Lecture 10: Focus+Context

Information Visualization
CPSC 533C, Fall 2009

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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

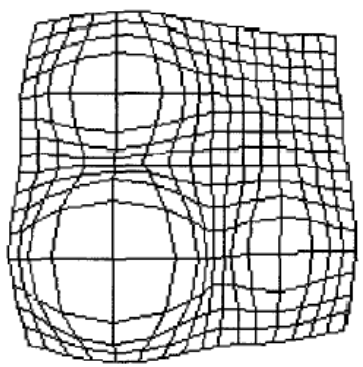
More Reading

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

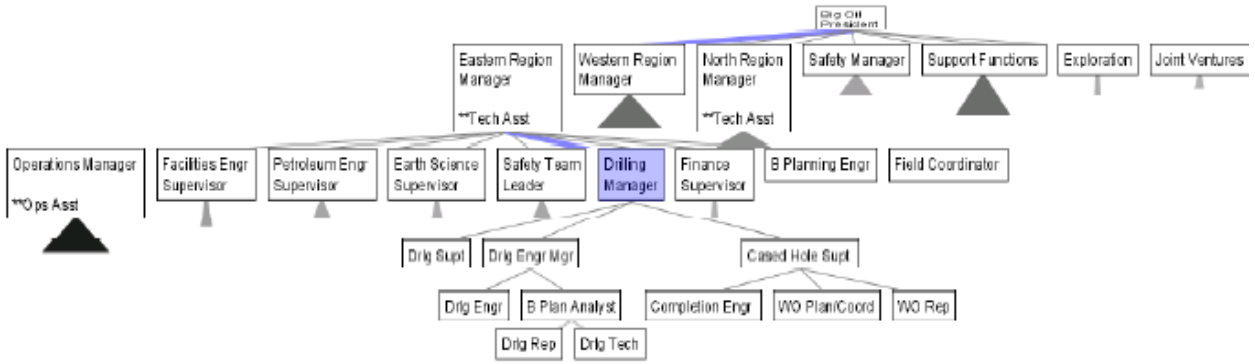
- DOI: API(x) - D(x,y)
  - API: a priori interest
  - D: distance, semantic or spatial
  - x: data element
  - y: current focus
- DOI for selective presentation vs. distortion
- infer DOI through interaction vs. explicit selection
- single vs. multiple foci



[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

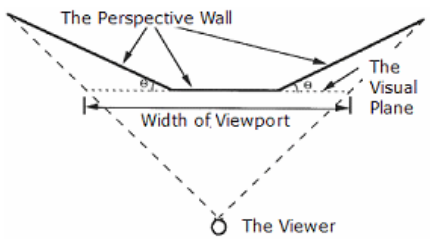


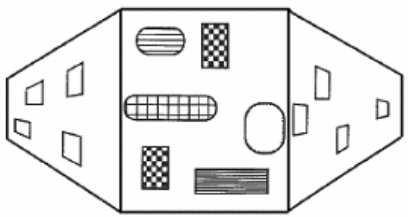
- semantic zooming

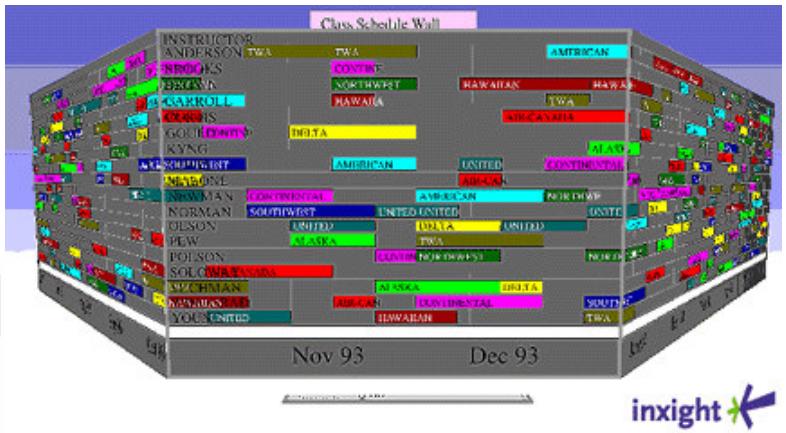
- demo

Focus+Context Distortion Intuition

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





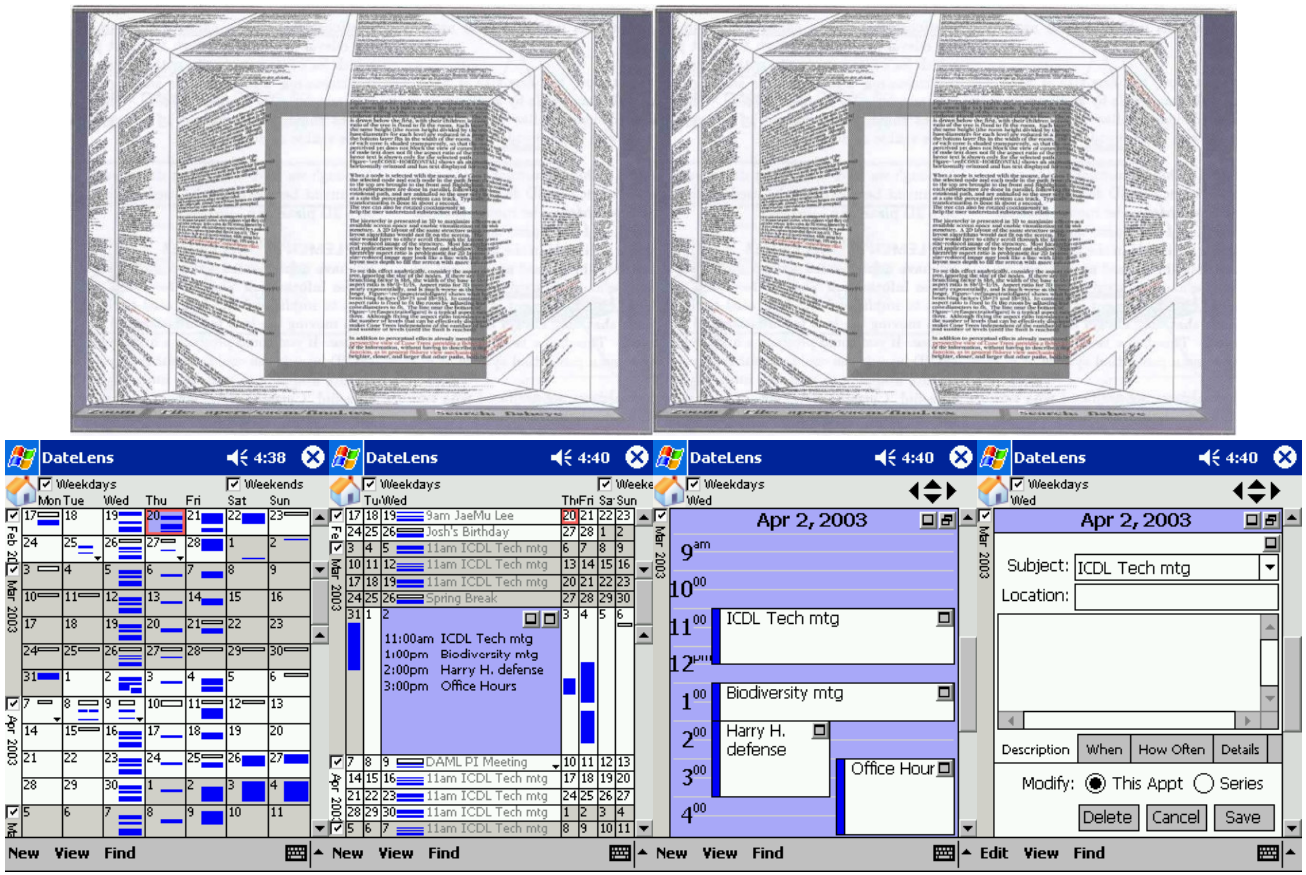


[A review of overview+detail, zooming, and focus+context interfaces. Cockburn, Karlson, and Bederson. ACM Computing Surveys 41(1), 2008. From Perspective Wall, Mackinlay Robertson and Card 1991]

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]

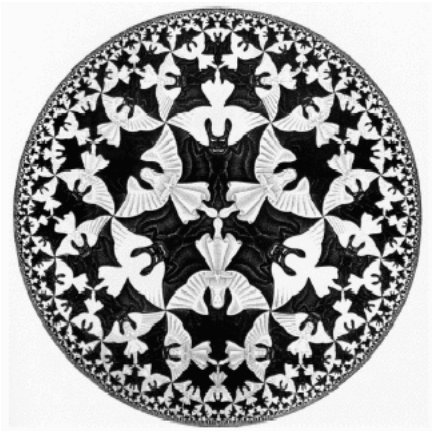
Document Lens, Table Lens

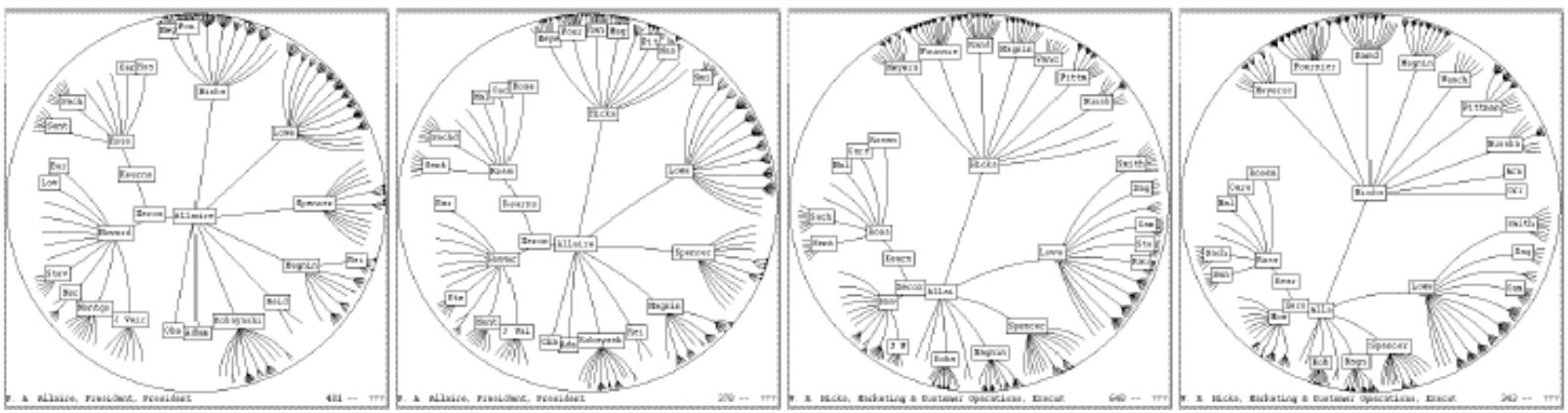


[A review of overview+detail, zooming, and focus+context interfaces. Cockburn, Karlson, and Bederson. ACM Computing Surveys 41(1), 2008. From: Document Lens, Robertson and Mackinlay 1993.
Table Lens, Rao and Card 1994.]

2D Hyperbolic Trees

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

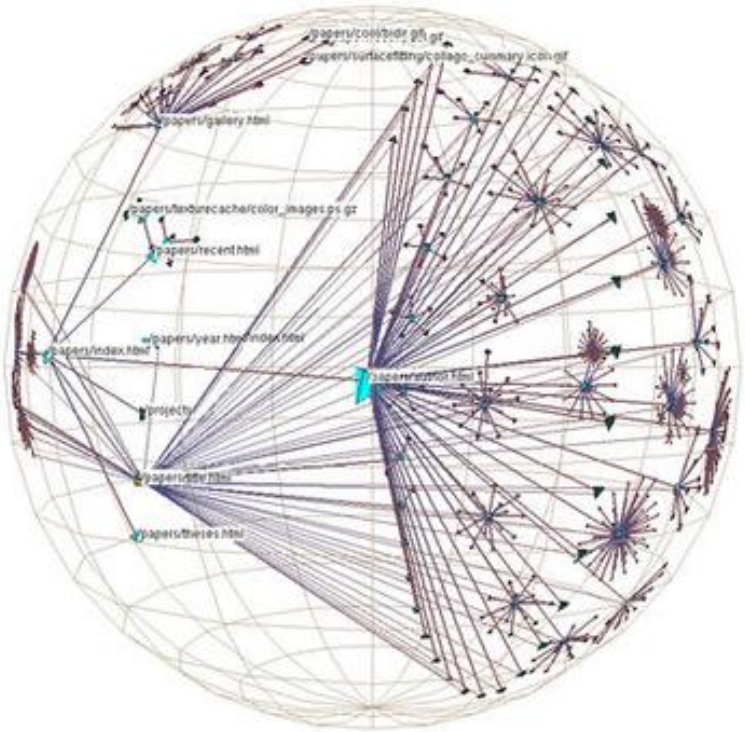




[The Hyperbolic Browser: A Focus + Context Technique for Visualizing Large Hierarchies. John Lamping and Ramana Rao, Proc SIGCHI '95.]

3D Hyperbolic Trees/Graphs

- scalability argument: information density at periphery

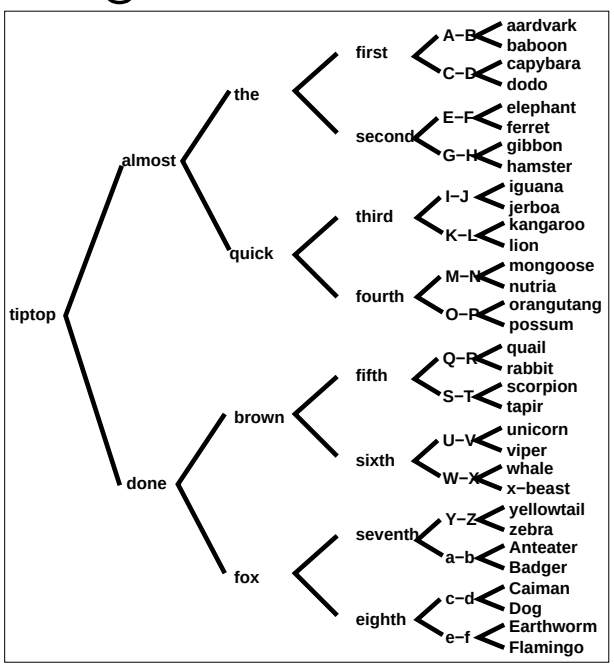


[H3: Laying Out Large Directed Graphs in 3D Hyperbolic Space. Tamara Munzner, Proc InfoVis 97.]

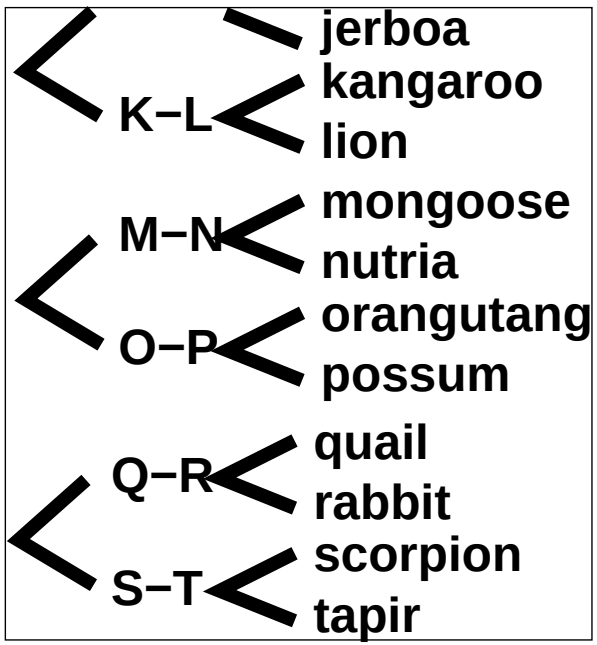
Avoiding Disorientation

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

global overview

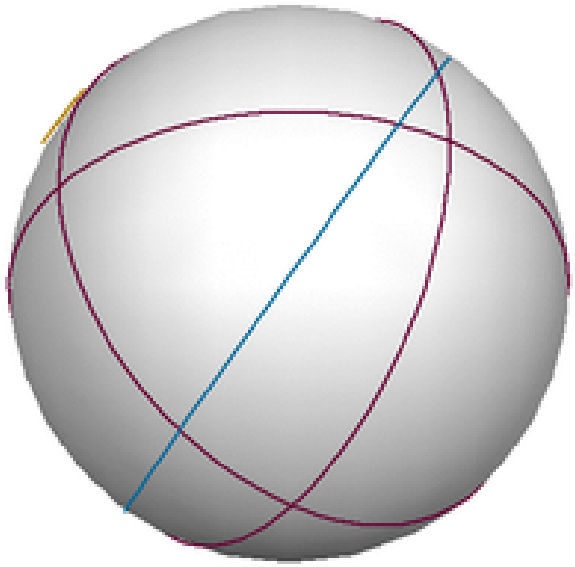


local detail



Noneuclidean Geometry

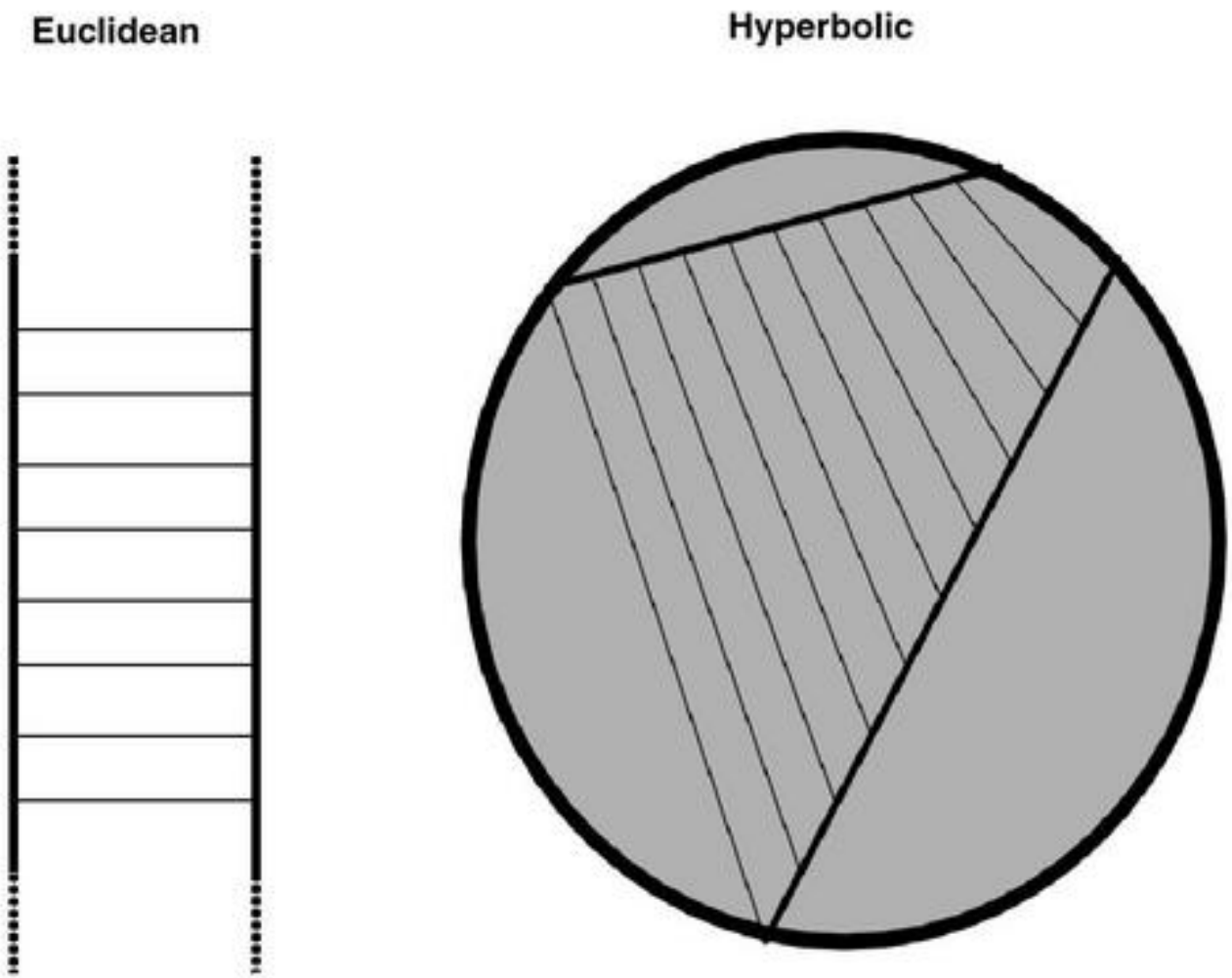
- Euclid's 5th Postulate
  - exactly 1 parallel line
- spherical
  - geodesic = great circle
  - no parallels
- hyperbolic
  - infinite parallels



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

Parallel vs. Equidistant

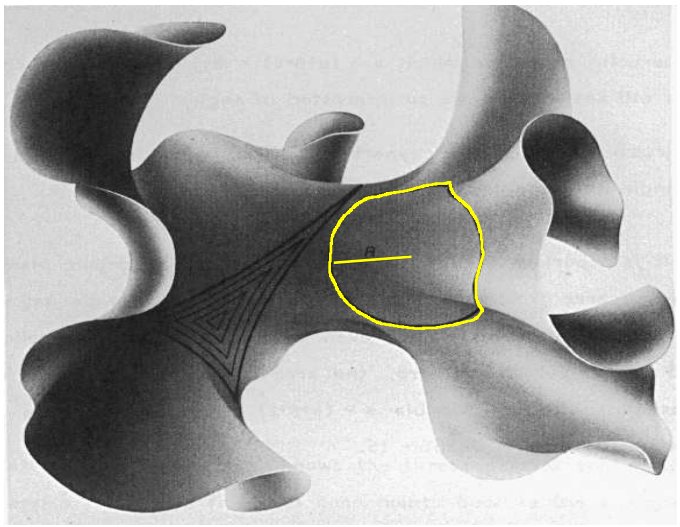
- euclidean: inseparable
- hyperbolic: different



Exponential Amount Of Room

room for exponential number of tree nodes

2D hyperbolic plane
embedded in 3D space



[Thurston and Weeks 84]

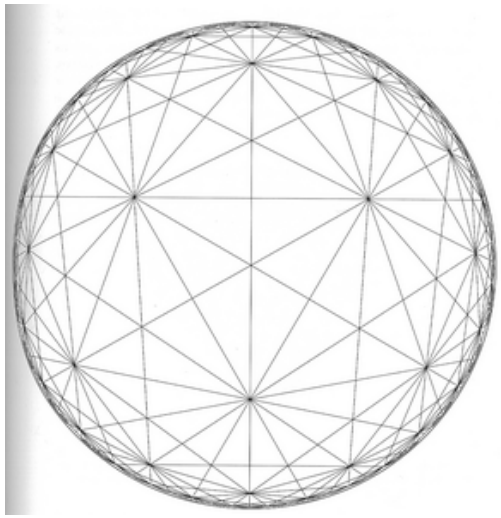
hemisphere area

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

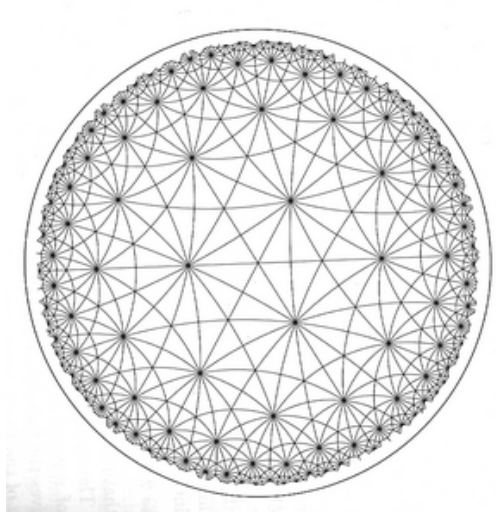
euclidean: polynomial
$2\pi r^2$

2D Hyperbolic Models

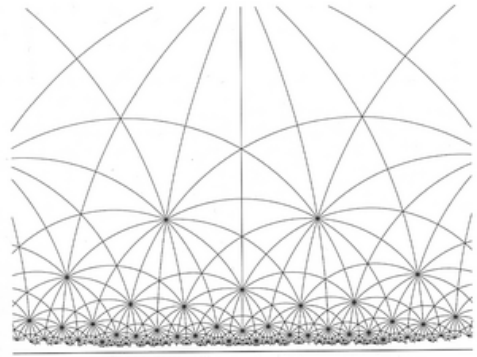
Klein/projective



Poincare/conformal

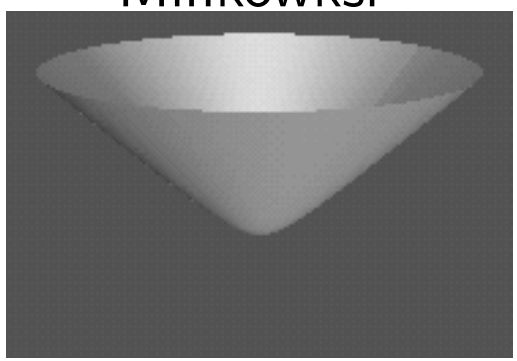


Upper Half Space



[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

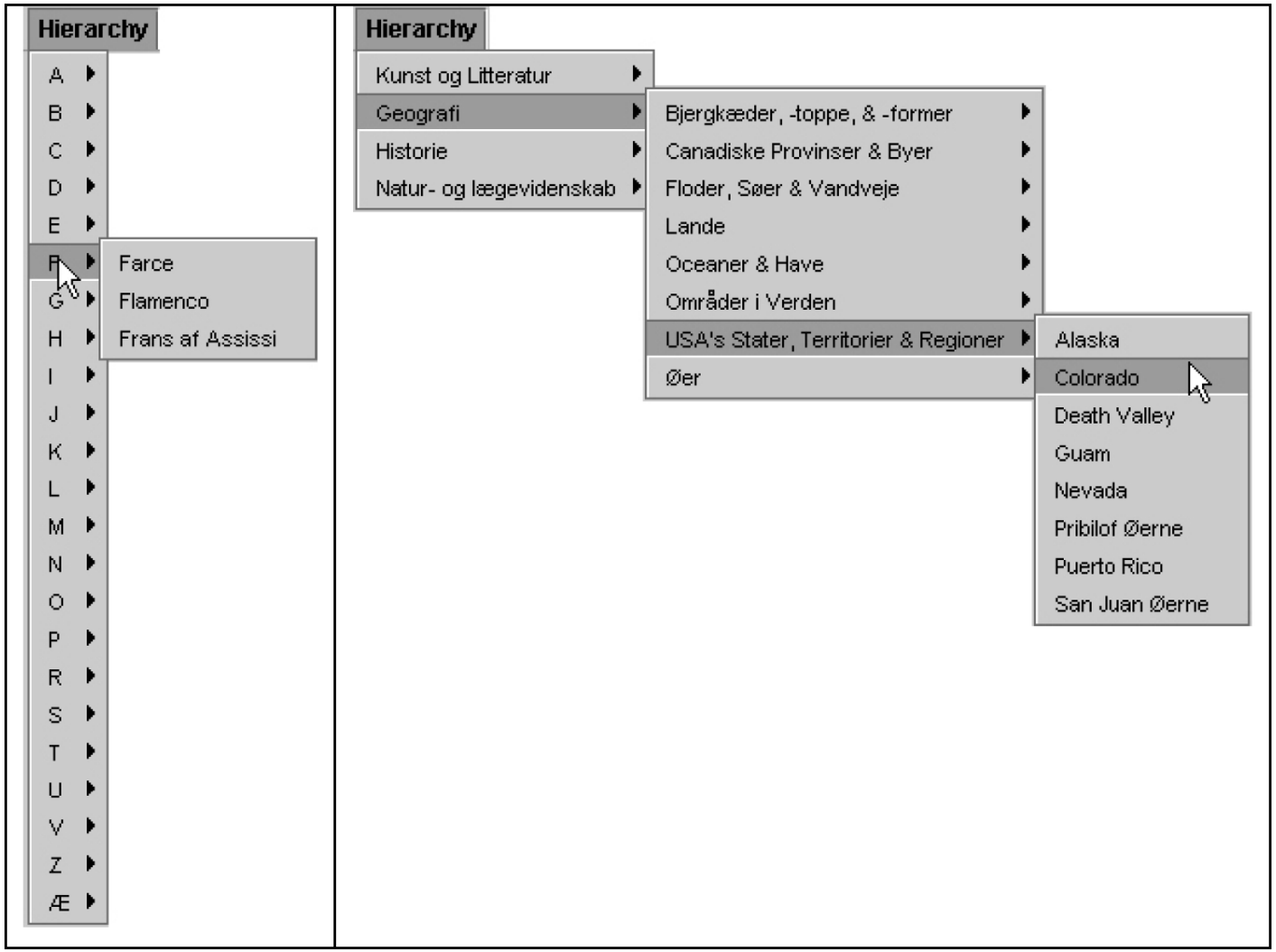
- compare fisheye, overview, multifocus, hierarchical
- measurements
  - performance time, errors
  - preferences
  - eyetracking
- design issues
  - distortion vs. O+D vs. hierarchical temporal
  - landmarks
  - fine-grained navigation: focus-lock when needed

[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



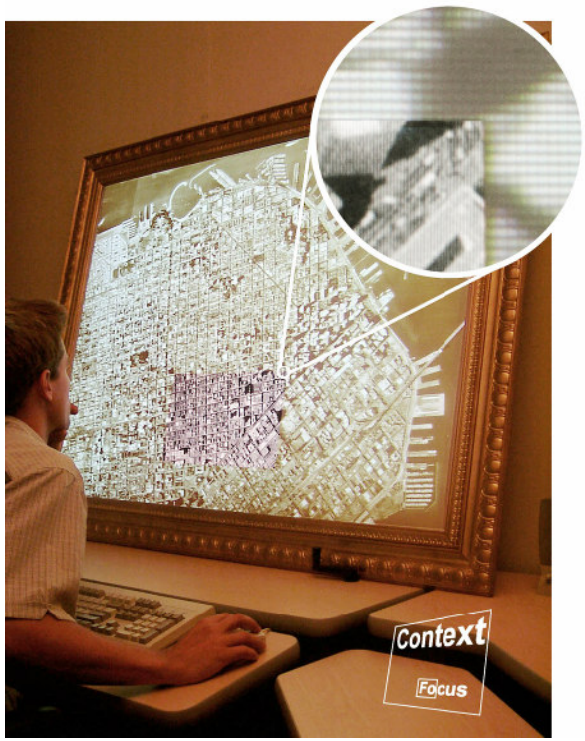
[Untangling the Usability of Fisheye Menus. Kaspar Hornbaek and Morton Hertzum, ACM Transactions on Human-Computer Interaction 14(2), 2007. Fig 5.]

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...

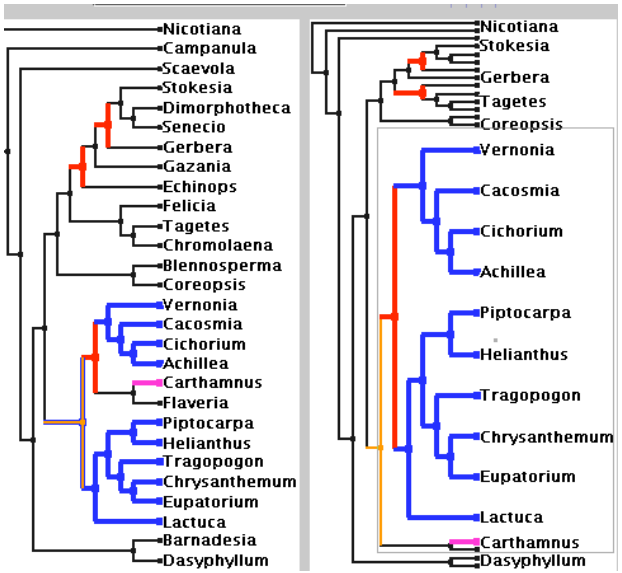
[A Fisheye Follow-up: Further Reflection on Focus + Context. George W. Furnas. SIGCHI 2006.]

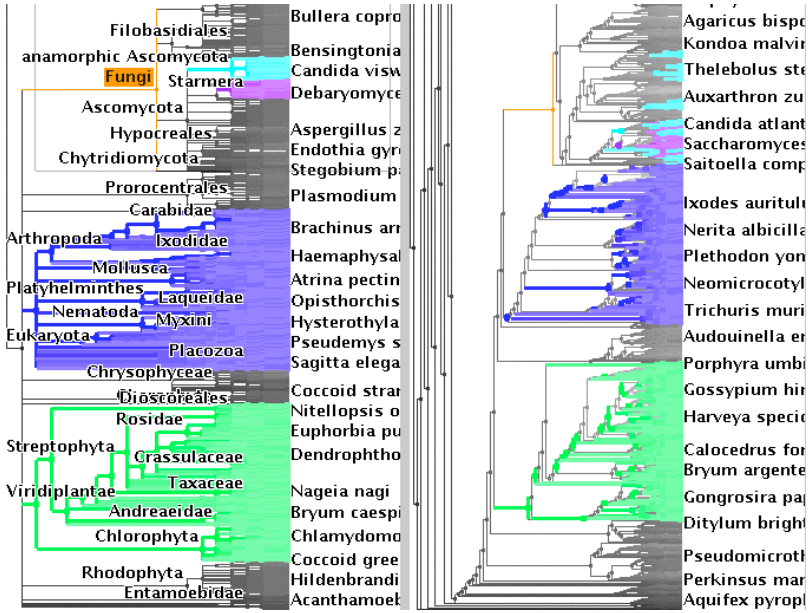
Generalized Fisheye Requirements

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

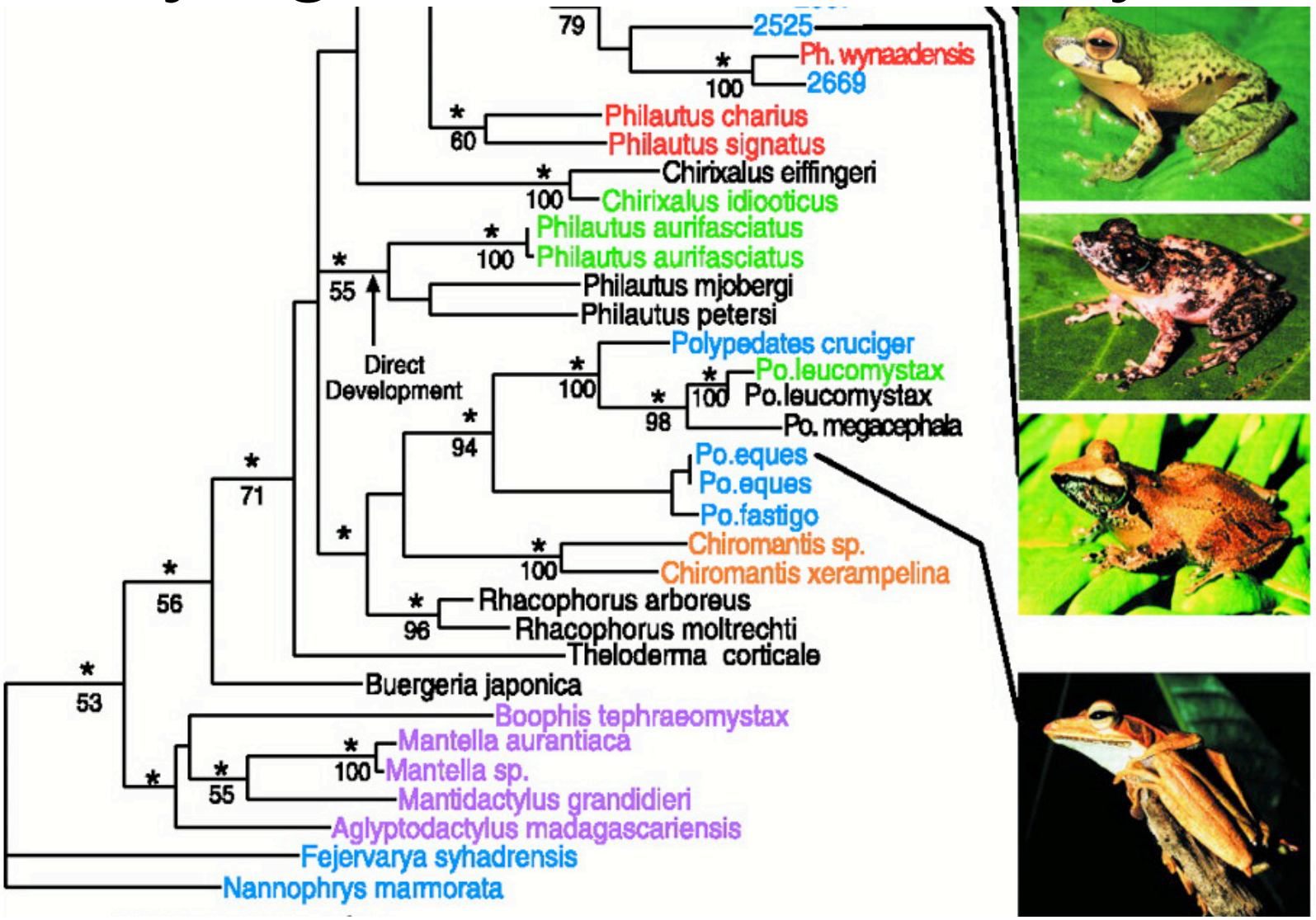
TreeJuxtaposer

- side by side comparison of evolutionary trees



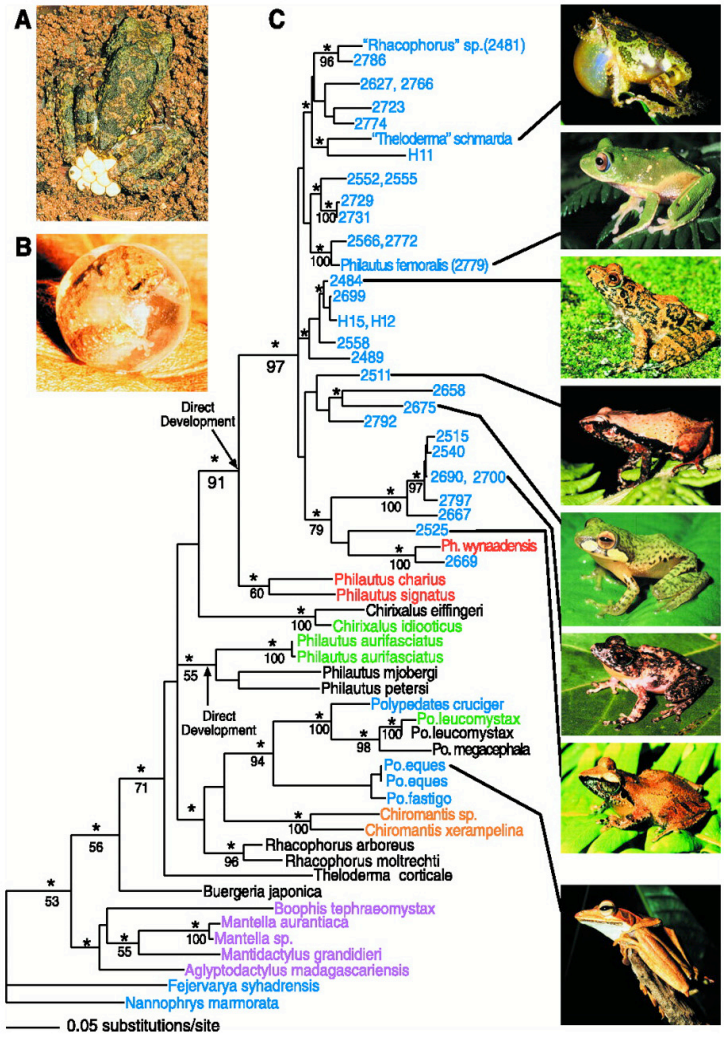


Phylogenetic/Evolutionary Tree



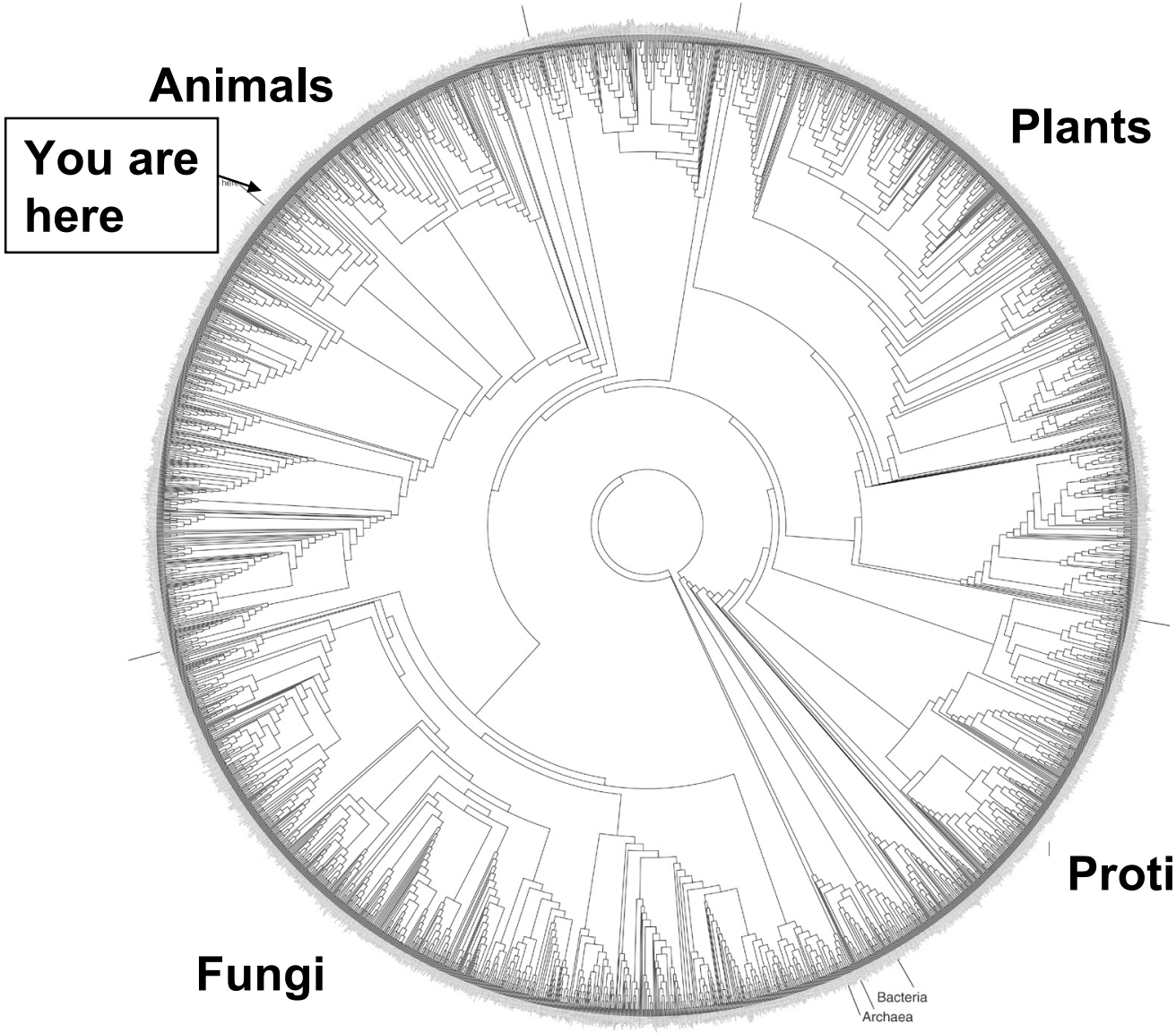
M Meegaskumbura et al., Science 298:379 (2002)

Common Dataset Size Today



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

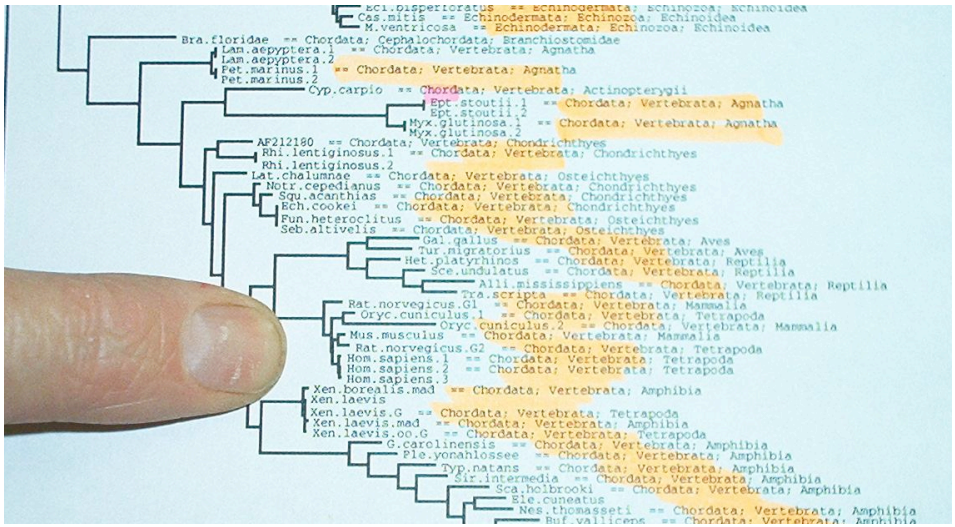
Future Goal: 10M node Tree of Life



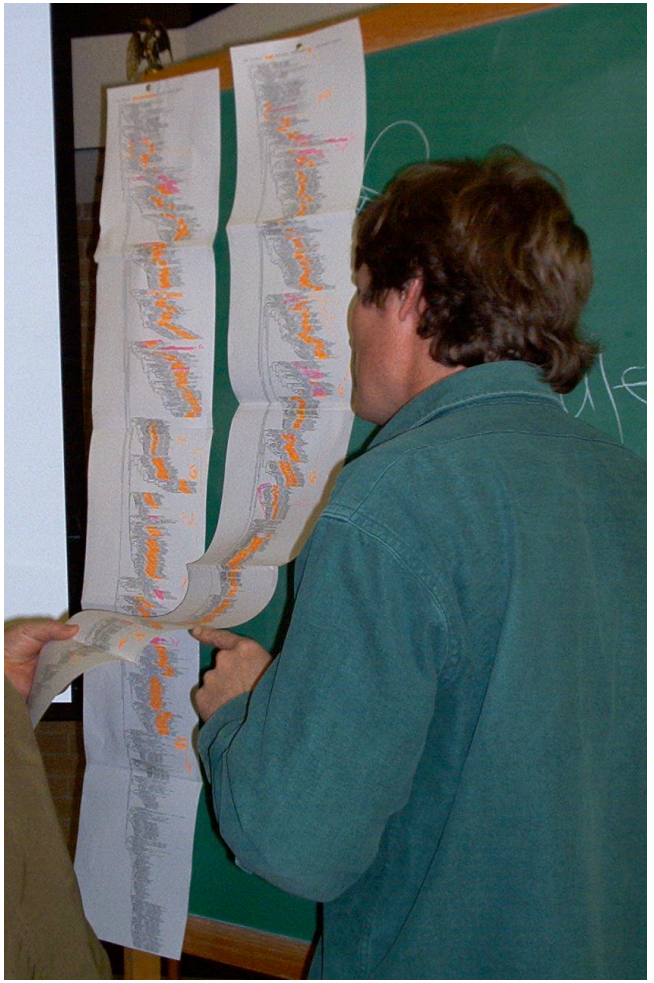
David Hillis, Science 300:1687 (2003)

Paper Comparison: Multiple Trees

focus

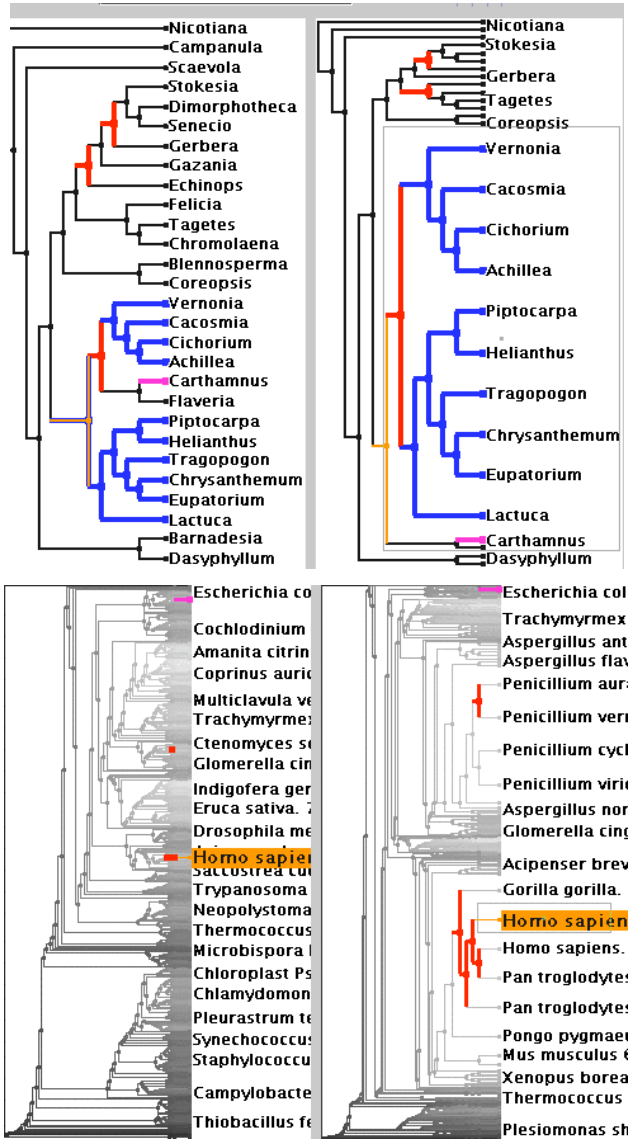


context



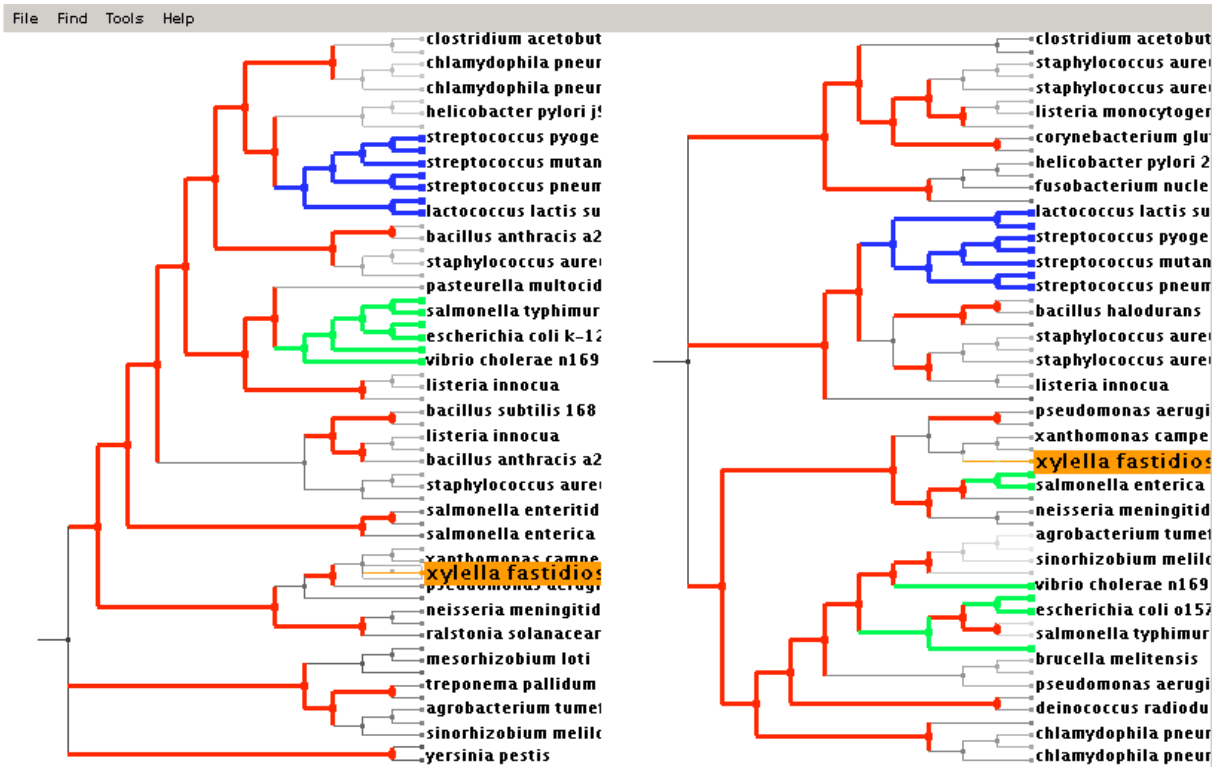
Accordion Drawing

- 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]

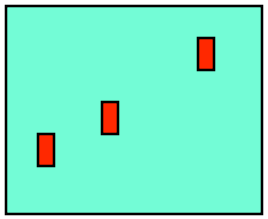


Guaranteed Visibility

- marks are always visible
- easy with small datasets



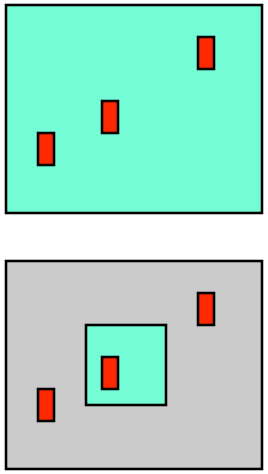
Guaranteed Visibility Challenges



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

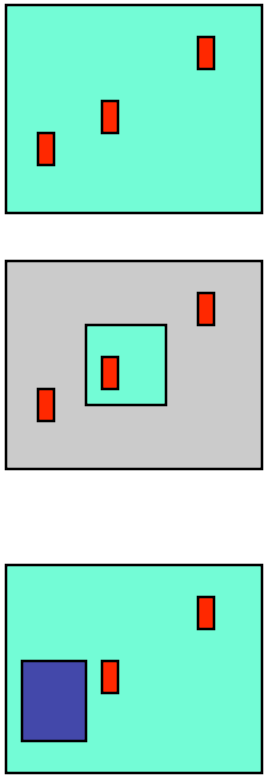
Guaranteed Visibility Challenges

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



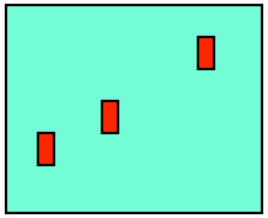
Guaranteed Visibility Challenges

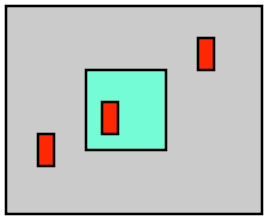
- hard with larger datasets
- reasons a mark could be invisible
  - outside the window
    - AD solution: constrained navigation
  - underneath other marks
    - AD solution: avoid 3D

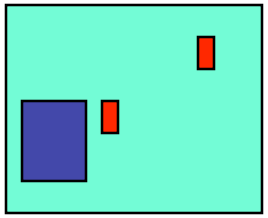


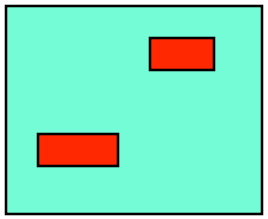
Guaranteed Visibility Challenges

- 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



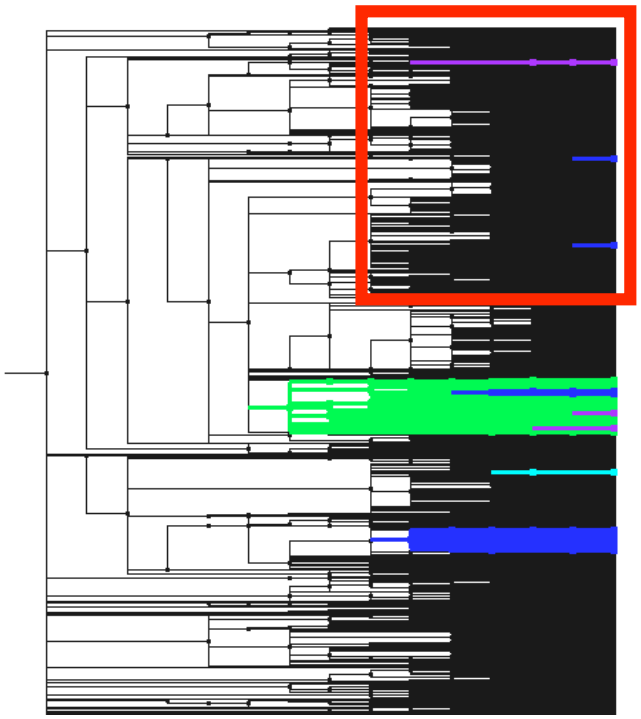




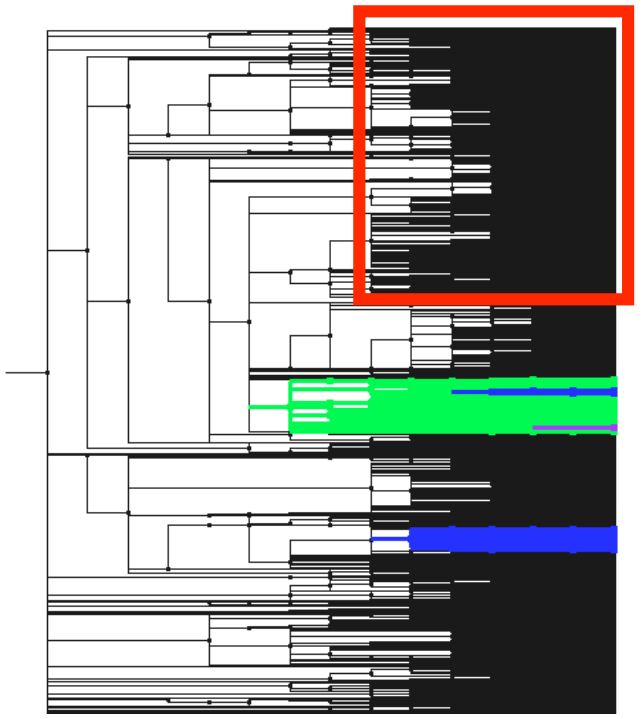


Guaranteed Visibility: Small Items

- Naïve culling may not draw all marked items



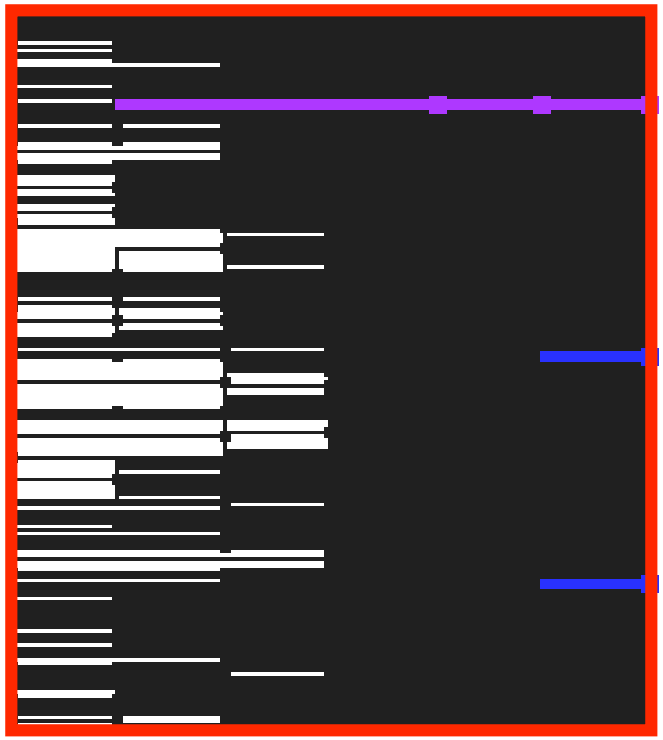
Guaranteed visibility of marks



No guaranteed visibility

Guaranteed Visibility: Small Items

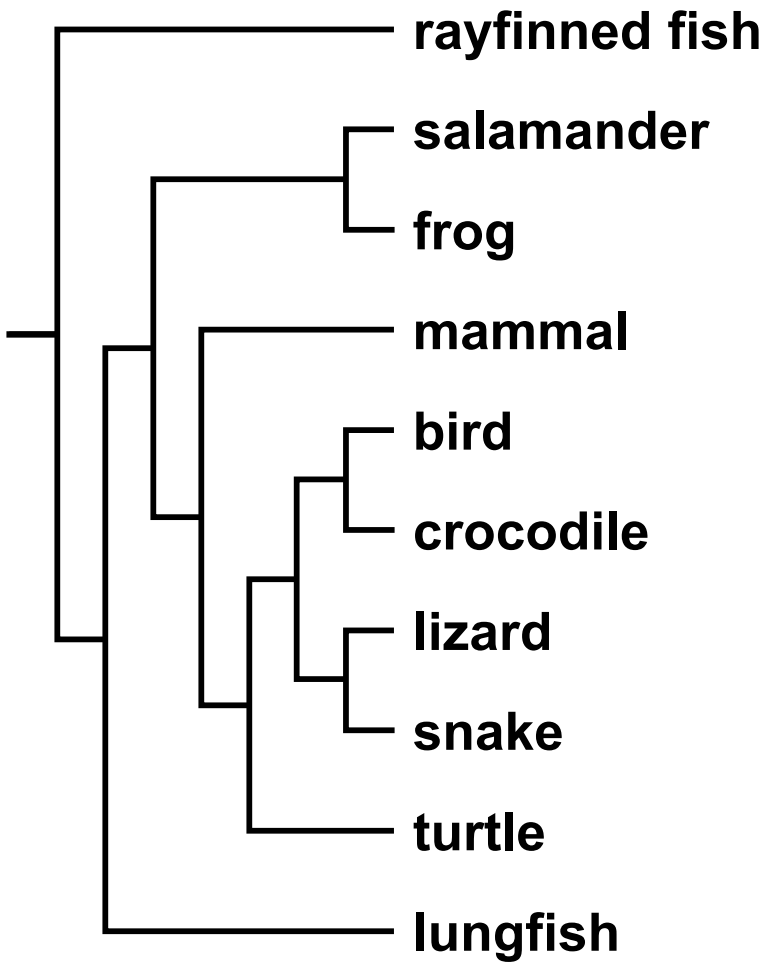
- Naïve culling may not draw all marked items

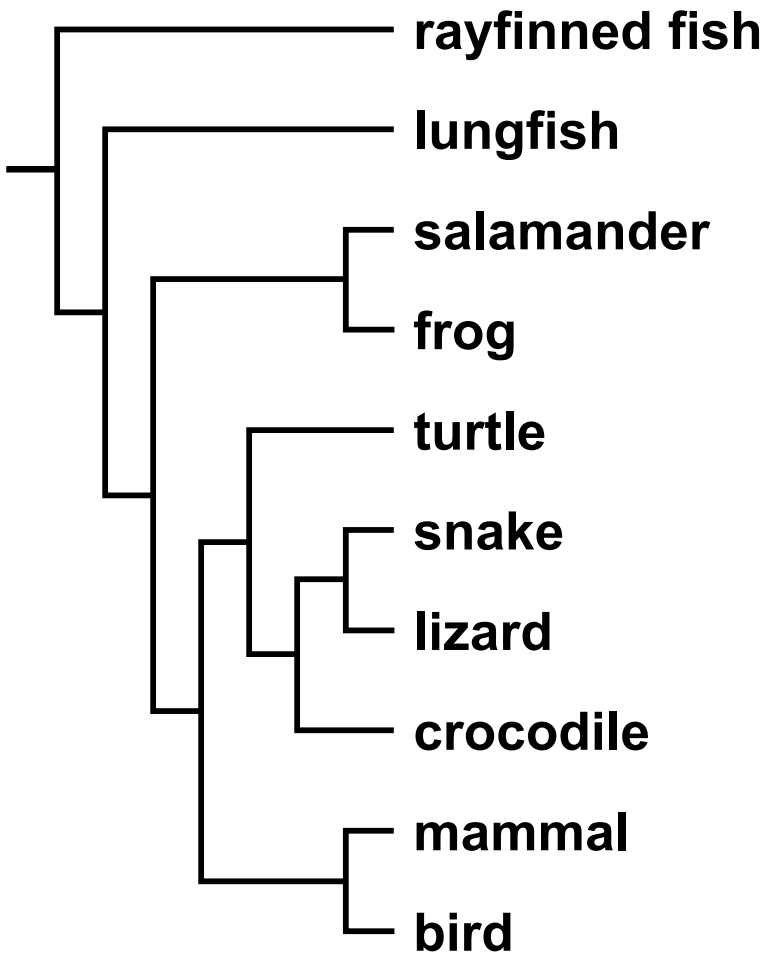


Guaranteed visibility of marks

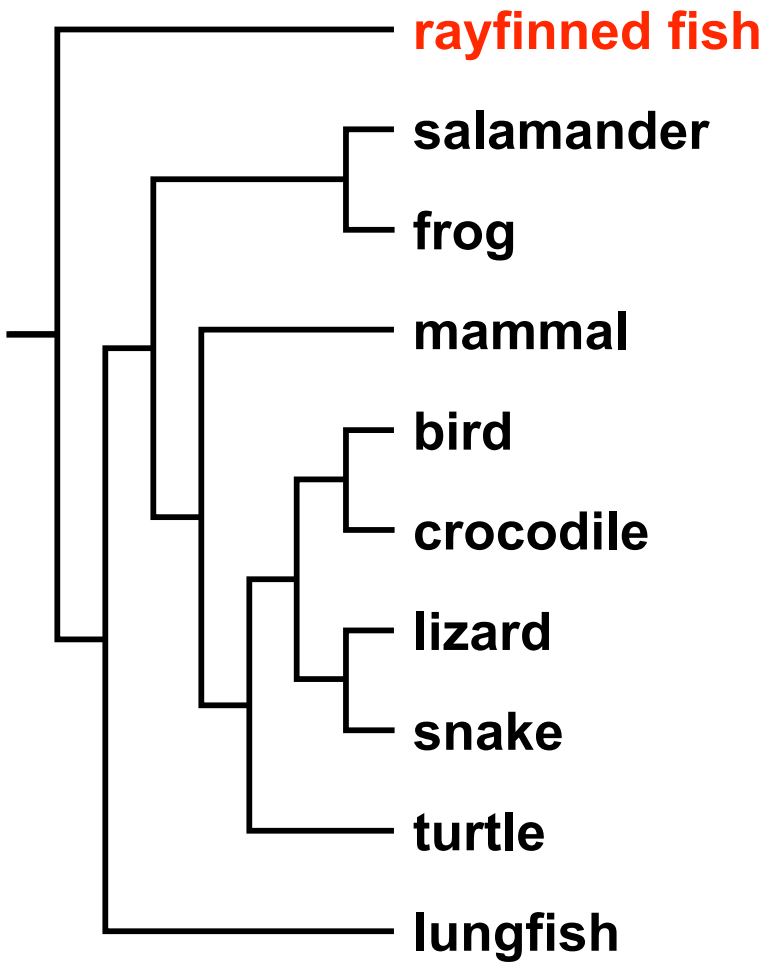
No guaranteed visibility

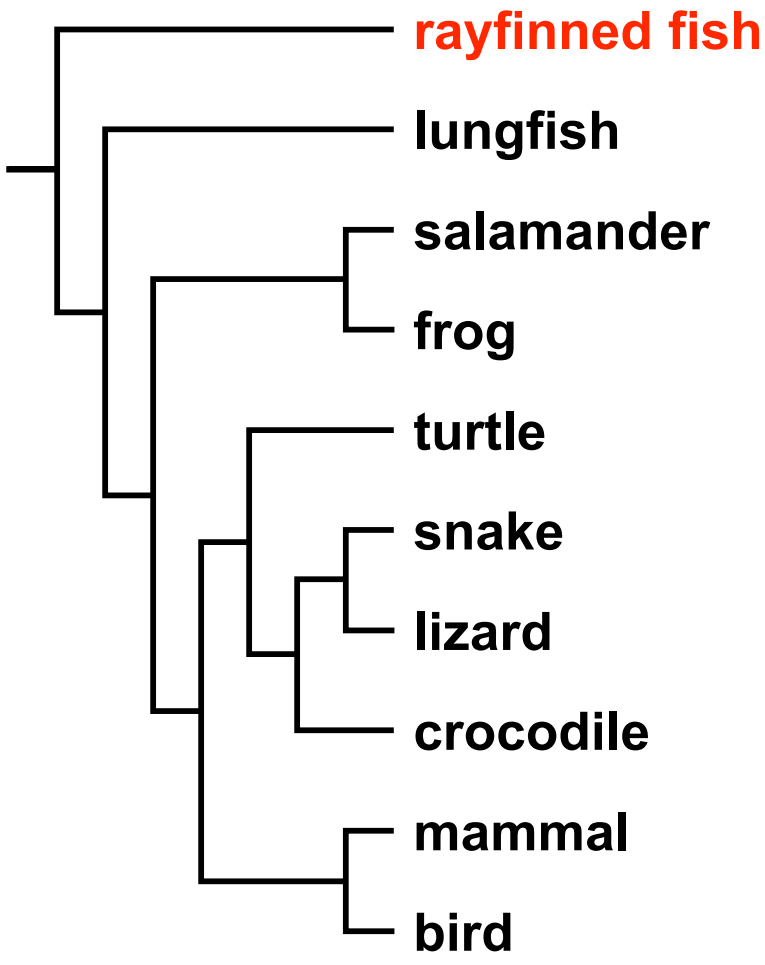
Structural Comparison



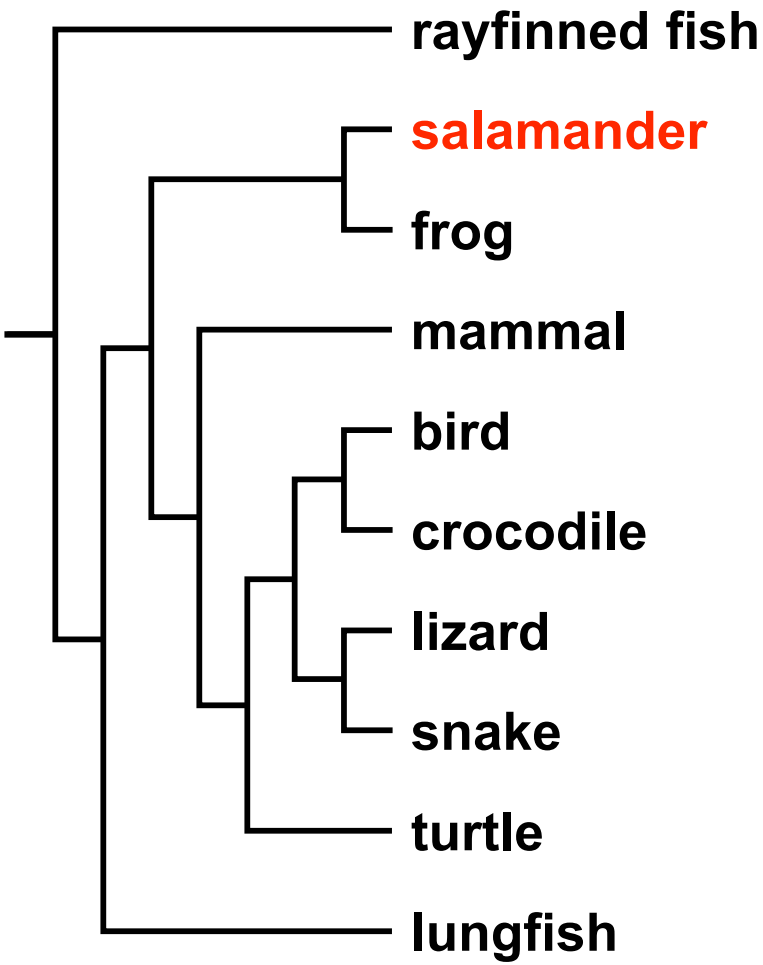


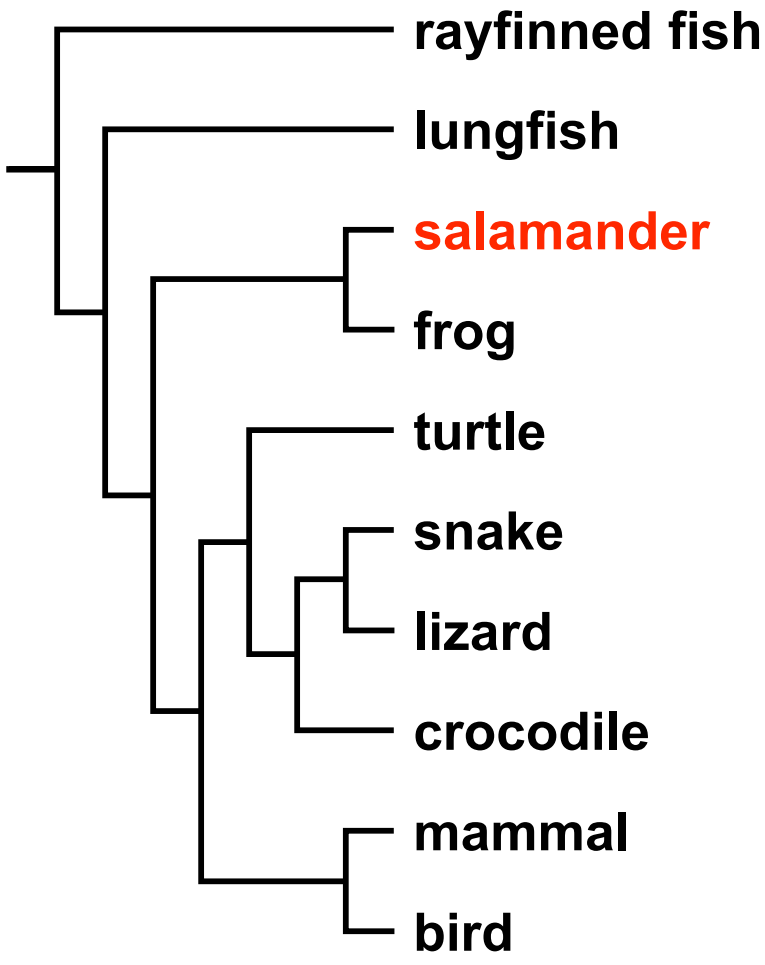
Matching Leaf Nodes



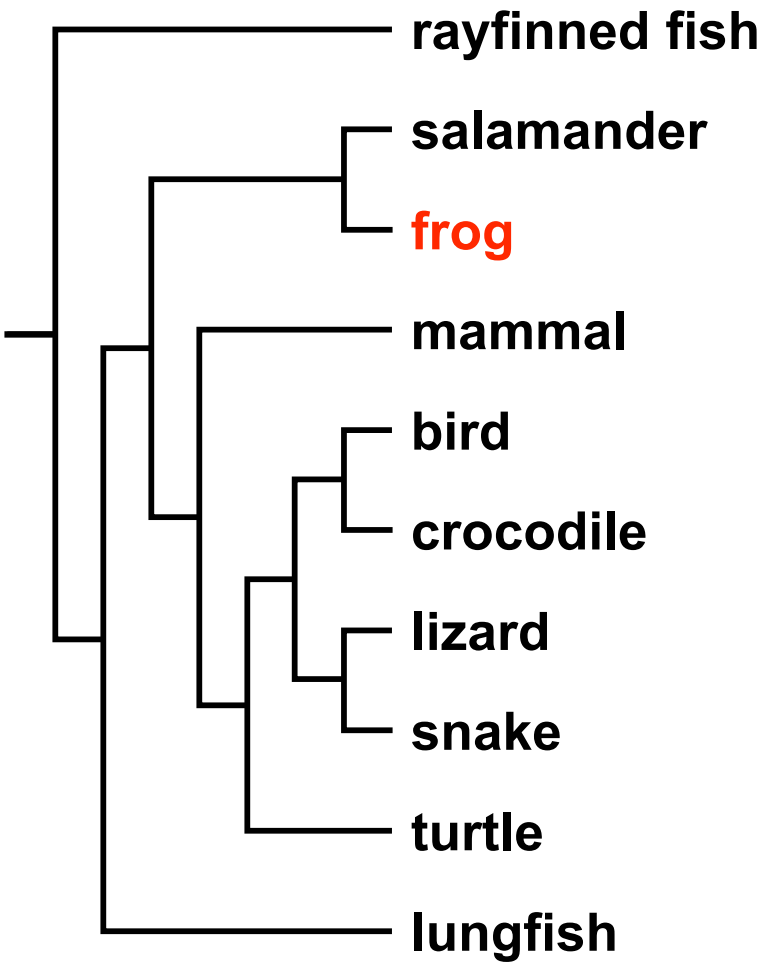


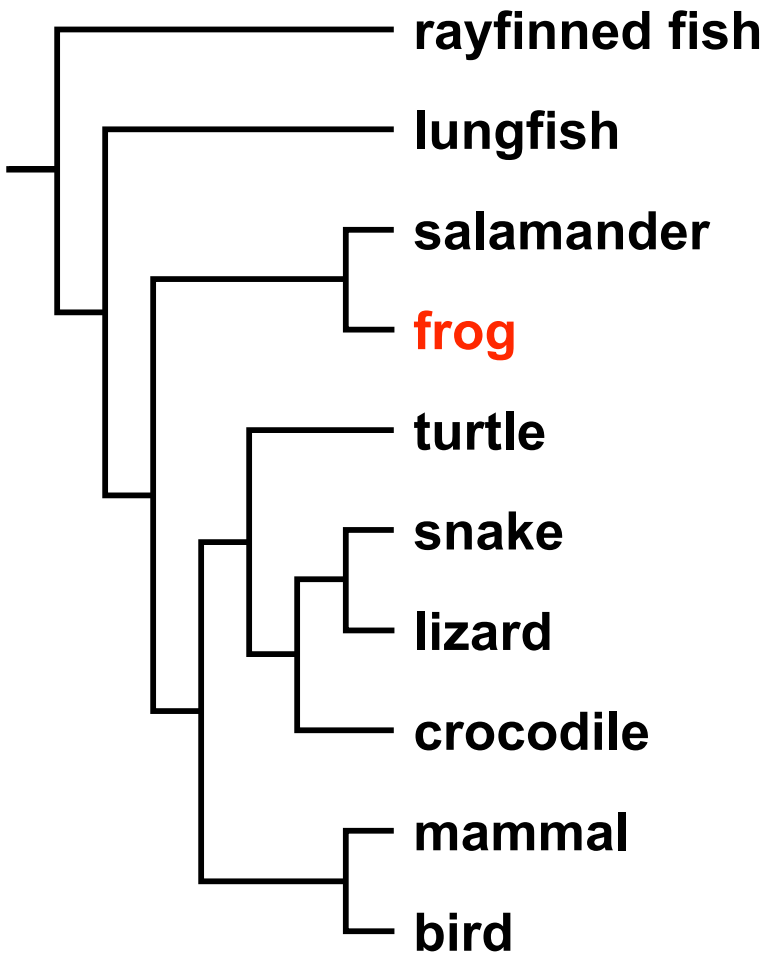
Matching Leaf Nodes



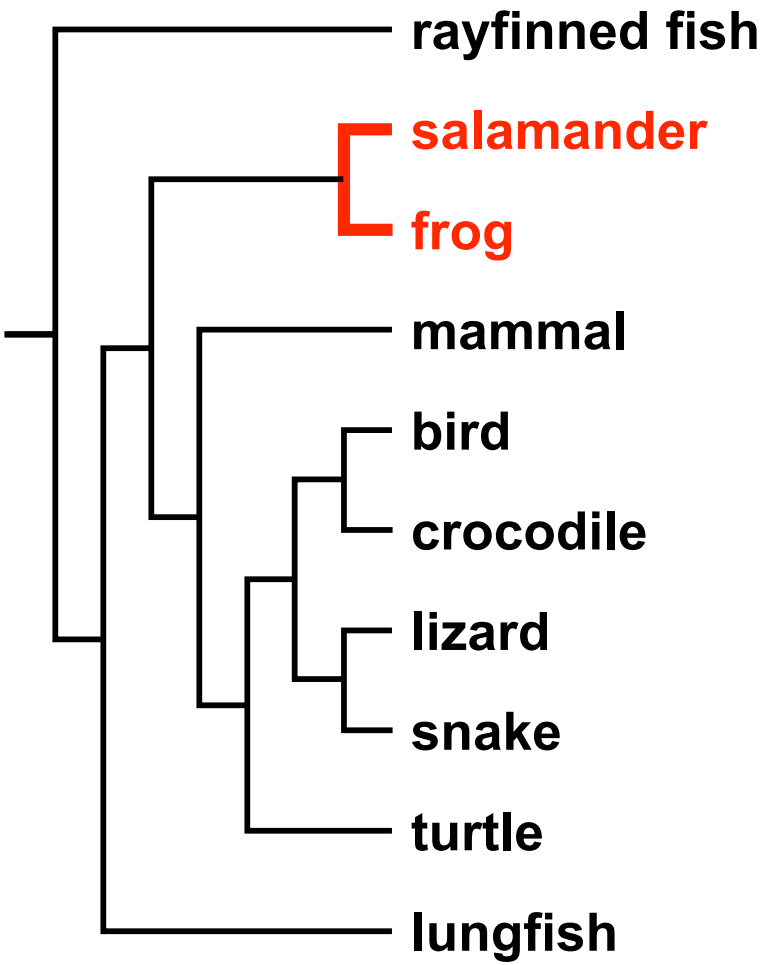


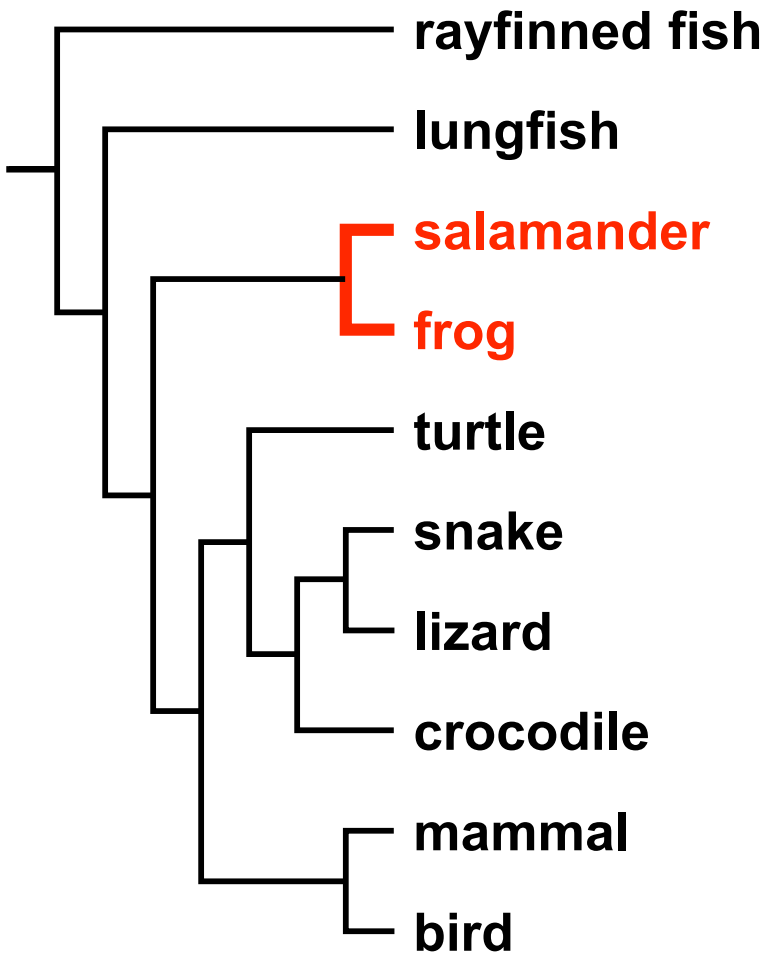
Matching Leaf Nodes



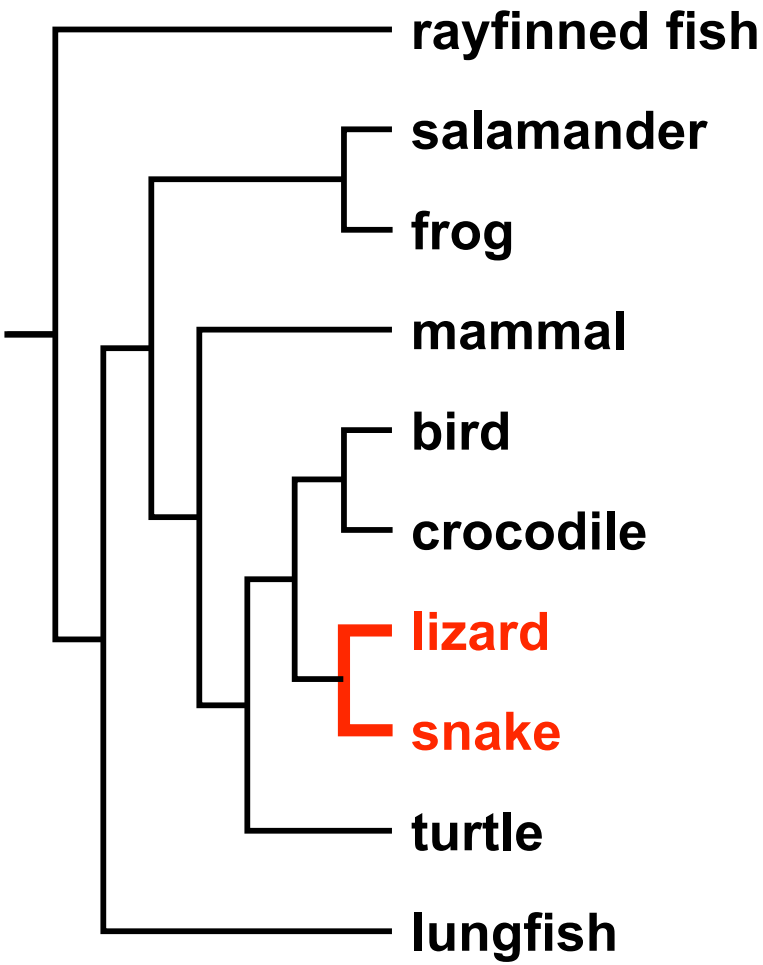


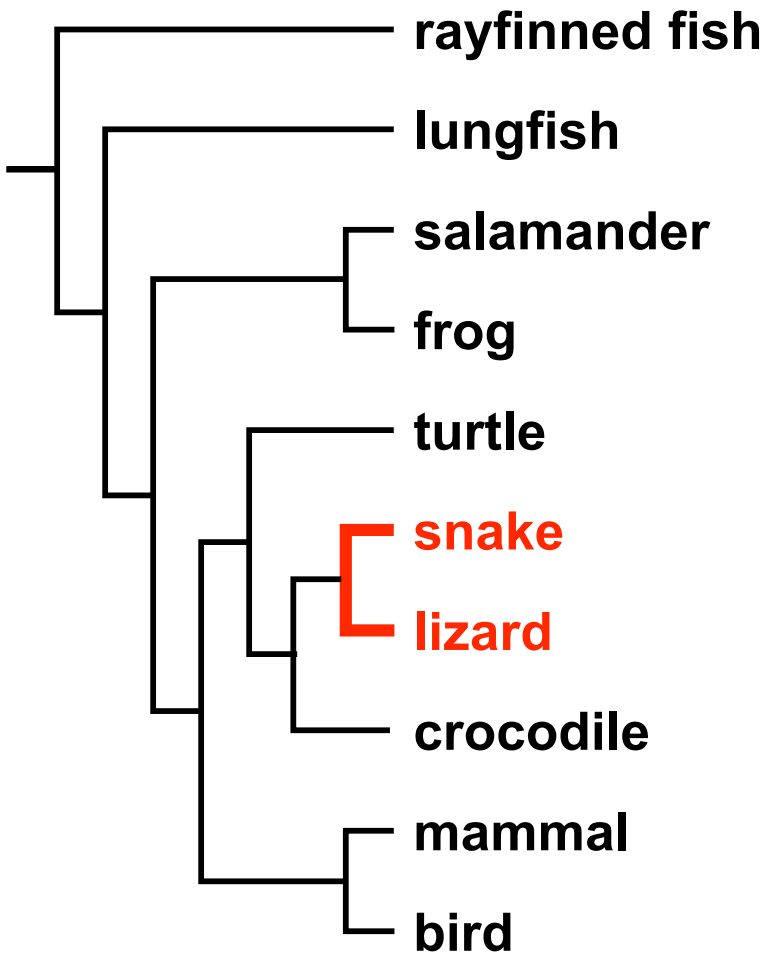
Matching Interior Nodes



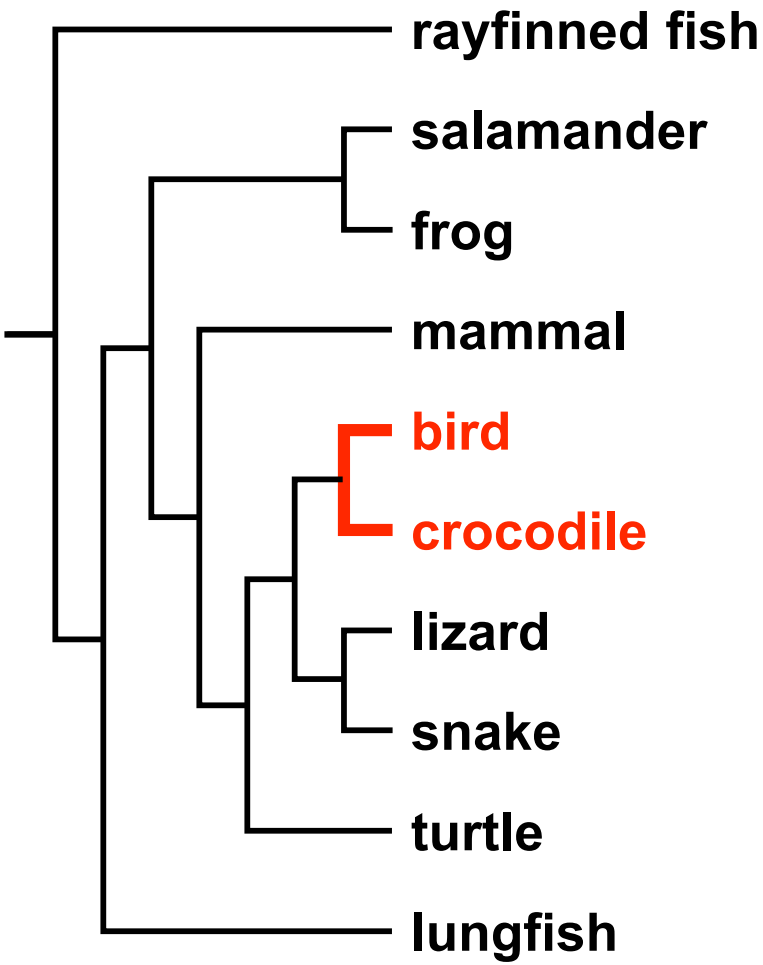


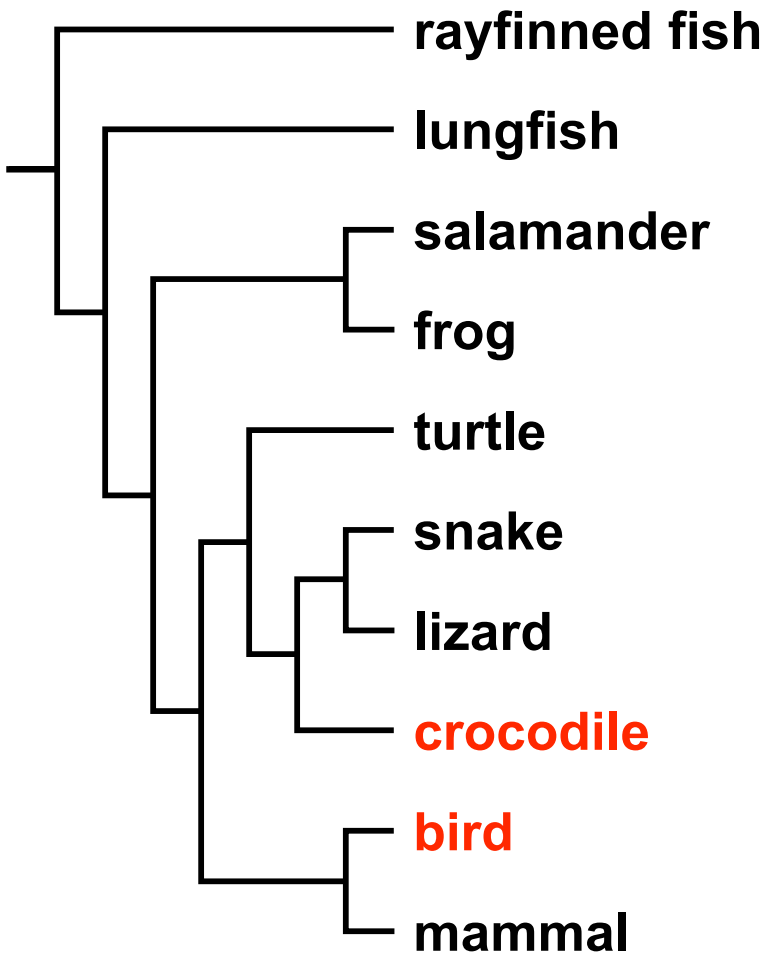
Matching Interior Nodes



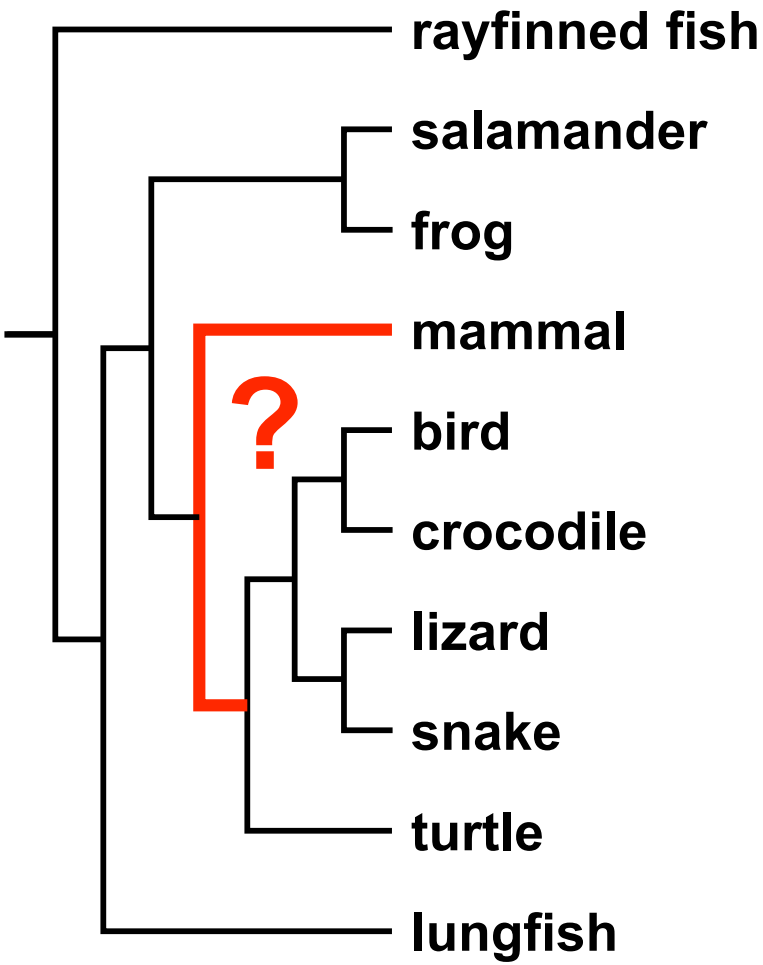


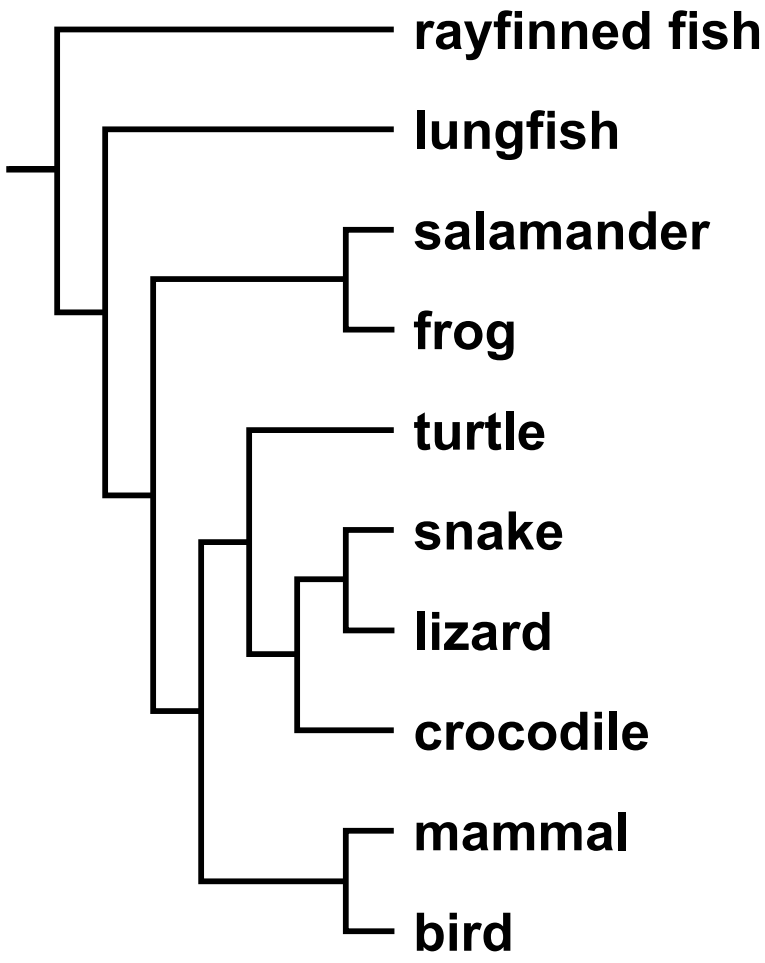
Matching Interior Nodes



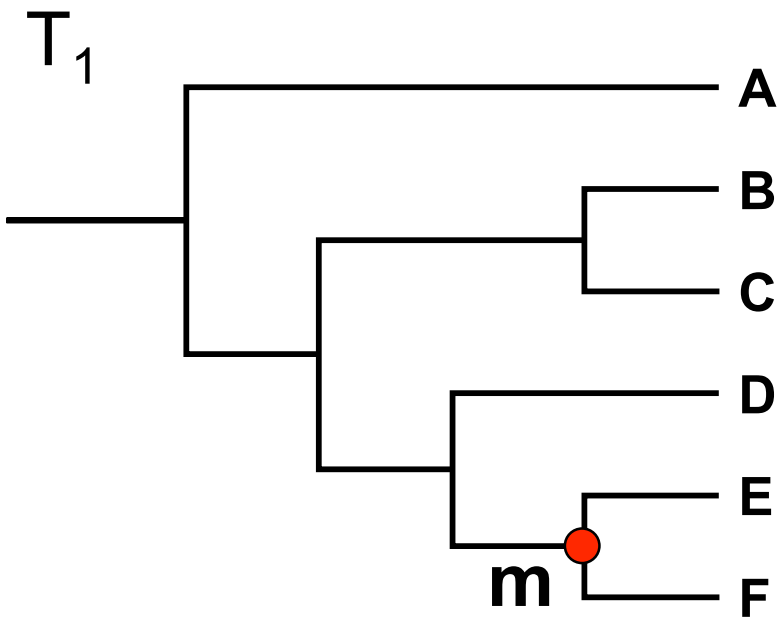


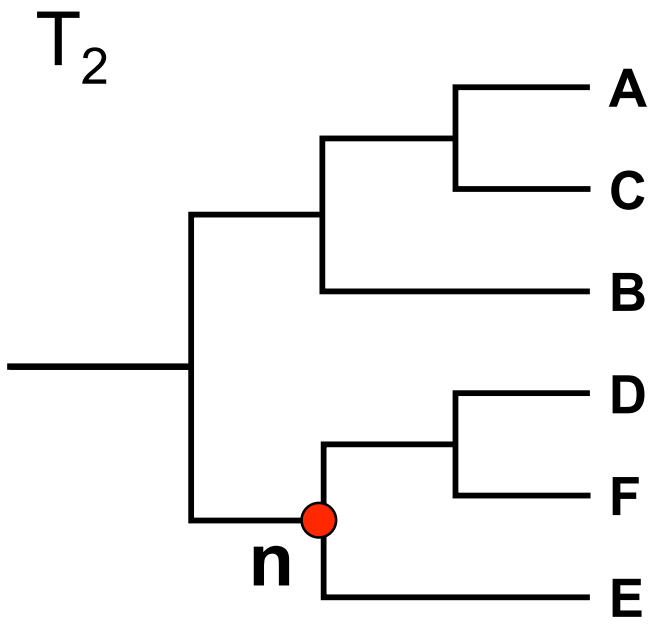
Matching Interior Nodes





Similarity Score: S(m,n)



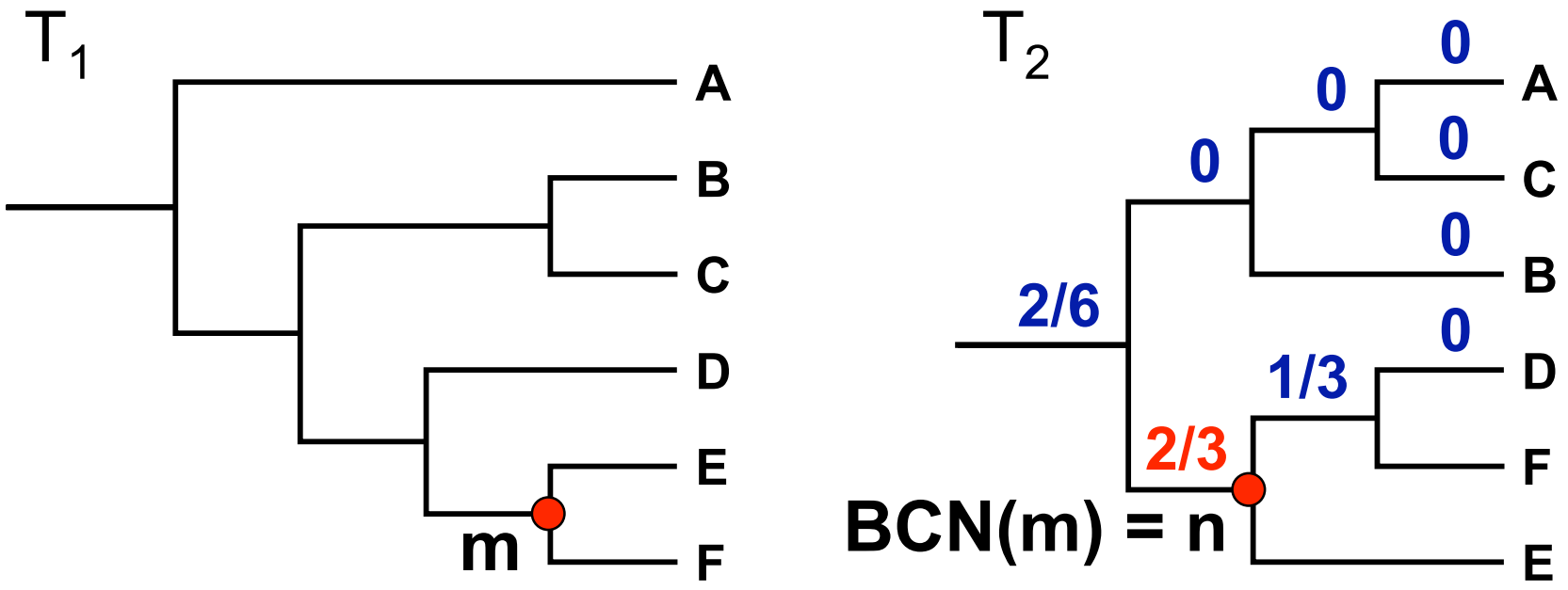


$$L(\text{m}) = \{\text{E},\text{F}\}$$

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

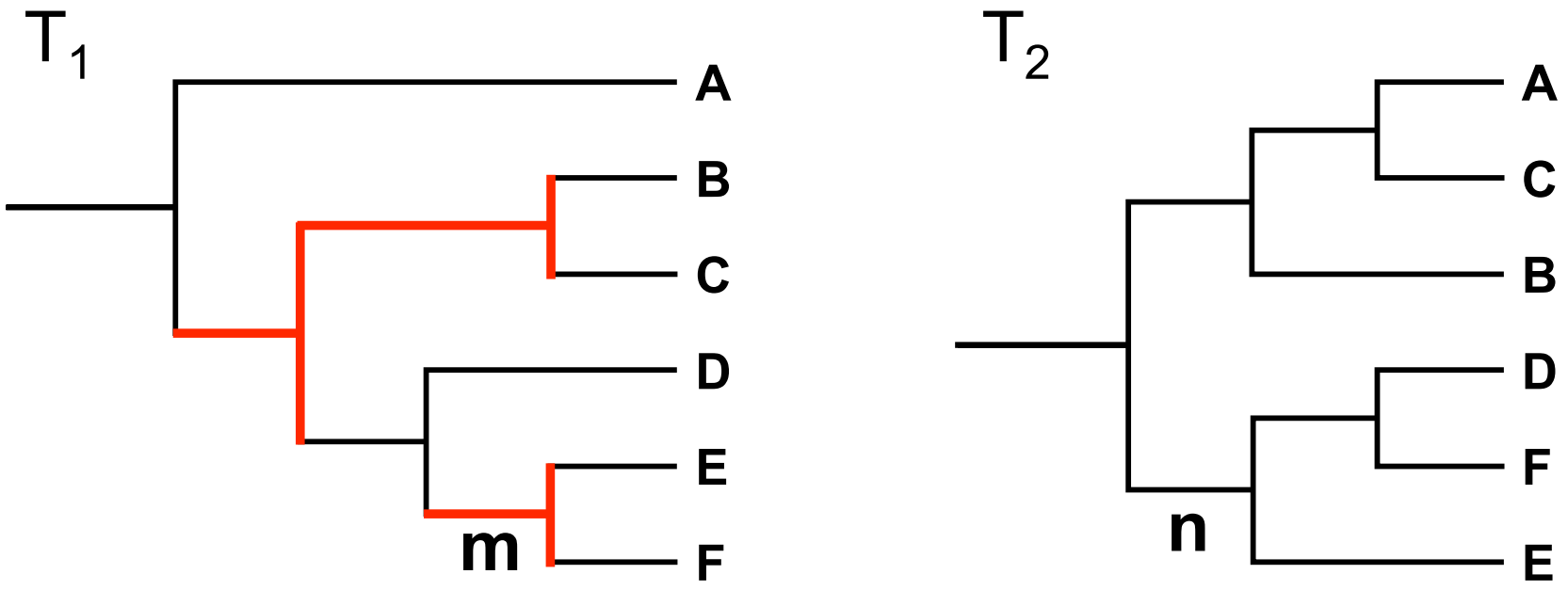
$$S(\text{m},\text{n}) = \frac{|L(\text{m}) \cap L(\text{n})|}{|L(\text{m}) \cup L(\text{n})|} = \frac{|\{\text{E},\text{F}\}|}{|\{\text{D},\text{E},\text{F}\}|} = \frac{2}{3}$$

Best Corresponding Node



- $\mathrm{BCN}(m) = \mathrm{argmax}_{v \in T_2} (S(m, v))$
  - 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