Aiding Library Writers in Optimizing the Use of High-Level Abstractions in Scientific Applications *

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Abstract

ROSE is a programmable source-to-source transformation tool for the optimization of C++ object-oriented frameworks. ROSE applies equally well to any object-oriented application. A common problem within object-oriented C++ scientific computing is that the high level semantics of abstractions introduced (e.g. parallel array objects) are ignored by the C++ compiler. User defined classes, data stuctures, and functions are seen as unoptimizable structures and function calls. Such abstractions can provide for particularly simple development of large scale parallel scientific software, but the lack of optimization greatly effects performance and utility. ROSE represents a mechanism to build preprocessors that read the user's application source code and output highly optimized C++ code. The output from a preprocessor build from ROSE is itself C++ code (but transformed using the semantics of the object-oriented abstractions represented within the framework). The result is a compile time mechanism that leverages any vendor's compiler, but provides for highly specialized optimizations and thus better performance. The effect is to treat a library as a domain-specific language with all the opportunities for optimizations that only a library-specific compiler can bring to bare.

The heart of the mechanism within ROSE is the construction of multiple high-level grammars to define essentially high-level languages that are the union of the C++ language with a library's abstractions. The high-level grammars simplify the recognition of user-defined abstractions within an application's AST. We automate the construction of these high-level grammars, and provide other mechanisms within ROSE to make is easy for library developers to implement library-specific optimizing compilers (source-to-source preprocessors).

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