Software Support for Regular and Irregular Applications in Parallel Computing

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Regular & Irregular Application

- Control structures
- Data structures
- Communication patterns

Innovation from Software

- Programming model
- Runtime
- Compiler
Application Specific Acceleration

Integral Histogram

Multiple Pairwise NW
Equation-based Programming Model

\[ H(x, y, b) = \sum_{i=0}^{x} \sum_{j=0}^{y} Q((i, j), b) \]

Integral Histogram

\[ M(i, j) = \max \begin{cases} 
M(i-1, j-1) + S(x_i, y_j) \\
M(i-1, j) + G \\
M(i, j-1) + G 
\end{cases} \]

Needleman-Wunsch

\[ C(i, j) = \sum_{k=0}^{n} A(i, k) \times B(k, j) \]

Matrix Multiplication
Adaptive Runtime for Graph Algorithm

<table>
<thead>
<tr>
<th>Network</th>
<th>#Nodes</th>
<th>#Edges</th>
<th>Node Outdegree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>min</td>
</tr>
<tr>
<td>CO-road</td>
<td>435,666</td>
<td>~1M</td>
<td>1</td>
</tr>
<tr>
<td>CiteSear</td>
<td>434,102</td>
<td>~16M</td>
<td>1</td>
</tr>
<tr>
<td>P2p</td>
<td>36,692</td>
<td>~0.18M</td>
<td>0</td>
</tr>
<tr>
<td>Amazon</td>
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<td>~1.7M</td>
<td>0</td>
</tr>
<tr>
<td>Google</td>
<td>739,454</td>
<td>~2.5M</td>
<td>0</td>
</tr>
<tr>
<td>SNS</td>
<td>4,308,452</td>
<td>~34.5M</td>
<td>0</td>
</tr>
</tbody>
</table>

Graph API

Graph Inspector

Runtime

Decision Maker

Libraries

BFS

SSSP