Query-based Debugging and Visualization in JIVE

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JIVE: Java Interactive Visualization Environment

Motivation

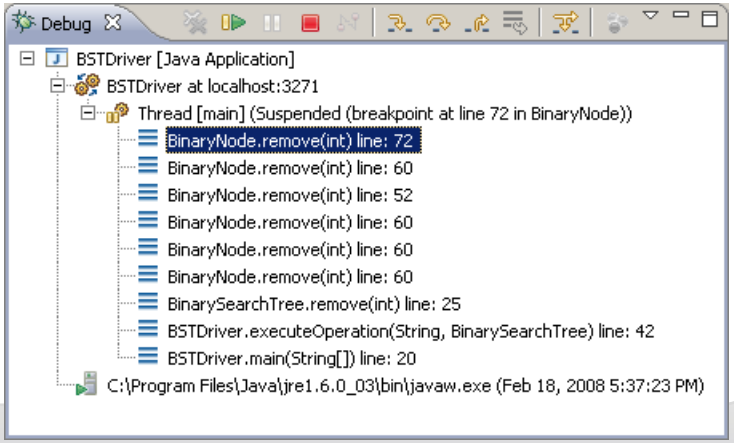
- *"Software bugs, or errors, are so prevalent and so detrimental that they cost the U.S. economy an estimated $59.5 billion annually."*

  National Institute of Standards and Technology
  http://www.nist.gov/public_affairs/releases/n02-10.htm

- According to the same study, $22.2 billion can be saved through more effective identification and removal of bugs.

Motivation

- Debugger technology has not changed much
  - Setting breakpoints
  - Spying on variables
  - Stepping forward in execution
  - Examining variables using the call stack
- Modern debuggers are still mainly *procedural* and *textual* in nature



Declarative and Visual Approach

- Visualize execution history and state to clarify object interactions and object structure
  - Enhanced Object Diagram (execution state)
  - Sequence Diagram (execution history)
- Provide an extensible set of queries over a program's execution history and individual runtime states
  - Formulate queries using diagrams or source code
  - Report results as diagram annotations
- Allow revisiting previous runtime states

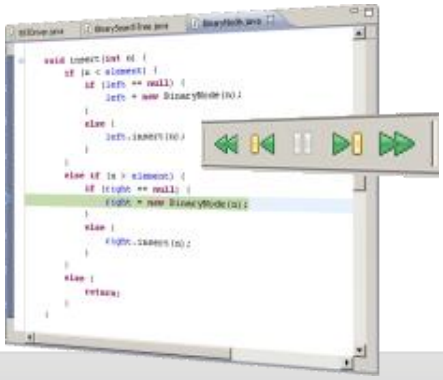
JIVE: Java Interactive Visualization Environment

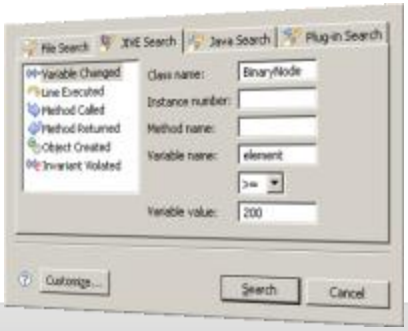
Declarative debugging complements procedural debugging just as web searching complements web browsing.

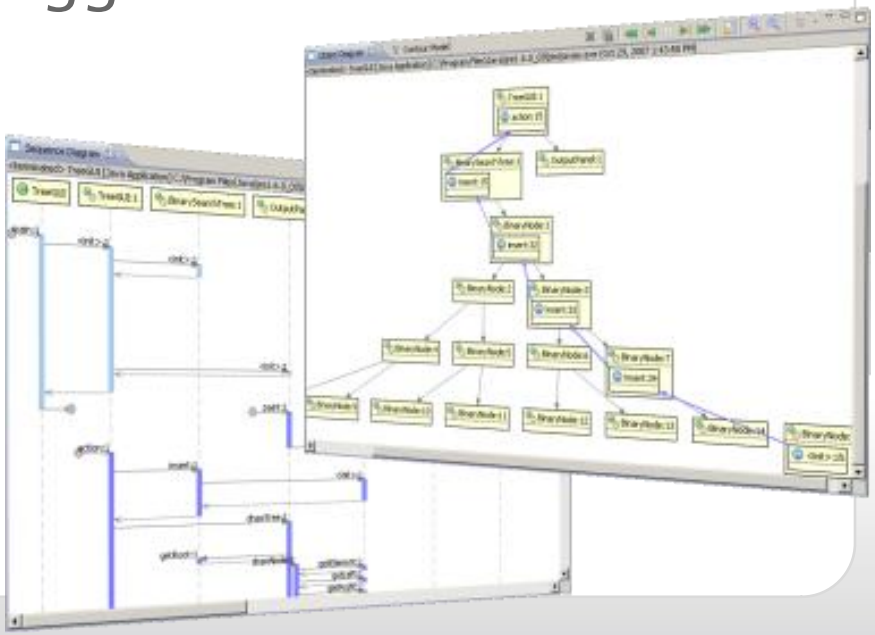
JIVE: Java Interactive Visualization Environment

What is JIVE?

- Interactive Execution Environment for Eclipse
  - Declarative and Visual Approach to Debugging
  - Pedagogic Tool
- Extension of the JDT Debugger
  - Interactive Visualization
  - Query-based Debugging
  - Reverse Stepping







JIVE: Java Interactive Visualization Environment

Principles of JIVE

- Support Full Java Language
- Depict Objects as Environments
- Visualize Current State and Execution History
- Provide Multiple Views of Runtime State
- Produce Aesthetic Layouts
- Support Forward and Reverse Execution
- Support Declarative Queries on Runtime States
- Use Existing Java Technology

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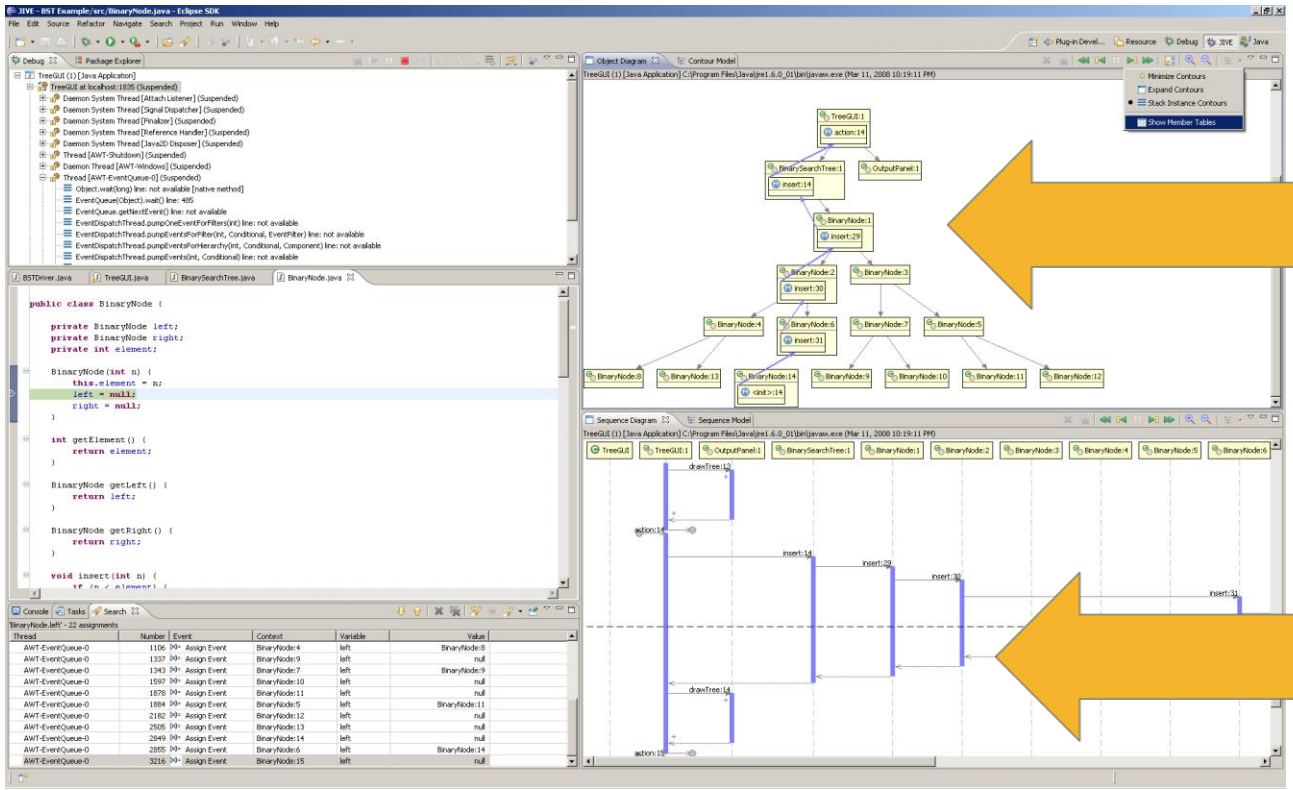
JIVE Perspective



Interactive Execution

- JIVE depicts the current runtime state and execution history of a program in a visual manner
  - Enhanced Object Diagram
  - Sequence Diagram
- Diagrams are formed dynamically at runtime
  - Object Diagram changes as methods are called and returned, objects are created, variables assigned, etc.
  - Sequence Diagram grows as the program executes
- Each point on the Sequence Diagram corresponds to a runtime state (depicted by the Object Diagram)

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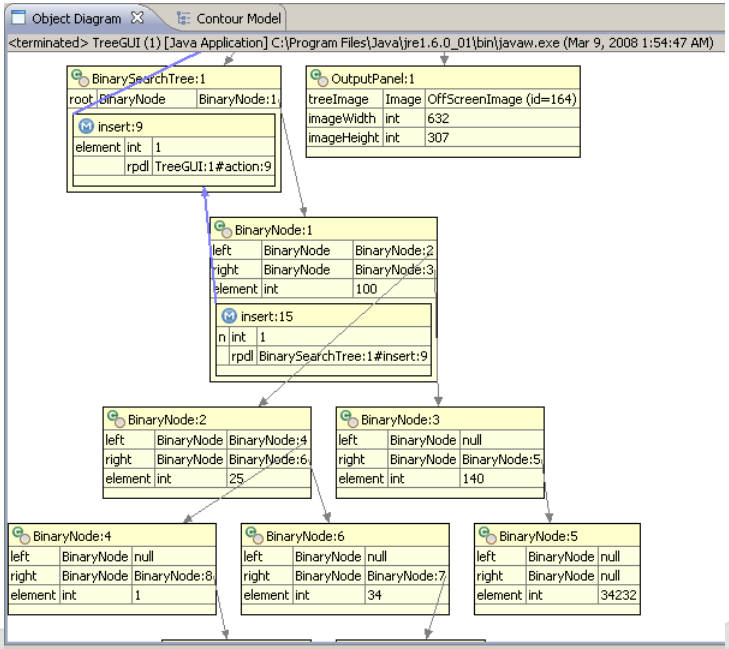
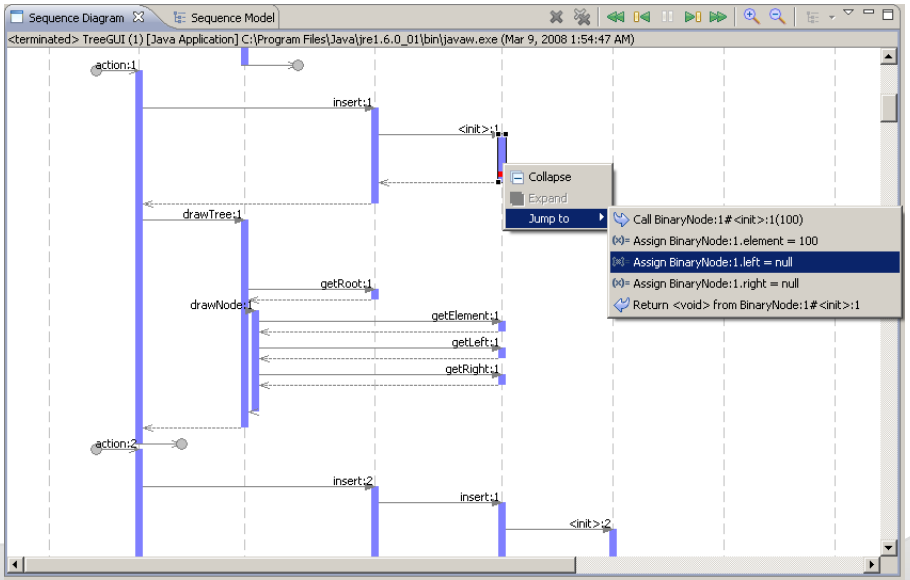
Object Diagram

- Depicts the current runtime state
- Method activations shown within their proper object contexts
- Call path shown
- Clarifies object structure
- Expand/Collapse objects
- Show/Hide member tables



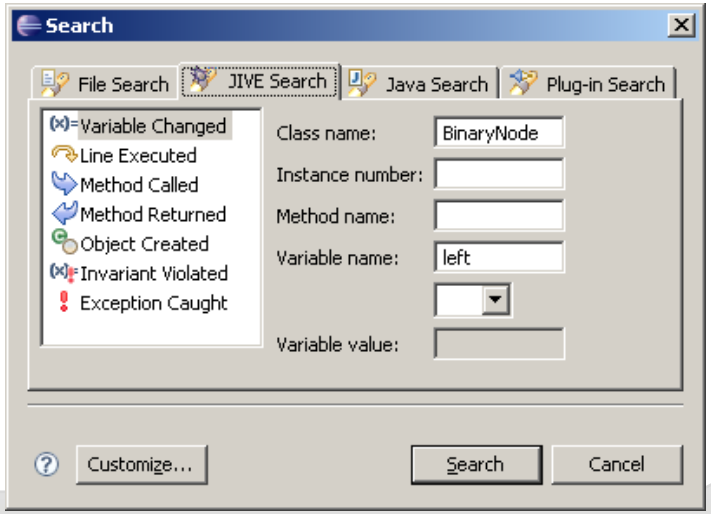
Sequence Diagram

- Depicts history of execution
- Method activations shown along object lifelines
- Expand/Collapse method activations
- Jump back to previous runtime states
- View search results
- Clarifies object inter-actions



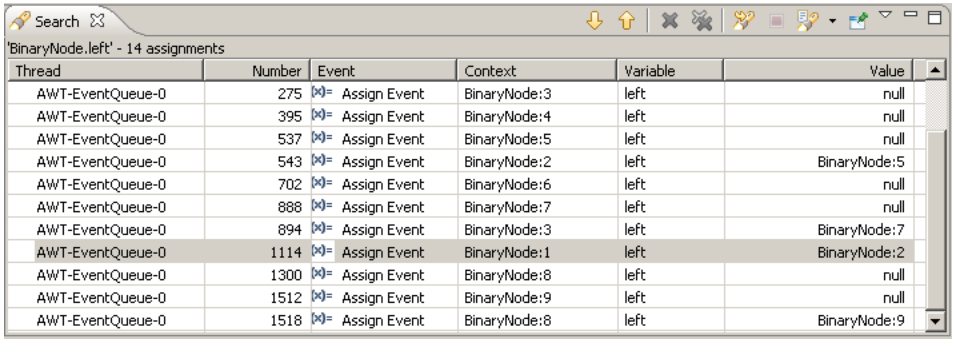
Query-based Debugging

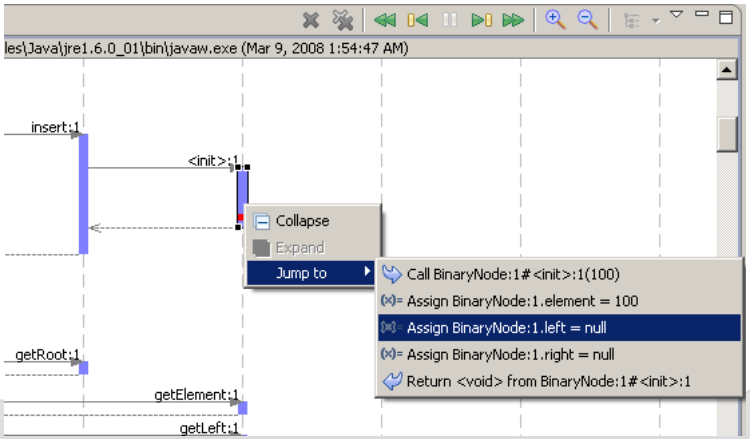
- Search individual states or execution history
  - Object Attribute and Local Variable Changes
  - Class/Object Invariant Checking
  - Object Creations
  - Method Activations
  - Statement Executions
  - Exceptions Thrown/Caught
- Result reporting
  - Diagram annotations
  - Tabular form
  - Call path to event



Reverse Stepping

- Often bugs are not discovered until after the errant statement executes
- JIVE supports stepping forward or backward through execution to review past states
- Can jump immediately back to a point of interest using the diagram or query results





Future Work

- Reduce Overheads of Data Collection
- Produce Scalable Visualizations
- Runtime Flow Analysis for 'Why' Queries
- Database Support for Long Executions
- Efficient Jumping to Previous States
- Closer Integration with the JDT Debugger

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JIVE Web Site

- http://www.cse.buffalo.edu/jive/
- Download using update manager
- Subscribe to RSS feed for latest news and releases
- Comments and suggestions welcome

Thank you!