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Intra-Query Parallelism for Multidimensional Array Data

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Multidimensional Discrete Data (MDD)

Example: 3D MDD Simulation Data (© Max-Planck-Institute for Meteorology)

- Dimensionality: 3
- Domain: 128 x 64 x 120 cells
- Cells: Temperature (float)

Collection of 64 3D MDD

‘Get max temperature of MDD where average in AOI exceeds threshold’

```
SELECT max_cells(mpim)
FROM mpim, mask
WHERE avg_cells(mpim*mask) > 293.0
```
ESTEDI Parallelism Hierarchy

Parallel Query Processing

Intra-Query
parallel execution of single query

MDD-based
distribution of complete objects

Inter-Query
parallel execution of a set of queries

Tile-based
partitioning of objects

TODO
MDD-Based Data Parallelism

Master Process
- Client-Server Communication
- Load Balancing

Several Worker Processes
- Multidimensional Operations
- Utilisation of Cached Objects

Tuple Server Process
- Central Administration of Multidimensional Objects
- Allocation on Demand
First Measurements (2CPUs)

Response time of CPU-bound queries

<table>
<thead>
<tr>
<th>Queries</th>
<th>Time [sec]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original RasDaMan</td>
<td>0, 10, 20, 30, 40, 50, 60, 70, 80</td>
</tr>
<tr>
<td>Parallel RasDaMan</td>
<td>0, 10, 20, 30, 40, 50, 60, 70, 80</td>
</tr>
</tbody>
</table>

Speed-up of queries

<table>
<thead>
<tr>
<th>Queries</th>
<th>Speed-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed-up on server</td>
<td>0, 0.5, 1, 1.5, 2, 2.5</td>
</tr>
<tr>
<td>Speed-up on client</td>
<td>0, 0.5, 1, 1.5, 2, 2.5</td>
</tr>
</tbody>
</table>
Outlook

Further Measurements
- SMP computers with up to 16 CPUs
- Linux cluster with up to 80 nodes

Tile-based parallelism
- Partitioning strategy (regarding tiling)
- Adaptation of multidimensional operations

Dynamic query execution control
- What parallelism (MDD vs. tile-based) to use in this query
- (Multidimensional) data distribution in a workstation cluster