

Oracle Spatial and Graph in Oracle Database 19c



Multimodel Database

- Oracle Database supports multiple models
 - Relational, In-memory, Sharded
 - Document Store
 - JSON
 - XML
 - Text
 - OLAP
 - Spatial Database
 - Graph Database and Triple Store
- Oracle Database support multiple languages and access protocols



Spatial and Graph Analysis – It is about relationships



- Are things in the same location? Who is the nearest? What **tax zone** is this in? **Where can deliver in 35 minutes?** What is in my sales **territory?** Is this built in a flood zone?
- Which supplier am I most dependent upon? **Who is the most influential customer?** Do my products appeal to certain **communities?** What **patterns** are there in fraudulent behavior?

Oracle Spatial and Graph

Three major features



Spatial



Property Graph



RDF Graph

Oracle Spatial and Graph

On Premises, Cloud and in Autonomous Database



Oracle Spatial and Graph

Location and graph analysis with secure storage for enterprise data

Deployable Services



Mapping

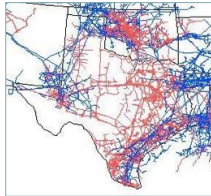
Geocoding

Routing

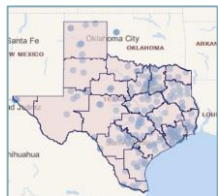
Web Services (OGC)



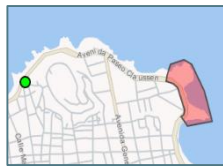
Points



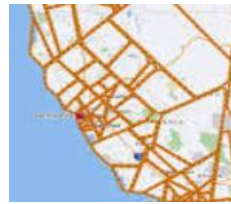
Lines



Polygons



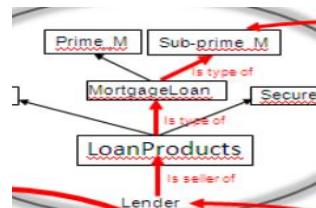
Location Tracking
(Geofencing)



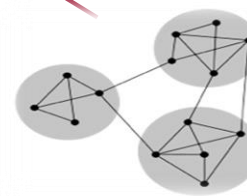
Networks



19^c



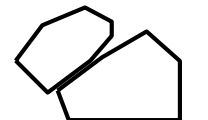
RDF Graphs



Property Graphs



3D / LiDAR



Topologies



Raster

Oracle Spatial and Graph 19c

Three major features



Spatial



Property Graph

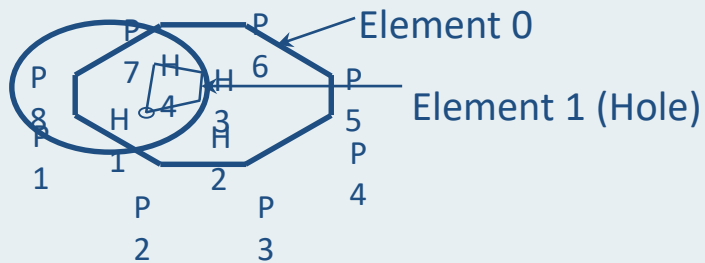


RDF Graph

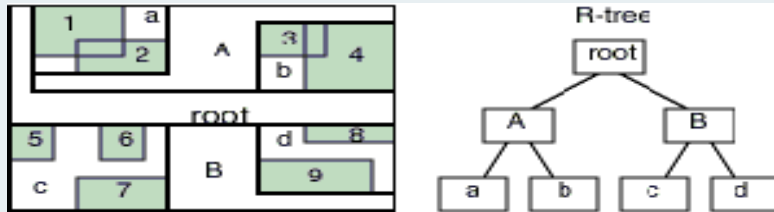
Spatial Processing in Oracle Database

Native Geometry Data Types

Points, Lines, Polygons, etc.



Spatial Indexing



Operators and Functions



Select, within distance, nearest neighbor, intersection, union, centroid, ...

Geometries in Oracle Tables

ROADS

RNAME	ID	TYPE	LANES	GEOM1	GEOM2
M40	140	HWY	6		
M25	141	HWY	4		

SQL Query and Analysis

```
SELECT a.owner_name, a.acquisition_status
FROM properties a, projects b
WHERE sdo_within_distance
(a.property_geom1, b.project_geom,
'distance = .1 unit = mile') = 'TRUE' and
b.project_id=189498;
```


Spatial Analysis

- 100's of SQL spatial analysis operators
 - Filter
 - Combine
 - Transform
 - Measure

Spatial Analysis Operations

All Filter Combine Transform Measure

Search

- Calculate area**
SDO_GEOM.SDO_AREA
More information
- Add a buffer of a specified distance**
SDO_GEOM.SDO_BUFFER
More information
- Calculate minimum distance between shapes**
SDO_GEOM.SDO_DISTANCE
More information
- Calculate length or perimeter**
SDO_GEOM.SDO_LENGTH
More information
- Determine if shapes are within a specific distance of each other**
SDO_GEOM.WITHIN_DISTANCE
More information
- Combine a set of shapes into one**
SDO_AGGR_UNION
More information
- Add a buffer of a specified distance**
SDO_GEOM.SDO_BUFFER
More information
- Return shapes nearest to another**
SDO_NN
More information
- Create point in the middle of a shape**
SDO_GEOM.SDO_CENTROID
More information
- Return shapes having any spatial interaction with another**
SDO_ANYINTERACT
More information
- Return shapes that contain another**
SDO_CONTAINS
More information
- Return shapes that are inside another**
SDO_INSIDE
More information
- Combine a set of shapes into one**
SDO_AGGR_UNION
More information
- Return shapes within a specified distance of another**
SDO_WITHIN_DISTANCE
More information

► **Advanced**

Advanced Spatial Data Models

- Spatial networks for roads, transport, pipelines, telcos and other geographically connected analysis
- Topology for mapping, land management and cadastre applications

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Analysis Result:
From: 575456205
To: 575491535

Drive/Walk to "CONNECTICUT AV and WYOMING AV" (31 meters).

[1]
Board Route 227 (Inbound)
At "CONNECTICUT AV and WYOMING AV"
Dep. Time : 10:10:42

Get down at "NW CONNECTICUT AV and NW 20TH ST";

[2]
Transfer to Route 86
Board Route 86 (Outbound)
At "NW CONNECTICUT AV and NW 20TH ST"
Dep. Time : 10:21:00

Get down at "MW H ST and NW JACKSON PL";

[3]
Transfer to Route 75
Board Route 75 (Inbound)
At "MW H ST and NW JACKSON PL"
Dep. Time : 10:32:42

Get down at "SE INDEPENDENCE AV and SE 1ST ST";

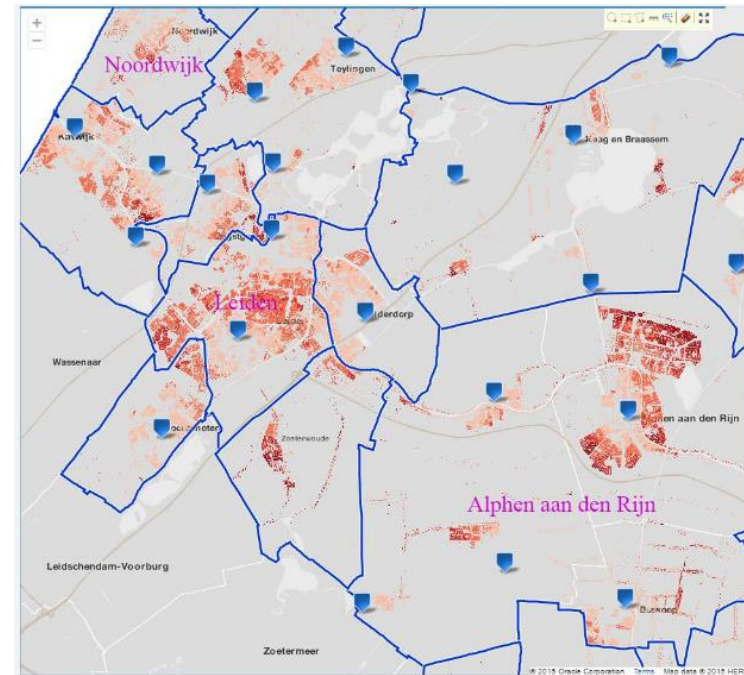
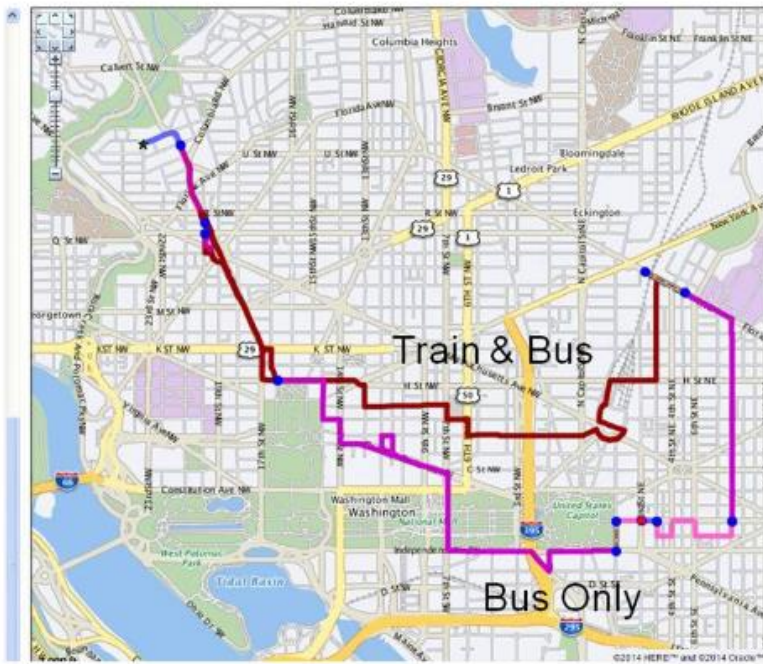
[4]
Transfer to Route 131
Board Route 131 (Outbound)
At "E CAPITOL ST and SE 1ST ST"
Dep. Time : 11:01:06

Get down at "E CAPITOL ST and SE 3RD ST"
At 11:02:00

Drive/Walk from "E CAPITOL ST and SE 3RD ST" (0 meters) to destination.

Trip Travel Time: 51 minutes.

Number of Bus Routes: 4

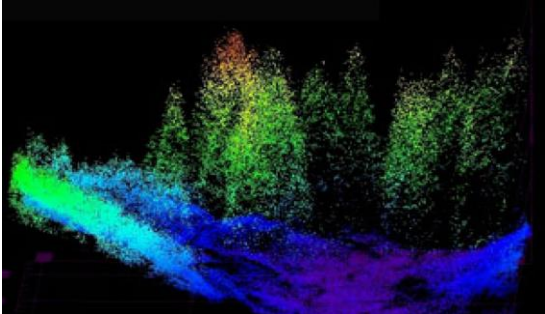


Raster, 3D, Point Clouds and LiDAR support

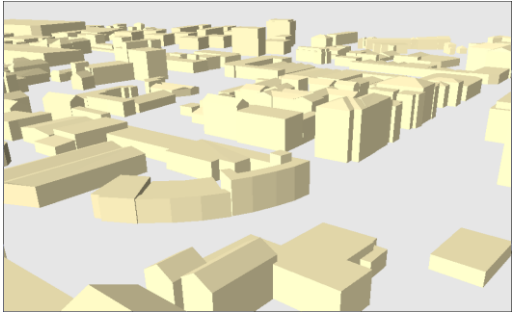
Raster



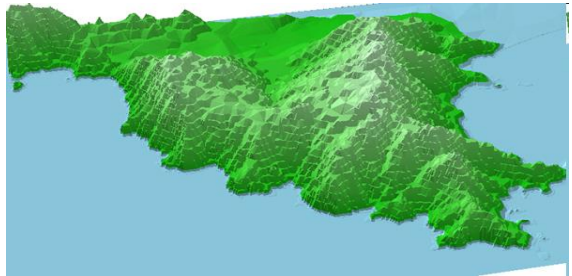
Point Clouds



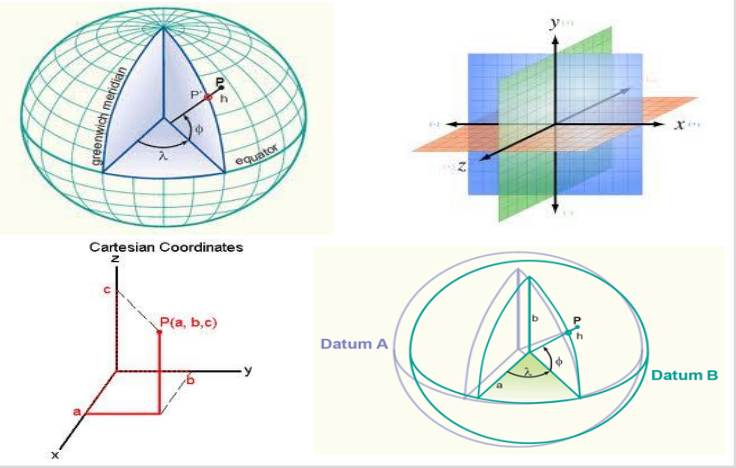
Solids



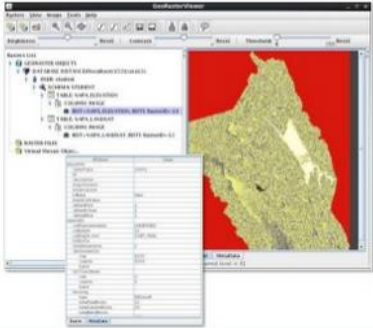
Triangular Irregular



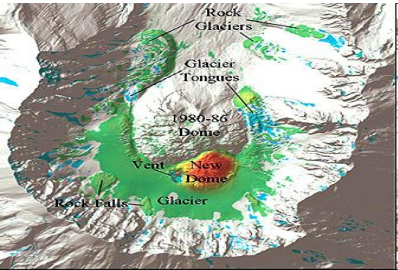
3D Coordinate Systems



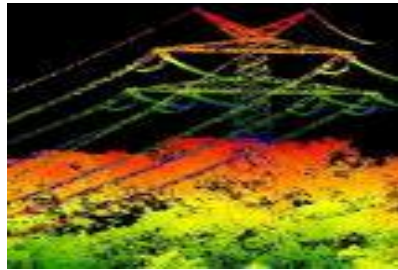
Raster and 3D Queries



Raster Analysis and Operations



Volumetric Analysis



Visibility queries



Major New Spatial Features

Ease of Use

- JSON and Oracle REST Data Services improvements
- Improved web services user interface, CSW and WFS enhancements
- Self-service development tool

Performance

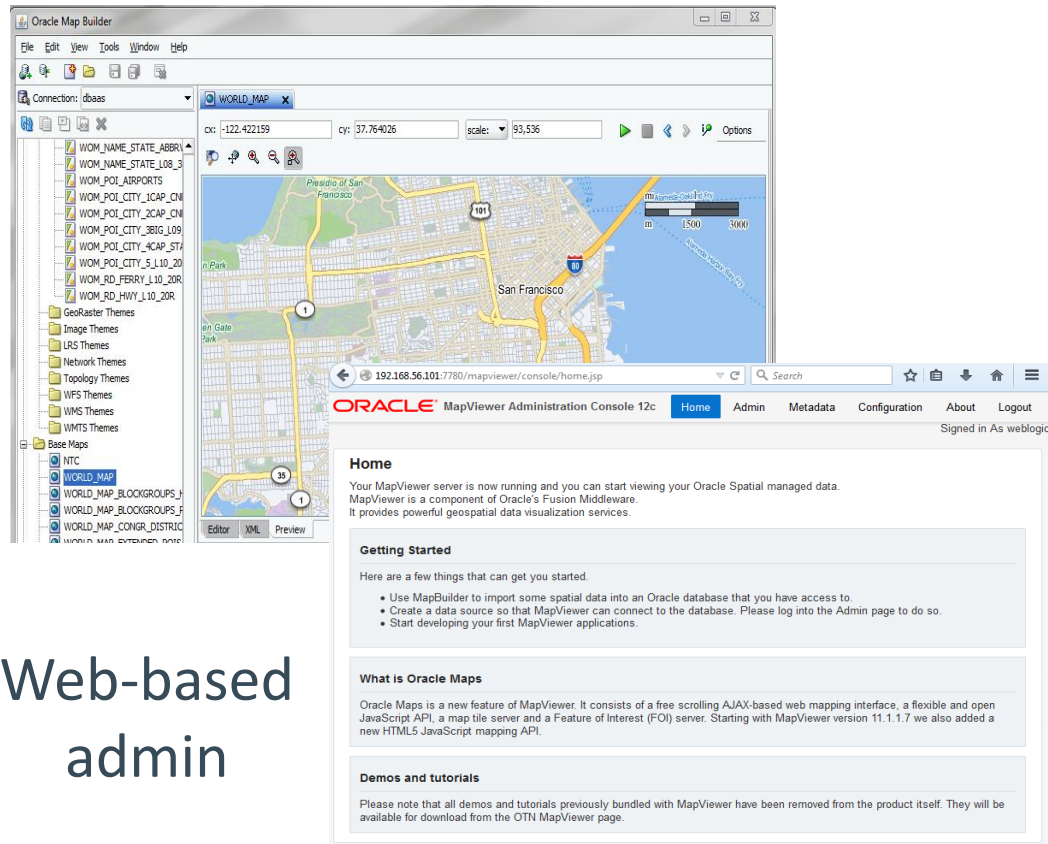
- Ability to use spatial operators without a spatial index
- Spatial index performance improvements
 - Enhancements to CBTree index to use the data layer directly for Spatial index access.
 - 3x faster query performance for large point data sets.

Improved Database Support

- Spatial support for distributed transactions
- Spatial support for database sharding

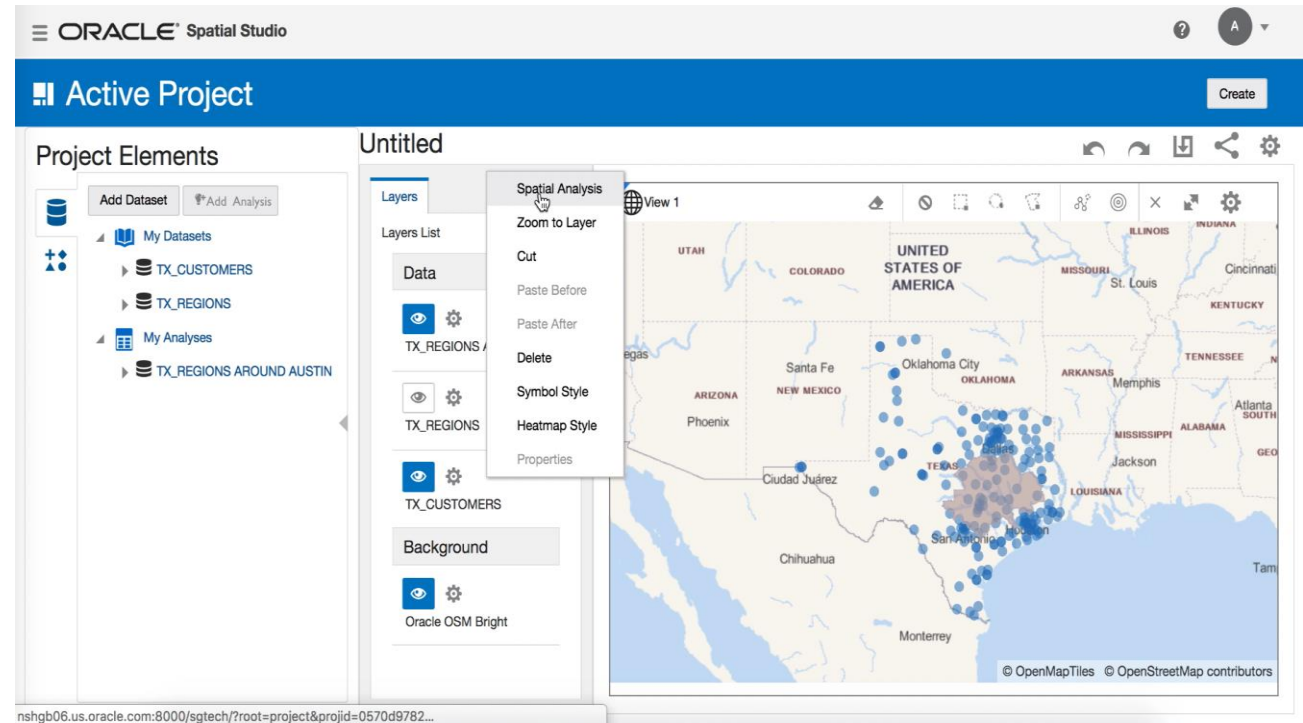
Spatial Visualization

Map authoring tool



Web-based admin

Self-service spatial analytics



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Spatial



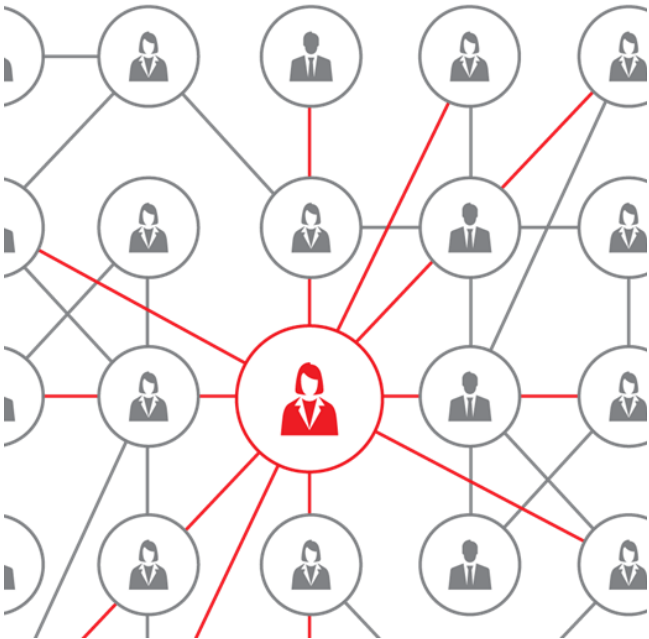
Property Graph



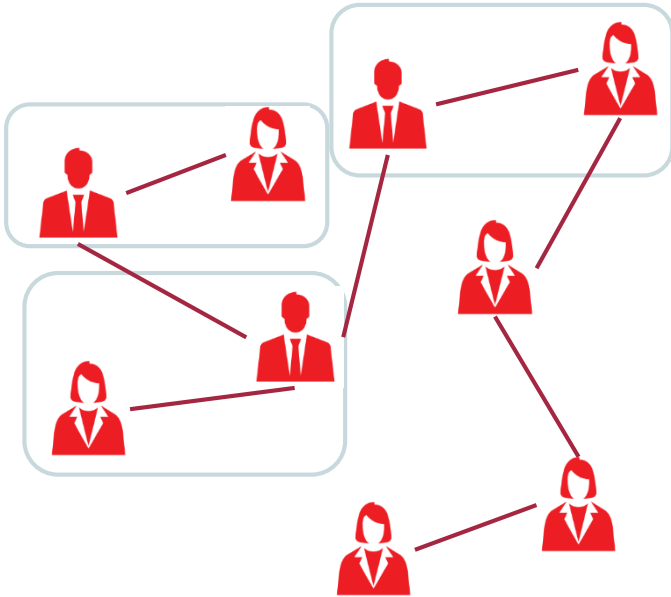
RDF Graph

Property Graph Analysis for Business Insight

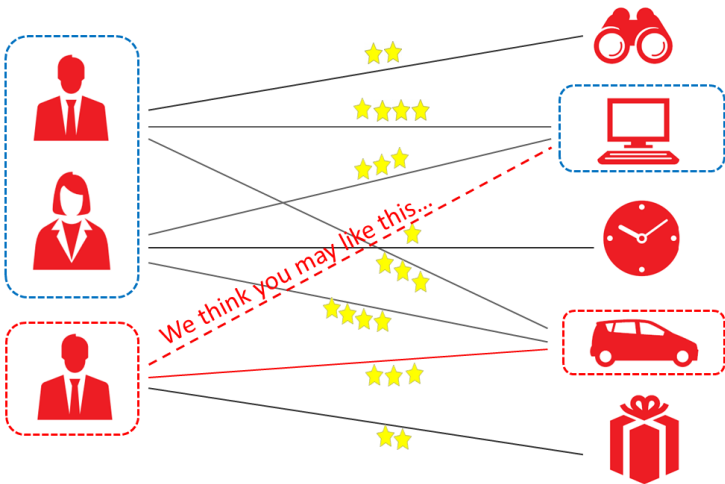
Identify Influencers



Discover Graph Patterns in Big Data



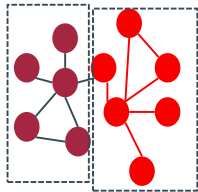
Generate Recommendations



Computational Property Graph Analytics: Built-in Package

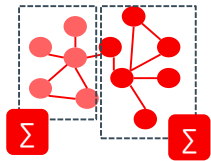
Rich set of built-in parallel graph algorithms

Detecting Components and Communities



Tarjan's, Kosaraju's, Weakly Connected Components, Label Propagation (w/ variants), Soman and Narang's Spacification

Evaluating Community Structures

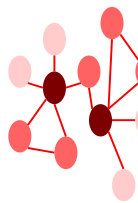


Conductance, Modularity, Clustering Coefficient (Triangle Counting), Adamic-Adar

Link Prediction

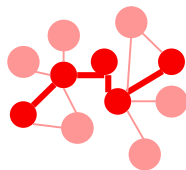
SALSA (Twitter's Who-to-follow)

Ranking and Walking



Pagerank, Personalized Pagerank, Betweenness Centrality (w/ variants), Closeness Centrality, Degree Centrality, Eigenvector Centrality, HITS, Random walking and sampling (w/ variants)

Path-Finding

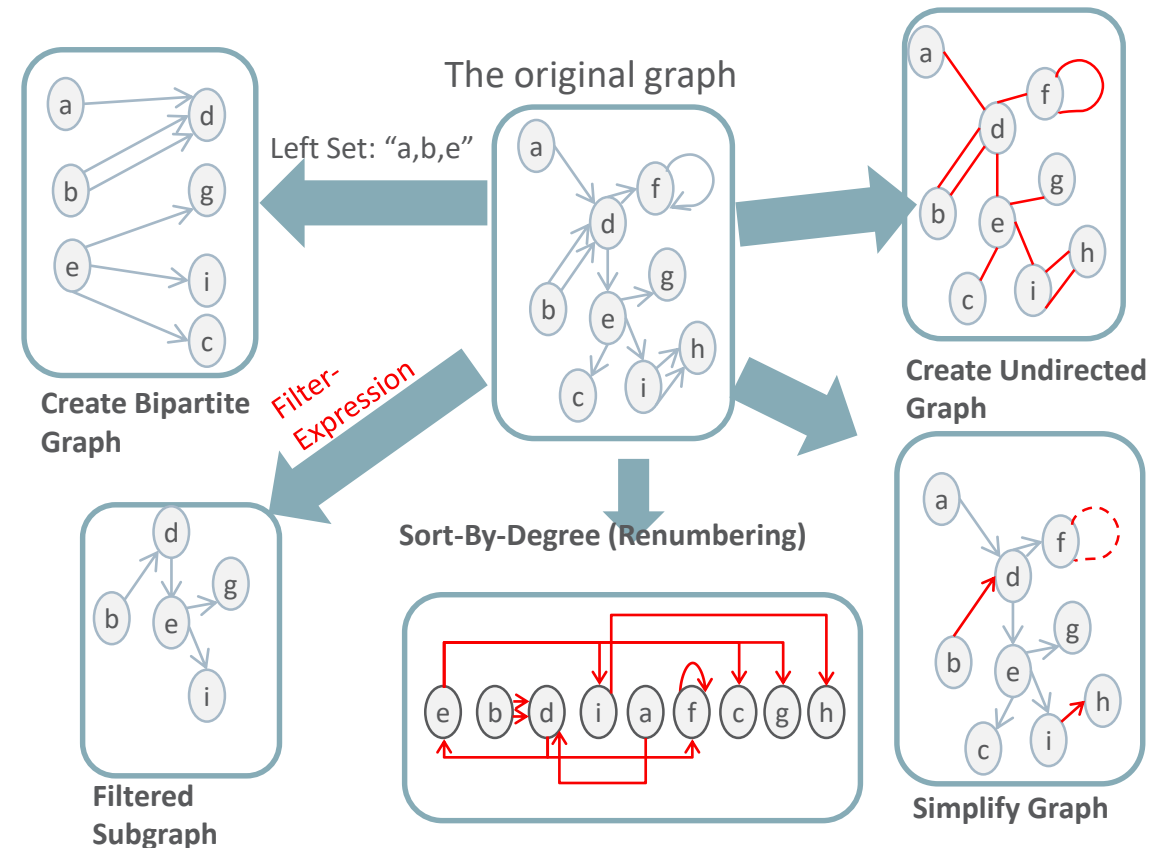


Hop-Distance (BFS), Dijkstra's, Bi-directional Dijkstra's, Bellman-Ford's

Other Classics

Vertex Cover, Minimum Spanning-Tree (Prim's)

... and parallel graph mutation operations



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RDF Graph

RDF for Knowledge Graph, Linked-Data and Semantic Data Integration

W3C Standards

- Native support for W3C standards for semantic data, ontologies and inferencing
- RDF and RDB2RDF
- Inferencing with RDFS, OWL, SKOS, and user-defined rules
- OGC GeoSPARQL support

Languages, Tools, and APIs

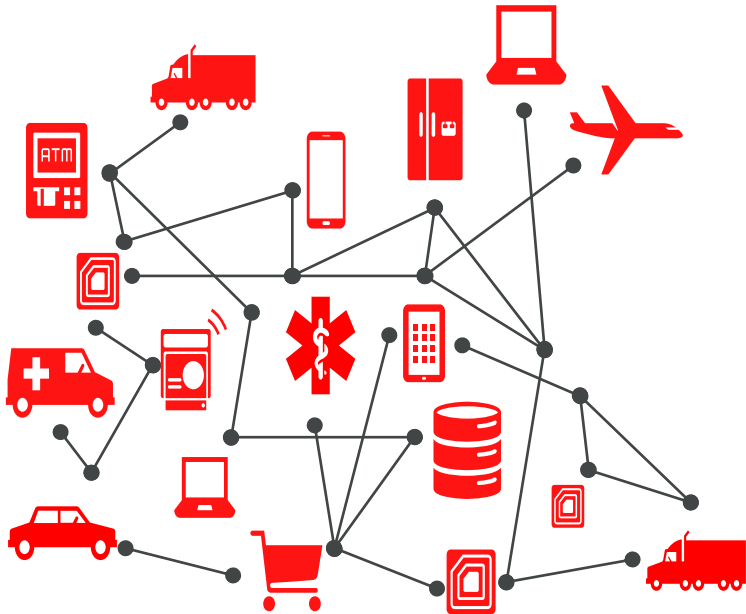
- SQL query support
- SPARQL query language
SPARQL/update, SPARQL endpoint
- Ontology-assisted query using SQL
- Java APIs via Jena, Joseki and Sesame
- Protégé ontology editing
- Cytoscape visualization plug-in

Enterprise Database

- Scalable to over 54 billion triples, up to 8 PB
- Fine-grained Security
- RDF Views on relational tables and Property Graphs
- Supports Property Graph analysis on RDF data
- Compressed, partitioned storage
- Multitenant database support

Oracle's Graph Advantages

Extreme Performance and
Massively Scalable



Flexible Deployment



Ease of Development



Major New Graph Features

- SQL Developer for RDF
- Data Vault support and Schema-private networks in RDF
- Property Graph Query Language (PGQL) for in-memory and in-database Property Graphs
- New Property Graph in-memory analytics: Personalized SALSA, K-Core, Approximate and Weighted Pagerank
- Property Graph Views on RDF Graphs
- RDF Views on Property Graphs

Summary

By treating spatial and graph data the same as other business data, Oracle Spatial and Graph enables enterprises to realize these benefits:

- Integrate analysis in the IT infrastructure
- Reduce operational costs
- Minimize strategic risk
- Reduce development effort





Resources

Oracle Spatial and Graph

 Product homepage: oracle.com/database/technologies/spatialandgraph.html

 Blog: blogs.oracle.com/oraclespatial

 Forum:
community.oracle.com/community/database/oracle-database-options/spatial

 Oracle Spatial and Graph Group: linkedin.com/groups/1848520/

 YouTube Channel: youtube.com/c/OracleSpatialandGraph

 Twitter: [@SpatialHannes](https://twitter.com/SpatialHannes)