Speaker notes
Who am I?

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- from Bielefeld, Germany
- Studied electric engineering, computer science, and biology
- OpenStreetMapper since 2007
- Principal Database Support Engineer at MariaDB Corp.
  (and previously MySQL, Sun, Oracle, SkySQL)

Speaker notes
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We need a tool that converts map data to pretty pictures. For this we need to be able to:

- read different map data formats
- apply different styles to data we read
- create pictures in different formats from this
- be able to control operations with code
- and to draw extra stuff on top of the map somehow
Speaker notes
Data Sources

Mapnik can read map data from many different sources:

- Shapefiles
- SQL database result sets
- GeoJson

Multiple other formats via plugins:
- ... OGR for various vector and raster formats, e.g. OSM XML and GPX
- ... GDAL for various raster formats

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See also:
https://github.com/mapnik/mapnik/wiki/PluginArchitecture
https://github.com/mapnik/mapnik/wiki/OGR
https://github.com/mapnik/mapnik/wiki/GDAL
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Mapnik can produce output in various formats

- PNG (32bit and 8bit)
- JPG
- SVG
- PDF
- PostScript

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Rendered by either AGG or Cairo Graphics. We focus on Cairo here.
See also https://github.com/mapnik/mapnik/wiki/OutputFormats
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How data is rendered is defined by styles:

- Styles can be defined in program code
- or via XML style files
- Some other style formats can be converted into Mapnik XML (mostly CartoCSS at this time)
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Mapnik comes as a library written in C++, not a full application. So some extra code is needed to actually make it work.

- native C++
- Python bindings
- Experimental bindings for PHP 7

Speaker notes

Python Bindings used to be bundled with Mapnik v2, but are now a standalone project https://github.com/mapnik/python-mapnik

PHP bindings https://github.com/garrettrayj/php7-mapnik
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We need the following components:

- Python (2 or 3)
- Mapnik 3 (2?)
- Python bindings for Mapnik, Cairo, and Pango

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The code we’re going to show is pretty simple and should work with both Python version 2 and 3, unless explicitly stating differences. The Mapnik specific code should also work with both Mapnik versions 2 and 3, but this was not tested. Python and Mapnik version numbers only match by coincidence.
Installation

Debian/Ubuntu:

1. `apt-get install \
   2. python3-mapnik \
   3. gir1.2-pango-1.0 \
   4. gir1.2-rsvg-2.0 \
   5. python3-gi-cairo

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TODO
Points, Lines and Polygons:

All Mapnik data sources provide geo data as a collection of

- Points
- Lines
- Polygons
- Raster Images

Depending on the underlying data source some conversions may happen on the way.

All geo objects may have additional attributes that you can filter by, or use to decide how to display them (e.g. “name” text)
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A Mapnik Layer is importing some data using one of the available data sources and binds it to one or more styles to present the imported data.

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A Style can filter imported data and defines which symbolizer(s) to use to present the data.

Speaker notes
Symbolizers perform the actual rendering of data. There are four basic types:

- PointSymbolizer
- LineSymbolizer
- PolygonSymbolizer
- RasterSymbolizer

Speaker notes

We get to these in detail later
Symbolizers (cont.)

- MarkerSymbolizer
- LinePatterSymbolizer
- TextSymbolizer
- ShieldSymbolizer
- PolygonPatternSymbolizer
- BuildingSymbolizer

Speaker notes

We get to these in detail later
Speaker notes
import mapnik

map = mapnik.Map(600,300)

mapnik.render_to_file(map, 'world.png', 'png')

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This is the minimal Mapnik program in python. We're just importing the Mapnik bindings, creating a map object with given pixel size, and write it to a PNG image right away.
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Obviously there is nothing on the map yet, it is totally empty and transparent.
A minimal example

```python
import mapnik

map = mapnik.Map(600, 300)
map.background = mapnik.Color('steelblue')

polygons = mapnik.PolygonSymbolizer()
polygons.fill = mapnik.Color('lightgreen')

rules = mapnik.Rule()
rules.symbols.append(polygons)

style = mapnik.Style()
style.rules.append(rules)
map.append_style('Countries', style)

layer = mapnik.Layer('world')
layer.datasource = mapnik.Shapefile(file='countries.shp')
layer.styles.append('Countries')

map.layers.append(layer)
map.zoom_all()
mapnik.render_to_file(map, 'world.png', 'png')
```

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So lets add some content. First we’re making the background blue instead of transparent.

Then we

- set up a polygon Symbolizer that just fills polygons with green color
- create a Rule that simply applies the polygon Symbolizer to every polygon
- create a Style, add the Rule to it, and then add it to the Map by name “Countries”
- create a Layer named “world”
- set a Shapefile containing all country borders as data source
- bind the style we created earlier to this layer
- add the layer to the map
- make sure all data is shown with `zoom_all()`
- and write the output to a file again
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Now we actually see a world map, with green continents on a blue background. We also see country borders even though we didn’t define any style for these, so where did these come from? The borders are actually artifact due to antialiasing being applied to the polygon edges. When turning off antialiasing with `gamma=0.0` these artifacts will vanish.
Now let's add a second rule to the style that only renders a specific object. For this we first create a 2nd polygon symbolizer that uses a different fill color.

Next we create a 2nd rule that does not simply show all objects, but only those that match a specific filter condition, here “name equals Germany”. Then we append the 2nd rule to the style, and continue as before.
... and its result

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Now we see, as expected, that the continents are still painted green, and due to the additional 2nd rule we have highlighted Germany in red. The border lines of other countries have vanished as we’ve added `polygons.gamma = 0.0` to the original polygon symbolizers definition.
import mapnik

map = mapnik.Map(600,300)

mapnik.load_map(m, 'world.xml')

map.zoom_all()

mapnik.render_to_file(map, 'world.png', 'png')

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Using python to create symbolizers, rules, styles and layers can become tedious. Luckily Mapnik provides us with a more compact alternative in the form of loadable XML stylesheets.

We’re now going to create the same map, but with XML. In the program code we simply replace all the style related code with a simple call to `load_map()`

Using XML style files is the usual mode of operation, specifying layers and styles directly in Python code allows for more dynamic operations though. Also both approaches can be combined in the same program, e.g. by loading an XML style first and then extending it dynamically using Python code.
XML style definition

```xml
<?xml version="1.0" encoding="utf-8"?>
<Map background-color='steelblue'>
  <Style name="Borders">
    <Rule>
      <PolygonSymbolizer fill="green" gamma="0.0"/>
    </Rule>
    <Rule>
      <Filter>([NAME]='Germany')</Filter>
      <PolygonSymbolizer fill="red"/>
    </Rule>
  </Style>
  <Layer name="world">
    <StyleName>Borders</StyleName>
    <Datasource>
      <Parameter name="file">ne_110m_admin_0_countries.shp</Parameter>
      <Parameter name="type">shape</Parameter>
    </Datasource>
  </Layer>
</Map>
```

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This is the XML stylesheet syntax that is equivalent to our previous example program. Being XML-based this format is still rather verbose, but already much more compact than the previous Python-only example.
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As expected we don’t see any visual difference to the previous examples result.
We’re now going to have a closer look at some of the other symbolizers provided by Mapnik (TODO: work in progress).
For the following examples we’re going to use simple GeoJSON files as data source as this is the most readable of the different supported input formats.
import mapnik

map = mapnik.Map(600,300)

mapnik.load_map(map, 'example.xml')

map.zoom_all() # zoom to fit
map.zoom(-1.1) # zoom out 10% more

mapnik.render_to_file(map, 'world.png', 'png')

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## Speaker notes

We start with a slightly modified version of the previous XML example program. After zooming the map to just the necessary size needed to include all data from the data source with `zoom_all()` we then zoom out by 10% with `zoom(-1.1)`. The negative number tells Mapnik that we want to zoom out, not in. Zooming out a bit is needed as otherwise part of what we paint will be cut off as `zoom_all()` does only take data size into account, not graphics size.
The most basic symbolizer we can use to produce graphical map output is the point symbolizer. This symbolizer will place whatever graphical symbol we pass to it on every point in the data.
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This is the test data we’re going to use with the point symbolizer, consisting of two points only.

For a full description of PointSymbolizer properties see https://github.com/mapnik/mapnik/wiki/PointSymbolizer
Speaker notes

As somewhat expected: we’re only seeing two points here.
Speaker notes

Next we’re using a GeoJSON file containing a simple line.
Line Symbolizer

```xml
<?xml version="1.0" encoding="utf-8"?>
<Map background-color='white'>
  <Style name='line'>
    <Rule>
      <LineSymbolizer stroke='steelblue' stroke-width='30'>
        <TextSymbolizer placement="line" face-name="DejaVu Sans Book" size="30"
          fill="black" halo-fill="white" halo-radius="1">
          [name]
        </TextSymbolizer>
      </Rule>
    </Style>
  </Layer name="test">
    <StyleName>line</StyleName>
  [...]
</Map>
```

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We’re using a combination of a LineSymbolizer and TextSymbolizer here. The LineSymbolizer will just draw the line in blue at a width of 30 points. The TextSymbolizer overlays the blue line with black text placed along the line, and with a small white halo around the letters. For a full description of the symbolizers properties see https://github.com/mapnik/mapnik/wiki/LineSymbolizer and https://github.com/mapnik/mapnik/wiki/TextSymbolizer
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The other symbolizers

Symbolizers not covered by examples yet

- PolygonSymbolizer (seen earlier)
- MarkerSymbolizer - repeated symbol along line
- ShieldSymbolizer - flexible symbol with text along line
- LinePatternSymbolizer - line with attached symbols
- PolygonPatternSymbolizer - fill polygon with repeated image
- BuildingSymbolizer - draw pseudo-3D buildings

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For a list of all supported symbolizers see
https://github.com/mapnik/mapnik/wiki/SymbologySupport#
user-content-symbolizers
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Not everything can be handled by Mapnik alone. Adding map decorations, additional text, and map features for that no suitable symbolizer exists yet is possible by using Cairo Graphics.
Here we create a PDF Cairo surface, and a Cairo context. We then create a map as before, but tell Mapnik to render into the given Cairo surface instead of writing to a file directly. Then we use the Cairo context to draw a simple rectangle on top of the rendered map, and finally create the output file by telling the surface to finish itself.
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The example result in a PDF viewer.
Adding SVG images v2

```python
import mapnik
import cairo
import rsvg

surface = cairo.PDFSurface('world.pdf', 600, 300)
context = cairo.Context(surface)

map = mapnik.Map(600,300)
[...]  
mapnik.render(map, surface)

svg = rsvg.Handle('compass.svg')
context.move_to(10,10)
context.scale(0.5, 0.5)
svg.render_cairo(context)

surface.finish()
```

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With help of the RSVG library we can also easily put SVGs on top of our maps.
import mapnik
import cairo
import gi

gi.require_version('Rsvg', '2.0')
from gi.repository import Rsvg

rsvg = rsvg.Handle()
svg = rsvg.new_from_file('compass.svg')
context.move_to(10, 10)
context.scale(0.5, 0.5)
svg.render_cairo(context)
surface.finish()

Speaker notes

With help of the RSVG library we can also easily put SVGs on top of our maps.
Speaker notes
Adding Text

```python
context.select_font_face("Droid Sans Bold", cairo.FONT_SLANT_NORMAL, cairo.FONT_WEIGHT_BOLD)
context.set_font_size(48)
context.set_source_rgb(1, 1, 1)

text = 'Some text'

x_bearing, y_bearing, width, height = context.text_extents(text)[:4]

context.move_to(100, 100)
context.show_text(text)
```

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For more sophisticated layout tasks you should use Pango for font handling and text rendering instead.
For this talk we’re sticking with basic Cairo functionality.
This also has the advantage of working the same on Python 3 and 4.
Some text

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This is a real world showing a combination of all the techniques that were presented here.
The map itself is drawn using the default OpenStreetMap CartoCSS stylesheet.
The map title, frame, footer text, and side bar index are drawn using Cairo Graphics.
The red “You are here” circle is drawn using Cairo Graphics, and the markers on the map corresponding to the side bar index entries are drawn using CairoGraphics and RSVG.
Another featured Example

maposmatic.osm-baustelle.de

And another one

maposmatic.osm-baustelle.de
What we learned

- Code wise it is actually rather easy
- The devil is in the styles (and details)
- Flexible solution to mix map rendering ...
- ... and custom image decorations
- Mapnik documentation is suboptimal :(

Speaker notes
Questions, Remarks, Wishes?

Speaker notes
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Mapnik Wiki: https://github.com/mapnik/mapnik/wiki
Cairo Graphics: https://cairographics.org/pycairo/