# Resolving Conflicting Insights in Asynchronous Collaborative Visual Analysis

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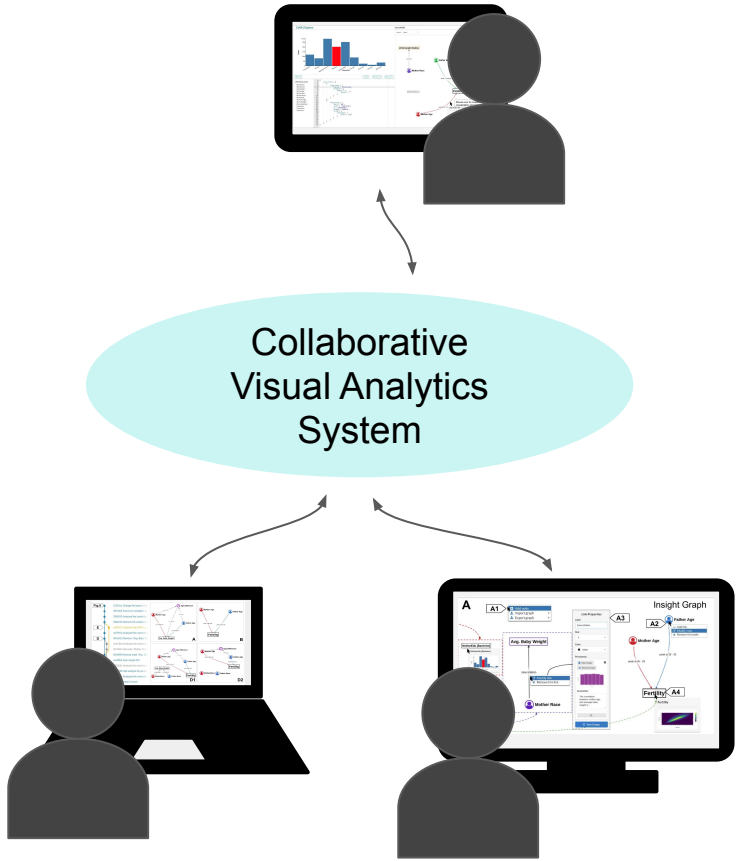
EuroVis 2020

# Collaborative Visual Analytics

- Collaborating in a team of analysts
- Using shared visualizations
- Exploring and analyzing data together



# Motivation

**Methods for identifying and resolving conflicts is missing!**

- Crucial for accurate analysis results
- Especially important for asynchronous collaborations

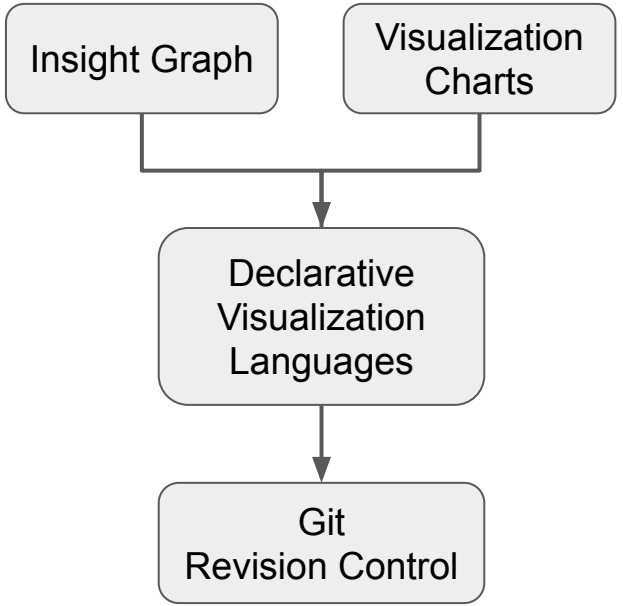
**Goal:** *take the initial step for providing conflict resolution in collaborative data analysis and visualization*

# Our Approach

- **Insight Graph** for managing insights
- **Declarative languages** for saving all visualizations
- **Git revision control** for managing collaborations

# Our Approach

- **Insight Graph** for managing insights
  - ★ Nodes represent insights
  - ★ Links represent for relations between insights
  - ★ Visualizations attached to nodes or links as insight provenance
- **Declarative languages** for saving all visualization
  - ★ Flexible for data exploration by rapidly specifying charts
  - ★ Easy to understand and track insight provenance
  - ★ Turn visualizations into texts and files
- **Git revision control** for managing collaborations
  - ★ Track and manage changes for shared results
  - ★ Detect conflicts in results



# System Framework

Exploratory Data Analysis

Findings and Insights

Insight Management

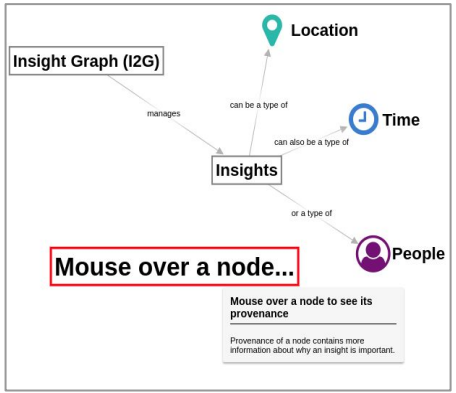
Revisions of Results

Combined Results

Collaboration Management

Declarative language for visualization

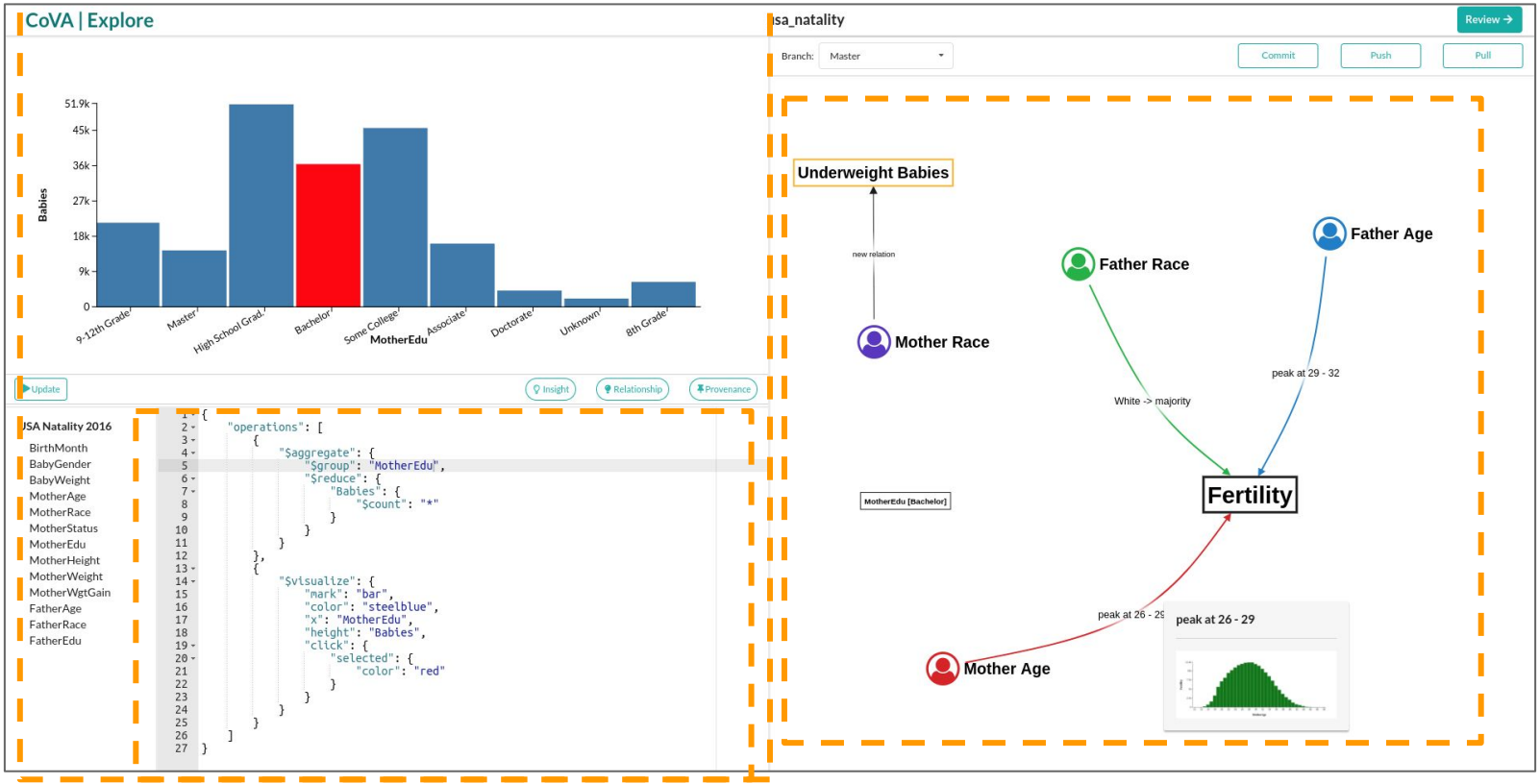
```
{
  "data": { ... },
  "views": [ ... ],
  "operations": [
    { "$match": { ... } },
    { "$derive": { ... } },
    { "$aggregate": { ... } },
    { "$visualize": { ... } },
    { "$interact": { ... } }
  ]
}
```



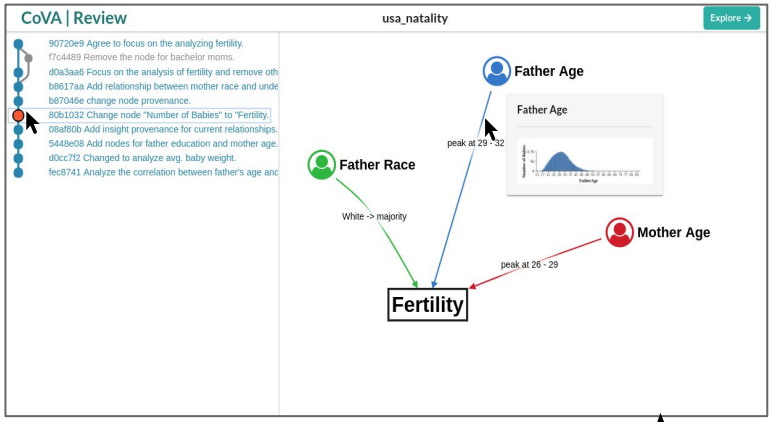

GUI for resolving conflicts

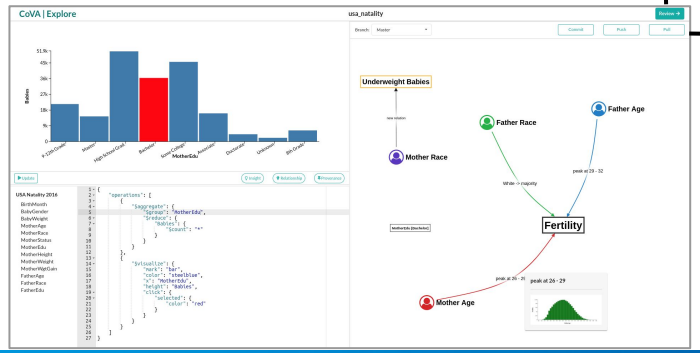
Revision control (Git)

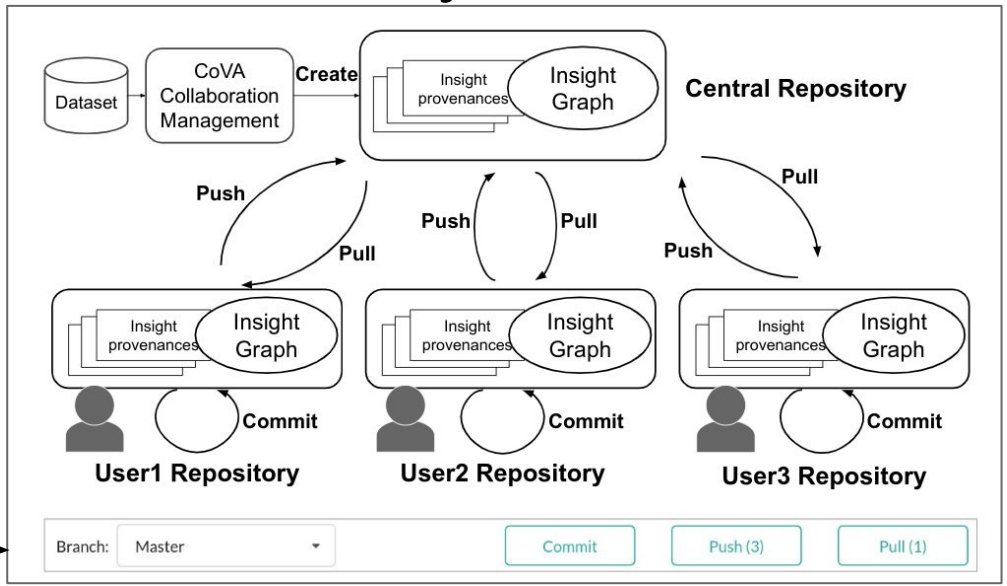
# Research Prototype: CoVA



# Git for Supporting Collaborative Analysis

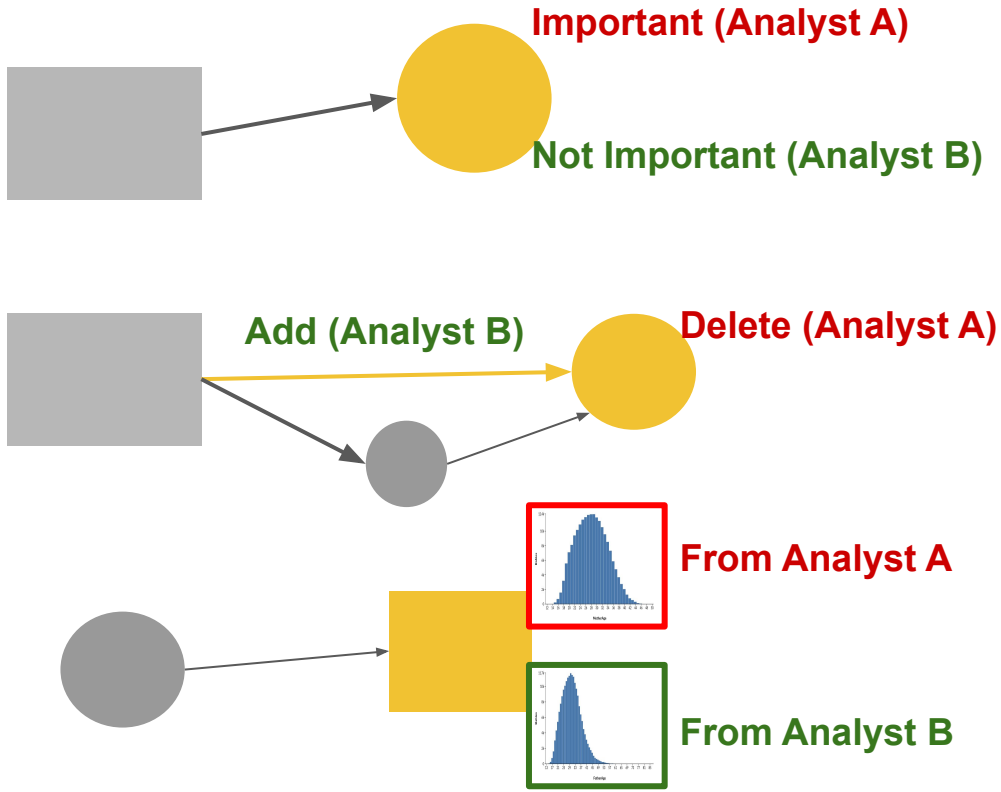


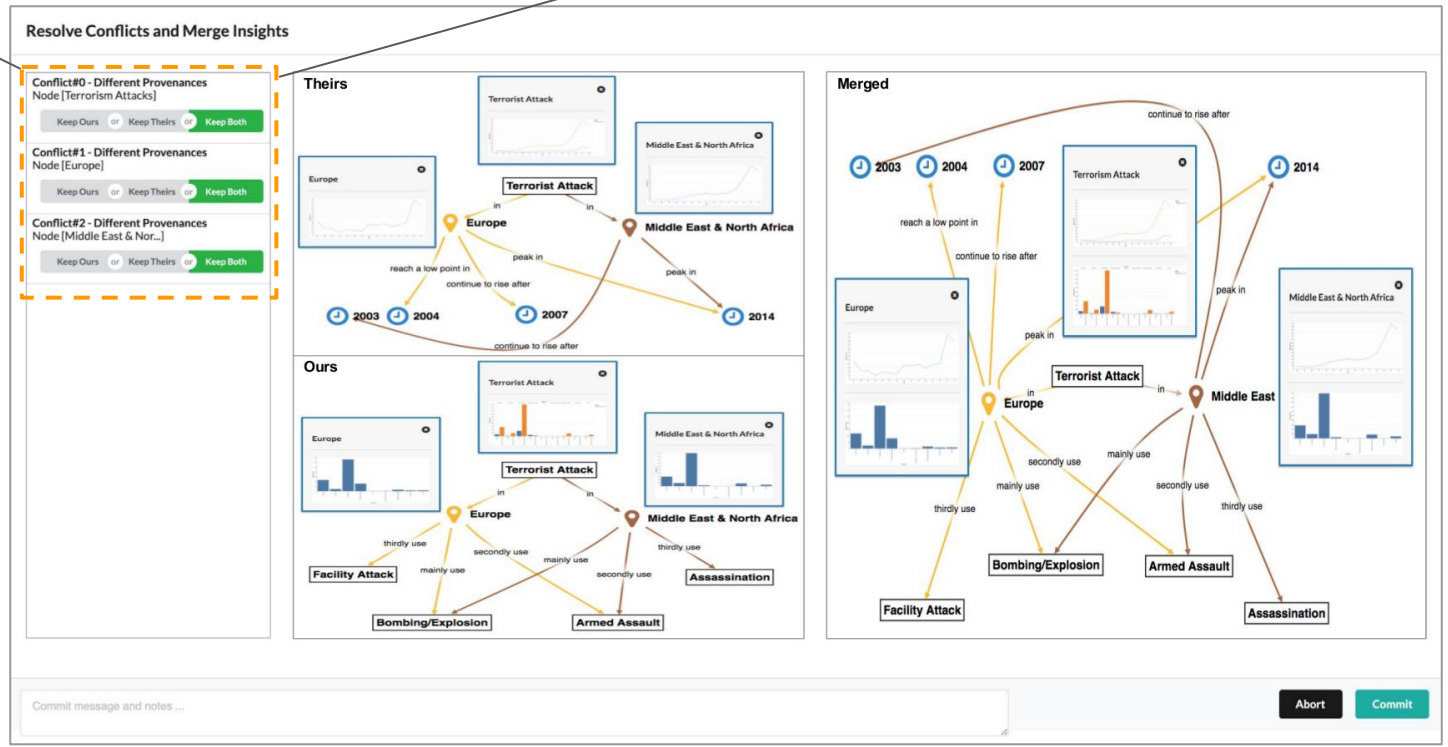
# Common Types of Conflicts

- Property Mismatch
- Node Dissonance
- Provenance Mismatch



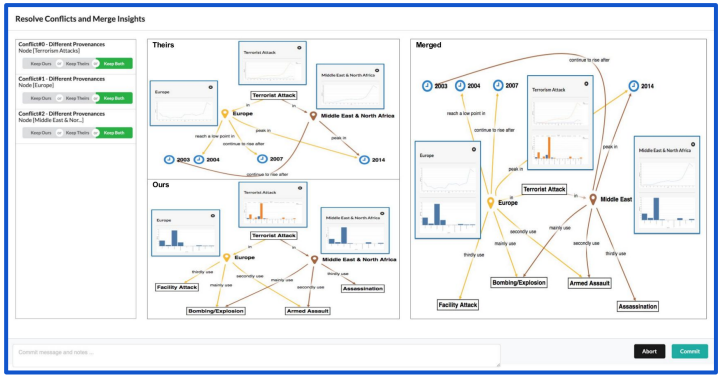
# Visual Interface for Resolve Conflicts

Keep Ours or Keep Theirs or Keep Both



# Evaluation

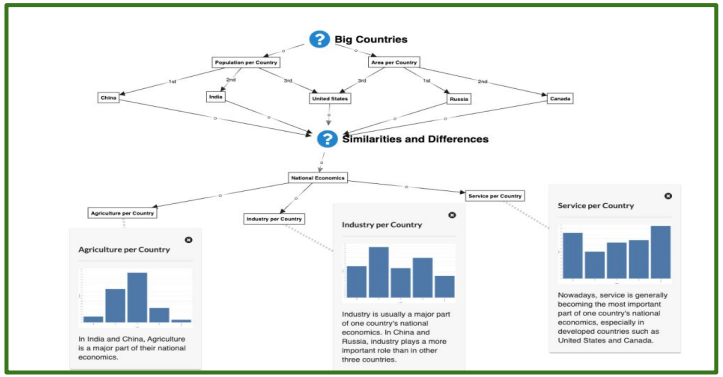
## CoVA




Use CoVA's visual interface for identifying and resolving conflicting insights

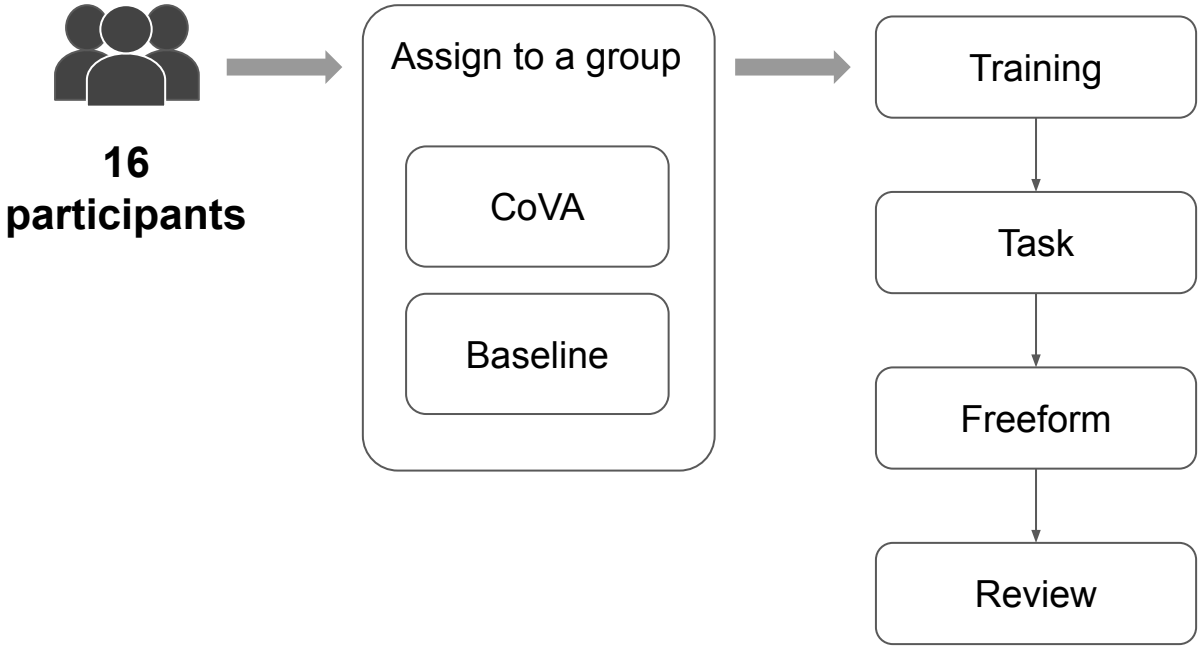
VS

## Baseline




Use the conventional graph merging method to combine the results. No visual interface for identifying and resolving conflicts.

# User Study Setup



# Analysis Tasks

**Simulated an asynchronous collaboration scenario**

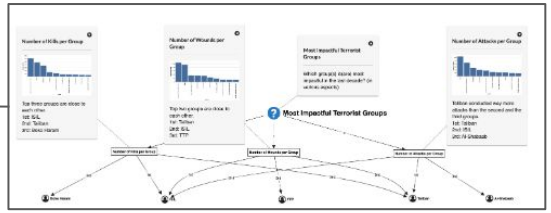
Training

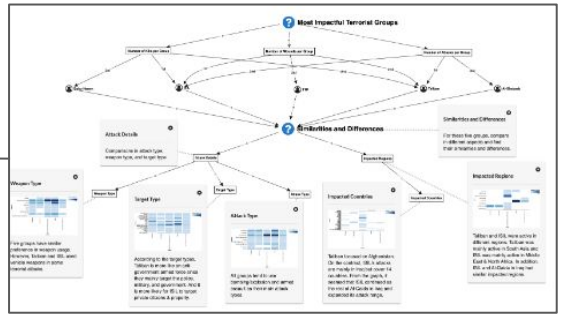
Task

Freeform

Review

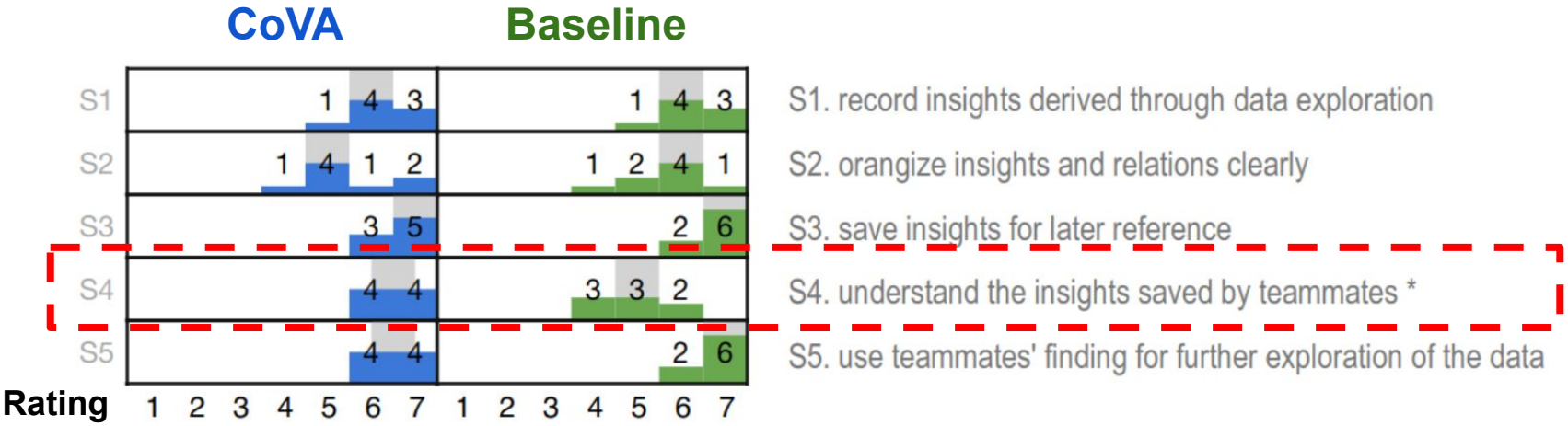
- Start with an **initial Insight Graph**
- Explore three specific aspects in a dataset
- Commit the findings
- Receive new results from **the simulated collaborator**
- Combine all results




- Continue to explore the dataset
- Add findings to the combined graph
- Stop after 10 minutes

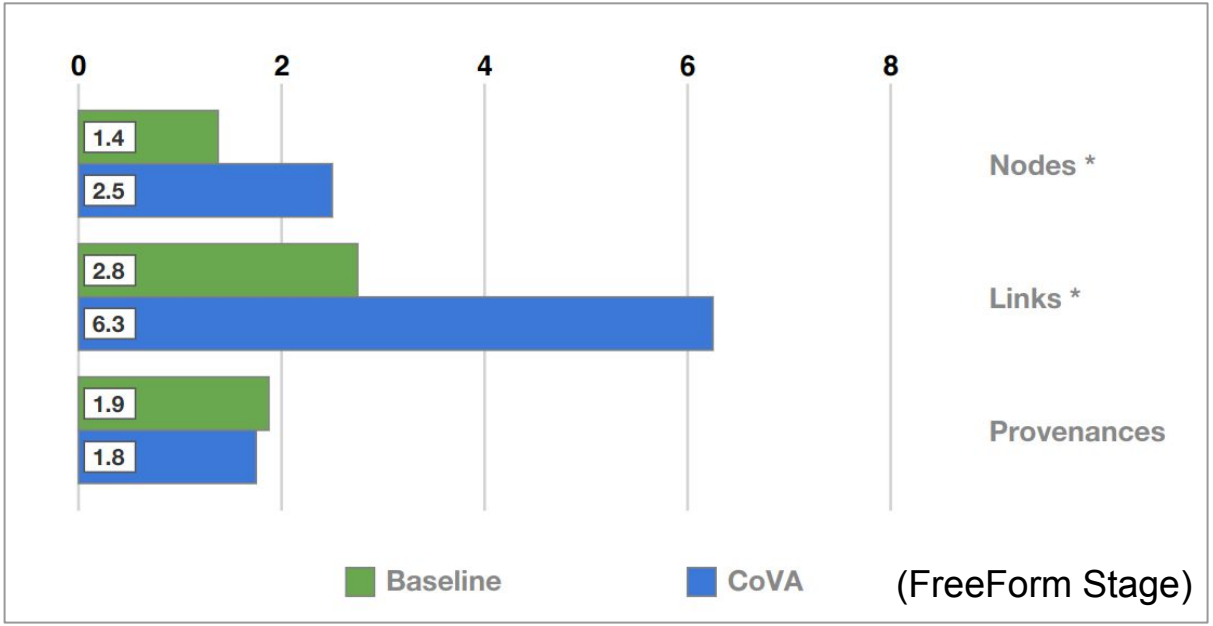
# Better Understanding of Collaborative Analysis Results




Range of 1 (strongly disagree) to 7 (strongly agree)

*** CoVA allows better understanding of the insights saved by the other analyst ($p < 0.05$).**

# Better Use of Collaborative Analysis Results

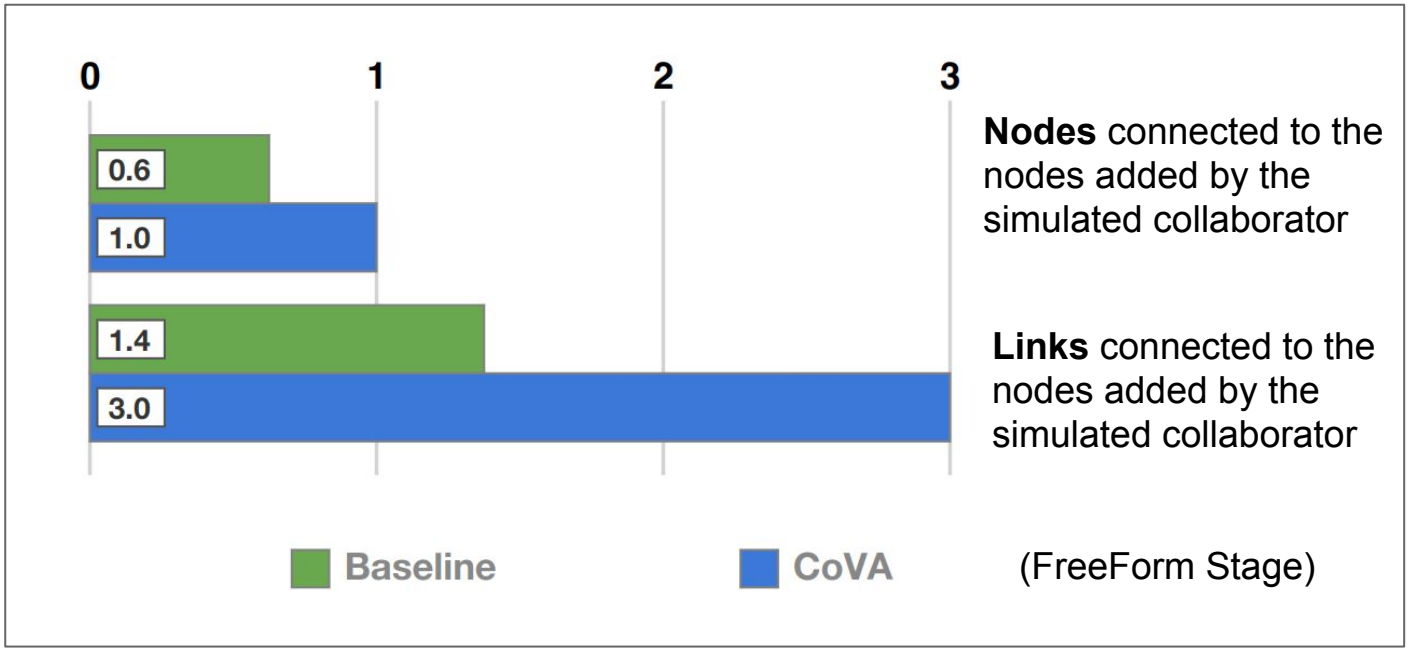



$p$ = 0.0490
Effect size = 0.9 (large)

$p$ = 0.00381
Effect size = 1.72 (large)

**CoVA allows users to develop more insights in collaborative data analysis.**

# Better Collaborations




**Nodes** connected to the nodes added by the simulated collaborator

*p* = 0.368
Effect size = 0.18 (small)

**Links** connected to the nodes added by the simulated collaborator

*p* = 0.007
Effect size = 1.44 (largel)

(FreeForm Stage)

# Conclusion

- System Limitations
  - Need better UI associated with declarative visualization grammars for data exploration
  - Need more effective way for externalizing insights and adding provenance
- User Study Limitations
  - Only two analysts in collaboration
  - Future work: conduct user studies with more users
- Identifying and resolving conflicts → Better collaborative visual analytics
  - Allows better understanding of shared analysis results
  - Leads to more findings and insights as well as better collaborations
- **Lots of opportunities for future work!**

# Thank You!

## Resolving Conflicting Insights in Asynchronous Collaborative Visual Analysis

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### Acknowledgements

This research was supported in part by the U.S. National Science Foundation through grants IIS-320229 and IIS-1741536.