Lecture 10: Focus+Context

Information Visualization
CPSC 533C, Fall 2009

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UBC Computer Science

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News

- project meetings due this Fri 10/23
- written proposals due next Fri 10/30

Papers Covered

A review of overview+detail, zooming, and focus+context interfaces. Andy Cockburn, Amy Karlson, and Benjamin B. Bederson. ACM Computing Surveys 41(1), 2008. (continued)

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

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

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

Untangling the Usability of Fisheye Menus. Kaspar Hornbaek and Morton Hertzum, ACM Transactions on Human-Computer Interaction 14(2), 2007.

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

More Reading

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

H3: Laying Out Large Directed Graphs in 3D Hyperbolic Space. Tamara Munzner, Proc InfoVis 97.

Focus+Context: Cockburn

- DOI: API(x) - D(x,y)
  - API: a priori interest
  - D: distance, semantic or spatial
  - x: data element
  - y: current focus
- DOI for selective presentation vs. distortion
- infer DOI through interaction vs. explicit selection
- single vs. multiple foci

[A Review and Taxonomy of Distortion-Oriented Presentation Techniques. Leung and Apperley, ACM ToCHI 1(2):126-160, Jun 1994.]

SpaceTree

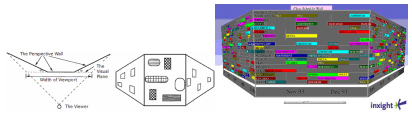
- focus+context tree: filtering, not geometric distortion
  - animated transitions

- semantic zooming

- demo

Focus+Context Distortion Intuition

- move part of surface closer to eye
  - Perspective Wall example

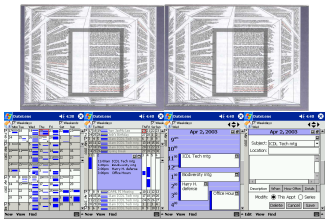


[A review of overview+detail, zooming, and focus+context interfaces. Cockburn, Karlson, and Bederson. ACM Computing Surveys 41(1), 2008. From Perspective Wall, Mackinlay Robertson and Card 1991]

Graphical Fisheye Views

[A review of overview+detail, zooming, and focus+context interfaces. Cockburn, Karlson, and Bederson. ACM Computing Surveys 41(1), 2008. From Graphical Fisheye Views, Sarkar and Brown 1992]

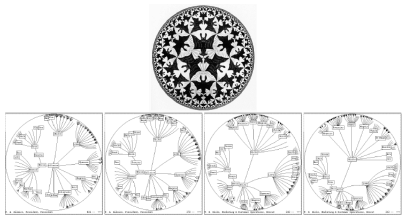
Document Lens, Table Lens



[A review of overview+detail, zooming, and focus+context interfaces. Cockburn, Karlson, and Bederson. ACM Computing Surveys 41(1), 2008. From: Document Lens, Robertson and Mackinlay 1993.
Table Lens, Rao and Card 1994.]

2D Hyperbolic Trees

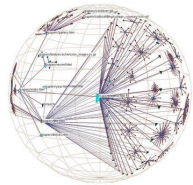
- fisheye effect from hyperbolic geometry
  - video: open-video.org/details.php?videoid=4567



[The Hyperbolic Browser: A Focus + Context Technique for Visualizing Large Hierarchies. John Lamping and Ramana Rao, Proc SIGCHI '95.]

3D Hyperbolic Trees/Graphs

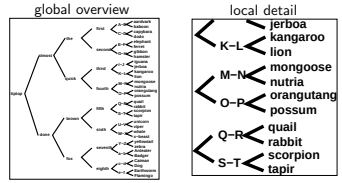
- scalability argument: information density at periphery



[H3: Laying Out Large Directed Graphs in 3D Hyperbolic Space. Tamara Munzner, Proc InfoVis 97.]

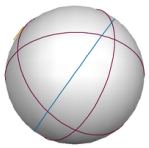
Avoiding Disorientation

- problem
  - maintain user orientation when showing detail
  - hard for big datasets
- exponential in depth
  - node count, space needed



Noneuclidean Geometry

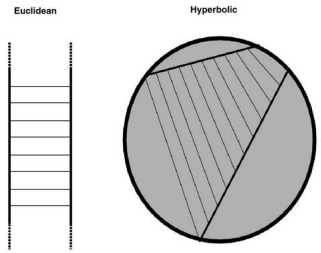
- Euclid's 5th Postulate
  - exactly 1 parallel line
- spherical
  - geodesic = great circle
  - no parallels
- hyperbolic
  - infinite parallels



(torus.math.uiuc.edu/jms/java/dragsphere

Parallel vs. Equidistant

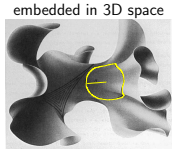
- euclidean: inseparable
- hyperbolic: different



Exponential Amount Of Room

room for exponential number of tree nodes

2D hyperbolic plane embedded in 3D space



[Thurston and Weeks 84]

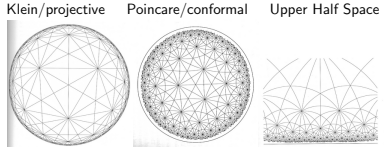
hemisphere area

hyperbolic: exponential
$2\pi \sinh^2 r$

euclidean: polynomial
$2\pi r^2$

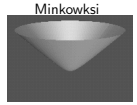
2D Hyperbolic Models

Klein/projective | Poincare/conformal | Upper Half Space



[Three Dimensional Geometry and Topology, William Thurston, Princeton University Press]

Minkowksi



Distortion Challenges

- how to visually communicate distortion
  - gridlines, shading
- target acquisition problem
  - lens displacing items away from screen loction
- unsuitable if must make relative spatial judgements
- mixed results comparing to O+D, pan/zoom

Untangling Usability of Fisheye Menus

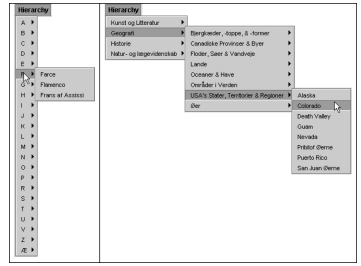
- compare fisheye, overview, multifocus, hierarchical
- measurements
  - performance time, errors
  - preferences
  - eyetracking
- design issues
  - distortion vs. O+D vs. hierarchical temporal
  - landmarks
  - fine-grained navigation: focus-lock when needed

[Untangling the Usability of Fisheye Menus. Kaspar Hornbaek and Morton Hertzum, ACM Transactions on Human-Computer Interaction 14(2), 2007. Fig 2.]

Menus: Fisheye, Overview, Multifocus

[Untangling the Usability of Fisheye Menus. Kaspar Hornbaek and Morton Hertzum, ACM Transactions on Human-Computer Interaction 14(2), 2007. Fig 2.]

Menus: Hierarchical



[Untangling the Usability of Fisheye Menus. Kaspar Hornbaek and Morton Hertzum, ACM Transactions on Human-Computer Interaction 14(2), 2007. Fig 5.]

Results

- troubles with focus-lock mode
  - demo: www.cs.umd.edu/hcil/fisheyemenu
- hierarchical (baseline) outperformed for known-item task
  - faster, more accurate
  - smaller screen footprint
- no differences for browsing tasks
- eyetrack: transition and context regions not used much for fisheye
  - readability important - multifocus
  - give up on showing entire context?
  - less space for transition regions?

F+C Without Distortion

- specialized hardware

[A review of overview+detail, zooming, and focus+context interfaces. Cockburn, Karlson, and Bederson. ACM Computing Surveys 41(1), 2008. From: Baudisch 1992.]

Fisheye Followup

- degree of interest (DOI): a priori importance (API), distance (D)
  - distance can be semantic or spatial
  - distortion vs. selection
  - agnostic to geometry
- DOI for selective presentation vs. distortion
  - what to shown vs. how it is shown
- how shown
  - geometric distortion: TrueSize as implicit API
  - ZUIs: temporal/memory harder than side by side
  - multiple views: topological discontinuity at edges
  - multires displays: big and heavy...

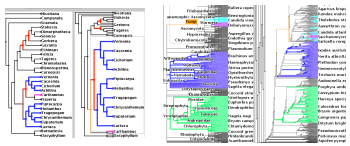
[A Fisheye Follow-up: Further Reflection on Focus + Context. George W. Furnas. SIGCHI 2006.]

Generalized Fisheye Requirements

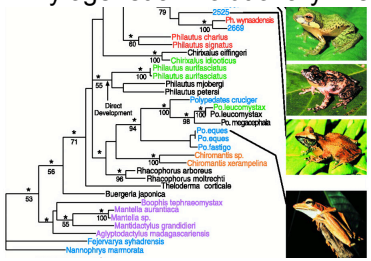
- static structure, allowing distance defn
- LOD/API at points within structure
- interaction focused at point/region

TreeJuxtaposer

- side by side comparison of evolutionary trees

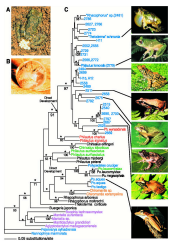


Phylogenetic/Evolutionary Tree



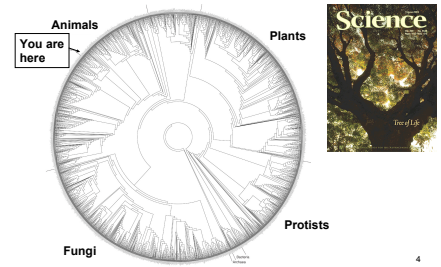
M Meegaskumbura et al., Science 298:379 (2002)

Common Dataset Size Today



M Meegaskumbura et al., Science 298:379 (2002)

Future Goal: 10M node Tree of Life

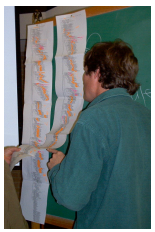


David Hillis, Science 300:1687 (2003)

Paper Comparison: Multiple Trees

focus

context

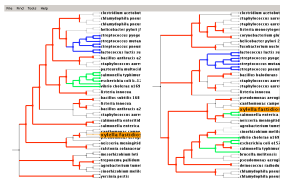


Accordion Drawing

- rubber-sheet navigation
  - stretch out part of surface, the rest squishes
  - borders nailed down
  - Focus+Context technique
    - integrated overview, details
  - old idea
    - [Sarkar et al 93], [Robertson et al 91]
- guaranteed visibility
  - marks always visible
  - important for scalability
  - new idea
    - [Munzner et al 03]

Guaranteed Visibility

- marks are always visible
- easy with small datasets

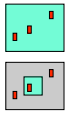


Guaranteed Visibility Challenges

- hard with larger datasets
- reasons a mark could be invisible

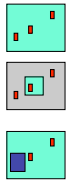
Guaranteed Visibility Challenges

- hard with larger datasets
- reasons a mark could be invisible
  - outside the window
    - AD solution: constrained navigation



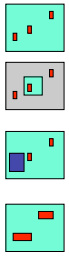
Guaranteed Visibility Challenges

- hard with larger datasets
- reasons a mark could be invisible
  - outside the window
    - AD solution: constrained navigation
  - underneath other marks
    - AD solution: avoid 3D



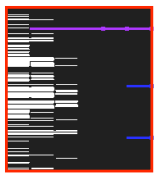
Guaranteed Visibility Challenges

- hard with larger datasets
- reasons a mark could be invisible
  - outside the window
    - AD solution: constrained navigation
  - underneath other marks
    - AD solution: avoid 3D
  - smaller than a pixel
    - AD solution: smart culling



Guaranteed Visibility: Small Items

- Naïve culling may not draw all marked items

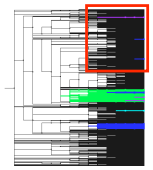


Guaranteed visibility of marks

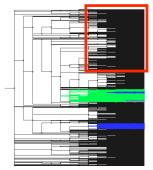
No guaranteed visibility

Guaranteed Visibility: Small Items

- Naïve culling may not draw all marked items

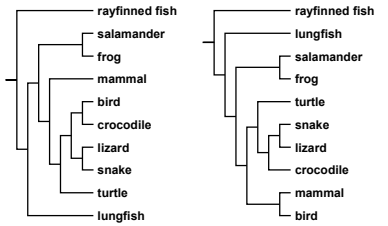


Guaranteed visibility of marks

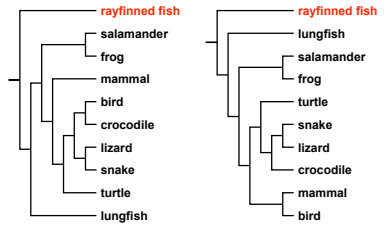


No guaranteed visibility

Structural Comparison



Matching Leaf Nodes



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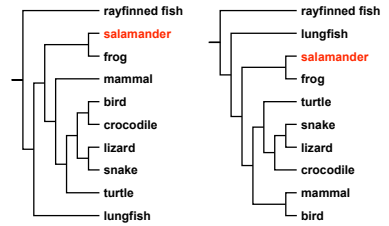
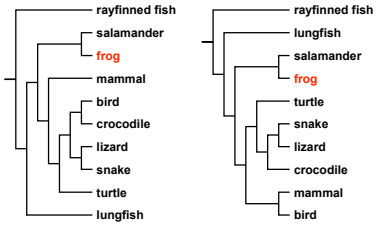
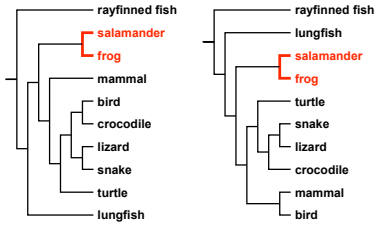


Matching Leaf Nodes



Matching Interior Nodes



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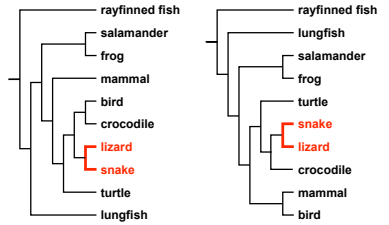
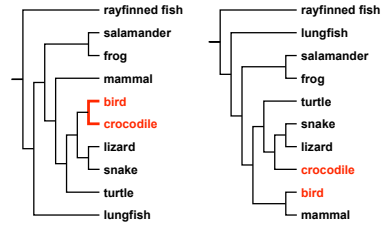


Matching Interior Nodes



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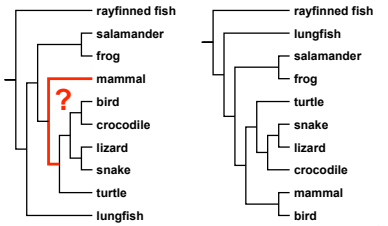
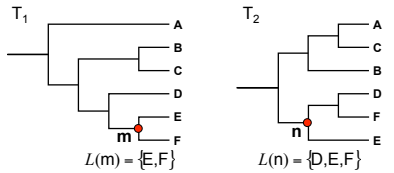


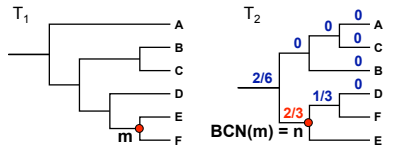
Similarity Score: $S(m,n)$



$L(m) = \{E,F\}$ $L(n) = \{D,E,F\}$

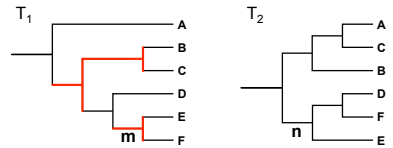
$$S(m,n) = \frac{|L(m) \cap L(n)|}{|L(m) \cup L(n)|} = \frac{|\{E,F\}|}{|\{D,E,F\}|} = \frac{2}{3}$$

Best Corresponding Node



- $BCN(m) = \text{argmax}_{v \in T_2}(S(m,v))$
  - computable in $O(n \log^2 n)$
  - linked highlighting

Marking Structural Differences



- Nodes for which $S(v,\text{BCN}(v)) \neq 1$
  - Matches intuition

TreeJuxtaposer

- video, software from olduvai.sourceforge.net/tj