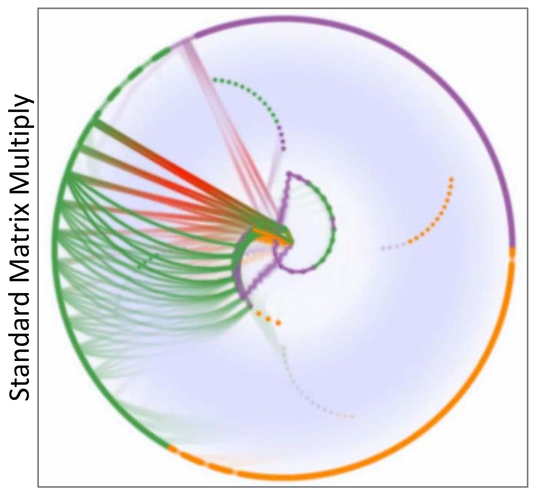
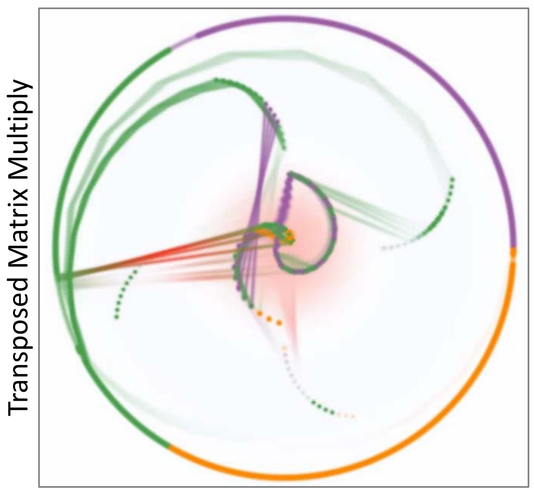
Visualization Approaches for Performance Analysis of Massively Parallel Applications

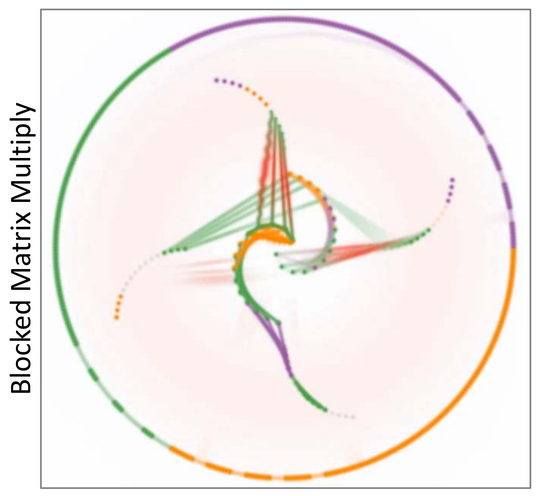
Paul Rosen, A.N.M. Imroz Choudhury, Bei Wang, and Valerio Pascucci

Abstract Visualization of Runtime Memory Behavior

We present a system for visualizing memory reference traces using a structured layout representing the levels of a cache and a set of glyphs representing the pieces of data in memory. The glyphs move in response to events generated by a cache simulator. Within the levels, the glyphs arrange themselves into shapes representing the structure of the cache levels. We make careful use of the various visual channels, including structure, motion, color, and size, to convey salient events as they occur. Our visualization provides a high-level, global view of memory behavior, while giving insight about important events that may assist engineers in better understanding software performance.



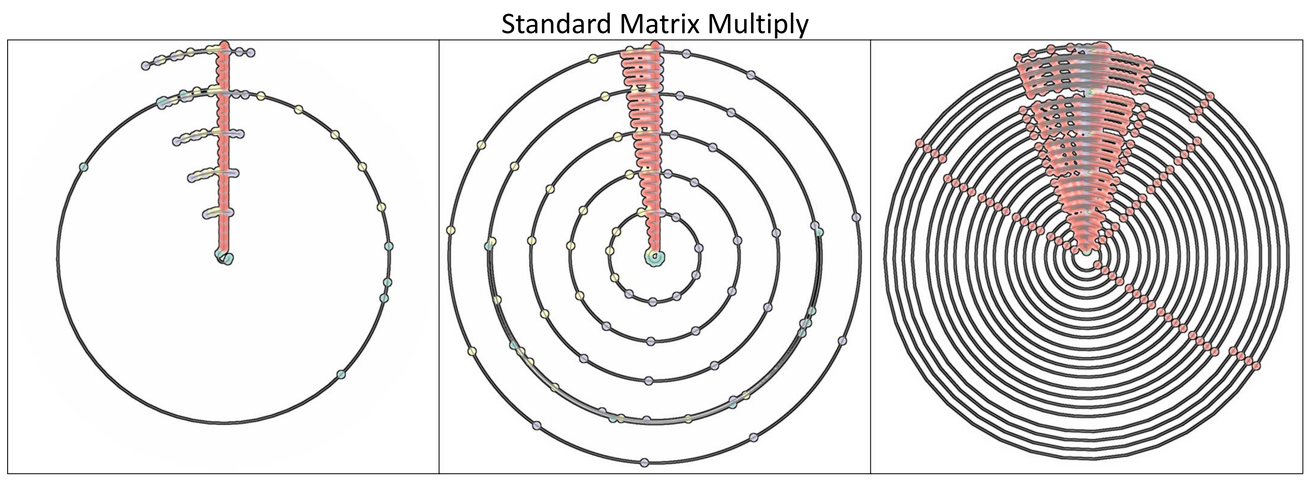


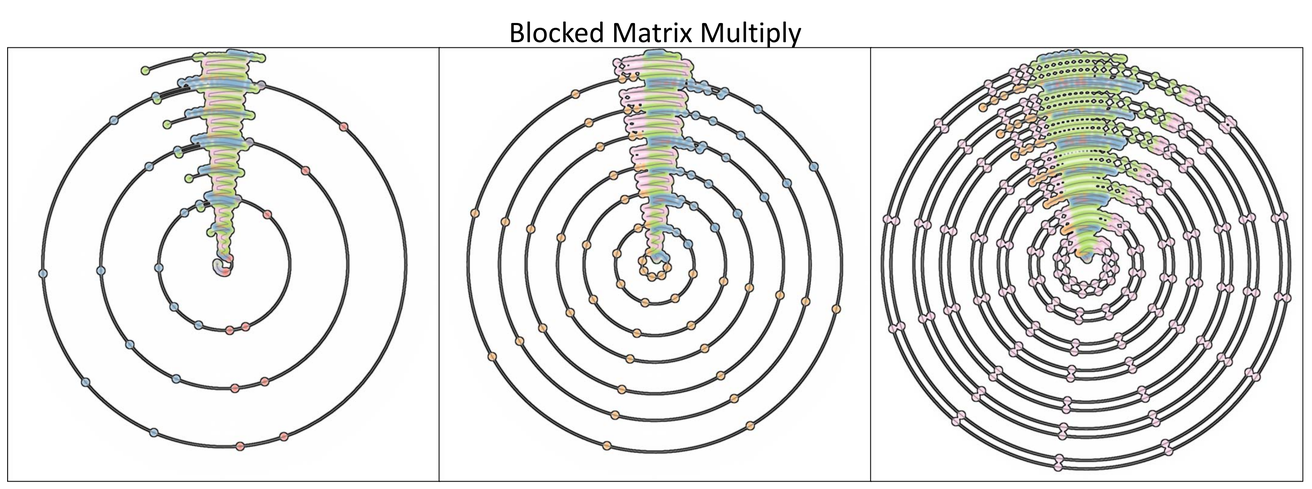


A.N.M. Imroz Choudhury, Paul Rosen. **"Abstract Visualization of Runtime Memory Behavior,"** *IEEE International Workshop on Visualizing Software for Understanding and Analysis (VISSOFT 2011)*, pp. 22-29. 2011.

Topological Analysis and Visualization of Cyclical Memory Reference Behavior

We demonstrate the application of topological analysis techniques to the rather unexpected domain of software visualization. We collect a memory reference trace from a running program, recasting the linear flow of trace records as a high-dimensional point cloud in a metric space. We use topological persistence to automatically detect circular structures in the point cloud, which represent recurrent or cyclical runtime program behaviors. We visualize such recurrences using radial plots to display their time evolution, offering multi-scale visual insights, and detecting potential candidates for memory performance optimization. We then present several case studies to demonstrate some key insights obtained using our techniques.

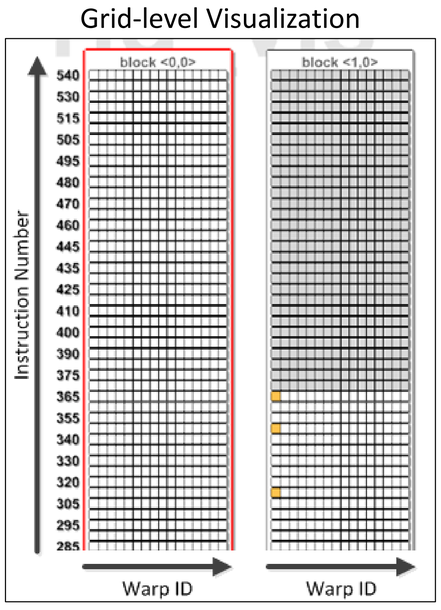


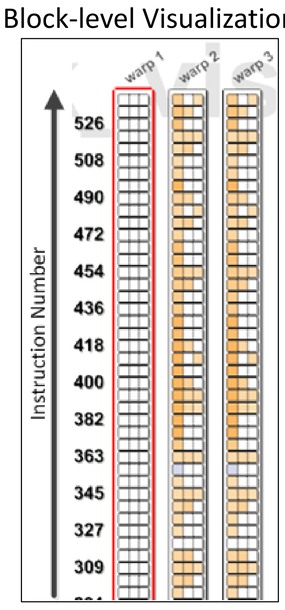


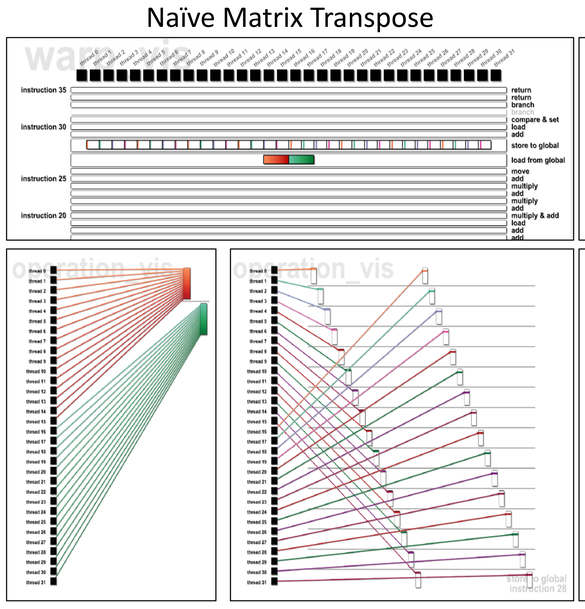
A.N.M. Imroz Choudhury, Bei Wang, Paul Rosen, Valerio Pascucci, **"Topological Analysis and Visualization of Cyclical Behavior in Memory Reference Traces,"** In *IEEE Pacific Visualization Symposium (PacificVis)*, pp. 9-16, 2012.

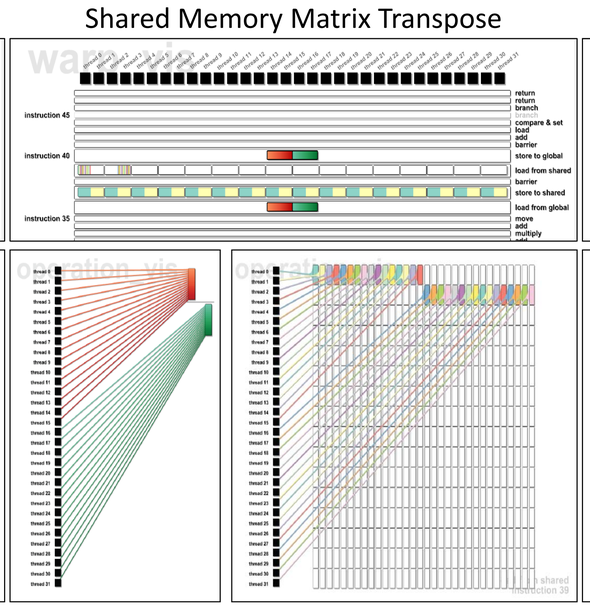
A Visual Approach to Investigating Shared and Global Memory Behavior of CUDA Kernels

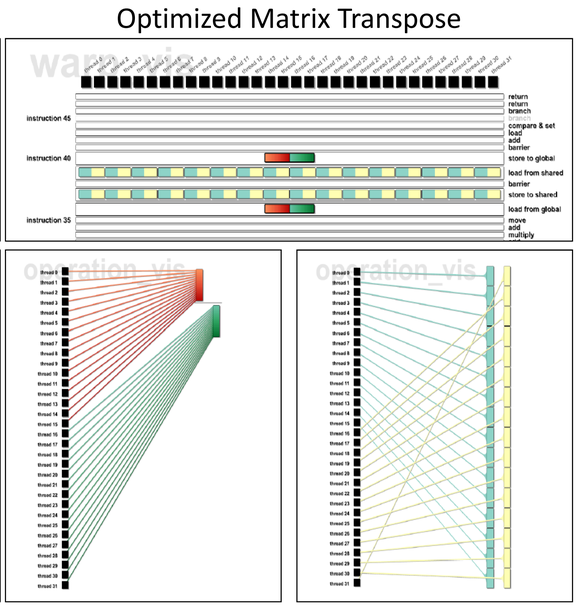
We present an approach to investigating the memory behavior of a parallel kernel executing on thousands of threads simultaneously within the CUDA architecture. Our top-down approach allows for quickly identifying any significant differences between the execution of the many blocks and warps. As interesting warps are identified, we allow further investigation of memory behavior by visualizing the shared memory bank conflicts and global memory coalescence, first with an overview of a single warp with many operations and, finally, with a detailed view of a single warp and a single operation.











Paul Rosen, **"A Visual Approach to Investigating Shared and Global Memory Behavior of CUDA Kernels,"** Under review.