PARSEC vs. SPLASH-2: A Quantitative Comparison of Two Multithreaded Benchmark Suites

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Outline

• Overview
  – What is PARSEC?
  – Why a new benchmark suite?

• Objectives of PARSEC
  – Technology Trend 1: Proliferation of CMPs
  – Technology Trend 2: Change of Technology Constraints
  – Technology Trend 3: Growth of World Data

• Characteristics Analysis
  – Methodology
  – Results

• Conclusions
What is PARSEC?

- Princeton Application Repository for Shared-Memory Computers
- Benchmark Suite for Chip-Multiprocessors
- Started as Joint-Venture between Intel and Princeton University
- Freely available at:

  http://parsec.cs.princeton.edu/

- You can use it for your research

But what distinguishes PARSEC from SPLASH-2?
Requirements for a Benchmark Suite for CMPs

• Multithreaded Applications
  Future programs must run on multiprocessors

• Emerging Workloads
  Increasing CPU performance enables new applications

• Diverse
  Multiprocessors are being used for more and more tasks

• State-of-Art Techniques
  Algorithms and programming techniques evolve rapidly

• Support Research
  Our goal is insight, not numbers
### Assessment of Situation

<table>
<thead>
<tr>
<th></th>
<th>Multithreaded</th>
<th>Emerging Workloads</th>
<th>Diverse</th>
<th>Not HPC-Focused</th>
<th>Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPEC CPU2006</td>
<td>No</td>
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<td>SPEC OMP2001</td>
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<td>SPLASH-2</td>
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<td>ALPBench</td>
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<td>BioBench</td>
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</tbody>
</table>

This is why we created PARSEC
## Workloads

<table>
<thead>
<tr>
<th>Program</th>
<th>Application Domain</th>
<th>Parallelization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackscholes</td>
<td>Financial Analysis</td>
<td>Data-parallel</td>
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<tr>
<td>Bodytrack</td>
<td>Computer Vision</td>
<td>Data-parallel</td>
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<td>Canneal</td>
<td>Engineering</td>
<td>Unstructured</td>
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<td>Dedup</td>
<td>Enterprise Storage</td>
<td>Pipeline</td>
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<td>Facesim</td>
<td>Animation</td>
<td>Data-parallel</td>
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<tr>
<td>Ferret</td>
<td>Similarity Search</td>
<td>Pipeline</td>
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<td>Fluidanimate</td>
<td>Animation</td>
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<td>Swaptions</td>
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<td>Vips</td>
<td>Media Processing</td>
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<tr>
<td>X264</td>
<td>Media Processing</td>
<td>Pipeline</td>
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</tbody>
</table>

PARSEC is substantially different from SPLASH-2
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Objectives of PARSEC

- PARSEC was designed to capture recent technology trends:
  - **Proliferation of CMPs**
    Multiprocessors are used in more and more areas
  - **Change of Technology Constraints**
    Different software optimizations required for CMPs
  - **Growth of World Data**
    Huge increase of stored data which must be processed

- These trends are changing programs
Impact of Technology Trends

- Proliferation of CMPs:
  - New application areas (e.g. video games)
  - New parallelization models (e.g. pipelining)

- Change of Technology Constraints:
  - Constrained off-chip bandwidth
  - Shared caches

- Growth of World Data:
  - Huge increase of input data
  - Higher importance of linear algorithms

We show that these trends affect program characteristics
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Methodology

- Simulate abstract cache hierarchy with CMP$im$
- Preprocess chosen characteristics with Principal Component Analysis (PCA) to eliminate correlation
- Compute similarity with hierarchical clustering
- Visualize results with dendrograms and scatter plots

44 characteristics chosen:
- Instruction mix (4 characteristics)
- Working set (8 characteristics)
- Sharing (32 characteristics)
Redundancy & Similarity

Clustering within SPLASH-2

Clustering of Unique Workloads
Redundancy & Similarity

Clustering of Unique Workloads

Clustering within SPLASH-2

Linkage Distance

d = ~0.42

d = ~0.72
PARSEC is more diverse than SPLASH-2
PARSEC and SPLASH-2 have little in common

Benchmark suites cluster in different areas, little overlap
Instruction Mix Differences

PARSEC workloads use cores differently
Some PARSEC workloads use memory differently
PARSEC workloads communicate differently
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- PARSEC and SPLASH-2 are substantially different benchmark suites
- PARSEC is more diverse
- No single reason for differences

You should expect different results
Thank you!

Questions?