Exploring Geospatial Query Results

Existing Map UIs cannot handle large results

**Query:** All farm buildings

Existing map UIs quickly become unresponsive, even for moderate result set sizes, or have a limit on the number of objects

Results are typically sent completely (in some serialization format) to the map UI, overloading the client

**Bottleneck 1:** Transferring query results from DB to map UI

**Bottleneck 2:** Managing many objects in the web browser

**Idea**

- Keep all geometries in a middleware index
- Prepare geometries for fast rendering
- During query time, only transfer raw geometry IDs from DB
- Render maps on the server side
- Load additional object data only on interaction (click or pan)

Architecture

**User frontend**

SPARQL Engine (QLever)

Geometry Cache

Sessions

Map PNG (WMS)

Click requests

Exports

Attribute queries

Full ID queries

Startup request

Results

Time to interactive UI (including query time):

<table>
<thead>
<tr>
<th>#objects</th>
<th>Overpass</th>
<th>pgAdmin</th>
<th>OSCAR</th>
<th>ours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>1</td>
<td>120 ms</td>
<td>0.1 s</td>
<td>0.1 s 0.2 s</td>
</tr>
<tr>
<td>Q2</td>
<td>2.5 k</td>
<td>8.8 s</td>
<td>1.6 s</td>
<td>0.3 s 0.4 s</td>
</tr>
<tr>
<td>Q3</td>
<td>48 k</td>
<td>2 m</td>
<td>6.1 s</td>
<td>1.2 s 0.5 s</td>
</tr>
<tr>
<td>Q4</td>
<td>358 k</td>
<td>—</td>
<td>—</td>
<td>3.9 s 0.7 s</td>
</tr>
<tr>
<td>Q5</td>
<td>15 M</td>
<td>—</td>
<td>—</td>
<td>—     7.3 s</td>
</tr>
<tr>
<td>Q6</td>
<td>218 M</td>
<td>—</td>
<td>—</td>
<td>—     1.5 m</td>
</tr>
</tbody>
</table>

Time to interactive UI after zoom \( t_z \) and map pan \( t_p \):

<table>
<thead>
<tr>
<th></th>
<th>Overpass</th>
<th>pgAdmin</th>
<th>OSCAR</th>
<th>ours</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t_z )</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>( t_p )</td>
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</tbody>
</table>

Results

Map UI: Heatmap and Object Map

https://qlever.cs.uni-freiburg.de/osm-planet

SPARQL Queries

**Example query: All streets in Germany**

```sparql
SELECT ?highway ?type ?geometry WHERE {
  ?highway geo:hasGeometry ?geometry .
}
```

Evaluated queries:

- (Q1) The building with OSM way id 98284318
- (Q2) All castle buildings (building=castle)
- (Q3) All train station buildings (building=train_station)
- (Q4) All farm buildings (building=farm)
- (Q5) All residential buildings (building=residential)
- (Q6) All streets (highway=*)