Enabling Sparse Matrix Computation in Multi-locale Chapel

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***Abstract*—Solving large sparse systems of linear equations is at the core of many problems in scientific computing. Conjugate Gradient (CG), an iterative method, is one of the prominent techniques for solving such systems of the form Ax = b. In addition to many scientific applications, CG is also chosen for high performance benchmarks, i.e. to evaluate the performance of massively parallel computing systems. Traditionally, MPI (Message Passing Interface) based libraries are used to implement CG algorithms, but a new wave of partitioned global address space (PGAS) languages like Chapel are naturally fit for the task. Chapel seeks to provide syntactic and library support for a variety of parallel-programming concepts wherein data-parallel applications are supported via the concepts of domains and distributions. Unlike 'arrays' of traditional languages, Chapel domains are used to represent sets of indices and distributions provide a storage representation for domains, along with their associated arrays of data.**

Chapel's native support for sparse data, the Compressed Sparse Row (CSR) distribution, currently lacks multi-locale support. In this paper, we present MSBD, a multi-locale sparse block distribution for Chapel, which enables distribution and access of compressed sparse arrays over a multi-locale cluster of Chapel nodes. The basic idea of MSBD is to use fixed block partitioning as a method to distribute the sparse domain and its data, where only the non-zero/not-empty indices are stored on each locale. The performance of MSBD is evaluated using a Chapel port of a popular high performance benchmark CG algorithm.

Keywords: **Sparse matrix, Conjugate gradient, PGAS, Chapel, Compressed sparse row, Sparse block distribution.**

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