VERROU: a CESTAC evaluation without recompilation

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As an industrial facility relying on numerical simulation to improve the safety and efficiency of its electricity production units, EDF is committed to ensure that all the numerical simulation codes it develops and uses are correctly validated and verified. Within this context, the accuracy of floating-point operations has progressively become one of the important topics to study, especially since computing codes are exploited on ever more powerful hardware to solve ever larger problems. The Verification and Validation (V&V) process should therefore include the monitoring of inaccuracies introduced by floating-point arithmetic, as well as the verification that they are kept within acceptable limits.

Numerous tools exist to diagnose floating-point problems, among which CADNA [2] is one of the most advanced. It allows to assess floating-point inaccuracies, detect their origin in the source code, and follow their propagation throughout the computation. To this end, CADNA requires instrumentating the source code to replace standard floating-point arithmetic by Discrete Stochastic Arithmetic (DSA), which is based on a synchronous CESTAC [4] method. CADNA has already been successfully used on large industrial simulation codes [3], but instrumenting the source code of such tools can be hard, as there generally are numerous dependencies to third-party software libraries of which the development team only has limited understanding.

We present the VERROU tool, a valgrind-based system which implements an asynchronous CESTAC method to monitor the accuracy of floating-point operations without needing to instrument the source

code or even recompile it. This tool is therefore well-suited to be part of an industrial V&V process. It has been successfully tested both on small-scale, well understood numerical applications, and on large-scale, more complex industrial computing codes such as Athena [1] which is used to simulate the propagation of ultrasonic waves in steel welds.

References:

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