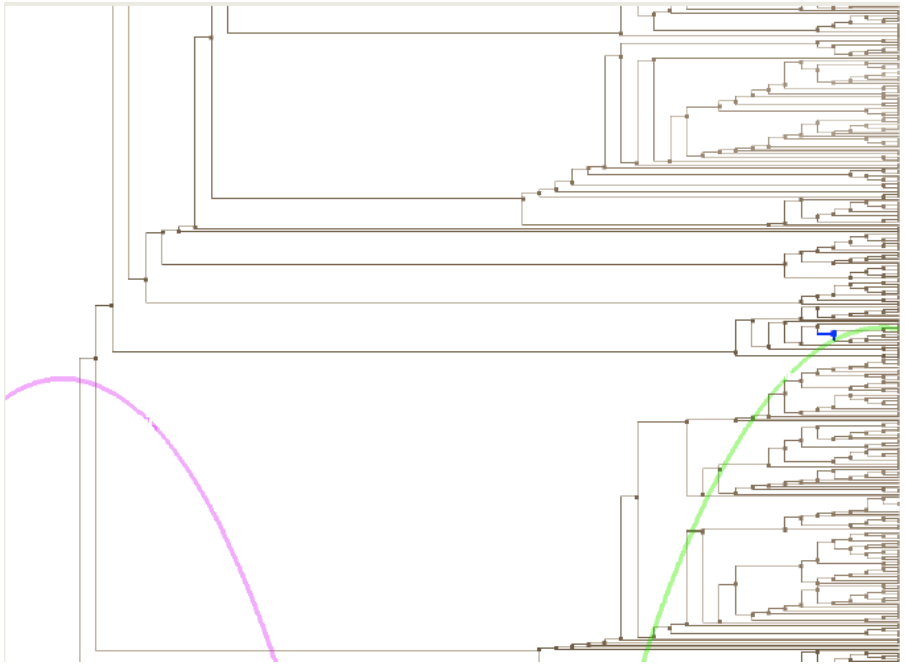
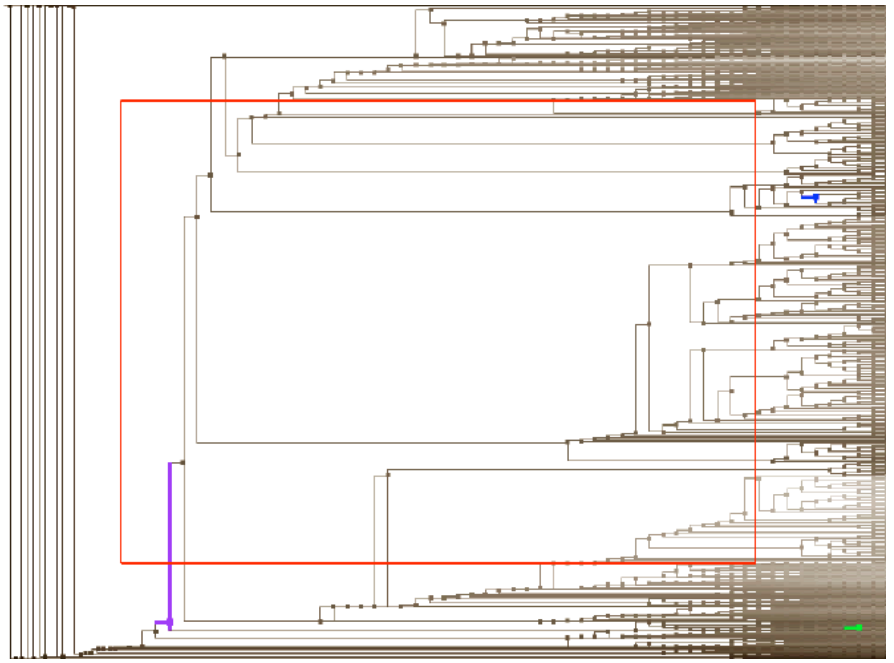
An Evaluation of Pan & Zoom and Rubber Sheet Navigation with and without an Overview



Pan & Zoom



Rubber Sheet Navigation

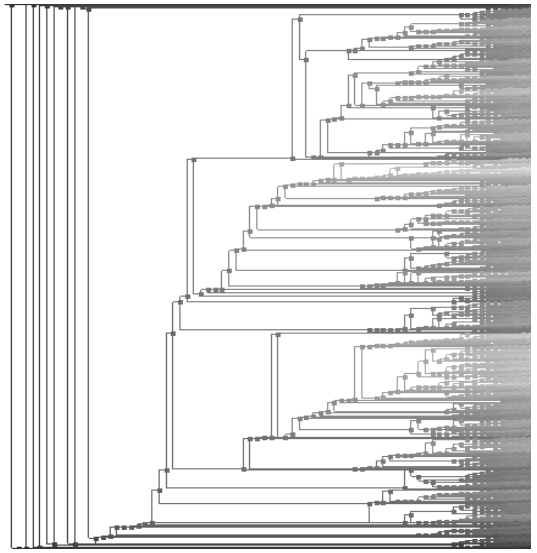
Dmitry Nekrasovski, Adam Bodnar, Joanna McGrenere, François Guimbretière, and Tamara Munzner

UBC Imager Laboratory for Graphics, Visualization and HCI

UNIVERSITY OF MARYLAND HCIL

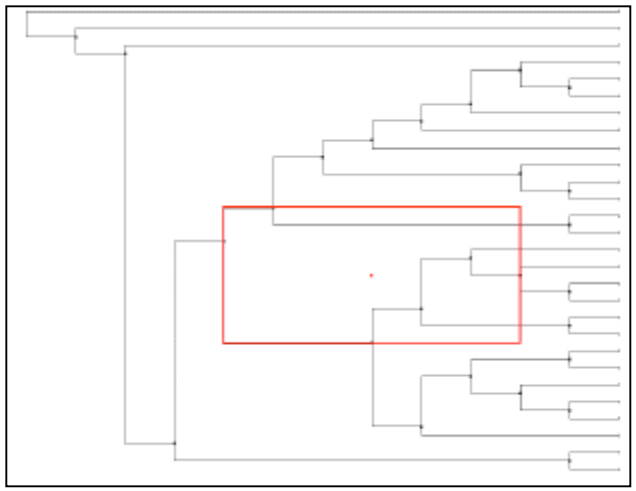
Motivation

- Problem: Help make sense of large datasets
- Solution: Interactive Visualization!
- Challenge: Efficient navigation techniques

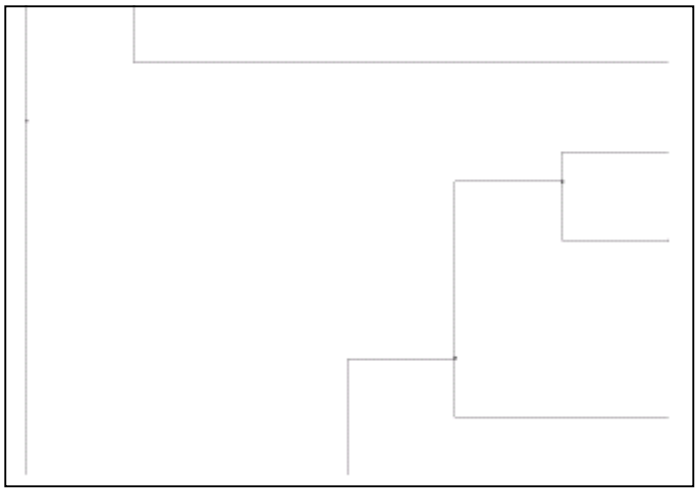


Conventional Pan & Zoom (PZN)

- Navigation via panning (translation) and zooming (uniform scale changes)
- Easy to lose context and become lost



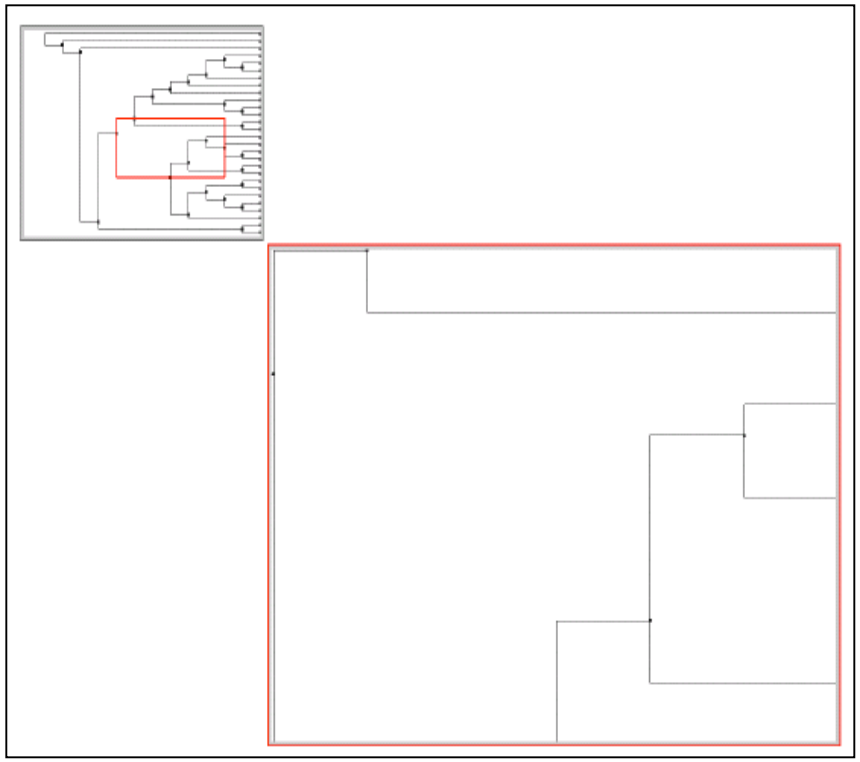
Selecting region to zoom



Zooming result

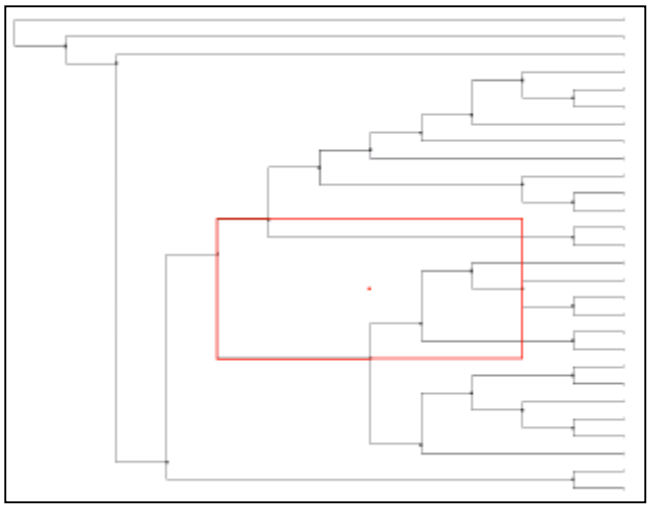
Overviews

- Separate global view of the dataset
- Maintain contextual awareness
- Force attention split between views

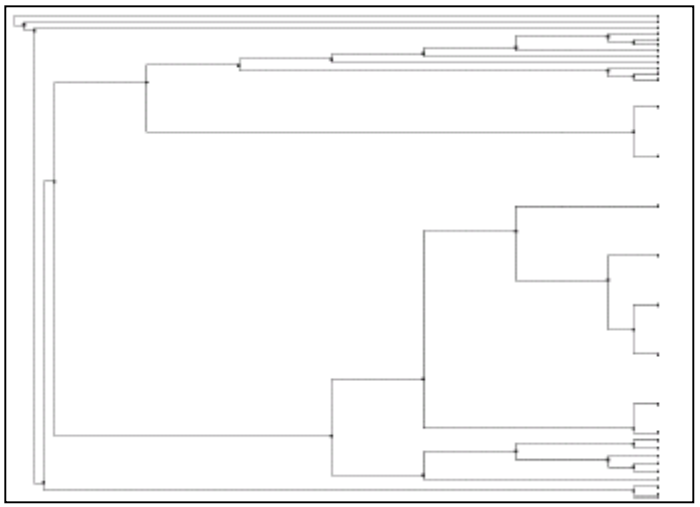


Rubber Sheet Navigation (RSN)

- Focus + Context technique
- Stretching and squishing rubber sheet metaphor
- Maintain contextual awareness in single view



Selecting region to zoom



Zooming result

Previous Findings Mixed

- Mixed results for navigation and overviews
- Speed: F+C faster than PZN

  [Schaffer et al., 1996; Gutwin and Skopik, 2003]

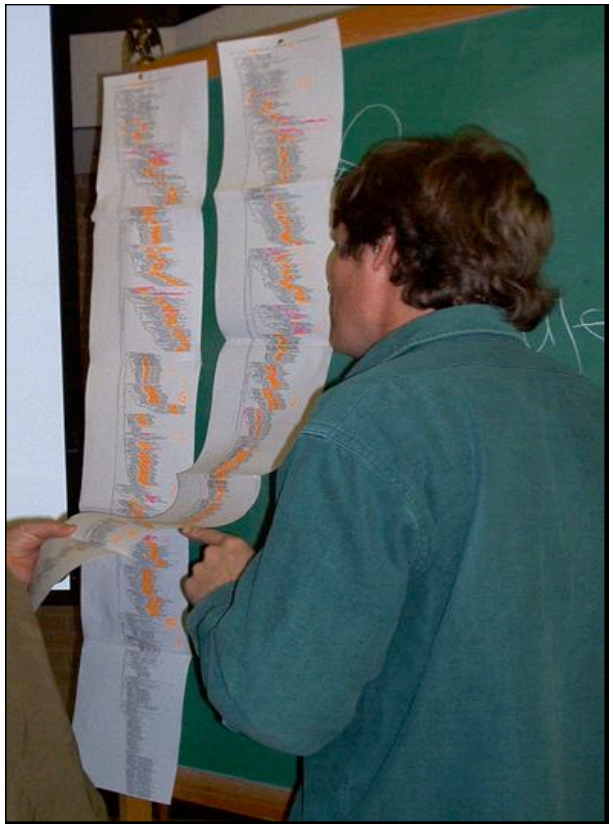
- Accuracy: PZN more accurate than F+C
  [Hornbaek and Frokjaer, 2001; Gutwin and Fedak, 2004]
- Preference: Overviews generally preferred
  [Beard and Walker, 1990; Plaisant et al., 2002]

Goals

- Evaluate RSN navigation technique
- Clarify utility of overviews for navigation
  - Why add overview to F+C?
    - Need evidence to support or refute common InfoVis assumption regarding usefulness of overviews

Motivating Domain

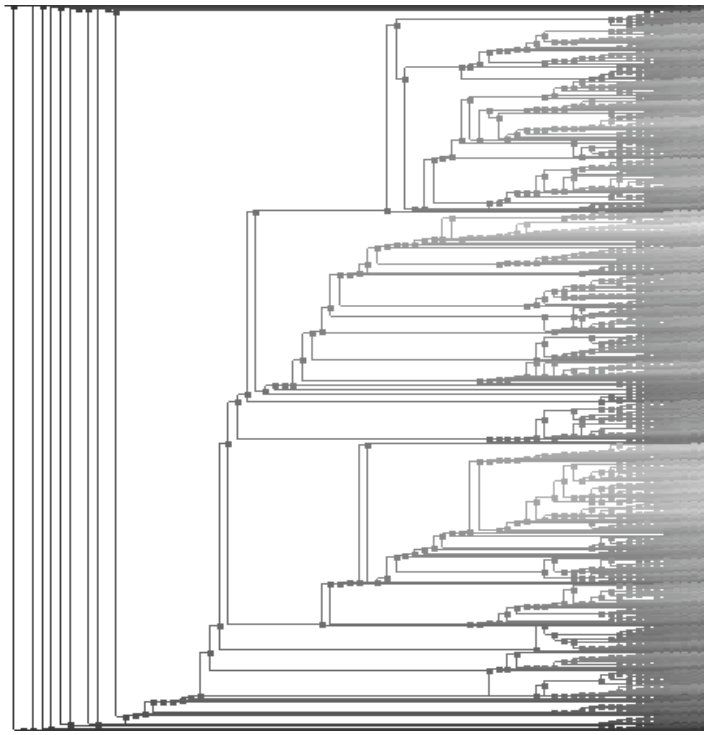
- Evolutionary biologists model relationships between species as large tree datasets
- Large datasets and clear tasks
- Requires understanding of topological structure at different places and scales
  - Efficient navigation techniques



[Munzner et al., 2003]

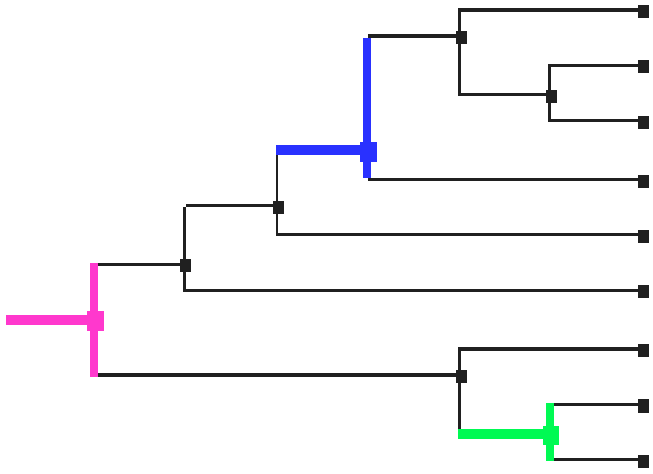
Dataset

- 5,918 node binary tree
- Leaves are species, internal nodes are ancestors
- Labels removed
  - Surprisingly seldom used
  - More interested in topological structure



Task

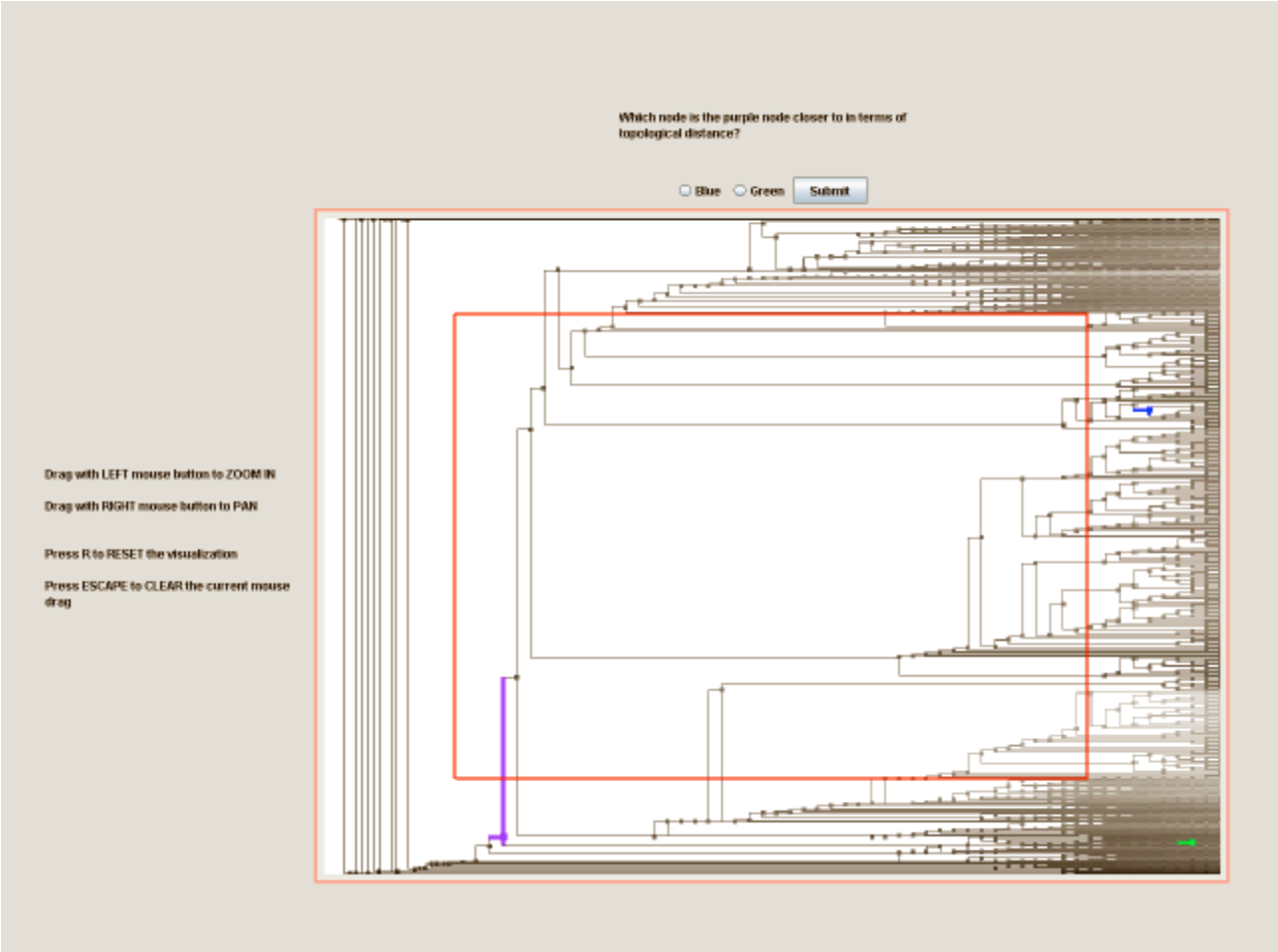
- Generalized version requiring no specialized knowledge of evolutionary trees
- Compare topological distance between marked nodes
- Requires multiple navigation actions to complete
- Several instances isomorphic in difficulty



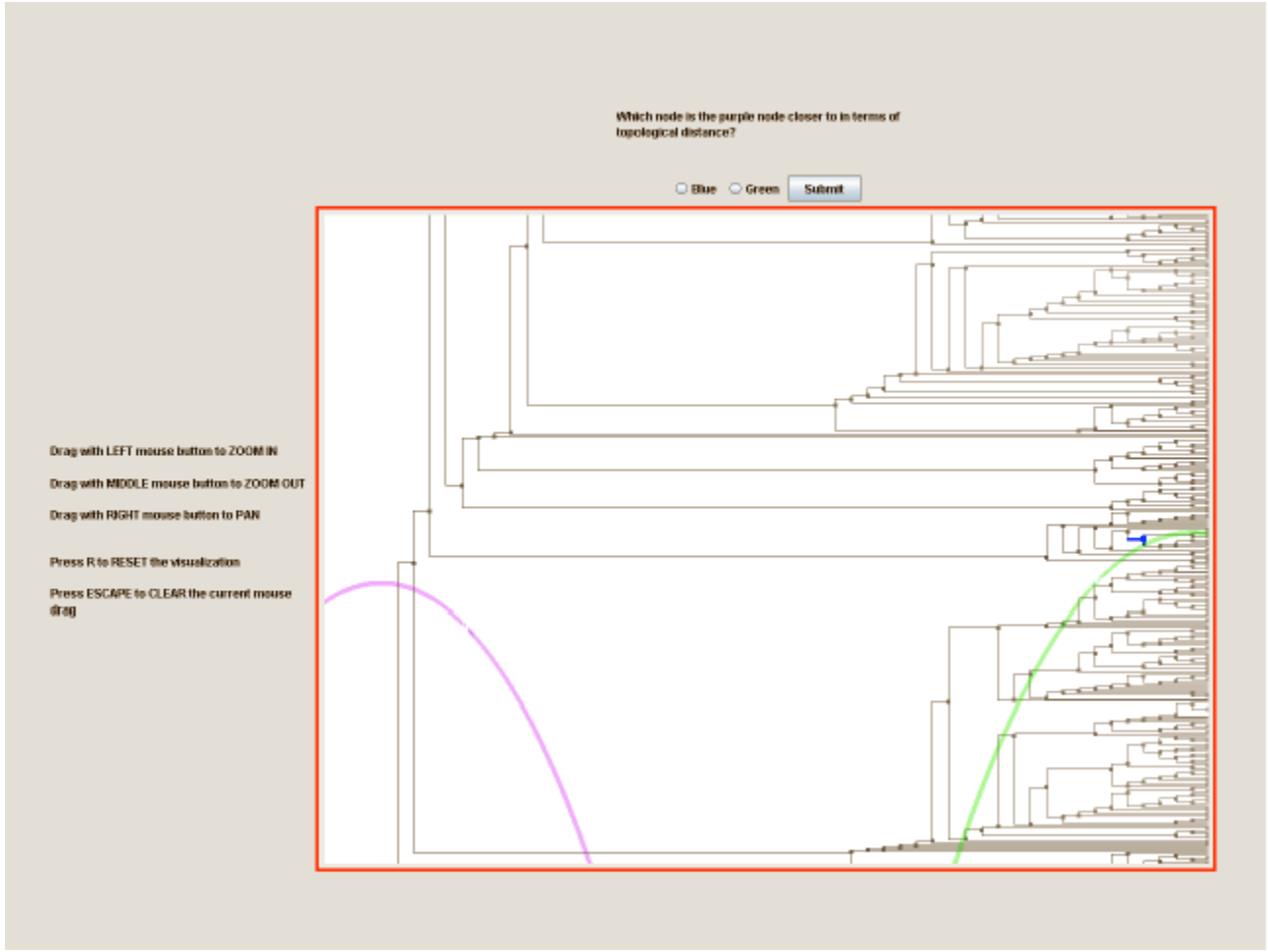
Experiment Interfaces

- Common visual representation and interaction model
  - Lacking in majority of previous evaluations
- Common set of navigation actions
- Guarantee visibility of areas of interest

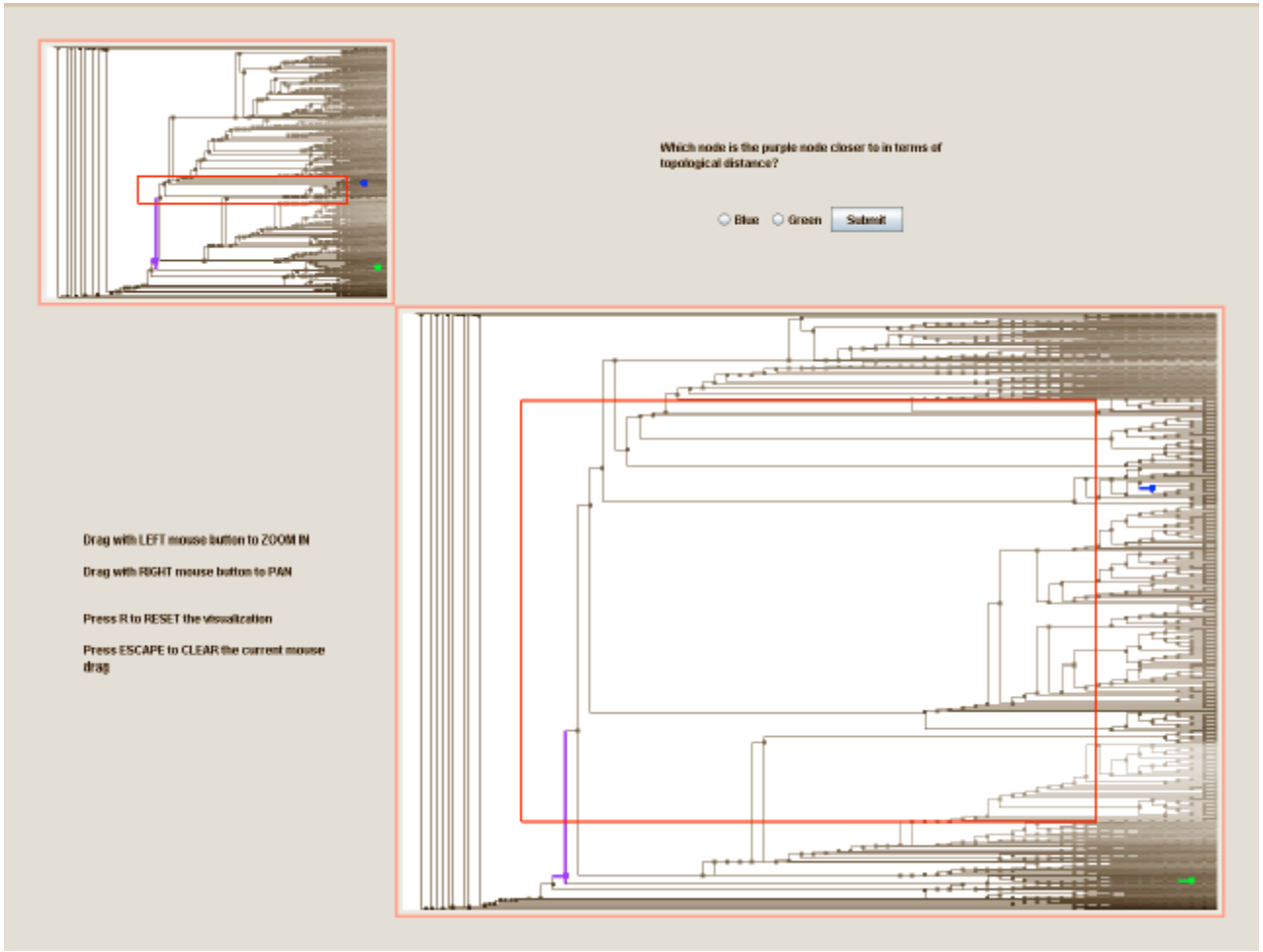
RSN


Which node is the purple node closer to in terms of topological distance?
Blue
Green
Submit
Drag with LEFT mouse button to ZOOM IN
Drag with RIGHT mouse button to PAN
Press R to RESET the visualization
Press ESCAPE to CLEAR the current mouse drag

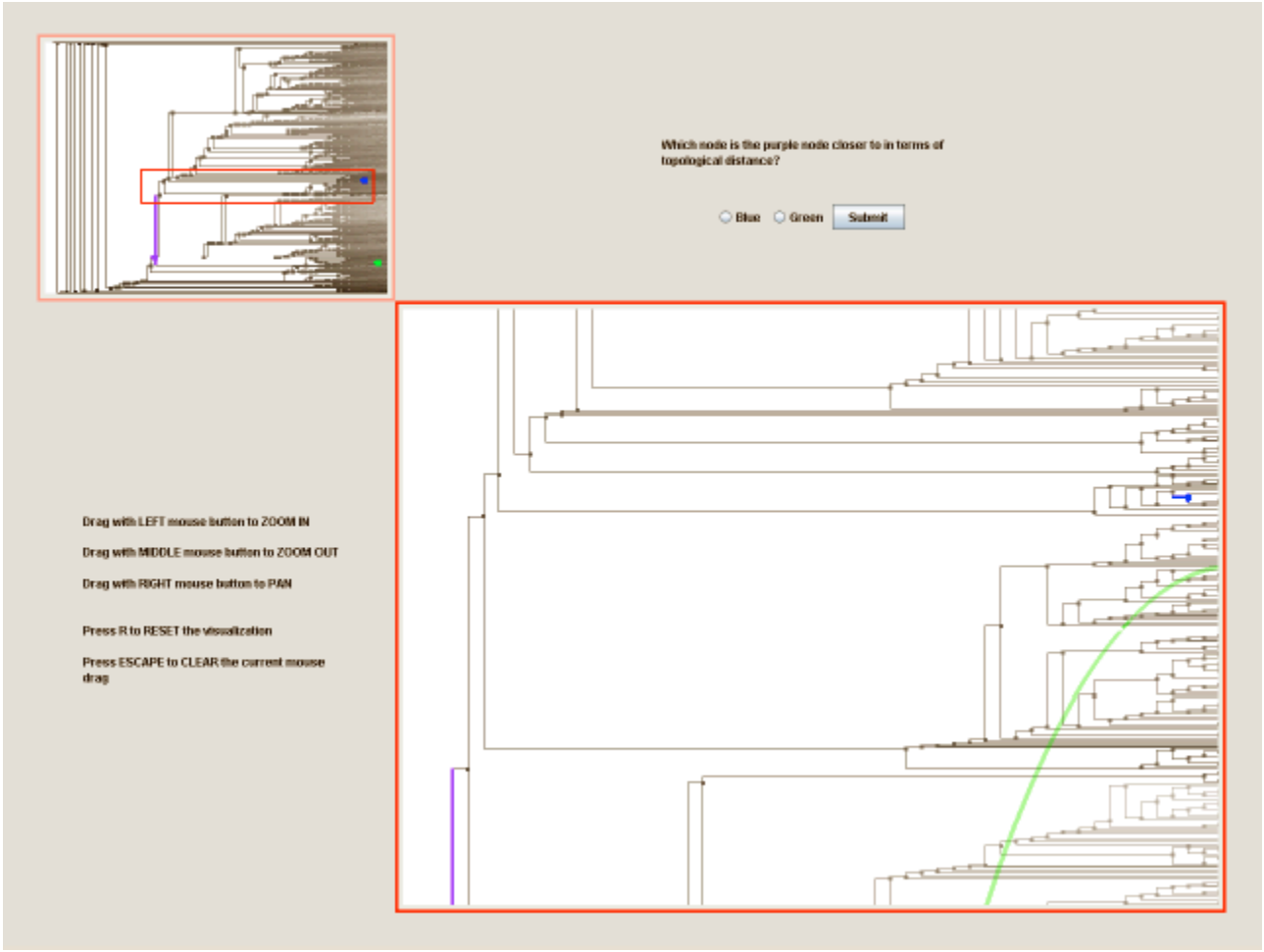
PZN


Which node is the purple node closer to in terms of topological distance?
Blue
Green
Submit
Drag with LEFT mouse button to ZOOM IN
Drag with MIDDLE mouse button to ZOOM OUT
Drag with RIGHT mouse button to PAN
Press R to RESET the visualization
Press ESCAPE to CLEAR the current mouse drag

RSN + Overview

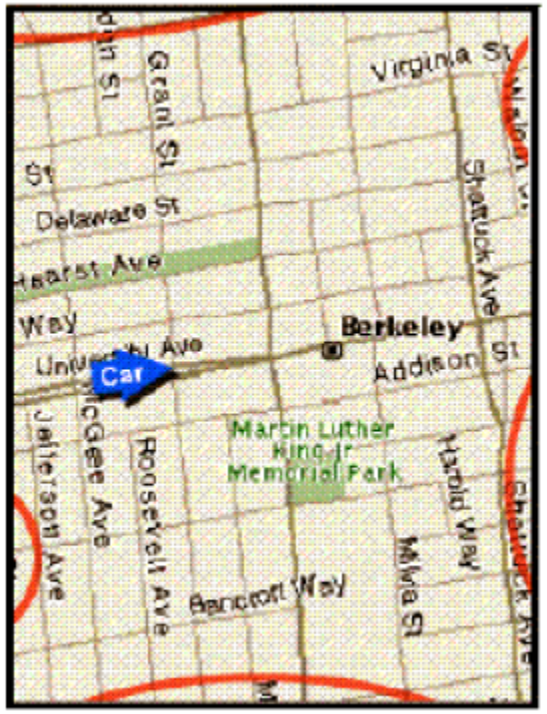


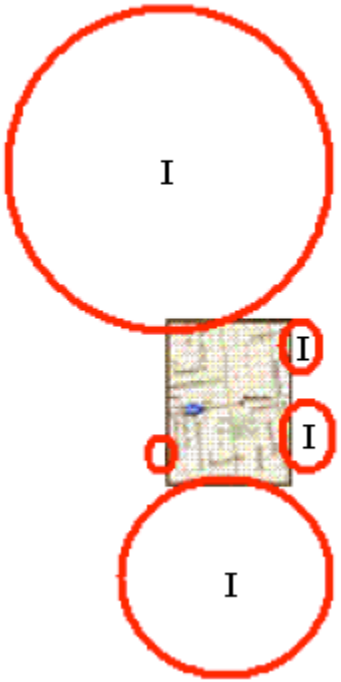
PZN + Overview



Guaranteed Visibility

- PZN
  - Implemented in PZN similarly to Halo
    [Baudisch et al., 2003]
- RSN
  - Implicit as areas of interest compressed along bounds of display
- Sub-pixel marked regions always drawn using PRISAD framework
  [Slack et al., 2005]





Hypotheses

H1 - RSN performs better than PZN independent of overview presence

H2 - For RSN, presence of overview does not result in better performance

H3 - For PZN, presence of overview results in better performance

Design

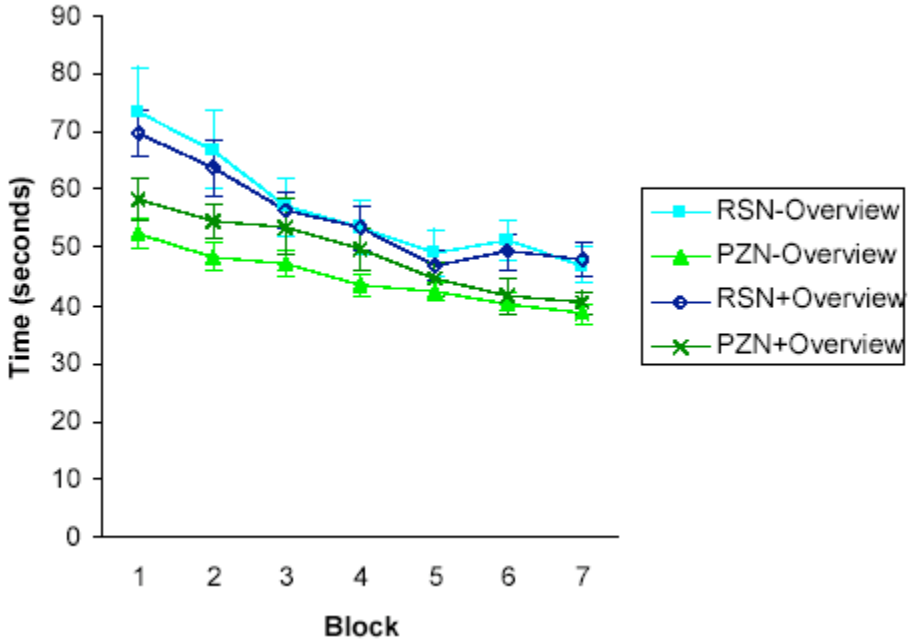
- 2 (navigation, between) x 2 (presence of overview, between) x 7 (blocks, within)
- Each block contained 5 randomized trials
- 40 subjects, each randomly assigned to each interface

Procedure and Measures

- Training protocols used to train subjects in effective strategies to solve task
- Subjects completed 35 trials (7 blocks x 5 trials), each isomorphic in difficulty
- Completion time, navigation actions, resets, errors, and subjective NASA-TLX workload

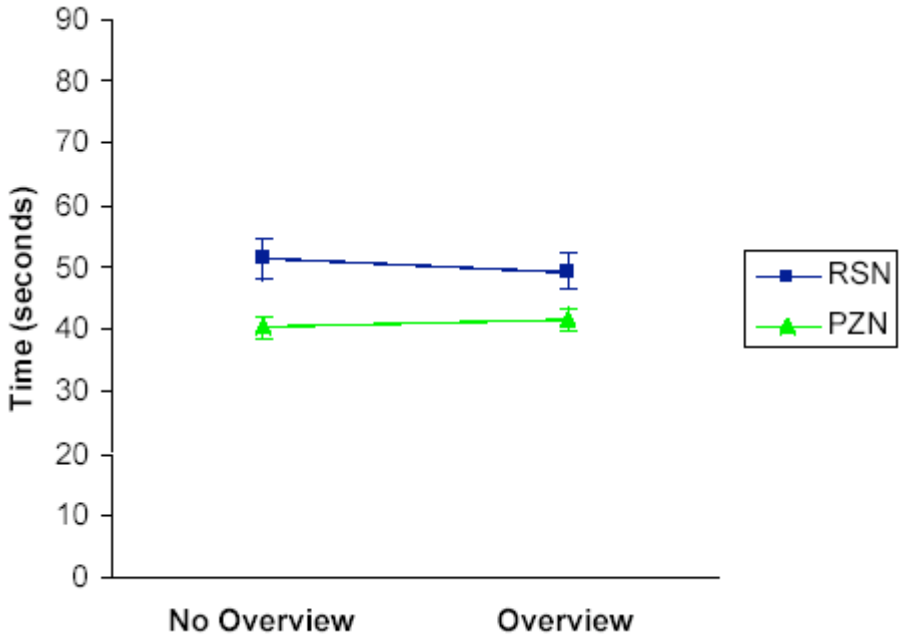
Results - Navigation

- PZN outperformed RSN ($p < 0.001$)
- Learning effect shows performance plateau
- Subjects using PZN performed fewer navigation actions and fewer resets
- Subjects using PZN reported less mental demand ($p < 0.05$)



Results – Presence of Overview

- No effect on any performance measure
- Subjects using overviews reported less physical demand and more enjoyment ($p < 0.05$)



Summary of Results

H 1 - RSN performs better than PZN independent of overview presence

- No – PZN outperformed RSN

H 2 - For RSN, presence of overview does not result in better performance

- Yes – No effect of overview on performance

H 3 - For PZN, presence of overview results in better performance

- No – No effect of overview on performance

Discussion – Navigation

- Performance differences cannot be ascribed to unfamiliarity with the techniques
- Design guidelines for PZN extensively studied, but not so for F+C or RSN

Discussion – Overviews

- Overviews for PZN and RSN:
  - No performance benefits
  - Preference for overview
- Overview may act as *cognitive cushion*
  - Provide subjective but not performance benefits
- Guaranteed visibility may provide same benefits as overviews

Future Work

- Investigate methods of providing contextual information with guaranteed visibility
- Explore patterns of overview use though eye tracking technology
  - Interact vs. glance vs. ignore

Conclusions

- Presented first evaluation comparing PZN and RSN techniques with and without an overview
- Performance:
  - PZN faster and more accurate than RSN
- Preference:
  - Overviews preferred, but no performance benefits

Acknowledgements

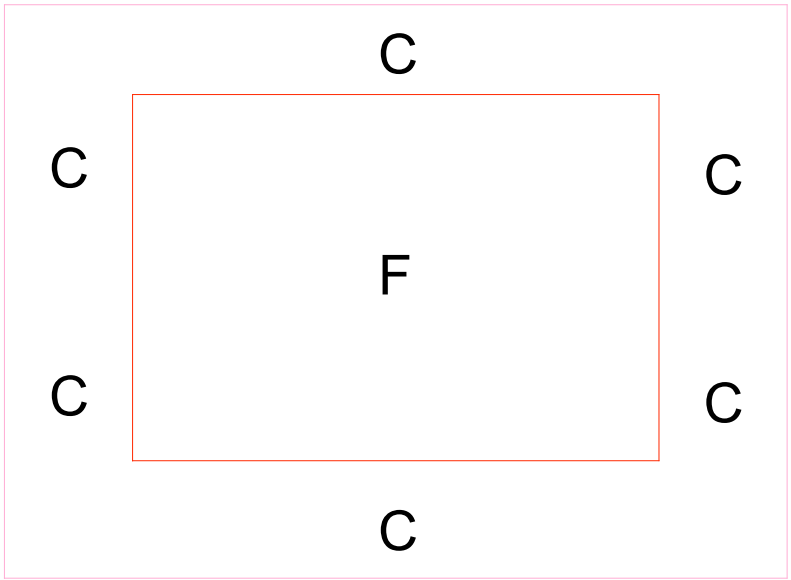
- David Hillis and research group from University of Texas at Austin for discussions and dataset

- James Slack from University of British Columbia for help with the PRISAD framework

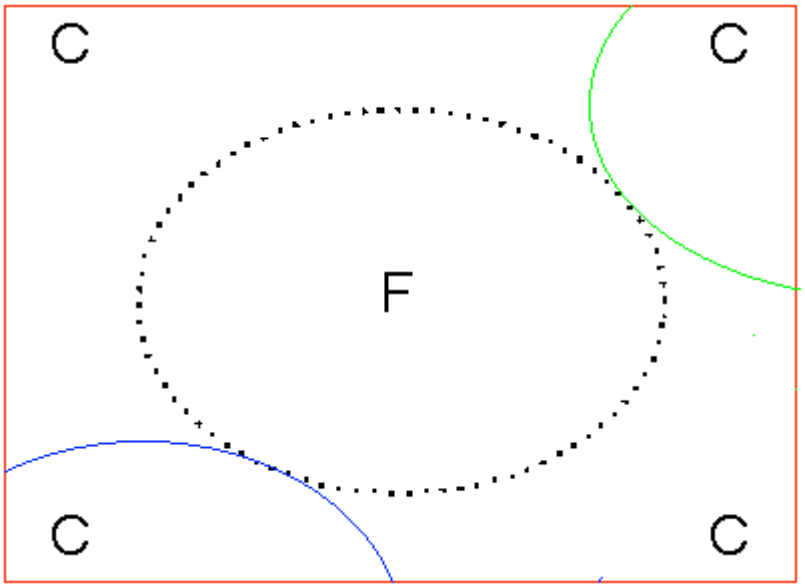
- NSERC and NSF for funding

Backup Slides

Level of Context



RSN



PZN