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Use APEX to Visualize Spatial Data

- Display data on maps with minimal efforts

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~~http://oisene.blogspot.com~~

https://enesi.no/

SYSCO http://sysco.no

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Agenda

- Quick intro to APEX
- Find some cool data - Import them to Oracle
- Use Apex to build a nice web page.

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I’m a DBA - so why APEX?

- Fun to create something on my own
- It is fast!
- DBA should recommend APEX
  - it gives you less pain
  - Fewer moving parts than
  - We know the technology behind it
- With APEX I can report easily to management
- Customers love it

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OK, but why spatial?

- People love maps
- People move around and like to see it in 2D
- Boring data can be enriched and look great on maps
- Lots of people don’t know how easy you can work with geographic data in Oracle

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Licenses

- Not my favourite subject
- Locator — subset of Spatial included with your db license
- Locator includes what you need for fun
- You can do a lot of advanced stuff with extra Spatial and Graph license
- Test in lab and check DBA_FEATURE_USAGE_STATISTICS

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Installation

- Use Docker or Virtual Box with Vagrant
- Or download Oracle Database App Development VM for VirtualBox
- Or apex.oracle.com
- Or your friend's cloud?

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A note on Docker

- Learning Docker is a good investment
- Set up your own lab with little hassle
- Focus on your task - not installation
- Excellent support from Oracle
  - https://github.com/oracle/docker-images
  - Also check out work by Gerald Venzl
- See a short intro at the end.

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A Little Bit of History

- It used to be complicated

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Maps before Google

- Complicated and slow APIs
- Involved heavy server-side technology
- Required some insight to cartography

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Maps with Google

- Google and Open Street Maps (OSM) made simple APIs
- Maps and data could be accessed without a degree in GIS
- Show maps as tiles with 256 x 256 px
- Zooming and panning done by loading tiles without complete refresh of page

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Even simplier

- Leaflet wanted to simplify further
- Mapbox is a startup build on Leaflet with more features.
- You can chose JavaScript API from one place
- And a tile server from another.

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Let’s get started

In APEX

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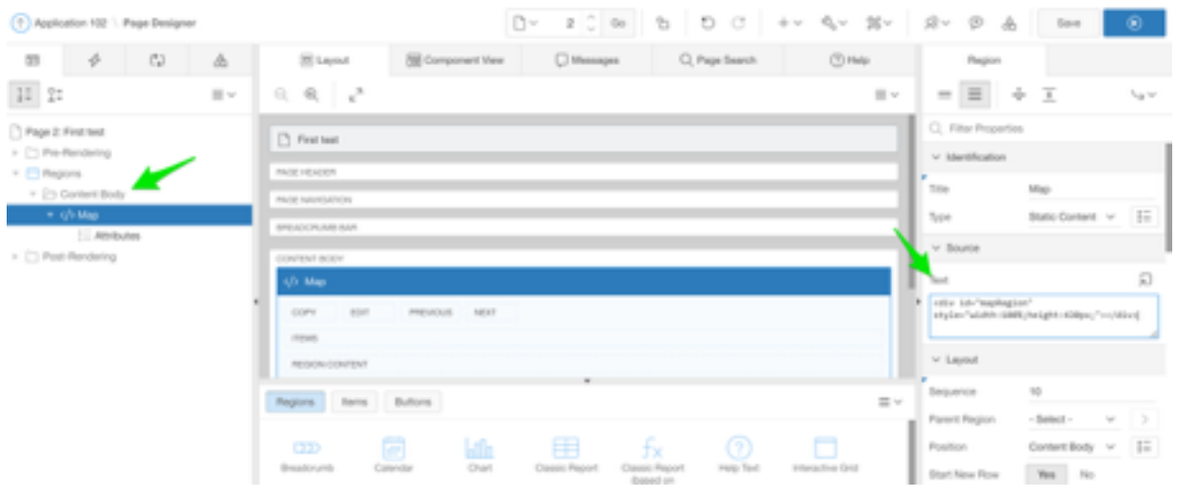
Create a new empty page

Create a static region with the following source:

```
<div id="mapRegion" style="width:100%;height:430px;"></div>
```

You'll need this later



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JavaScript and CSS

- From mapbox in this example
- Several other options exist
- JS API contains functions to show map and draw on it
- CSS makes it look good
- URLs for JS and CSS is added to the page in APEX

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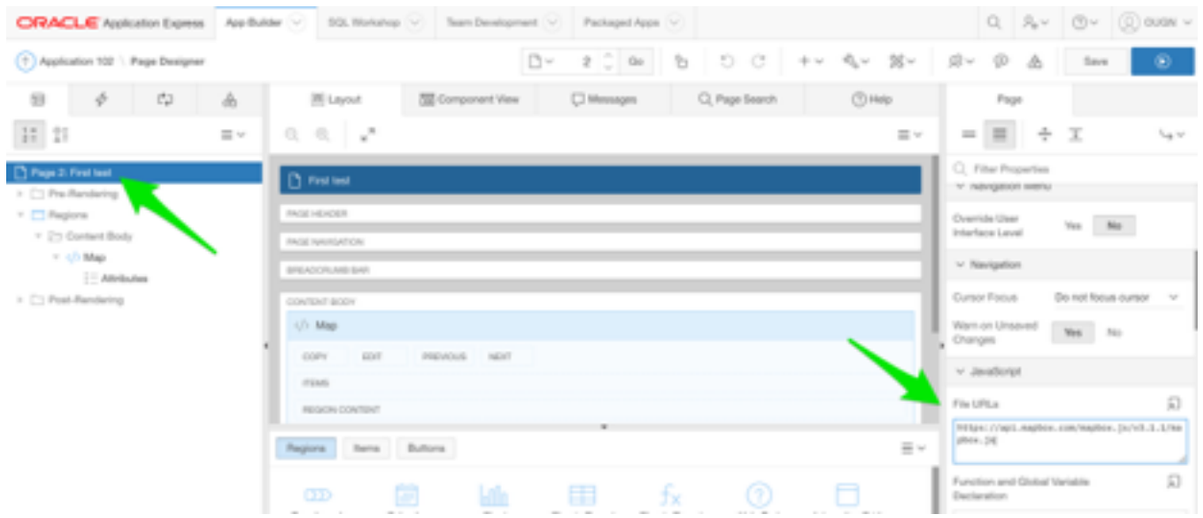

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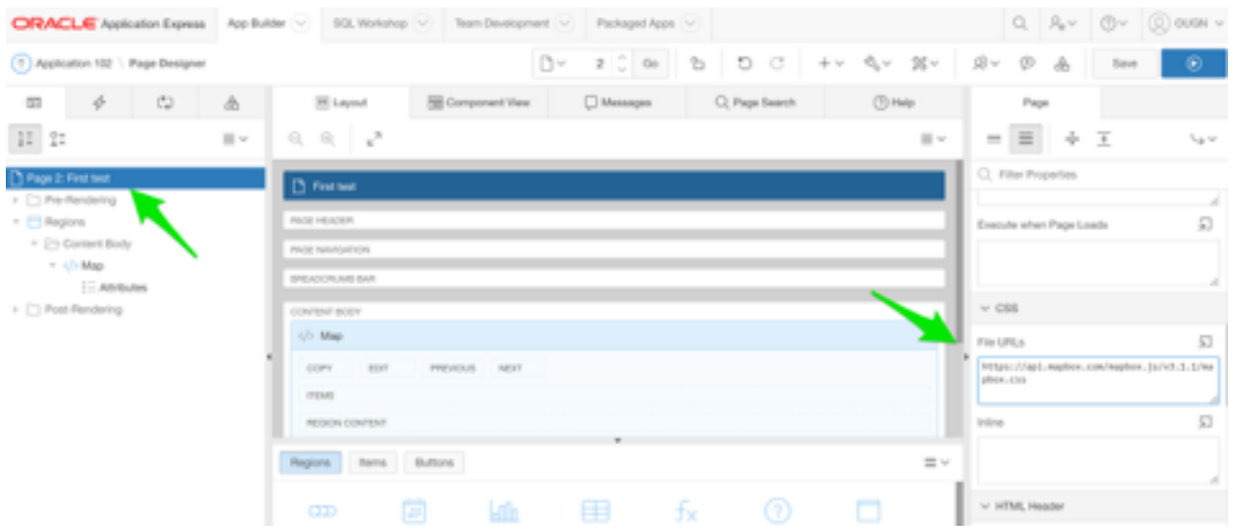

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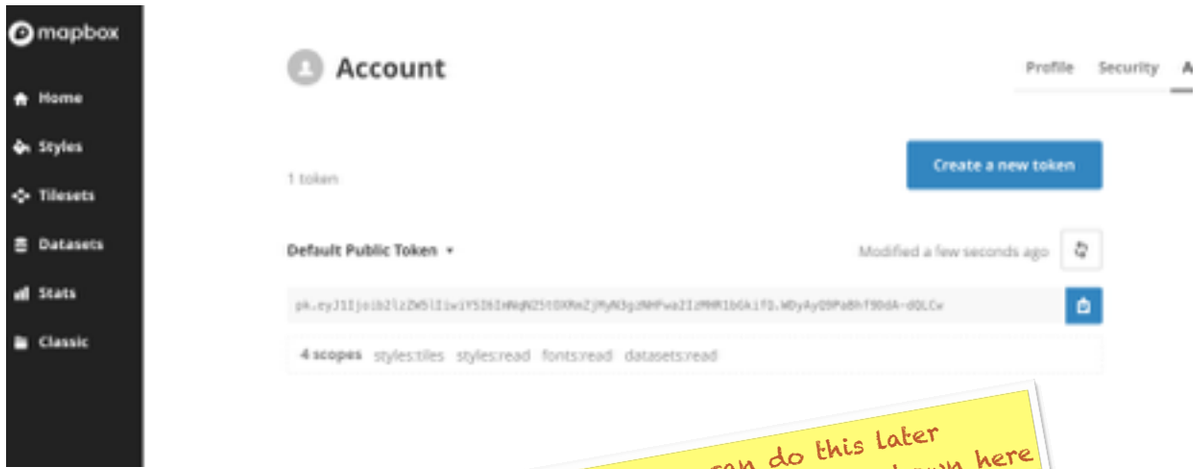
Create a user at Mapbox



Actually, you can do this later
and use the public token shown here

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Some code…

```
L.mapbox.accessToken =
'pk.eyJ1Ijoib2lzZW5lIiwiYSI6ImNqN25tOXRmZjMyN3gzNHFwa2IzMHR1bGkifQ.WDyAyQ9PaBhf9DdA-dQLCw';
var map = L.mapbox.map('mapRegion', 'mapbox.streets')
    .setView([59.910349, 10.725035], 9);
var marker = L.marker([59.910349, 10.725035]).addTo(map);
```

Your id from <div …>

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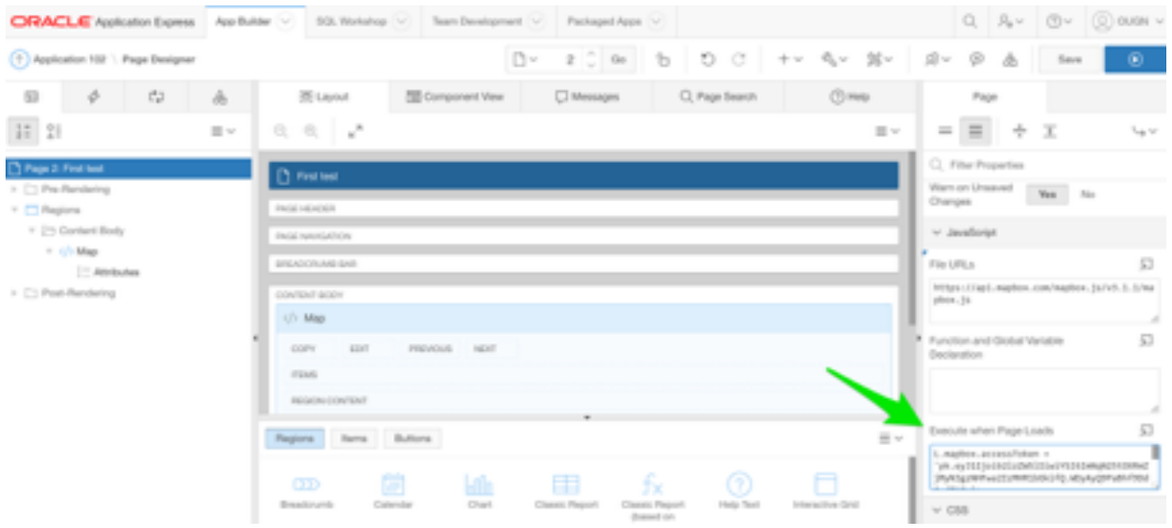
Add it here



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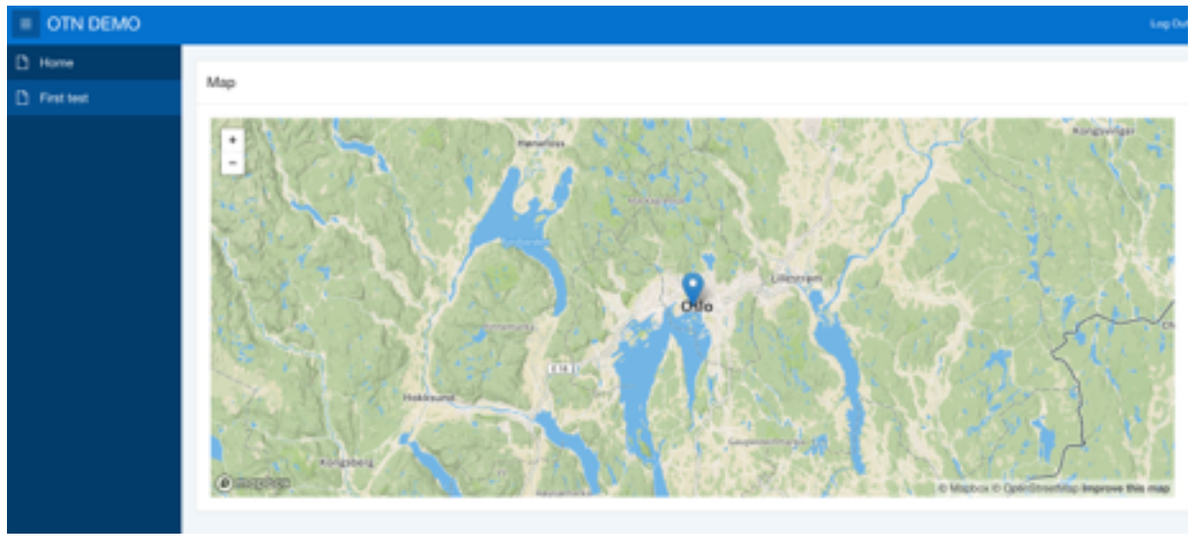

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It works, let us map some data

from the database, of course

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Find a (cool) data set

- data.norge.no
- Use Google
- Or see my next session

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Example with post offices

- http://www.bedreinnsikt.no/innhold/datasett-postnummer
- Data downloaded as text file
- Import with SQL Developer

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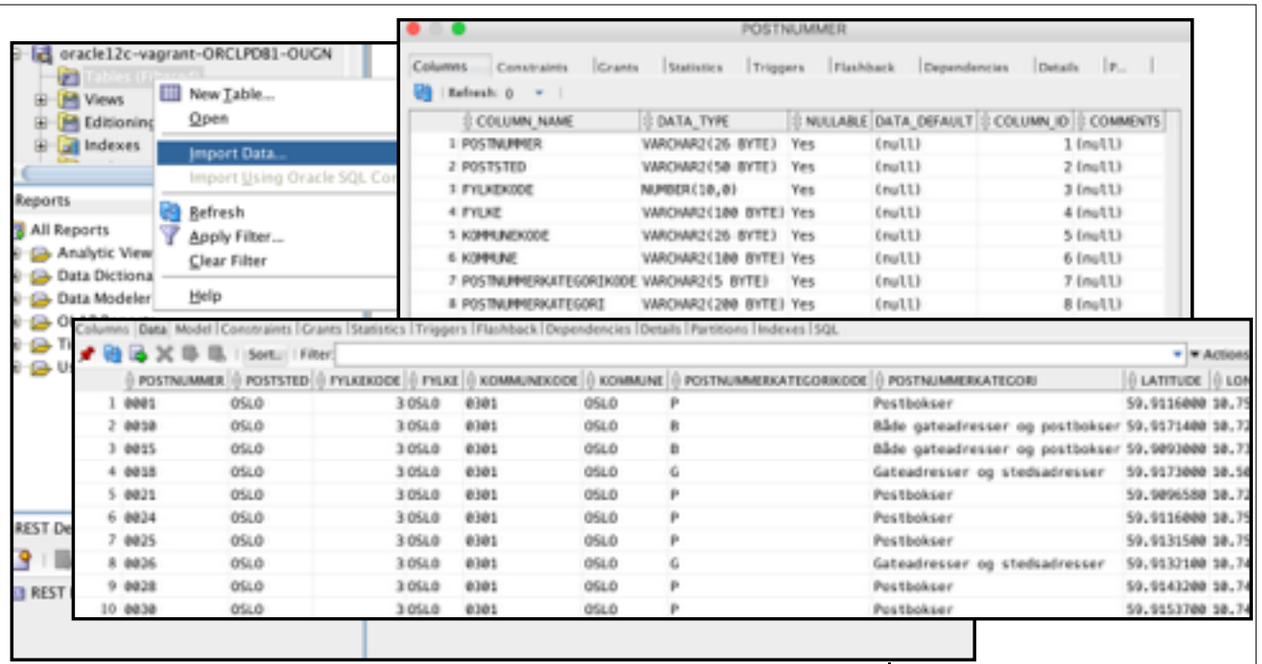

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A few slides on JavaScript and JSON

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JavaScript and JSON

- JS library wants data in JSON
- Not too difficult to generate with PL/SQL
- 12c comes with rich JSON support
  - A good reason to upgrade!

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JSON support in 12c

- Generate JSON with SQL
- Store JSON in your database
- Enables schema-on-read (“store now — think later”)
- Check out “JSON Developers Guide”
  - even if you’re a DBA

Every new database release
is an opportunity to simplify code

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Useful functions

- JSON_OBJECT
  - creates a JSON-object from column(s)
- JSON_ARRAYAGG
  - aggregate function
  - JSON-array of objects or column(s)

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Return a list of points

```
select json_object('postnummer' value json_arrayagg(json_longlat )) json_arr
from (
select json_object('postnummer' value postnummer,
  'poststed' value apex_escape.html(poststed),
  'lat' value latitude, 'lng' value longitude) json_longlat
from postnummer
where rownum < 10
);
```

APEX is full of useful packages
that makes life easier

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One annoying bug

- Functions can return VARCHAR2 (max 4000 bytes) or CLOB
- But due to bug 25186856, CLOB doesn't work :(
  - See *Database Readme*
- A rewrite not too complicated

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Consider extended data types

- Increase limit from 4000 to 32767 bytes for VARCHAR2 (for 12c)
- This is done by default in the cloud
- For on-prem database you'll need to do it.
- See Tim Halls post: https://oracle-base.com/articles/12c/extended-data-types-12cR1

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PL/SQL to be called from APEX

```
create or replace function get_json return varchar2 is
  l_json varchar2(32767);
  i pls_integer;
begin
  i:=0;
  for piece in ( select json_object('id' value id,
     'postnummer' value postnummer,
     'poststed' value apex_escape.html(poststed),
     'kategori' value postnummerkategori,'lat' value latitude,
     'lng' value longitude null on null) longlat
    from postnummer
    where rownum < 20) loop
    if i>1 then
      l_json := l_json || ',' || piece.longlat;
    else
      l_json := piece.longlat;
    end if;
    i := i + 1;
  end loop;
  return '{"postnummer": [' || l_json || ']}';
end;
/
```

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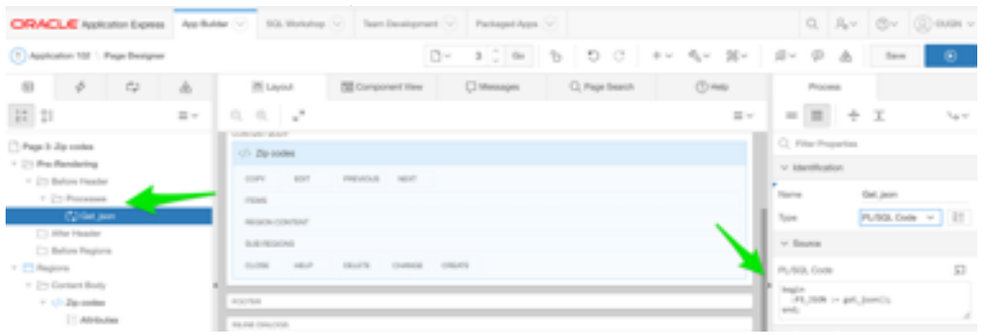
Back to APEX example

- Add a hidden item to store the JSON-array
- Add a process to be executed *Before Header*



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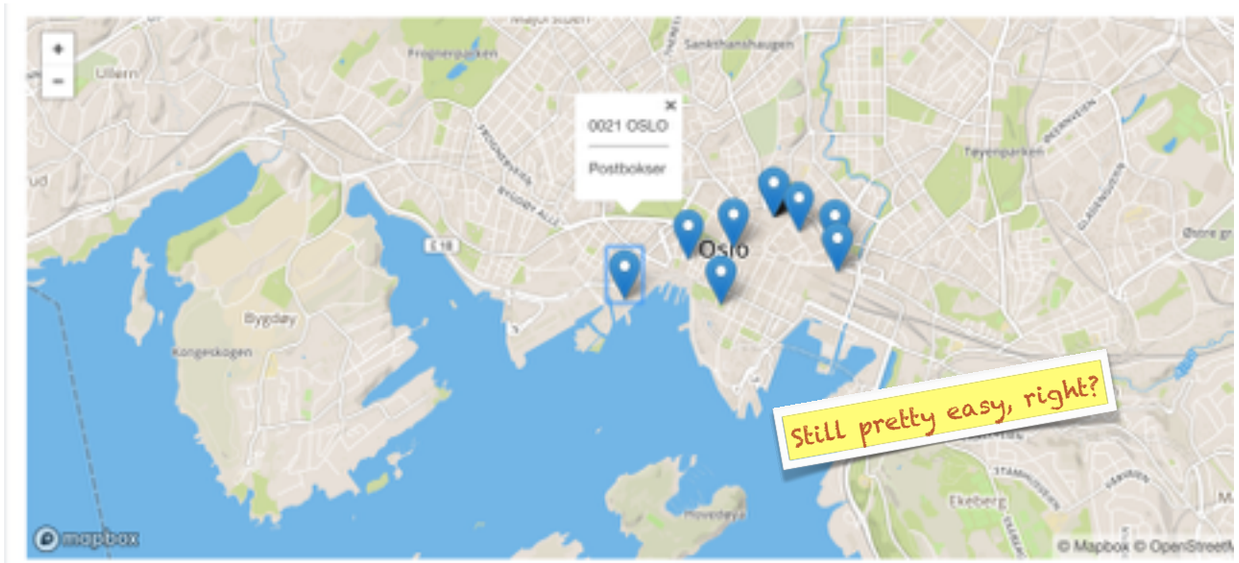
Add to previous "Execute when Page loads"

```
var popupOptions = {
    offset: new L.Point(3,-25)
};

var json = JSON.parse($v('P3_JSON'));
var pn = json.postnummer;
var marker, nummer, text, id ,lat, lng, sted,kategori;
var Markers = [];

for (var i = 0; i < pn.length; i++) {
    id = [i].id;
    lat = Number(pn[i].lat);
    lng = Number(pn[i].lng);
    nummer = pn[i].postnummer;
    sted = pn[i].poststed;
    kategori = pn[i].kategori
    text = '<span class="postnummer">' + nummer + " " + sted + "<hr>" + kategori + '</span>';
    marker = L.marker([lat,lng]);
    marker.bindPopup(text,popupOptions);
    marker.id = id;
    marker.name = name;
    Markers.push(marker);
    marker.addTo(map);
}

window.removeMarkers = function() {
    Markers.forEach (function(e){
        map.removeLayer(e);
    });
    Markers = [];
}
```

```
L.mapbox.accessToken = 'pk.eyJ1Ijoib2lzZW5lIiwiYSI6ImNqN25tOXRmZjMyN3gzNHFwa2IzMHR1bGkifQ.WDyAyQ9PaBhf9DdA-dQLCw';
var map = L.mapbox.map('mapRegion', 'mapbox.streets')
   .setView([59.910349, 10.725035], 9);
var marker = L.marker([59.910349, 10.725035]).addTo(map);


var popupOptions = {
   offset: new L.Point(3,-25)
};

var json = JSON.parse($v('P3_JSON'));
var pn = json.postnummer;
var marker, nummer, text, id ,lat, lng, sted,kategori;
var Markers = [];

for (var i = 0; i < pn.length; i++) {
   id = [i].id;
   lat = Number(pn[i].lat);
   lng = Number(pn[i].lng);
   nummer = pn[i].postnummer;
   sted = pn[i].poststed;
```



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Add more Stuff

- Add circles, polygons, etc
- Check out API documentation from mapbox
- https://www.mapbox.com/mapbox.js/api/v3.1.1/

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What about Spatial?

When you need to analyse your stuff

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SDO_GEOMETRY

- Datatype to store spatial objects in database
- From a point to complex objects
- Needed for spatial analysis
- Spatial applications use this datatype
- Their data can be displayed in APEX.

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Some cleanup first

```
update postnummer set longitude = null,latitude = null
where latitude ='(blank)' or longitude='(blank)';
```

Convert your data to SDO_GEOMETRY

```
alter table postnummer add geom_location sdo_geometry;
-- 8307 for WGS 84 with order lon,lat
update postnummer
set geom_location=sdo_geometry(2001, 8307,
  sdo_point_type(longitude,latitude,null),null,null)
where longitude is not null and latitude is not null;
```

Type of map for these data, 8307 is common

2001 for points

Columns in table (longitude, latitude) from dataset
Slightly confusing names. Look at data to see what is what

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With SDO_GEOMETRY

- You can use functions in Spatial

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“What is the minimum distance to next place, for each place?”

```
select postnummer,round(min(distance)) distance
from (
    select a.postnummer,  SDO_GEOM.sdo_distance(
      a.geom_location,
      SDO_DIM_ARRAY(
        SDO_DIM_ELEMENT('long', -180,180,1),
        SDO_DIM_ELEMENT('lat',-90,90,1)),
      b.geom_location,
      SDO_DIM_ARRAY(
        SDO_DIM_ELEMENT('long', -180,180,1),
        SDO_DIM_ELEMENT('lat',-90,90,1))) distance
    from postnummer a, postnummer b
    where a.FYLKE='FINNMARK'
    and a.postnummerkategori ='Postbokser'
    and b.postnummerkategori ='Postbokser'
    and a.latitude != b.latitude )
group by postnummer
order by 2 ;
```

POSTNUMMER	DISTANCE
9505	1682
9504	1682
9502	1682
9501	1682
9506	1682
9503	1682
9916	2425
9914	2425
9508	3409
9507	3409
9915	4770
9846	14181
9820	14181
9811	16472
9810	16472
9616	21161
9621	21161
9615	21161
9991	32239
9981	32239

Default unit is meter for geodetic data

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Spatial Index

- Special index to speed up search
- Oracle needs some data about the data — *metadata* before an index can be created
- Insert one row in USER_SDO_GEOM_METADATA for each column (aka *layer*)
- Not all functions requires a spatial index (previous example)
- All *Spatial Operators* do!

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```
insert into user_sdo_geom_metadata
(TABLE_NAME,COLUMN_NAME,DIMINFO,SRID)
values ('POSTNUMMER','GEOM_LOCATION',SDO_DIM_ARRAY(
  SDO_DIM_ELEMENT('long', -180,180,1),
  SDO_DIM_ELEMENT('lat',-90,90,1)),
  8307
);
commit;
```

Lower boundary

Tolerance

Name you give the dimension

Higher boundary

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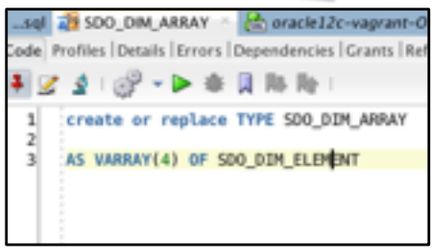
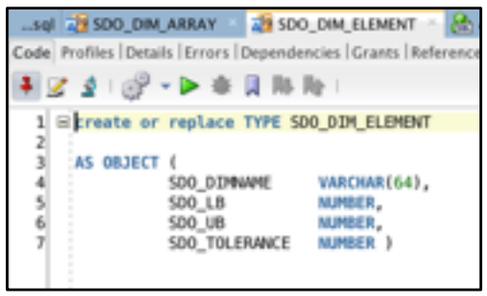
Tip: Shift-F4 in SQL Developer

Put cursor on object_type
Hit Shift-F4





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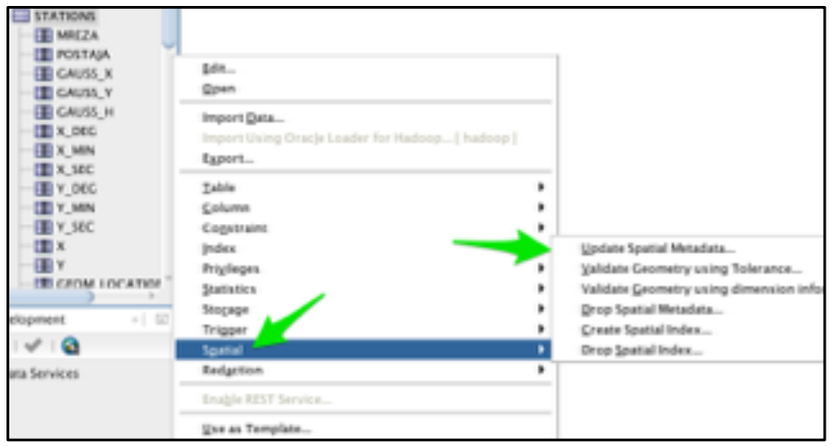
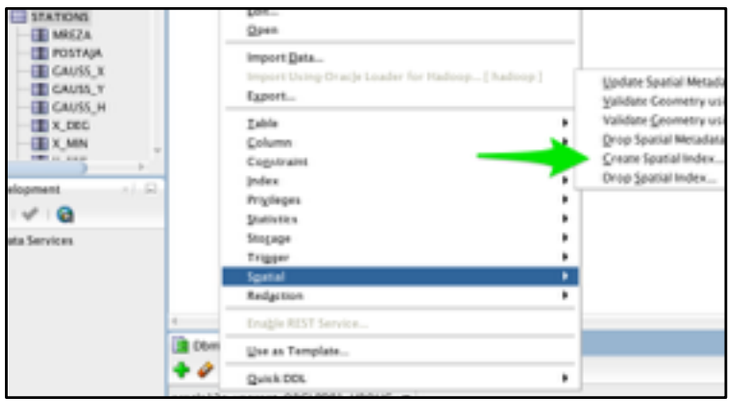
Or use menus in SQL Developer



Create the Index

```
create index postnummer_geom_location_si
on POSTNUMMER(geom_location)
indextype is MDSYS.SPATIAL_INDEX;
```



Package APEX_SPATIAL can also help with this.

Spatial Operators

- Used as normal operators in WHERE clause
- Filter rows as early before further processing
- Require *Spatial Index*

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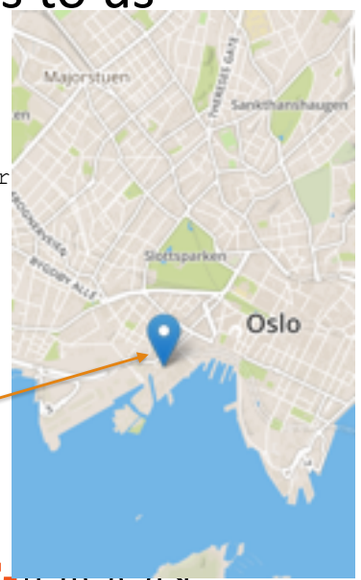
Find the three closest places to us

```
select postnummer,round(sdo_nn_distance(1)) distance_meter
  geom_location
from postnummer
where
sdo_nn(geom_location,
  sdo_geometry(2001, 8307,
    sdo_point_type(10.725035,59.910349,null),null,null),
  'sdo_num_res=3',1) = 'TRUE'
order by 2;
```

Our position



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POSTNUMMER	DISTANCE_METERS	GEOM_LOCATION
0250	47	[MDSYS.SDO_GEOMETRY]
0021	80	[MDSYS.SDO_GEOMETRY]
0252	241	[MDSYS.SDO_GEOMETRY]

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TO_GEOJSON

- Convert SDO_GEOMETRY to GEO_JSON
- GEO_JSON supported in JS API
- SDO_UTIL.TO_GEOJSON
- Example with previous query
- **Warning**: GeoJSON inverts the order (lon, lat)

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```
select postnummer,round(sdo_nn_distance(1)) distance_m,
  sdo_util.to_geojson(geom_location)location_json
from postnummer
where
sdo_nn(geom_location,
  sdo_geometry(2001, 8307,
    sdo_point_type(10.725035,59.910349,null),null,null),
  'sdo_num_res=3',1) = 'TRUE'
order by 2;
```

POSTNUMMER	DISTANCE_M	LOCATION_JSON
250	47	{ "type": "Point", "coordinates": [10.72507, 59.90993] }
21	80	{ "type": "Point", "coordinates": [10.725392, 59.909658] }
252	241	{ "type": "Point", "coordinates": [10.72301, 59.90844] }

Again, 12c makes this so much easier

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Code before header

```
begin
select  '[' || listagg(geo_json,',')
   within group ( order by id) || ']' into :P4_JSON
from (
  select id, sdo_util.to_geojson(geom_location) geo_json
  from postnummer
    where
    sdo_nn(geom_location,
      sdo_geometry(2001, 8307,
        sdo_point_type(10.725035,59.910349,null),null,null),
      'sdo_num_res=3',1) = 'TRUE'
);
end;
```

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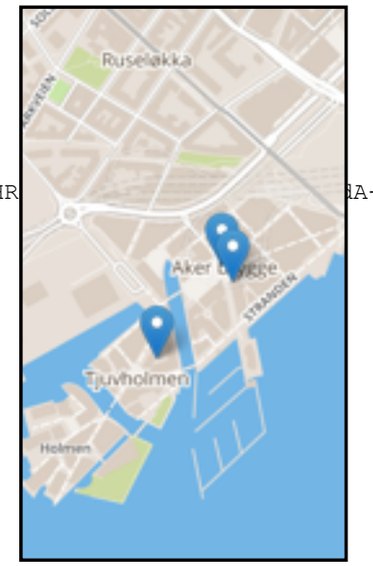
JS on load

```
L.mapbox.accessToken =
'pk.eyJ1Ijoib2lzZW5lIiwiYSI6ImNqN25tOXRmZjMyN3gzNHFwa2IzMHR                    HA-
dQLCw';
var map = L.mapbox.map('map2Region', 'mapbox.streets')
    .setView([59.910349, 10.725035], 9);

var geo_json = JSON.parse($v('P4_JSON'));
var layer = L.geoJson(geo_json).addTo(map);
```

Here the order is lat, lon

GeoJSON uses lon, lat



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Add to GeoJSON

- to_geojson returns the geometries-part of GeoJSON
- Add other columns for better UX

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```
{ "type": "FeatureCollection",
    "features": [
      { "type": "Feature",
        "geometry": {"type": "Point", "coordinates": [102.0, 0.5]},
        "properties": {"prop0": "value0"}
        },
      { "type": "Feature",
        "geometry": {
          "type": "LineString",
          "coordinates": [
            [102.0, 0.0], [103.0, 1.0], [104.0, 0.0], [105.0, 1.0]
            ]
          },
        "properties": {
          "prop0": "value0",
          "prop1": 0.0
          }
        },
      { "type": "Feature",
         "geometry": {
           "type": "Polygon",
           "coordinates": [
             [ [100.0, 0.0], [101.0, 0.0], [101.0, 1.0],
               [100.0, 1.0], [100.0, 0.0] ]
             ]
         },
         "properties": {
           "prop0": "value0",
           "prop1": {"this": "that"}
           }
         }
       ]
     }
```

GeoJSON example

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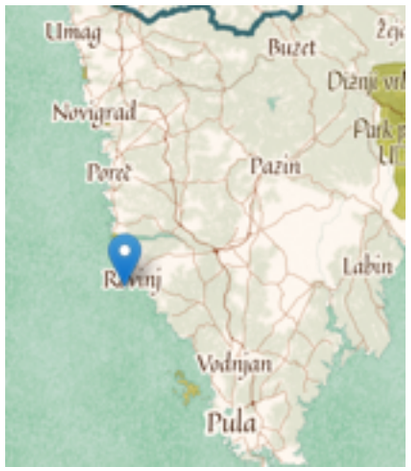
Try different map styles

- Parameter to L.mapbox.map
- Try mapbox.pirates, mapbox.pencil, mapbox.comic, etc



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Beer Data from Untappd

My drinking on a map

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UNTAPPD
DRINK SOCIALLY

- Supporting users can download their data
- Position for each venue and other information.
- As earlier, easy to import with SQL Developer

	COLUMN_NAME	DATA_TYPE
1	BEER_NAME	VARCHAR2(200 BYTE)
2	BREWERY_NAME	VARCHAR2(128 BYTE)
3	BEER_TYPE	VARCHAR2(128 BYTE)
4	BEER_ABV	NUMBER(6,2)
5	BEER_IBU	NUMBER(5,0)
6	TASTING_COMMENT	VARCHAR2(500 BYTE)
7	VENUE_NAME	VARCHAR2(128 BYTE)
8	VENUE_CITY	VARCHAR2(50 BYTE)
9	VENUE_STATE	VARCHAR2(128 BYTE)
10	VENUE_COUNTRY	VARCHAR2(50 BYTE)
11	VENUE_LAT	NUMBER(8,4)
12	VENUE_LNG	NUMBER(12,7)
13	RATING_SCORE	NUMBER(5,2)
14	CREATED_AT	DATE
15	CHECKIN_URL	VARCHAR2(128 BYTE)
16	BEER_URL	VARCHAR2(128 BYTE)
17	BREWERY_URL	VARCHAR2(128 BYTE)
18	BREWERY_COUNTRY	VARCHAR2(128 BYTE)
19	BREWERY_CITY	VARCHAR2(50 BYTE)
20	BREWERY_STATE	VARCHAR2(50 BYTE)

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Add spatial column

```
alter table untappd
add location sdo_geometry;

update untappd set location=
  sdo_geometry(2001, 8307,
    sdo_point_type(venue_lng,VENUE_LAT,null),null,null)
where venue_lng is not null
  and venue_lat is not null;
commit;
```

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Code fetching data

```
select json_object('type' value 'FeatureCollection',
  'features' value
  json_arrayagg(feature format json returning varchar2(32000)) returning varchar2(32000))
into :P7_JSON
from (
  select json_object('type' value 'Feature',
  'properties' value json_object('description' value beer_name
    , 'title' value venue_name) ,
  'geometry' value cast (sdo_util.to_geojson(location)
     as varchar2(32000)) format json)   feature
from untappd
where venue_city='Oslo');
```

Extended data types has been enabled

JavaScript code

```
L.mapbox.accessToken =
'pk.eyJ1Ijoib2lzZW5lIiwiYSI6ImNqN25tOXRmZjMyN3gzNHFwa2IzMHR1bGkifQ.WDyAyQ9PaBhf9DdA-
dQLCw';

var map = L.mapbox.map('mapRegion', 'mapbox.streets')
    .setView([59.910349, 10.725035], 13);

var geo_json = JSON.parse($v('P7_JSON'));
L.mapbox.featureLayer(geo_json).addTo(map);
```

My drinking on a map

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Other Suppliers

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Tiles Servers

- JavaScript library uses a tile server to fetch map tiles
  - Some available:
    - Google
    - Open Street Map
    - MapQuest
    - Nokia
    - Microsoft
    - Mapbox
    - Statens Kartverk

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$$$

- Some require registration (API key)
- Free use up to a limit (request pr time period)
- Extra features or enterprise use costs money.
- You can host your own (open source).

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Previous Example with Statens Kartverk

Code Editor - Execute when Page Loads

```
var map = L.map('mapRegion').setView([59.918149, 10.7258351, 13);
            L.tileLayer('http://opencache.statkart.no/gatekeeper/gk/gk.open_gmaps?layers=topo2&zoom={z}&x={x}&y={y}', {
                attribution: '<a href="http://www.kartverket.no/">Kartverket</a>'
            }).addTo(map);

var geo_json = JSON.parse($v('P5_JSON'));
var layer = L.geoJson(geo_json).addTo(map);
```

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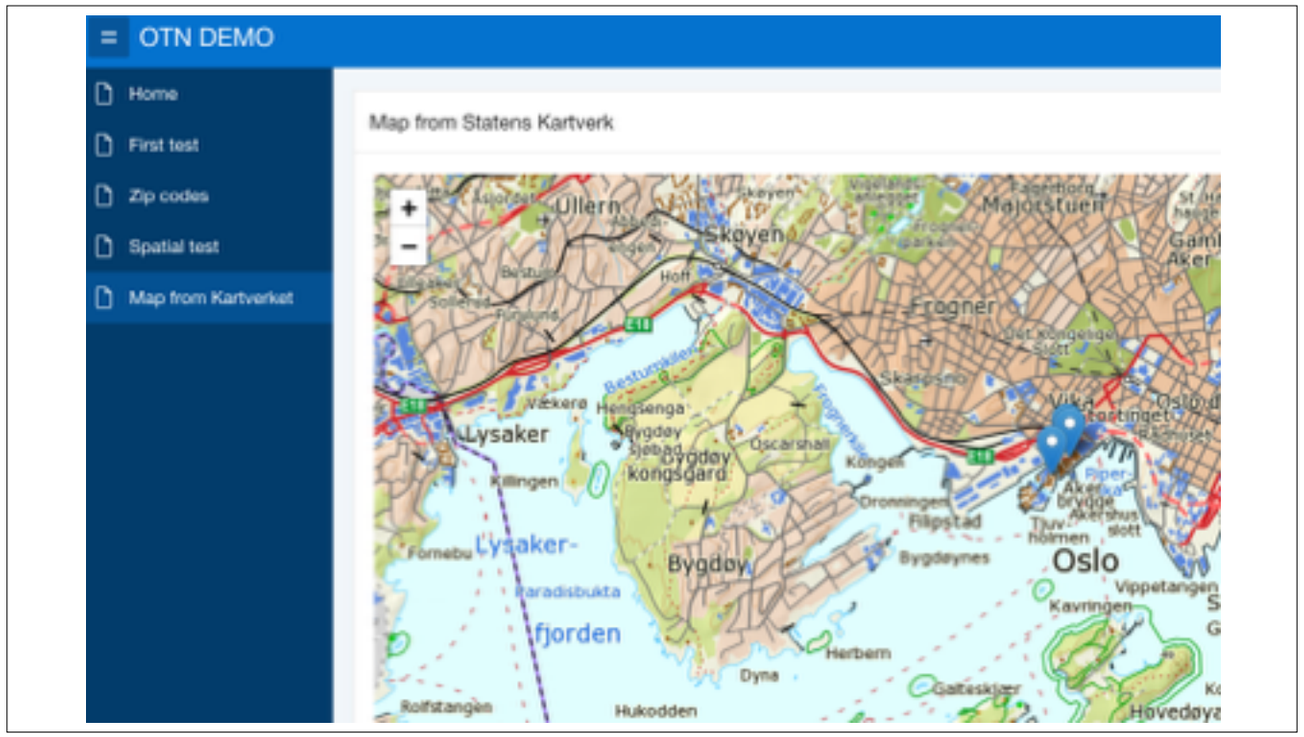
OTN DEMO
Home
First test
Zip codes
Spatial test
Map from Kartverket
Map from Statens Kartverk
Ullern
Skøyen
Majorstuen
Frogner
Lysaker
Bygdøy
Oslo
Lysaker-
fjorden
Bygdøy kongsgård
Filipstad
Bygdøynes
Herbern
Dyna
Hukodden
Rolfstangen
Kavringen
Vippetangen
Hovedøya

More mapping options

- See https://www.kartverket.no/data/lage-kart-pa-nett/ for details
- Try different kind of maps (at least 6 available)

Google Maps?

- Different API
- Not too difficult when you know Leaflet
- Need to sign up for an API key
- I found Leaflet / Mapbox easier to work with

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Google Maps Test

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Summary - You need

- One JavaScript library / API needed
  - Use Leaflet or Mapbox
- A tile server that serves you map tiles
  - OpenStreetMap, Mapbox, Mapquest
  - Automatic in Mapbox
- A process to load data into JSON
- JavaScript code that renders it on the map

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Tips at the end

for troubleshooting and fun

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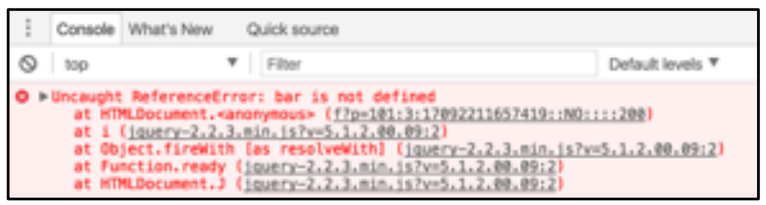
When your page is blank

- Developer Tool in Chrome
- “F12” in IE
- Check console for error messages
- Pretty easy to spot typos



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Log to console

- console.log()
- Verify data and logic
- If data are not shown it may be wrong order
  - RFC 5870

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Conclusion

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- Apex is easy and fun
- Good support for JSON in 12c
- Display easily spatial and “normal” data
- Show your data and get attention!

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Crash introduction to Docker

Spend time on learning, not installation

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Oracle on Docker in few steps

1. Download Docker:
   - www.docker.com/docker-mac
   - www.docker.com/docker-windows
   - www.docker.com/docker-oracle-linux
2. Download Oracle database software
   - otn.oracle.com
3. Clone Dockerfiles by Oracle from Github
   - `git clone` github.com/oracle/docker-images

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Build and start with

```
4../buildDockerImage.sh -v 12.2.0.1 -e

5. docker run -p 1521:1521 \
-p 8080:8080 \
—name oracle-ee \
oracle/database:12.2.0.1-ee
```

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Up and running

- SYS and SYSTEM password is generated each time a container is created
- Password printed out to screen
- Database is created during first run.
- Use SQL Developer Command Line for easy testing

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Or perhaps Vagrant?

- If you know Virtual Box, Vagrant may be even easier.
- Find ready to use stuff here: https://github.com/gvenzl/vagrant-boxes

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