SomeTitle

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Abstract

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1 Introduction

New students may find programming in general, and object oriented programming in particular, difficult. The understanding of computers, and how they work, is not given a lot of focus in the school system, and only a few students have actually tried learning programming before coming to the university. With little or no previous knowledge, it can be hard to understand the concepts, and to get a mental model of what is going on when writing a program. Especially code not written by themselves, for example exercise frameworks, and code generated by various tools, can be hard to get a good understanding of. Traditional debuggers are not necessarily helping when detecting a runtime error, and often significant amounts of time is spent searching for the cause of a bug, instead of actually fixing it[3]. Tools that present the state of a program in a simple, visual way may help to understand how a program works, and how its components interact with each other.

During the second year of the computer science study at NTNU, there is an increased focus on projects and more complex software. Among the mandatory courses, ... Learning goals for MMI-course (man-machine-interaction):
Introduce the student to concepts, methods and techniques for designing man-machine-interfaces, knowledge and skills in object oriented construction of graphical window-based interfaces.

Will such tools be useful in helping students to reach the learning goals of MMI and other beginner-courses? Are existing tools good enough? If not, can something be modified to better fit the purpose?

2 Task Description

Examine whether tools like JIVE can be used to aid students with their understanding of programming, and software structures. Attempt to identify changes that may be necessary e.g. default configuration, handling of visual models, performance. Which changes are actually possible to do? How to do them?

3 Prestudy

3.1 Methods

There are several ways a debugger can aid the programmer beyond just showing the current state of a program at a breakpoint chosen before running. For a fresh programmer, either in general, or at a certain project, the most useful method is probably to generate diagrams that visualize the current state, and the path of execution. I.e. some form of object-, and/or sequence–diagram. Such diagrams can make it easier to get an overview of a programs current state, see the contents of objects and how they relate to each other, and to understand how the various components work together.

In order to generate the diagrams, the tools can analyze both the source-code, and an execution trace, depending on the type of diagrams to generate. For a general overview, a class diagram, showing how object types are composed, can be generated by simply analyzing the source code. But in order to get a more specific view, for example of how the different components interact, an analysis, either in real-time or from an execution trace, of a running program is needed. Such an analysis can be used to generate object diagrams that show how objects interact and what values they have at a given time. One can also get a sequence diagram, showing what methods were called, and in what order.

Execution traces can also be used to enable backwards stepping of program execution. Stepping back in time allows the user to not only see the failure state of a program, but to go back and see what caused the problem, instead of adding a new breakpoint and running the program again. Each reverse step can be fairly cheap, but it may still be impractical to make large jumps in the execution history.

One can avoid the potential disadvantages of manual backstepping by using queries instead. Queries enable the user to asks the debugger about the current and earlier states of execution in a simple way. The debugger then does the work of finding what was asked for, instead of the user manually searching through the program states.

3.2 Existing Tools

There currently exists several tools that provide one or two of the methods mentioned above. GDB offers a tracing environment, but due to its command-line interface it is not necessarily easy to use on its own. The Trace Viewer Plugin[4] for g-eclipse, uses a trace to generate visualizations of the program execution, and thus makes it easier to understand, but is designed for massive parallelism, and may not be very useful for understanding smaller programs. Whyline[2], and the Trace-Oriented Debugger[7] also utilize execution traces, but use them to enable querying, instead of providing visualizations. Additionally, Whyline exists only as a separate application, and does not integrate into any IDE.

JAVAVIS[5] provides visualizations in the form of UML-diagrams, but does not provide any debugging features. Code Canvas uses an interesting way of visualizing an entire project, everything from source-code to design documents and diagrams are layered onto a large canvas, allowing easy navigation between various elements, but is restricted to Microsoft Visual Studio. Jinsight[6] is a powerful tool built by IBM, supporting both tracing and visualization. However, it is restricted to z/OS and linux on system Z, preventing most people from using it.

JIVE seems to be the only tool that utilizes all three methods, as well as being freely available as a plugin for eclipse, making it easy to install and use. During program executiion, Jive generates a contour diagram[1], and a sequence diagram. Combined with an execution trace, it allows the user to jump back and forth in the execution, and have the diagrams updated accordingly. Querying is supported through the JQL, and is accessed trough a simple graphical interface with templates for the most common queries, as well as a text-field allowing the user to write any kind of query.

Due to all the extra work being done when using jive to debug a program, the performance is not always acceptable. For small non-interactive programs, the added waiting time may not be a problem, but larger programs may suffer from a significantly longer execution time, and even simple interactive programs can use up to a second to respond to input on a fairly powerful computer.

4 Conclusion

Glossary

Breakpoint A source code marker telling the debugger to halt program execution at a certain point. 4

Code Canvas A visualization-tool for Microsoft visual studio, showing code, diagrams and documents on a large layered ccanvas. 4

Contour diagram An enhanced object diagram, showing objects, their variables and their relations to other objects[1][8]. 4

Execution trace A log of all changes to the state of a program throughout its execution. 4

GDB GNU debugger. A multiplatform, multilanguage CLI-debugger with tracing. http://www.sourceware.org/gdb/. 4

IDE Integrated Development Environment. A software application that provides facilities for software development such as source code editor, compiler etc. 4

JAVAVIS Tool that generates UML diagrams from running java applications[5]. 4

Jinsight An advanced debugger made by IBM, supports visualization, and powerful analysis[6]. 4

JIVE An advanced debugging tool supporting visualisation, backward stepping, and querying. http://www.cse.buffalo.edu/jive/. 4

JQL Jive Query Language, used to formuate queries within the jive debugging environment. 5

Trace Viewer Plugin Tool to visualize and analyze communication of parallel message passing programs
citeKranzlmuller. 4

Trace-Oriented Debugger Trace-Oriented Debugger. A debugging tool that executes queries on program traces[7]. 4

Whyline A query-based debugger that provides an easy way to find out why things are as they are[2]. 4

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