Point clouds in PostgreSQL: store and publish

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Oslandia

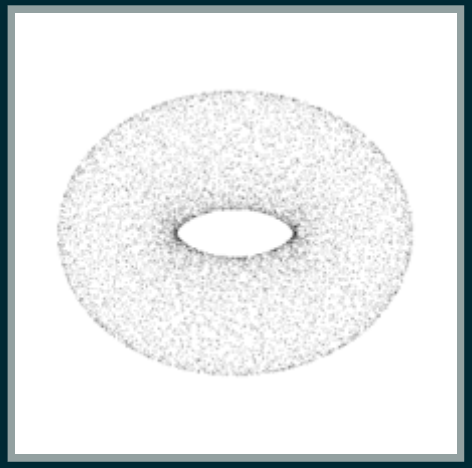
Oslandia provides service on open-source software

- GIS
- 3D
- DATA

Point clouds!

Point clouds

« A point cloud is a set of data points in space. »



source: wikipedia

Point clouds

- Generally produced by 3D scanners (LiDAR)
- Can also be created using Photogrammetry

LiDAR

Terrestrial, Airborne, Mobile, Unmanned

Many applications!

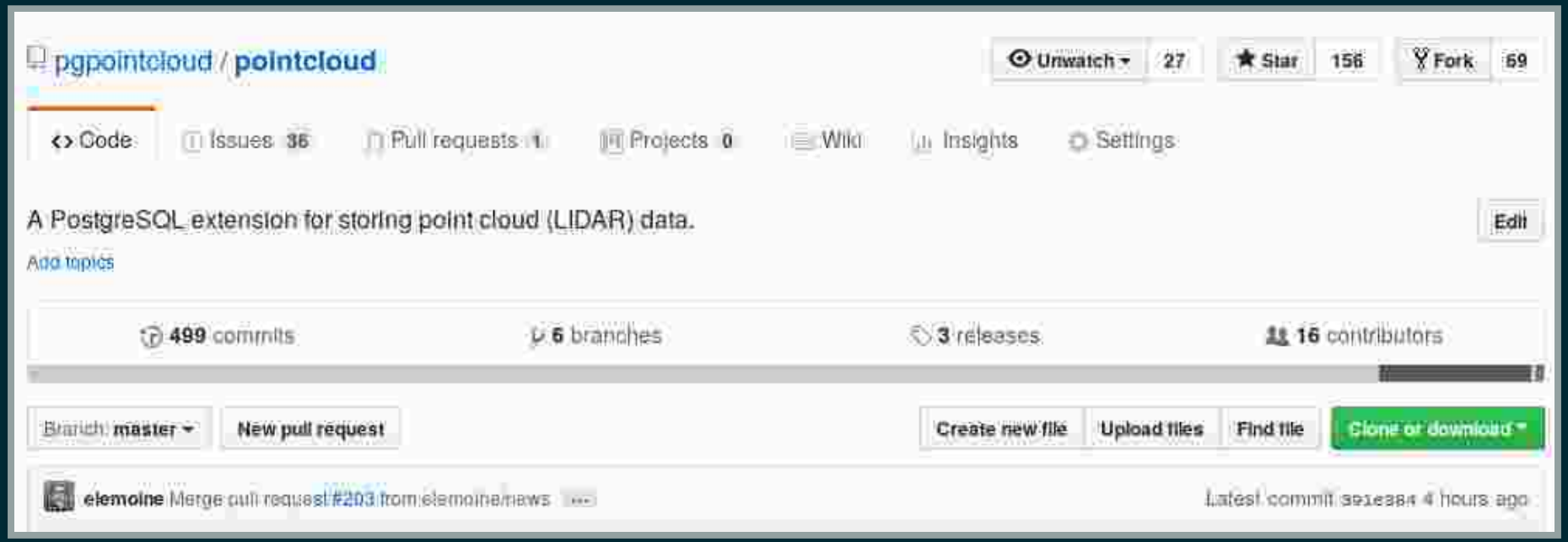
- Create Digital Elevation Models (DEMs)
- Create 3D models
- Detect objets and obstacles
- etc.

Point clouds in PostgreSQL

Pointcloud

"PostgreSQL extension for storing point cloud data"

https://github.com/pgpointcloud/pointcloud



Pointcloud

- Initially developed by Paul Ramsey (funded by Natural Resources Canada)
- Now developed and maintained by Oslandia and IGN

Goals

- Storing LiDAR data in PostgreSQL
- Leveraging that data for analysis in PostGIS

Why not use PostGIS?

```
     Column       |        Type
------------------+-------------------
 id               | integer
 geom             | geometry(PointZ)
 intensity        | double precision
 returnnumber     | double precision
 numberofreturns  | double precision
 classification   | double precision
 scananglerank    | double precision
 red              | double precision
 green            | double precision
 blue             | double precision
```

Why not use PostGIS?

- One point per row means billions of rows
- Does not work!

Patches of points

- Organize the points into patches
- → Millions of rows insteaf of billions

```
 Column |    Type
--------+------------
 id     | integer
 pa     | pcpatch(1)
```

Two types

- `PcPoint(pcid)`
- `PcPatch(pcid)`

Use Pointcloud

```
CREATE EXTENSION pointcloud;
CREATE EXTENSION postgis;            -- optional
CREATE EXTENSION pointcloud_postgis; -- optional
```

Use Pointcloud

```
 Schema |         Name         |   Type
--------+----------------------+----------
 public | geography_columns    | view
 public | geometry_columns     | view
 public | pointcloud_columns   | view
 public | pointcloud_formats   | table
 public | raster_columns       | view
 public | raster_overviews     | view
 public | spatial_ref_sys      | table
```

Schema

```
 pcid | srid |                                  schema
------+------+-------------------------------------------------------------------------------
    1 | 4326 | <?xml version="1.0" encoding="UTF-8"?>                                       +
      |      | <pc:PointCloudSchema xmlns:pc="http://pointcloud.org/schemas/PC/1.1"         +
      |      |     xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">                   +
      |      |   <pc:dimension>                                                             +
      |      |     <pc:position>1</pc:position>                                             +
      |      |     <pc:size>4</pc:size>                                                     +
      |      |     <pc:description>X coordinate as a long integer. You must use the         +
      |      |                     scale and offset information of the header to            +
      |      |                     determine the double value.</pc:description>             +
      |      |     <pc:name>X</pc:name>                                                     +
      |      |     <pc:interpretation>int32_t</pc:interpretation>                           +
      |      |     <pc:scale>0.01</pc:scale>                                                +
      |      |   </pc:dimension>                                                            +
      |      |   <pc:dimension>                                                             +
      |      |     <pc:position>2</pc:position>                                             +
      |      |     <pc:size>4</pc:size>                                                     +
      |      |     <pc:description>Y coordinate as a long integer. You must use the         +
      |      |                     scale and offset information of the header to            +
      |      |                     determine the double value.</pc:description>             +
      |      |     <pc:name>Y</pc:name>                                                     +
      |      |     <pc:interpretation>int32_t</pc:interpretation>                           +
      |      |     <pc:scale>0.01</pc:scale>                                                +
      |      |   </pc:dimension>                                                            +
      |      |   <pc:dimension>                                                             +
      |      |     <pc:position>3</pc:position>                                             +
      |      |     <pc:size>4</pc:size>                                                     +
      |      |     <pc:description>Z coordinate as a long integer. You must use the         +
```

```
SELECT pa FROM patches LIMIT 1;
------------------------------------------------------------------
 0101000000020000000900000002100000000400000060CEFFFFBC9A78560000
(1 row)
```

```
SELECT PC_AsText(pa) FROM patches LIMIT 1;
-------------------------------------------------------------------
 {"pcid":1,"pts":[[-126.99,45.01,1,0],[-126.98,45.02,2,0],[-126.9
(1 row)
```

Working with real data

Load data using PDAL

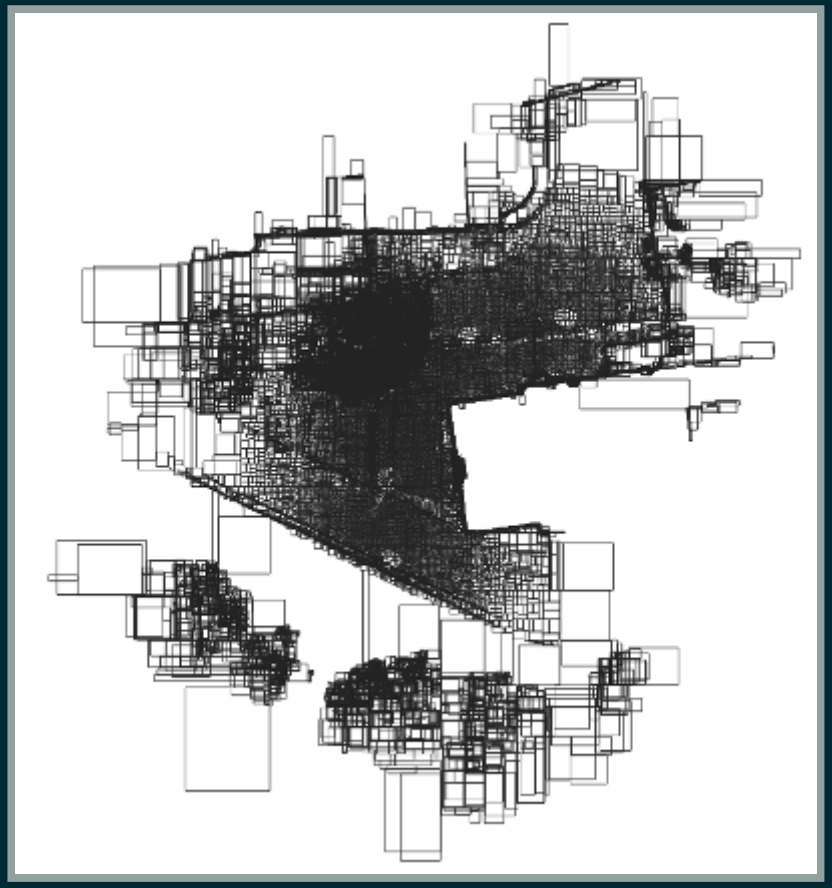
```
{
  "pipeline": [
    {
        "type": "readers.las",
        "filename":"inrap.las"
    },
    {
        "type": "filters.chipper",
        "capacity": "400"
    },
    {
        "type":"writers.pgpointcloud",
        "connection":"dbname=lopocs host=localhost user=lopocs",
        "schema": "public",
        "table":"inrap",
        "compression":"none",
        "srid":"3946",
        "overwrite":"true",
        "column": "points",
        "scale_x": "0.01",
        "scale_y": "0.01",
        "scale_z": "0.01",
        "offset_x": "831587.0631",
        "offset_y": "6287650.923",
        "offset_z": "30.921565055000002"
    }
  ]
}
```

```
SELECT count(*) num_patches,
       sum(PC_NumPoints(points)) num_points
FROM inrap;

 num_patches | num_points
-------------+------------
       45952 |   18380597
(1 row)
```

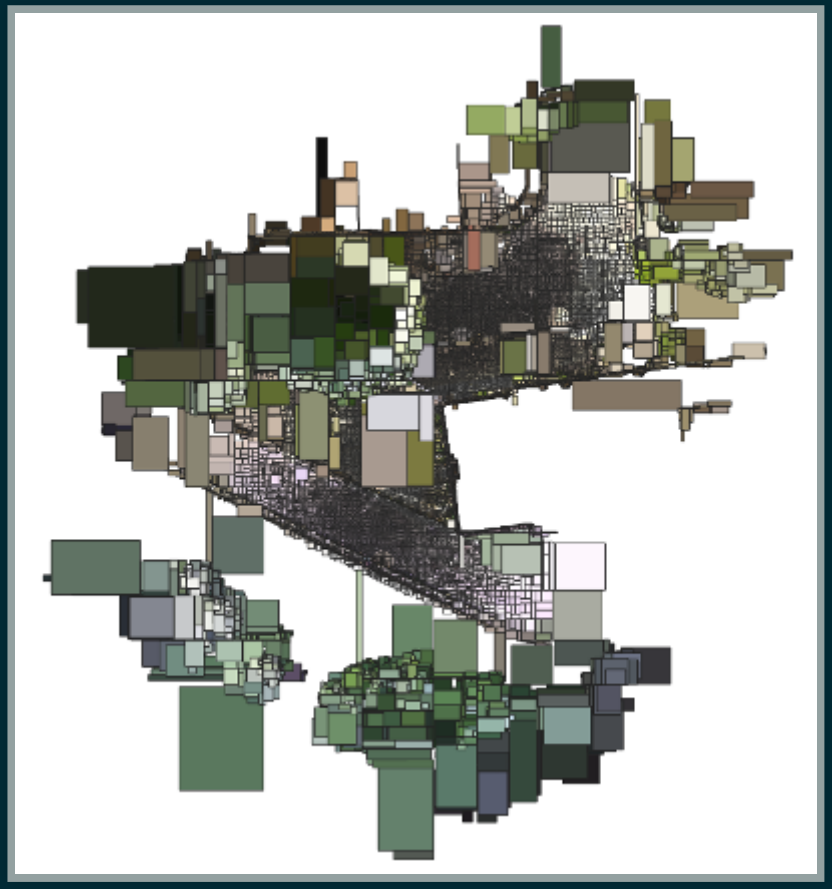
Visualize in QGIS

```
SELECT id, points FROM inrap
```



Visualize in QGIS

```
SELECT id, points, PC_PatchAvg(points, 'red') || ',' ||
                   PC_PatchAvg(points, 'green') || ',' ||
                   PC_PatchAvg(points, 'blue') || ',255' color FROM inrap;
```

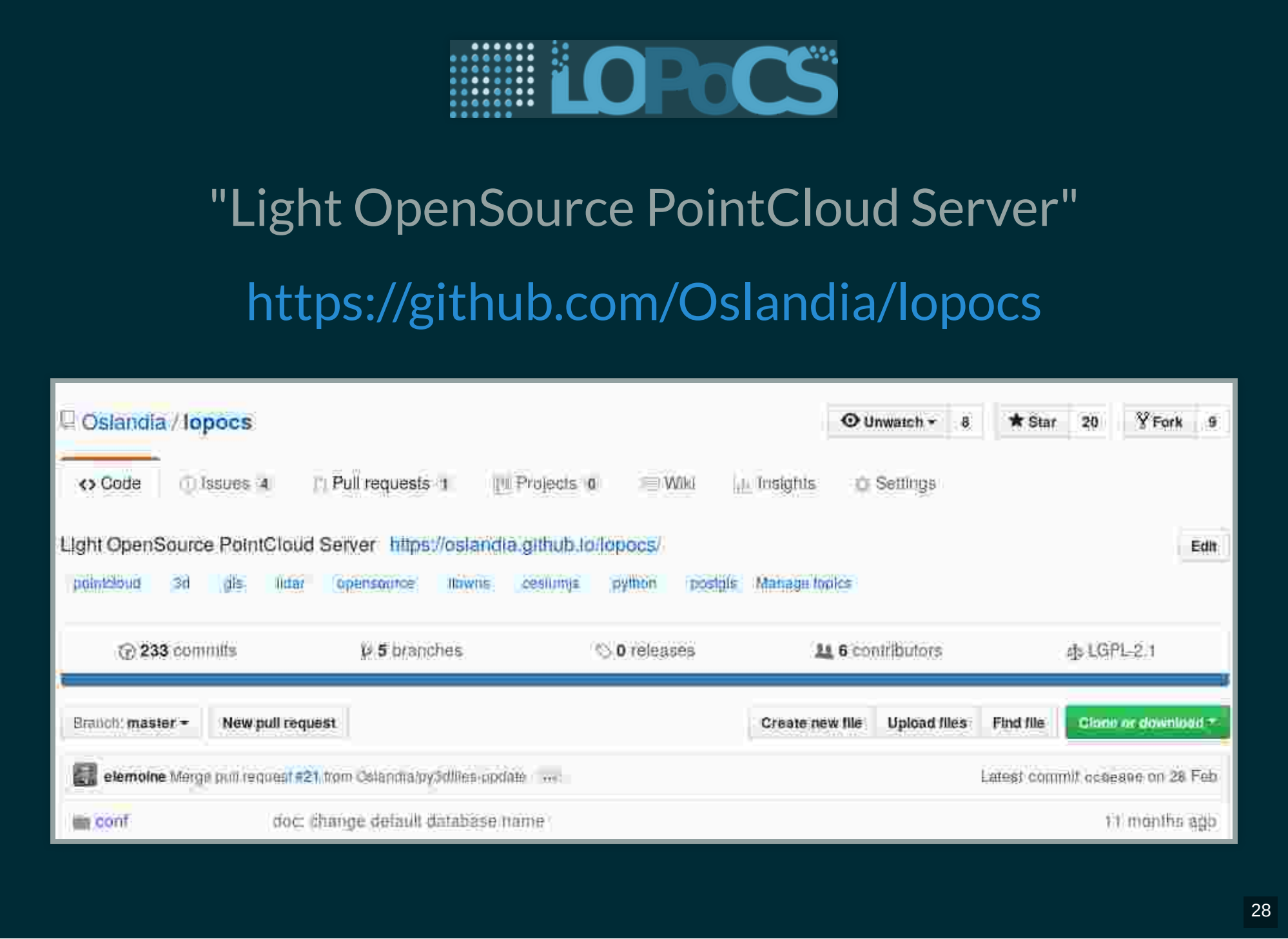


v1.1.0

Released the 2018-04-31

New functions include:

- `PC_Patch{Avg,Max,Min}(p pcpatch, dimname text)`
- `PC_Range(p pcpatch, start int4, n int4)`
- `PC_SetPCId(p pcpatch, pcid int4, def float8 default 0.0)`
- `PC_Transform(p pcpatch, pcid int4, def float8 default 0.0)`
- `PC_BoundingDiagonalAsBinary(p pcpatch)`



"Light OpenSource PointCloud Server"

https://github.com/Oslandia/lopocs

LOPoCS

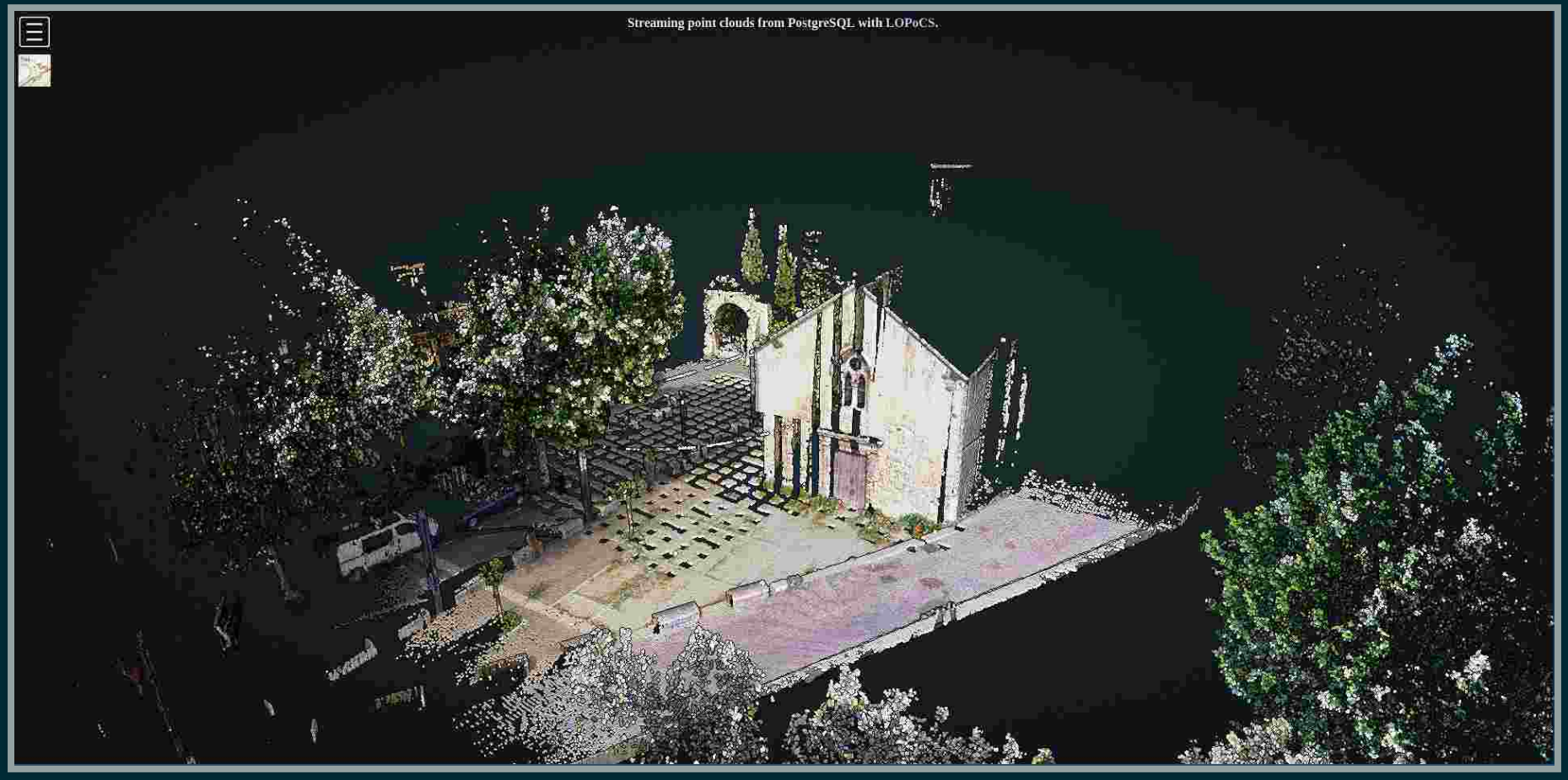
- Streams point cloud data stored in PostgreSQL
- Supports multiple streaming protocols (Greyhound and 3D Tiles currently supported)
- → works with Potree, Cesium, iTowns

Greyhound in a nutshell

Greyhound is a dynamic point cloud server architecture that performs progressive level-of-detail streaming of indexed resources on-demand

https://greyhound.io/

Potree/Greyhound



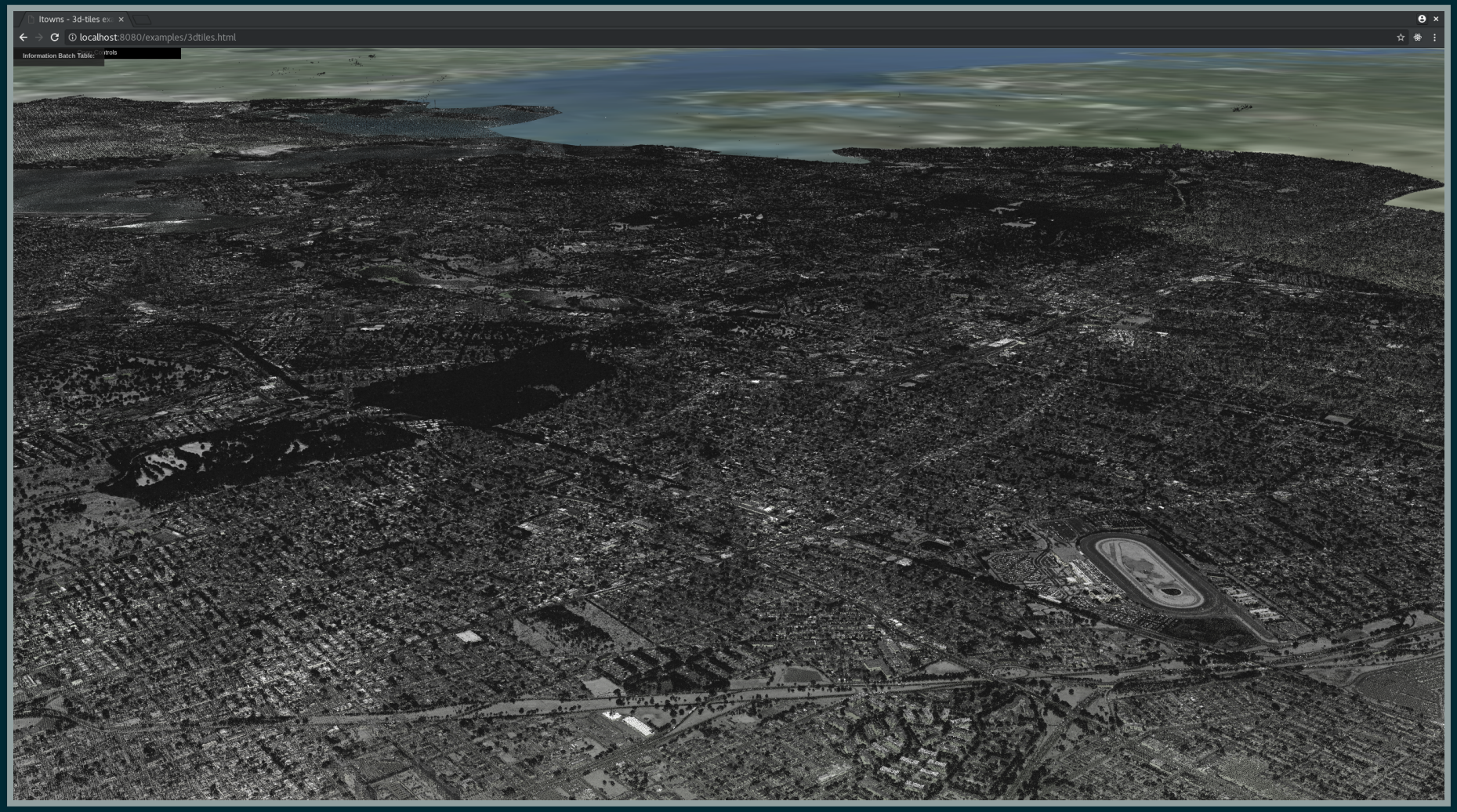
3D Tiles in a nutshell

Specification for streaming massive heterogeneous 3D geospatial datasets

https://github.com/AnalyticalGraphicsInc/3d-tiles

Cesium/3D Tiles

iTowns/3D Tiles



Motivation

- Stream point cloud data directly from Postgres
- No export/indexing step required
- Nice for pre-visualization and prototyping

Technologies

- Language: Python 3
- Web framework: Flask
- Main libraries: py3dtiles, lazperf

LOPoCS Future

- Improve the selection of points
- Make rendering as good and performant as possible

Thanks!