Parallel Paradigms for Experimental Mathematics

Elise de Doncker, Western Michigan University

It is common practice to layer parallel methods over a platform that provides the necessary interface with the underlying architecture. Such platforms include MPI (Message Passing Interface) that supports paradigms based on interprocess communication, on architectures that range from personal workstations to clusters, and to large distributed systems on local area or wide area networks. On individual nodes of the network, the OpenMP system may be used for multithreading on the cores. Furthermore, with the advent of coprocessors such as GPUs (Graphics Processing Units), the CUDA (Compute Unified Device Architecture) language allows for program acceleration on thousands of CUDA cores or streaming processors on Nvidia GPU boards.

Applications will be presented based on multivariate integration/cubature, e.g., to Feynman loop integrals in high energy physics, and problems in computational geometry. Results have been obtained for multivariate adaptive integration algorithms implemented on MPI, iterated multithreaded adaptive integration on OpenMP, and Monte Carlo type methods on GPUs programmed using CUDA C. Apart from the integral approximation result, the Monte Carlo integrator returns a variance based error estimate, and a condition number to gauge the number of digits lost in the computation. The choice of the random number generator and the effects of special summation techniques will be addressed. Features of CUDA-5.0 and CUDA-6.0 will also be illustrated.