Dipl.-Ing. Christoph Pichler, BSc.
Institute for System Software

T +43 732 2468 4349
F +43 732 2468 4345
christoph.pichler@jku.at

Secretary:
Karin Gusenbauer
Ext 4342
karin.gusenbauer@jku.at

Bachelor's Thesis

Extending Sulong's Debug Expression Evaluation for C++ Expressions

Student: Halil Bahar

SKZ/Matr.Nr.:   521/k********

Email: -

Advisors: Dipl.-Ing. Christoph Pichler, Bsc

                      o.Univ.-Prof. Dipl.-Ing. Dr.Dr.h.c. Hanspeter Mössenböck

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Sulong[1],[2] is an interpreter for LLVM IR, an intermediate representation of source code that can be produced by the Clang[3] compiler for C/C++ code. It is based on the Truffle[4],[5] framework for implementing interpreters for programming languages and part of the GraalVM[6] project. In addition to executing programs that were compiled to LLVM IR, Sulong also supports Truffle's framework for program instrumentation and debugging to allow users to debug these programs at source-level. At the moment, this debugging support is limited to a subset of commands of the C language.

As C++ uses some advanced concepts such as method overloading or dynamic binding, symbol names or parameters of the LLVM bitcode (output of Clang) differ from those in the C++ source code. This prevents Sulong's existing expression evaluation to correctly evaluate debug expressions.

The goal of this thesis is to adjust and extend Sulong's existing debug expression evaluation to C++ features, such that using the evaluation of C++ expressions in the debugger is possible. This allows C++ developers to more effectively inspect and understand the current program state.

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1   Manuel Rigger, Roland Schatz, René Mayrhofer, Matthias Grimmer, and Hanspeter Mössenböck. 2018. Sulong, and Thanks for All the Bugs: Finding Errors in C Programs by Abstracting from the Native Execution Model. SIGPLAN Not. 53, 2 (February 2018), 377–391. https://doi.org/10.1145/3296957.3173174
2   https://github.com/oracle/graal/tree/master/sulong
3   https://clang.llvm.org/
4   Thomas Würthinger, Christian Wimmer, Andreas Wöß, Lukas Stadler, Gilles Duboscq, Christian Humer, Gregor Richards, Doug Simon, and Mario Wolczko. 2013. One VM to rule them all. In Proceedings of the 2013 ACM international symposium on New ideas, new paradigms, and reflections on programming & software (Onward! 2013). Association for Computing Machinery, New York, NY, USA, 187–204. https://doi.org/10.1145/2509578.2509581
5   https://github.com/oracle/graal/tree/master/truffle
6   https://www.graalvm.org/

Goals of this thesis are:

- Inspecting the differences between C++ source code and the produced LLVM bitcode, especially name mangling and (statically and dynamically bound) object methods.
- Extending Sulong's existing infrastructure to evaluate C++ method calls in the debugger. This contains at least C++ functions and (statically and dynamically bound) object methods.
- Providing a test-suite to demonstrate and verify the functionality of the expression evaluation engine for C++ expressions.
- The code written as part of this thesis is intended to be merged into the Sulong project, therefore it must meet the project's standards with respect to code quality, documentation and test coverage. The code must also be able to pass the Sulong project's requirements for being merged[7].

Optional goals of this thesis are:

- Extending Sulong's existing infrastructure to evaluate C++ expressions in the debugger containing features of C++ not listed above

Explicit non-goals of this thesis are:

- Full support for expressions of all C++ language features

Modalities

The progress of the project should be discussed at least every two weeks with the advisor. A time schedule and a milestone plan must be set up within the first 3 weeks. It should be continuously refined and monitored to make sure that the thesis will be completed in time. The final version of the thesis must be submitted not later than April 30, 2025.

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[7] https://github.com/oracle/graal/tree/master/sulong/docs/contributor