Dynamic Data Shapers Optimize Performance in Dynamic Binary Optimization (DBO) Environment

Processor hardware has been architected with the assumption that most data access patterns would be linearly spatial in nature. But, most applications involve algorithms that are designed with optimal efficiency in mind, which results in non-spatial, multi-dimensional data access. Moreover, this data view or access pattern changes dynamically in different program phases. This results in a mismatch between the processor hardware's view of data and the algorithmic view of data, leading to significant memory access bottlenecks. This variation in data views is especially more pronounced in applications involving large datasets, leading to significantly increased latency and user response times. Previous attempts to tackle this problem were primarily targeted at execution time optimization.

We present a dynamic technique piggybacked on the classical dynamic binary optimization (DBO) to shape the data view for each program phase differently resulting in program execution time reduction along with reductions in access energy. Our implementation rearranges non-adjacent data into a contiguous dataview. It uses wrappers to replace irregular data access patterns with spatially local dataview. HDTrans, a runtime dynamic binary optimization framework has been used to perform runtime instrumentation and dynamic data optimization to achieve this goal. This scheme not only ensures a reduced program execution time, but also results in lower energy use. Some of the commonly used benchmarks from the SPEC 2006 suite were profiled to determine irregular data accesses from procedures which contributed heavily to the overall execution time. Wrappers built to replace these accesses with spatially adjacent data led to a significant improvement in the total execution time. On average, 20% reduction in time was achieved along with a 5% reduction in energy.