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Spatial Technology in Oracle AI Database 26ai

Oracle provides innovative, robust spatial features in a multi-model, multi-workload, multi-tenant converged database. With no-code location analytics and visualization, it's easier than ever to get started. Developers, database professionals, and analysts have a flexible platform for location-enabled business and mapping services and advanced geospatial systems. Oracle has comprehensive data types, models, services, and tools for spatial data management, analytics, and visualization. The spatial features benefit from Oracle AI Database enterprise scalability, security, and performance. Organizations worldwide rely on Oracle to handle their most demanding, mission-critical spatial requirements.

Location Analysis

Oracle's mission is to help people see data in new ways, discover insights, and unlock endless possibilities. Location analysis is about understanding complex interactions based on geographic relationships—answering questions based on where people, assets, and resources are located. Spatial insights enable you to provide better customer service, optimize your workforce, locate retail and distribution centers, evaluate sales and marketing campaigns, and more.

Developers, database professionals, and analysts can use Oracle's comprehensive suite of spatial data management, analytics, and visualization tools to integrate spatial analysis and mapping into applications on enterprise-grade data management infrastructure, Oracle AI Database and Oracle Exadata. Innovative technologies in Oracle Cloud and Oracle Autonomous AI Database—the industry's first self-driving, self-securing, and self-repairing database—are available to spatial applications.

Spatial Features

Oracle AI Database includes advanced spatial analysis and processing. It supports all major spatial data types and models, addressing business-critical requirements from industries including transportation, utilities, energy, public sector, defense, and commercial location intelligence.

Comprehensive Spatial, Mapping, and Location Analytics Platform

- Oracle spatial technology is an integral part of Oracle AI Database. The spatial features are included in all editions of Oracle AI Database, database cloud services, and Autonomous AI Database without additional licensing costs.

Key Benefits

- Native storage, management, and analysis of all major geospatial data types and models
- Oracle AI Database scalability, security, and manageability for enterprise spatial applications
- Fully managed or self-service map visualization and creation of analytic workflows geared towards non-experts
- Engineered systems support
- Supported by all leading geospatial vendors and open-source components

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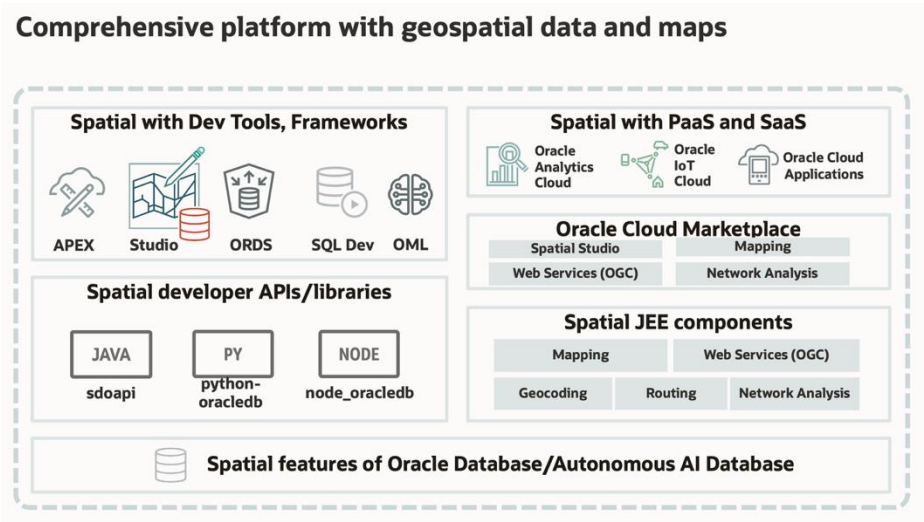

Figure 1: Spatial Analytics and Cloud Service Platform

Data model and comprehensive analytics for 2D spatial data

You can perform queries based on proximity (how near or far something may be) and containment (whether something is within or outside a given region). Hundreds of functions and operations are provided to filter data, measure distance relationships, and combine and/or transform geometries.

3D point clouds and LiDAR

These features manage spatial sensor data used for enterprise 3D GIS and Smart City applications. The 3D support is optimized for point cloud and CityGML workflows. This enables the production and management of seamless 3D point cloud models ranging from small local areas to large cities and countries.

Spatial Studio for self-service spatial data prep, analysis, and visualization.

This web application is a visual, no-code map canvas, and spatial analysis tool. It is available as a fully managed tool on Oracle Autonomous AI Database-Serverless or self-managed for other deployment options. Analysts using Oracle AI Database and Autonomous AI Database can perform spatial analysis and mapping without writing a line of code. They can also incorporate code in applications, make results available to REST services, publish the results as web pages, or hand them off to Oracle Analytics Cloud.

New Spatial Features

- Spatial AI to detect location patterns and improve predictions, with spatial algorithms in Oracle Machine Learning in Autonomous AI Database
- Vector tiles support in Oracle AI Database to create highly performant maps for web clients
- H3 hexagonal indexing and aggregations for map visualization of large-scale point data sets
- Simplified creation of spatial data, automated creation of spatial index metadata
- GeoRaster REST API supporting access and processing of GeoRaster objects, virtual mosaics, and import/export through web clients
- 3D point cloud support—more functions for cross section, difference, and mesh
- Geocoding SQL API in Oracle Autonomous AI Database-Serverless

Key Spatial Features

- Spatial object type for vector data, spatial index type, and hundreds of spatial operators and functions
- Spatial Studio—fully-managed or self-service, visual, no-code map canvas and spatial analysis tool
- Spatial index and partitioning
- Comprehensive support for coordinate systems and transformations
- GeoRaster support for geo-referenced imagery and gridded data, including raster loading tool and functions for

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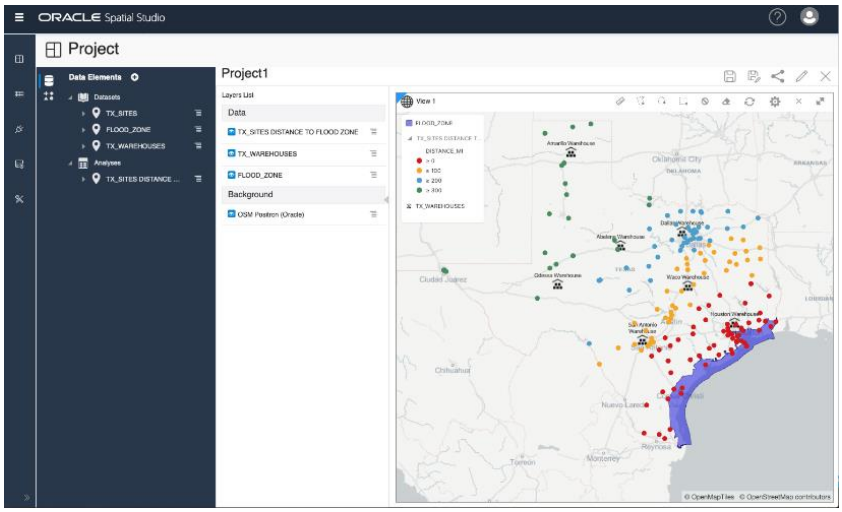

Figure 2: Screenshot of Oracle Spatial Studio

Standards-based SQL, Java, Python, JSON, and REST

Developers can easily add spatial capabilities to applications using their choice of modern application frameworks, without having to learn new languages. Spatial data can be read via standard interfaces and published on the web using standard formats. Popular tools such as APEX and SQL Developer also support Oracle Spatial.

Spatial support for partitioning, in-memory, distributed transactions, and sharding

Spatial applications can leverage these high-performance features used on large data sets, in large-scale web and cloud-based applications, and for massively scalable and reliable OLTP applications.

Spatial AI

You can incorporate location into your data science and machine learning-based solutions, using spatial algorithms in Oracle Machine Learning in Autonomous AI Database. Detect location patterns and make better predictions with geospatial machine learning algorithms, using Python with Oracle Machine Learning notebooks. You can also develop and operationalize geospatial-based predictive models, at scale.

Support for OGC web services

Oracle AI Database includes standard Open Geospatial Consortium web services to publish spatial data and interoperate with a wide range of commercial, open source, or custom data sources and applications.

Vector tiles and H3 for map visualization

Vector tiles let you make very large maps fast and with full flexibility on design. Now, developers can easily create vector tiles to add maps to web clients directly from Oracle AI Database. With a simple SQL call, large amounts of spatial data from the database can be efficiently streamed to web clients. Vector tiles enable dynamic styling, fast performance, smooth map interactions, and dynamic map queries. They're also the preferred method for modern map data delivery in the industry.

For large amounts of dense point data, hexagons are useful for map visualization to summarize and view patterns in data. Oracle Spatial includes H3 indexing support to

image processing and analytics
- 3D data model—native support for 3D geometries, surfaces, and LiDAR point clouds
- Support for OGC and ISO geospatial standards—Web Feature Service, Web Map Service/Tile Service, Web Coverage Service, Web Catalog Service
- Geocoding and routing engines
- Topology data model; linear referencing system
- Network Data Model to represent graphs and networks in link and node tables
- JSON support for spatial data access, REST APIs
- Location data enrichment API with geographic hierarchy and place names data set
- Map visualization of geographic data
- Location tracking server
- Contact tracing APIs
- Spatial support for database features such as in-memory, distributed transactions, sharding

Related Products

- Oracle AI Database
- Oracle Autonomous AI Database
- Oracle AI APEX
- Oracle REST Data Services
- Oracle Machine Learning
- Oracle Exadata
- Oracle Analytics Cloud

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create hexagonal cells and data aggregations in the database, and to generate vector tiles for map visualizations to any web client.

Map visualization component

Developers can incorporate highly interactive maps and spatial analysis into business applications. This deployable JEE component serves spatial data from Oracle as GeoJSON, vector tiles, and raster tiles. The content may be consumed by all modern standards-based map clients such as MapLibre and OpenLayers.

Geocoding and reverse geocoding

Geocoding is a fundamental process that helps organizations refine and enrich existing address and location information found in relational tables. It generates latitude/longitude from existing customer addresses (or site locations) and is usually the first step in location intelligence applications. Geocoding in Oracle Autonomous AI Database is now easier, with a new SQL API that supports geocoding without the need to install reference data.

Network Data Model and routing engine

Network Data Model feature lets you model physical and logical networks and real-world features with a geographic component. Typically, it's used to represent road, transportation, telecommunications, utility, energy, and other networks so you can analyze them for the shortest path, nearest neighbors, within cost, and reachability. The networks can be partitioned and loaded into memory on demand to enable scalable in-memory analysis of very large networks.

A routing engine, based on the Network Data Model, provides driving directions along street networks, and can incorporate data feeds such as traffic patterns.

GeoRaster

Oracle AI Database stores and processes geo-referenced raster data, such as satellite imagery and gridded data. It provides a powerful raster algebra library and supports the creation of virtual mosaics. GeoRaster has an integrated loading tool to load and export raster data. It supports on-the-fly image processing and analytics for real-time applications. GeoRaster is used in energy, natural resource management, and national security applications.

Topology data model

Topology is used by mapping and land management organizations that require a high degree of feature editing and data integrity across their maps and map layers.

Location data enrichment services

The enrichment process associates authoritative location terms (place names, addresses, and latitude/longitude) with text found in database tables. This data enrichment allows for better joining and integration of locations with other data in the database or with streaming services to perform spatial and text analysis.

Location tracking server and contact tracing APIs

The location tracking server supports tracking millions of moving objects against thousands of regions of interest in the database, for logistics and IOT applications. The

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location of moving objects can also be analyzed for pair-wise interactions for the purpose of contact tracing via a scalable, automatic API.

The World's Leading Platform for Spatial Data

Oracle's spatial features are native to Oracle's converged database—and to the world's leading information technology platform for Oracle Cloud and on-premises deployments. Developers can easily incorporate these capabilities into their solutions using modern development frameworks. Spatial applications developed with Oracle benefit from the leading performance, scalability, and security capabilities of Oracle AI Database. They can also exploit the extreme processing power and bandwidth of Oracle Exadata Database Machine. Oracle tools and enterprise applications and leading vendors support Oracle's spatial features. The largest enterprises worldwide—mapping agencies, transportation, utilities, telecommunication services, insurance, energy, financial services, and more—rely on Oracle for their spatial processing needs.

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