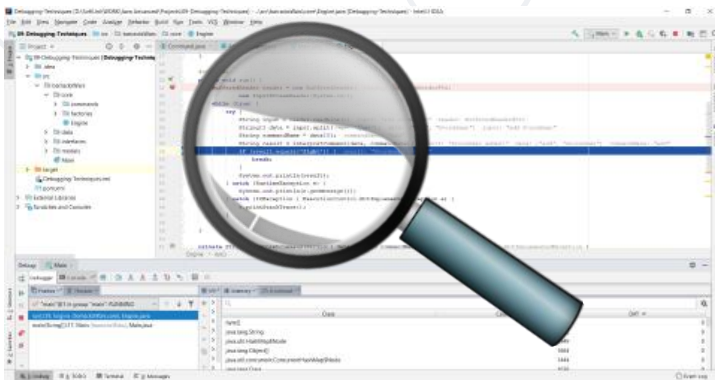


Debugging

Building Rock-Solid Software



SoftUni Team
Technical Trainers



SoftUni



Software University

<https://softuni.bg>

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#java-advanced

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Introduction to Debugging

What is Debugging?

- The process of locating and fixing or bypassing **bugs** (errors) in computer program code
- To **debug** a program:
 - Start with a **problem**
 - Isolate the **source** of the problem
 - **Fix** it
- **Debugging tools** (called **debuggers**) help identify coding errors at various development stages

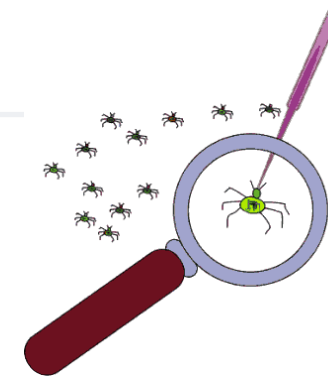
Debugging vs. Testing

- **Testing**

- A means of initial detection of errors

- **Debugging**

- A means of diagnosing and correcting the root causes of errors that have already been detected



- \$60 Billion per year in economic **losses** due to software **defects**
 - E.g. the **Cluster spacecraft failure** was caused by a bug
- Perfect code is an illusion
 - There are factors that are out of our control
- Legacy code
 - You should be able to debug code that is written years ago
- A deeper understanding of the system as a whole

- Debugging can be viewed as one big **decision tree**
 - Individual nodes represent **theories**
 - Leaf nodes represent possible **root causes**
 - Traversal of tree boils down to process state **inspection**
 - Minimizing time to resolution is **key**
 - Careful traversal of the decision tree
 - Pattern recognition
 - Visualization and ease of use helps minimize time to resolution

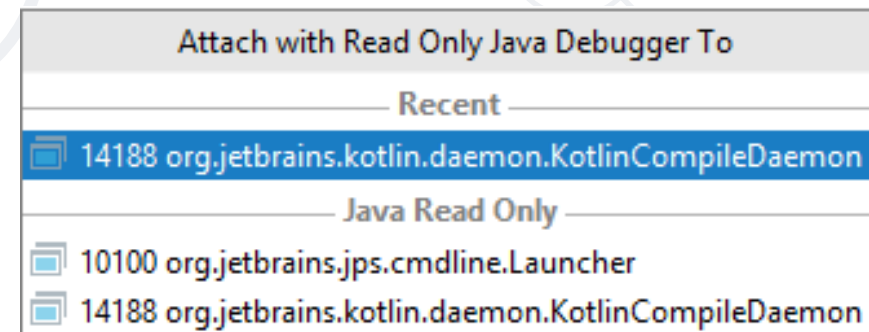


IntelliJ IDEA Debugger

- IntelliJ IDE gives us a lot of **tools** to **debug** your application
 - Adding **breakpoints**
 - Visualize the **program flow**
 - Control the **flow of execution**
 - **Data tips**
 - **Watch variables**
 - Debugging **multithreaded programs**
 - And many more...

How to Debug a Process

- Starting a process under the IntelliJ debugger
- Attaching to an already running process
 - Without a solution loaded you can still debug
 - Useful when a solution isn't readily available
 - **Ctrl + Alt + F5**



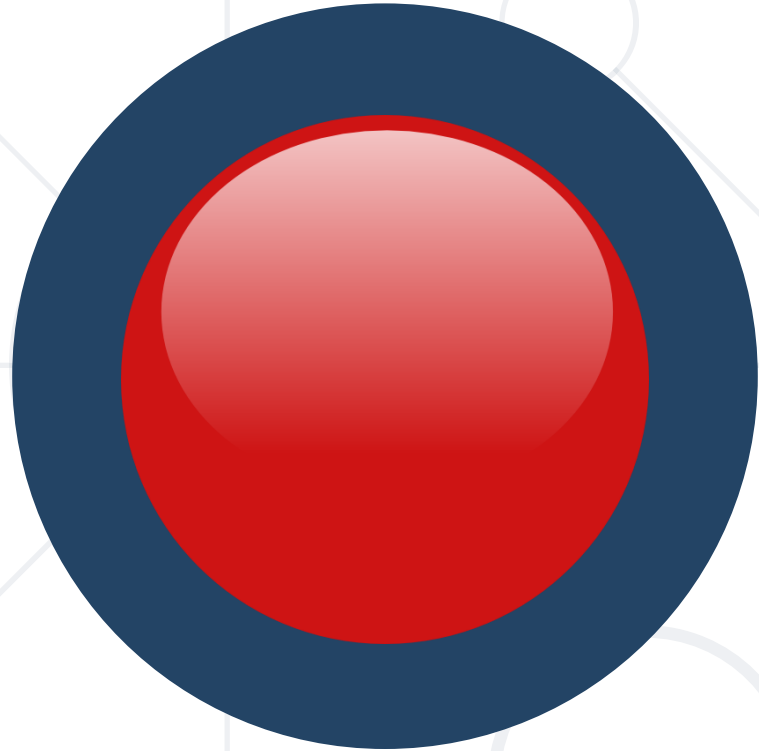
- Right click in **main** method, Debug '{class}.main()'
 - **Shift** + **F9** is a shortcut
- Easier access to the source code and symbols since its loaded in the solution
- Certain differences exist in comparison to debugging an already running process

- Debug Windows are the means to introspect on the state of a process
- Opens a new window with the selected information in it
- Window categories
 - Frames / Threads
 - Variables
 - Watches
- Accessible from Debug window

- A convenient shortcut to common debugging tasks
 - **Step over** – F8
 - **Force Step Into** – through the method calls - Alt + Shift + F7
 - **Step Out** – Shift + F8
 - **Step into** – F7
 - **Continue**
 - **Break**
 - **Breakpoints**

- By default, an app will run uninterrupted (and stop on exception or breakpoint)
- Debugging is all about looking at the **state of the process**
- Controlling execution allows:
 - **Pausing** execution
 - **Resuming** execution

- IntelliJ offers quite a few knobs and tweaks in the debugging experience
- Options and settings is available via Settings/Preferences -> Build, Execution and Deployment (Ctrl + Alt + S):
 - Debugger -> Data Views -> **Java**
 - Compiler -> **Java Compiler**
- **Project Structure** (Ctrl + Shift + Alt + S)



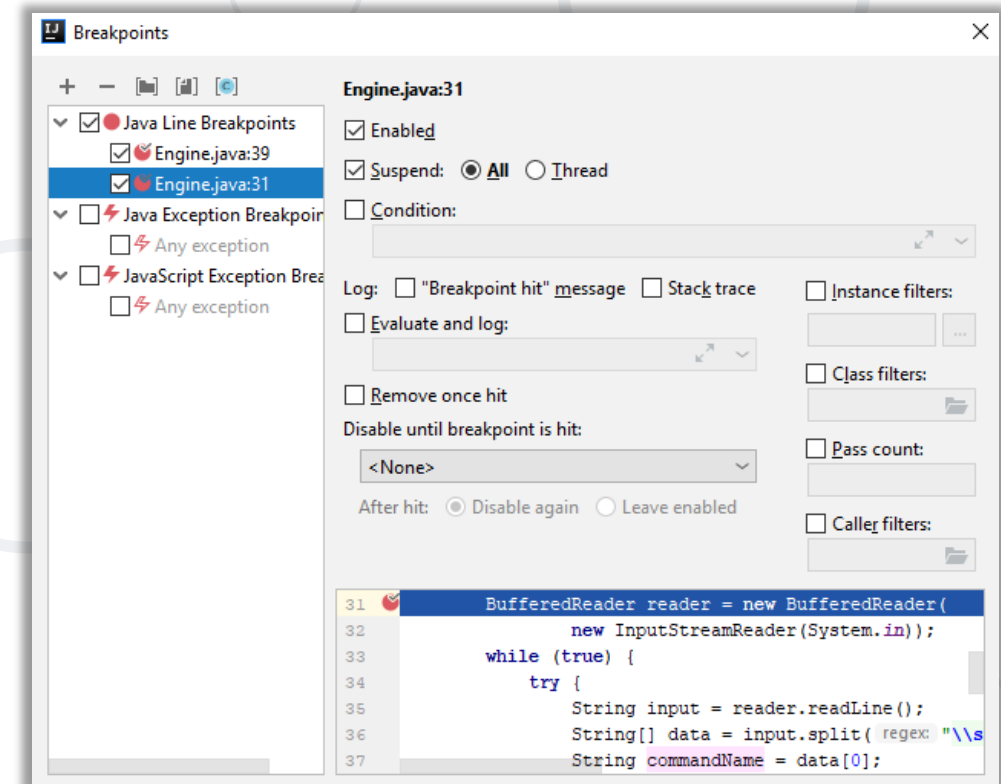
Breakpoints

- The ability to stop execution based on certain criteria is key when debugging
 - When a function is hit
 - When data changes
 - When a specific thread hits a function
 - Much more...
- IntelliJ's debugger has a huge feature set when it comes to breakpoints

- Stops execution at a specific instruction (line of code)
 - Can be set using:
 - **Ctrl** + **F8** shortcut
 - Clicking on the left most side of the source code window
- By default, the breakpoint will hit every time execution reaches the line of the code
- Additional capabilities: condition, hit count, value changed, when hit, filters

Managing Breakpoints

- Managed in the breakpoint window
- Adding breakpoints
- Removing or **disabling** breakpoints
- Open Breakpoints window
 - Ctrl + Shift + F8

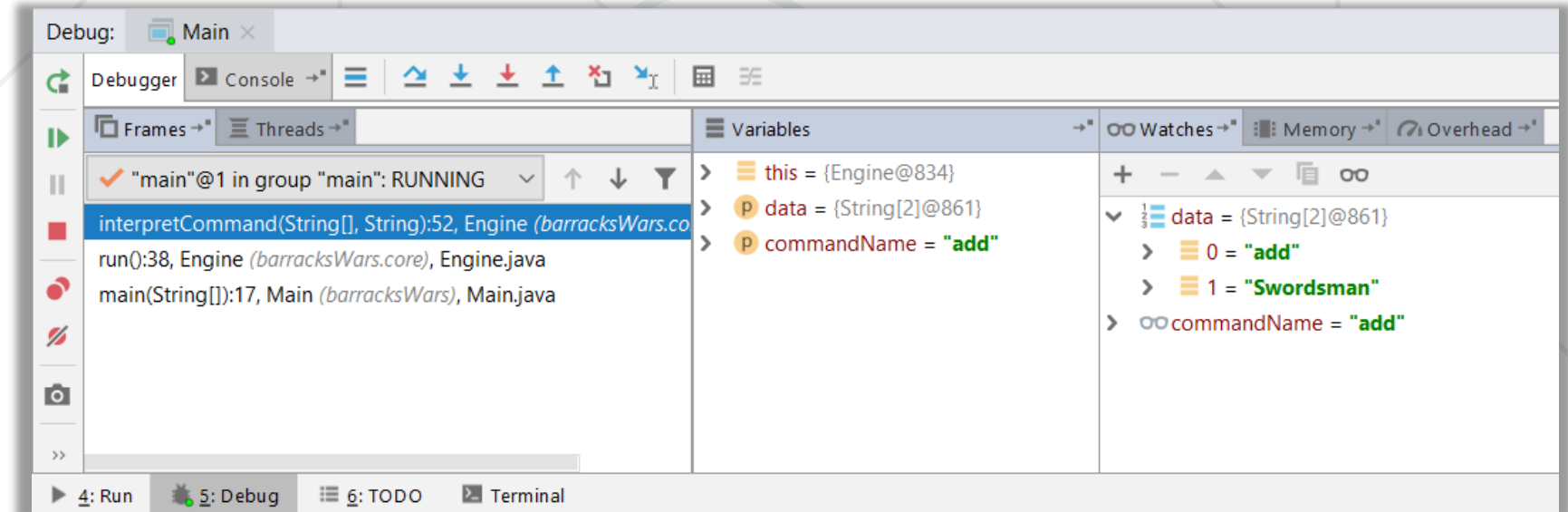




Data Inspection

- Debugging is all about data inspection
 - What are the **local variables**?
 - What is in **memory**?
 - What is the **code flow**?
 - In general - What is the state of the process right now and how did it get there?
- As such, the ease of data inspection is key to the **quick resolution of problems**

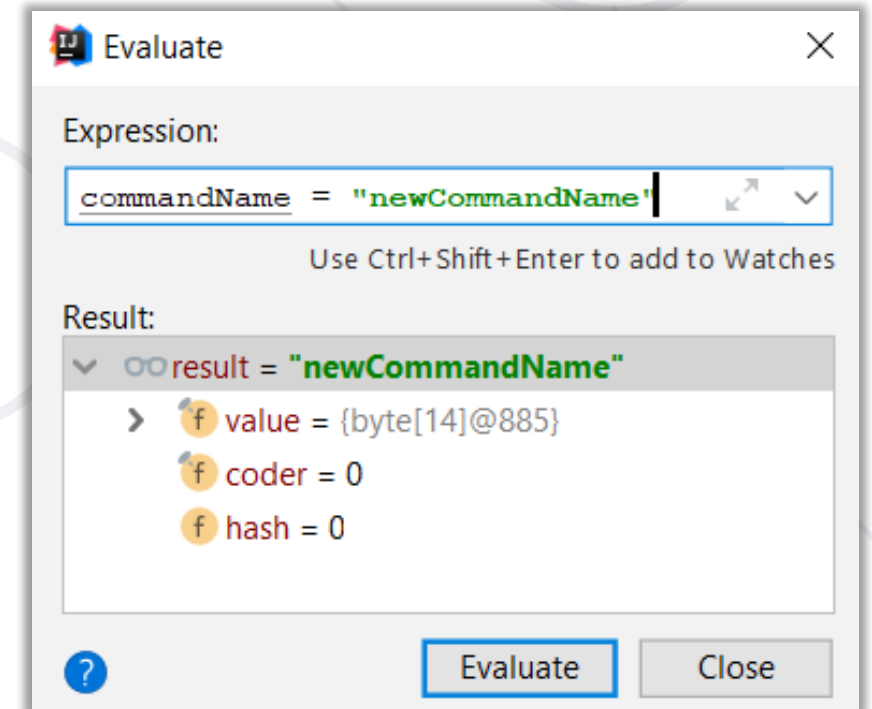
- IntelliJ offers great data inspection features
 - Variables
 - Watches
 - Memory
 - Overhead



- Allows you to inspect various states of your application
- Several different kinds of "predefined" watches window
- "Custom" watches windows are also possible
 - Contains only variables that you choose to add
 - Right click on the variable and select "Add to Watches"
 - Write the variable name in the Watches window

Evaluate Expression Window

- Enables to evaluate expressions and code fragments in the context of a stack frame
- Also evaluate operator expressions, lambda expressions, and anonymous classes
- Shortcut – Alt + F8





Finding a Defect

- Stabilize the error
- Locate the source of the error
 - Gather the data
 - Analyze the data and form a hypothesis
 - Determine how to prove or disprove the hypothesis
- Fix the defect
- Test the fix
- Look for similar errors



Tips for Finding Defects

- Use all available data
- Refine the test cases
- Check unit tests
- Use available tools
- Reproduce the error in several different ways
- Generate more data to generate more hypotheses
- Use the results of negative tests
- Brainstorm for possible hypotheses



Tips for Finding Defects

- Narrow the suspicious region of the code
- Be suspicious of classes and routines that have had defects before
- Check code that's changed recently
- Expand the suspicious region of the code
- Integrate incrementally
- Check for common defects
- Talk to someone else about the problem
- Take a break from the problem

Fixing a Defect

- Understand the problem before you fix it
- Understand the program, not just the problem
- Confirm the defect diagnosis
- Relax
- Save the original source code
- Fix the problem, not the symptom
- Make one change at a time
- Add a unit test that exposes the defect
- Look for similar defects

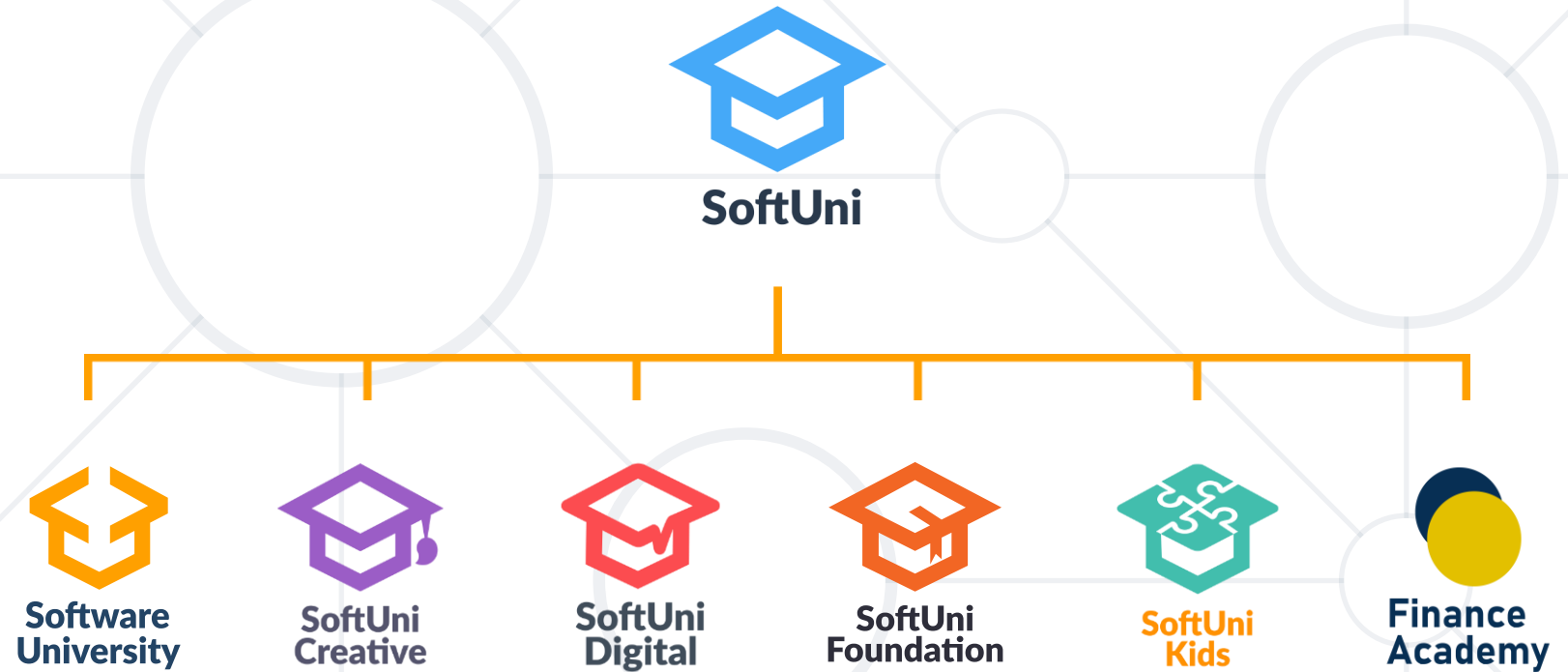


- Your ego tells you that your code is good and doesn't have a defect even when you've seen that it has
- How "psychological set" contributes to debugging blindness
 - People expect a new phenomenon to resemble similar phenomena they've seen before
 - Do not expect anything to work "by default"
 - Do not be too devoted to your code – establish psychological distance

- Introduction to **Debugging**
- IntelliJ IDEA Debugger
- **Breakpoints**
- Data Inspection
 - **Variables, Watches, Frames**
- Finding a **Defect**



Questions?



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