Analyzing and Improving Visualizations of Formal Models

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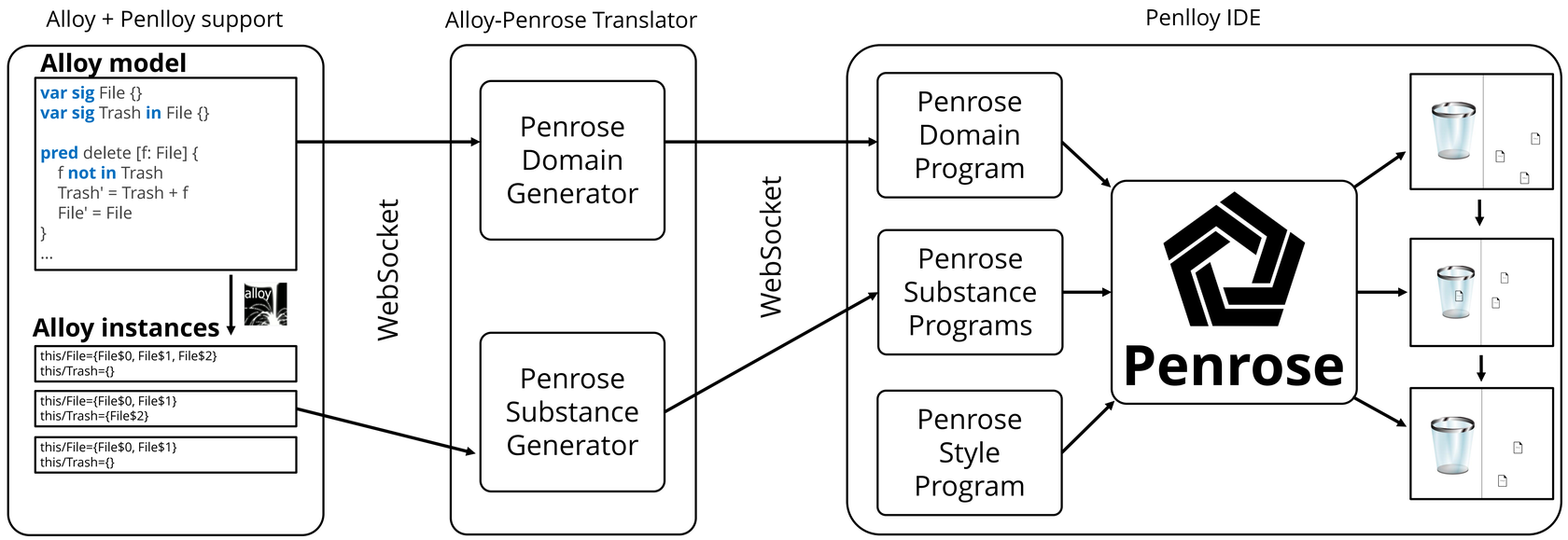
Background

Formal methods are powerful tools in validating system behavior, but their use of complex notations make understanding and debugging difficult.
Visualizations may help in these tasks.

At a Glance

- **Interview study** to understand how formal method users use visualizations
- **Penlloy**, a Penrose-based visualizer tool for the Alloy modeling language

Penlloy Visualization Tool for Domain-Specific Visualizations



Interview Study

- Pre-screened interview study
- Surveyed users on
  - uses of formal methods tools
  - how they used visualizations
  - what makes visualizations helpful
  - what they desire in their visualizations
- Interviewed 15 users of formal modeling tools, including:

Alloy	P	Racq
Lean 4	TSL	Dash+
EventB		

Insights:
- Aesthetically pleasing visuals → **"play around"** with the visualization → **gain insight** → **iterate**
- Visualizations help abstract away technical details to **present to outside stakeholders**
- **Visual properties** of a system help to **quickly validate** model behavior during specification

Limitations of current tools:
- **Lack of domain specificity**
  - **Lack of customizable shapes**
  - **Weak visual mappings of relations**
  - **Difficulties** representing **different levels** of **abstraction**.
- **Lack of positional consistency across states** for different visual elements. These make **tracing changes across multiple states difficult**, especially **when debugging** a model.

These insights and visualization tool limitations shed lights on a **need for domain specific visualizations** to explore and debug formal models, something we explore in **Penlloy**.

S3D
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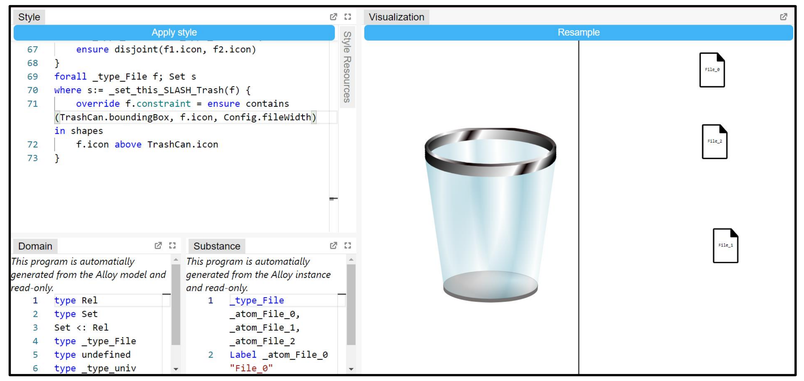
Deleting File Example Trace



Future Work

- Gain deeper insight into uses of visualization from further interviews of more formal modeling tools
- Improve consistency across states in visualizations
- Improve visualizations of adjacent temporal instances in traces through generating side-by-side diagrams