Automatic Summarization and Visualization of Incident Reports

Robert Gove

✉ robert.gove@twosixtech.com
🐦 @rpgove

twosix TECHNOLOGIES

Nathan Danneman

✉ nathandanneman@datamachines.io

datamachines

This research was developed with funding from the Defense Advanced Research Projects Agency (DARPA).
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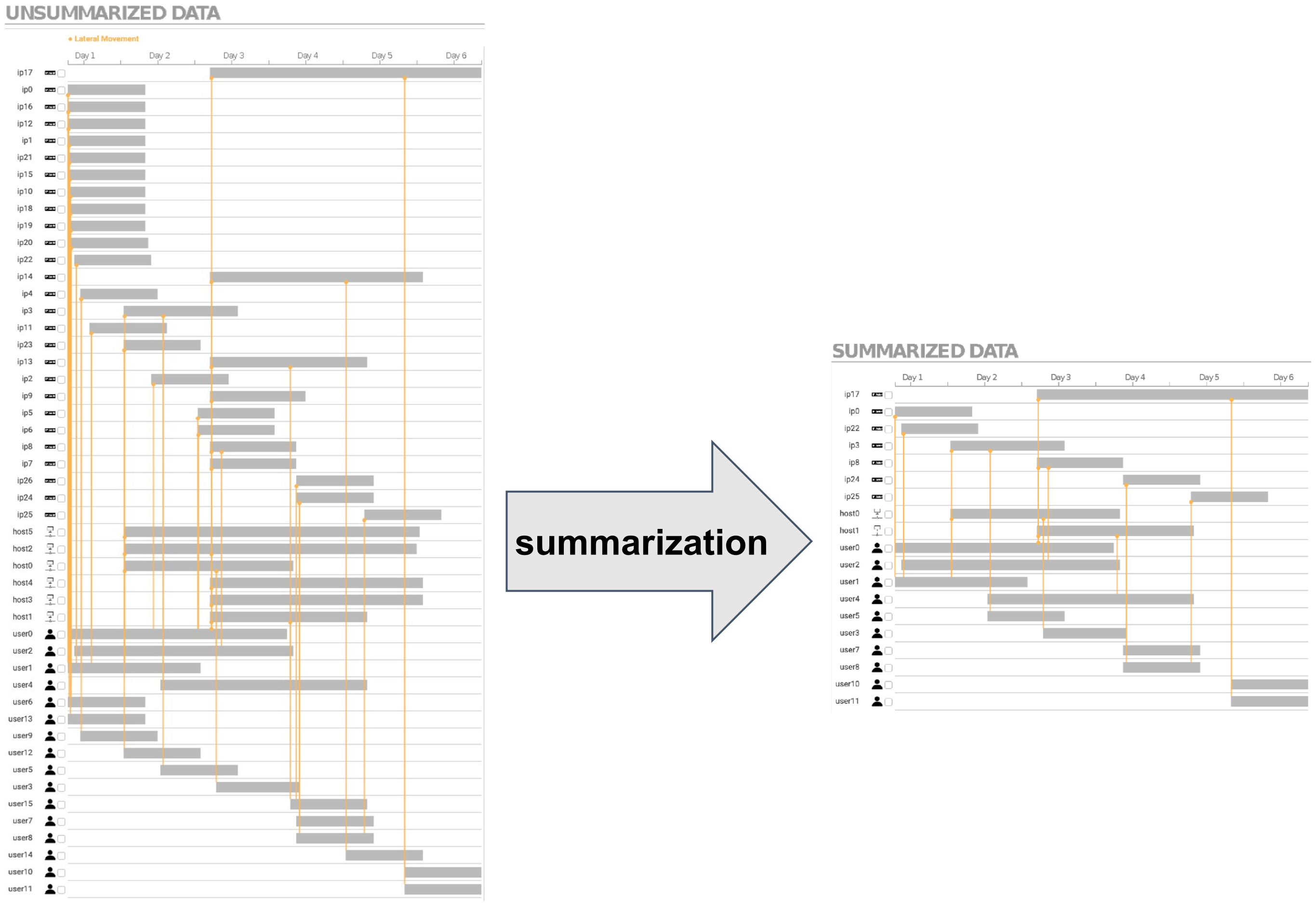
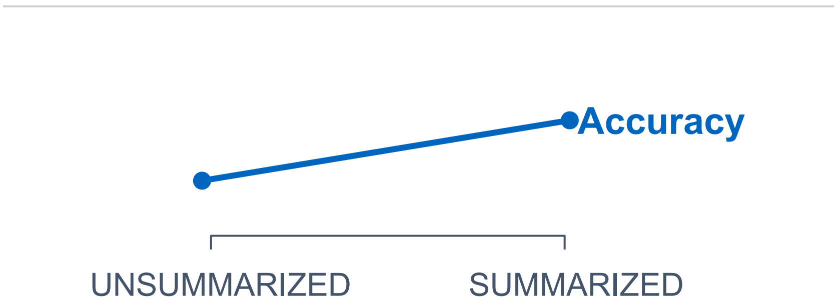
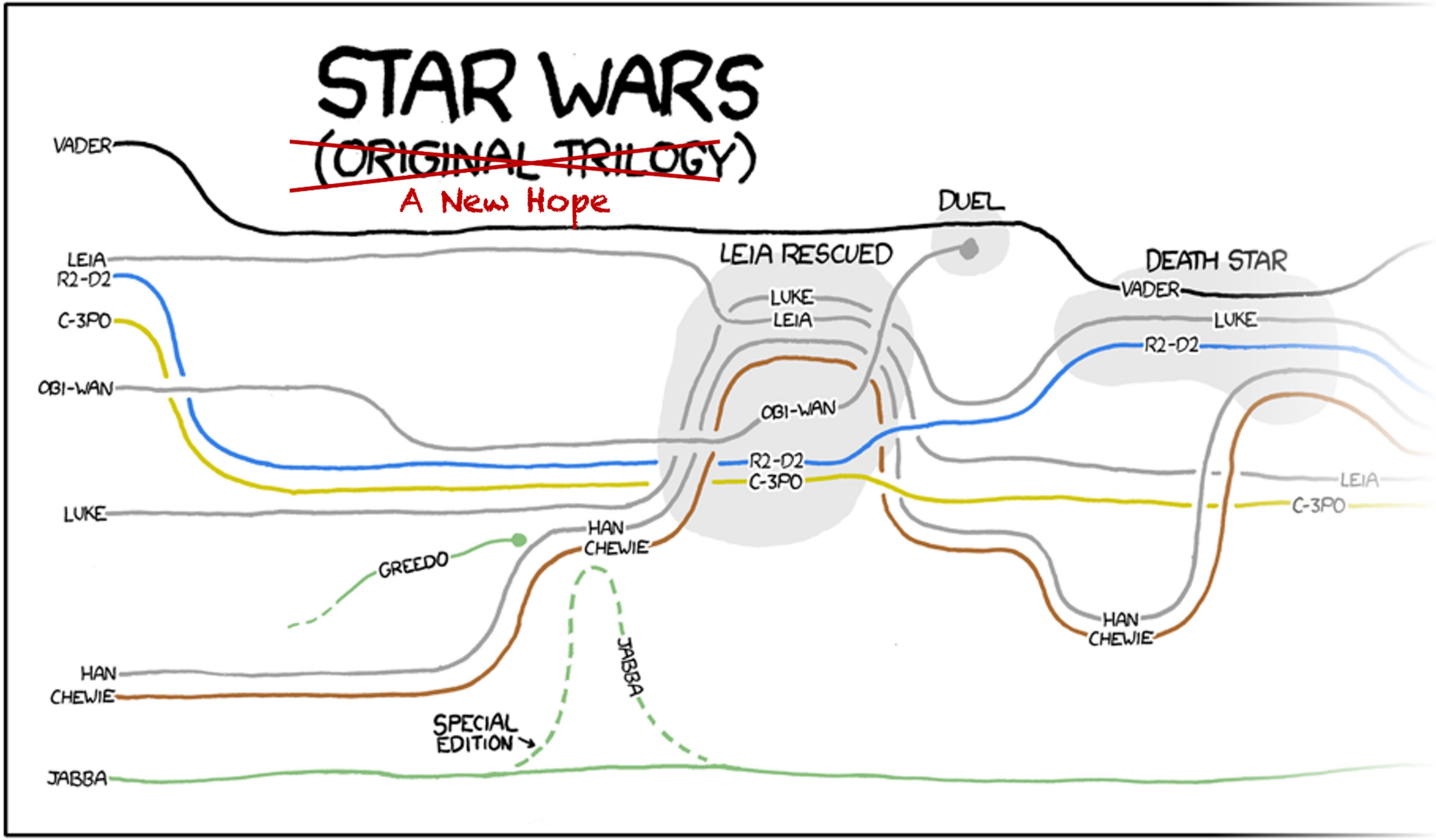
Big Goals

Visualize complex incident reports.

Summarize incident reports in a way that simplifies and preserves (or even enhances?) accuracy.







Randall Munroe. Movie Narrative Charts. https://xkcd.com/657/

Summarization Prior Art

Natural language processing

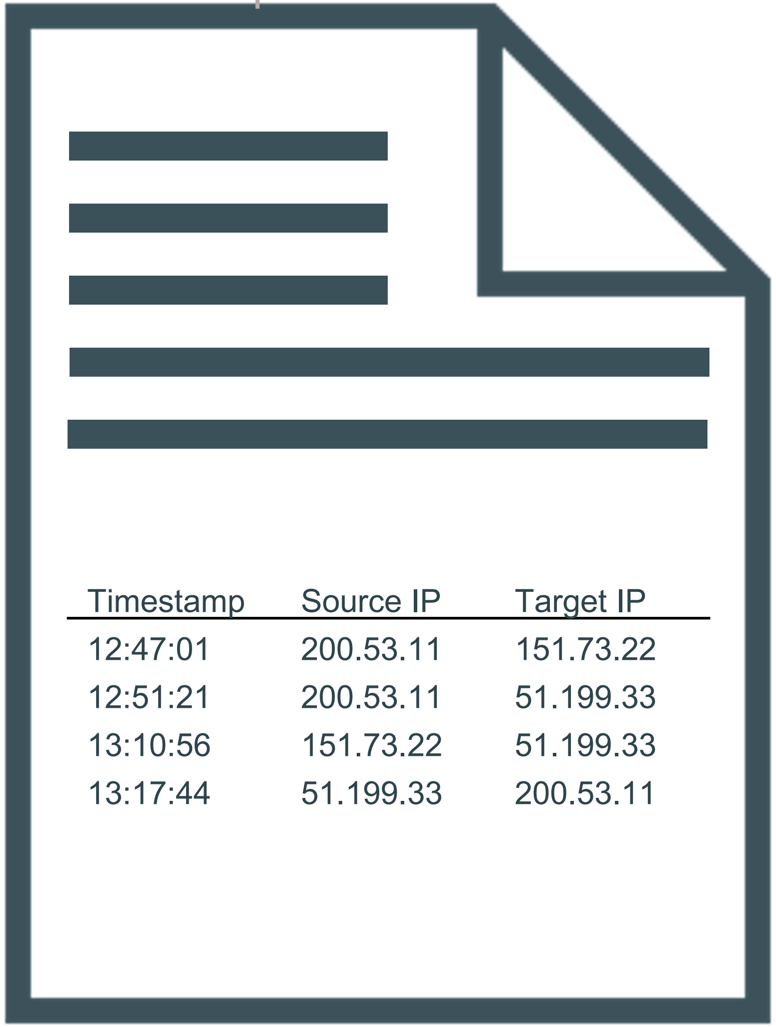
- Summarization vs. simplification
- Extractive vs. abstractive
- Relies on *natural* language
    - We have structured data

Graph theory

- Proxy graphs
    - Derive smaller representative graphs
    - Sampling, filtering, graph filtrations, etc.

Incident Reports → Dynamic Graphs

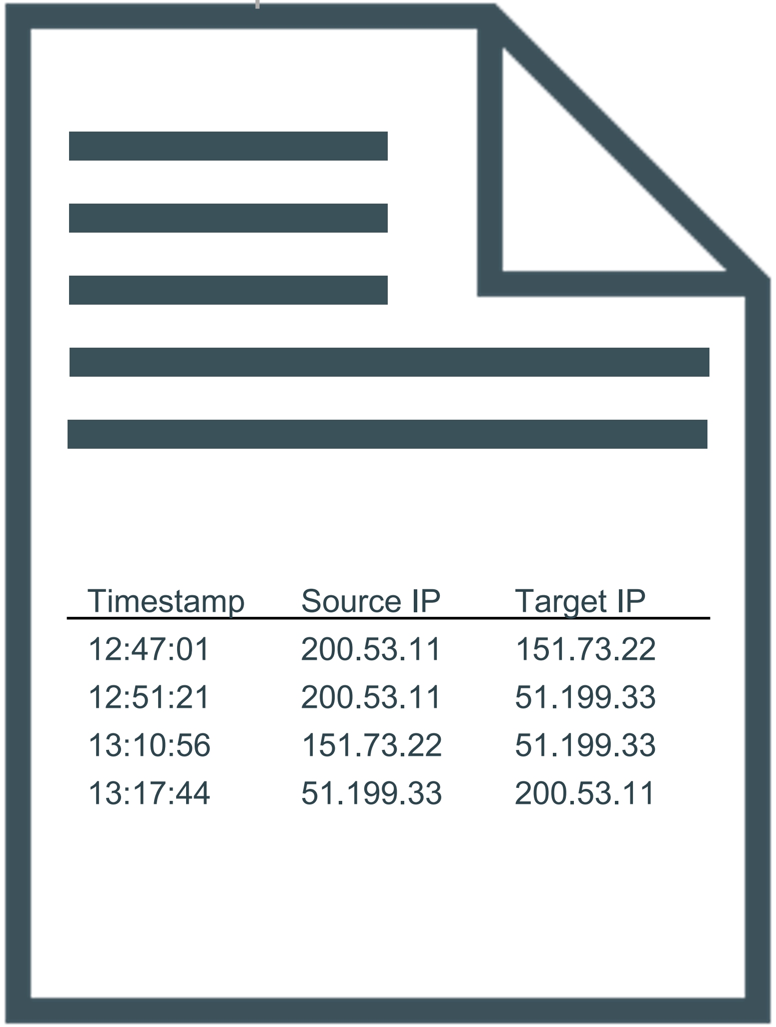
Incident report



Timestamp	Source IP	Target IP
12:47:01	200.53.11	151.73.22
12:51:21	200.53.11	51.199.33
13:10:56	151.73.22	51.199.33
13:17:44	51.199.33	200.53.11

Incident Reports → Dynamic Graphs

Incident report



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13:17:44	51.199.33	200.53.11

Tabular log data

Incident Reports → Dynamic Graphs

Incident report

Timestamp	Source IP	Target IP
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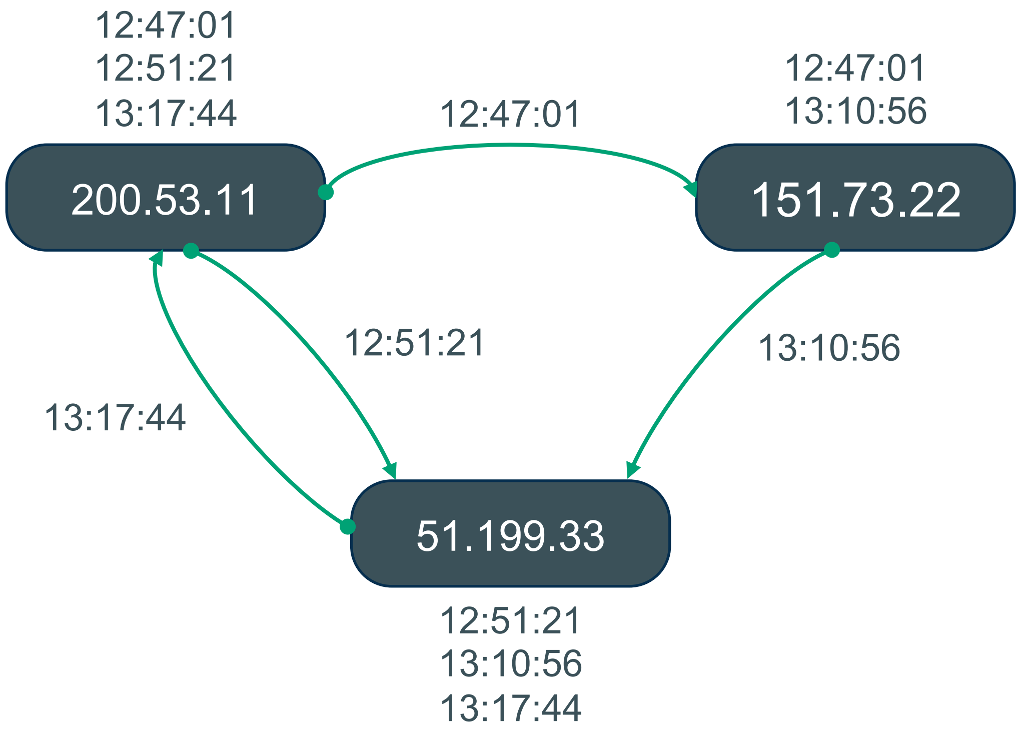
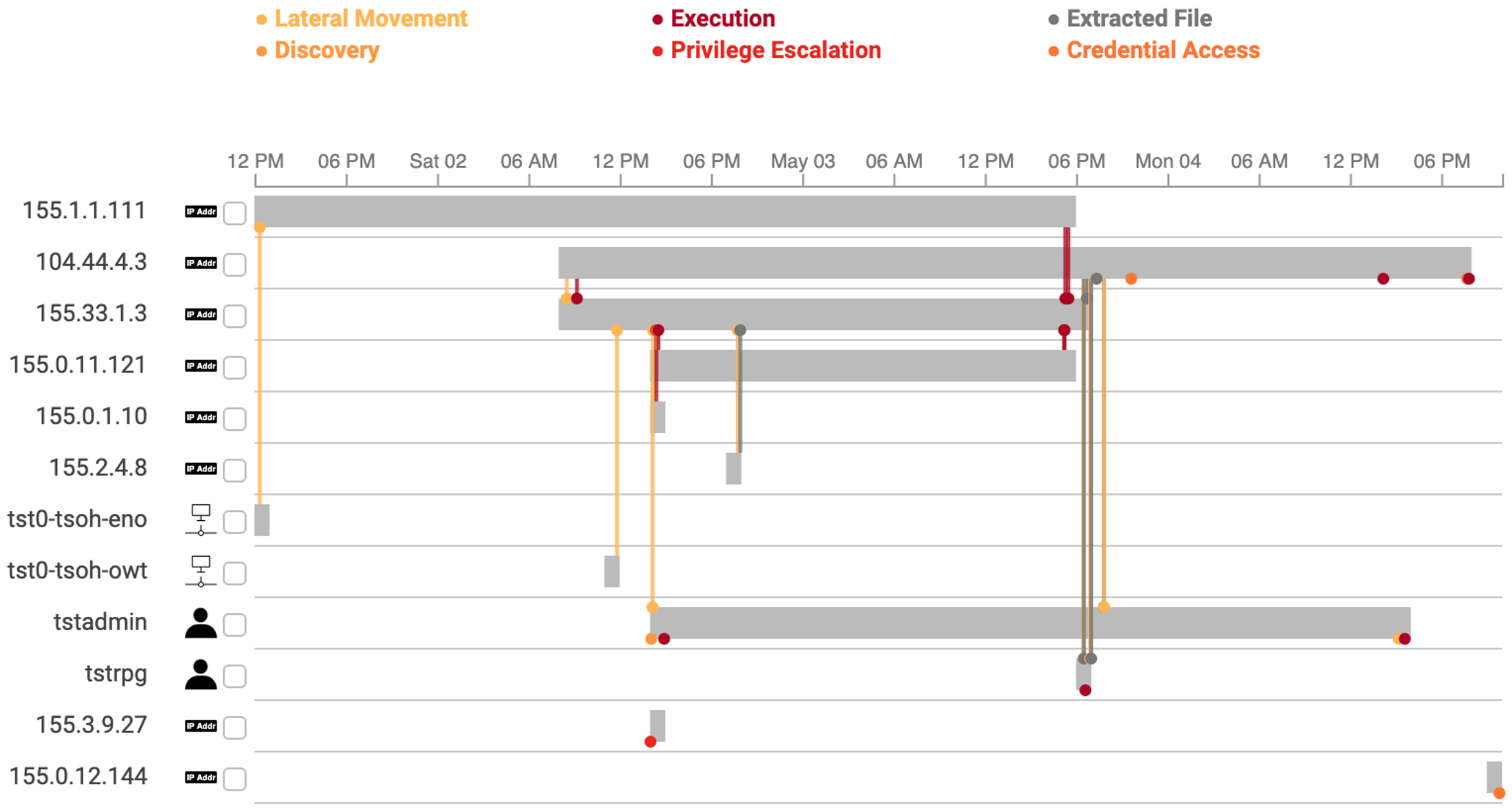


Tabular log data converted to a dynamic graph

Visualization Design

Goals:

- Succinctness
- Consistency
- Activity progression
- Patterns
- Learnability



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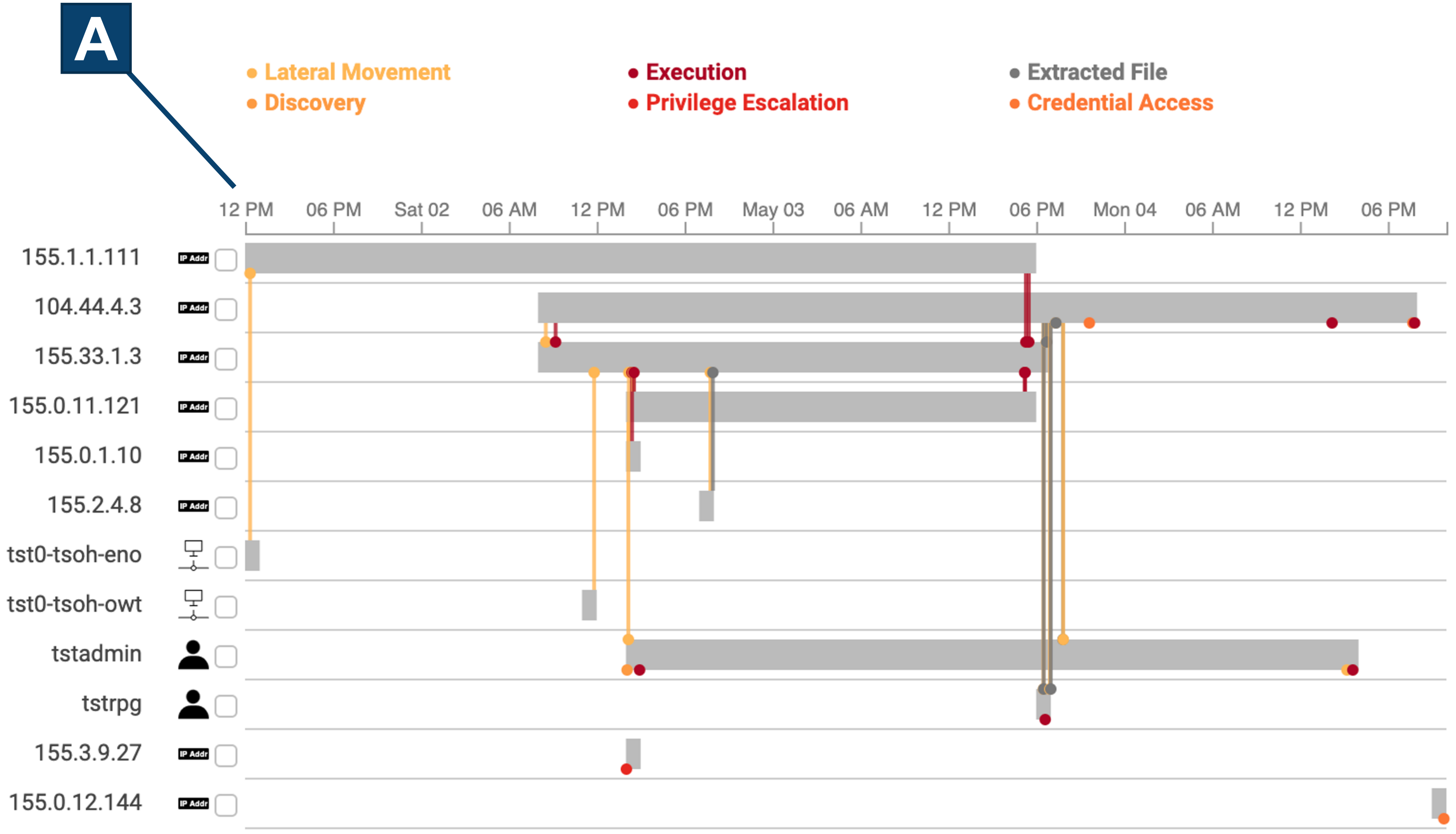

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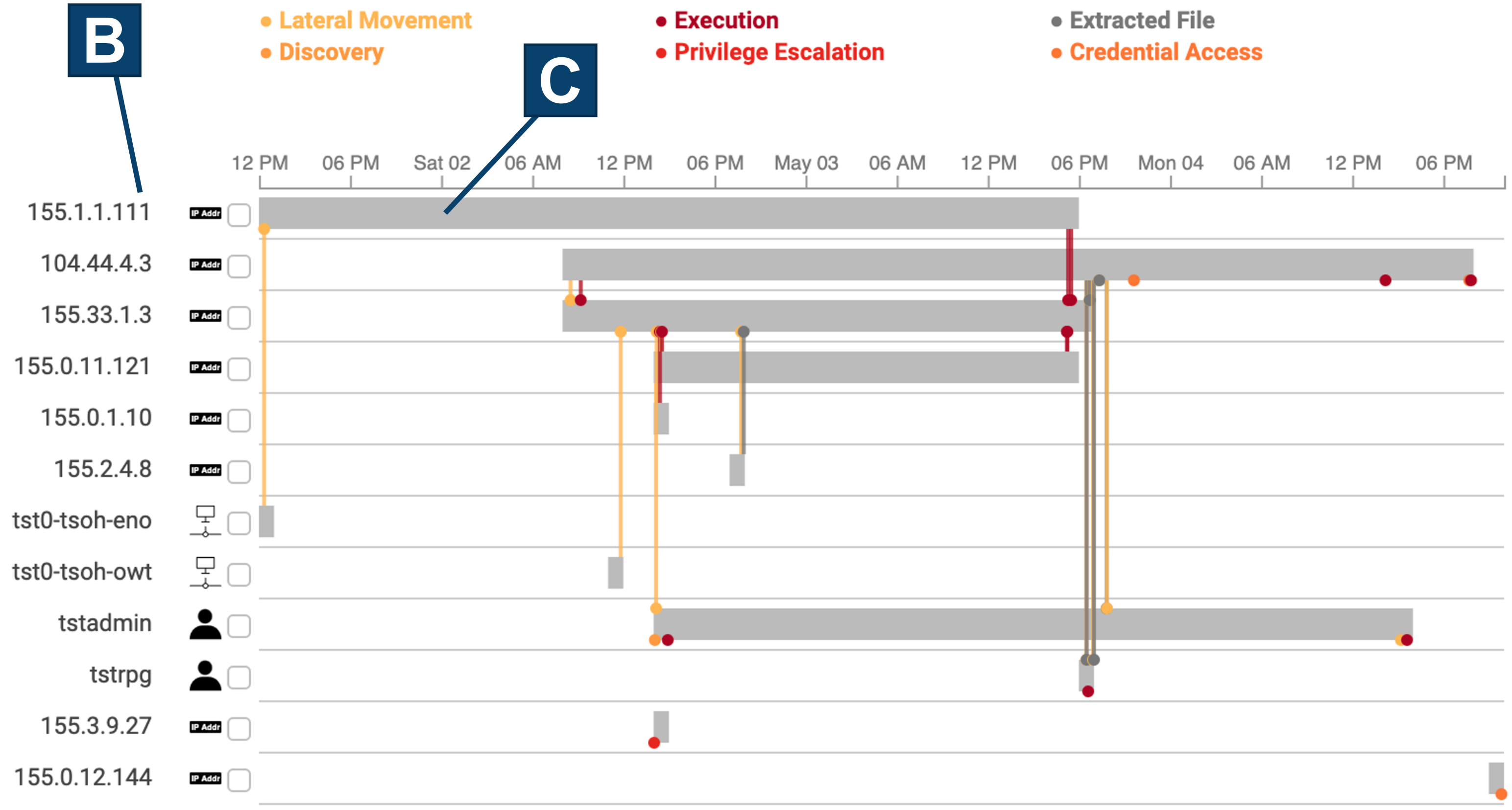

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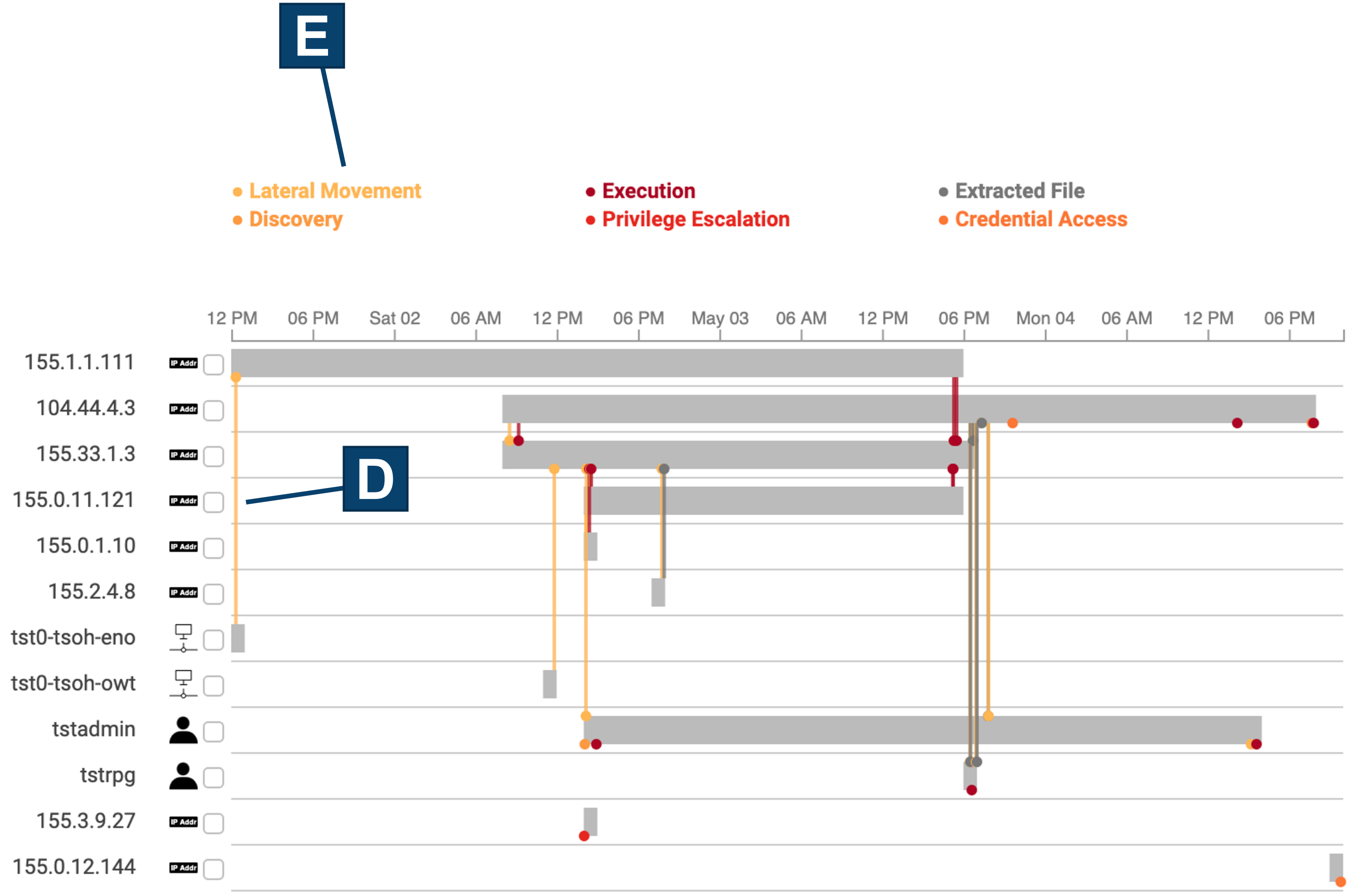

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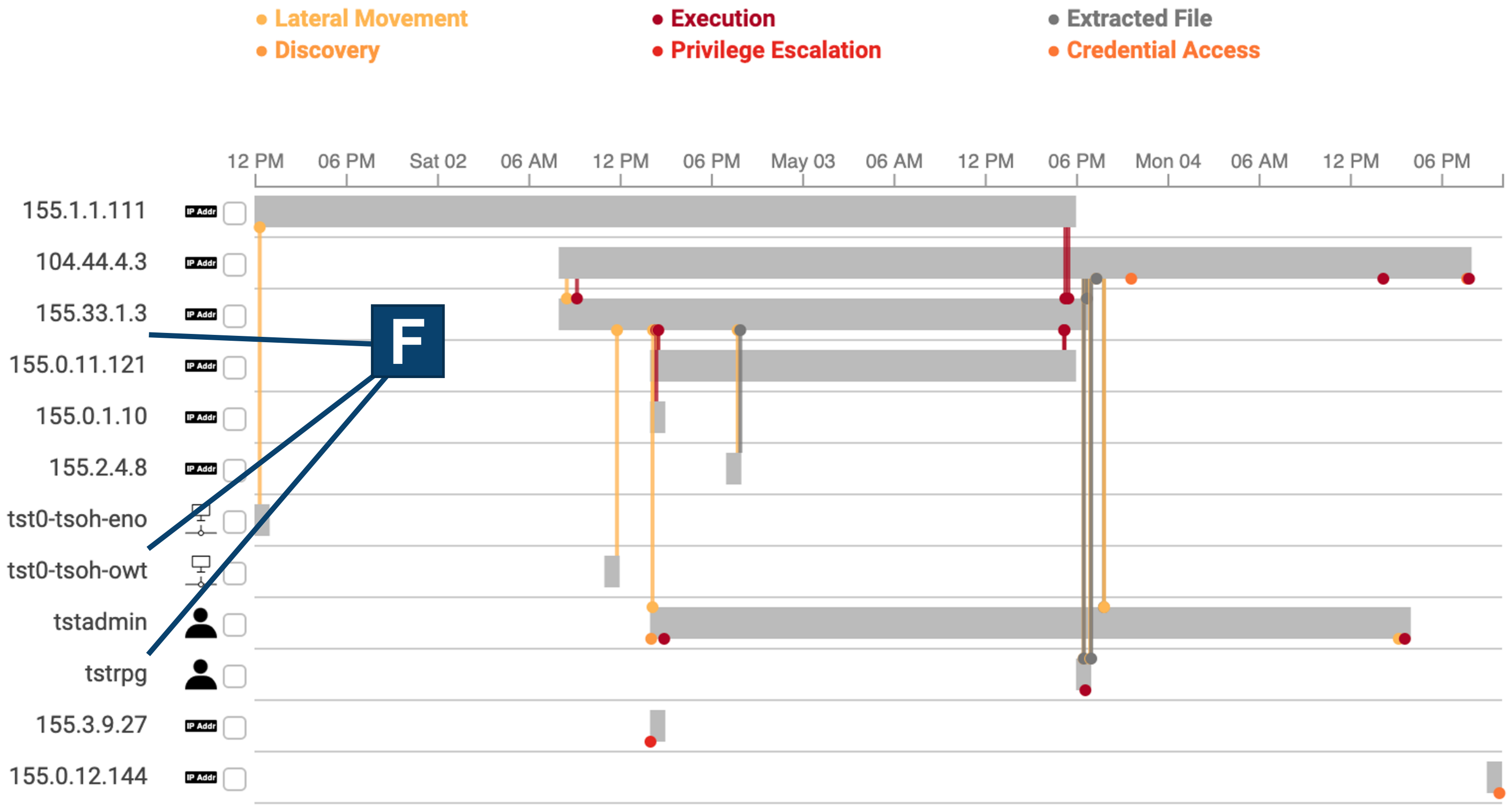


Summarization: What is good?

Evaluation Criteria

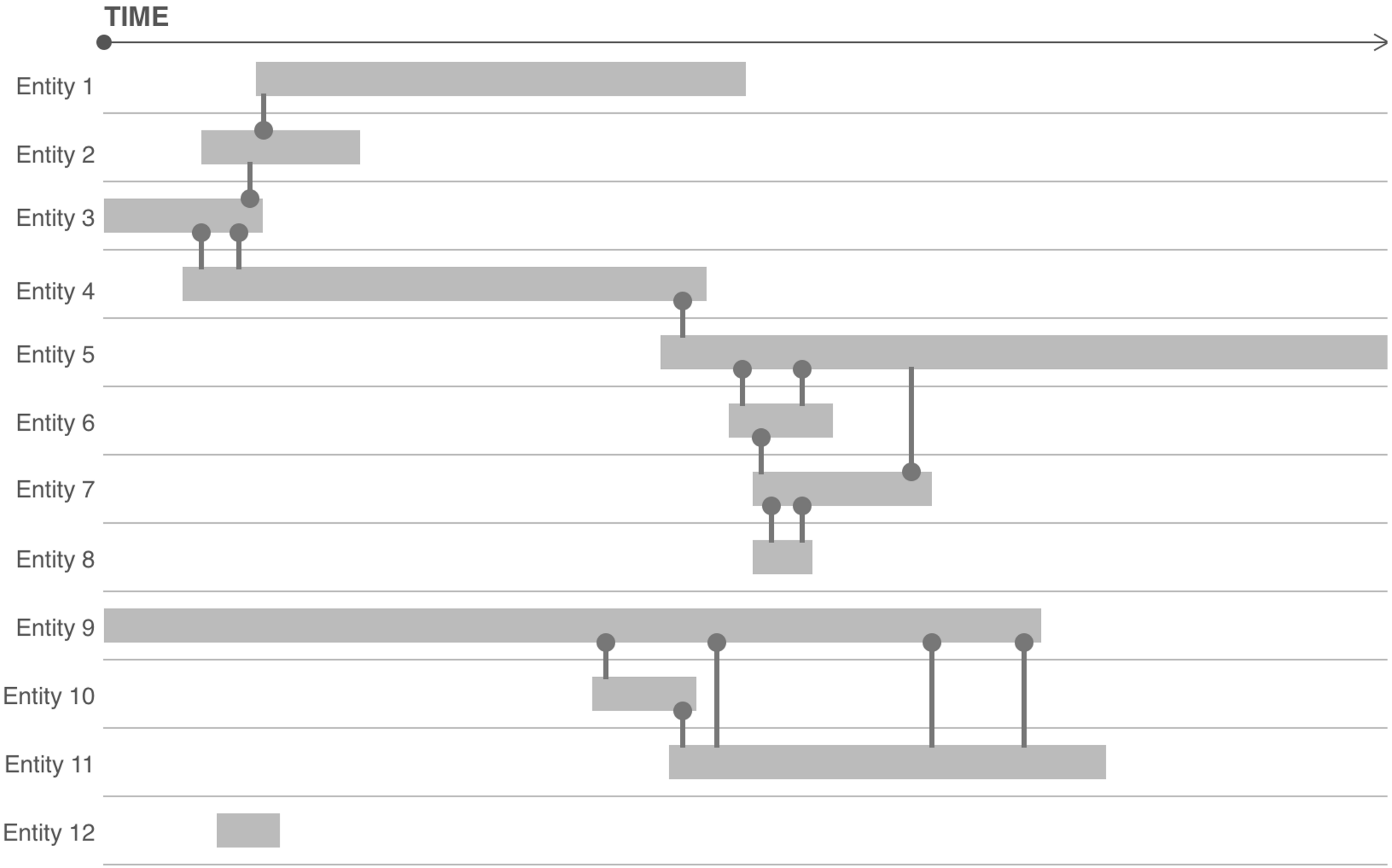
- Size: smaller incident reports are better
- Accuracy: don't drop entities that are true positives
- Useful for analysts

Wait, is that reasonable?

- Incident reports are the results of algorithms with access to more information…
- Detector authors have strong incentives to optimize precision and recall…

Featurizing Incident Report Dynamic Graphs

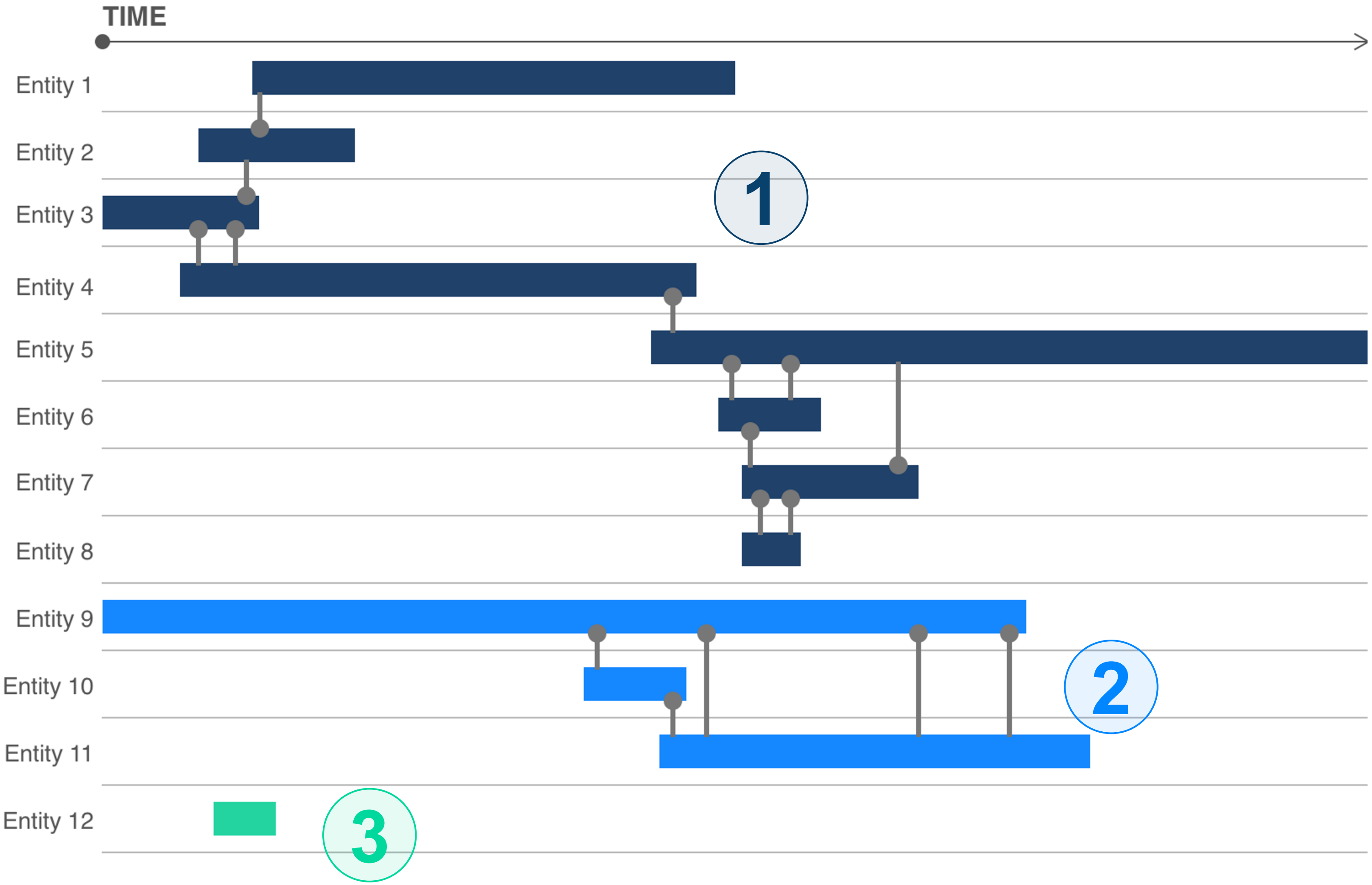
Calculate scores



Featurizing Incident Report Dynamic Graphs

Calculate scores

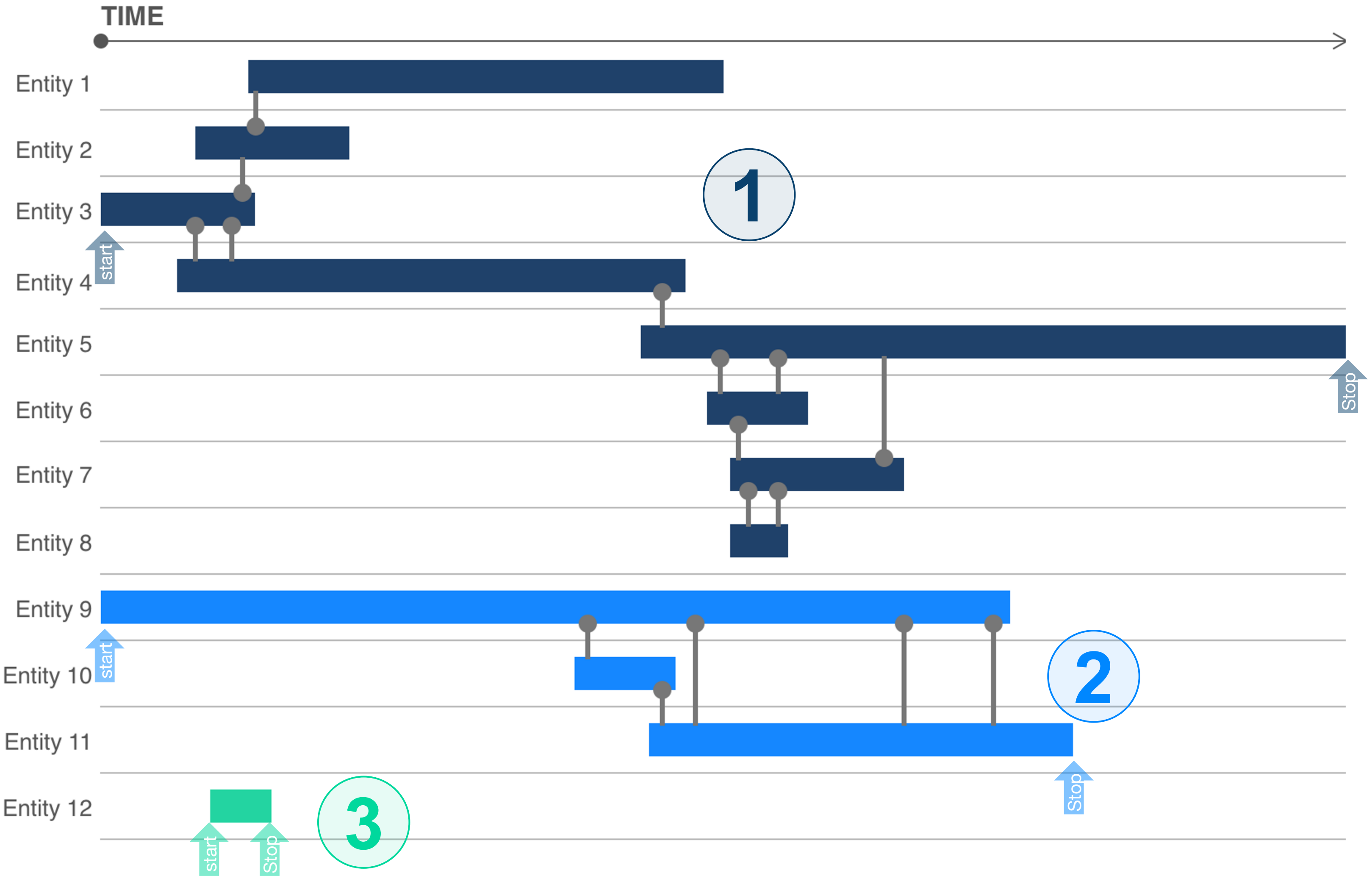
- Component scores



Featurizing Incident Report Dynamic Graphs

Calculate scores

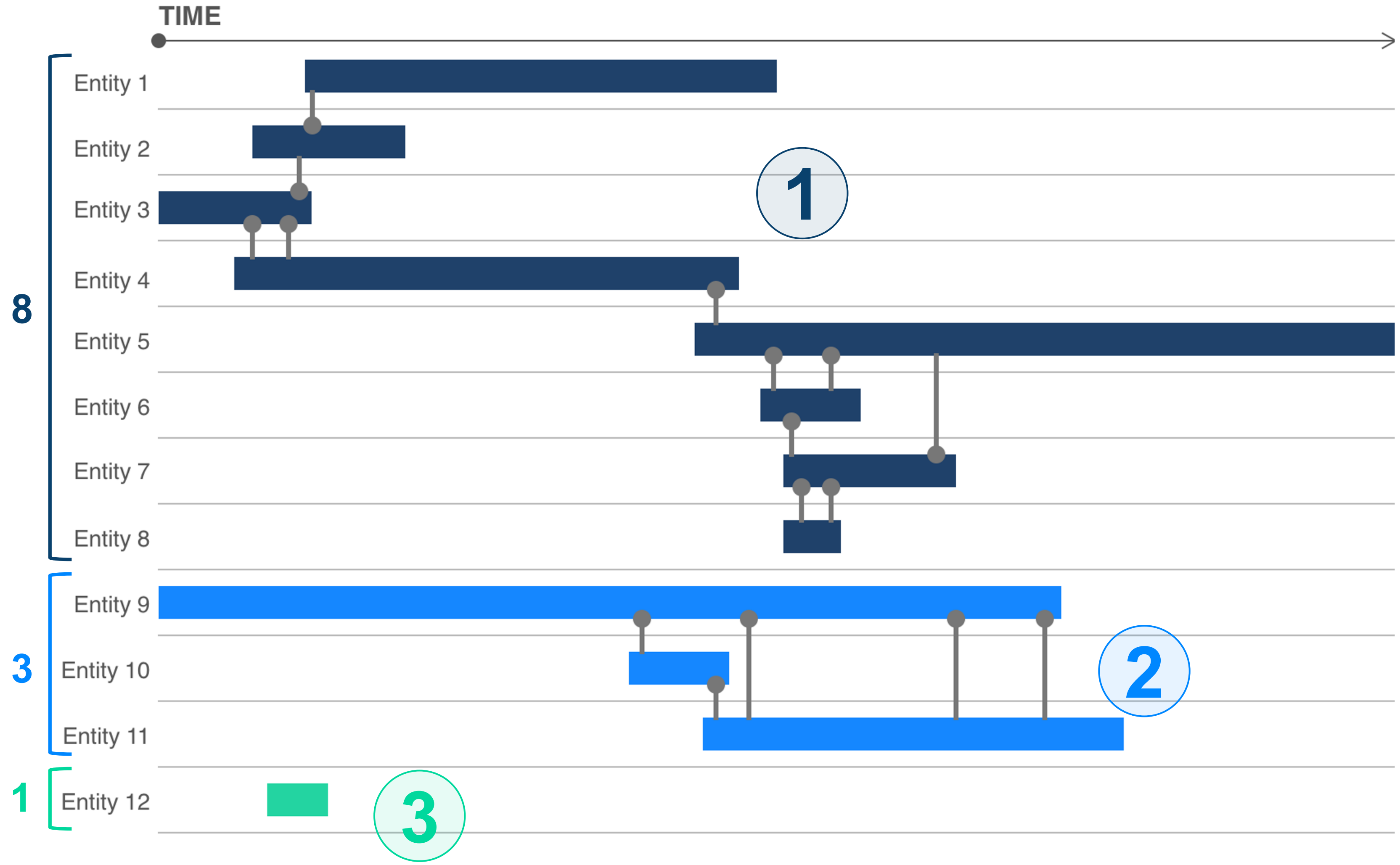
- Component scores
  - Relative duration



Featurizing Incident Report Dynamic Graphs

Calculate scores

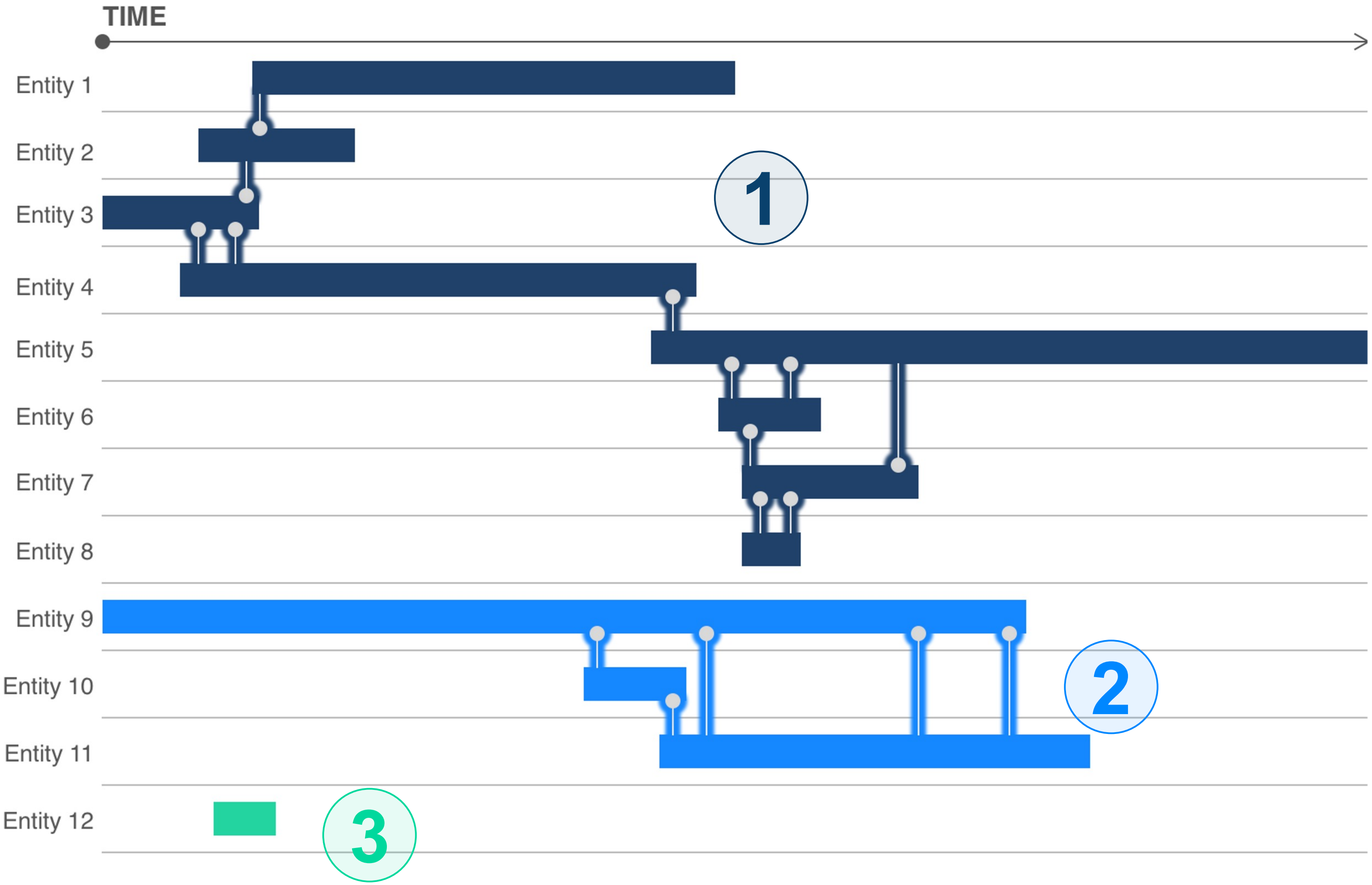
- Component scores
  - Relative duration
  - Relative number of entities



Featurizing Incident Report Dynamic Graphs

Calculate scores

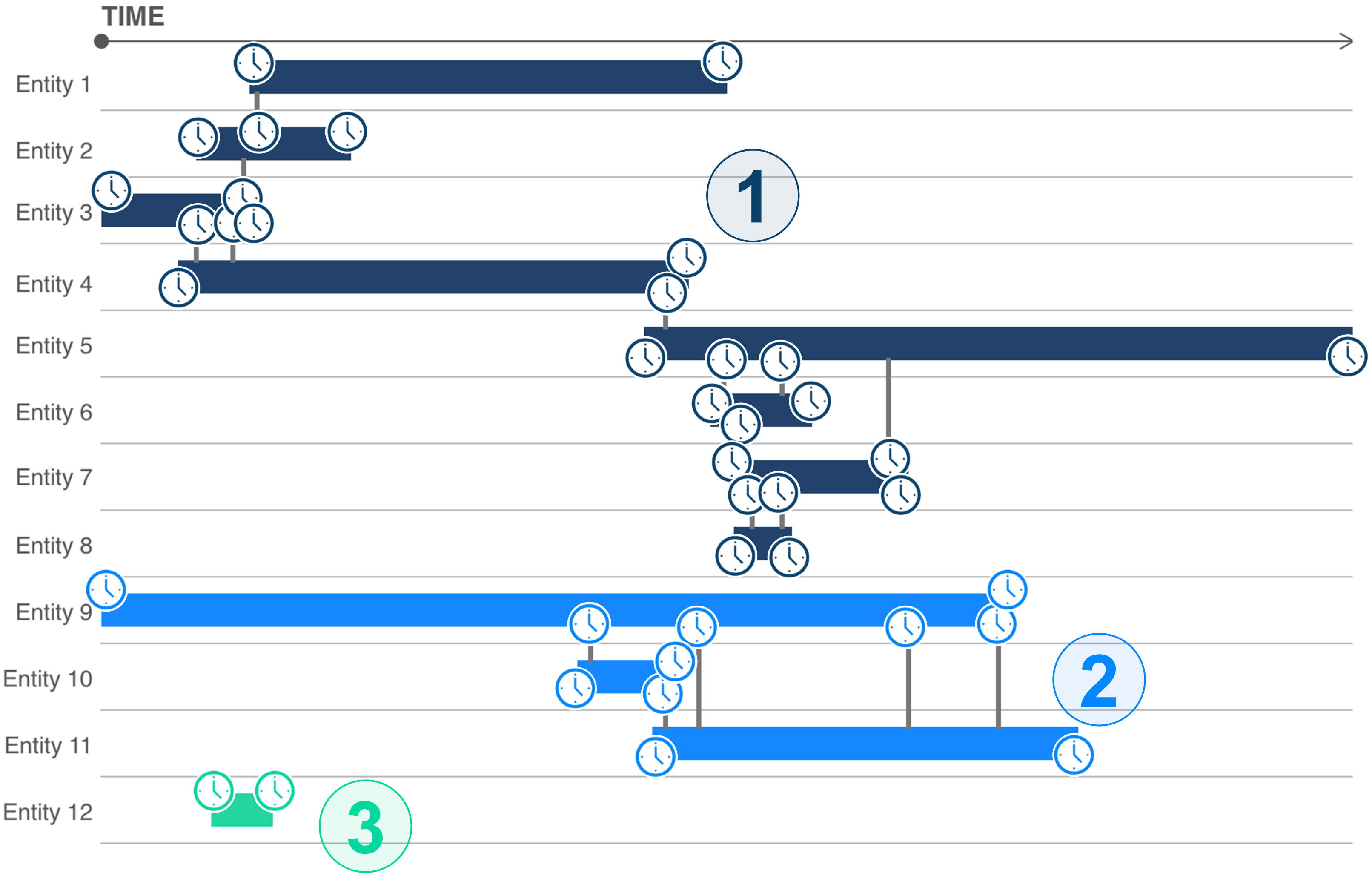
- Component scores
  - Relative duration
  - Relative number of entities
  - Relative number of relationships



Featurizing Incident Report Dynamic Graphs

Calculate scores

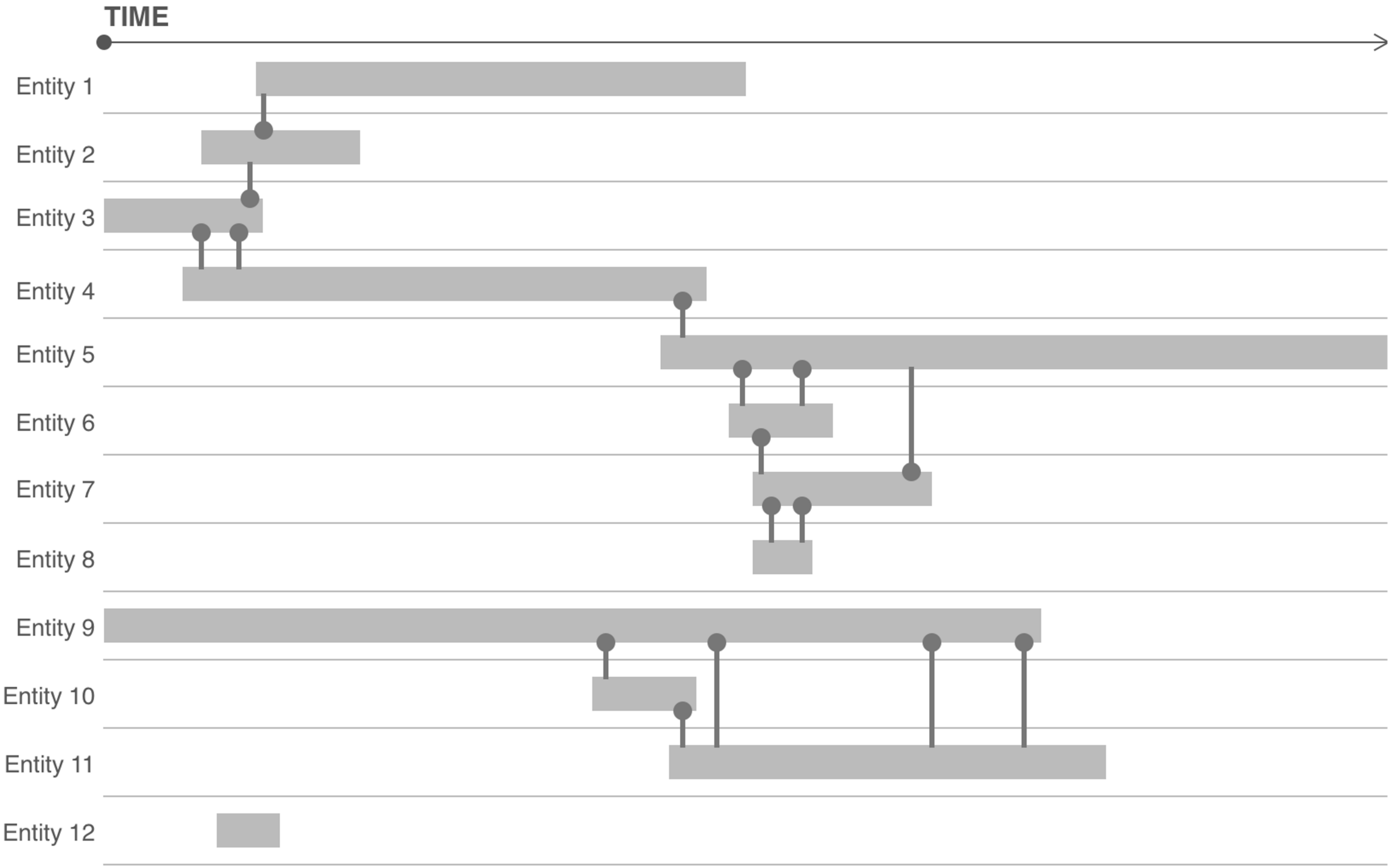
- Component scores
  - Relative duration
  - Relative number of entities
  - Relative number of relationships
  - Relative number of timestamps



Featurizing Incident Report Dynamic Graphs

Calculate scores

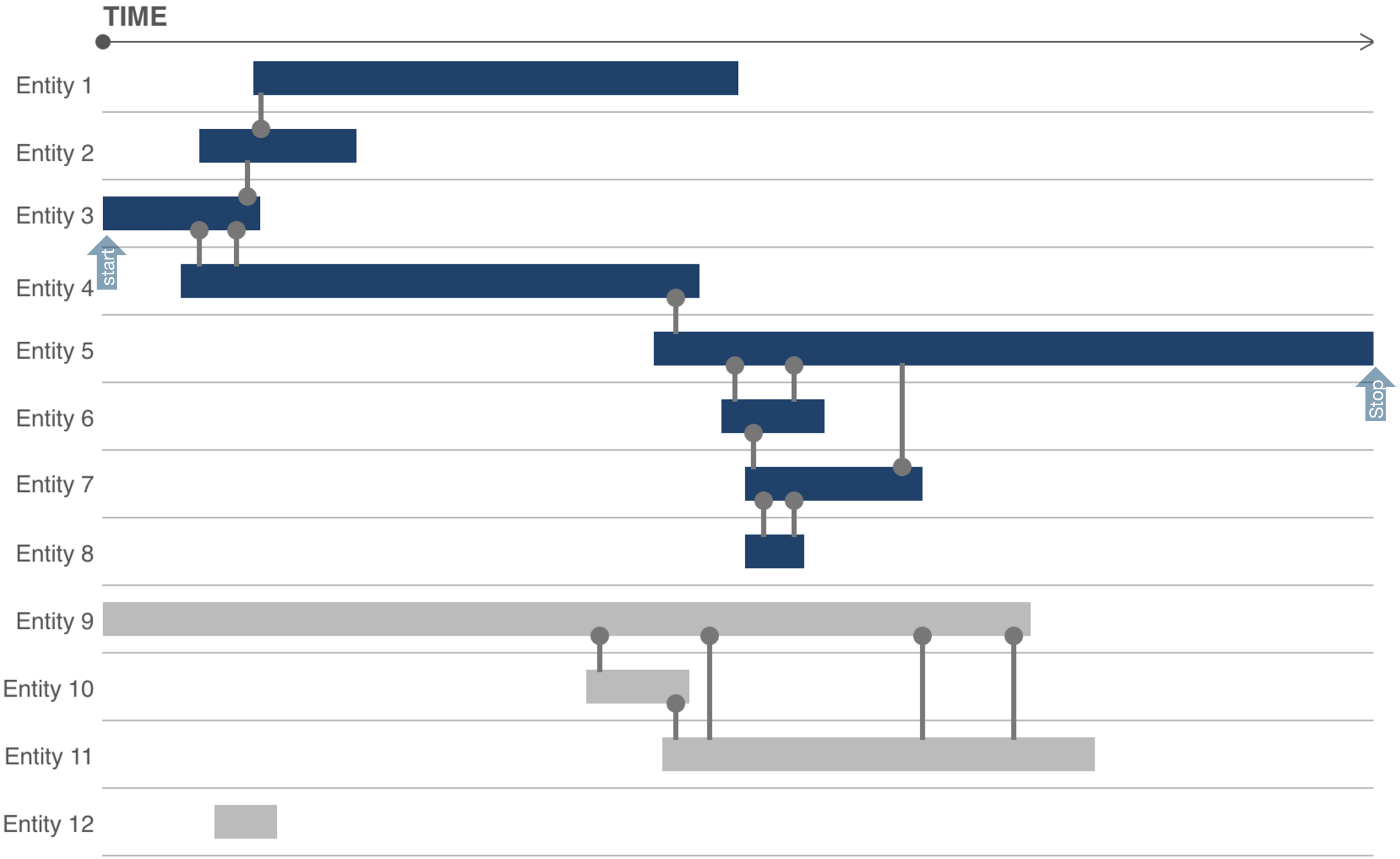
- Component scores
- Branch scores



Featurizing Incident Report Dynamic Graphs

Calculate scores

- Component scores
- Branch scores
  - Core sequence of events



Featurizing Incident Report Dynamic Graphs

Calculate scores

- Component scores
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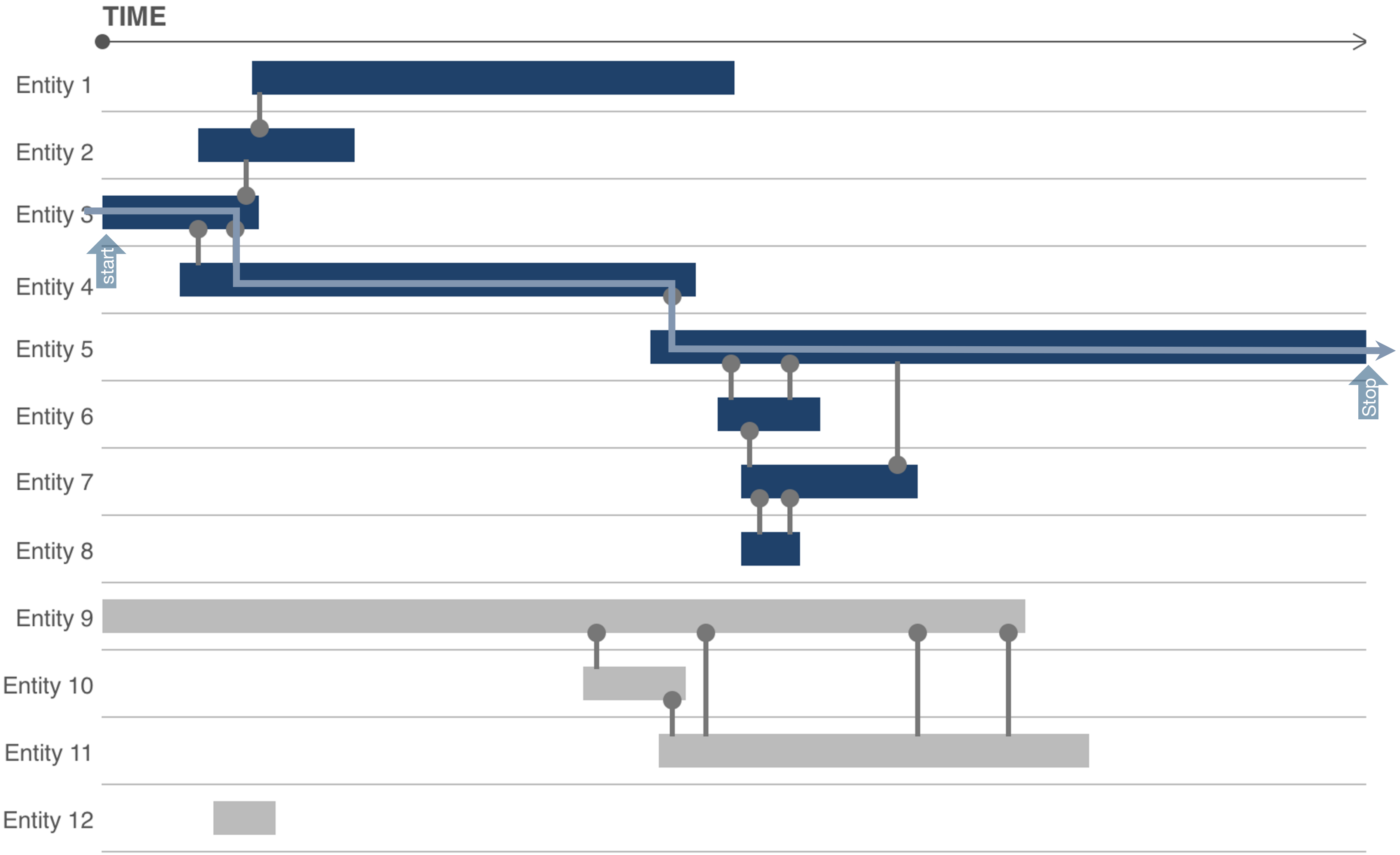
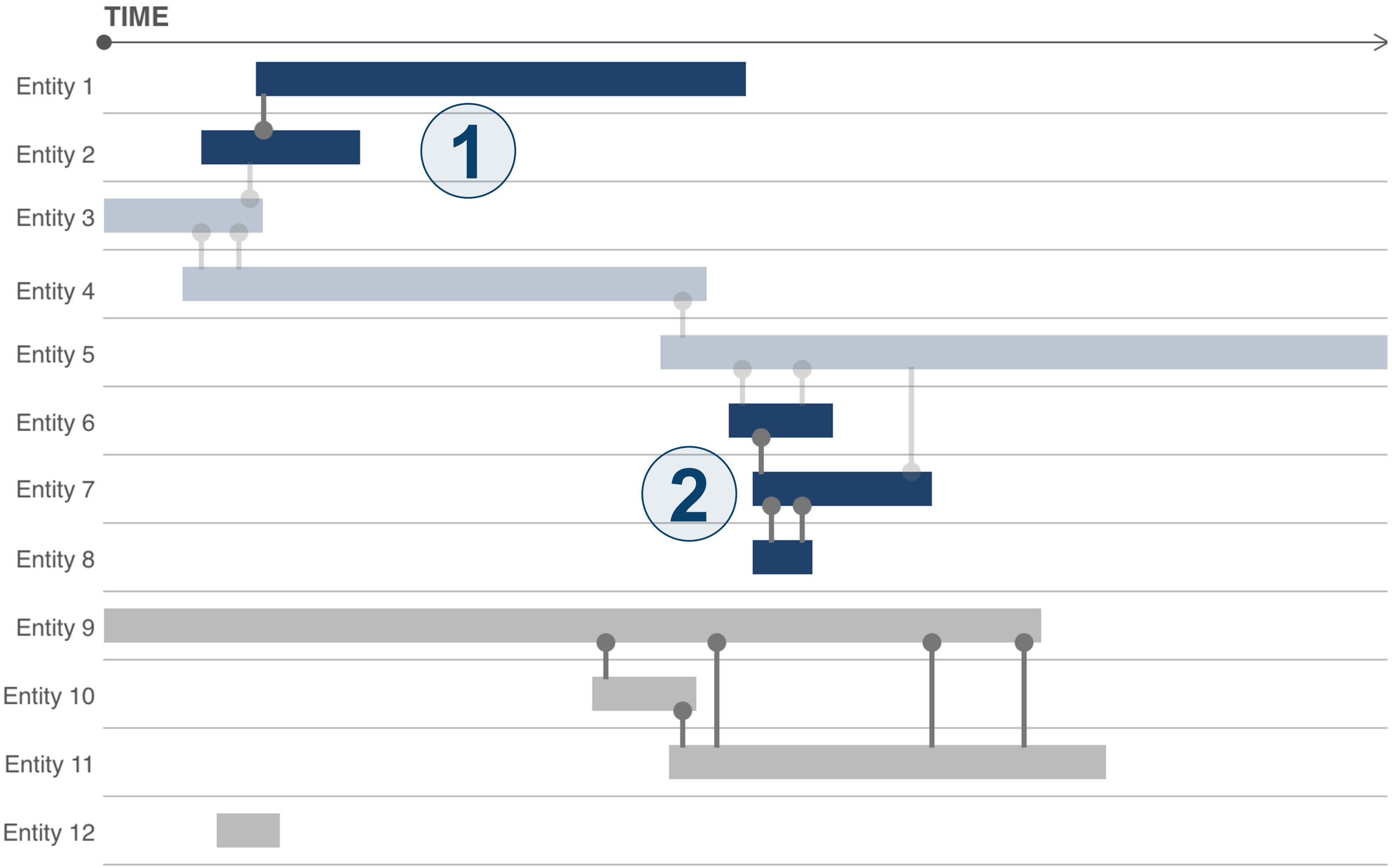
  - Core sequence of events



Featurizing Incident Report Dynamic Graphs

Calculate scores

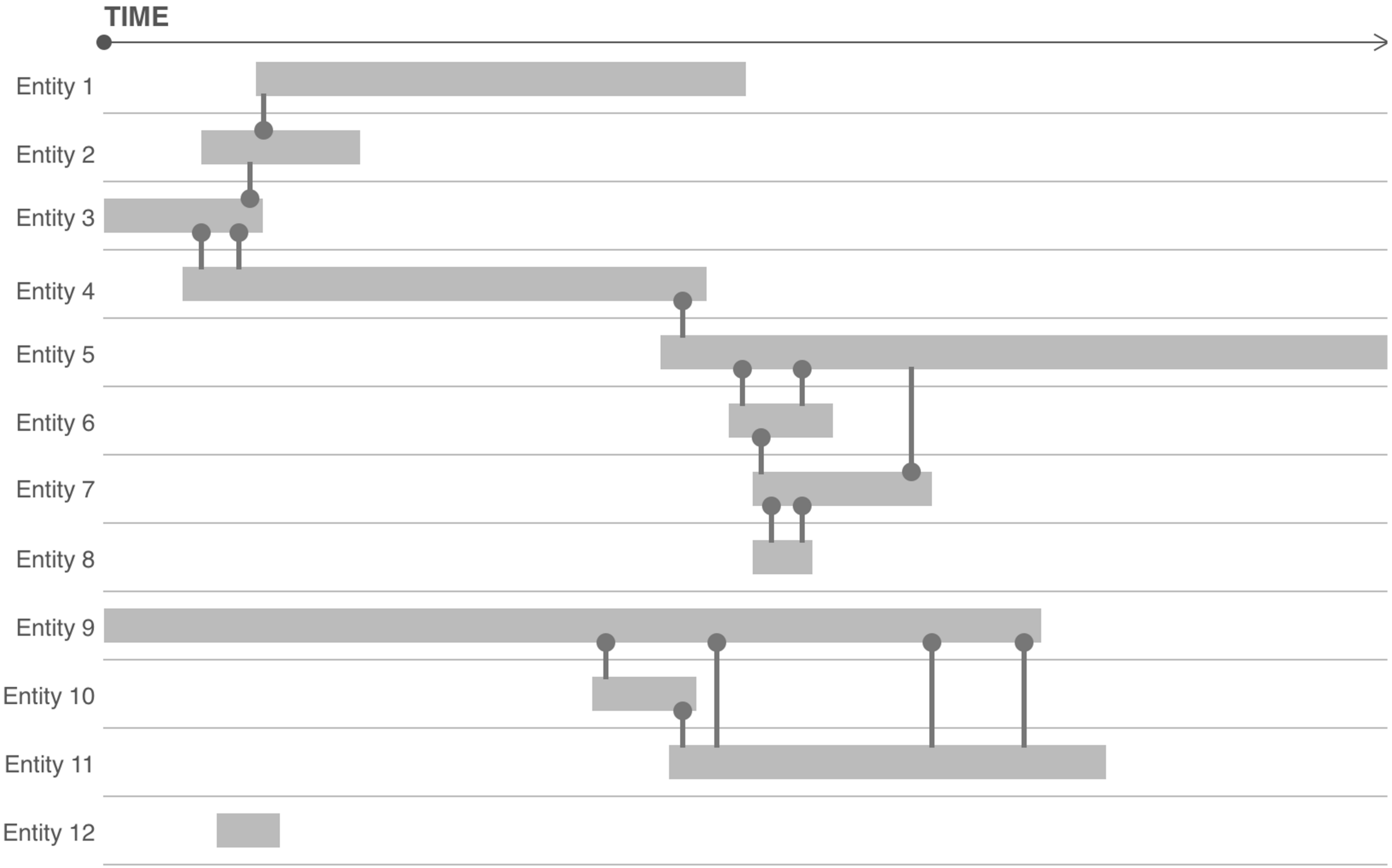
- Component scores
- Branch scores
    - Core sequence of events
    - Earliness of branch
    - Relative branch duration
    - Relative number of timestamps
    - Relative number of entities
    - Relative number of relationships
    - MITRE ATT&CK severity



Featurizing Incident Report Dynamic Graphs

Calculate scores

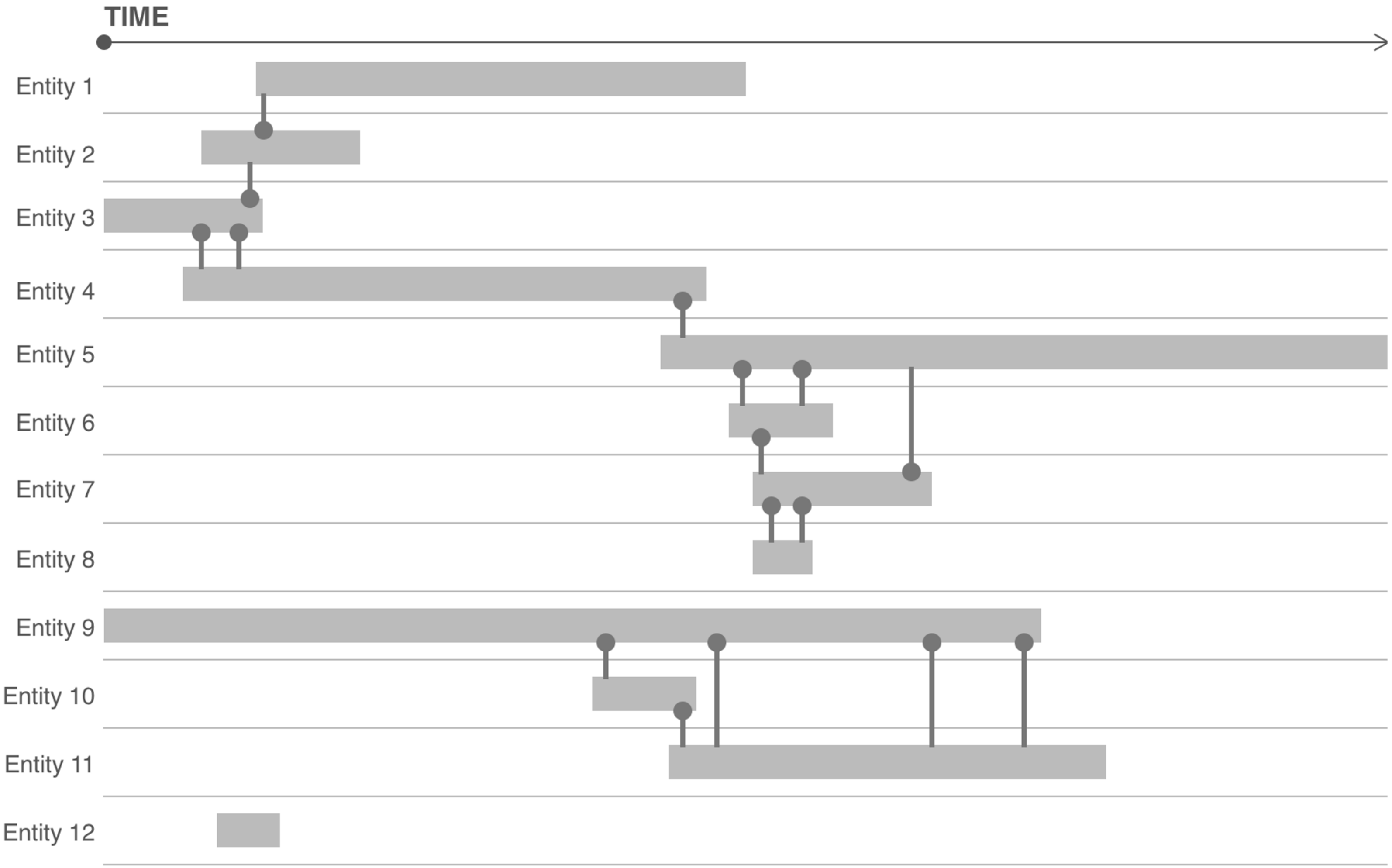
- Component scores
- Branch scores
- Entity score



Featurizing Incident Report Dynamic Graphs

Calculate scores

- Component scores
- Branch scores
- Entity score
    - Severity from a cyber security analytic

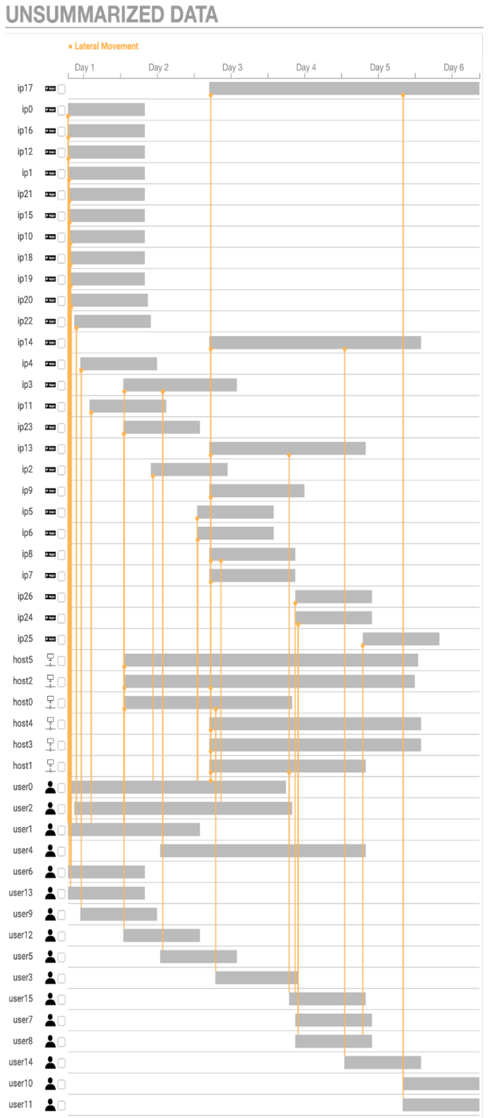


Summarizing Incident Reports: Naive Approach

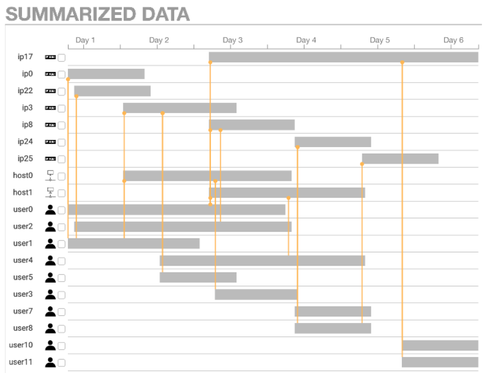
Average and filter

- Remove an entity if:

  For a summarization threshold *t:*
  mean(*component scores*) < *t*, or
  mean(*branch & entity scores*) < *t*



SUMMARIZE



Summarizing Incident Reports: Hierarchical Approach

Data and Challenges

- Data from 2 Red Team events against monitored network with known detectors (ground truth!)
- Small data
  - 460 observations
- Lots of *structure*
  - 2 RT events, 2 detectors, 15 reports
  - **entities** within **branches** within **components** within **reports**
- Heterogeneous covariate availability
  - correlated with detector

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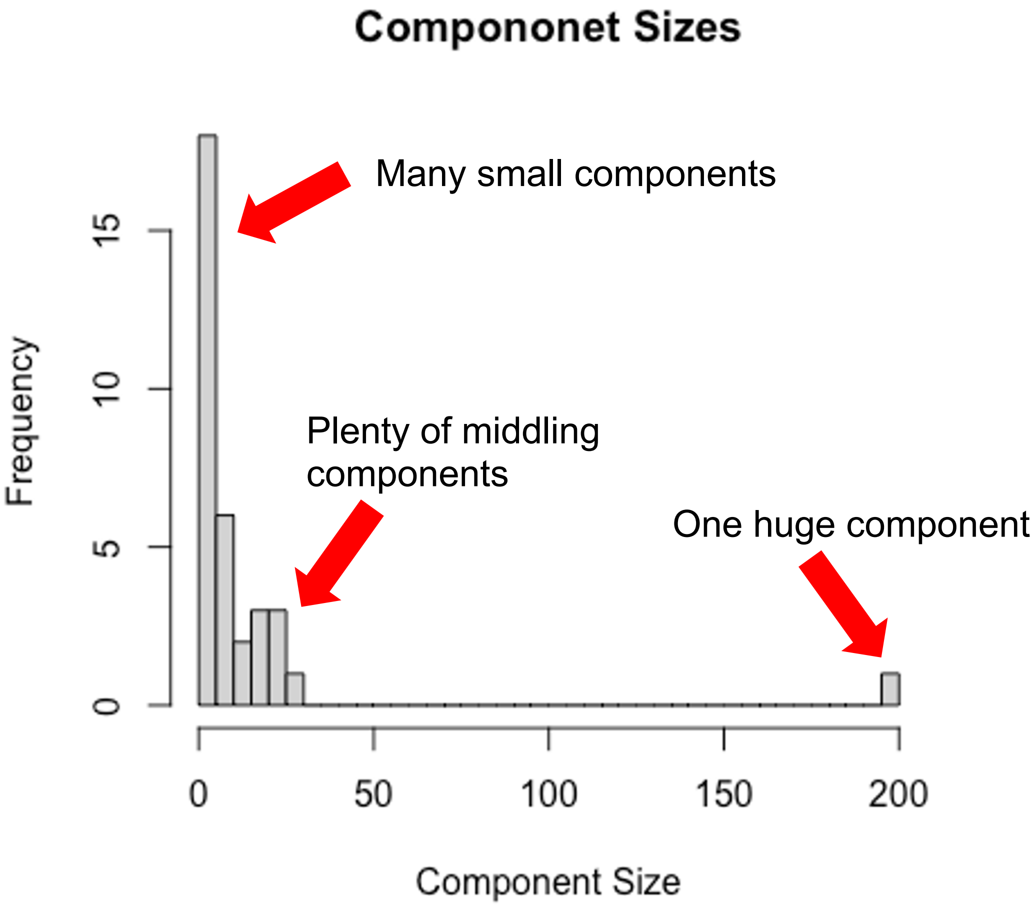
Approach: Bayesian Hierarchical Model

- Small data: priors and structure instead of "just throw it in a NN"
- Structure: covariates at the entity, branch, component, detector, and RT event levels
  - In practice omitted RT event effects; too few to matter
- Detector-specific data modeled with...detector-specific (entity-level) models

Summarizing Incident Reports: Model Details

- Varying-intercept, fixed slopes model
- entity model: f(intercept, type, MITRE location)
  - detector-specific data modeled via interactions
- branch model: f(core sequence, duration, connections…)
- component model: f(duration, entities, relationships, timestamps)
- logistic link
- scaled inverse-Wishart distribution for priors over related within-level coefficients



Summarizing Incident Reports: Alternatives?

- A flat model with fixed effects?
  - Low bias, high variance
  - Zero degrees of freedom in many components/branches
- Feed forward neural network?
  - Small data
  - Unclear how to leverage structure
  - Finger-cross strategy for missing data

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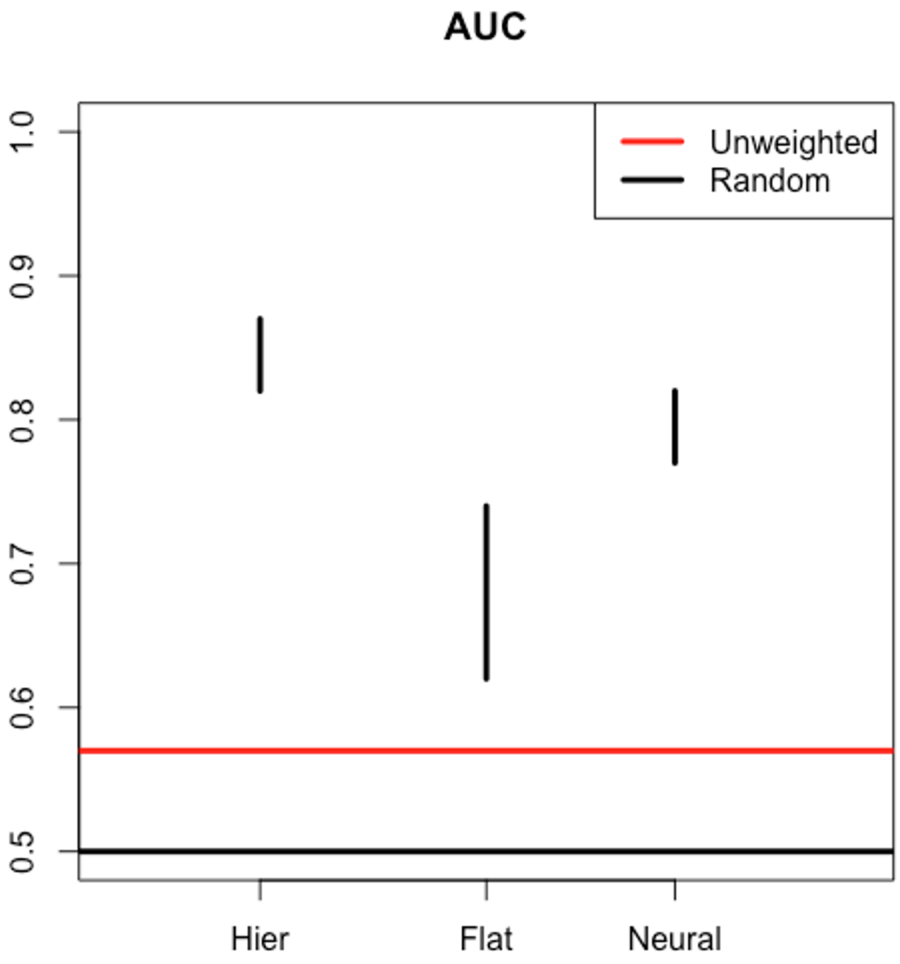
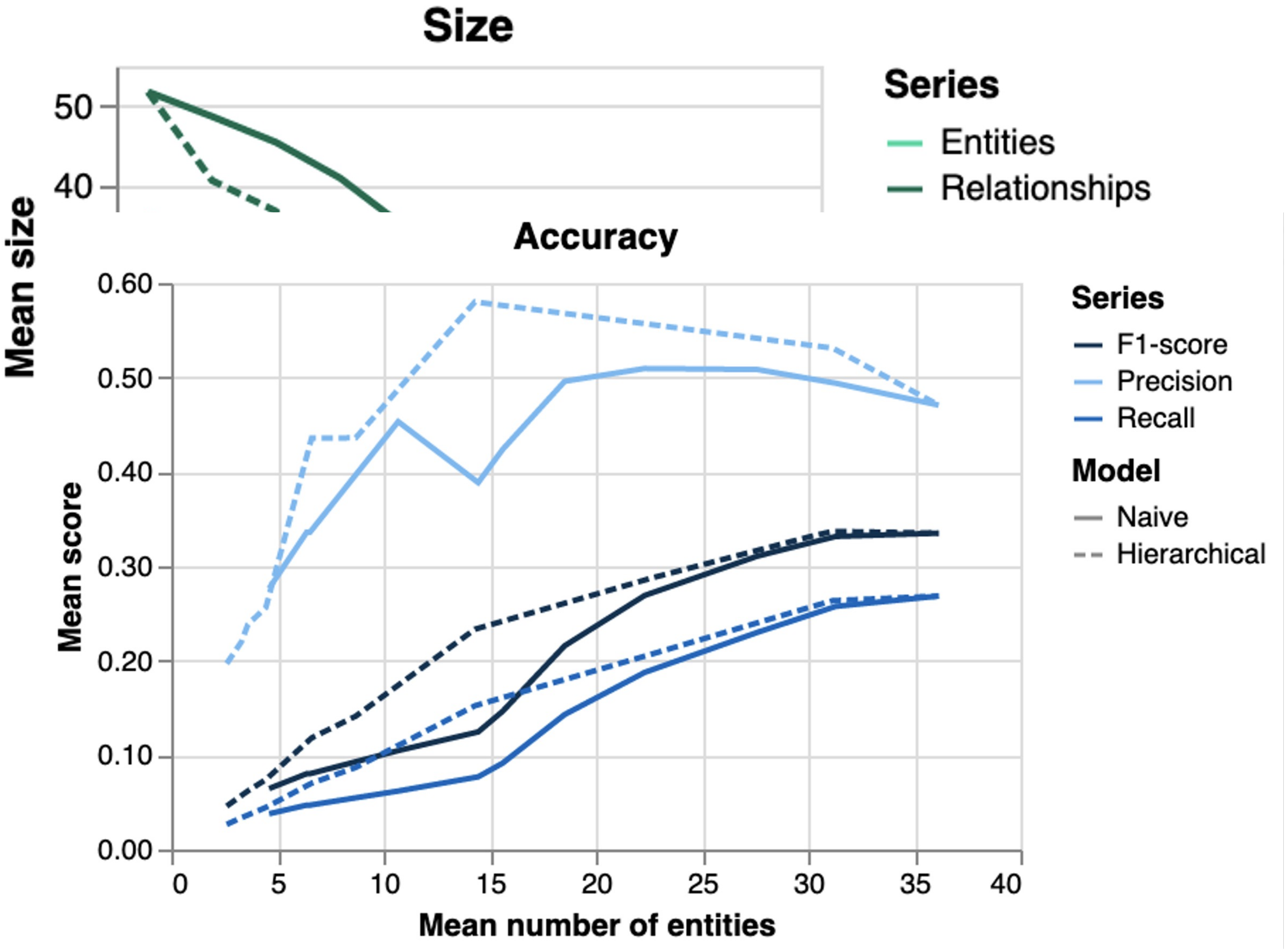


Evaluating Summarization Performance

Goals:

- Size: enable the dynamic creation of smaller incident reports
- Accuracy: don’t drop entities that are true positives



Qualitative Feedback

In live testing in a real environment, a SOC lead gave the following feedback:

He liked the visualization design, saying **“I feel like I can look at this and get an understanding of the key parts faster”** compared to looking at the tables of data contained in typical incident reports. Regarding the summarizations, he commented **“you’re going to save me a bunch of time”** compared to analyzing unsummarized incident reports.

Future Work

- Generalizability
- Cross-tool amalgamation
- Package/deployment

Visualizing incident reports is useful.

Moderate ML effort allows you to accurately summarize incident reports as well.

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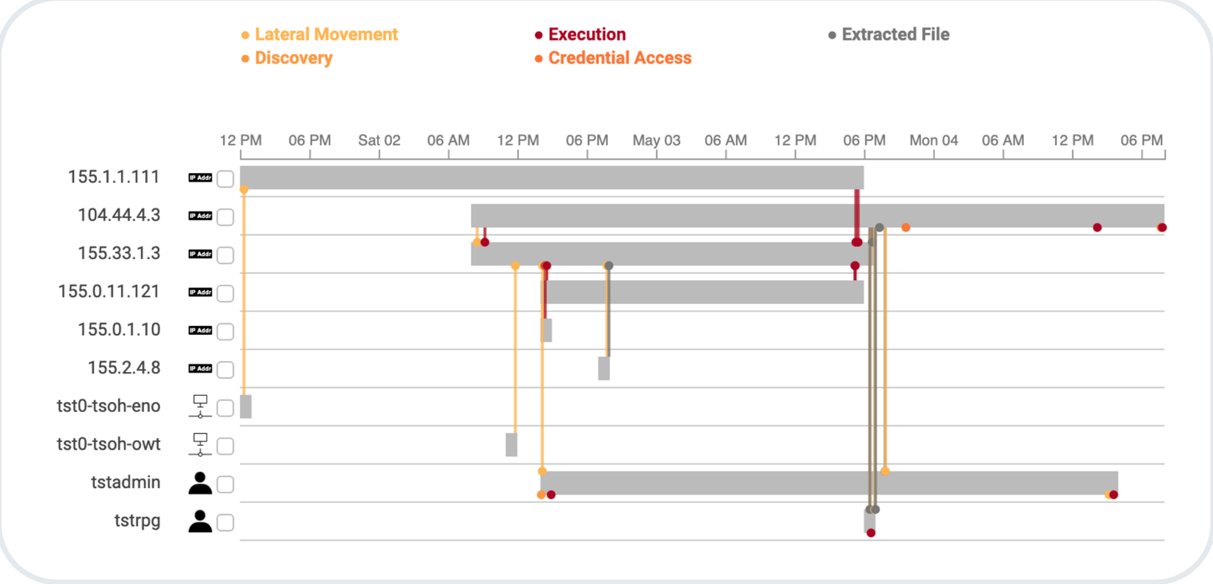
● Lateral Movement
● Discovery
● Execution
● Credential Access
● Extracted File
12 PM
06 PM
Sat 02
06 AM
12 PM
06 PM
May 03
06 AM
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tstadmin
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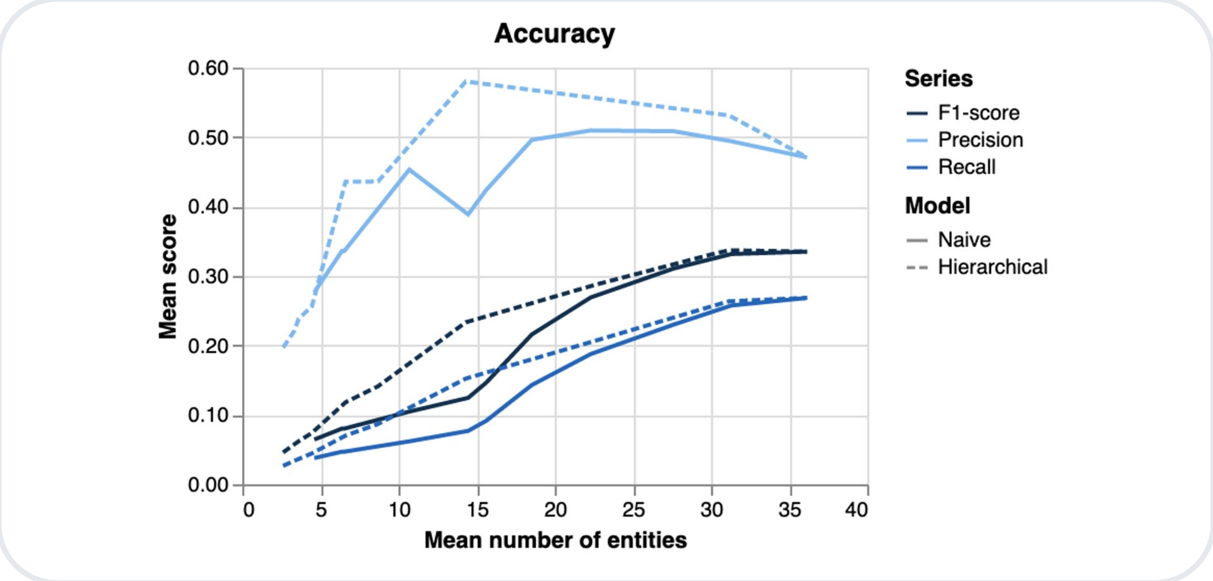
Accuracy
Mean score
Mean number of entities
Series
F1-score
Precision
Recall
Model
Naive
Hierarchical