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Domain-Specific Abstractions for High-Productivity, High-Performance Scientific Computing

The task of developing software for high-performance scientific computing is becoming increasingly difficult due to deepening memory hierrachy and architectural heterogeneity (e.g. multicore CPU's and GPU's). A promising approach to addressing this problem is the development of domain-specific abstractions that are both convenient for application developers as well as amenable to automated compiler transformation for efficient execution on different targets.

The talk will briefly describe two efforts in this regard: 1) Tensor Contraction Engine, a domain-specific compiler for a class of tensor expressions arising in quantum chemistry, and 2) Pluto, a source-to-source compiler for automatic parallelization and data-locality optimization of affine loop nests.

A main question of interest is: Can we define convenient and useful abstractions for the domain of tensor computations that can be automatically transformed for efficient parallel execution?