LOCALLY REFINED SPLINE REPRESENTATIONS FOR GEOSPATIAL BIG DATA

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Observation: When viewed from distance, large parts of the topography of landmasses and the bathymetry of the sea and ocean floor can be regarded as a smooth background with local features.
At each iteration level either of two approximation methods can be employed:

1. Least squares approximation with a smoothing term
2. Multilevel LR B-spline approximation

Method 1 used for the first levels, then method 2.
A tolerance of 0.5 m, and six levels of iterations give a refinement that provides enough detail to show the trends of the underlying terrain, without picking out the finer details.
EXAMPLE: BATHYMETRY DATA SET

DATA COURTESY HR WALLINGFORD: SEAZONE

- 58,578,420 points
- 8 km x 12 km
- Height varying approximately 30 m

An LR B-spline approximation of the point cloud.

The surface is trimmed with respect to the shape of the cloud.

<table>
<thead>
<tr>
<th>Number points</th>
<th>Number polynomial patches</th>
<th>Maximum error</th>
<th>Average error (all points)</th>
<th>Average error (OOT points)</th>
<th>Proportion of OOT points</th>
</tr>
</thead>
<tbody>
<tr>
<td>58 578 420</td>
<td>59 458</td>
<td>5.55 m.</td>
<td>0.092 m.</td>
<td>0.66 m.</td>
<td>0.56 %</td>
</tr>
<tr>
<td>29 289 210</td>
<td>58 993</td>
<td>5.39 m.</td>
<td>0.092 m.</td>
<td>0.66 m.</td>
<td>0.54 %</td>
</tr>
<tr>
<td>14 644 604</td>
<td>59 210</td>
<td>5.39 m.</td>
<td>0.092 m.</td>
<td>0.65 m.</td>
<td>0.52 %</td>
</tr>
<tr>
<td>7 322 302</td>
<td>59 701</td>
<td>5.33 m.</td>
<td>0.093 m.</td>
<td>0.65 m.</td>
<td>0.50 %</td>
</tr>
<tr>
<td>3 661 151</td>
<td>60 967</td>
<td>5.25 m.</td>
<td>0.093 m.</td>
<td>0.65 m.</td>
<td>0.41 %</td>
</tr>
</tbody>
</table>

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ISPRS GeoBigData
The point cloud is divided into regular tiles. Each tile is approximated by a single LR B-spline surface. Tiling ensures that the algorithms are scalable to very large data sets.