



Styling and publication of vector tiles

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Vector Tiles

› Features:

- › Multiple styles with same data
- › Dynamic filters
- › Mousover information
- › Continous zoom
- › Rotation (Map + labels)

› Vector Tile Examples

- › <https://blog.mapbox.com/tagged/data-visualization>



Vector Tile formats

- **GeoJSON / TopoJSON (TileStache, Tangram)**
- **Mapbox Vektor Tiles (MVT)**
 - compact
 - optimized for display (!)
 - Vector Tile 3.0 specification has started (See Github: 3D, multi-level attributes, ...)
- **I3S (Indexed 3D Scene Layers)**
- **Cesium 3D Tiles**



MVT format - binary

<https://github.com/mapbox/vector-tile-spec>

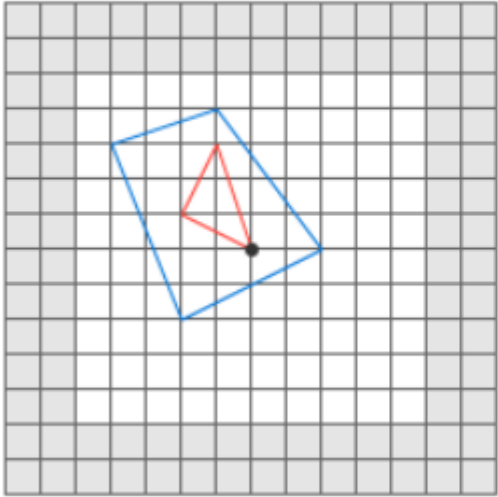
- › **Protocol Buffer Format (PBF)**
 - › Binary
 - › Streamable
 - › Concatenation support
- › **Attributes**
 - › With optional feature ID
- › **Multiple layers per tile**



MVT format - geometries

<https://www.mapbox.com/vector-tiles/specification/>

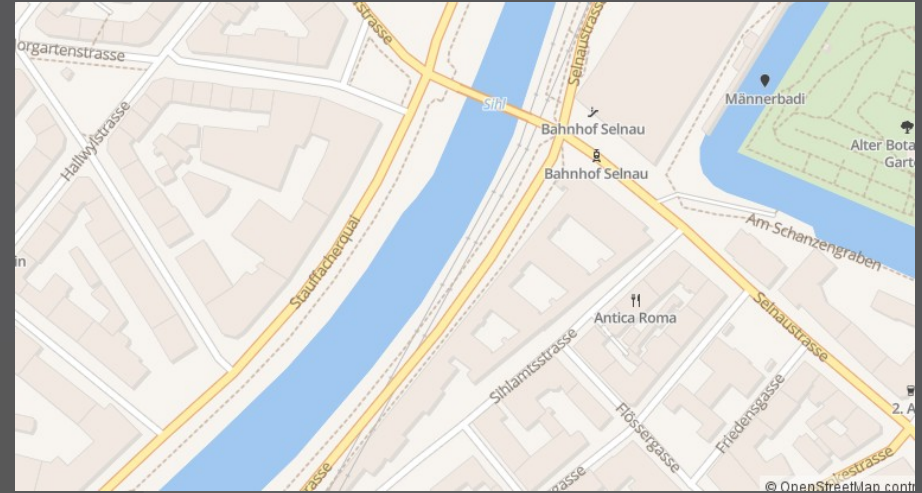
- › Tiles with a buffer
 - › Size defined per layer
- › Geometry in screen coordinates
 - › Integers
 - › ZigZag encoded
- › Multipoint
- › Multiline
- › Multipolygon

Vector Tile Grid	Commands
	<pre>MoveTo(1,2) LineTo(3,-1) LineTo(3,4) LineTo(-4,2) ClosePath() MoveTo(1,-5) LineTo(-1,2) LineTo(2,1) ClosePath()</pre>



MVT file sizes

- **OSM data set:**
 - Boston: 24 MB
 - USA: 7.2 GB
 - Planet: 55 GB
- **Offline maps!**





WMS -> WMTS -> Vector Tiles

- › **WMS**
 - › No tiling problems (labels, etc.)
 - › Printing
 - › Easy embedding as image
 - › Areal imagery, etc.
- › **WMTS**
 - › Scalability
 - › Caching (server and client)
- › **Vector Tiles**
 - › Interactivity
 - › Flexible styling (client-side rendering)
 - › Hi-DPI
 - › Scalability
 - › Caching (server and client)



Vector tile creation

- › Read geodata within tiles borders
- › Clip geometries
- › Simplify geometries
 - › Polygons: e.g. SnapToGrid
 - › Lines: e.g. Douglas-Peucker
 - › Points: clustering
- › Generate label points
- › Deliver MVT (Protobuf) format
- › Serve live or seed cache (parallelization!)

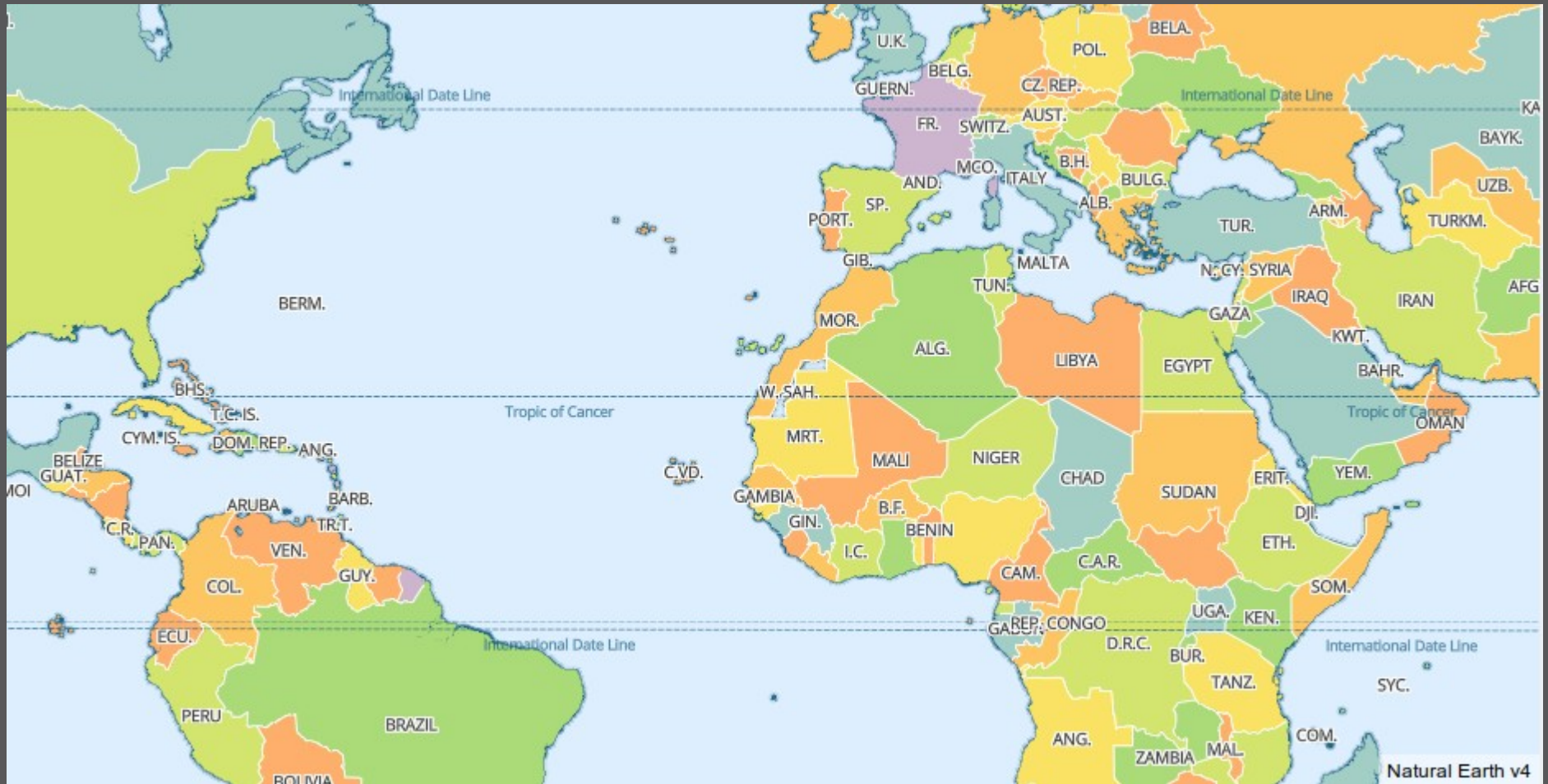
Vector Tile server for custom data (PG)

- › node-mapnik (Kartotherian, tesseract)
- › t-rex
- › Tegola
- › GeoServer
- › UMN MapServer
- › GDAL
- › PostGIS ST_AsMVT

<https://github.com/mapbox/awesome-vector-tiles>



Benchmarking



<https://github.com/pka/mvt-benchmark>



Hosting vector tiles

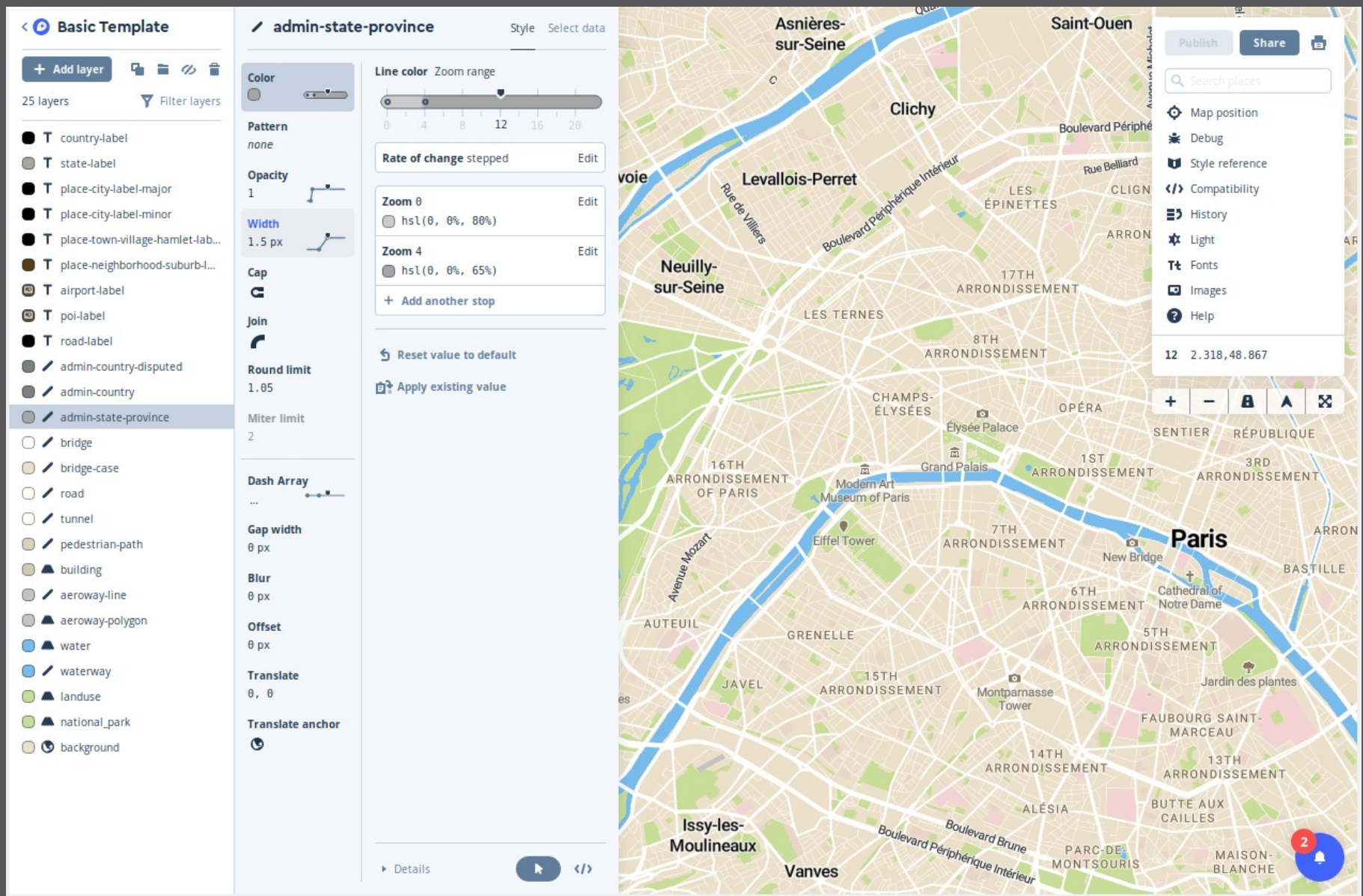
- › **Static MVT files**
 - › Webserver (Apache, Nginx)
 - › Service: S3, etc.
- › **MIME type 'application/x-protobuf'**
- › **Content-Encoding 'gzip'**
- › **Cache headers**
- › **CORS headers**
- › **Layer concatenation**
- › **Live data**
 - › Proxy in front of tile server (Varnish, etc.)
 - › NodeJS based server



Styling / Viewer

- › **Mapbox Styles (JSON)**
 - › Viewer:
 - › Mapbox GL JS
 - › Leaflet (mapbox-gl-leaflet plugin)
 - › OpenLayers (ol-mapbox-style)
 - › Style Editor (OSS)
 - › Maputnik
- › **Generic vector styling**
 - › Viewer:
 - › OpenLayers
 - › Leaflet (VectorGrid plugin)
 - › HTML Canvas
 - › Custom projections, etc.

Styling GUI: Mapbox Studio (non-OSS)



Basic Template

+ Add layer

25 layers

- country-label
- state-label
- place-city-label-major
- place-city-label-minor
- place-town-village-hamlet-lab...
- place-neighborhood-suburb-l...
- airport-label
- poi-label
- road-label
- admin-country-disputed
- admin-country
- admin-state-province**
- bridge
- bridge-case
- road
- tunnel
- pedestrian-path
- building
- aeroway-line
- aeroway-polygon
- water
- waterway
- landuse
- national_park
- background

admin-state-province Style Select data

Color

Line color Zoom range

Rate of change stepped Edit

Zoom 0 Edit

Zoom 4 Edit

+ Add another stop

Reset value to default

Apply existing value

Details

Map position

Debug

Style reference

Compatibility

History

Light

Fonts

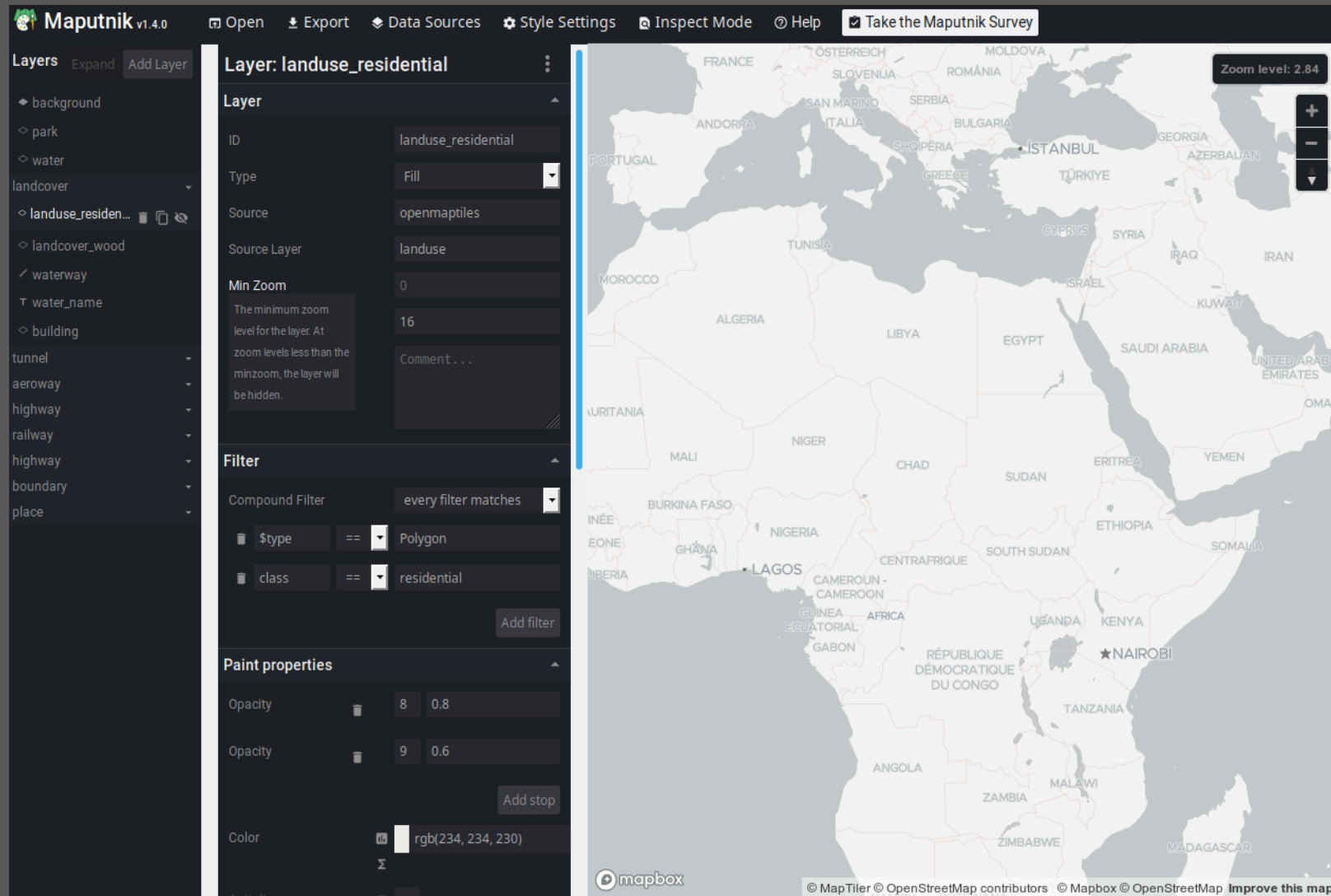
Images

Help

12 2,318,48.867



Styling GUI: Maputnik



<https://github.com/maputnik/editor>



<https://www.mapbox.com/mapbox-gl-js/>

```
var map = new mapboxgl.Map({  
  container: 'map',  
  style: 'http://tileserver.ch/map.style.json',  
  center: [-74.50, 40],  
  zoom: 9  
});
```



Mapbox Styles

<https://www.mapbox.com/mapbox-gl-js/style-spec>

➤ JSON with data sources and map style

```
{
  "version": 8,
  "name": "Mapbox Streets",
  "sprite": "mapbox://sprites/mapbox/streets-v8",
  "glyphs": "mapbox://fonts/mapbox/{fontstack}/{range}.pbf",
  "sources": {...},
  "layers": [...]
}
```




Data sources

➤ TileJSON endpoint

```
"source-name": {  
  "type": "vector",  
  "url": "http://tileserver.ch/tilejson.json"  
}
```

➤ Tile URL

```
"countries": {  
  "type": "vector",  
  "tiles": ["http://tileserver.ch/countries/{z}/{x}/{y}.pbf"]  
}
```

➤ Maxzoom

Maximum zoom level for which tiles are available. Data from tiles at the maxzoom are used when displaying the map at higher zoom levels.

<https://www.mapbox.com/mapbox-gl-js/style-spec/#sources>



Other data sources

- › **GeoJSON**
- › **Raster**
 - › Raster tiles (XYZ, TMS)
 - › Tiled WMS
- › **Image**
- › **Video**
- › **Canvas**



Sprites & Fonts

› Sprites

- › Image sprites used for patterns and icons

```
"sprite": "http://openmaptiles.org/sprites/"
```

› Fonts

- › Font glyphs (Protobuf format)

```
"glyphs": "http://fonts.openmaptiles.org/{fontstack}/{range}.pbf"
```

More info:

<https://openmaptiles.org/docs/style/mapbox-gl-style-spec/>



› Layers with styles

```
"layers": [  
  {  
    "id": "water",  
    "source": "mapbox-streets",  
    "source-layer": "water",  
    "type": "fill",  
    "paint": {  
      "fill-color": "#00ffff"  
    }  
  }  
]
```

- › Layers drawn in the order of this array
- › Layout + Paint properties



Layer rendering types

- › **"fill": Filled polygon with an optional stroked border**
- › **"line": Stroked line**
- › **"symbol": Icon or text label**
- › **"circle": Filled circle**
- › **"heatmap": Heatmap**
- › **"fill-extrusion": Extruded (3D) polygon**
- › **"raster": Raster map textures such as satellite imagery**
- › **"background": Background color or pattern of the map.**
GeoJSON



➤ Attribute based styling with filter

```
{
  "id": "population_lt_2m",
  "type": "fill",
  "source": "states",
  "filter": ["<=", "PERSONS", 2000000],
  "paint": {
    "fill-color": "#A6CEE3",
    "fill-opacity": 0.7
  }
}
```

➤ Update with Javascript based on user input



➤ Resolution based styling

```
{
  "id": "state_abbreviations",
  "type": "symbol",
  "source": "states",
  "minzoom": 1.8,
  "maxzoom": 4,
  "layout": {
    "text-field": "{STATE_ABBR}",
    "text-size": 12,
    "text-font": ["Open Sans Regular"]
  }
}
```



Functions

➤ The value for any layout or paint property may be specified as a function

➤ Zoom functions

```
{
  "circle-radius": {
    "stops": [
      // zoom is 5 -> circle radius will be 1px
      [5, 1],
      // zoom is 10 -> circle radius will be 2px
      [10, 2]
    ]
  }
}
```




› Property functions

```
{
  "circle-color": {
    "property": "temperature",
    "stops": [
      // "temperature" is 0    -> circle color will be blue
      [0, "blue"],
      // "temperature" is 100 -> circle color will be red
      [100, "red"]
    ]
  }
}
```

› Zoom-and-property functions

<https://www.mapbox.com/mapbox-gl-js/style-spec/#other-function>



Expressions

➤ Expressions (MB GL 0.41.0)

```
"circle-radius": [  
  "sqrt", ["/", ["get", "population"], 10000]  
]
```



<http://openlayers.org/>

- › Support for WMTS, WFS, etc.
- › Support for Non-Mercator CRS
- › Conversion of GL-Styles to OL-Styles
 - › <https://github.com/boundlessgeo/ol-mapbox-style/>
 - › Not all features supported
- › Uses browser canvas-API



Thank you!



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