STAR
WORLD

Section 2:
Developer tools and you

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What is an SSH client?

- Uses the secure shell protocol (SSH) to connect to a remote computer
    - Enables you to work on a lab machine from home
    - Similar to remote desktop
- Windows and Linux users: PuTTY and WinSCP
    - Windows and Linux users
- Mac users: Terminal application
    - Go to Applications/Utilities/Terminal
    - Type in "ssh –XY cseNetID@attu.cs.washington.edu"

What is UNIX?

- Command-line based operating system
  - Like Windows or Mac OS without the mouse

Command	What it does
pwd	**p**rints the name of the **w**orking **d**irectory
ls	lists the files in a directory (i.e., **l**ists **s**tuff)
cd	**c**hanges a **d**irectory
cp	**c**o**p**ies a file or directory
mv	**m**o**v**e/rename a file or directory
rm	**r**e**m**oves a file
mkdir	**m**a**k**e a new **dir**ectory
rmdir	**r**e**m**ove an empty **dir**ectory
man	pulls up the **man**ual pages

DEMO #1

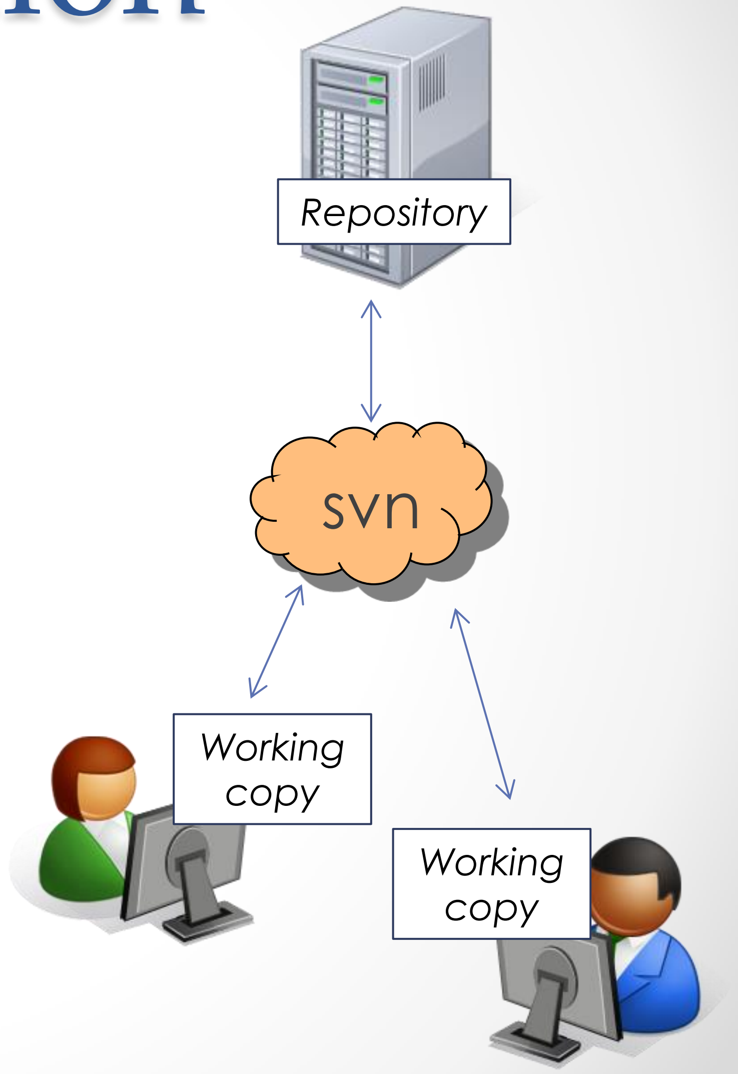
http://courses.cs.washington.edu/courses/cse331/14sp/tools/WorkingAtHome.html

What is source control?

- Also known as version control/revision control
- System for tracking changes to code
  - Software for developing software
- Essential for managing projects
  - See a history of changes
  - Revert back to an older version
  - Back up your work
  - Merge changes from multiple sources
- We'll be talking about Subversion, but there are alternatives
  - ✓ Git, Mercurial, CVS
  - × Email, Dropbox, USB sticks

Source control organization

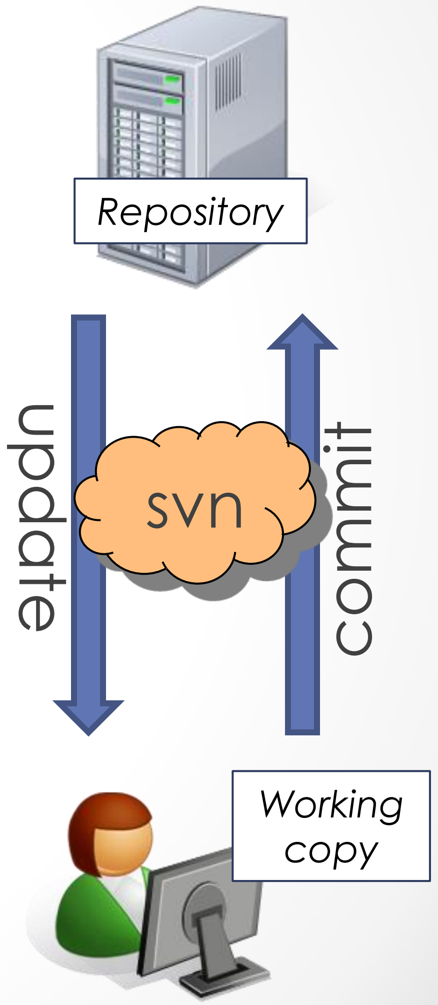
- A *repository* stores the master copy of the project
  - Someone creates the repo for a new project
  - Then nobody touches this copy directly
  - Lives on a server everyone can access
- Each person *checks out* her own *working copy*
  - Makes a local copy of the repo
  - You'll always work off of this copy
  - The version control system syncs the repo and working copy (with your help)



Source control common actions

Most common commands:

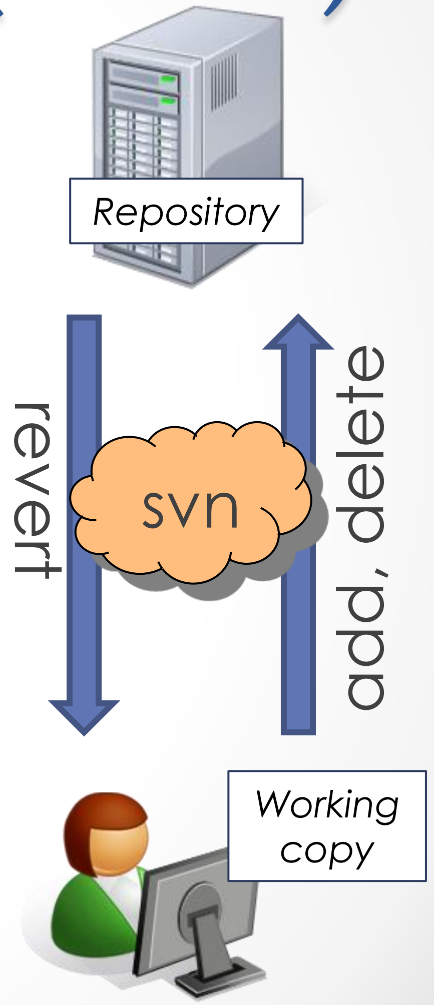
- Commit / checkin
  - integrate changes *from* your working copy *into* the repository
- Update
  - integrate changes *into* your working copy *from* the repository



Source control common actions (cont.)

More common commands:

- Add, delete
  - add or delete a file in the repository
  - just putting a new file in your working copy does not add it to the repo!
- Revert
  - wipe out your local changes to a file
- Resolve, diff, merge
  - handle a conflict – two users editing the same code



How to use Subversion

1. Eclipse plugin: Subclipse
2. GUI interface: TortoiseSVN, NautilusSVN
3. Command line: PuTTY

This Quarter

- We distribute starter code by adding it to your **repo**
- You will **code** in Eclipse just as you would have in your previous classes
- You turn in your files by **adding** them to the repo and **committing** your changes
- You will **validate** your homework by **SSHing** onto attu and running an Ant build file

DEMO #2

http://www.cs.washington.edu/education/courses/cse331/14sp/tools/versioncontrol.html

Theoretical Scenario

You are working on a computer in the lab and feel like you are at a good stopping point. You hit "Save" on your computer and start driving to Canada, only to realize that you forgot to commit your changes to your repo. Do you have to turn around and drive back?

No, SSH into the attu, change to your eclipse workspace directory, and then call "svn commit"

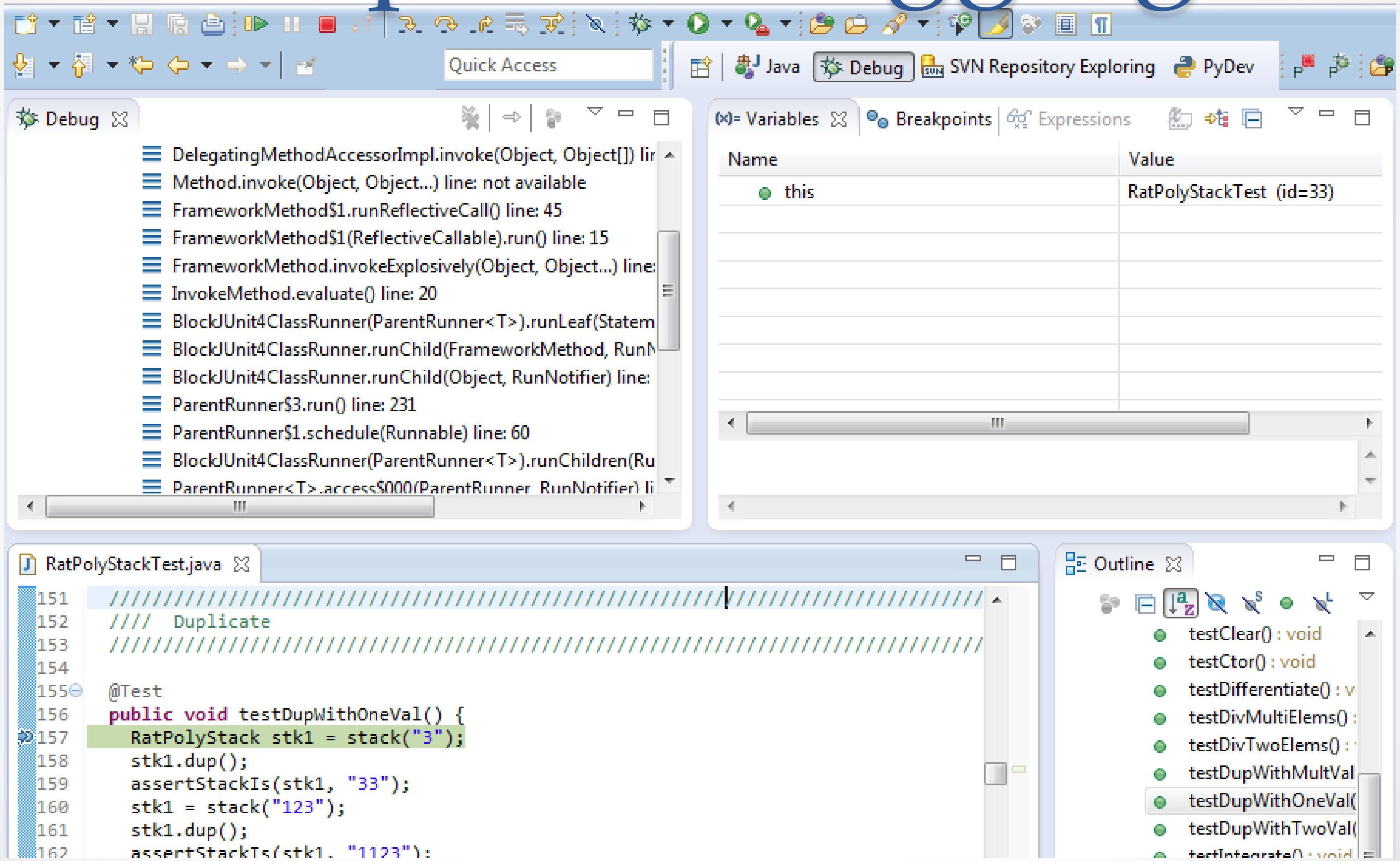
Eclipse shortcuts

Shortcut	Purpose
Ctrl + D	Delete an entire line
Alt + Shift + R	Refactor (rename)
Ctrl + Shift + O	Clean up imports
Ctrl + /	Toggle comment
Ctrl + Shift + F	Make my code look nice ☺

Eclipse Debugging

- System.out.println() works for debugging…
  - It's quick
  - It's dirty
  - Everyone knows how to do it
- …but there are drawbacks
  - What if I'm printing something that's null?
  - What if I want to look at something that can't easily be printed (e.g., what does my binary search tree look like now)?
- Eclipse's debugger is powerful…if you know how to use it

Eclipse Debugging



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Name	Value
● this	RatPolyStackTest (id=33)

```java
//////////////////////////////////////////////////////////////////////////////////////
////  Duplicate
//////////////////////////////////////////////////////////////////////////////////////

@Test
public void testDupWithOneVal() {
  RatPolyStack stk1 = stack("3");
  stk1.dup();
  assertStackIs(stk1, "33");
  stk1 = stack("123");
  stk1.dup();
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```

- ● testClear() : void
- ● testCtor() : void
- ● testDifferentiate() : v
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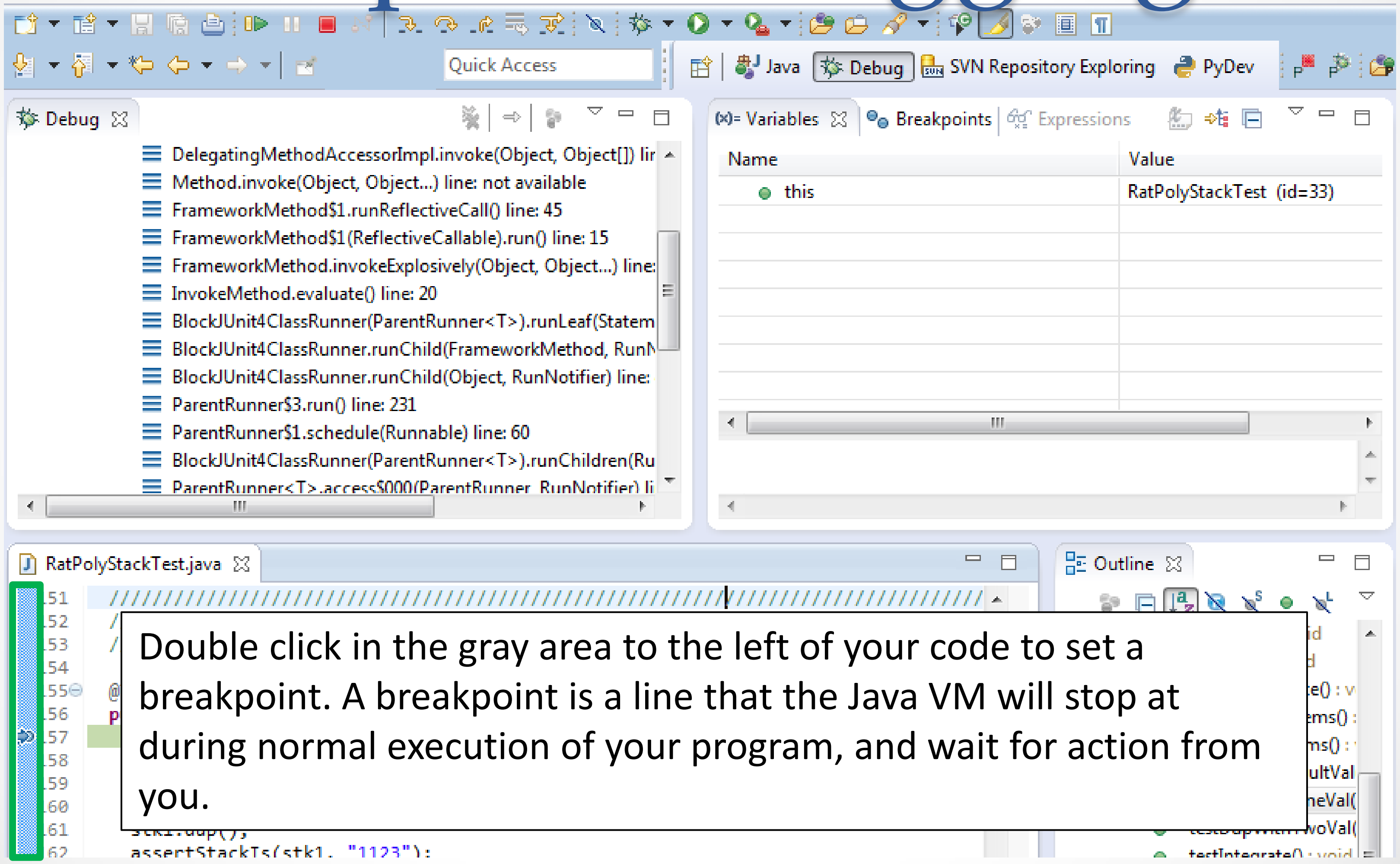
Eclipse Debugging



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Name	Value
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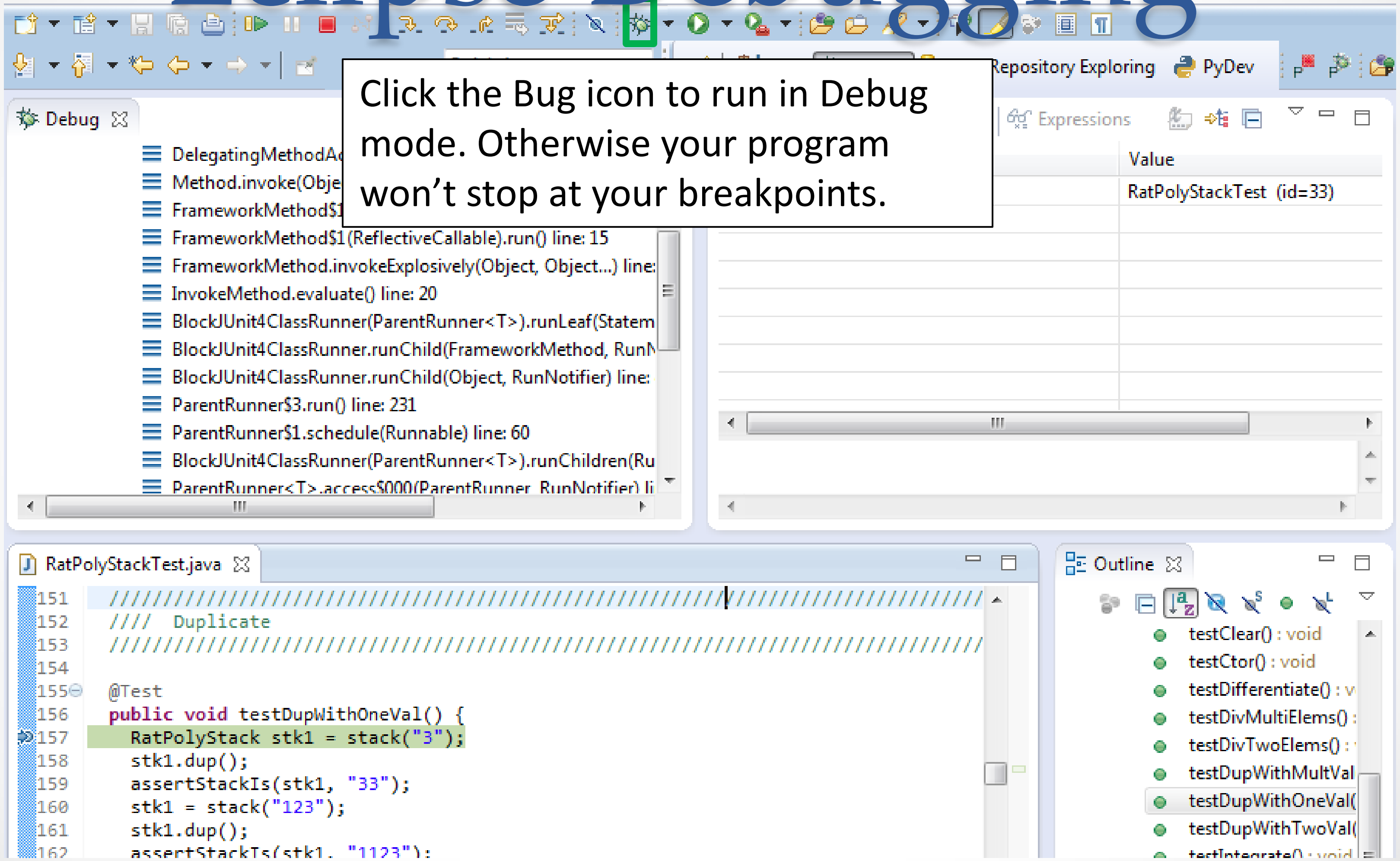
```
////////////////////////////////////////////////////////////////////
stk1.dup();
assertStackIs(stk1, "1123");
```

Double click in the gray area to the left of your code to set a breakpoint. A breakpoint is a line that the Java VM will stop at during normal execution of your program, and wait for action from you.

Eclipse Debugging



Click the Bug icon to run in Debug mode. Otherwise your program won't stop at your breakpoints.

```
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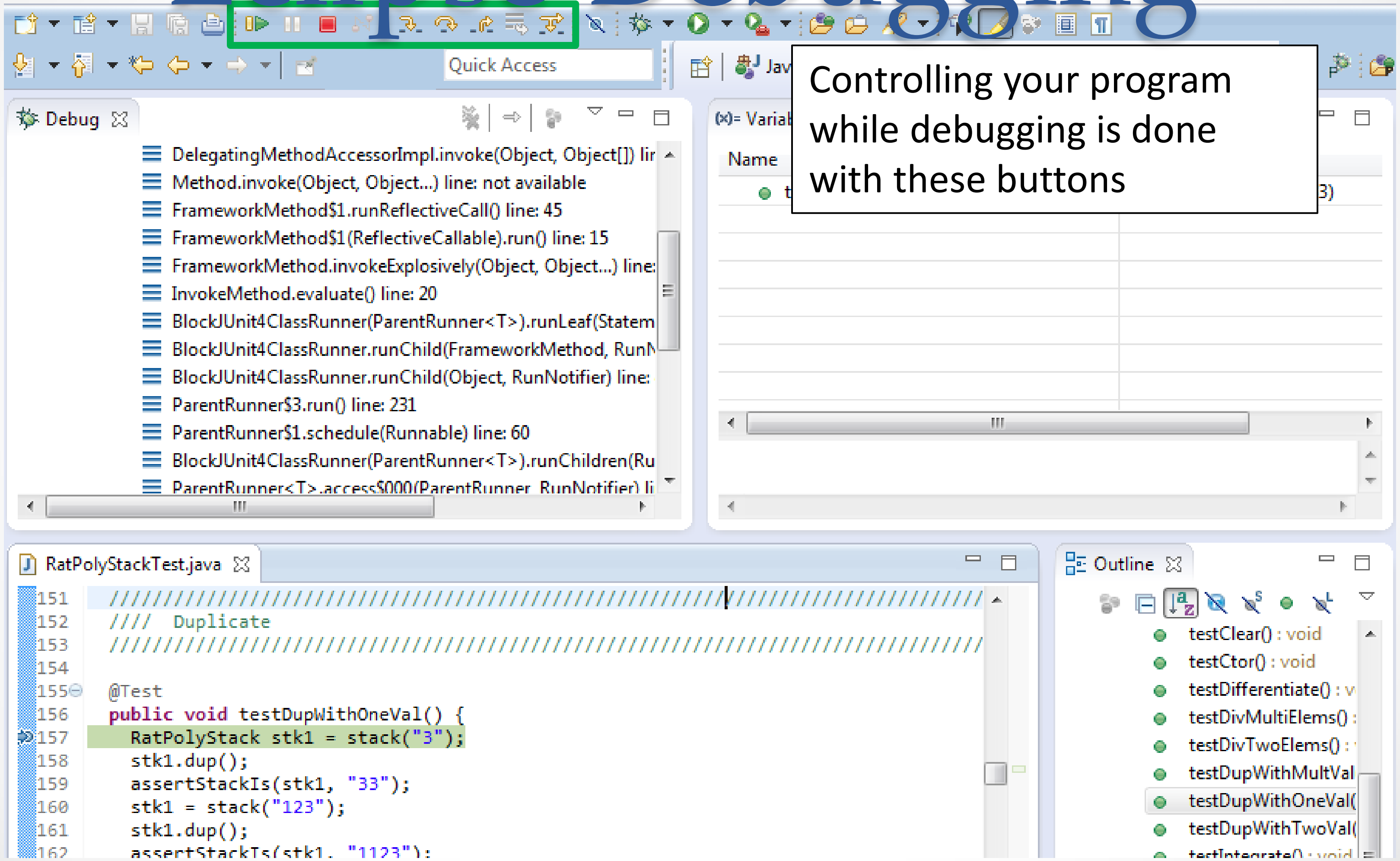

Controlling your program while debugging is done with these buttons

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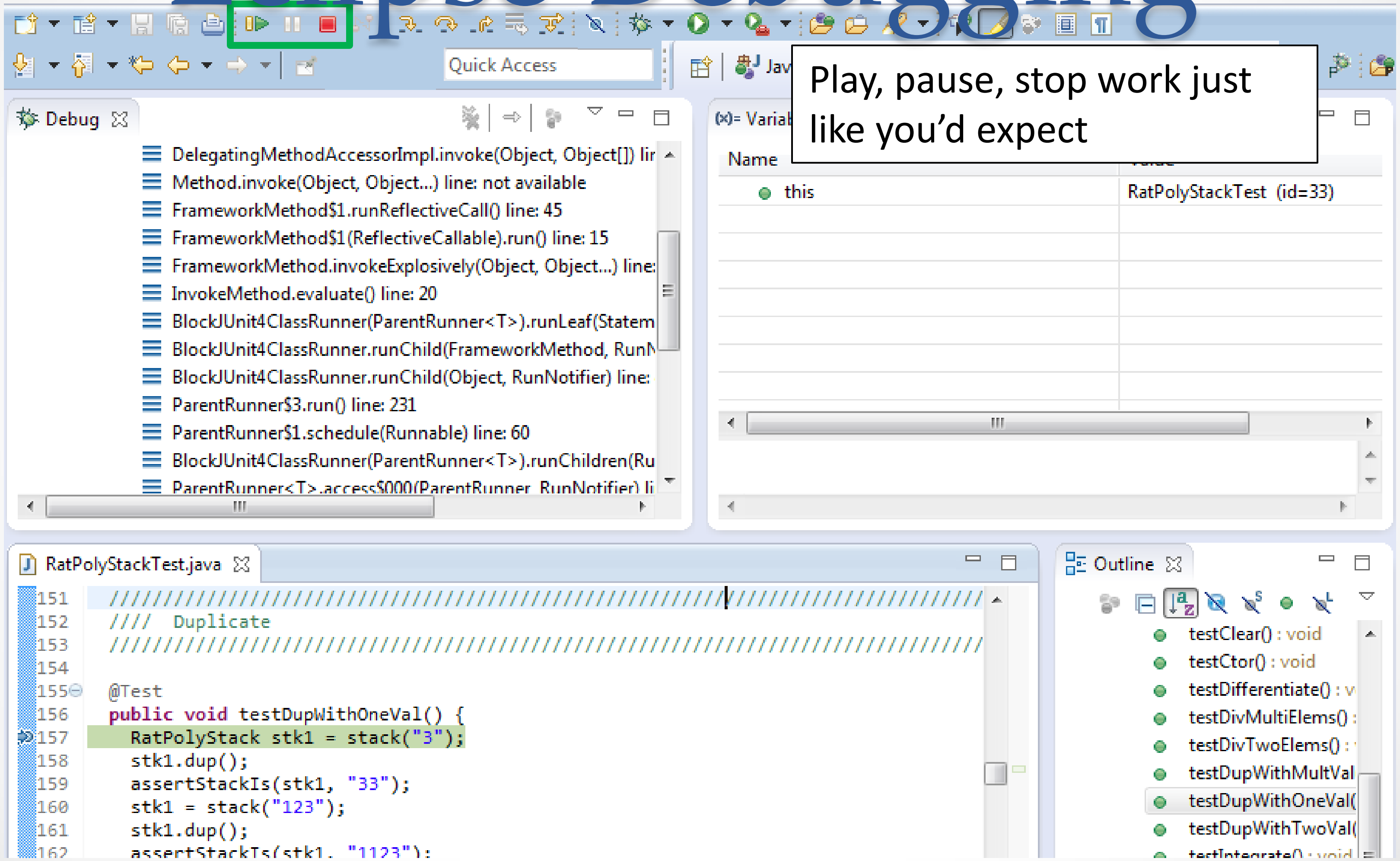
Eclipse Debugging



Play, pause, stop work just like you'd expect

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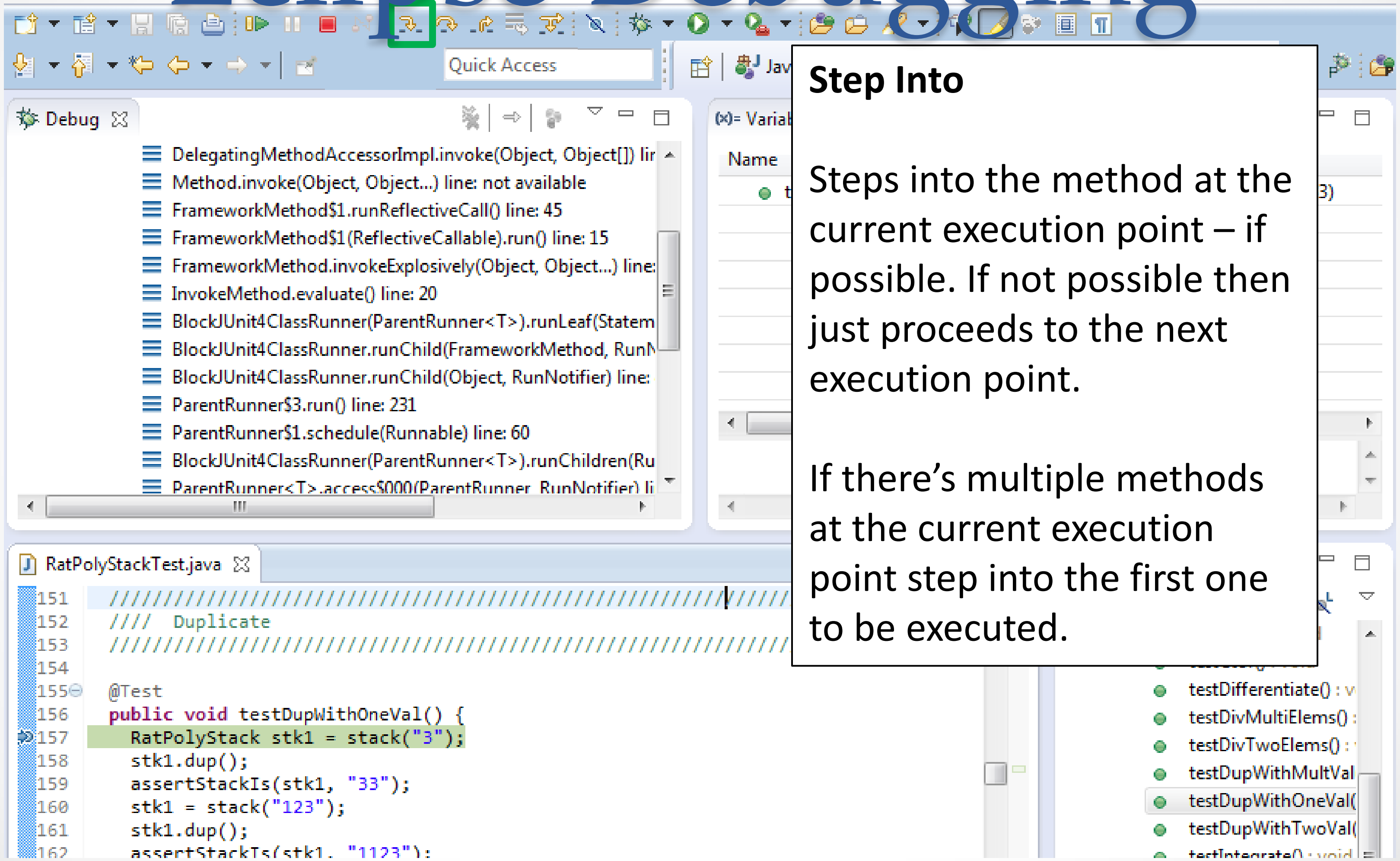

Quick Access

Debug

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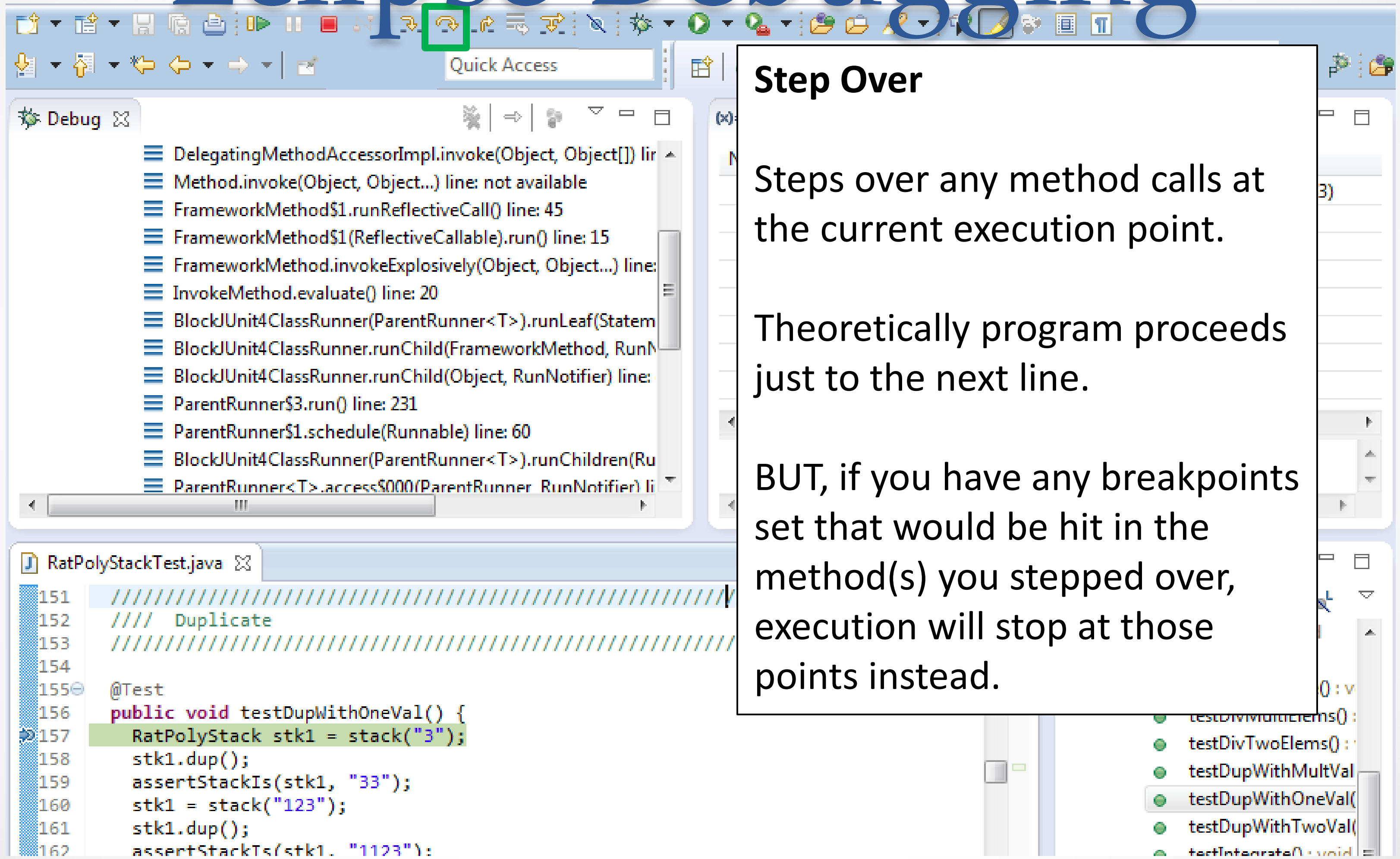
Step Into

Steps into the method at the current execution point – if possible. If not possible then just proceeds to the next execution point.

If there's multiple methods at the current execution point step into the first one to be executed.

Eclipse Debugging



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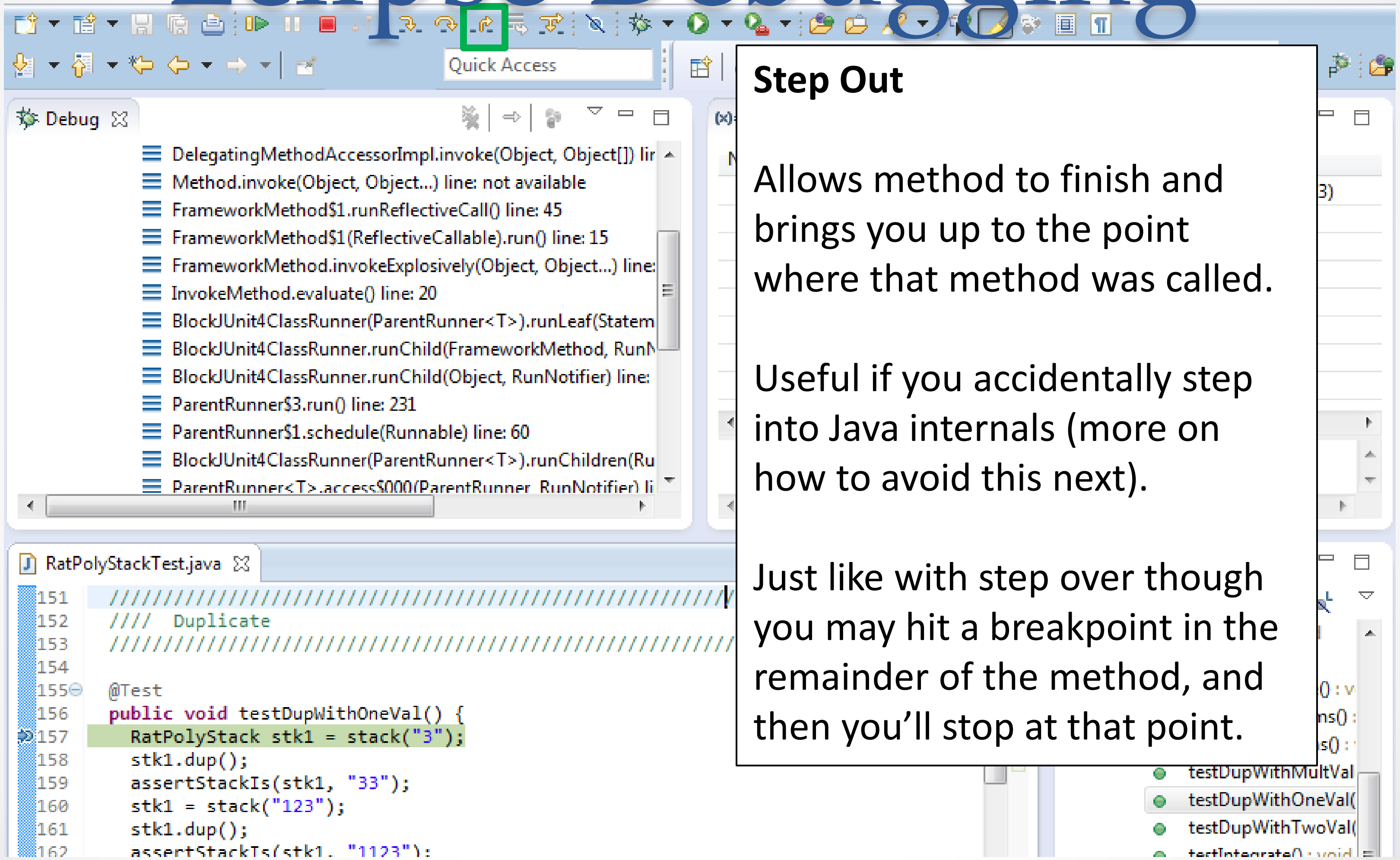
Step Over

Steps over any method calls at the current execution point.

Theoretically program proceeds just to the next line.

BUT, if you have any breakpoints set that would be hit in the method(s) you stepped over, execution will stop at those points instead.

Eclipse Debugging



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```

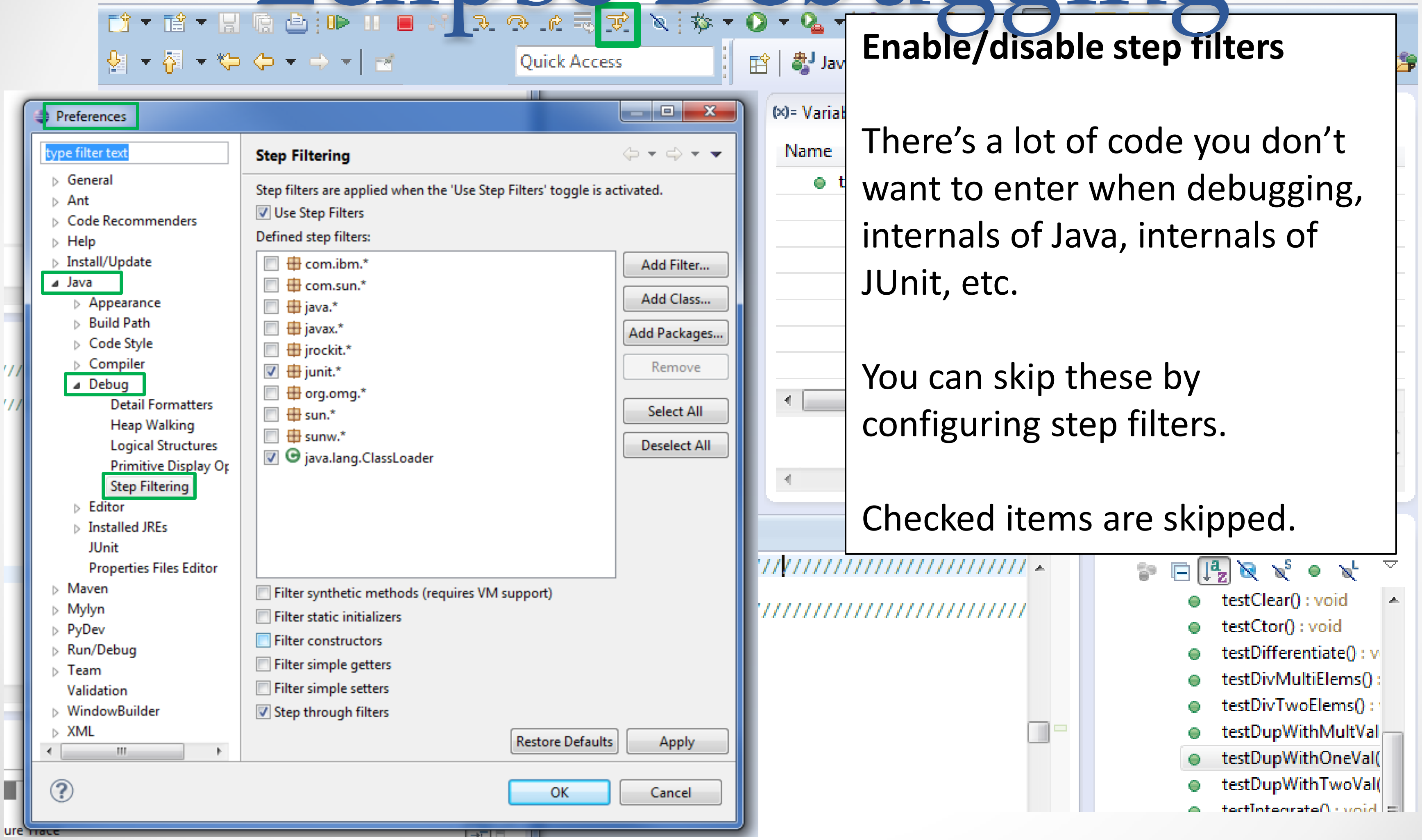
Step Out

Allows method to finish and brings you up to the point where that method was called.

Useful if you accidentally step into Java internals (more on how to avoid this next).

Just like with step over though you may hit a breakpoint in the remainder of the method, and then you'll stop at that point.

Eclipse Debugging



Preferences

Step Filtering

Step filters are applied when the 'Use Step Filters' toggle is activated.

[✓] Use Step Filters

Defined step filters:

- [ ] com.ibm.*
- [ ] com.sun.*
- [ ] java.*
- [ ] javax.*
- [ ] jrockit.*
- [✓] junit.*
- [ ] org.omg.*
- [ ] sun.*
- [ ] sunw.*
- [✓] java.lang.ClassLoader

- [ ] Filter synthetic methods (requires VM support)
- [ ] Filter static initializers
- [ ] Filter constructors
- [ ] Filter simple getters
- [ ] Filter simple setters
- [✓] Step through filters

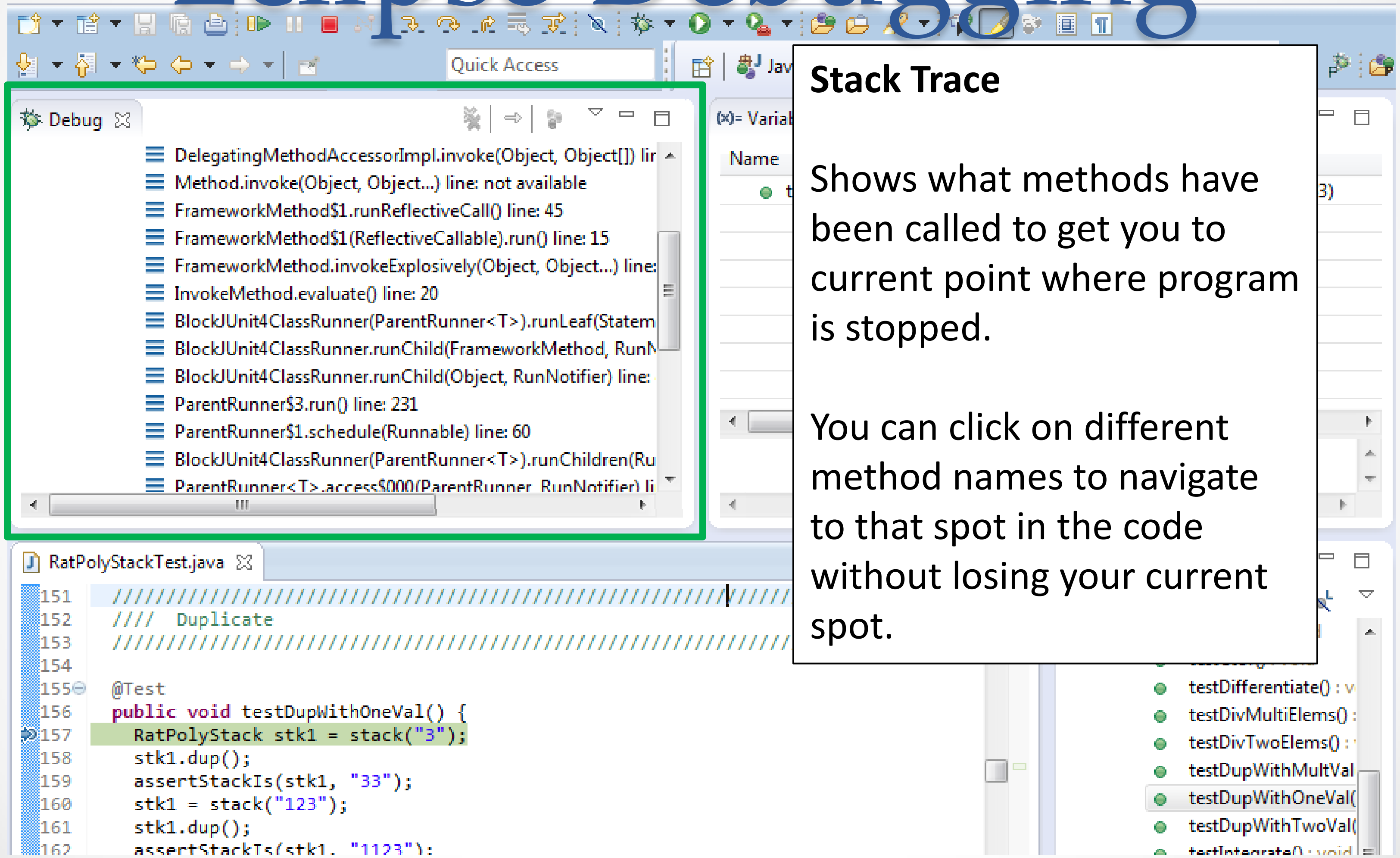
Enable/disable step filters

There's a lot of code you don't want to enter when debugging, internals of Java, internals of JUnit, etc.

You can skip these by configuring step filters.

Checked items are skipped.

Eclipse Debugging



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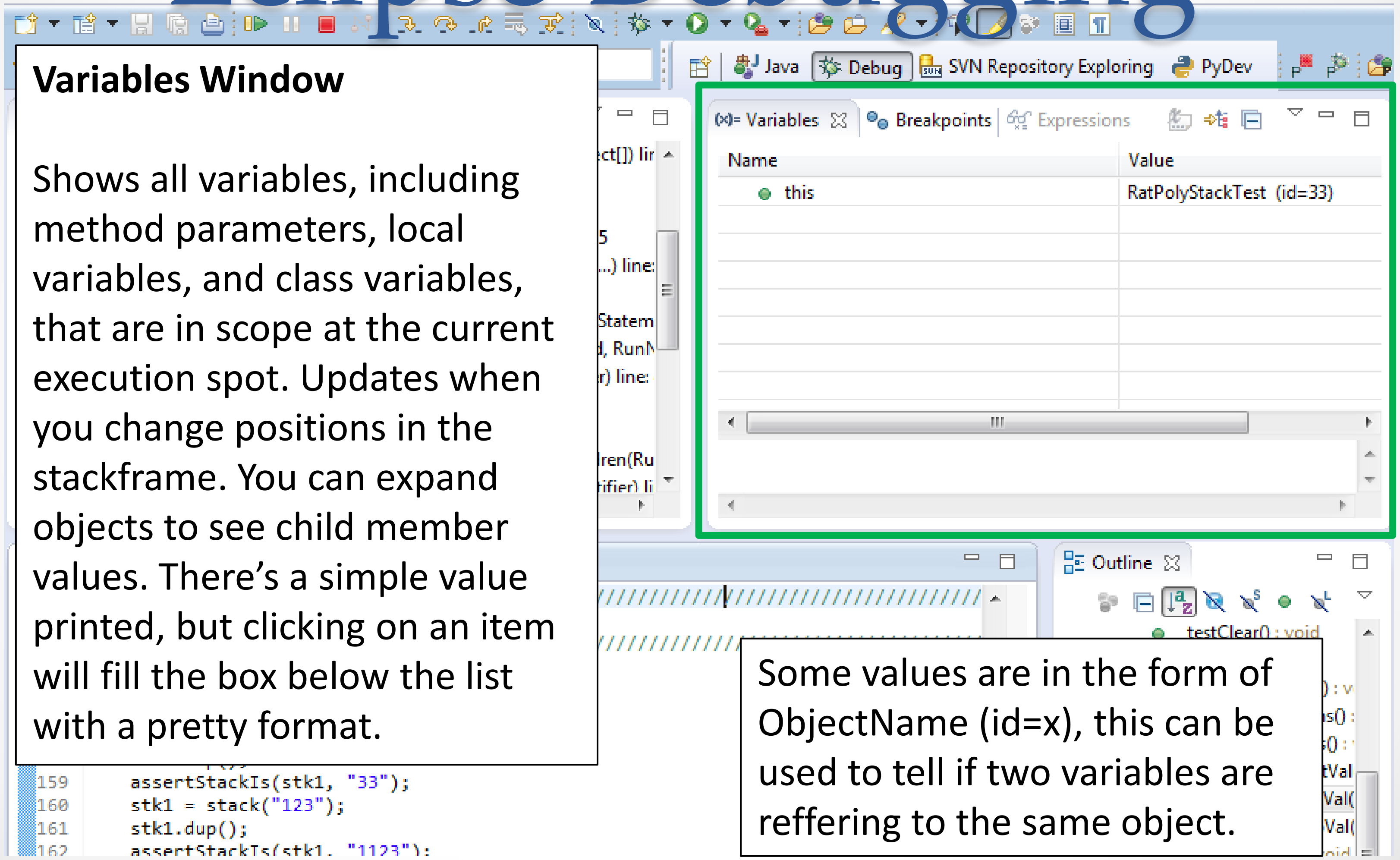
Stack Trace

Shows what methods have been called to get you to current point where program is stopped.

You can click on different method names to navigate to that spot in the code without losing your current spot.

Eclipse Debugging



Name	Value
this	RatPolyStackTest (id=33)

```
assertStackIs(stk1, "33");
stk1 = stack("123");
stk1.dup();
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```

Variables Window

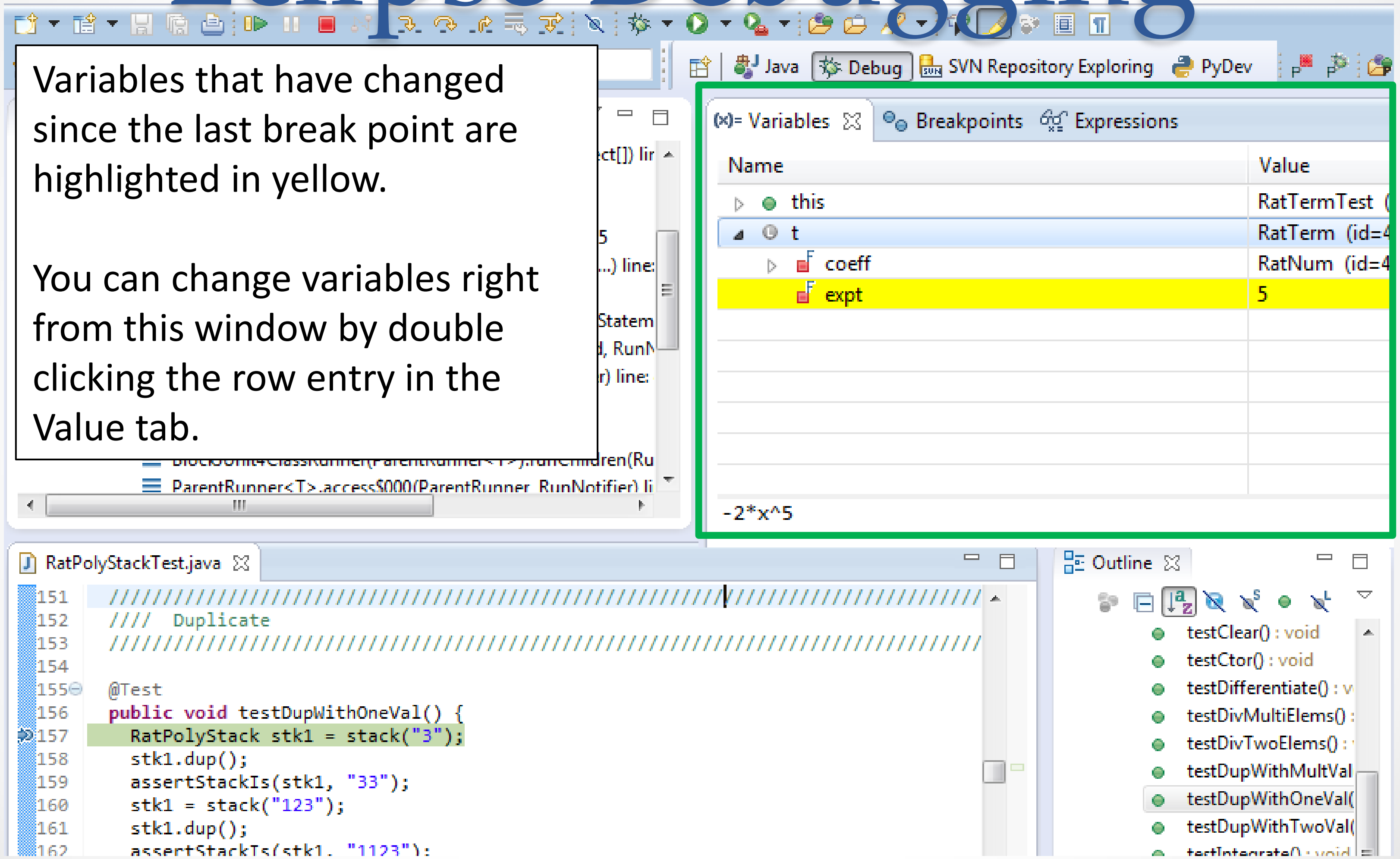
Shows all variables, including method parameters, local variables, and class variables, that are in scope at the current execution spot. Updates when you change positions in the stackframe. You can expand objects to see child member values. There's a simple value printed, but clicking on an item will fill the box below the list with a pretty format.

Some values are in the form of ObjectName (id=x), this can be used to tell if two variables are reffering to the same object.

Eclipse Debugging

Variables that have changed since the last break point are highlighted in yellow.

You can change variables right from this window by double clicking the row entry in the Value tab.



Name	Value
this	RatTermTest (
t	RatTerm (id=4
coeff	RatNum (id=4
expt	5

```
-2*x^5
```

```
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    ////////////////////////////////////////////////////////////////////////

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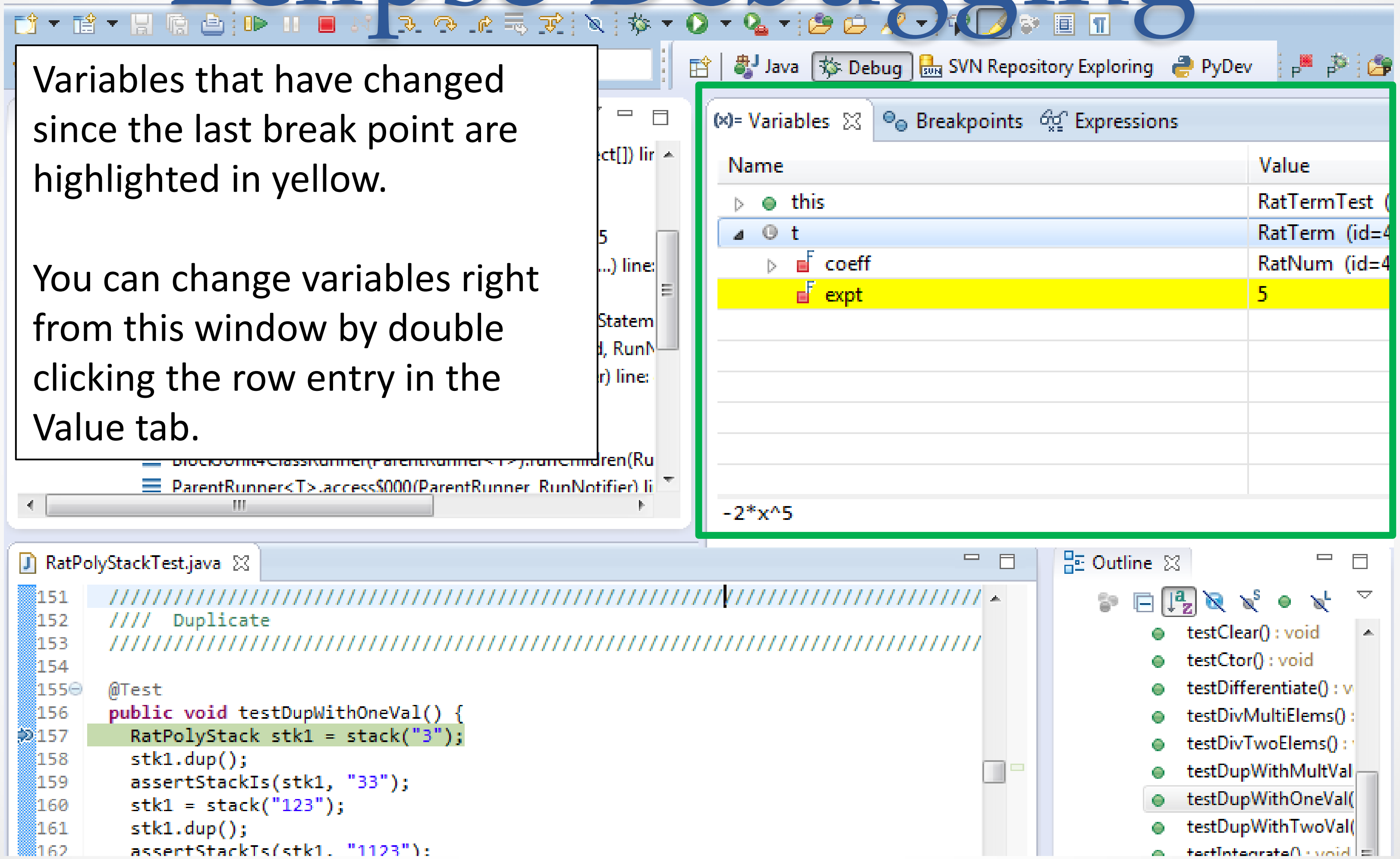

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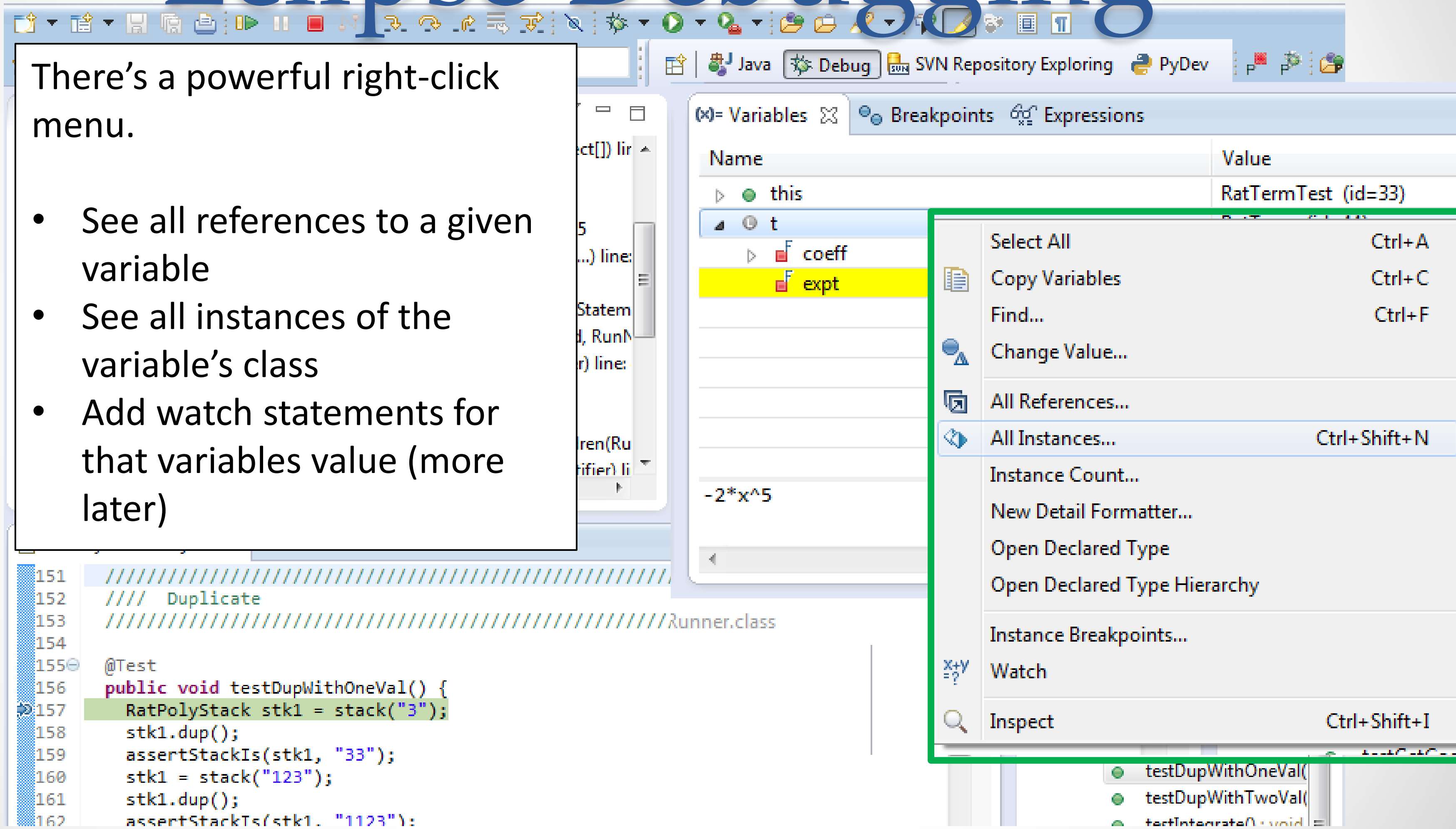
Eclipse Debugging

There's a powerful right-click menu.

- See all references to a given variable
- See all instances of the variable's class
- Add watch statements for that variables value (more later)



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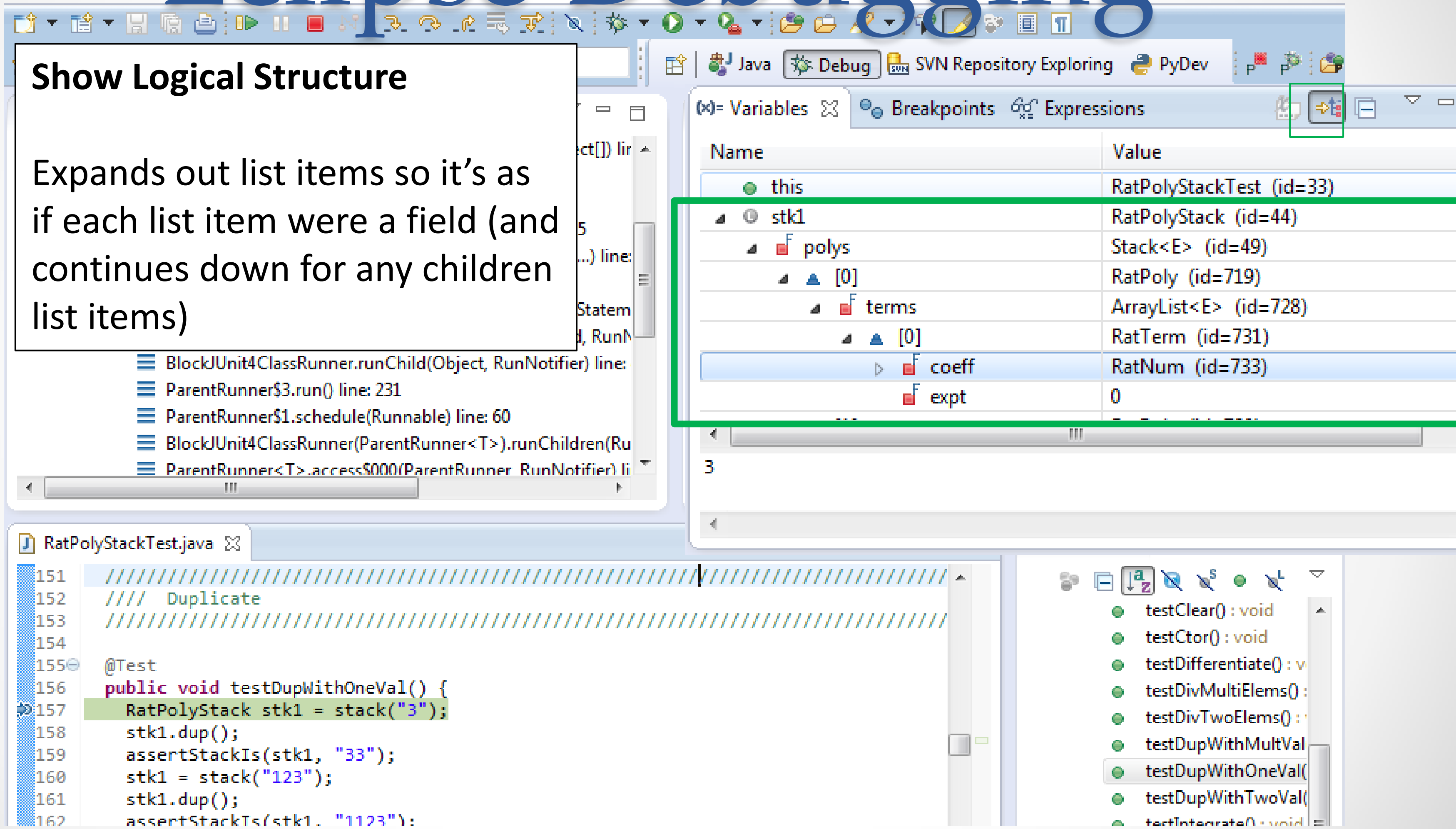


Show Logical Structure

Expands out list items so it's as if each list item were a field (and continues down for any children list items)

Name	Value
this	RatPolyStackTest (id=33)
stk1	RatPolyStack (id=44)
polys	Stack<E> (id=49)
[0]	RatPoly (id=719)
terms	ArrayList<E> (id=728)
[0]	RatTerm (id=731)
coeff	RatNum (id=733)
expt	0

```
BlockJUnit4ClassRunner.runChild(Object, RunNotifier) line:
ParentRunner$3.run() line: 231
ParentRunner$1.schedule(Runnable) line: 60
BlockJUnit4ClassRunner(ParentRunner<T>).runChildren(Ru
ParentRunner<T>.access$000(ParentRunner, RunNotifier) li
```

```
////////////////////////////////////////////////////////////////////////////
////  Duplicate
////////////////////////////////////////////////////////////////////////////

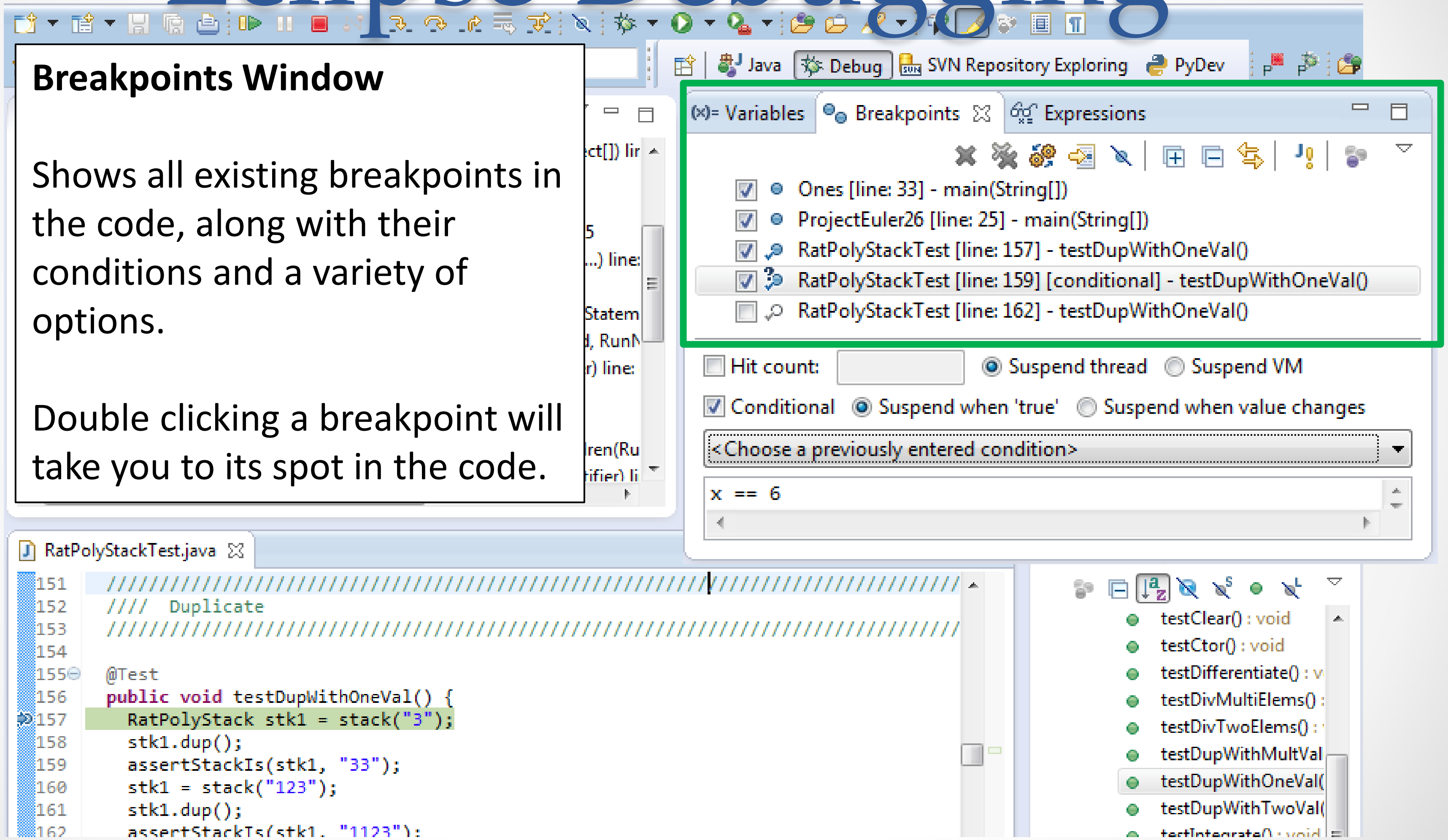
@Test
public void testDupWithOneVal() {
  RatPolyStack stk1 = stack("3");
  stk1.dup();
  assertStackIs(stk1, "33");
  stk1 = stack("123");
  stk1.dup();
  assertStackIs(stk1, "1123");
```

Eclipse Debugging

Breakpoints Window

Shows all existing breakpoints in the code, along with their conditions and a variety of options.

Double clicking a breakpoint will take you to its spot in the code.



☑ Ones [line: 33] - main(String[])
☑ ProjectEuler26 [line: 25] - main(String[])
☑ RatPolyStackTest [line: 157] - testDupWithOneVal()
☑ RatPolyStackTest [line: 159] [conditional] - testDupWithOneVal()
☐ RatPolyStackTest [line: 162] - testDupWithOneVal()

☐ Hit count: [✓ Suspend thread] Suspend VM

☑ Conditional [✓ Suspend when 'true'] Suspend when value changes

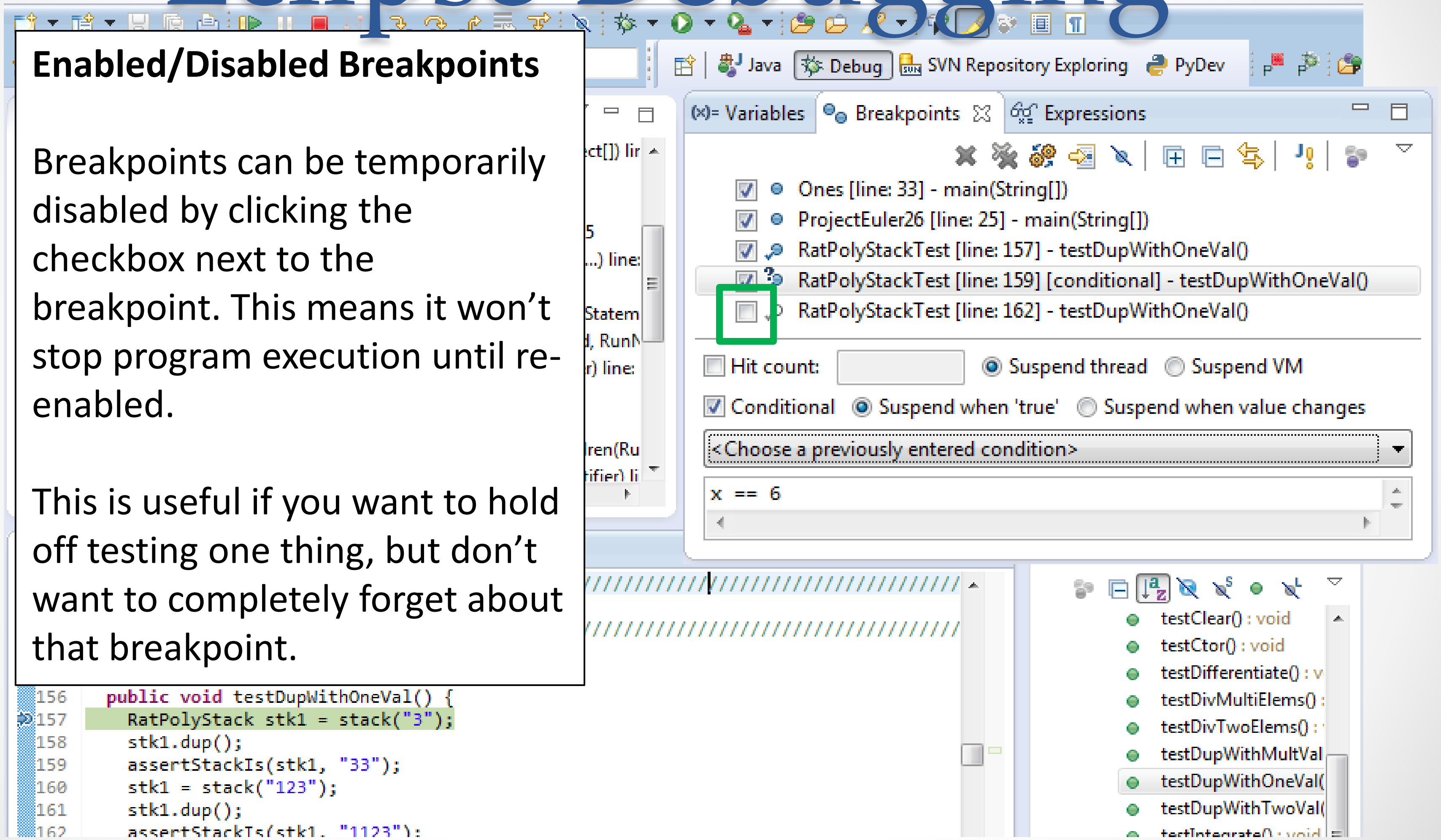
<Choose a previously entered condition>

```
x == 6
```

```
151 ////////////////////////////////////////////////////////////////////////////
152 ////  Duplicate
153 ////////////////////////////////////////////////////////////////////////////
154
155 @Test
156 public void testDupWithOneVal() {
157   RatPolyStack stk1 = stack("3");
158   stk1.dup();
159   assertStackIs(stk1, "33");
160   stk1 = stack("123");
161   stk1.dup();
162   assertStackIs(stk1, "1123");
```

```
testClear() : void
testCtor() : void
testDifferentiate() : v
testDivMultiElems() :
testDivTwoElems() :
testDupWithMultVal
testDupWithOneVal(
testDupWithTwoVal(
testIntegrate() : void
```

Eclipse Debugging



Enabled/Disabled Breakpoints

Breakpoints can be temporarily disabled by clicking the checkbox next to the breakpoint. This means it won't stop program execution until re-enabled.

This is useful if you want to hold off testing one thing, but don't want to completely forget about that breakpoint.

- [✓] Ones [line: 33] - main(String[])
- [✓] ProjectEuler26 [line: 25] - main(String[])
- [✓] RatPolyStackTest [line: 157] - testDupWithOneVal()
- [✓] RatPolyStackTest [line: 159] [conditional] - testDupWithOneVal()
- [ ] RatPolyStackTest [line: 162] - testDupWithOneVal()

[ ] Hit count: [✓ Suspend thread] Suspend VM

[✓] Conditional [✓ Suspend when 'true'] Suspend when value changes

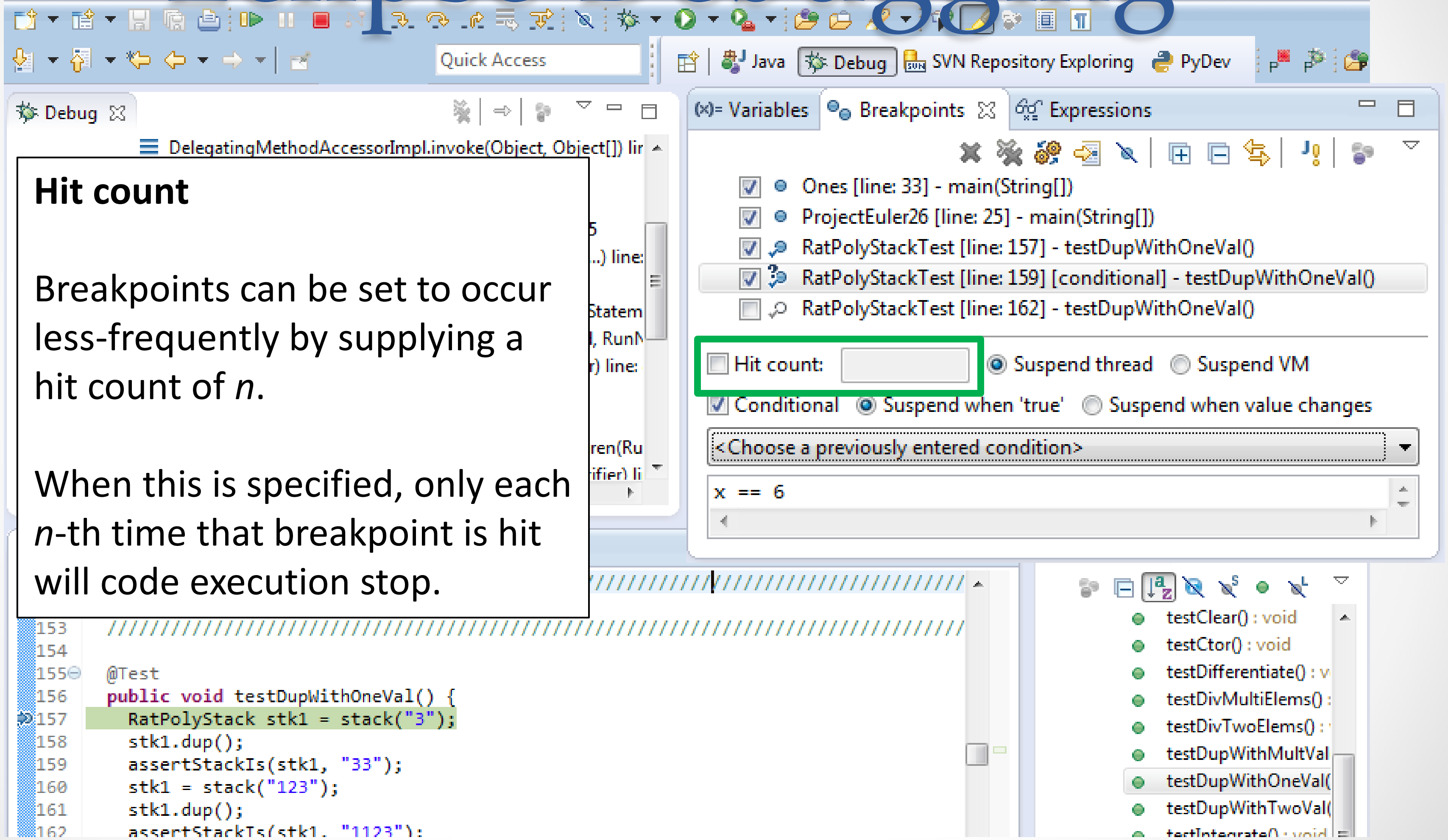
<Choose a previously entered condition>

```
x == 6
```

```
156   public void testDupWithOneVal() {
157     RatPolyStack stk1 = stack("3");
158     stk1.dup();
159     assertStackIs(stk1, "33");
160     stk1 = stack("123");
161     stk1.dup();
162     assertStackIs(stk1, "1123");
```

```
testClear() : void
testCtor() : void
testDifferentiate() : v
testDivMultiElems() :
testDivTwoElems() :
testDupWithMultVal
testDupWithOneVal(
testDupWithTwoVal(
testIntegrate() : void
```

Eclipse Debugging



Hit count

Breakpoints can be set to occur less-frequently by supplying a hit count of *n*.

When this is specified, only each *n*-th time that breakpoint is hit will code execution stop.

- [✓] Ones [line: 33] - main(String[])
- [✓] ProjectEuler26 [line: 25] - main(String[])
- [✓] RatPolyStackTest [line: 157] - testDupWithOneVal()
- [✓] RatPolyStackTest [line: 159] [conditional] - testDupWithOneVal()
- [ ] RatPolyStackTest [line: 162] - testDupWithOneVal()

[ ] Hit count: [✓ Suspend thread] Suspend VM

[✓] Conditional [✓ Suspend when 'true'] Suspend when value changes

<Choose a previously entered condition>

```
x == 6
```

```
//////////////////////////////////////////////////////////////////////

@Test
public void testDupWithOneVal() {
  RatPolyStack stk1 = stack("3");
  stk1.dup();
  assertStackIs(stk1, "33");
  stk1 = stack("123");
  stk1.dup();
  assertStackIs(stk1, "1123");
```

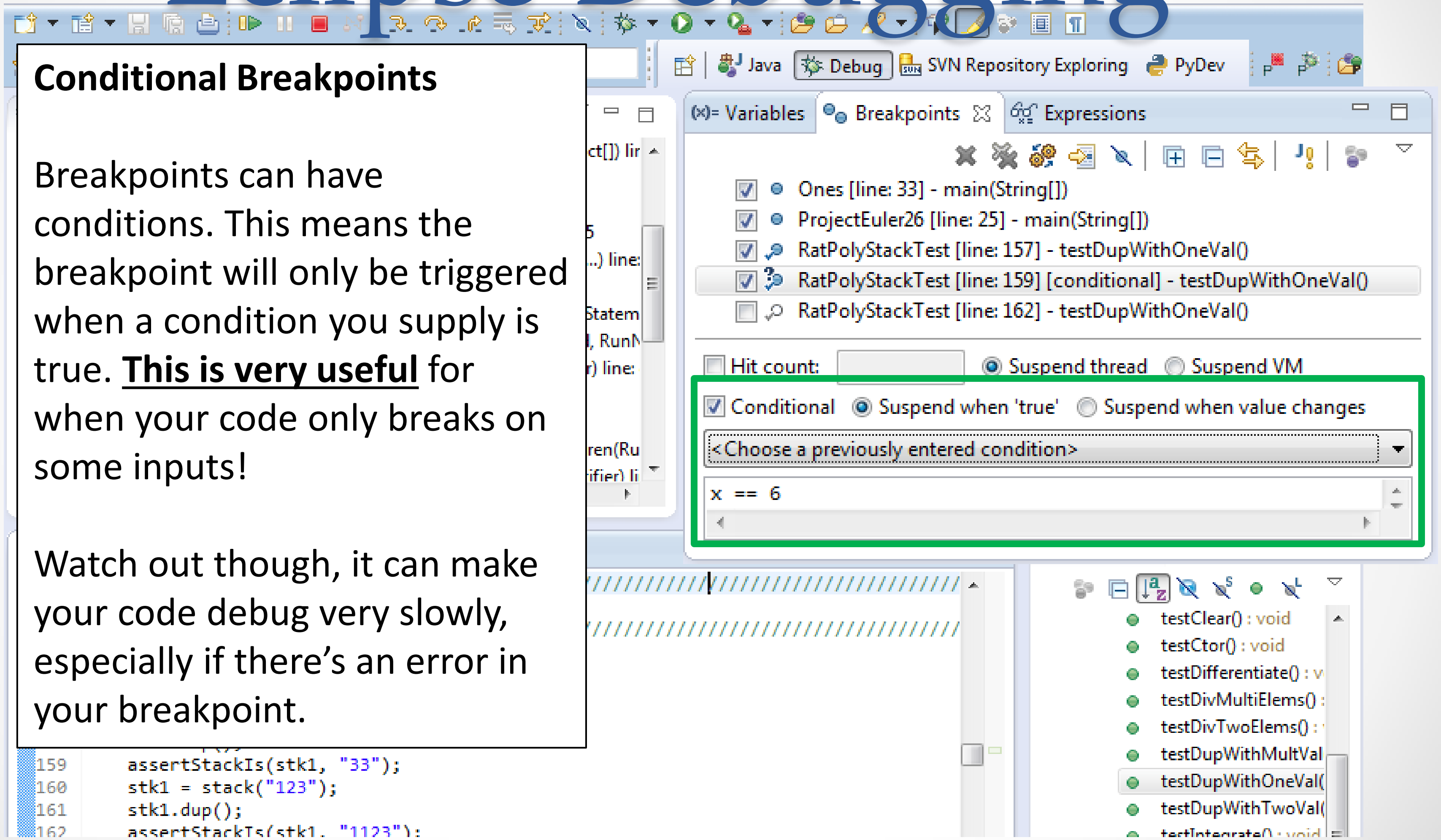
- testClear() : void
- testCtor() : void
- testDifferentiate() : v
- testDivMultiElems() :
- testDivTwoElems() :
- testDupWithMultVal
- testDupWithOneVal(
- testDupWithTwoVal(
- testIntegrate() : void

Eclipse Debugging

Conditional Breakpoints

Breakpoints can have conditions. This means the breakpoint will only be triggered when a condition you supply is true. <u>**This is very useful**</u> for when your code only breaks on some inputs!

Watch out though, it can make your code debug very slowly, especially if there's an error in your breakpoint.



- [✓] Ones [line: 33] - main(String[])
- [✓] ProjectEuler26 [line: 25] - main(String[])
- [✓] RatPolyStackTest [line: 157] - testDupWithOneVal()
- [✓] RatPolyStackTest [line: 159] [conditional] - testDupWithOneVal()
- [ ] RatPolyStackTest [line: 162] - testDupWithOneVal()

[ ] Hit count: [✓ Suspend thread] Suspend VM

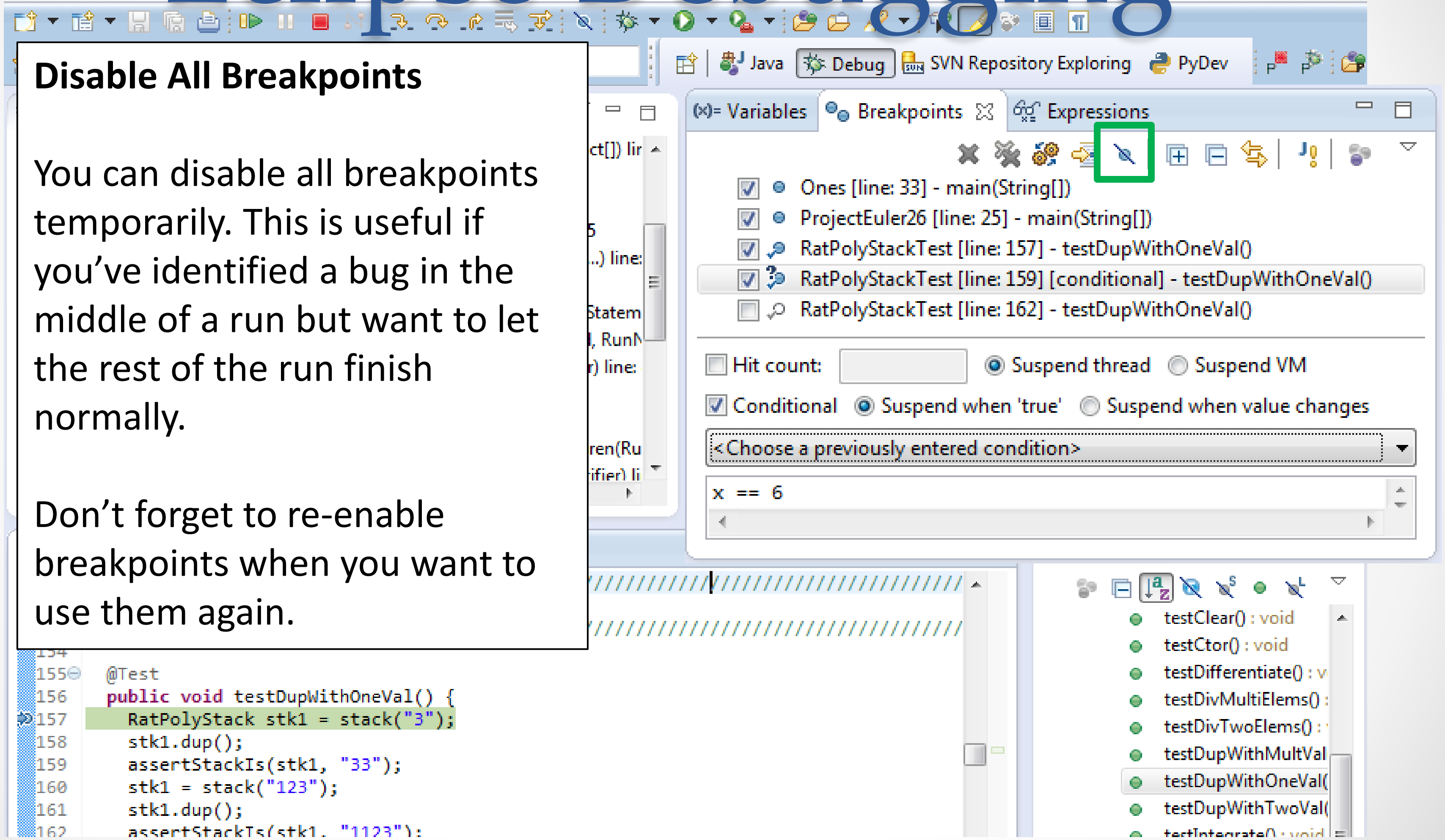
[✓] Conditional [✓ Suspend when 'true'] Suspend when value changes

<Choose a previously entered condition>

```
x == 6
```

```
159    assertStackIs(stk1, "33");
160    stk1 = stack("123");
161    stk1.dup();
162    assertStackIs(stk1, "1123");
```

Eclipse Debugging



Disable All Breakpoints

You can disable all breakpoints temporarily. This is useful if you've identified a bug in the middle of a run but want to let the rest of the run finish normally.

Don't forget to re-enable breakpoints when you want to use them again.

```
Ones [line: 33] - main(String[])
ProjectEuler26 [line: 25] - main(String[])
RatPolyStackTest [line: 157] - testDupWithOneVal()
RatPolyStackTest [line: 159] [conditional] - testDupWithOneVal()
RatPolyStackTest [line: 162] - testDupWithOneVal()
```

Hit count: [✓ Suspend thread] Suspend VM

[✓ Conditional] [✓ Suspend when 'true'] Suspend when value changes

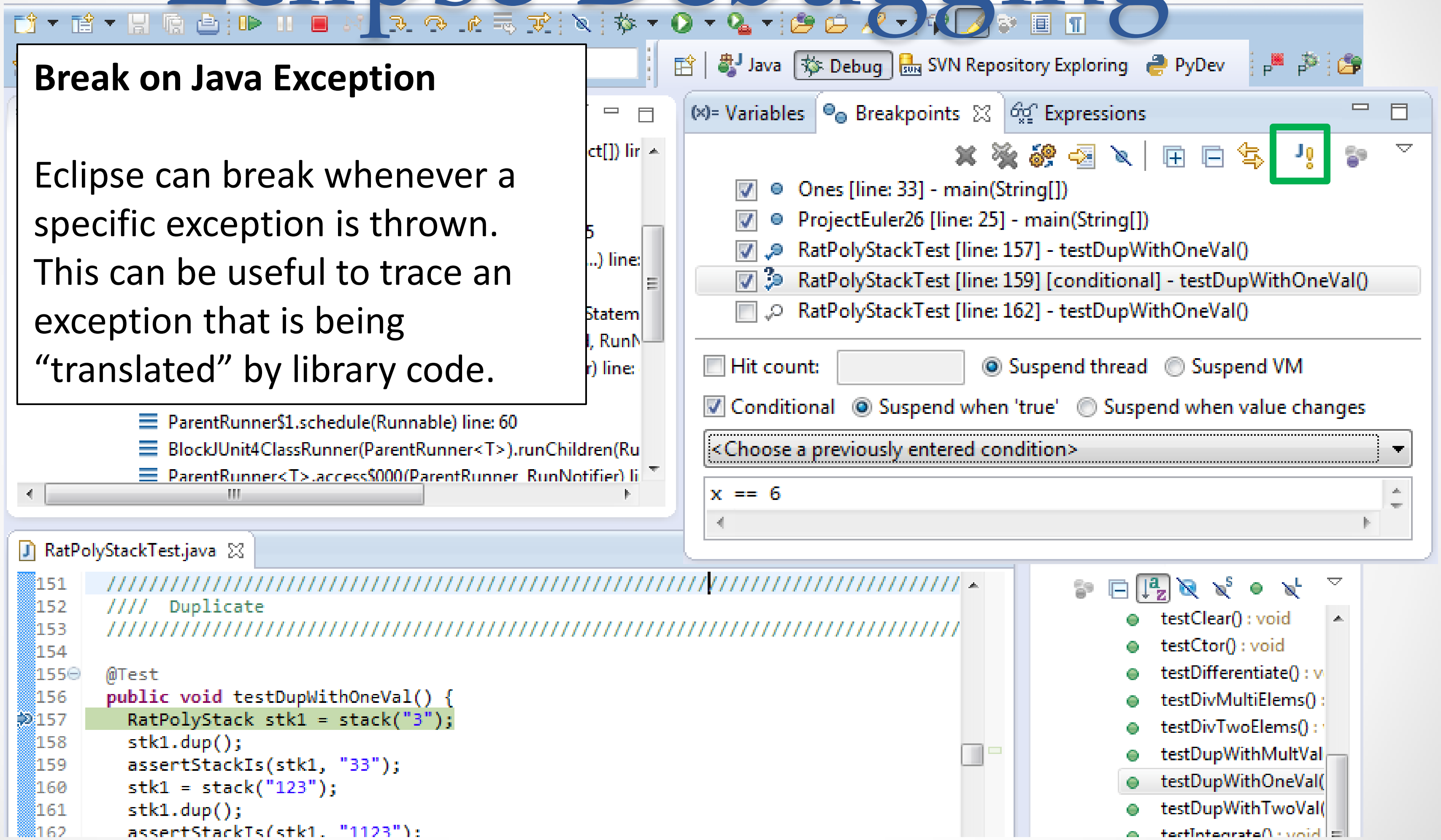
<Choose a previously entered condition>

```
x == 6
```

```
@Test
public void testDupWithOneVal() {
  RatPolyStack stk1 = stack("3");
  stk1.dup();
  assertStackIs(stk1, "33");
  stk1 = stack("123");
  stk1.dup();
  assertStackIs(stk1, "1123");
```

```
testClear() : void
testCtor() : void
testDifferentiate() : v
testDivMultiElems() :
testDivTwoElems() :
testDupWithMultVal
testDupWithOneVal(
testDupWithTwoVal(
testIntegrate() : void
```

Eclipse Debugging



Break on Java Exception

Eclipse can break whenever a specific exception is thrown. This can be useful to trace an exception that is being “translated” by library code.

- [✓] Ones [line: 33] - main(String[])
- [✓] ProjectEuler26 [line: 25] - main(String[])
- [✓] RatPolyStackTest [line: 157] - testDupWithOneVal()
- [✓] RatPolyStackTest [line: 159] [conditional] - testDupWithOneVal()
- [ ] RatPolyStackTest [line: 162] - testDupWithOneVal()

[ ] Hit count: [✓ Suspend thread] Suspend VM

[✓] Conditional [✓ Suspend when 'true'] Suspend when value changes

<Choose a previously entered condition>

```
x == 6
```

```
ParentRunner$1.schedule(Runnable) line: 60
BlockJUnit4ClassRunner(ParentRunner<T>).runChildren(Ru
ParentRunner<T>.access$000(ParentRunner, RunNotifier) li
```

```
////////////////////////////////////////////////////////////////////////////////////
////  Duplicate
////////////////////////////////////////////////////////////////////////////////////

@Test
public void testDupWithOneVal() {
  RatPolyStack stk1 = stack("3");
  stk1.dup();
  assertStackIs(stk1, "33");
  stk1 = stack("123");
  stk1.dup();
  assertStackIs(stk1, "1123");
```

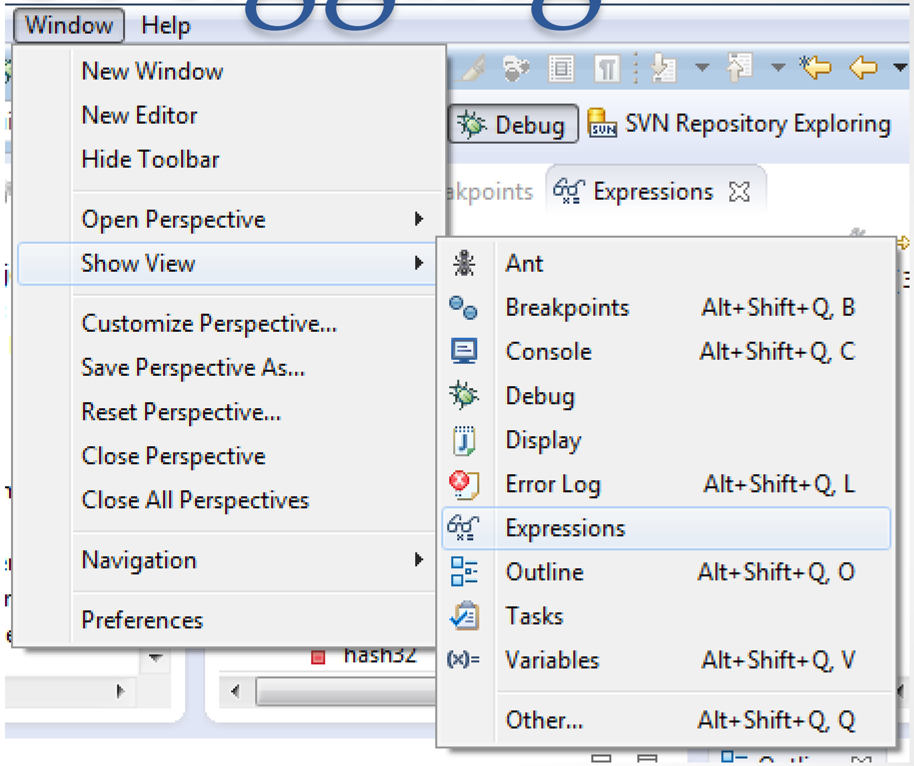
```
testClear() : void
testCtor() : void
testDifferentiate() : v
testDivMultiElems() :
testDivTwoElems() :
testDupWithMultVal
testDupWithOneVal(
testDupWithTwoVal(
testIntegrate() : void
```

Eclipse Debugging

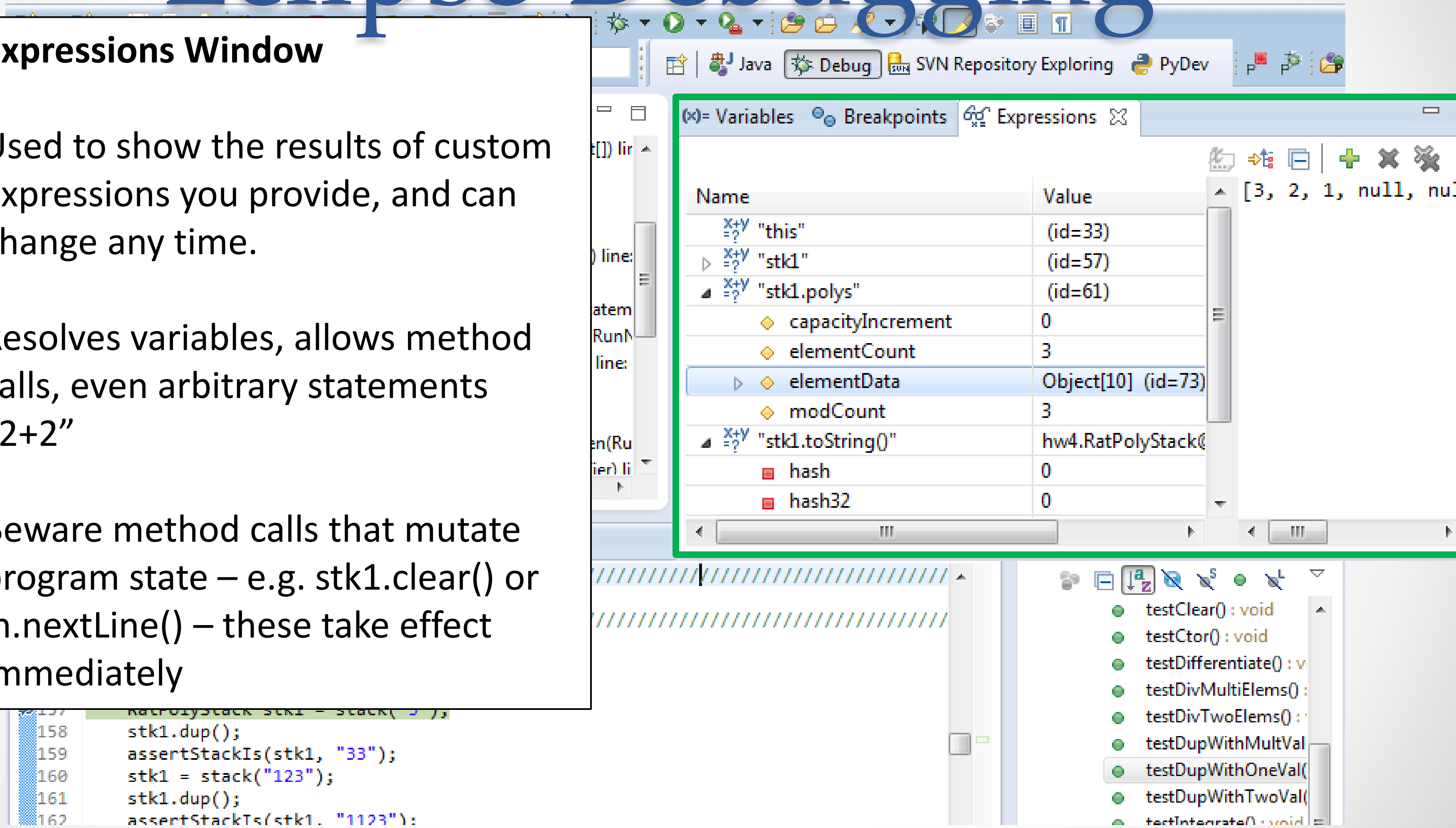
Expressions Window

Used to show the results of custom expressions you provide, and can change any time.

Not shown by default but highly recommended.



Eclipse Debugging



Name	Value
"this"	(id=33)
"stk1"	(id=57)
"stk1.polys"	(id=61)
capacityIncrement	0
elementCount	3
elementData	Object[10] (id=73)
modCount	3
"stk1.toString()"	hw4.RatPolyStack@
hash	0
hash32	0

```
[3, 2, 1, null, nu
```

```
    RatPolyStack stk1 = stack("3");
    stk1.dup();
    assertStackIs(stk1, "33");
    stk1 = stack("123");
    stk1.dup();
    assertStackIs(stk1, "1123");
```

```
testClear() : void
testCtor() : void
testDifferentiate() : v
testDivMultiElems() :
testDivTwoElems() :
testDupWithMultVal
testDupWithOneVal(
testDupWithTwoVal(
testIntegrate() : void
```

Expressions Window

Used to show the results of custom expressions you provide, and can change any time.

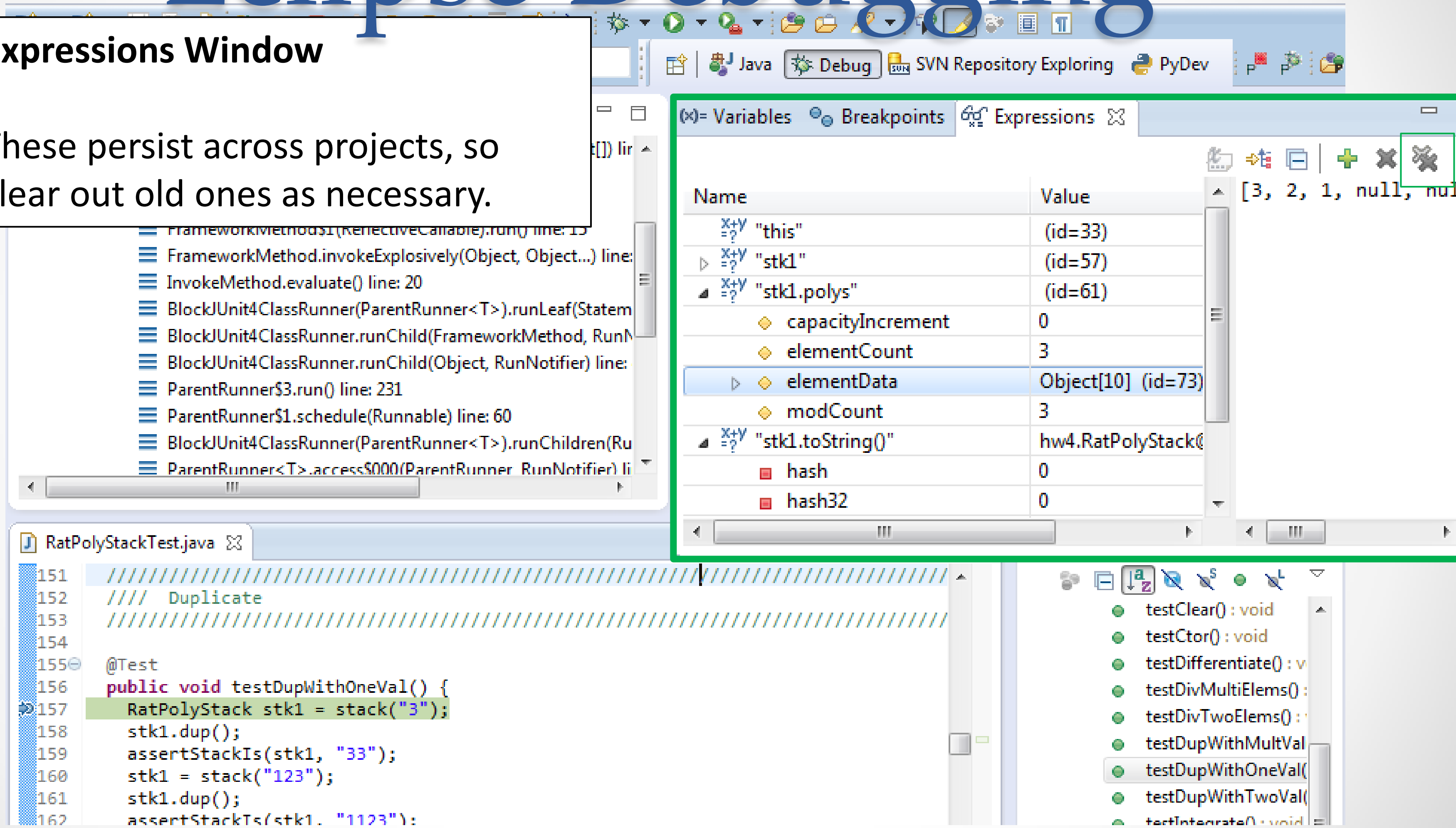
Resolves variables, allows method calls, even arbitrary statements “2+2”

Beware method calls that mutate program state – e.g. stk1.clear() or in.nextLine() – these take effect immediately

Eclipse Debugging

Expressions Window

These persist across projects, so clear out old ones as necessary.



```
FrameworkMethod$1(ReflectiveCallable).run() line: 15
FrameworkMethod.invokeExplosively(Object, Object...) line:
InvokeMethod.evaluate() line: 20
BlockJUnit4ClassRunner(ParentRunner<T>).runLeaf(Statem
BlockJUnit4ClassRunner.runChild(FrameworkMethod, RunN
BlockJUnit4ClassRunner.runChild(Object, RunNotifier) line:
ParentRunner$3.run() line: 231
ParentRunner$1.schedule(Runnable) line: 60
BlockJUnit4ClassRunner(ParentRunner<T>).runChildren(Ru
ParentRunner<T>.access$000(ParentRunner, RunNotifier) li
```

Name	Value
"this"	(id=33)
"stk1"	(id=57)
"stk1.polys"	(id=61)
capacityIncrement	0
elementCount	3
elementData	Object[10] (id=73)
modCount	3
"stk1.toString()"	hw4.RatPolyStack@
hash	0
hash32	0

```
[3, 2, 1, null, nu
```

```
////////////////////////////////////////////////////////////////////////////
////  Duplicate
////////////////////////////////////////////////////////////////////////////

@Test
public void testDupWithOneVal() {
  RatPolyStack stk1 = stack("3");
  stk1.dup();
  assertStackIs(stk1, "33");
  stk1 = stack("123");
  stk1.dup();
  assertStackIs(stk1, "1123");
```

```
testClear() : void
testCtor() : void
testDifferentiate() : v
testDivMultiElems() :
testDivTwoElems() :
testDupWithMultVal
testDupWithOneVal(
testDupWithTwoVal(
testIntegrate() : void
```

Eclipse Debugging

- The debugger is awesome, but not perfect
    - Not well-suited for time-dependent code
    - Recursion can get messy
- Technically, we talked about a "breakpoint debugger"
    - Allows you to stop execution and examine variables
    - Useful for stepping through and visualizing code
    - There are other approaches to debugging that don't involve a debugger

DEMO #3