Analyzing Location-based Patterns with Python and Oracle Database

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Why This Matters

Everything happens somewhere.

Location patterns provide powerful insights. The combination of an enterprise spatial data platform and an ecosystem of mature, specialized, open source spatial analysis libraries makes it easy to location-enable your data analyses in Python.

Agenda

- Python and Oracle Spatial
  - Concepts
  - Drivers
- Notebook demos
  - Building blocks
  - Basic spatial analyses
  - Advanced spatial analysis

Robust Python geospatial library ecosystem

- GeoDjango - Django geographic web framework.
- Landsat-util - Landsat-util is a command line utility that makes it easy to search, download, and process Landsat imagery.
- Rasterio - Rasterio employs GDAL under the hood for file I/O and raster formatting.
- Rasterstats - Python module for summarizing geospatial raster datasets based on vector geometries.
- PyQGIS - Python for QGIS.
- GeoPandas - Python tools for geographic data.
- Shapely - Manipulation and analysis of geometric objects in the Cartesian plane.
- mapboxgl-jupyter - Use Mapbox GL JS to visualize data in a Python Jupyter notebook.
- Cartopy - A library providing cartographic tools for python for plotting spatial data.
- Rtree - For efficiently querying spatial data.
- geoalchemy - Using SQLAlchemy with spatial databases.
- geopy - geopy is a Python 2 and 3 client for several popular geocoding web services.
- Fiona - For making it easy to read/write geospatial data formats.
- PySAL - For all your spatial econometrics needs.
- Descartes - Plot geometries in matplotlib.
- PyShp - For reading and writing shapefiles.
- PyProj - For conversions between projections.
- chupaESRI - ChupaESRI is a Python module/command line tool to extract features from ArcGIS Server map services.
- geojsonio.py - Open GeoJSON data on geojson.io from Python. geojsonio.py also contains a command line utility that is a Python port of geojsonio-cli.
- Ogcserver - Python WMS implementation using Mapnik.
- RSGISLib - The Remote Sensing and GIS software library (RSGISLib) is a collection of tools for processing remote sensing and GIS datasets. The tools are accessed using Python bindings or an XML interface.
- OSMnet - Tools for the extraction of OpenStreetMap street network data.
- geojson-area - Calculate the area inside of any GeoJSON geometry. This is a port of Mapbox's geojson-area for Python.
- GeoDaSpace - Software for Advanced Spatial Econometrics.
- Verde - Verde is a Python library for processing spatial data (bathymetry, geophysics surveys, etc) and interpolating it on regular grids (i.e., gridding).

- gpdvega - gpdvega is a bridge between GeoPandas and Altair that allows to seamlessly chart geospatial data.
- LANDSAT-Download - Automated download of LANDSAT data from USGS website.
- USGS API - USGS is a python module for interfacing with the US Geological Survey's API.
- som-tsp - Solving the Traveling Salesman Problem using Self-Organizing Maps.
- Centroids - This application reads a valid geojson FeatureCollection and returns a valid geojson FeatureColleciton of centroids.
- sentinelsat - Search and download Copernicus Sentinel satellite images.
- PyPostal - Python bindings to libpostal for fast international address parsing/normalization.
- python-opencage-geocoder - A Python module that uses the OpenCage Geocoding API.
- rio-tiler - Get mercator tile from landsat, sentinel or other AWS hosted raster.
- rio-cogeo - CloudOptimized GeoTIFF creation plugin for rasterio.
- GIPPY - Geospatial Image Processing for Python.
- ts-raster - ts-raster is a python package for analyzing time-series characteristics from raster data. It allows feature extraction, dimension reduction and applications of machine learning techniques for geospatial data.
- LT-ChangeDB - Scripts to extract spectral change information from LandTrendr data to a geodatabase.
- pymap3d - Python 3D coordinate conversions for geospace ecef enu eci.
- untiler - Stitch image tiles into larger composite TIFs.
- pyroSAR - A Python Framework for Large-Scale SAR Satellite Data Processing.
- RIOS - Raster I/O Simplification. A set of python modules which makes it easy to write raster processing code in Python.
- eo-box - Earth observation processing framework for machine learning in Python.
- lidar - Terrain and hydrological analysis using digital elevation models (DEMs).
- landsat-extract-gee - Get Landsat surface reflectance time-series from google earth engine.
- satpy - Satpy is a python library for reading, manipulating, and writing data from remote-sensing earth-observing meteorological satellite instruments.
- Python Geocoder - Simple and consistent geocoding library written in Python.
- EarthPy - A package built to support working with spatial data using open source python.
- scikit-mobility - Mobility analysis in Python.
- MovingPandas - Implementation of Trajectory classes and functions built on top of GeoPandas.

Key geospatial libraries

Shapely

Geometric object manipulation and analysis (cartesian)
Handles standard formats (JSON, WKT, WKB)

GeoPandas

Extends Pandas for geospatial (GeoDataFrame)
Uses Shapely geo types/operations
Uses add’l packages for i/o, plotting

PySAL

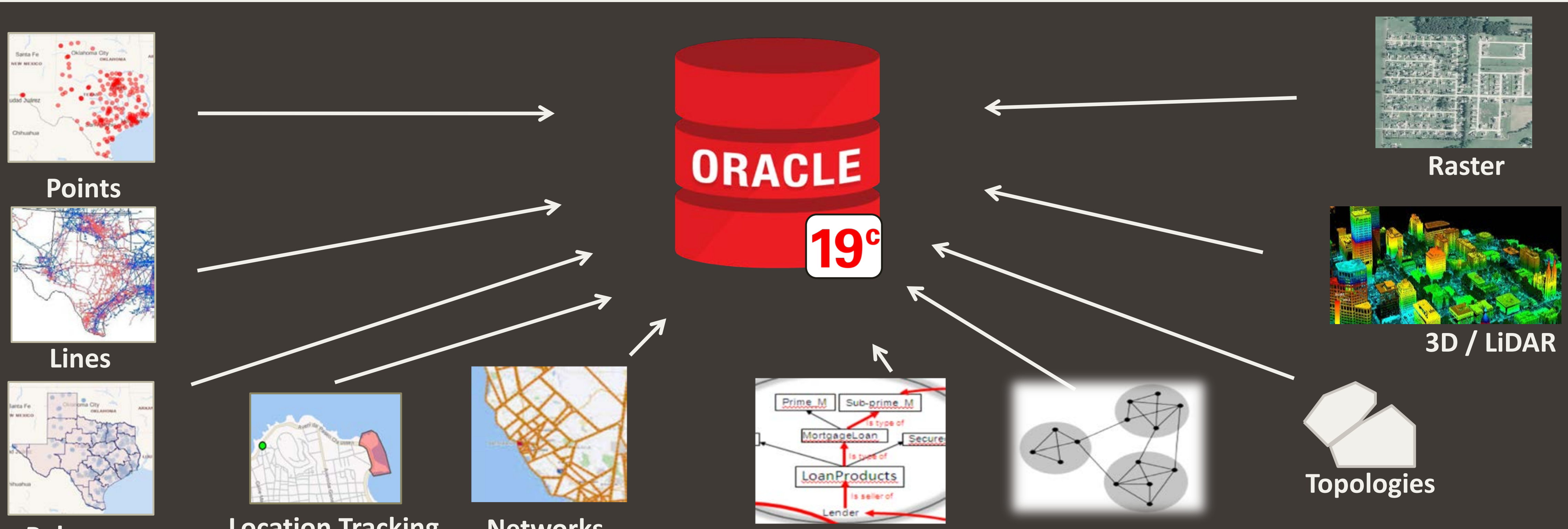
Geospatial data science library
Geostatistical, spatio-temporal, exploratory analyses (vast)
i.e. “Spatial Autocorrelation”

cx_Oracle module

- Robust access to Oracle Database from Python
- Handles advanced features and data types
  - Object types (i.e. SDO_GEOMETRY), LOBs, JSON
  - SODA (Simple Oracle Document Access)
  - Array operations
  - Cursor support
  - Advanced Queuing
  - too much more to mention here…
- https://oracle.github.io/python-cx_Oracle/

Oracle Database - Spatial and Graph

Deployable Components Mapping | Geocoding | Routing | Web Services (OGC) | Studio



Points

Lines

Polygons

Location Tracking (Geofencing)

Networks

RDF Graphs

Property Graphs

Topologies

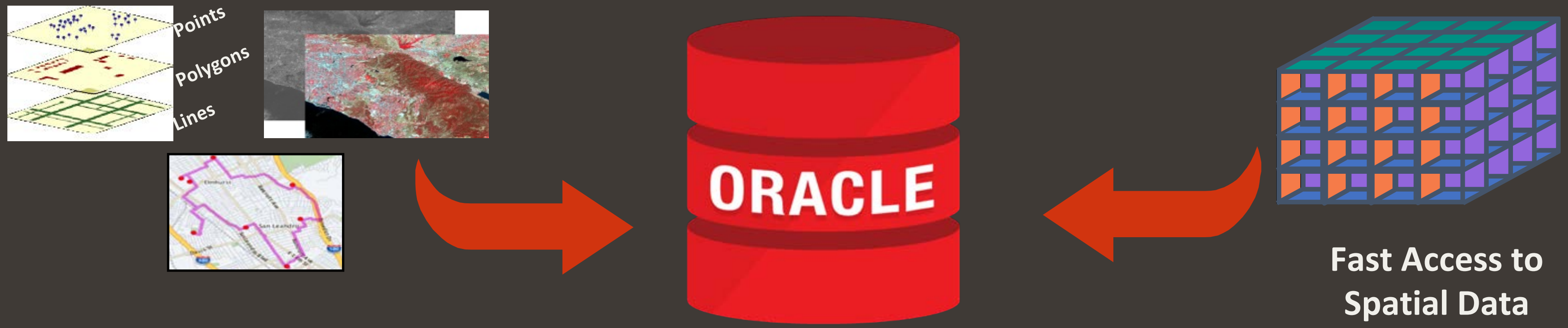
3D / LiDAR

Raster

Oracle Spatial and Graph

Native Geospatial Data Types

Native Spatial Indexing



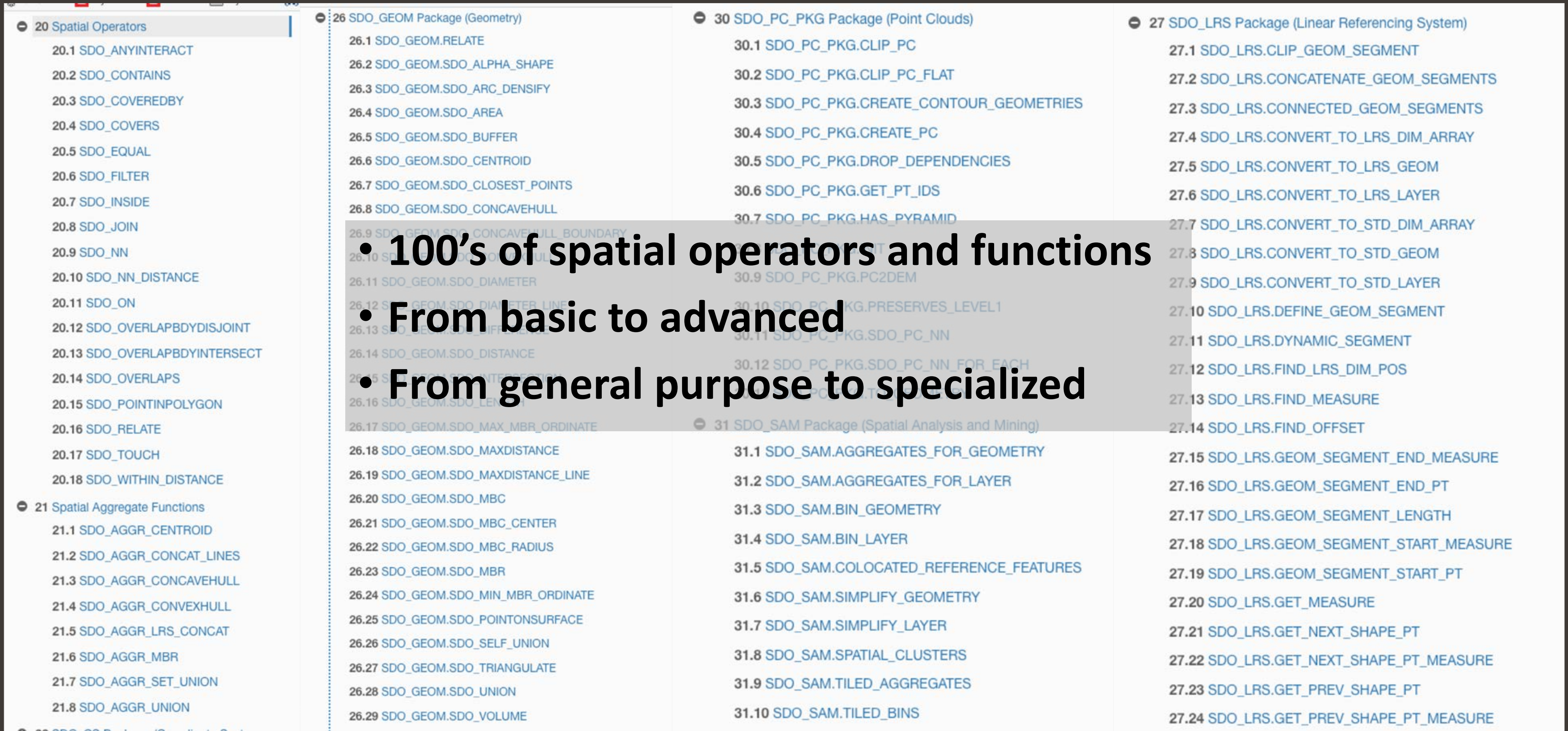
Fast Access to Spatial Data

Spatial Analysis Through SQL

```
SELECT a.customer_name, a.phone_number
FROM policy_holders a
WHERE sdo_within_distance( a.geom, hurricane_path_geom,
         'distance = 10 unit = mile') = 'TRUE';
```

Oracle Spatial and Graph

- 100’s of spatial operators and functions
- From basic to advanced
- From general purpose to specialized



20 Spatial Operators
20.1 SDO_ANYINTERACT
20.2 SDO_CONTAINS
20.3 SDO_COVEREDBY
20.4 SDO_COVERS
20.5 SDO_EQUAL
20.6 SDO_FILTER
20.7 SDO_INSIDE
20.8 SDO_JOIN
20.9 SDO_NN
20.10 SDO_NN_DISTANCE
20.11 SDO_ON
20.12 SDO_OVERLAPBDYDISJOINT
20.13 SDO_OVERLAPBDYINTERSECT
20.14 SDO_OVERLAPS
20.15 SDO_POINTINPOLYGON
20.16 SDO_RELATE
20.17 SDO_TOUCH
20.18 SDO_WITHIN_DISTANCE
21 Spatial Aggregate Functions
21.1 SDO_AGGR_CENTROID
21.2 SDO_AGGR_CONCAT_LINES
21.3 SDO_AGGR_CONCAVEHULL
21.4 SDO_AGGR_CONVEXHULL
21.5 SDO_AGGR_LRS_CONCAT
21.6 SDO_AGGR_MBR
21.7 SDO_AGGR_SET_UNION
21.8 SDO_AGGR_UNION

26 SDO_GEOM Package (Geometry)
26.1 SDO_GEOM.RELATE
26.2 SDO_GEOM.SDO_ALPHA_SHAPE
26.3 SDO_GEOM.SDO_ARC_DENSIFY
26.4 SDO_GEOM.SDO_AREA
26.5 SDO_GEOM.SDO_BUFFER
26.6 SDO_GEOM.SDO_CENTROID
26.7 SDO_GEOM.SDO_CLOSEST_POINTS
26.8 SDO_GEOM.SDO_CONCAVEHULL
26.9 SDO_GEOM.SDO_CONCAVEHULL_BOUNDARY
26.10 SDO_GEOM.SDO_CONVEXHULL
26.11 SDO_GEOM.SDO_DIAMETER
26.12 SDO_GEOM.SDO_DIAMETER_LINE
26.13 SDO_GEOM.SDO_DIFFERENCE
26.14 SDO_GEOM.SDO_DISTANCE
26.15 SDO_GEOM.SDO_INTERSECTION
26.16 SDO_GEOM.SDO_LENGTH
26.17 SDO_GEOM.SDO_MAX_MBR_ORDINATE
26.18 SDO_GEOM.SDO_MAXDISTANCE
26.19 SDO_GEOM.SDO_MAXDISTANCE_LINE
26.20 SDO_GEOM.SDO_MBC
26.21 SDO_GEOM.SDO_MBC_CENTER
26.22 SDO_GEOM.SDO_MBC_RADIUS
26.23 SDO_GEOM.SDO_MBR
26.24 SDO_GEOM.SDO_MIN_MBR_ORDINATE
26.25 SDO_GEOM.SDO_POINTONSURFACE
26.26 SDO_GEOM.SDO_SELF_UNION
26.27 SDO_GEOM.SDO_TRIANGULATE
26.28 SDO_GEOM.SDO_UNION
26.29 SDO_GEOM.SDO_VOLUME

30 SDO_PC_PKG Package (Point Clouds)
30.1 SDO_PC_PKG.CLIP_PC
30.2 SDO_PC_PKG.CLIP_PC_FLAT
30.3 SDO_PC_PKG.CREATE_CONTOUR_GEOMETRIES
30.4 SDO_PC_PKG.CREATE_PC
30.5 SDO_PC_PKG.DROP_DEPENDENCIES
30.6 SDO_PC_PKG.GET_PT_IDS
30.7 SDO_PC_PKG.HAS_PYRAMID
30.8 SDO_PC_PKG.INIT
30.9 SDO_PC_PKG.PC2DEM
30.10 SDO_PC_PKG.PRESERVES_LEVEL1
30.11 SDO_PC_PKG.SDO_PC_NN
30.12 SDO_PC_PKG.SDO_PC_NN_FOR_EACH
30.13 SDO_PC_PKG.TO_GEOMETRY
31 SDO_SAM Package (Spatial Analysis and Mining)
31.1 SDO_SAM.AGGREGATES_FOR_GEOMETRY
31.2 SDO_SAM.AGGREGATES_FOR_LAYER
31.3 SDO_SAM.BIN_GEOMETRY
31.4 SDO_SAM.BIN_LAYER
31.5 SDO_SAM.COLOCATED_REFERENCE_FEATURES
31.6 SDO_SAM.SIMPLIFY_GEOMETRY
31.7 SDO_SAM.SIMPLIFY_LAYER
31.8 SDO_SAM.SPATIAL_CLUSTERS
31.9 SDO_SAM.TILED_AGGREGATES
31.10 SDO_SAM.TILED_BINS

27 SDO_LRS Package (Linear Referencing System)
27.1 SDO_LRS.CLIP_GEOM_SEGMENT
27.2 SDO_LRS.CONCATENATE_GEOM_SEGMENTS
27.3 SDO_LRS.CONNECTED_GEOM_SEGMENTS
27.4 SDO_LRS.CONVERT_TO_LRS_DIM_ARRAY
27.5 SDO_LRS.CONVERT_TO_LRS_GEOM
27.6 SDO_LRS.CONVERT_TO_LRS_LAYER
27.7 SDO_LRS.CONVERT_TO_STD_DIM_ARRAY
27.8 SDO_LRS.CONVERT_TO_STD_GEOM
27.9 SDO_LRS.CONVERT_TO_STD_LAYER
27.10 SDO_LRS.DEFINE_GEOM_SEGMENT
27.11 SDO_LRS.DYNAMIC_SEGMENT
27.12 SDO_LRS.FIND_LRS_DIM_POS
27.13 SDO_LRS.FIND_MEASURE
27.14 SDO_LRS.FIND_OFFSET
27.15 SDO_LRS.GEOM_SEGMENT_END_MEASURE
27.16 SDO_LRS.GEOM_SEGMENT_END_PT
27.17 SDO_LRS.GEOM_SEGMENT_LENGTH
27.18 SDO_LRS.GEOM_SEGMENT_START_MEASURE
27.19 SDO_LRS.GEOM_SEGMENT_START_PT
27.20 SDO_LRS.GET_MEASURE
27.21 SDO_LRS.GET_NEXT_SHAPE_PT
27.22 SDO_LRS.GET_NEXT_SHAPE_PT_MEASURE
27.23 SDO_LRS.GET_PREV_SHAPE_PT
27.24 SDO_LRS.GET_PREV_SHAPE_PT_MEASURE

Spatial data type

```
SQL> desc countries
Name     Null? Type
-------- ----- ------------------
ID             NUMBER
ISO_A3         VARCHAR2(3)
NAME           VARCHAR2(26)
GEOMETRY       MDSYS.SDO_GEOMETRY
SQL>
```

```
SQL> SELECT geometry
  2  FROM countries
  3* WHERE name='Aruba’;

GEOMETRY
-----------------------------------------
SDO_GEOMETRY(2003, 8307, NULL,
SDO_ELEM_INFO_ARRAY(1, 1003, 1),
SDO_ORDINATE_ARRAY(-69.8760919, 12.42720123, -
69.879425, 12.45340118, -69.9150301,
12.49686106, -69.9238926, 12.51903025, -
69.935649, 12.5316393, -69.9961879,
12.57737295, ...
```

Spatial query

```
SQL> SELECT a.name
  2  FROM populated_places a, countries b
  3  WHERE sdo_inside(a.geometry, b.geometry) = 'TRUE'
  4* and b.name='Belize';

NAME
--------------------------------------------------------
El Cayo
Punta
Gorda
Belmopan
Orange
...
```

Spatial query

```
SQL>  SELECT name
  2   FROM countries
  3   WHERE sdo_contains(
  4            geometry,
  5            SDO_GEOMETRY(2001,8307,
  6                         SDO_POINT_TYPE(-99.3, 23.1, NULL), NULL, NULL))
  7            = 'TRUE';

NAME
--------------------------
Mexico
```

Spatial cast to/from GeoJSON

```
SQL> SELECT sdo_util.to_geojson(geometry)
  2  FROM countries
  3* WHERE name='Aruba’;

SDO_UTIL.TO_GEOJSON(GEOMETRY)
-------------------------------
{ "type": "Polygon", "coordinates": [ [ [-69.8760918785688,
12.4272012328116], [-69.8794250088263, 12.4534011841892],
[-69.9150300699863, 12.4968610642473], [-69.923892578319,
12.5190302533902], [-69.9356489664463, 12.5316393031227],
[-69.9961879071357, 12.5773729453627], [-70.006368164159,
12.5853827920903], [-70.0480452075418,
12.6319949343567],... ] }
```

Spatial cast to/from GeoJSON

```
SQL>  SELECT name
  2   FROM countries
  3   WHERE sdo_contains(
  4         geometry,
  4         sdo_util.from_geojson(
  5          '{"type": "Point", "coordinates": [-99.3, 23.1] }')
  6          = 'TRUE';

NAME
--------------------------
Mexico
```

Why Python with Spatial?

- Leverage specialized Python libraries to supplement database features
  - i.e., spatial econometrics
- Perform analyses that fuse database and external content
  - i.e., use a local GeoJSON file to filter data in Oracle Spatial
- Cloud-ready
  - Spatial on ExaCS, ExaCC, ADW, ATP, DBCS High/Extreme Performance

Notebook demos

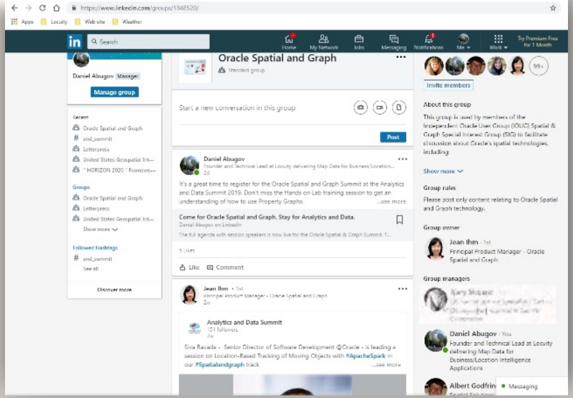
Takeaways

- Oracle Database includes a powerful spatial management and analysis platform for the enterprise
- Python can easily incorporate spatial analysis using mature open source libraries and connections to Oracle Spatial
- Specialized open source geospatial Python libraries can supplement the built-in features of Oracle Spatial
- cx_Oracle makes the integration easy

The Spatial & Graph SIG User Community

Now part of BIWA User Group

We are a vibrant community of customers and partners that connects and exchanges knowledge online, and at conferences and events.



Daniel Abugov Manager

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Oracle Spatial and Graph

Standard group

Start a new conversation in this group

Daniel Abugov
Founder and Technical Lead at Locuity delivering Map Data for Business/Location...
2d

It's a great time to register for the Oracle Spatial and Graph Summit at the Analytics and Data Summit 2019. Don't miss the Hands on Lab training session to get an understanding of how to use Property Graphs. ...see more

Come for Oracle Spatial and Graph. Stay for Analytics and Data.
Daniel Abugov on LinkedIn
The full agenda with session speakers is now live for the Oracle Spatial & Graph Summit. T...

5 Likes

Jean Ihm • 1st
Principal Product Manager - Oracle Spatial and Graph
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Analytics and Data Summit
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Siva Ravada - Senior Director of Software Development @Oracle - is leading a session on Location-Based Tracking of Moving Objects with #ApacheSpark in our #Spatialandgraph track ...see more

99+

About this group

This group is used by members of the Independent Oracle User Group (IOUG) Spatial & Graph Special Interest Group (SIG) to facilitate discussion about Oracle's spatial technologies, including:

Group rules

Please post only content relating to Oracle Spatial and Graph technology.

Group owner

Jean Ihm · 1st
Principal Product Manager - Oracle Spatial and Graph

Group managers

[illegible]

Daniel Abugov · You
Founder and Technical Lead at Locuity delivering Map Data for Business/Location Intelligence Applications

Albert Godfrin

Meet us at OpenWorld! Monday-Wednesday
Moscone West, Level 3, User Group area
at the *BIWA/Analytics Community* table

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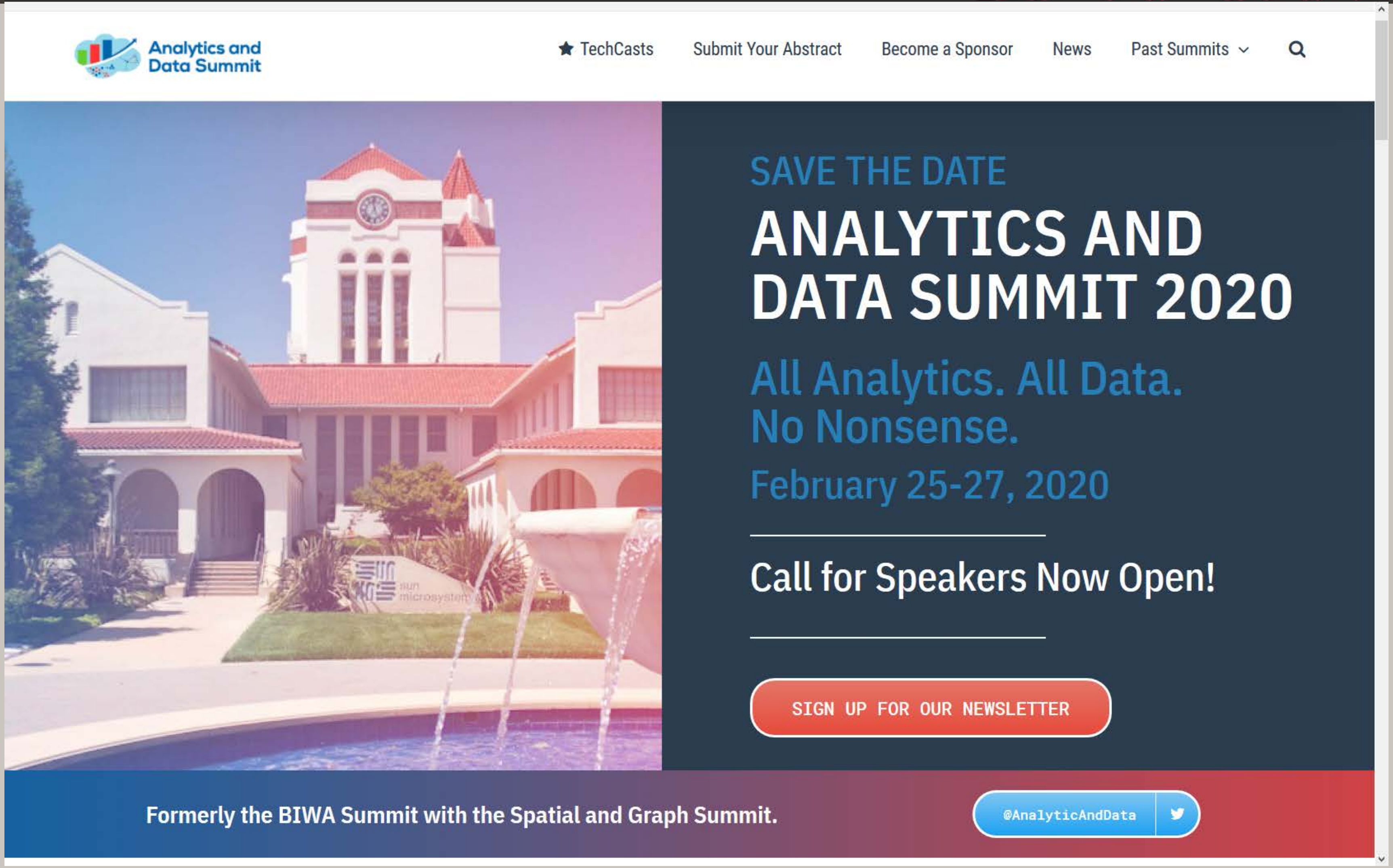

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All Analytics. All Data. No Nonsense.

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analyticsanddatasummit.org

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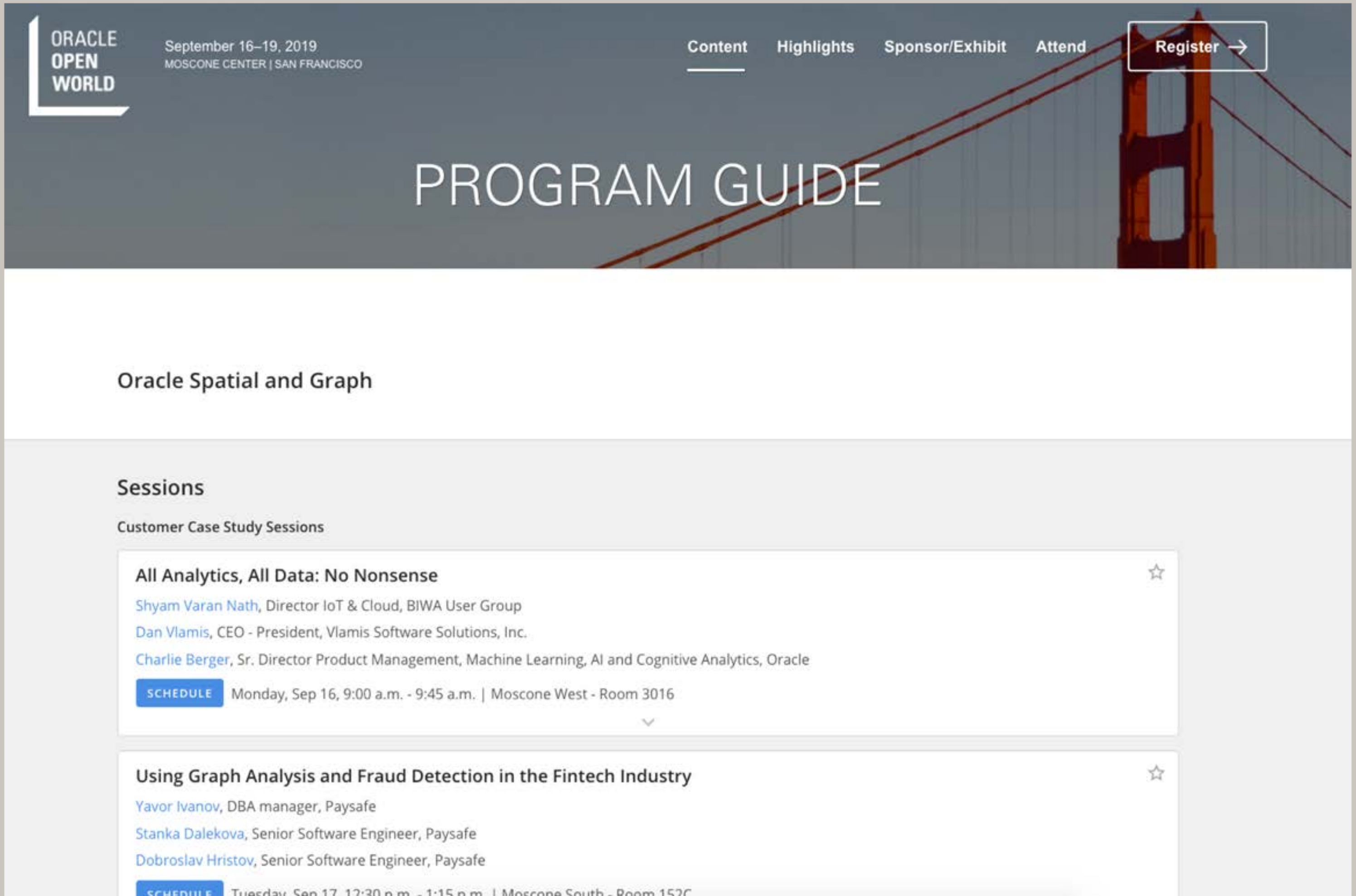

September 16–19, 2019
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PROGRAM GUIDE

Oracle Spatial and Graph

Sessions

Customer Case Study Sessions

All Analytics, All Data: No Nonsense

Shyam Varan Nath, Director IoT & Cloud, BIWA User Group
Dan Vlamis, CEO - President, Vlamis Software Solutions, Inc.
Charlie Berger, Sr. Director Product Management, Machine Learning, AI and Cognitive Analytics, Oracle

SCHEDULE Monday, Sep 16, 9:00 a.m. - 9:45 a.m. | Moscone West - Room 3016

Using Graph Analysis and Fraud Detection in the Fintech Industry

Yavor Ivanov, DBA manager, Paysafe
Stanka Dalekova, Senior Software Engineer, Paysafe
Dobroslav Hristov, Senior Software Engineer, Paysafe

SCHEDULE Tuesday, Sep 17, 12:30 p.m. - 1:15 p.m. | Moscone South - Room 152C

Resources - Get Started

Oracle Spatial and Graph product pages

oracle.com/technetwork/database/options/spatialandgraph

YouTube channel youtube.com/c/OracleSpatialandGraph

Blog – examples, tips & tricks

blogs.oracle.com/oraclespatial | blogs.oracle.com/bigdataspatialgraph

@SpatialHannes

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