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An Application-Specific Microbenchmark for Memory Access

Mahesh Lakshminarasimhan



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Mahesh Lakshminarasimhan, Dr. Catherine Olschanowsky

Department of Computer Science

BOISE STATE UNIVERSITY

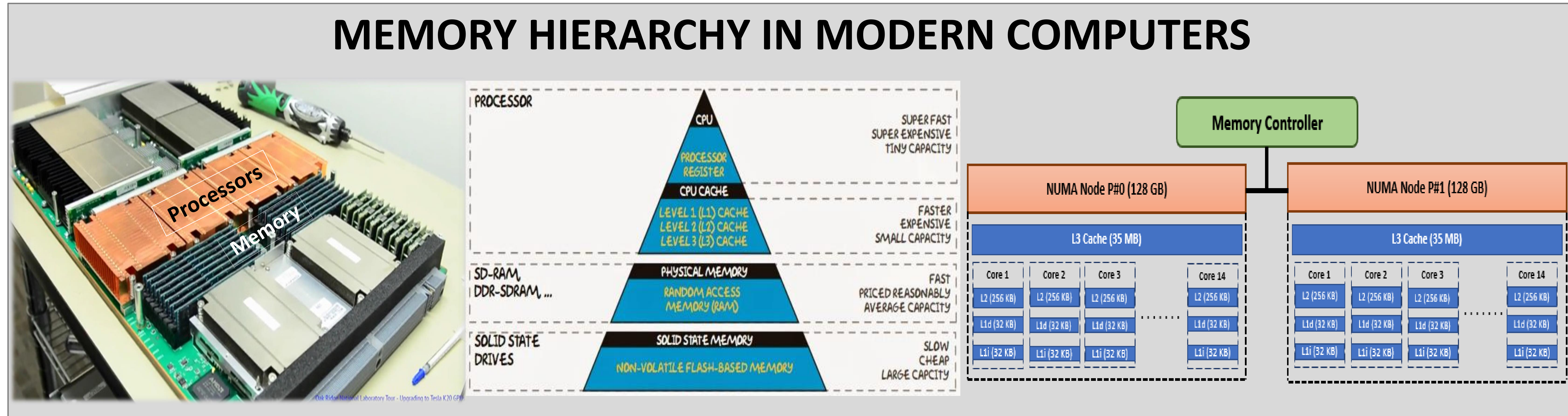
MOTIVATION

Benchmarking High Performance Computing Systems is essential to maximize scientific application performance. We present a configurable microbenchmark to advise memory optimization strategies for domain scientists.

APPROACH

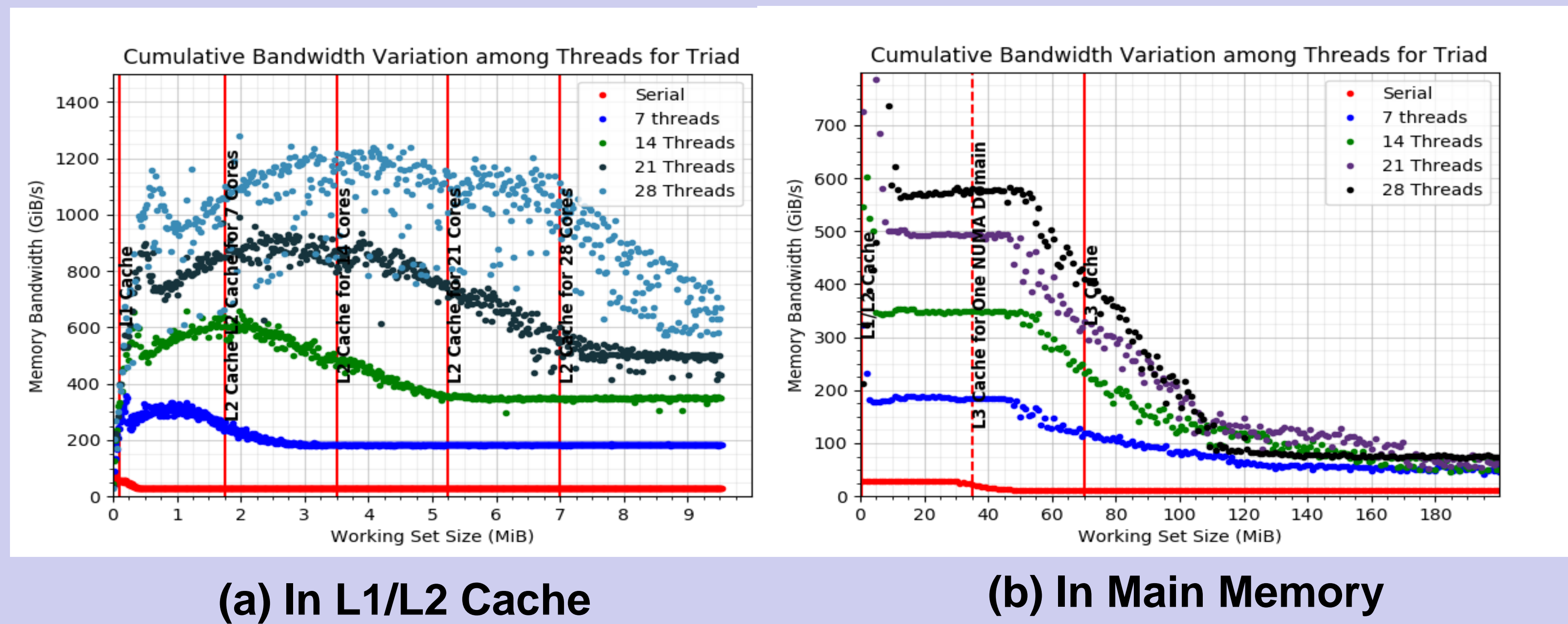
We explore the variation in memory bandwidth with working data set sizes across different levels of memory hierarchy for synthetic and realistic memory access patterns with different thread configurations.

MEMORY HIERARCHY IN MODERN COMPUTERS

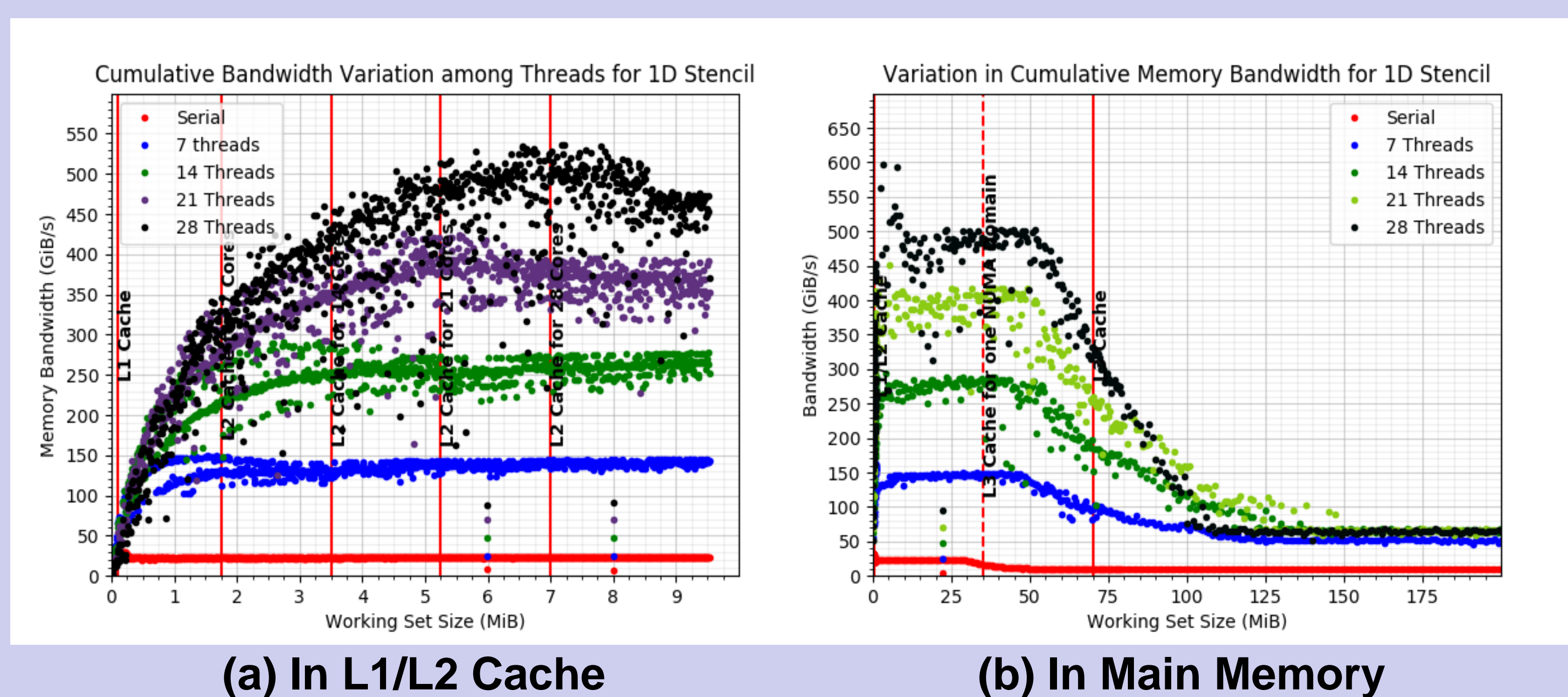


VARIATION IN CUMULATIVE MEMORY BANDWIDTH DUE TO MEMORY ACCESS PATTERNS

1. THE SYNTHETIC TRIAD KERNEL



2. ONE-DIMENSIONAL STENCIL OPERATION



CUSTOM BENCHMARK

CONFIGURATION `<triad_run.c>`

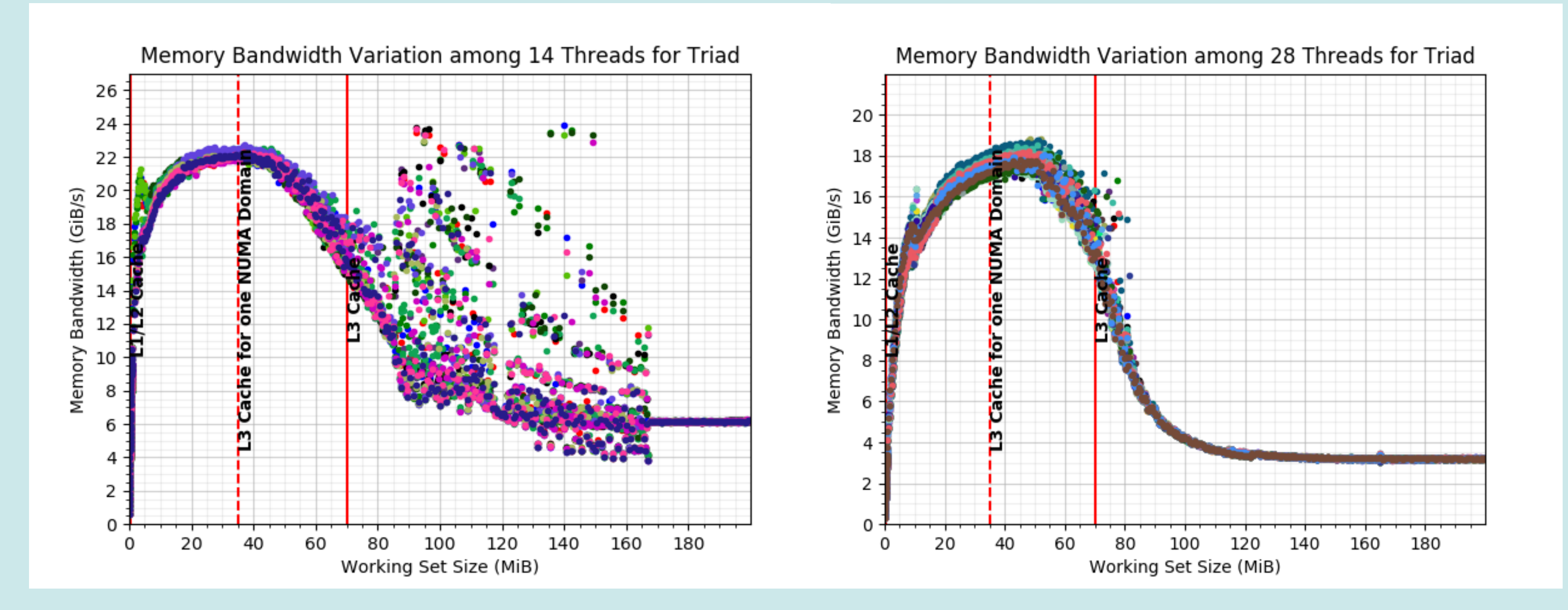
```
for(j=0; j<size; j++){
  a[j] = b[j] + d*c[j];
}
```

BENCHMARK TEMPLATE

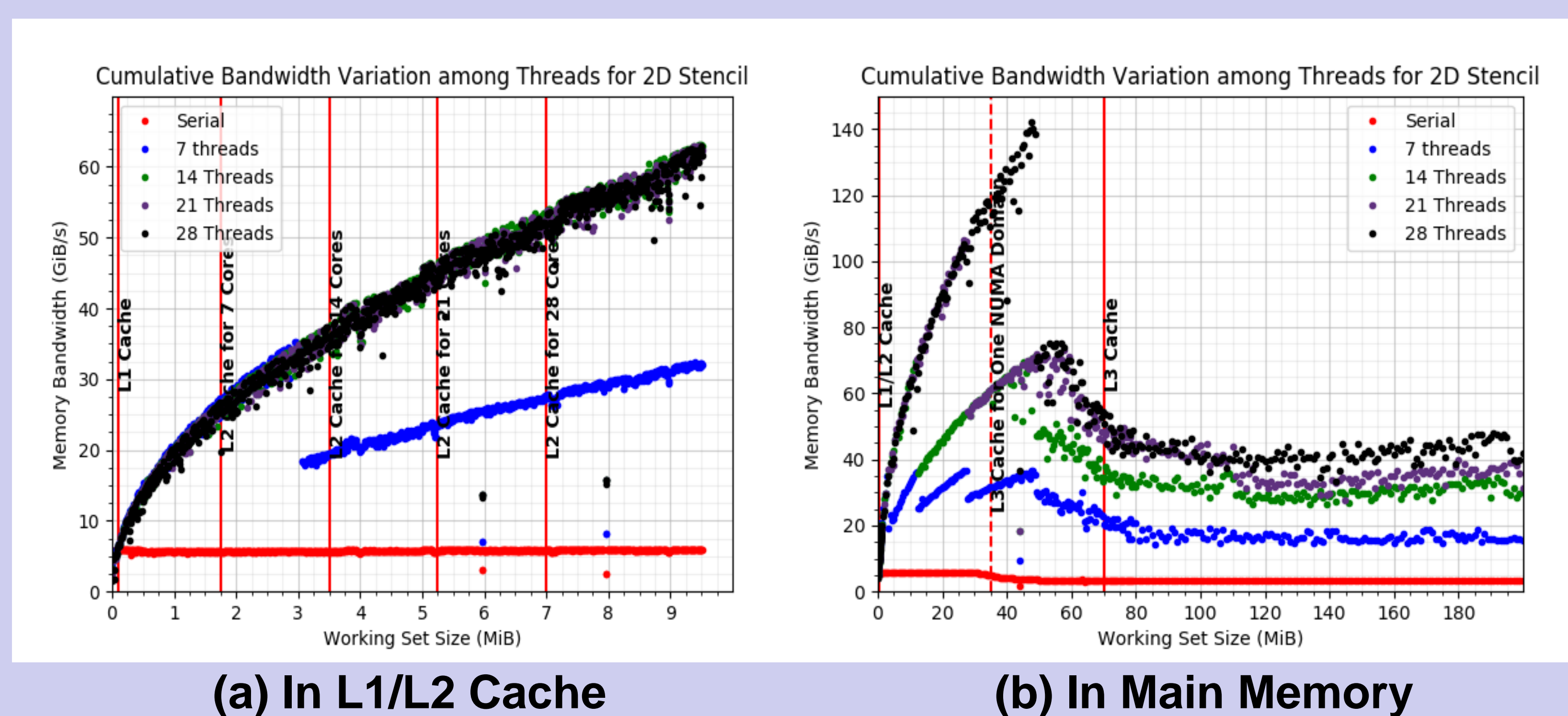
```
for(i=0; i<ntimes; i++){
  #include<triad_run.c>
}
```

PERFORMANCE VARIATION AMONG THREADS – TRIAD

We examine the variation in the memory bandwidth among each thread for 14 and 28 cores on executing the synthetic triad operation.



3. TWO-DIMENSIONAL STENCIL OPERATION



OBSERVATIONS

- Access patterns matter: The synthetic triad outperforms the more realistic multidimensional stencil patterns.
- Stencil operations, especially two dimensional stencil, struggle to scale across all levels of memory hierarchy.
- Some working set sizes are problematic and consistently yield low performance for different access patterns.
- Variation in performance increases when the working set sizes exit cache.