Correlating Sub-Phenomena in Performance Data in the Frequency Domain

Tom Vierjahn1,4, Marc-André Hermanns3,4, Bernd Mohr3,4, Matthias S. Müller2,4, Torsten W. Kuhlen1,4, Bernd Hentschel1,4

1 Visual Computing Institute, RWTH Aachen University, Germany
2 Chair for High-Performance Computing, RWTH Aachen University, Germany
3 Jülich Supercomputing Centre, Forschungszentrum Jülich GmbH, Germany
4 JARA-HPC, Aachen, Germany

1 Introduction
Finding and understanding correlated performance behaviour in high-performance computing applications is
• a time-consuming task, but
• key in understanding and optimization.
Thus, we propose to use
• automatic correlation analysis in the frequency domain
• allowing for filtering-out known sub-phenomena
• in order to detect new, unknown phenomena.

2 Performance Data
• Performance profiles store data (e.g., execution time)
per system resource (e.g., cores, threads, ...).
• These can be arranged in a Cartesian space,
the system topology (e.g., cores x threads)
• Performance data thus constitutes a space domain signal
\( v(x) \) \( x \) : location in the system topology
for which we can compute a spectrum
\( V(k) \) \( k \) : frequency

3 Automatic Correlation Analysis
Pearson correlation
• is sensitive to dominant sub-phenomena,
• weights all data equally,
• obscures new patterns.
Filtered correlation
• has selective sensitivity,
• filters-out known sub-phenomena,
• provides new insights.
Computing filtered correlation
(cosine-weighting, cross-correlation):
\[
W_i^2(k) = \frac{k^2}{k} \quad W_i^2(0) = 0
\]
\[
g_{y,x} = g^{-1} \left[ \sum_i f_i \cdot W_i^2(k) \cdot V_i^2(k) \cdot V_i^2(k) \right] (0)
\]
\[
r_f = \frac{g_{y,a}}{\sqrt{g_{y,a} \cdot 9b,b}}
\]

4 Interactive Visualization, Results
Interactive analysis tool inspired by Cube and ParaProf:
Efficient analysis with little memory overhead:

<table>
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<tr>
<th>Code</th>
<th>Threads</th>
<th>Size</th>
<th>Overhead</th>
<th>Views ≠ 0</th>
<th>Correl. Analysis</th>
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Acknowledgements
This work has been partially funded by the German Federal Ministry of Research and Education (BMBF) under grant number 01IH13001D (Score-E), and by the Excellence Initiative of the German federal and state governments.