Merge-tree: Visualizing the Integration of Commits into Linux

Evan Wilde, Daniel German.
2016 IEEE Working Conference on Software Visualization (VISSOFT), Raleigh, NC, pp. 1-10, 2016.

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Git Version Control

- Is a distributed version control system
- Supports non-linear workflows
- Uses directed acyclic graph (DAG)

- Commits
- Branches

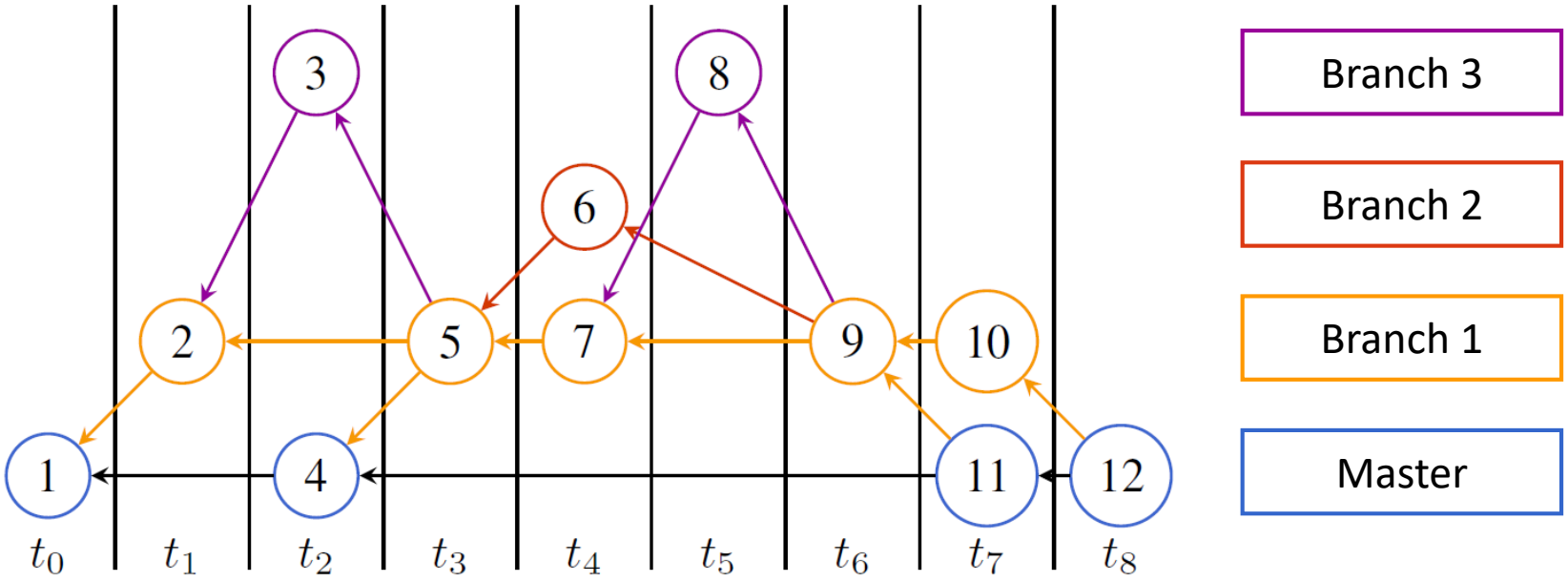
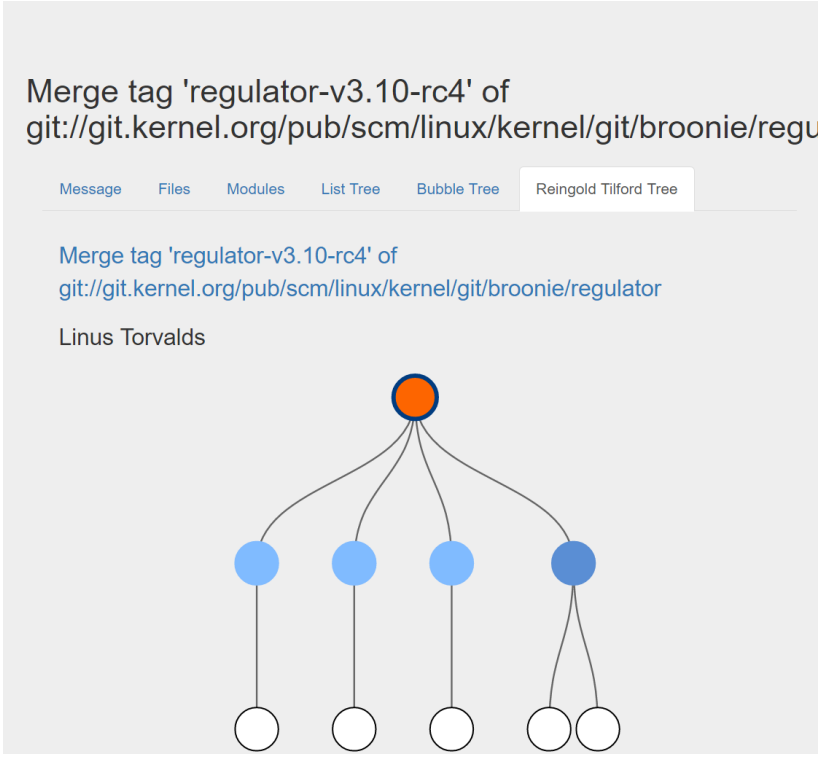


Fig. 3

Domain Task

- **Show when and how a commit was merged into master**
- Challenge: commits cannot be changed
  - can‘t link to later commits
  - can‘t track merge dates
- Solution: Linvis
  - Shows topological view of merges
  - Supports aggregation and filtering
  - Supports two use-cases
    1. top-to-bottom: aggregate
    2. bottom-to-top: see flow into master



Source: http://li.turingmachine.org

Merge-tree

- Transforms DAG into trees
  - each rooted on master
  - such that all commits are assigned to exactly one tree
- Algorithm
  - Invert DAG
  - For every commit
    - compute distance to each subsequent commit
    - only keep link to closest (in time) in merge-tree
    - stop at master commit
- Relies on specific Git workflow

Convert DAG to Trees

DAG Model

- Newer commits link to older
- All links present

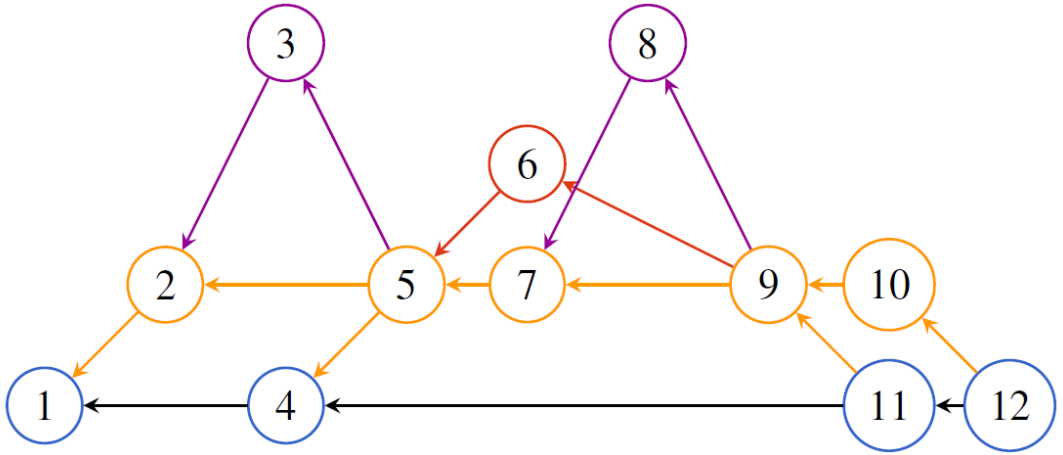


Fig. 4

Merge-tree Model

- Older commits link to newer
- Removed links
  - Only keep links on shortest path

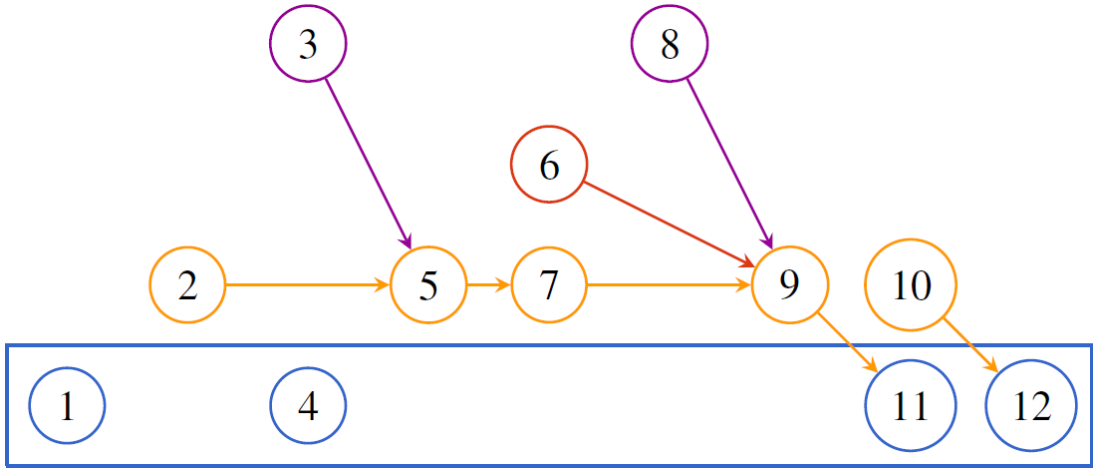


Fig. 5

Linvis Live Demo

http://li.turingmachine.org

Linvis analysis

- What: data
  - DAG
- What: derived
  - Merge-tree
- Why: tasks
  - Search for commits
  - Summarize changes
- How: reduce
  - Filtering
- How: Manipulate
  - Navigate with pan/zoom
  - Select

- How: encode
  - indented outline (*list tree*)
  - tree map using nested circles and radial containment (*bubble tree*)
  - vertical node-link (*Reingold-Tilford tree*)

Limitations + Next Steps

- **No evaluation of Linvis**
  - quantitative user-testing: improvements to user workflow
  - qualitative user-evaluation: do users think tool is helpful
- Merge-tree cannot be constructed for most repositories
- Cannot search by filename

- Aggregate commit patches
- Aggregate authorship information

Compare existing - GitHub

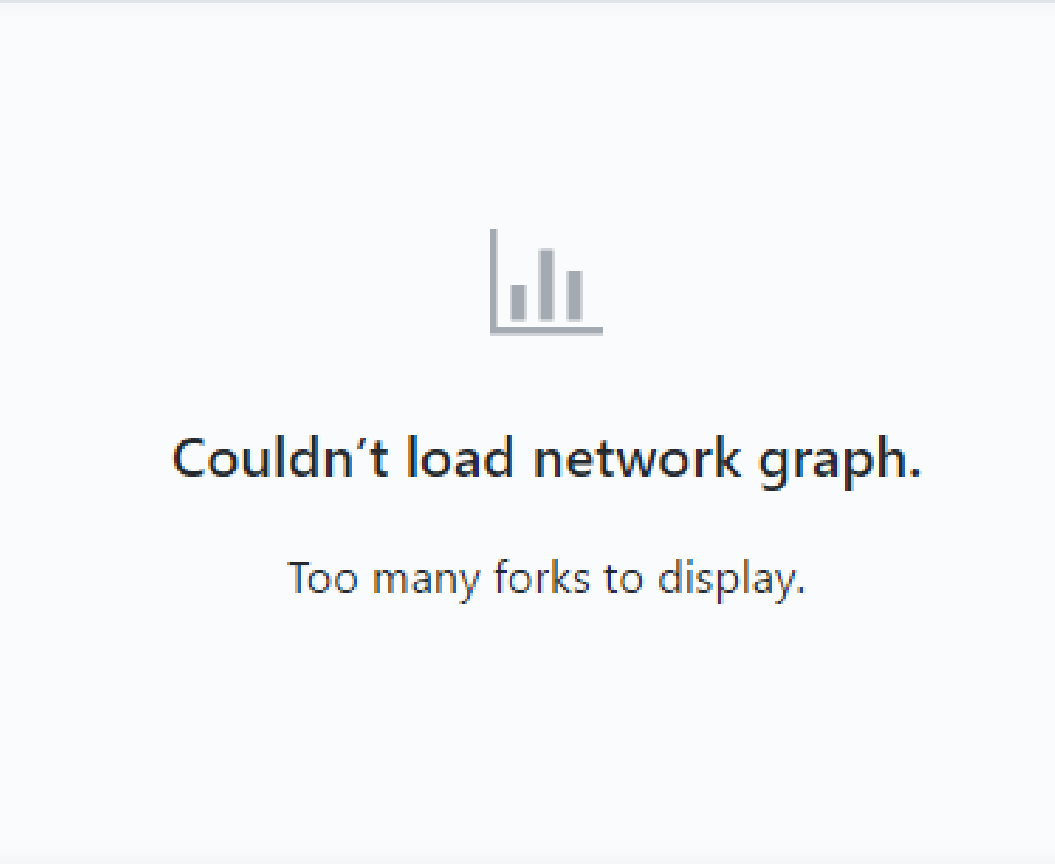


Fig. 2

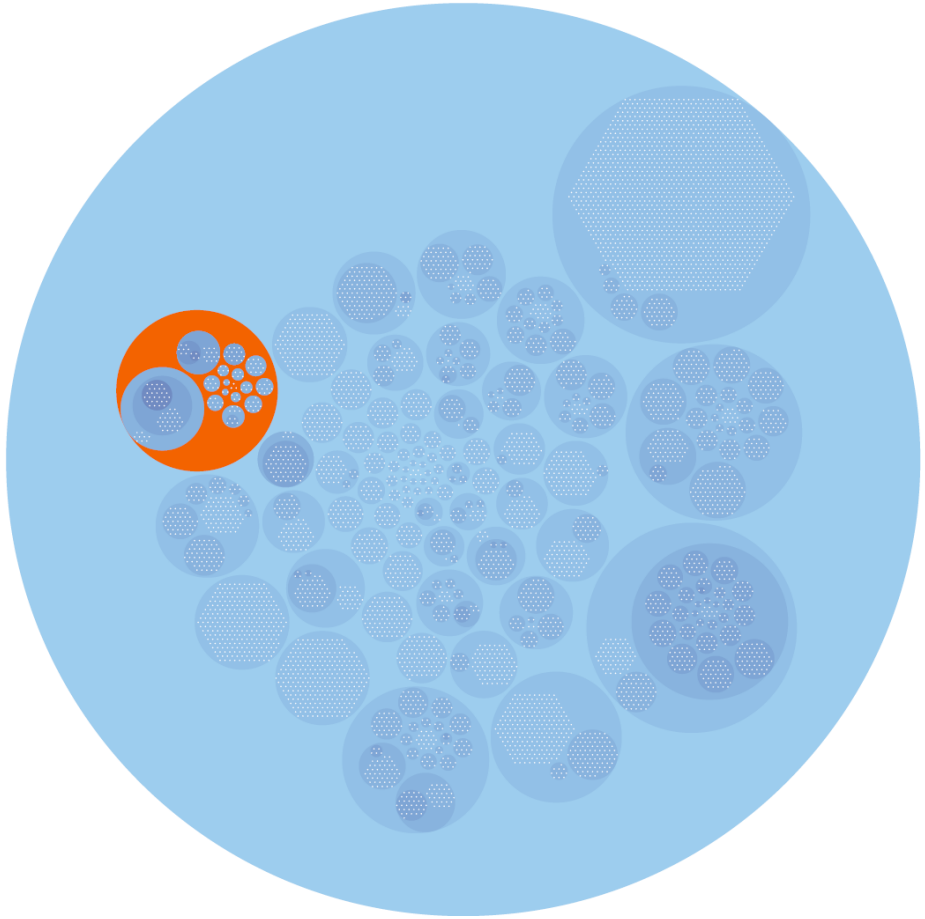


Fig. 15

Compare existing - Gitk

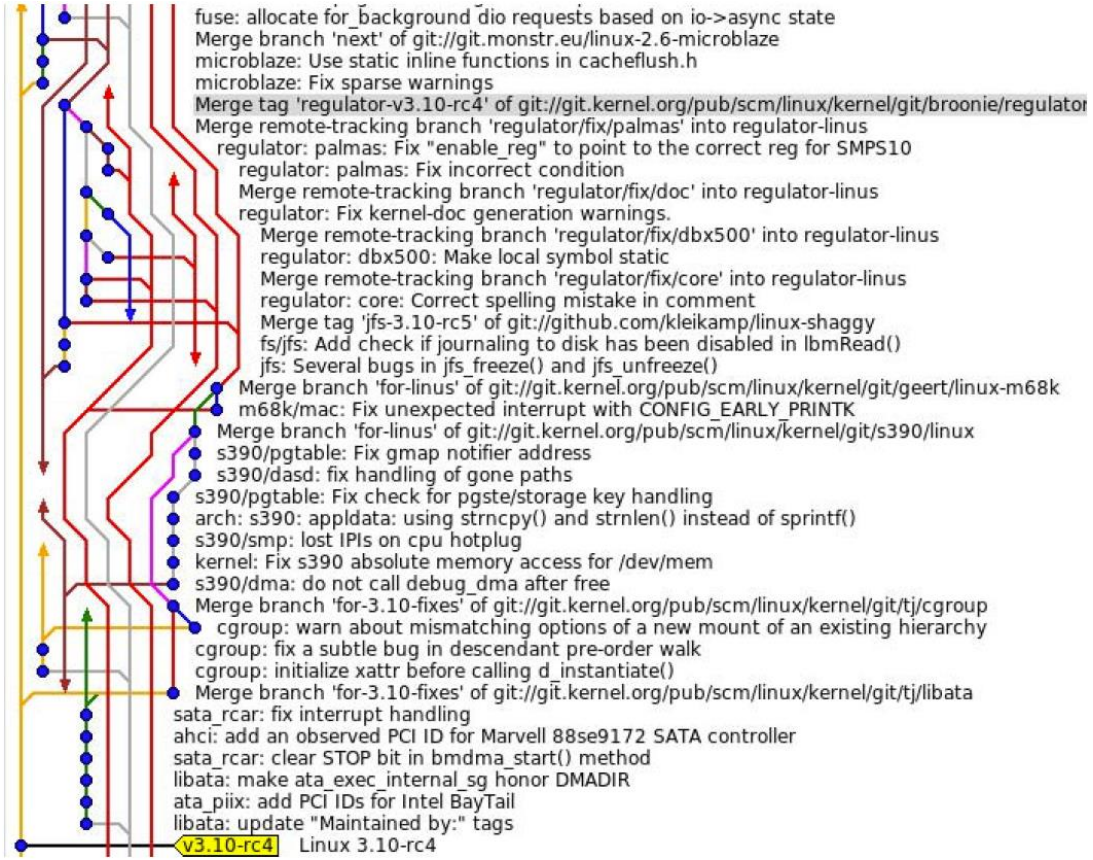


Fig. 16

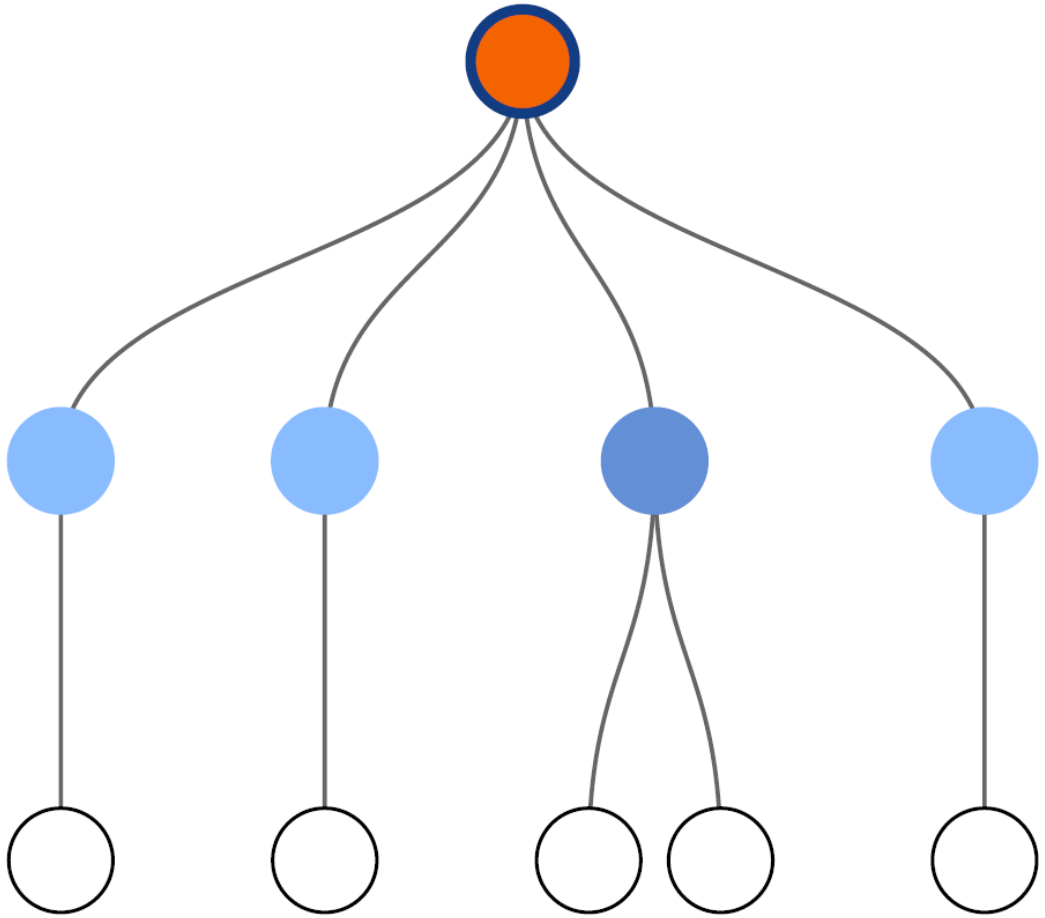


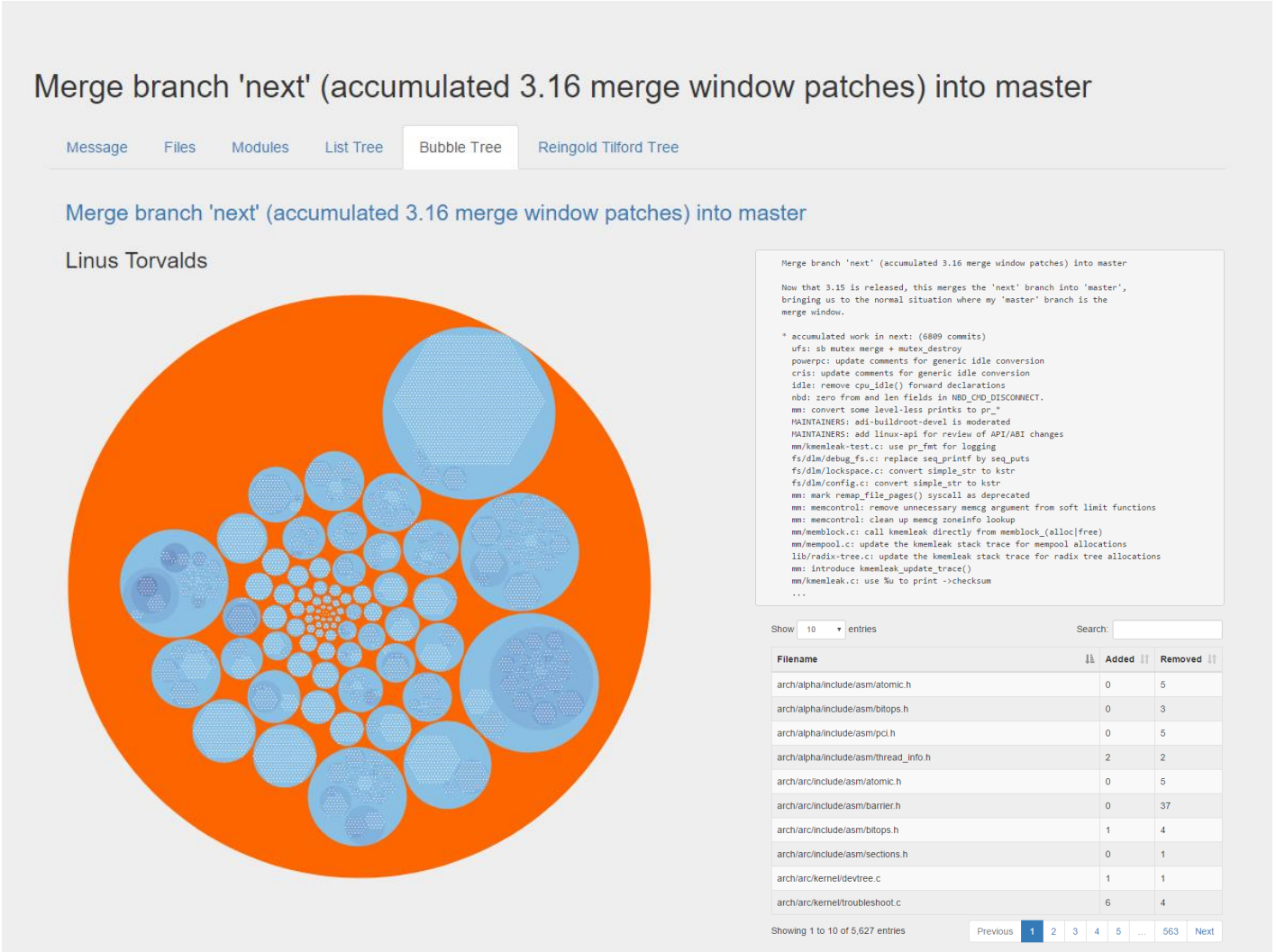
Fig. 17

Critique

- Strengths
  - Main contribution of merge-tree
  - Demonstrated on most complex DAG
  - Natural interactions (e.g. pan, zoom)
  - Different encodings of tree structure, all intuitive
- Weaknesses
  - Merge-tree algorithm not robust
  - Navigation between views cumbersome
  - Vis felt like afterthought

Suggestion

- Juxtapose:
  - Git log
  - Files
  - tree vis



Questions

Linvis Search View

- Allows filtering by
  - Merge date range
  - Commit author
  - Keyword
  - Commit ID

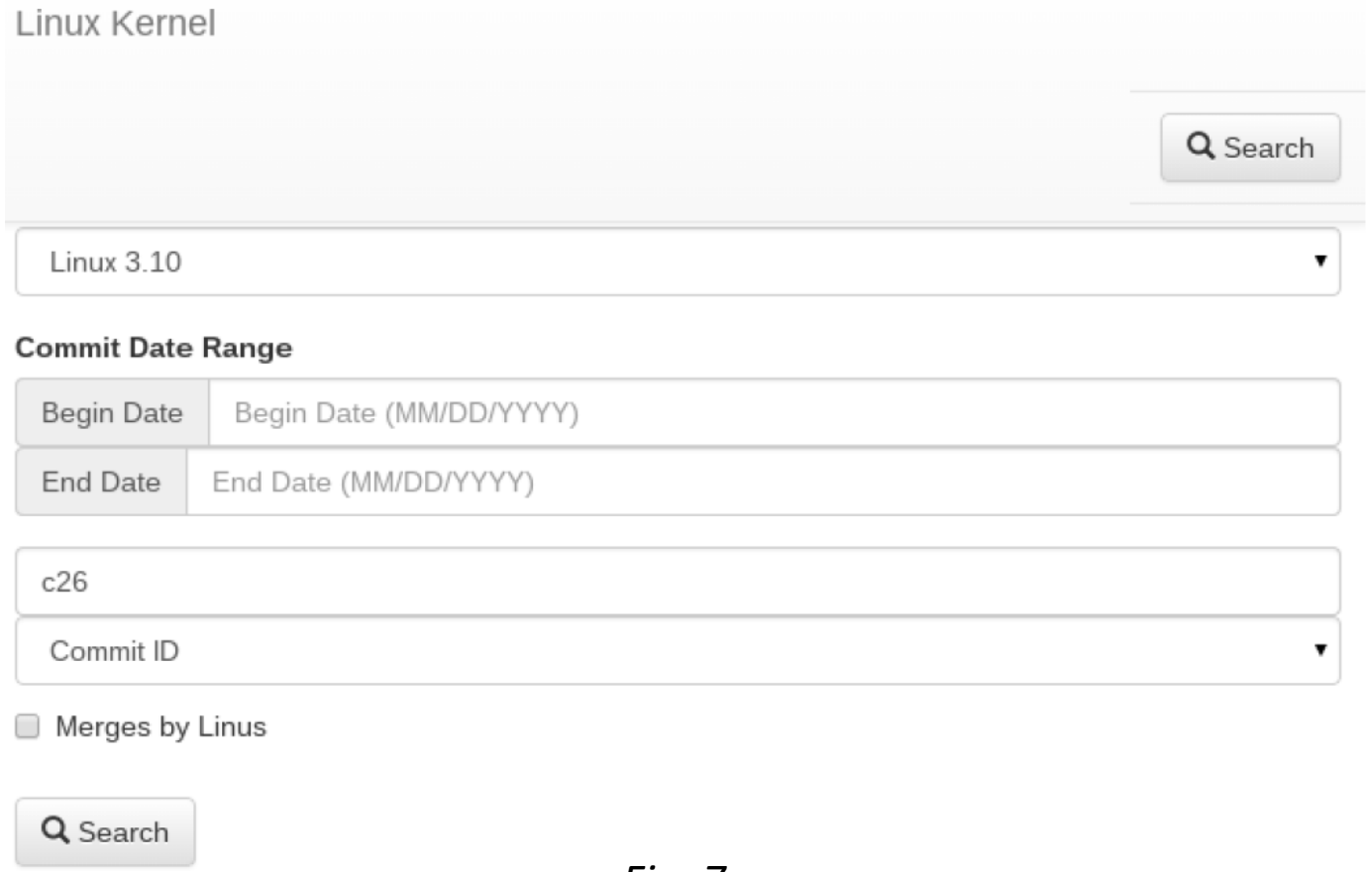


Fig. 7

Linvis Message Tab

- Displays Git log
- Included for completeness

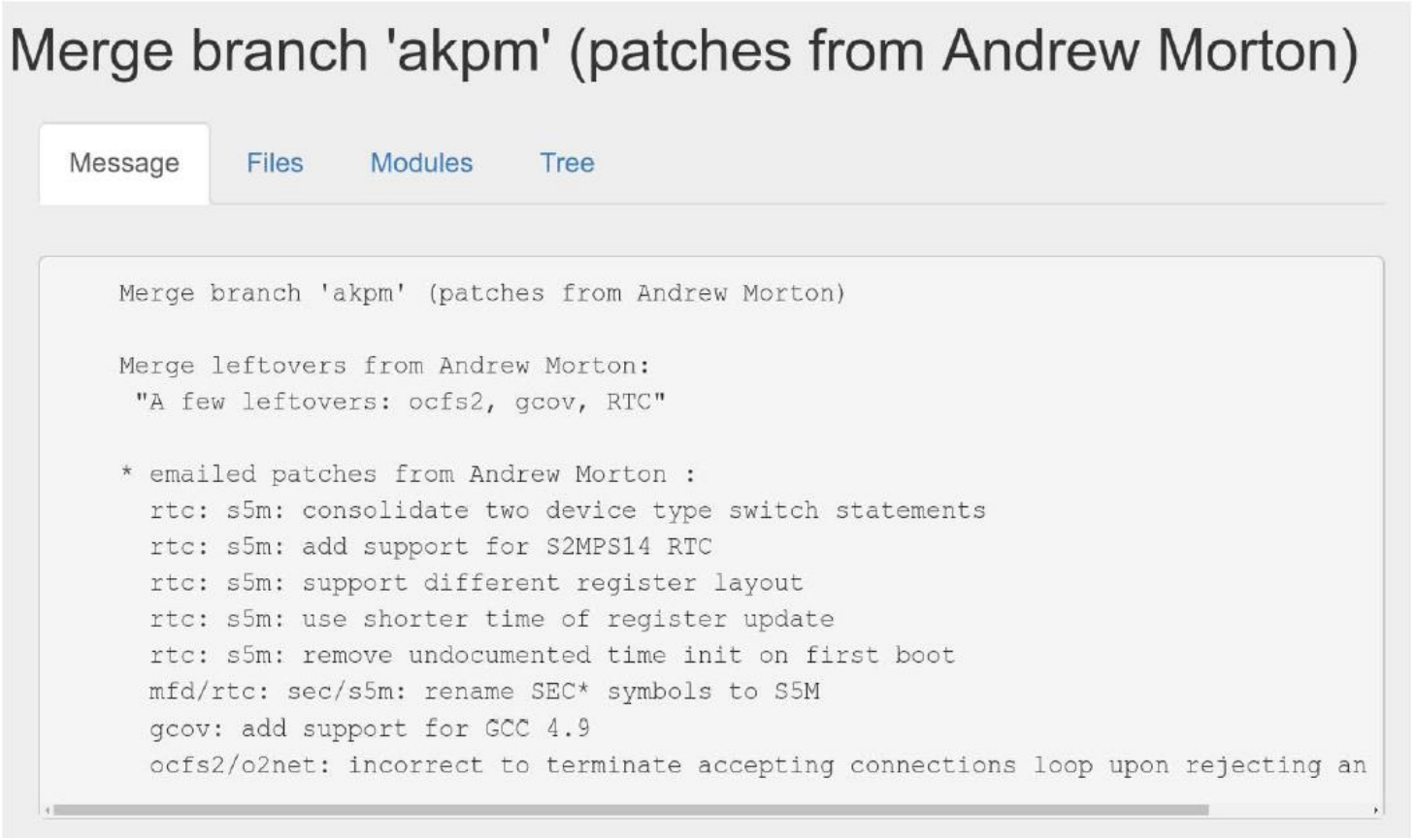


Fig. 9

Linvis File Tab

- Files changed in leaf commits
- Added/Removed columns show number of changed lines
- Aggregates number of changes to single file across all commits

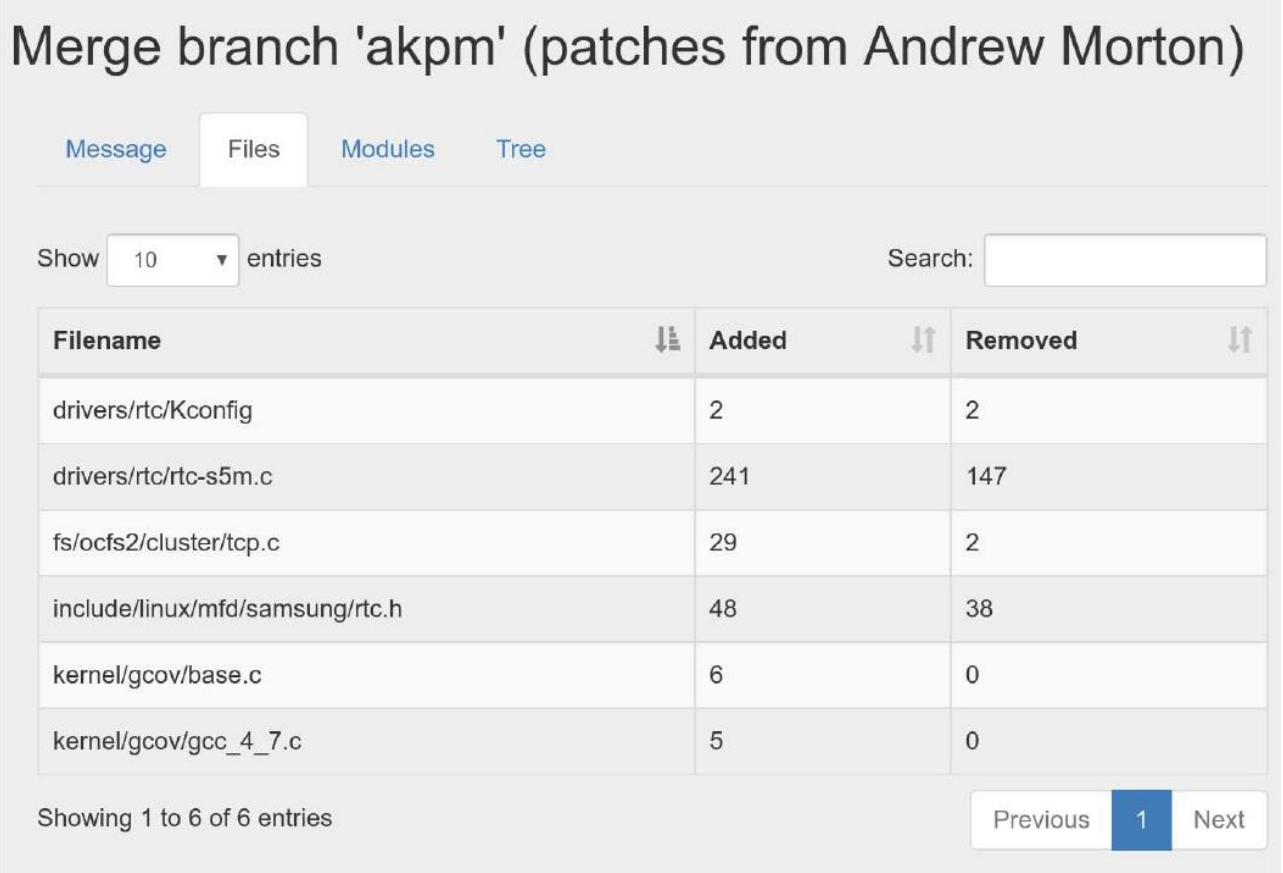


Fig. 10

Linvis Module Tab

- Linux specific
- Groups files
- Count column shows number of changed files for all leaf commits

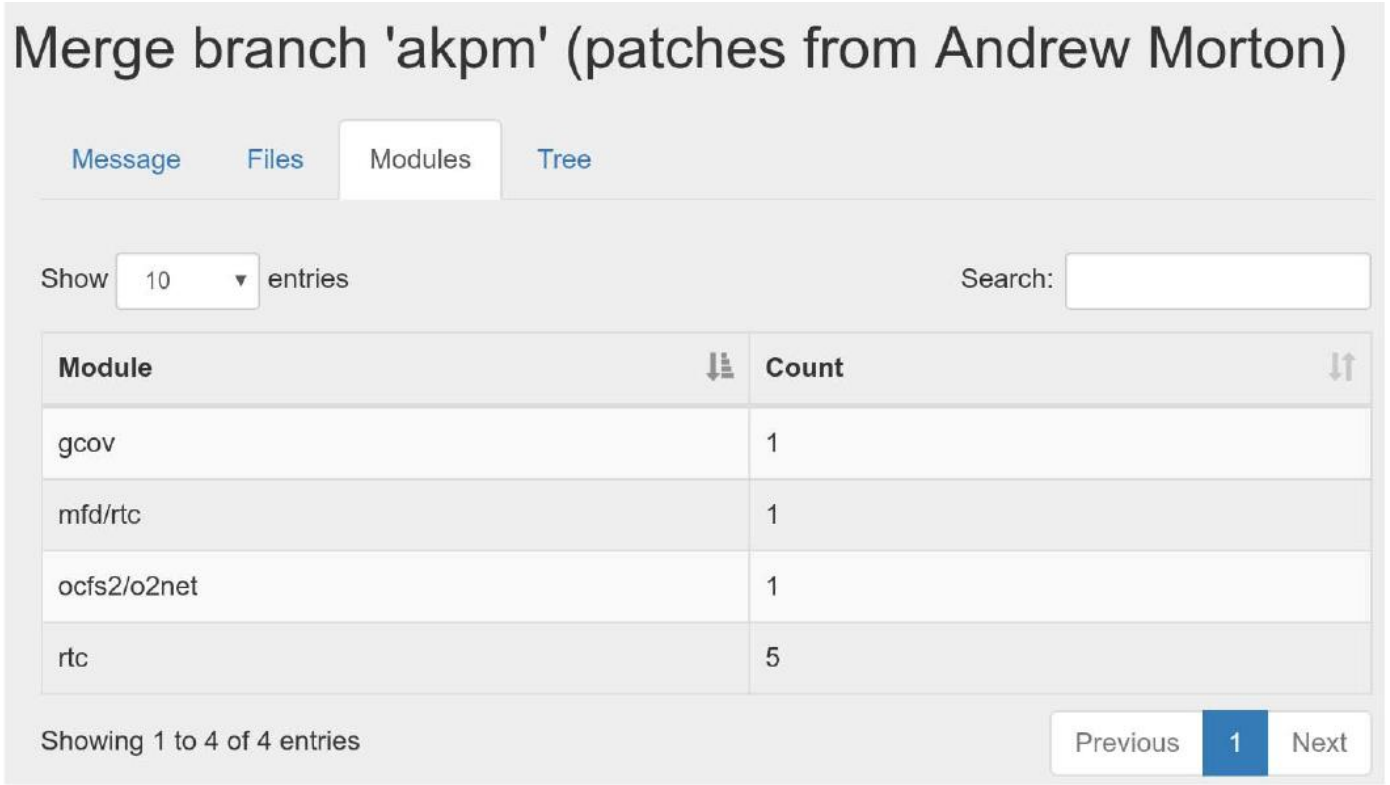


Fig. 11

Linvis List Tree

- Text-based representations of the merge-tree
- Nested lists show the hierarchy
- Designed to model tree-views of file browsers which are familiar to developers
- Easy to search and navigate

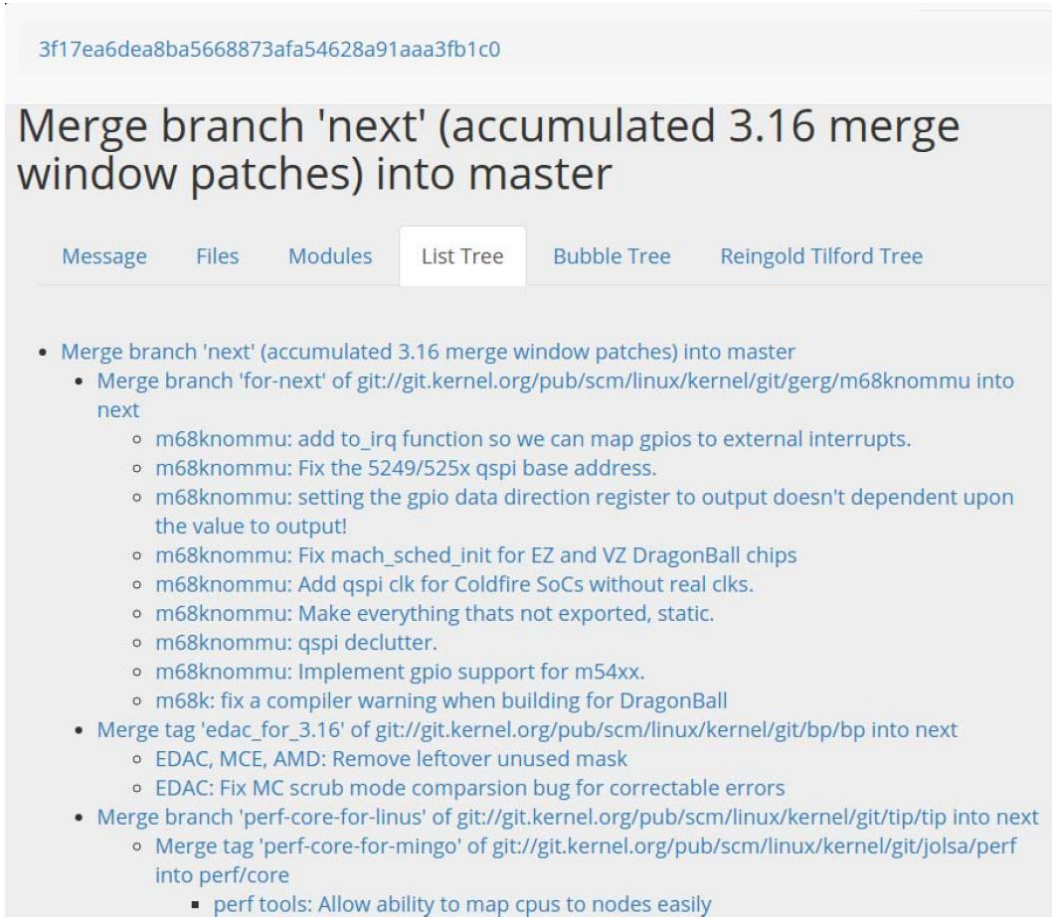


Fig. 12

Linvis Bubble Tree

- Organizes the commits hierarchically by having the parent commit contain the child commits
- Similar to tree maps but clearly shows leaf commits
- Good for providing clear visualization of wide, hierarchical data

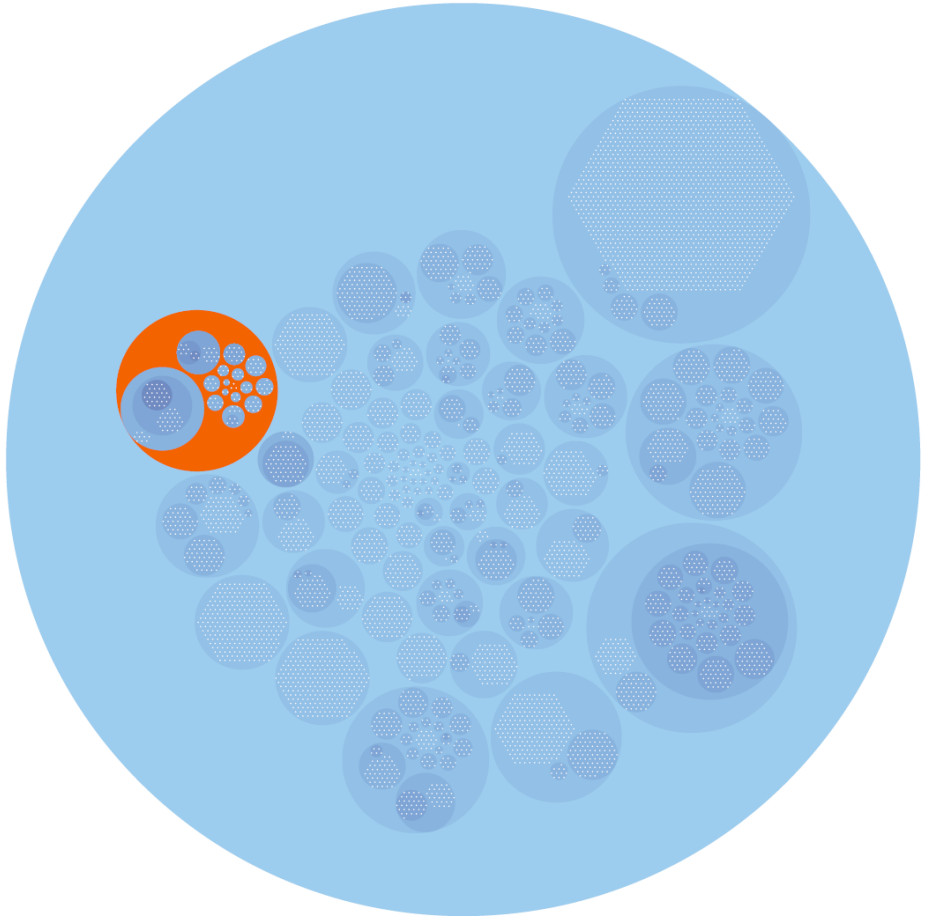


Fig. 15

Linvis Reingold-Tilford Tree

- Intuitive representation of merge-tree
- Not effective at display large trees

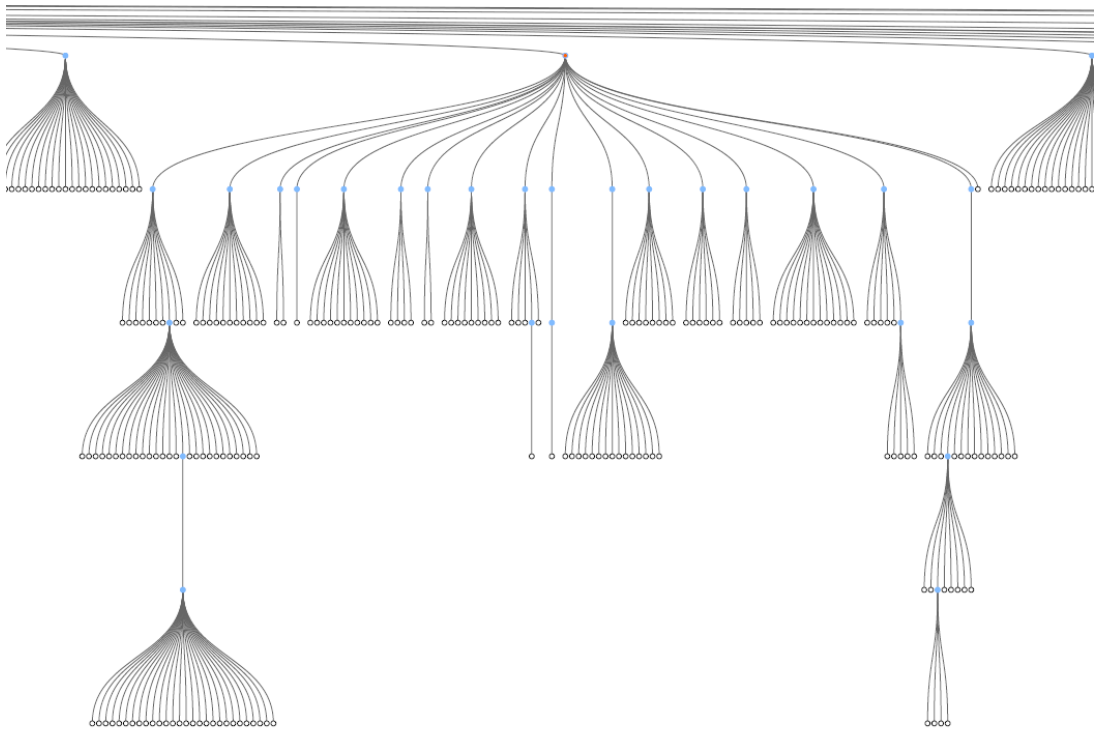


Fig. 13