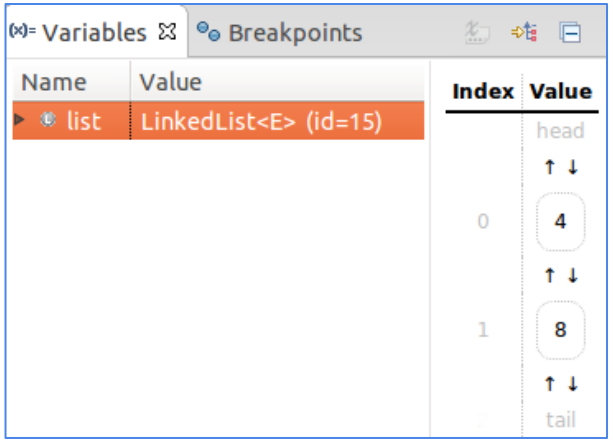
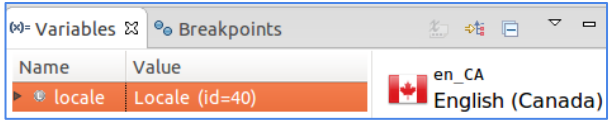
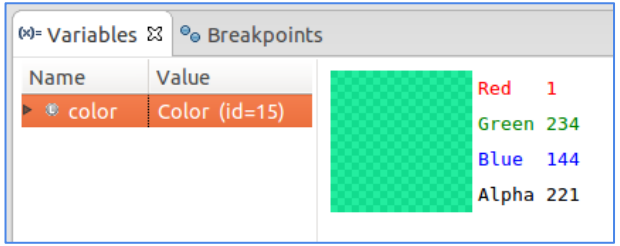
Templated visualization of object state with Vebugger







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Motivation

Inspecting program state is key to software engineering

For example, some common steps in debugging are:

- Step through code
- Inspect state
- Make changes

Motivation

Inspecting program state is key to software engineering

For example, some common steps in debugging are:

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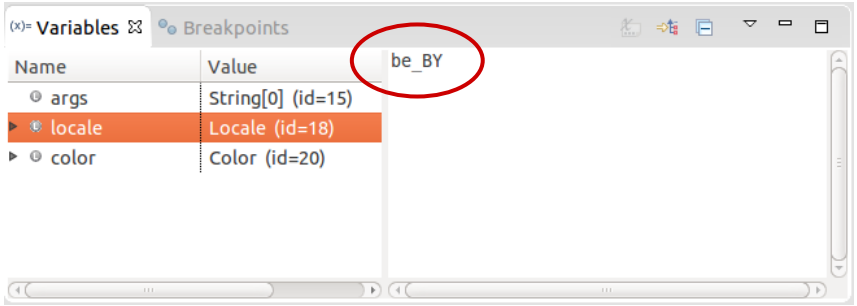
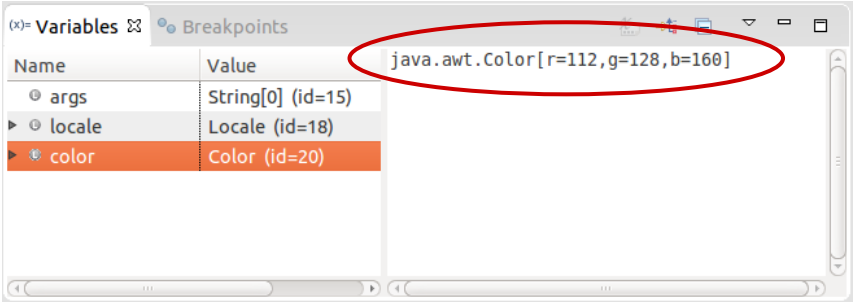
- **Inspect state**
- Make changes

State inspection: still hard

Mind the abstraction gap

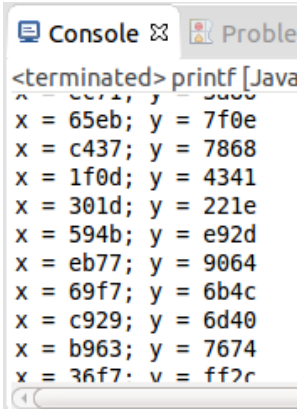


Which language and country are represented here?



What color is this?

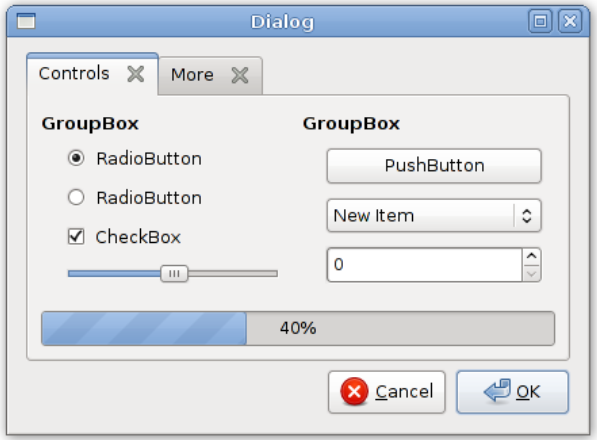
Established approaches to state inspection



printf

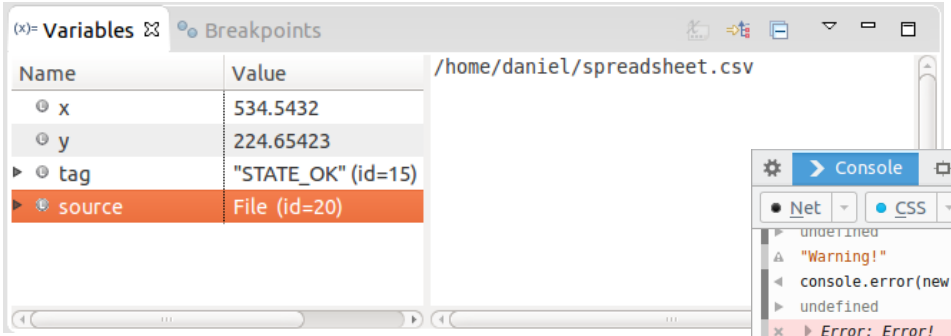
```
daniel@Anders:~$ gdb x_and_y
GNU gdb (Ubuntu 7.7-0ubuntu3.1) 7.7
Reading symbols from x_and_y...done.
(gdb) break x_and_y.c:6
Breakpoint 1 at 0x4004f8: file x_and_y.c, line 6.
(gdb) run
Starting program: /home/daniel/x_and_y

Breakpoint 1, main () at x_and_y.c:6
6               y = 2;
(gdb) p x
$1 = 5
(gdb) p y
$2 = 0
(gdb) step 1
8               return 0;
(gdb) p x
$3 = 5
(gdb) p y
$4 = 2
(gdb) c
Continuing.
[Inferior 1 (process 8229) exited normally]
(gdb) quit
daniel@Anders:~$
```

gdb

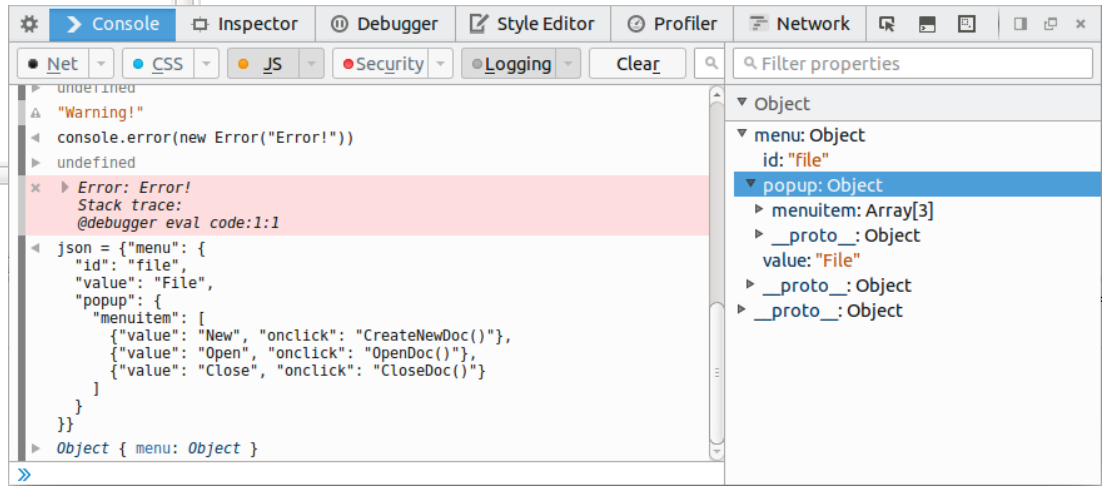


inspecting GUI directly

Recent approaches to state inspection

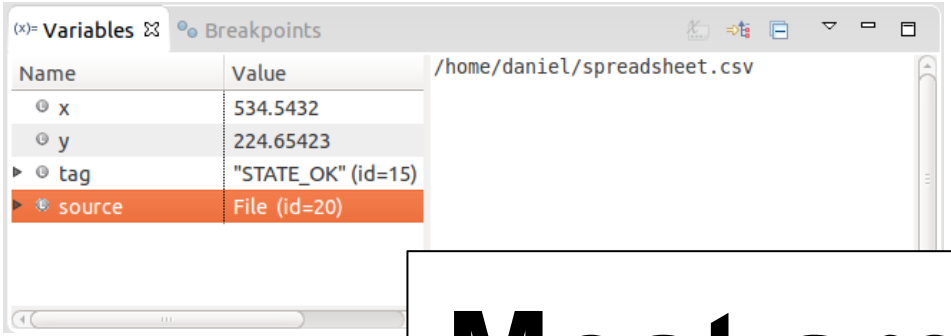


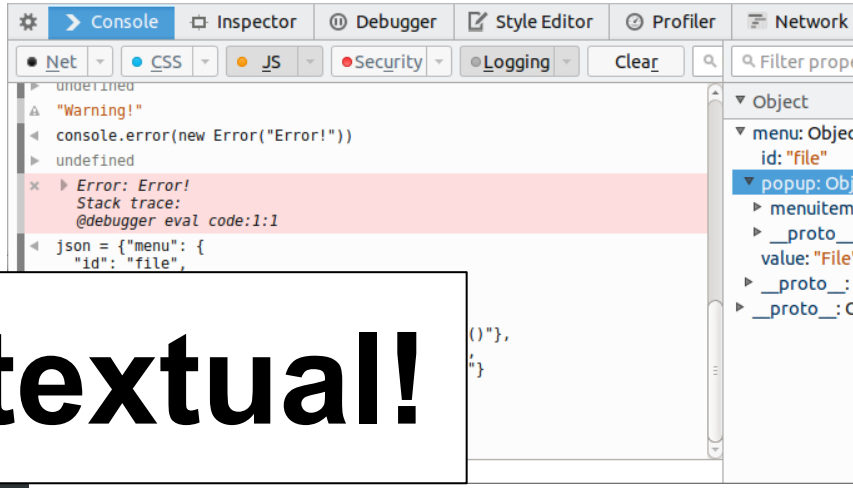
IDE integrated debugger



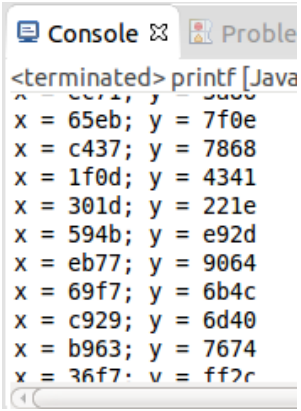
Browser-based development tool

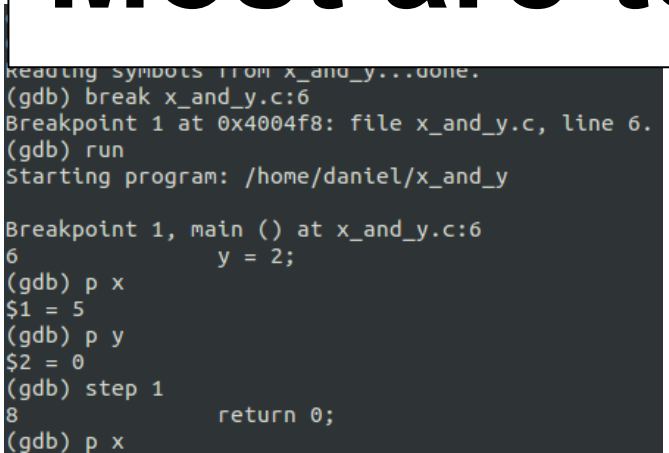
Approaches to state inspection

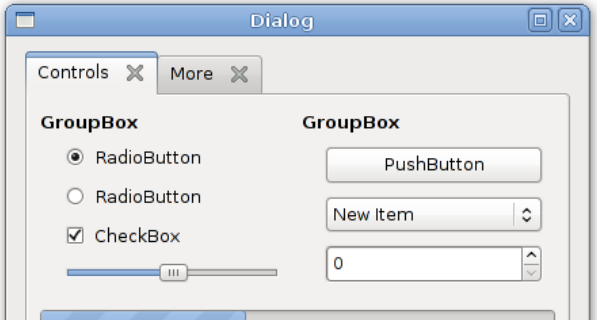




Most are textual!



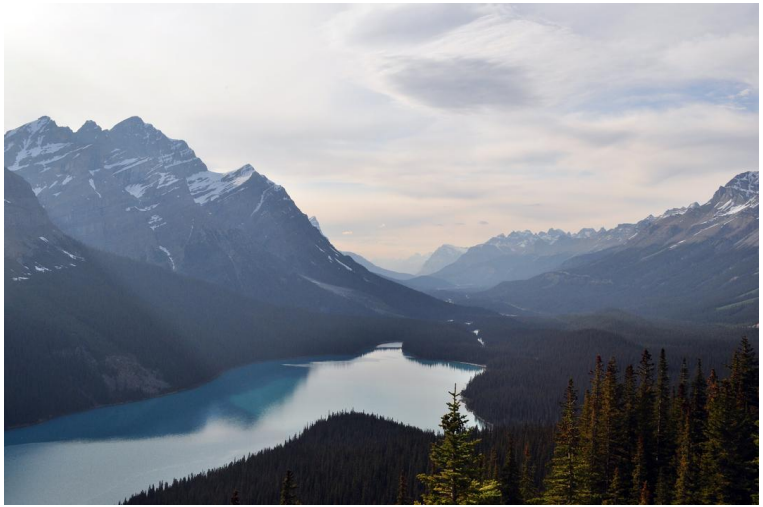




Text has its limits

UI elements, media, data structures, etc.

```
Image image = ImageIO.read(new File("/home/daniel/pyeto_lake.jpeg"));
```



>

```
BufferedImage@60f4ffd8: type = 5
ColorModel: #pixelBits = 24
numComponents = 3 color space =
java.awt.color.
ICC_ColorSpace@74c8efa2
transparency = 1 has alpha =
false isAlphaPre = false
ByteInterleavedRaster: width =
4288 height = 2848
#numDataElements 3 dataOff[0] =
2
```

Our goal

Mitigate the abstraction gap by augmenting the debugger's textual representation of object state with a visual representation.

Vebugger

Design criteria

- Typed visualizations
  - Visualizations should be distinguished by classes
- Extensibility through templates
  - Easy to create templates
- IDE integration
  - Developers expect tools to be integrated into IDE
- **Do no harm**
  - Revert to default behavior on any failure

Vebugger in a nutshell

- Typed visualizations
  - Uses Java types to determine which template to use
- Extensibility through templates
  - Uses HTML+CSS
- IDE integration
  - Integrates into Eclipse's "variable view" panel
- **Do no harm**
  - Displays the .toString() value when template missing

Demo time!

Future work

- Context-specific templates
- Navigation through visualizations
- Scalable visualizations
- Usability/viability user study
- Automating the template creation process
- Animating state transitions

Context-specific templates

StockTrackerTimerTask.java

```
import java.util.TimerTask;

public class StockTrackerTimerTask extends TimerTask {

    private final StockPriceSource source;
    private final String symbol;

    private double tickerPrice;

    public StockTrackerTimerTask(StockPriceSource source, String symbol) {
        this.source = source;
        this.symbol = symbol;
    }

    @Override
    public void run() {
        tickerPrice = source.getCurrentStockPriceBySymbol(symbol);
    }

    public double getTickerPrice() {
        return tickerPrice;
    }

}
```

Context-specific templates

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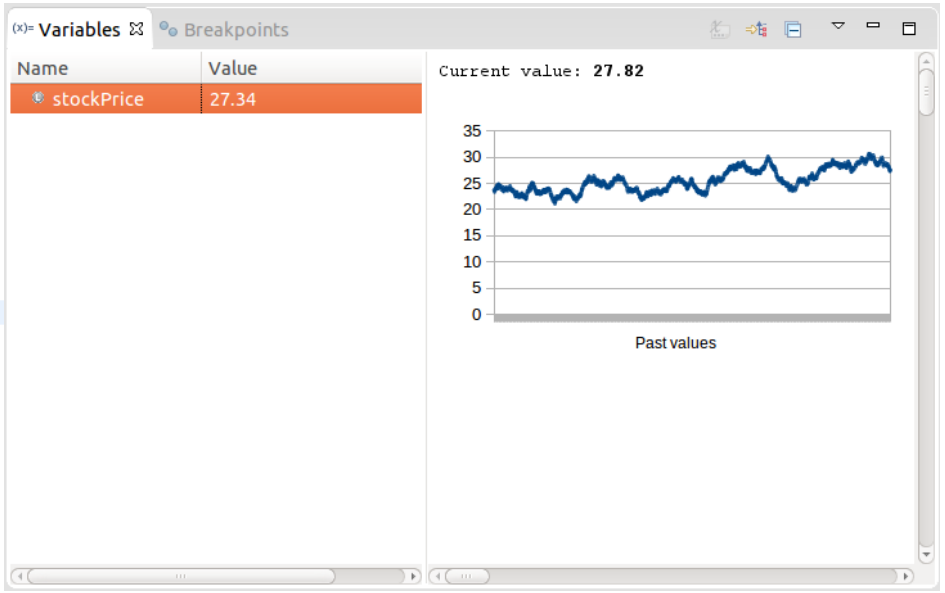
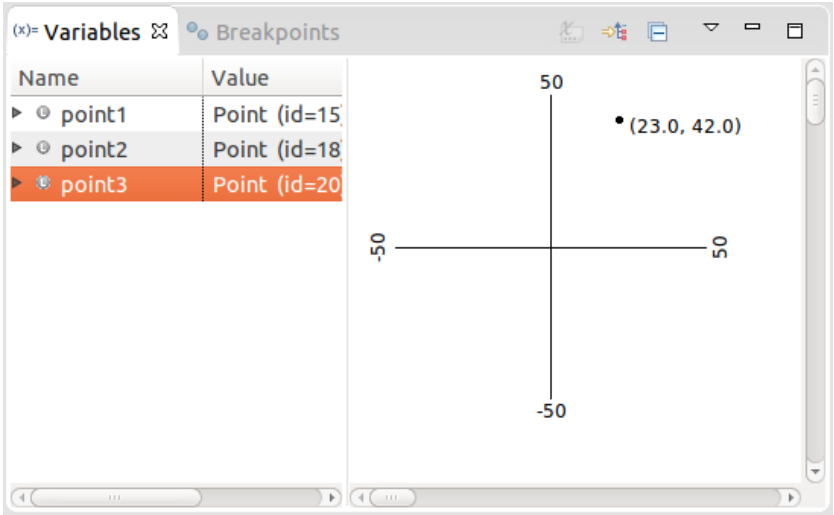


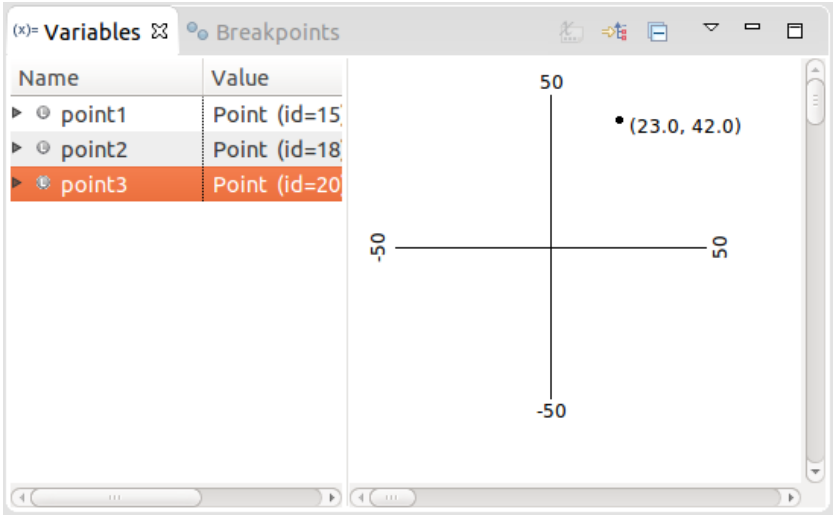
Beck et al. *VISSOFT*, 2013

Context-specific templates

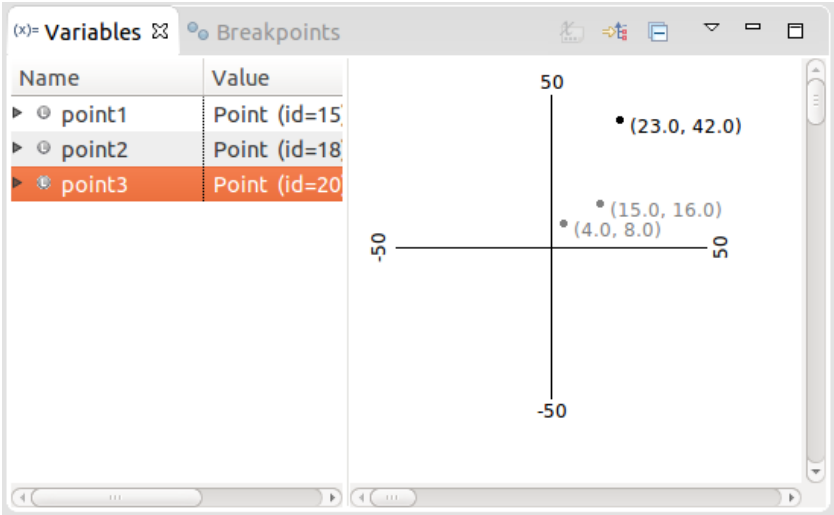


Without context

Context-specific templates



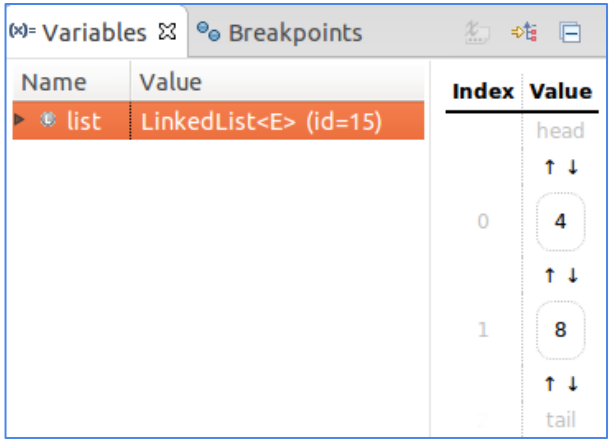
Without context

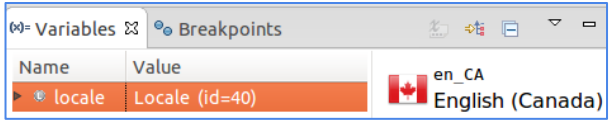


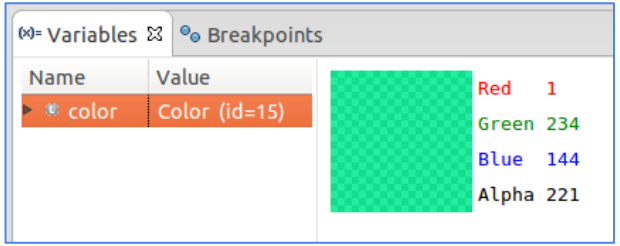
With context

Contributions

- Articulated design criteria for tools that expose object state for debugging purposes
- Built Vebugger, a framework for visualizing type-specific object state in an IDE







Vebugger is free software!
https://github.com/daniboy/vebugger

Backup slides

Related works

Other tools that show visual state

- T. D. Hendrix, J. H. Cross II, and L. A. Barowski. An extensible framework for providing dynamic data structure visualizations in a lightweight IDE. *ACM SIGCSE Bulletin*, 36(1):387–391, 2004
- C. Demetrescu and I. Finocchi. A data-driven graphical toolkit for software visualization. In *VISSOFT*, 2006
- B. Alsallakh, P. Bodesinsky, S. Miksch, and D. Nasseri. Visualizing Arrays in the Eclipse Java IDE. In *CSMR*, 2012

Exposing context-sensitive state

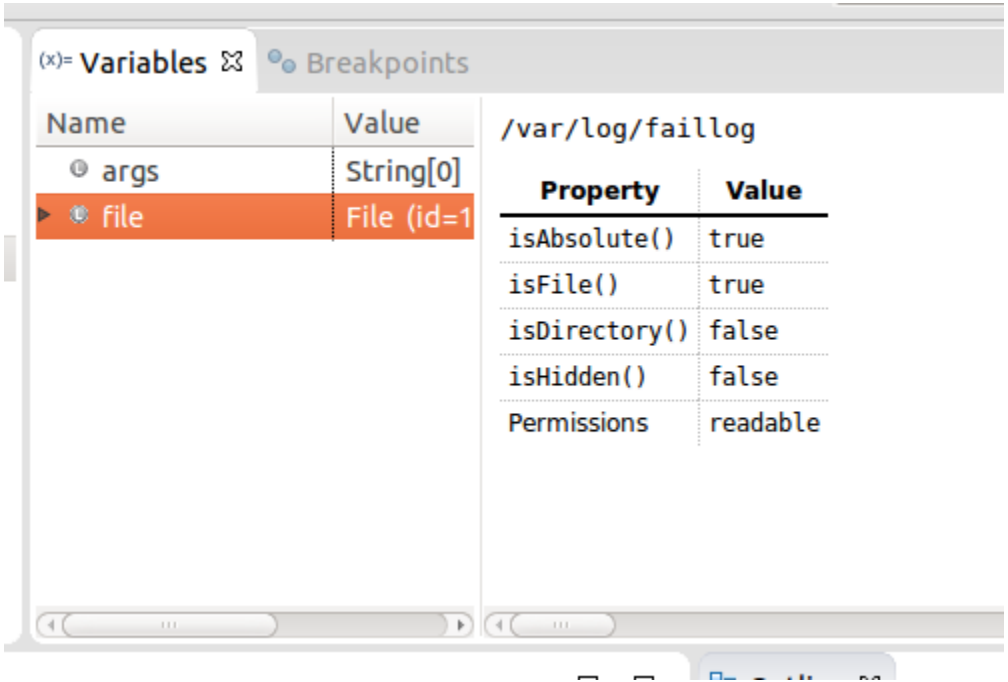
- D. A. Mellis. Tangible code. Master's thesis, Interaction Design Institute Ivrea, 2006
- F. Beck, F. Hollerich, S. Diehl, and D. Weiskopf. Visual monitoring of numeric variables embedded in source code. In *VISSOFT*, 2013
- A. J. Ko and B. A. Myers. Debugging reinvented. In *ICSE*, 2008

User studies of Vebugger

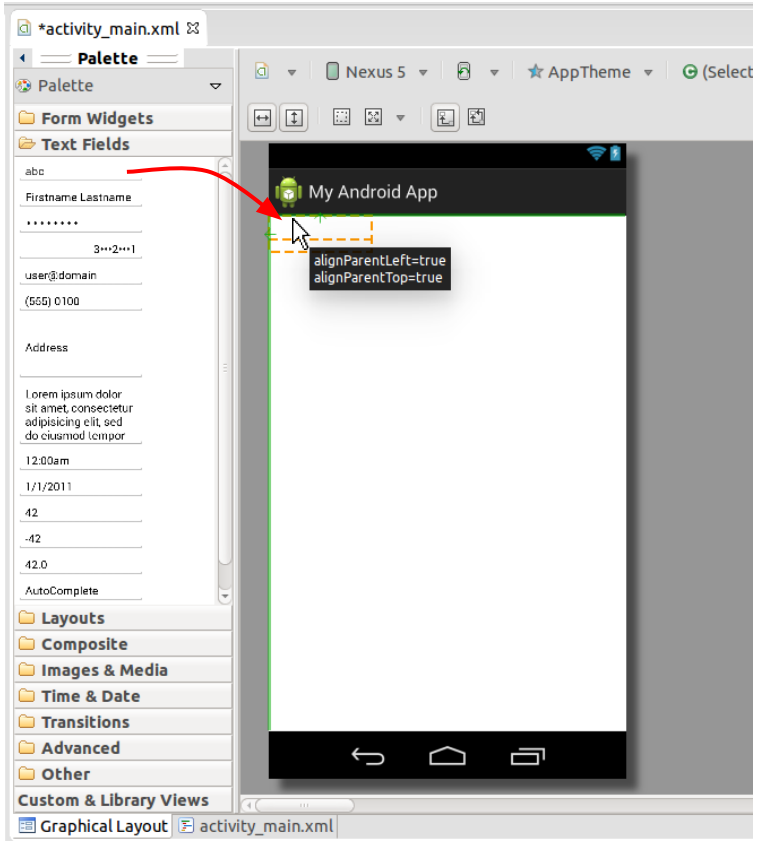
Interesting research questions:

- Which types can be visualized?
- Does comprehension of object state increase for developers who use Vebugger?

Automatic custom templates



WYSIWYG Editor for templates



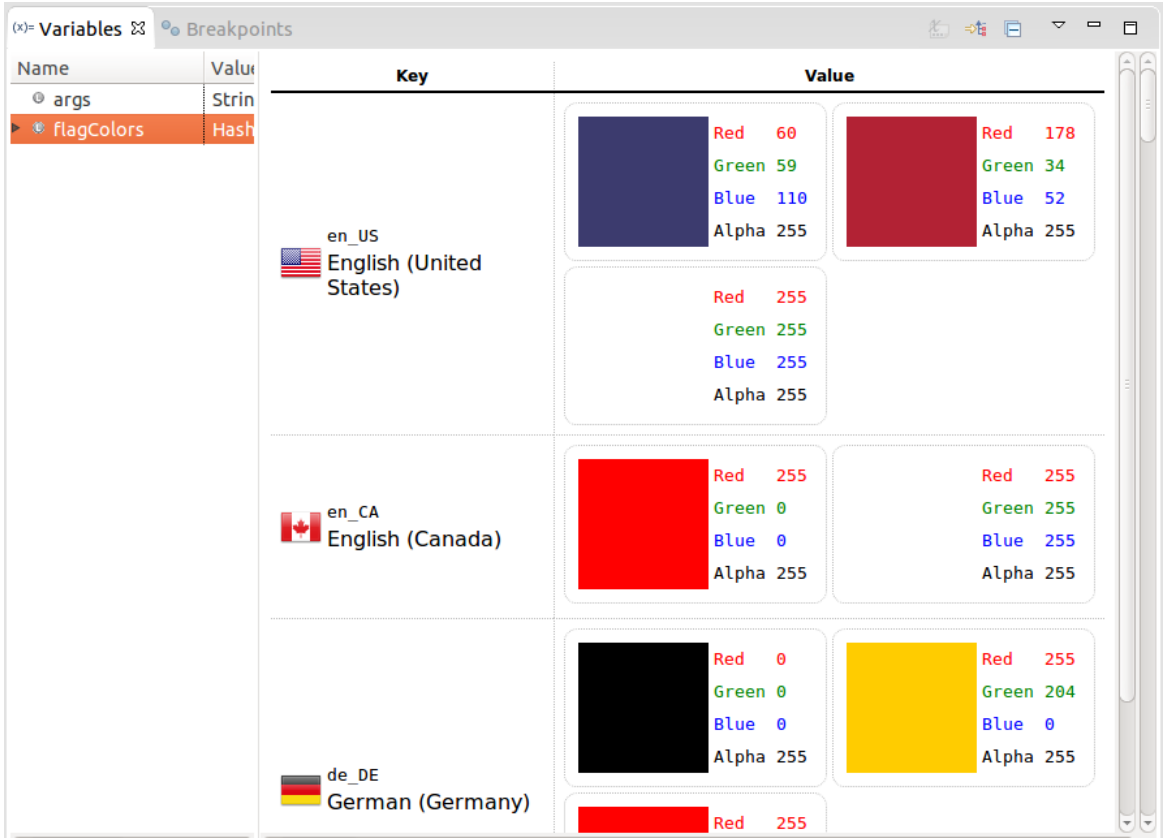
Limitations

- Heterogeneity — too many classes, too many contexts! How to streamline the template creation process to become a part of the debugging process?
- Scalability — exposing big-data without overwhelming the user or missing out on details. An open problem in Information Visualization.

Backup backup slides

Navigation with the aid of visualizations

Map<Locale, Set<Color>> flagColors = …



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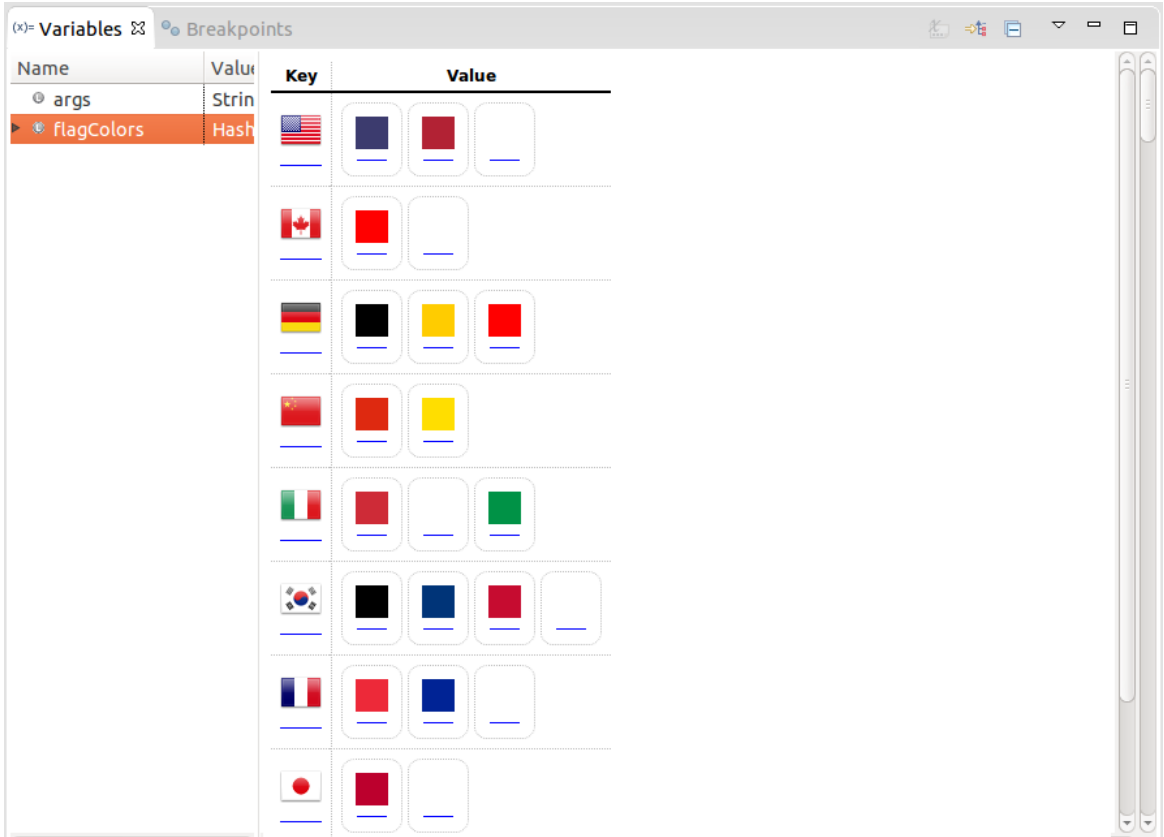

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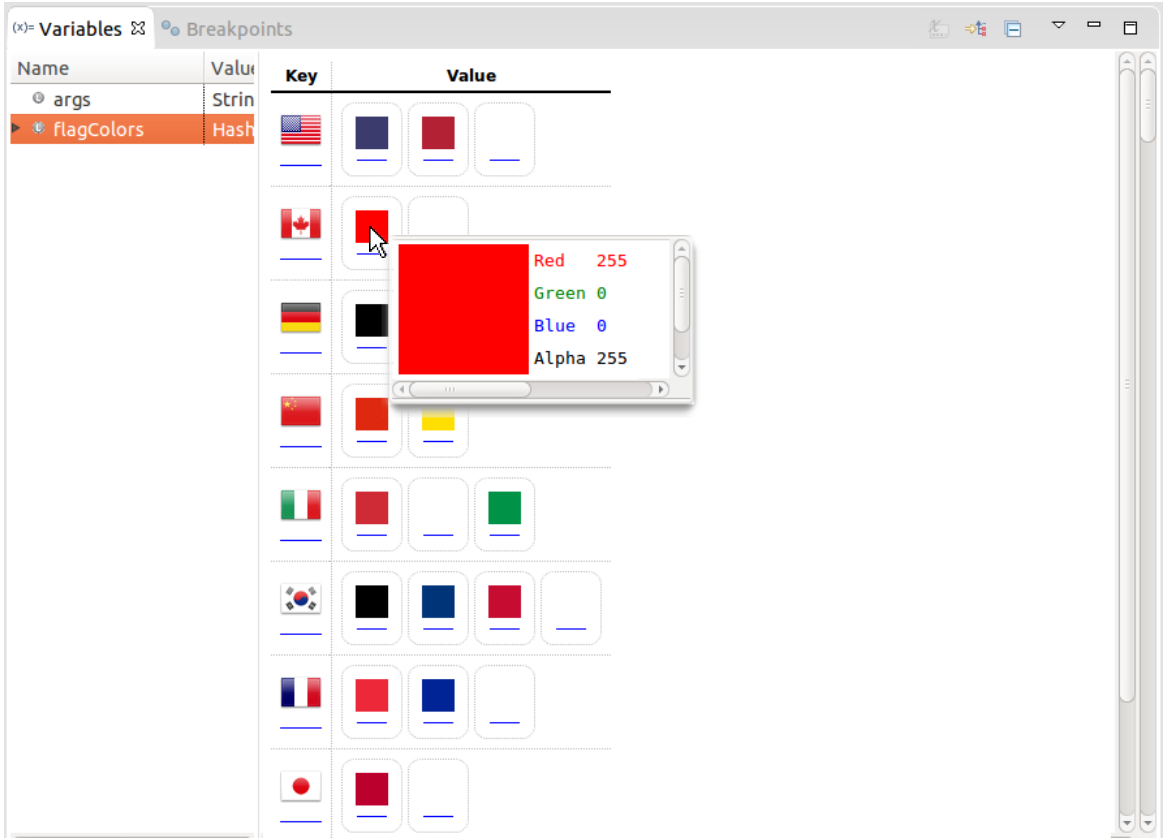
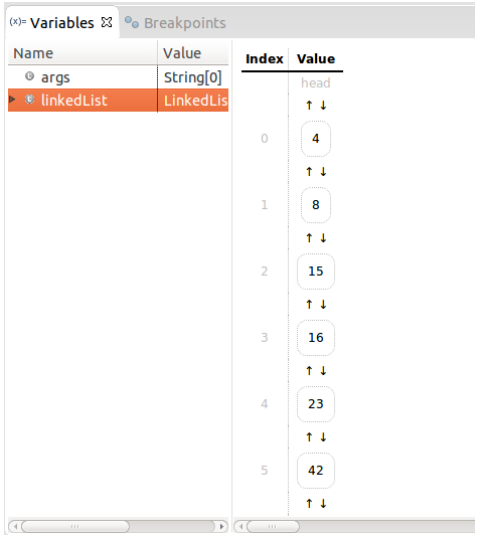


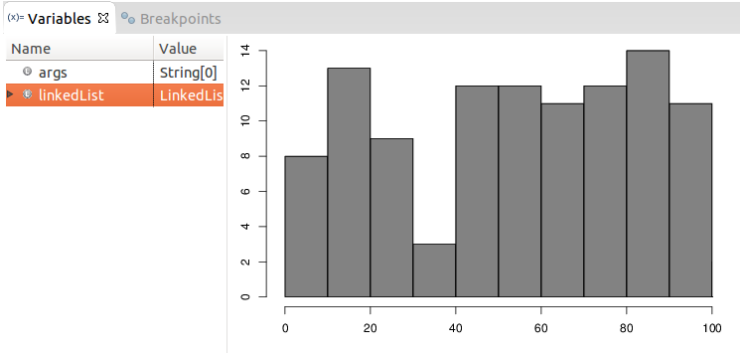
Scaling visualizations



Current implementation

PLACEHOLDER

“Fish-eye” visualization



Values histogram