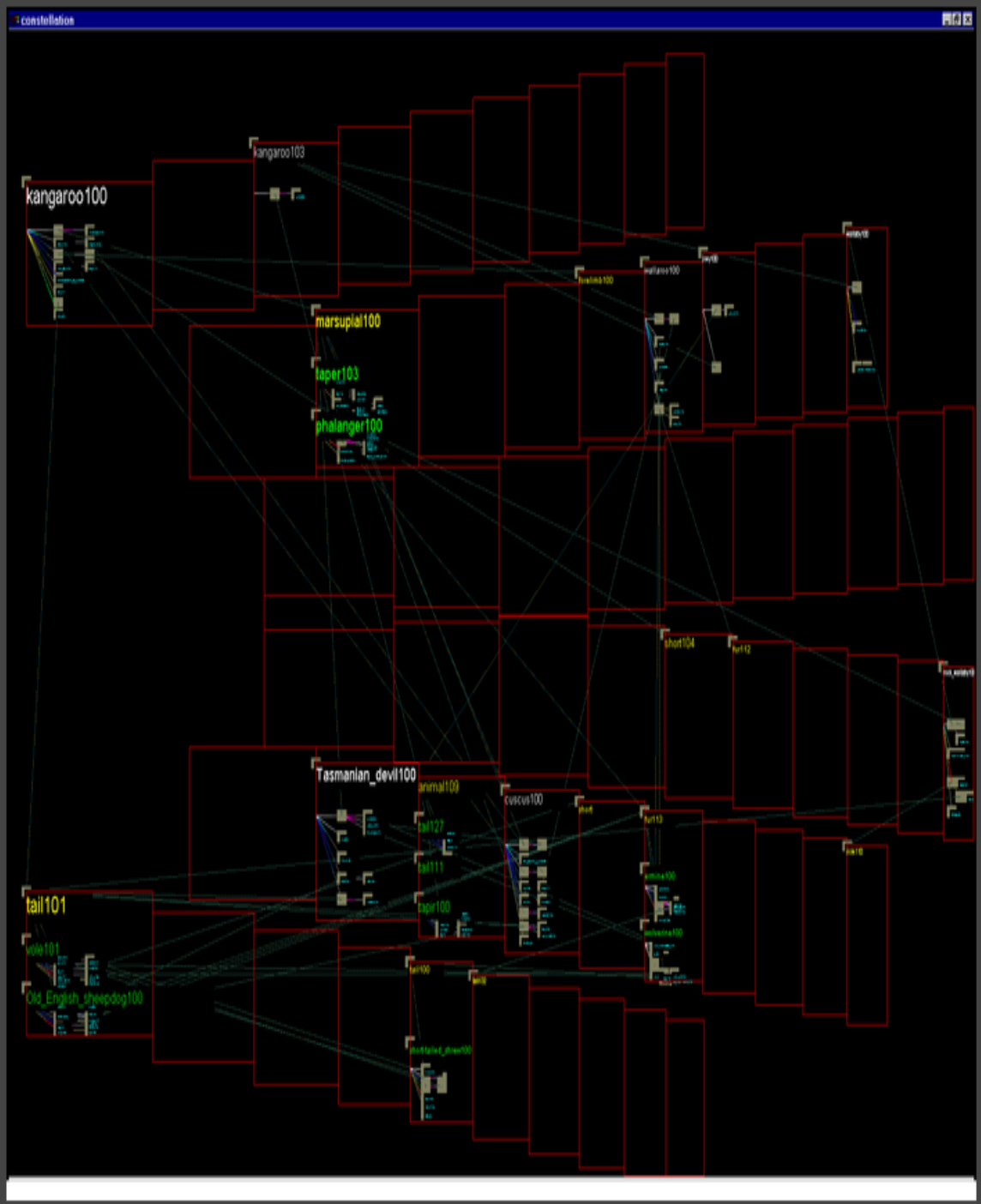
    draw false negative conclusions

Single vs. Multiple Word Instances



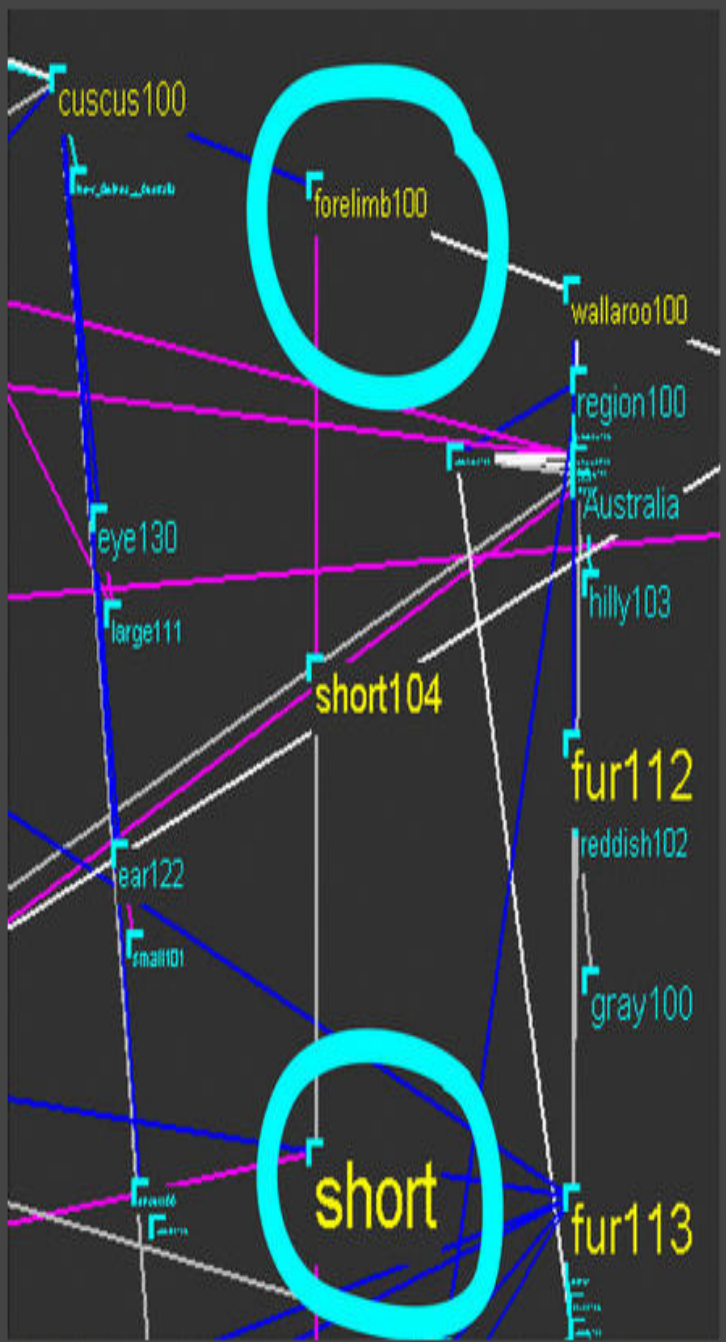
Information Density

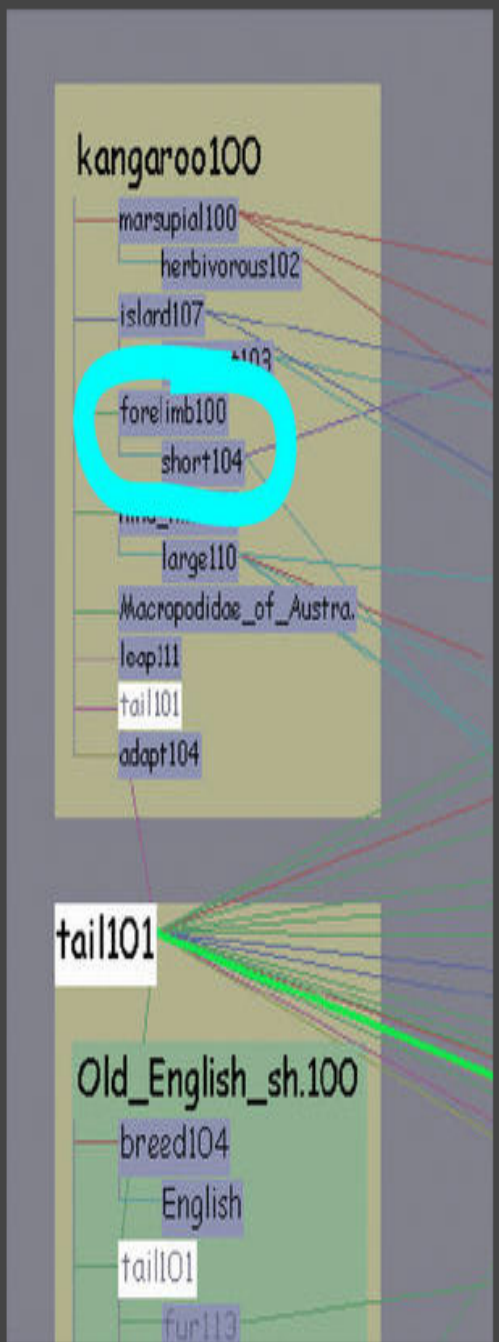
early prototype: poor



Information Density

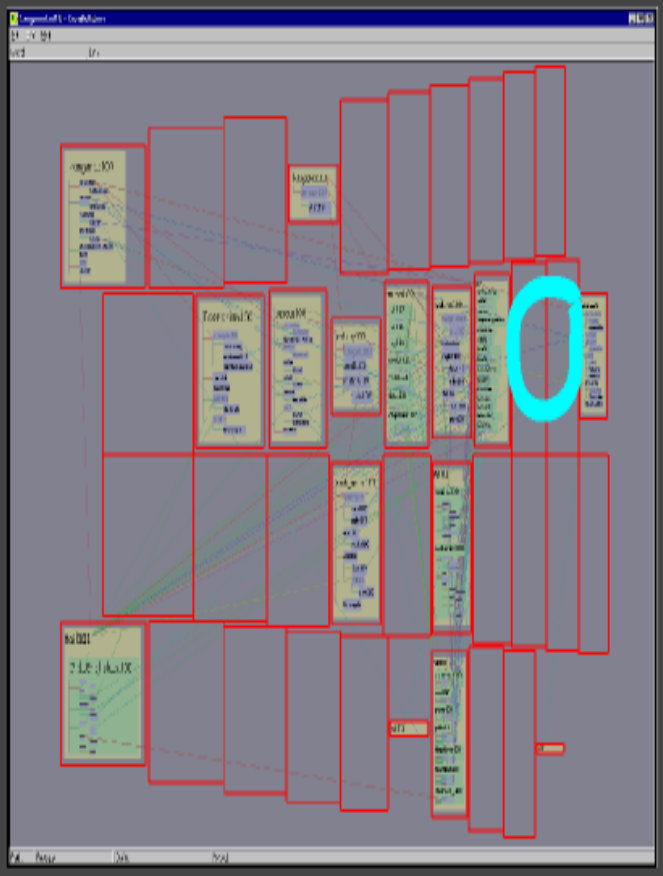
design tradeoff with visual salience

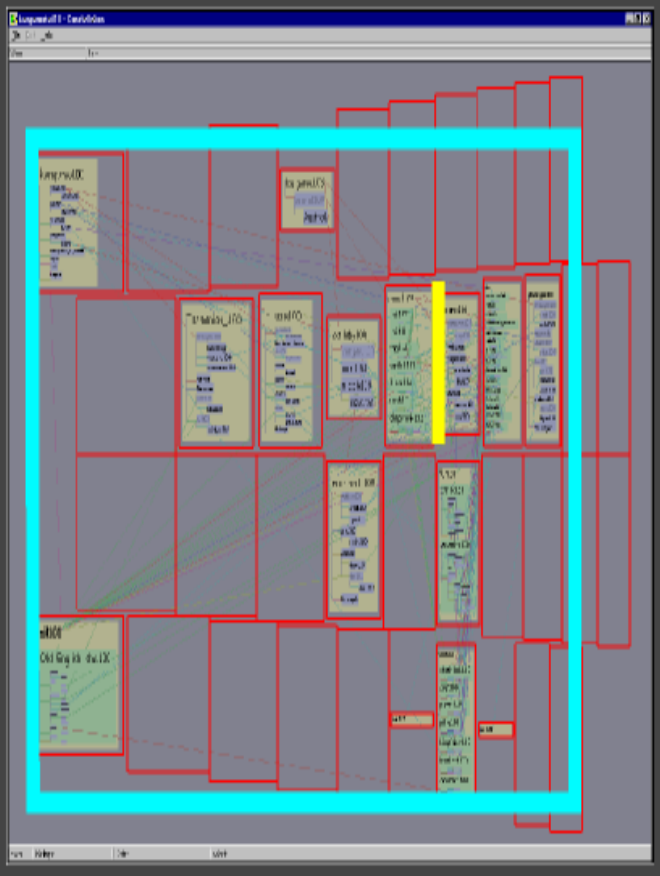


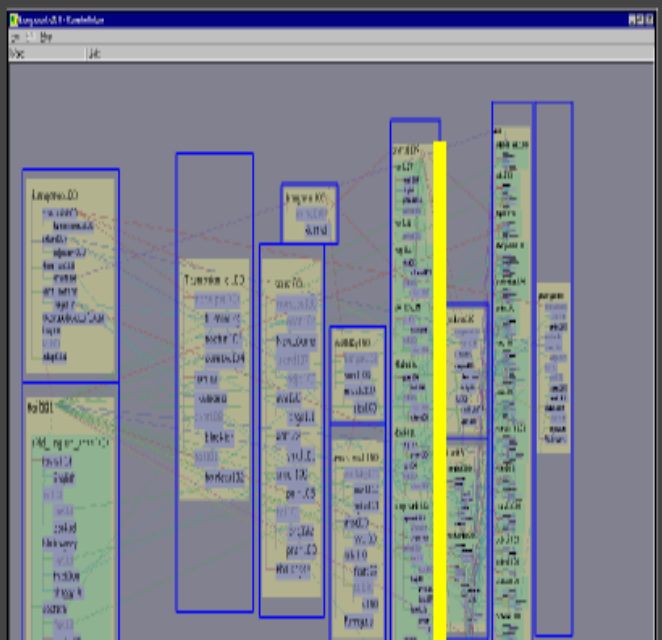


Information Density

grid adjustment

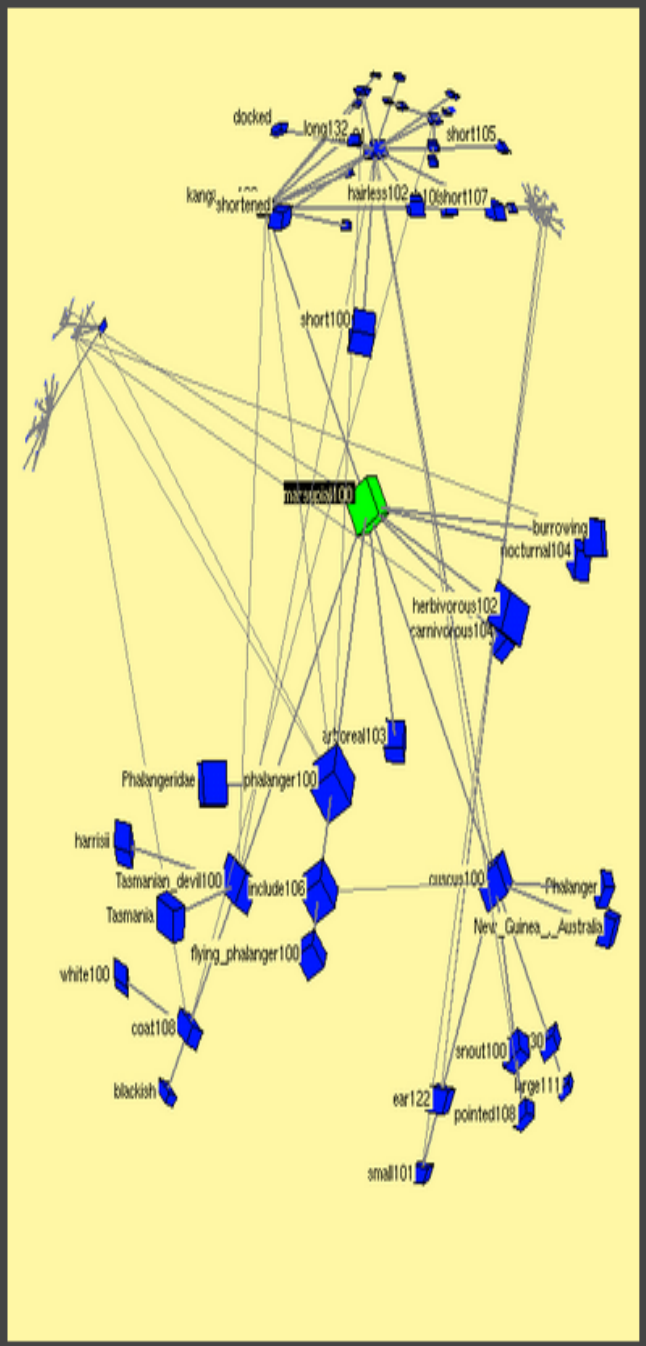


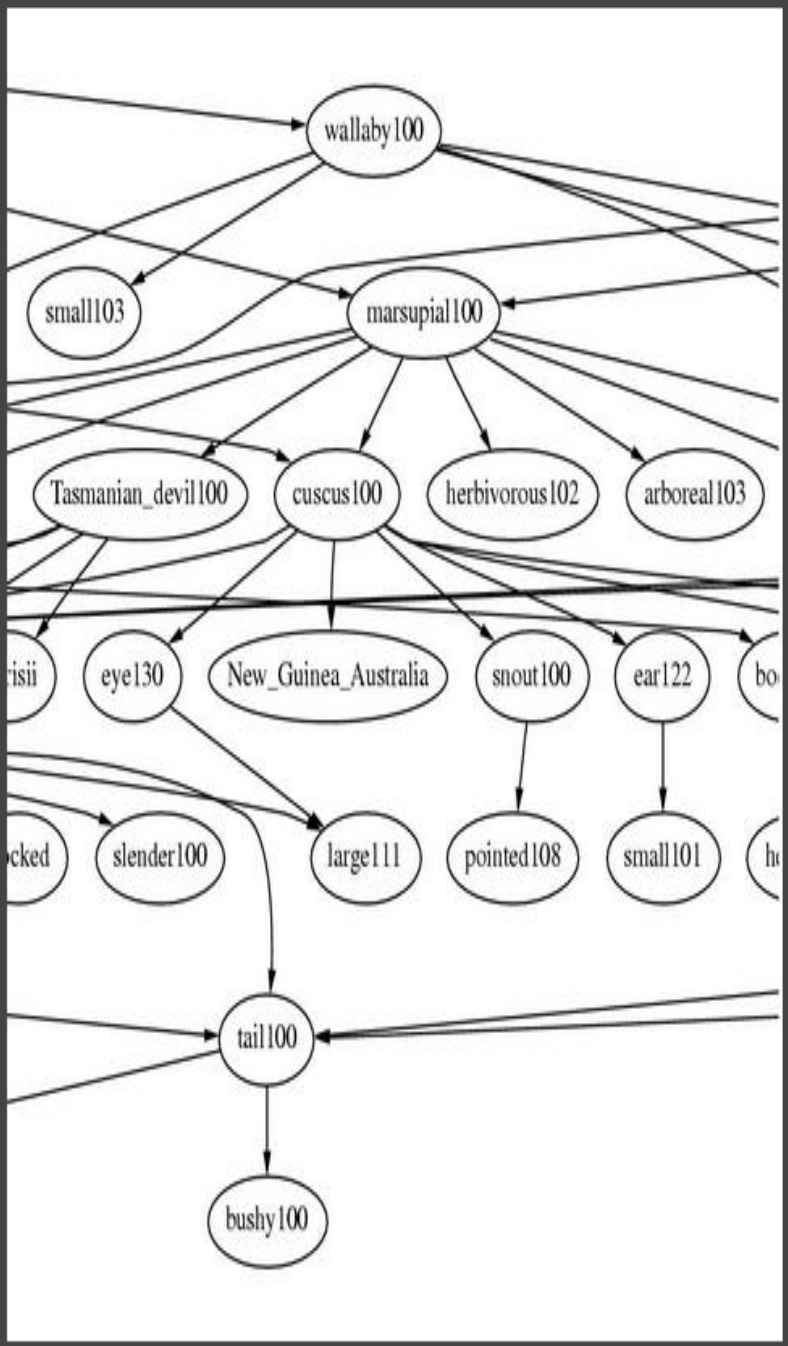




Task-oriented design

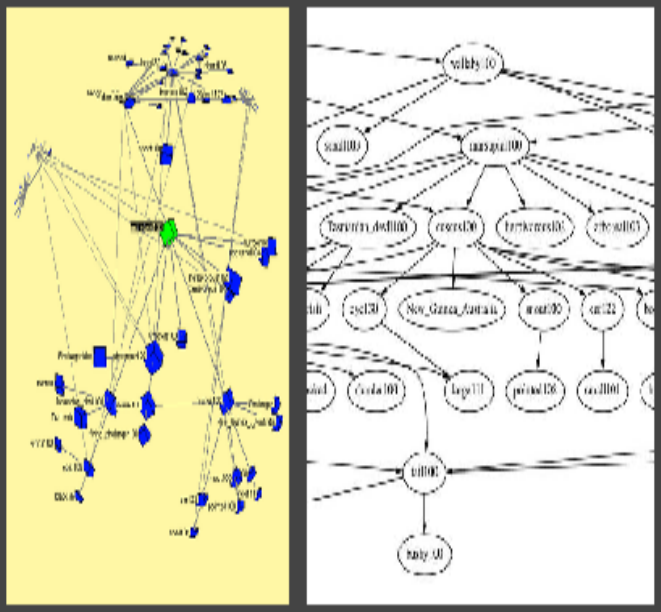
previous methods



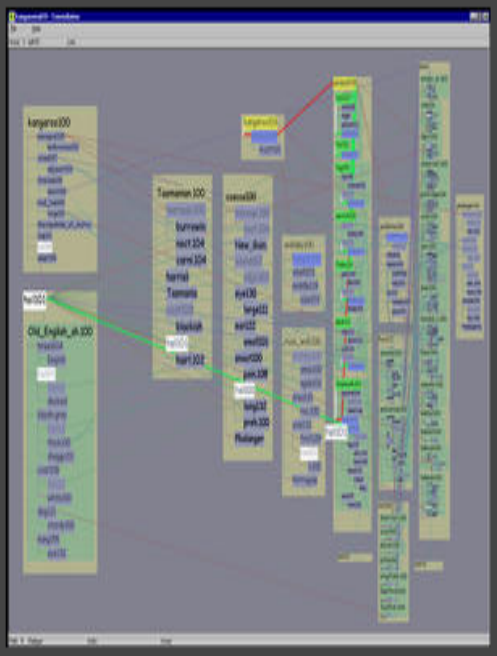


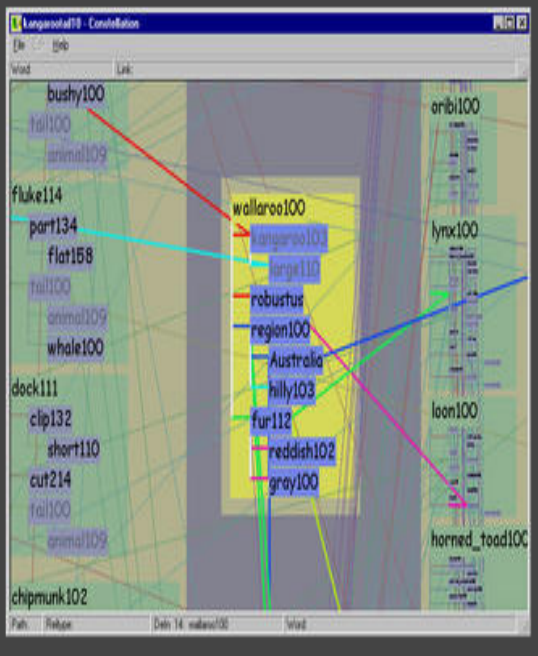
[graphics.stanford.edu/papers/munzner_thesis/html/node10.html#dotconstfig]

Task-oriented design



task-specific methods





[graphics.stanford.edu/papers/munzner_thesis/html/node10.html#layoutefffig]