Performance Analysis of Effective Symbolic Methods for Solving Band Matrix SLAEs

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Objectives

This paper presents an experimental performance study of implementations of three symbolic algorithms for solving band matrix systems of linear algebraic equations (SLAEs) with heptadiagonal (HD), pentadiagonal (PD) and tridiagonal (TD) coefficient matrices, the latter two of which were introduced and investigated in Veneva and Ayriyan (EPJ-WoC (2018), arXiv:1710.00428v2 and arXiv:1804.09666v1). The only assumption on the coefficient matrix is nonsingularity. These algorithms are implemented using the GInaC library of C++ and SymPy library of Python. Performance analysis of the implementations is done using the high-performance computing (HPC) platforms “HybriLIT” and “Avitohol”. To that purpose, the experimental setup and the results from the conducted computations on the individual computer systems are presented and discussed.

Investigated Methods

- SHDM: based on LU decomposition;
- SPDM: based on LU decomposition [1];
- STDM: symbolic Thomas method [2];
- implementations:
  - C++ and GInaC library;
  - Python and SymPy library;
- 5 different classes for data storing;
- assumptions on the coefficient matrix nonsingularity.

Experimental Setup

- Computer systems:
  - heterogeneous computational platform “HybriLIT” at LIT, JINR in Dubna, Russia (http://hlt.jinr.ru/en/);
  - cluster computer system “Avitohol” at ACDC. HICT, BAS in Sofia, Bulgaria (http://www.hpc.acad.bg/);

Software

- Software “HybriLIT” “Avitohol”
  - OS
  - Scientific Linux 7.4
  - Red Hat Linux
  - Compilers
  - GCC (4.9.3)
  - GCC (6.2.0)
  - Libraries
  - GInaC (1.7.2), CLN (1.3.4)
  - Optimization -OO
  - Version
  - Anaconda (5.0.1); Py2.7
  - Library
  - SymPy (1.1.1)

Results – “HybriLIT”

<table>
<thead>
<tr>
<th>Implementation</th>
<th>Processor</th>
<th>Rpeak [TFlop/s]</th>
<th>FREQ [GHz]</th>
<th>Cache [MB]</th>
</tr>
</thead>
<tbody>
<tr>
<td>“HybriLIT”</td>
<td>Intel Xeon E5-2605v2</td>
<td>500</td>
<td>2.4</td>
<td>30</td>
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<tr>
<td>“Avitohol”</td>
<td>Intel Xeon E5-2605v2</td>
<td>412.32</td>
<td>2.6</td>
<td>20</td>
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</tbody>
</table>

Results – “Avitohol”

<table>
<thead>
<tr>
<th>Implementation</th>
<th>Processor</th>
<th>Wall-clock time [s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>“HybriLIT”</td>
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<td>“Avitohol”</td>
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