Pixel-Adaptive Visual Comparison Between Many Phylogenetic Trees

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Asilomar Microcomputer Workshop #50
25 Apr 2024

http://www.cs.ubc.ca/~tmm/talks.html#amw24

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@tamaramunzner

Hi again, 15 years later!

- still doing data visualization
  - yet more papers / projects / videos / software
  - I edit a book series

http://www.cs.ubc.ca/~tmm/talks.html#amw24

Visualization book series highlights

- Data Sketches, by Nadieh Bremer & Shirley Wu
- Making with Data, by multitudes
- Building Science Graphics, by Jen Christiansen

https://www.routledge.com/AK-Peters-Visualization-Series/book-series/CRCVIS

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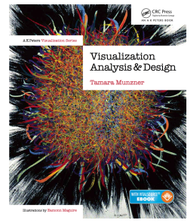

Visualization Analysis and Design. Munzner. CRC Press, AK Peters Visualization Series, 2014.

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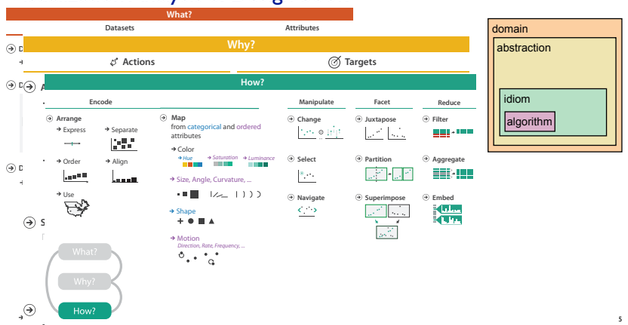
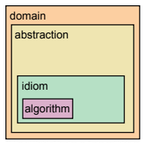
Visualization Analysis & Design book



Nested model: Four levels of visualization concerns



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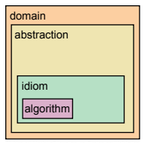

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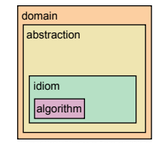

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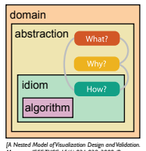

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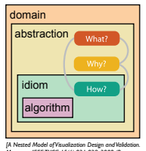

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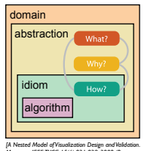

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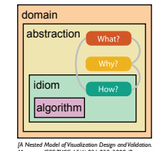

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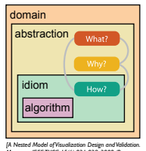

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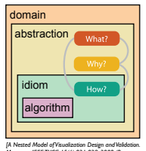

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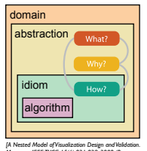
  - efficient computation



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Algorithm
Your code is too slow

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Validation solution: Use methods from appropriate fields at each level

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Measure human time with lab experiment (*lab study*)

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technique-driven work

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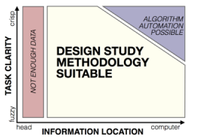


Michael Sedlmair

Miriah Meyer

Design Study Methodology

Reflections from the Trenches and from the Stacks

http://www.cs.ubc.ca/labs/imager/tr/2012/dsm/

Design Study Methodology: Reflections from the Trenches and from the Stacks.
Sedlmair, Meyer, Munzner. IEEE Trans. Visualization and Computer Graphics 18(12): 2431-2440, 2012 (Proc. InfoVis 2012).

Lessons learned from the trenches: 20+ between us


Cerebral genomics


MizBee genomics


Pathline genomics


MulteeSum genomics


Vismon fisheries management


QuestVis sustainability


WiKeVis in-car networks


MostVis in-car networks


Car-X-Ray in-car networks


ProgSpy2010 in-car networks


RelEx in-car networks


Cardiogram in-car networks


AutobahnVis in-car networks


VisTra in-car networks


Constellation linguistics


LibVis cultural heritage


Caidants multicast

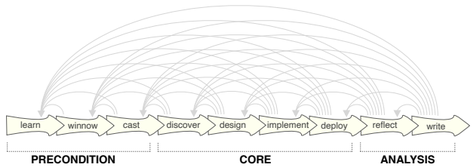

SessionViewer web log analysis


LiveRAC server hosting


PowerSetViewer data mining

9-stage framework

iterative



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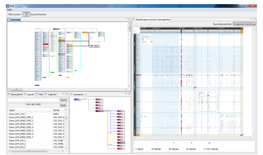
RelEx

Visualization for Actively Changing Overlay Network Specifications



joint work with:
Michael Sedlmair, Annika Frank, Andreas Butz

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Zipeng Liu

Shing Hei Zhan

Aggregated Dendrograms

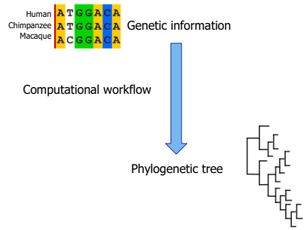
for Visual Comparison Between Many Phylogenetic Trees

http://www.cs.ubc.ca/labs/imager/tr/2019/adview

Aggregated Dendrograms for Visual Comparison Between Many Phylogenetic Trees.
Liu, Zhan, Munzner. IEEE Trans. Visualization and Computer Graphics (TVCG) 26(9):2732-2747, 2019.

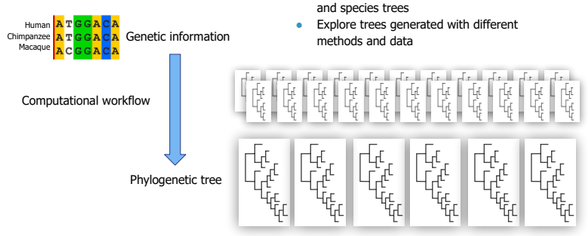
Phylogenetic tree

Evolutionary relationships of organisms

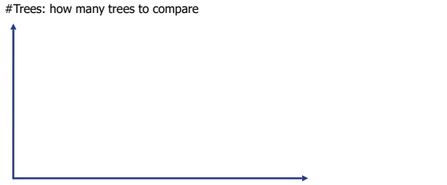


Many phylogenetic trees

- Understand relationships between genes and species trees
- Explore trees generated with different methods and data



Scalability of existing tree comparison systems



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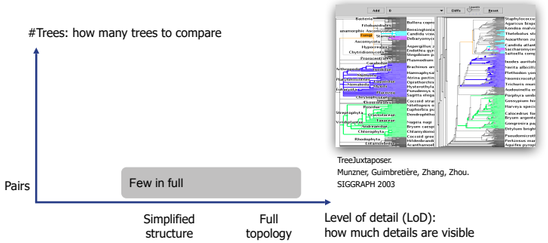

TreeJuxtaposer.
Munzner, Guimbretière, Zhang, Zhou.
SIGGRAPH 2003

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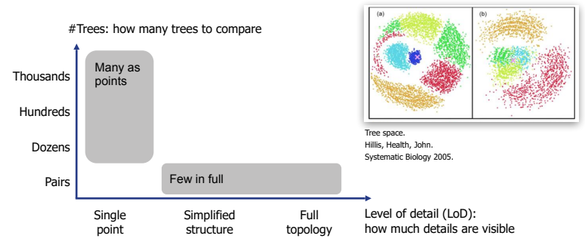

Tree space.
Hillis, Heath, John.
Systematic Biology 2005.

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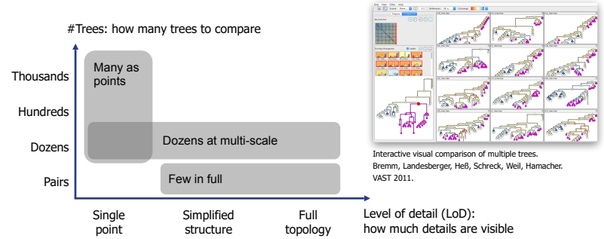
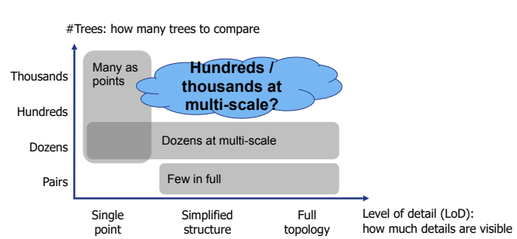


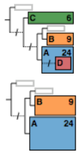
Interactive visual comparison of multiple trees.
Bremm, Landesberger, Hess, Schreck, Weil, Hamacher.
VAST 2011.

Comparing many phylogenetic trees



Contributions at abstraction, idiom, & algorithm levels

- data and task **abstractions** for comparison of phylogenetic trees
- new visual encoding **idiom**: Aggregated Dendrogram
  - compact tree representation that focuses on selected subtrees
  - **algorithm** that adapts to available screen space
- interactive multi-view tool: ADView
  - covers multiple levels of details for tree comparison



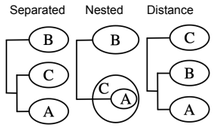
Data abstraction: Trees

Reference tree vs. Tree collection

Task abstraction

Task abstraction

Topological relationships & distance between subtrees / leaf nodes



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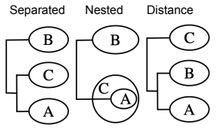
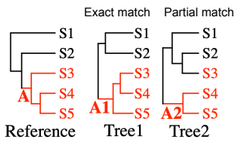
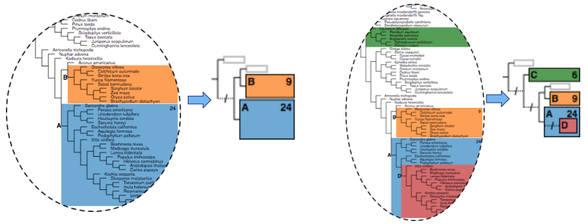
Leaf node memberships compared to reference tree





Aggregated Dendrogram: Intuition

Use glyphs to compress a tree according to user selections



Visual design: focus + context

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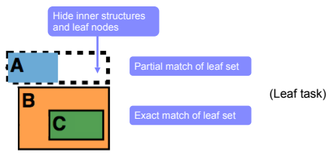
  - selected subtrees



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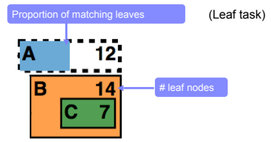

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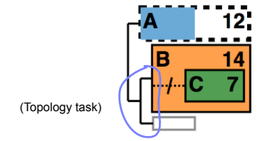
  - topological relationships between them



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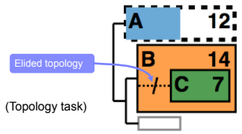
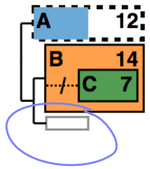


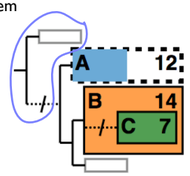
Visual design: focus + context

- focus
  - selected subtrees
  - topological relationships between them
- context
  - neighboring subtrees



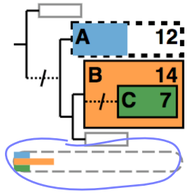
Visual design: focus + context

- focus
  - selected subtrees
  - topological relationships between them
- context
  - neighboring subtrees
  - upstream topology and root



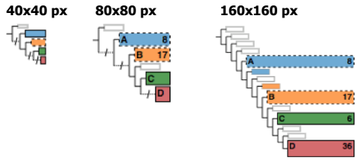
Visual design: focus + context

- focus
  - selected subtrees
  - topological relationships between them
- context
  - neighboring subtrees
  - upstream topology and root
  - missing leaf nodes

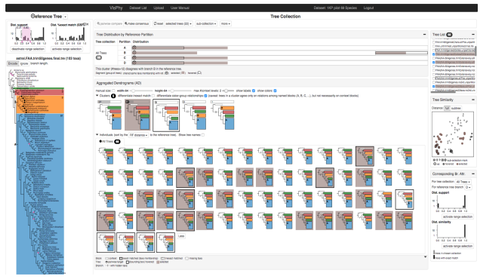


Visual design: algorithm adapts to space

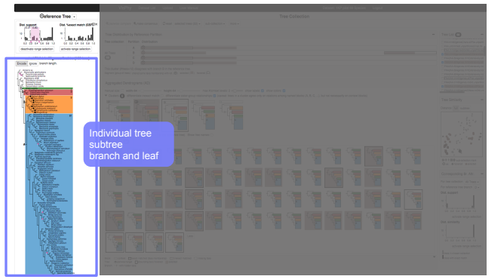
- show more info when space permitted
  - labels
  - # leaf nodes
  - neighboring blocks



ADView interface: Multi-level structure across views

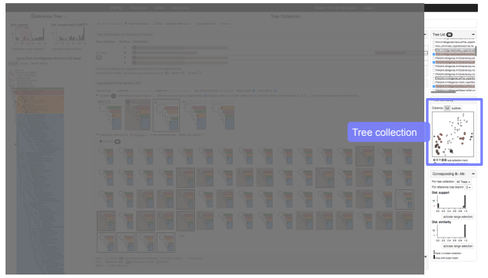


Interface walkthrough: reference tree



Interface walkthrough: individual & cluster ADs

Interface walkthrough: treespace



Validation with many biologists

- worked closely with a biology PhD student (second author)

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  - 10 biologists at different times throughout project

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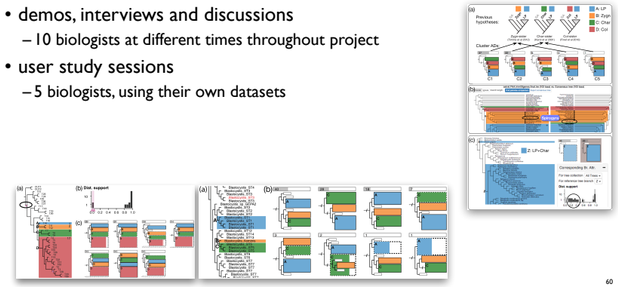
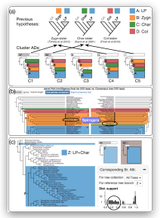
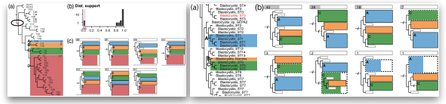


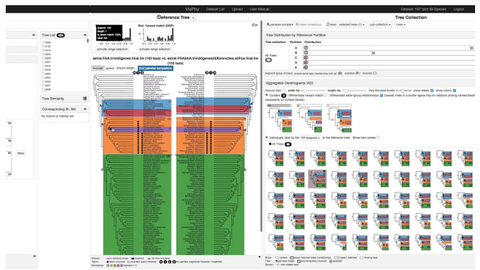
Validation with many biologists

- worked closely with a biology PhD student (second author)
- demos, interviews and discussions
  - 10 biologists at different times throughout project
- user study sessions
  - 5 biologists, using their own datasets
- biologists confirmed
  - validity of data and task abstractions
  - utility of ADView





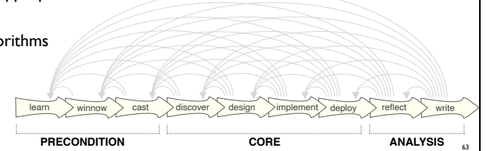
Video



https://www.youtube.com/watch?v=2SLcz7KNLJw

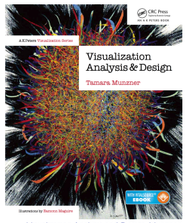
Problem-driven visualization with design study methodology

- work through all four levels of nested model
  - investigate domain
  - identify abstractions
    - crucial -- & difficult -- iterative process
  - select or create appropriate idioms
  - develop new algorithms
    - if need be



More information

- this talk
  http://www.cs.ubc.ca/~tmm/talks.html#amw24
- book
  http://www.cs.ubc.ca/~tmm/vadbook
  (hardcopy on demo/stuff table)
- full courses, papers, videos, software, talks
  http://www.cs.ubc.ca/group/infovis
  http://www.cs.ubc.ca/~tmm



Visualization Analysis and Design. Munzner.
CRC Press, AK Peters Visualization Series, 2014.

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