

Overview of Geospatial Information Systems

Overview of Geospatial Information Systems (GIS)

1. What is GIS?

- **Definition:** A GIS is a computer-based system that captures, stores, manages, analyzes, and visualizes spatial (location-based) data.
 - **Core Idea:** It links *attributes* (what something is) with *geometry* (where it is) to enable geographic reasoning and decision-making.
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2. Main Components

Component	Purpose	Typical Tools / Formats
Hardware	Processing, storage, and display of spatial data	Servers, workstations, GPS receivers, drones, mobile devices
Software	Create, edit, query, and visualize GIS data	ArcGIS, QGIS, GRASS, MapInfo, Google Earth Engine
Data	The foundation – spatial layers and attribute tables	Raster (satellite imagery, DEMs), Vector (points, lines, polygons), Tabular (CSV, DBF)
People	Analysts, cartographers, developers, decision-makers	Domain experts, GIS technicians, planners
Methods/Procedures	Standardized workflows for data acquisition, processing, and analysis	Data cleaning, projection management, spatial statistics, model building

3. Types of Spatial Data

Data Type	Geometry	Typical Sources	Common Uses
Vector	Points, lines, polygons	GPS surveys, digitized maps, CAD files	Feature mapping, network analysis, cadastral records

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Data Type	Geometry	Typical Sources	Common Uses
Raster	Grid of cells (pixels)	Satellite imagery, aerial photos, LiDAR, DEMs	Land cover classification, surface modeling, heat maps
Tabular (non-spatial)	Linked via IDs or coordinates	Census tables, sensor logs	Attribute enrichment, statistical analysis

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4. Key GIS Functions

1. Data Capture & Integration

- Surveying (total stations, GNSS)
- Remote sensing (satellite, UAV)
- Digitizing paper maps
- Importing existing datasets (shapefiles, GeoJSON, KML)

2. Data Management

- Geodatabases (File, Personal, Enterprise)
- Metadata creation (ISO 19115, FGDC)
- Versioning & editing workflows

3. Spatial Analysis

- **Overlay** – intersect, union, erase
- **Proximity** – buffer, nearest neighbor, service area
- **Network** – routing, flow accumulation
- **Surface** – slope, aspect, contour generation
- **Statistical** – hotspot detection, regression, kriging

4. Cartography & Visualization

- Thematic mapping (choropleth, proportional symbols)
- 3D scene rendering (extruded buildings, terrain)
- Interactive web maps (Leaflet, Mapbox GL, ArcGIS Online)

5. Modeling & Automation

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- ModelBuilder, Python scripting (ArcPy, PyQGIS)
 - Geoprocessing tools (toolboxes, custom scripts)
 - Machine learning integration (classification, object detection)
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5. GIS Data Standards & Interoperability

- **Coordinate Reference Systems (CRS)**
 - Geographic (lat/long, e.g., WGS84)
 - Projected (UTM, State Plane, Mercator)
- **Open Formats**
 - GeoJSON, GML, OGC WFS/WMS/WCS services
 - Cloud-optimized GeoTIFF (COG) for large rasters
- **Metadata Standards**
 - ISO 19115/19139, FGDC