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Use APEX to Visualize Spatial Data

- Display data on maps with minimal efforts

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ORACLE ACE

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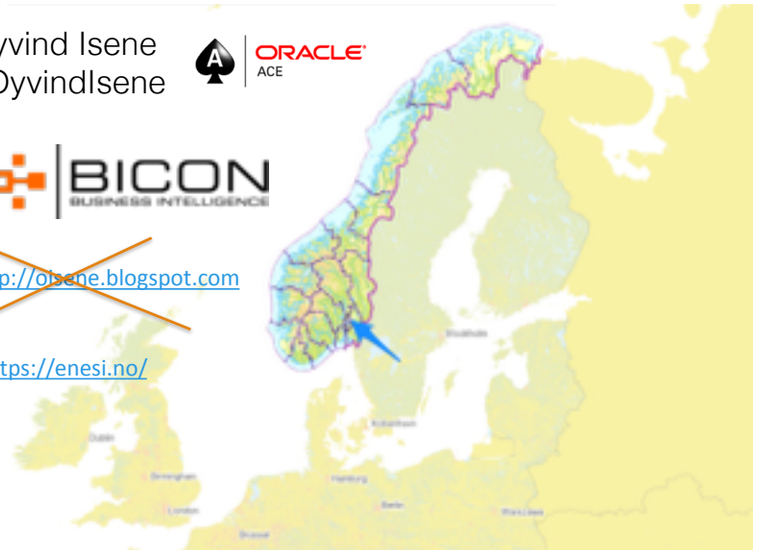
~~http://oisene.blogspot.com~~

https://enesi.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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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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Add JavaScript and CSS

- From mapbox
- Add JavaScript and CSS URLs to page

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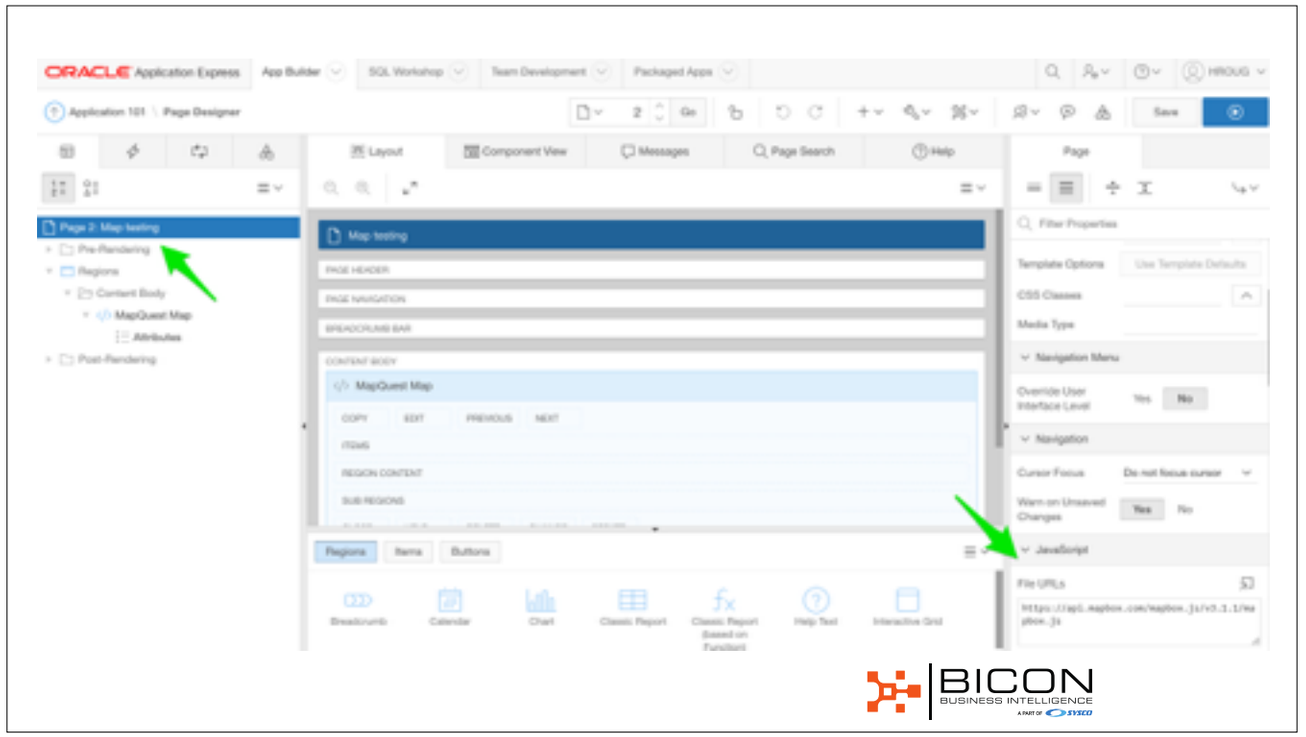

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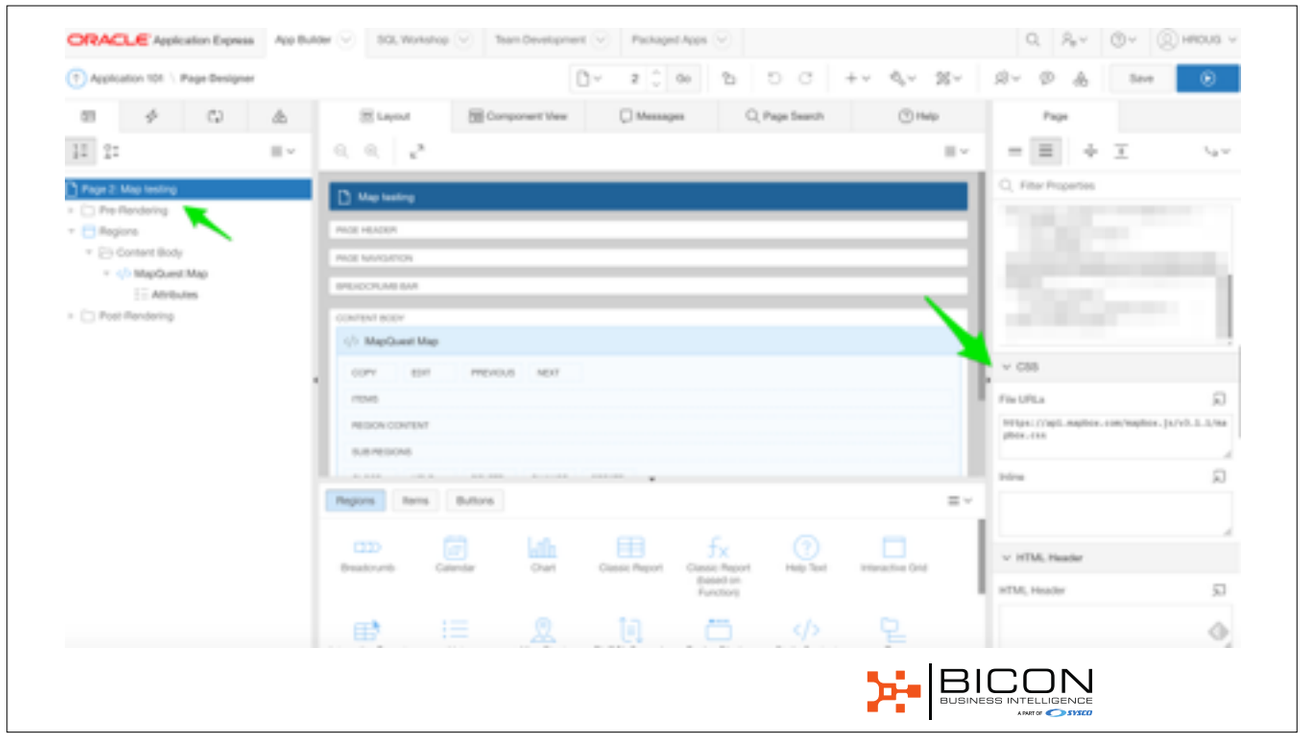
ORACLE Application Express
App Builder
SQL Workshop
Team Development
Packaged Apps
Application 101
Page Designer
Save
Layout
Component View
Messages
Page Search
Help
Page
Page 2: Map testing
Pre-Rendering
Regions
Content Body
MapQuest Map
Attributes
Post-Rendering
Map testing
PAGE HEADER
PAGE NAVIGATION
BREADCRUMB BAR
CONTENT BODY
MapQuest Map
COPY
EDIT
PREVIOUS
NEXT
ITEMS
REGION CONTENT
SUB REGIONS
Regions
Items
Buttons
Breadcrumb
Calendar
Chart
Classic Report
Classic Report (based on Function)
Help Text
Interactive Grid
Filter Properties
CSS
File URLs
Inline
HTML Header
HTML Header
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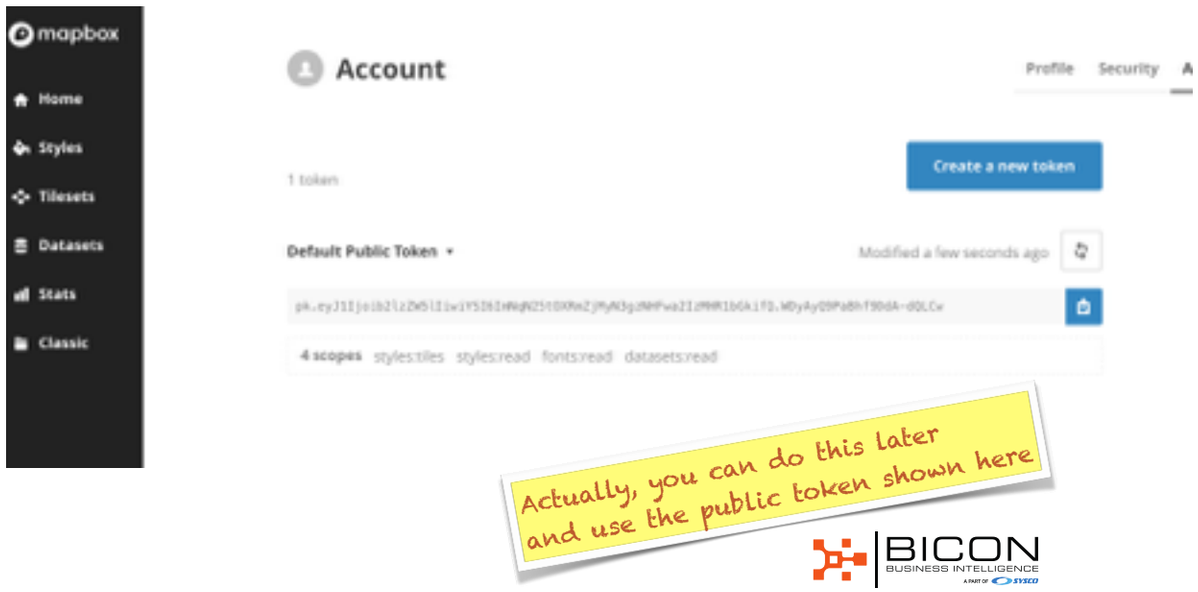
Create a user at Mapbox



Some code…

```
L.mapbox.accessToken =
'pk.eyJ1Ijoib2lzZW5lIiwiYSI6ImNqN25tOXRmZjMyN3gzNHFwa2IzMHR1bGkifQ.WDyAyQ9PaBhf9DdA-dQLCw';
var map = L.mapbox.map('mapRegion', 'mapbox.streets')
    .setView([45.059248, 13.627097], 9);
var marker = L.marker([45.059248, 13.627097]).addTo(map);
```

Your id from <div …>

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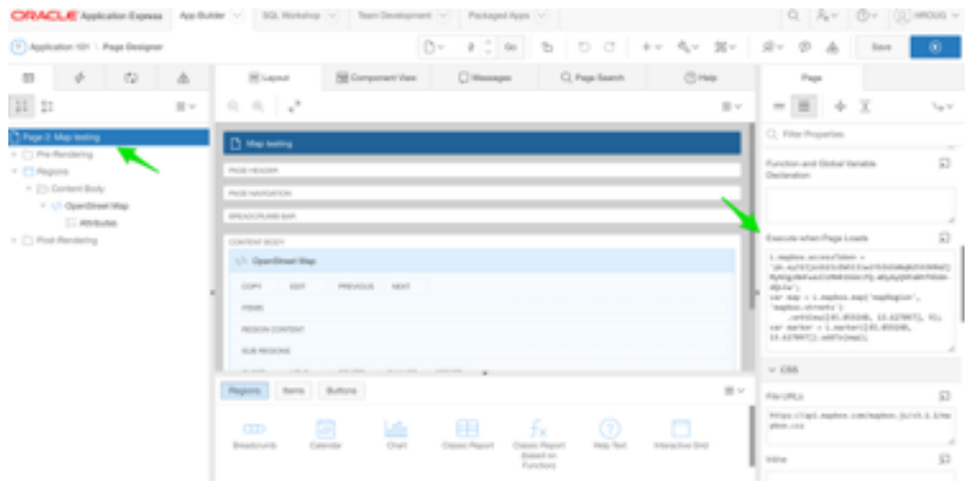
Add it here



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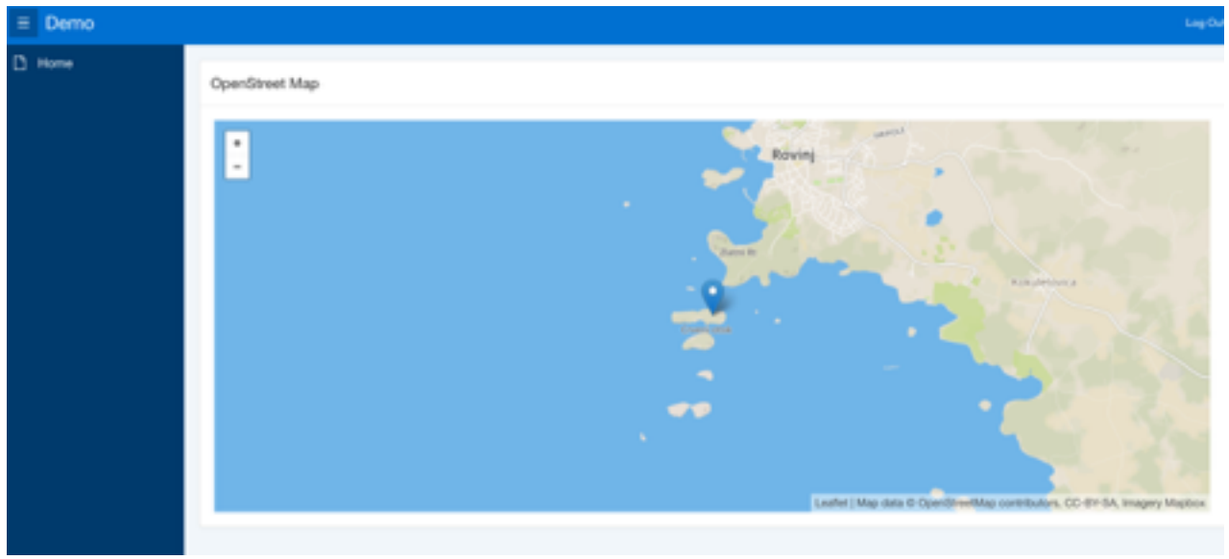

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It works, let us map some data

from the database, of course

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Find a cool data set

- data.gov.hr - open data from your government
  - not in English

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Example with air pollution

- http://iszz.azo.hr/iskzl/koordinate.htm
- Data downloaded as Excel file
- Open it and copy out the table, save in new file
- Import with SQL Developer

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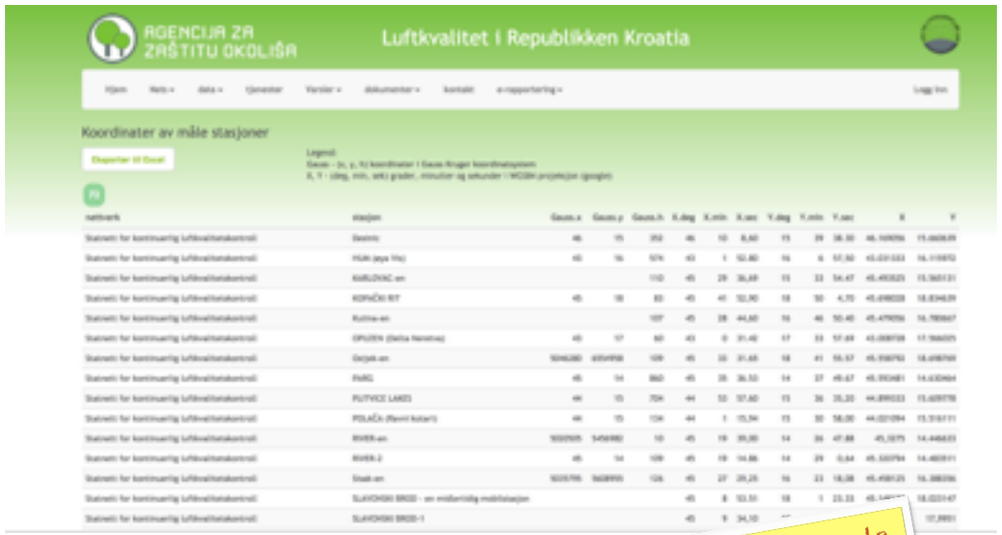
AGENCIJA ZA ZAŠTITU OKOLIŠA
Luftkvalitet i Republikken Kroatia
Koordinater av måle stasjoner
This is the web page after Google translated it to Norwegian...
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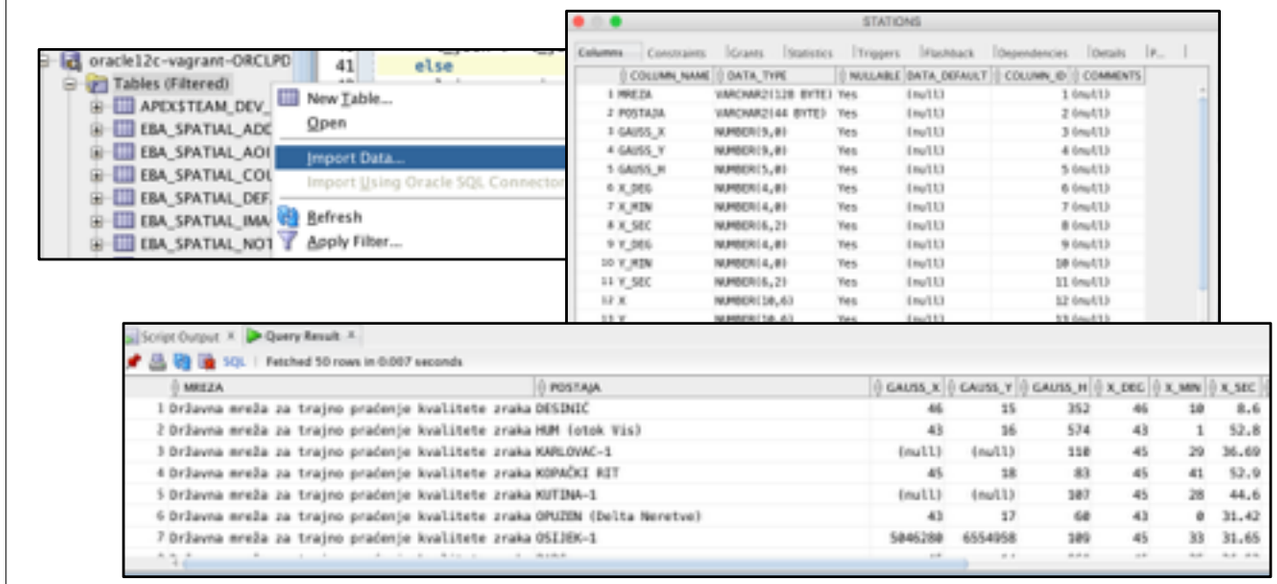

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JavaScript and JSON

- 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

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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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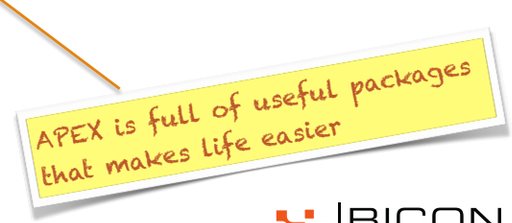
Return a list of points

```
select json_object('stations' value json_arrayagg(json_longlat )) json_arr
from (
select json_object('id' value id,
  'postaja' value apex_escape.html(postaja),
  'lat' value x, 'lng' value y) json_longlat
from stations
where id < 20
);
```



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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,'mreza'
     value apex_escape.html(mreza),
     'postaja' value postaja,'lat' value x,
     'lng' value y null on null) longlat
    from stations) loop
    if i>1 then
      l_json := l_json || ',' || piece.longlat;
    else
      l_json := piece.longlat;
    end if;
    i := i + 1;
  end loop;
  return '{"stations": [' || 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*

```
begin
  :P3_JSON := get_json();
end;
```

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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 postajas = json.stations;
var marker, name, text, id ,lat, lng, mreza;
var Markers = [];

for (var i = 0; i < postajas.length; i++) {
    id = postajas[i].id;
    lat = Number(postajas[i].lat);
    lng = Number(postajas[i].lng);
    name = postajas[i].postaja;
    mreza = postajas[i].mreza;
    text = '<span class="postaja">' + mreza + "<hr>" + name + '</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 = [];
}
```

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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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Convert your data to SDO_GEOMETRY

```
alter table stations add geom_location sdo_geometry;
-- 8307 for WGS 84 with order lon,lat
update stations
set geom_location=sdo_geometry(2001, 8307,
  sdo_point_type(y,x,null),null,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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“What is the minimum distance to next station, for each station?”

```
select postaja,round(min(distance)) distance
from (
    select a.POSTAJA, 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 stations a, stations b
    where a.id != b.id)
group by POSTAJA
order by 2 ;
```

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POSTAJA	DISTANCE
Ksaverska cesta	19
ZAGREB PPI PM2,5 - Ksaverska cesta	19
Umag sediment	20
Umag, Ulica Eduardo Pascali	20
SLAVONSKI BROD - privremena pokretna postaja	105
SLAVONSKI BROD-2	105
Mirogojska cesta	303
Vrh Martinšćice	410
Kostrena - Martinšćica	410
Vrhovec	640
Prilaz baruna Filipovića	640
Domobranska ulica 2	748
Dr.V.Mačeka 48	748
KUTINA-1	776
Vatrogasni dom (K2) - Kutina	776
KARLOVAC-1	795
RIJEKA-2	831
Banija 18	832
Gripe	867
Split-1	867

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 ('STATIONS','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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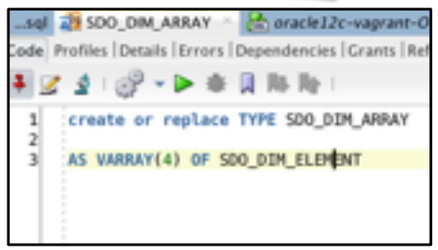
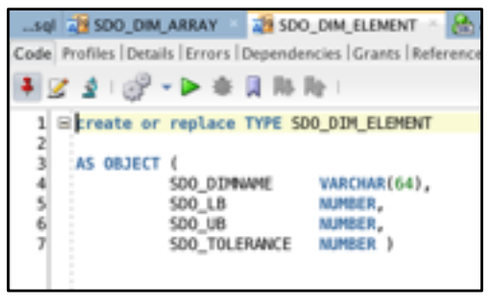
Tip: Shift-F4 in SQL Developer

Put cursor on object_type
Hit Shift-F4





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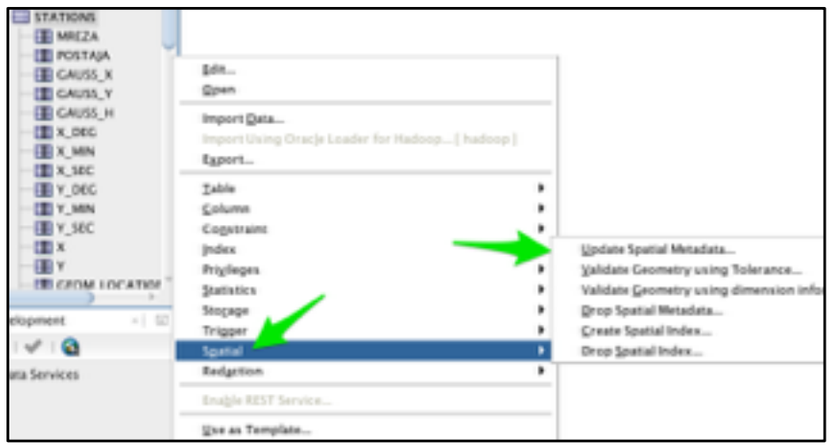
Or use menus in SQL Developer



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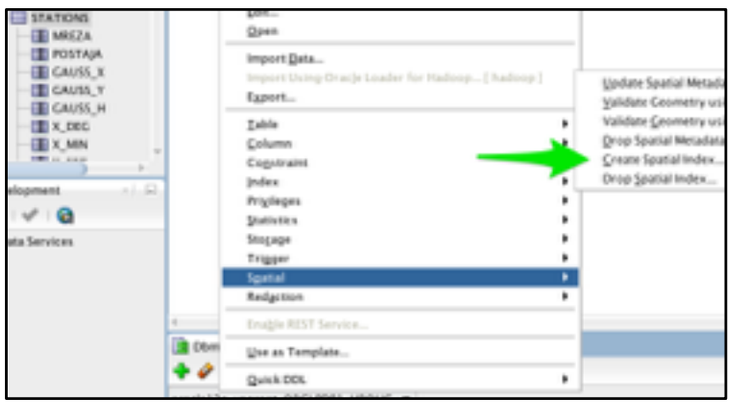
Create the Index

```
create index stations_geom_location_si
on stations(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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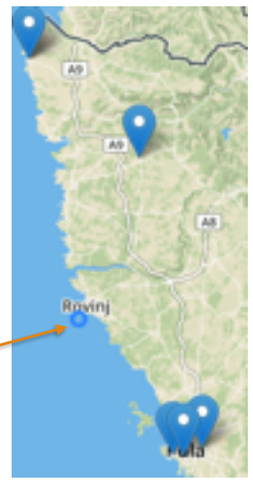
Find the three closest stations to us

```
select postaja,round(sdo_nn_distance(1)) distance_km,
  geom_location
from stations
where
sdo_nn(geom_location,
  sdo_geometry(2001, 8307,
    sdo_point_type(13.627097,45.059248,null),null,null),
  'sdo_num_res=3 unit=km',1) = 'TRUE'
order by 2;
```

Our position



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POSTAJA	DISTANCE_KM	GEOM_LOCATION
Pula Fižela	27	[MDSYS.SDO_GEOMETRY]
Ulica Kamenjak (Dječji vrtić)	28	[MDSYS.SDO_GEOMETRY]
VIŠNJAN	28	[MDSYS.SDO_GEOMETRY]

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 postaja,round(sdo_nn_distance(1)) distance_km,
  sdo_util.to_geojson(geom_location)location_json
from stations
where
sdo_nn(geom_location,
  sdo_geometry(2001, 8307,
    sdo_point_type(13.627097,45.059248,null),null,null),
  'sdo_num_res=3 unit=km',1) = 'TRUE'
order by 2;
```

POSTAJA	DISTANCE_KM	LOCATION_JSON
Pula Fižela	27	{ "type": "Point", "coordinates": [13.816858, 44.862469] }
Ulica Kamenjak (Dječji vrtić)	28	{ "type": "Point", "coordinates": [13.83925, 44.858889] }
VIŠNJAN	28	{ "type": "Point", "coordinates": [13.749778, 45.2…

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 stations
    where
    sdo_nn(geom_location,
      sdo_geometry(2001, 8307,
        sdo_point_type(13.627097,45.059248,null),null,null),
      'sdo_num_res=3 unit=km',1) = 'TRUE'
);
end;
```

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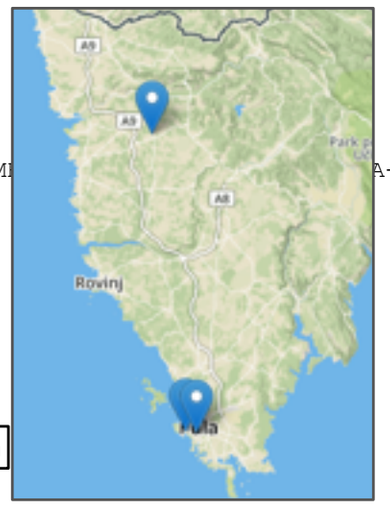
JS on load

```
L.mapbox.accessToken =
'pk.eyJ1Ijoib2lzZW5lIiwiYSI6ImNqN25tOXRmZjMyN3gzNHFwa2IzMI                    A-
dQLCw';
var map = L.mapbox.map('map2Region', 'mapbox.streets')
    .setView([45.059248, 13.627097], 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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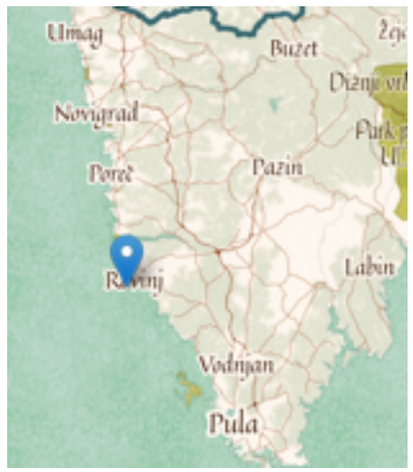
```
{ "type": "FeatureCollection",
    "features": [
      { "type": "Feature",
        "geometry": {"type": "Point", "coordinates": [102.0, 0.5]},
        "properties": {"prop0": "value0"}
        },
      { "type": "Feature",
        "geometry": {
          "type": "LineString",
          "coordinates": [
            [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

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)) into :P5_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(4000)) format json) feature
from untappd
where venue_city='Birmingham'
and created_at > date '2016-01-01')
;
```

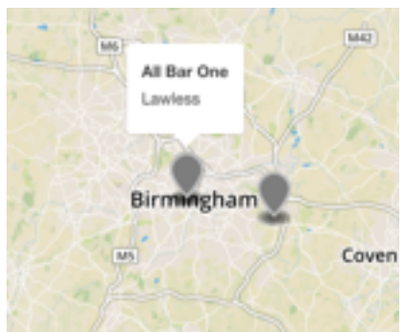
JSON_OBJECT() does not handle CLOB well.

JavaScript code

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

var map = L.mapbox.map('map2Region', 'mapbox.streets')
    .setView([52.489471, -1.898575], 9);

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



Summary - You need

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

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Tips at the end

for troubleshooting and fun

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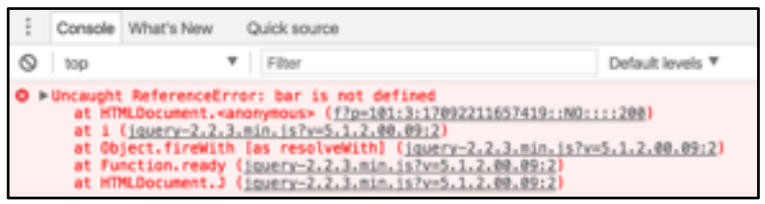
When your page is blank

- 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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