

# Module 3 : GIS

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# GIS

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- What are the advantages and functions of Geographic Information System?
- Explain the key components of a Geographic Information System.



# Sources of data for GIS

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- Data for GIS can come from a variety of sources, each providing different types of information. Here are some of the primary sources of data for GIS:
  - ❖ Remote Sensing
  - ❖ GPS (Global Positioning System)
  - ❖ Surveying
  - ❖ Existing GIS Databases
  - ❖ Commercial Data Providers
  - ❖ Crowd-Sourced Data
  - ❖ Sensor Networks
  - ❖ Historical Data
  - ❖ Social Media and Web Data
  - ❖ Scientific Research

# Sources of data for GIS:

## Remote Sensing

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- **Satellite Imagery:** High-resolution images captured by satellites. Examples include Landsat, Sentinel, and commercial providers like DigitalGlobe.
- **Aerial Photography:** Images taken from aircraft or drones, offering detailed and up-to-date information.
- **LiDAR:** Light Detection and Ranging technology, which uses laser pulses to create high-resolution 3D models of the terrain.

# Sources of data for GIS:

## GPS (Global Positioning System)

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- **Field Data Collection:** Coordinates and other spatial data collected using handheld GPS devices or smartphones.
- **Tracking Systems:** Data from GPS-enabled vehicles or devices, used for transportation, logistics, and asset management.



# Sources of data for GIS:

## Surveying

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- **Land Surveys:** Detailed measurements of land features conducted by surveyors using tools like total stations and GNSS (Global Navigation Satellite System).
- **Cadastral Surveys:** Maps and records related to property boundaries and ownership.

# Sources of data for GIS:

## Existing GIS Databases

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- **Government Agencies:** Data from national, state, and local governments, such as census data, land use, environmental data, and infrastructure maps. Examples include the USGS (United States Geological Survey), EPA (Environmental Protection Agency), and local planning departments.
- **International Organizations:** Data from organizations like the United Nations, World Bank, and NGOs, often focused on global issues like development, health, and environment.
- **Open Data Portals:** Many governments and institutions provide open access to their geospatial data. Examples include Data.gov, OpenStreetMap, and GeoPlatform.gov.

# Sources of data for GIS: Commercial Data Providers

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- Data Vendors
- Subscription Services



# Sources of data for GIS:

## Crowd-Sourced Data

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- **Volunteered Geographic Information (VGI):** Data collected by volunteers, such as OpenStreetMap, where users contribute to building and updating maps.
- **Citizen Science Projects:** Public participation in data collection, often for environmental monitoring and research projects.

# Sources of data for GIS: Historical Data

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- **Archival Maps:** Historical maps and documents that provide insights into past land use, development, and environmental conditions.
- **Aerial Photo Archives:** Collections of historical aerial photographs, useful for studying changes over time.

# Sources of data for GIS:

## Social Media and Web Data

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- **Geo-tagged Posts:** Data from social media platforms like Twitter, Instagram, and Facebook, where users tag their locations.
- **Web Scraping:** Extracting geospatial data from websites, such as real estate listings, business directories, and event locations.



# Sources of data for GIS: Scientific Research

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- **Academic Publications:** Research studies and papers that include geospatial data, often available through academic databases and journals.
- **Field Studies:** Data collected during scientific research, including ecological studies, geological surveys, and archaeological excavations.

# Question ?

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- Summarize the sources of data for Geographic Information System.

# Database in GIS

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- In GIS, databases are specialized systems designed to store, manage, and analyze geographic data.
- These databases can be categorized into different types based on their structure and capabilities.



# Advantages of GIS Databases

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- **Data Integration:** GIS databases can integrate various types of spatial and non-spatial data, enabling comprehensive analysis and visualization.
- **Scalability:** Capable of handling large volumes of data, suitable for regional to global scale projects.
- **Complex Analysis:** Support for advanced spatial analyses and modeling, such as network analysis, spatial statistics, and geostatistics.
- **Data Management:** Tools for maintaining data integrity, consistency, and security.
- **Visualization:** Ability to create detailed and interactive maps and visualizations.

# Disadvantages of GIS Databases

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- **Complexity:** Requires specialized knowledge to design, implement, and manage.
- **Cost:** Can be expensive, especially proprietary systems and software licenses.
- **Performance:** Performance can degrade with very large datasets or complex queries without proper optimization.
- **Compatibility:** Issues may arise when integrating data from different sources or formats.
- **Maintenance:** Regular maintenance is needed to ensure data quality and system performance.

# Question ?

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- Explain the main advantages and disadvantages of using a database in Geographic Information System.



# Data analysis in GIS

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- Data analysis in GIS (Geographic Information Systems) involves examining spatial and geographic data to extract meaningful insights, patterns, relationships, and trends.
- This process leverages various tools and techniques to interpret the data and support decision-making.
- Here are the key components and techniques involved in GIS data analysis:
  - **Data Collection and Preparation**
  - **Data Visualization**
  - **Spatial Analysis Techniques**
  - **Modeling and Simulation**

# Data Collection and Preparation:

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- **Data Collection:** Gathering spatial and attribute data from various sources like satellite imagery, GPS, surveys, and existing databases.
- **Data Cleaning:** Ensuring data accuracy by removing errors, duplicates, and inconsistencies.
- **Data Integration:** Combining data from different sources into a unified format.

# Data Visualization:

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- **Mapping:** Creating maps to visualize spatial data. This can include thematic maps (e.g., land use, population density) and interactive maps.
- **3D Visualization:** Representing data in three dimensions to analyze terrains, buildings, and other features.



# Spatial Analysis Techniques:

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- **Overlay Analysis:** Combining multiple layers of data to identify relationships between them. For example, overlaying soil type and vegetation layers to study agricultural suitability.
- **Proximity Analysis:** Determining the spatial relationship between features, such as finding the nearest hospital to a given location or analyzing buffer zones around rivers.
- **Network Analysis:** Analyzing linear networks like roads, pipelines, or utility networks to determine the shortest path, optimal routes, or service areas.

# Spatial Analysis Techniques:

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- **Surface Analysis:** Analyzing raster data to study elevation, slope, aspect, and other surface characteristics. This includes creating contour maps, hillshades, and digital elevation models (DEMs).
- **Spatial Statistics:** Using statistical methods to identify patterns and trends in spatial data, such as clustering, hot spot analysis, and spatial autocorrelation.
- **Geostatistics:** Advanced statistical techniques to model spatially correlated data, often used for interpolating values across a surface (e.g., kriging for environmental data).

# Modeling and Simulation

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- **Predictive Modeling:** Using historical and current data to predict future trends, such as urban growth, climate change impacts, or disease spread.
- **Simulation:** Creating models to simulate real-world processes and scenarios, such as flood modeling, wildfire spread, or traffic flow.



# Applications of GIS Data Analysis

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- **Urban Planning:** Analyzing land use patterns, infrastructure development, and zoning regulations.
- **Environmental Management:** Monitoring natural resources, assessing environmental impacts, and managing conservation efforts.
- **Public Health:** Tracking disease outbreaks, planning healthcare facilities, and analyzing environmental health risks.
- **Transportation:** Optimizing routes, analyzing traffic patterns, and planning new transportation infrastructure.
- **Disaster Management:** Preparing for and responding to natural disasters by identifying vulnerable areas, planning evacuation routes, and assessing damage.
- **Agriculture:** Analyzing soil conditions, crop health, and optimizing resource use through precision farming.

# Advantages of GIS Data Analysis

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- Enhanced Decision-Making
- Improved Efficiency
- Comprehensive Understanding
- Visual Communication
- Predictive Capabilities

# Question ?

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- Justify data analysis in the context of Geographic Information System and its important.
- What is network analysis in Geographic Information System?
- Explain the spatial data analysis techniques used in Geographic Information System.
- Describe network analysis in Geographic Information System and its applications.



# Outputs in GIS

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- Types of Outputs in GIS
  - Maps
  - Reports
  - Graphs and charts
  - Animations
  - Interactive web maps

# Outputs in GIS: Maps

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- **Thematic Maps:** Show specific themes or topics, such as population density, land use, or climate zones.
- **Topographic Maps:** Depict terrain features, including elevation contours, landforms, and vegetation.
- **Choropleth Maps:** Use varying shades or colors to represent data values in different areas, such as census data.
- **Dot Density Maps:** Use dots to represent the presence, quantity, or value of a phenomenon in a specific area.
- **Isopleth Maps:** Use contour lines to represent continuous data, such as elevation or temperature.

# Outputs in GIS : Reports & Graphs and charts

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- **Reports:**
  - **Statistical Reports:** Summarize numerical data derived from spatial analysis.
  - **Textual Reports:** Describe findings, methods, and interpretations from GIS analyses.
- **Graphs and Charts:**
  - **Bar Charts, Pie Charts, Line Graphs:** Visualize attribute data associated with spatial features.
  - **Histograms:** Show the distribution of data values within a dataset.



# Outputs in GIS: 3D Visualizations & Animation

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- **3D Visualizations:**
  - **3D Models:** Represent buildings, landscapes, and other features in three dimensions.
  - **Virtual Reality (VR) and Augmented Reality (AR):** Immersive visualizations for enhanced spatial understanding.
- **Animations:**
  - **Time-Series Animations:** Show changes in spatial data over time, such as urban growth or deforestation.

# Outputs in GIS: Interactive Web Maps

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- **Interactive Web Maps:**
  - **Web-based GIS Applications:** Allow users to interact with spatial data through web browsers, providing tools for querying, analyzing, and visualizing data.
  - **Story Maps:** Combine maps with narrative text, images, and multimedia content to tell a story about spatial data.

# Question ?

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- What are the typical outputs of Geographic Information System?



# Map Generation in GIS

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- Generating maps in GIS involves several key steps:
  - Data Preparation
  - Data Visualization
  - Map Design
  - Map Production
  - Interactive and Dynamic Mapping

# Map Generation in GIS: Data Preparation

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- **Data Collection:** Gather spatial and attribute data from various sources.
- **Data Cleaning:** Remove errors, inconsistencies, and duplicates.
- **Data Integration:** Combine data from different sources into a unified format.

# Map Generation in GIS: Data Visualization

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- **Symbology:** Choose appropriate symbols, colors, and styles to represent different features and data values.
- **Layering:** Stack multiple data layers to provide context and show relationships between different types of information.
- **Classification:** Categorize data into classes or ranges to simplify visualization and interpretation (e.g., population density ranges).



# Map Generation in GIS: **Map Design**

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- **Layout:** Arrange map elements, including the map itself, legend, scale bar, north arrow, title, and source information.
- **Cartographic Principles:** Apply principles of cartography to ensure clarity, readability, and accuracy. This includes considerations like color schemes, font choices, and element placement.

# Map Generation in GIS: **Map Production**

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- **Printing:** Produce high-quality printed maps for reports, presentations, and fieldwork.
- **Digital Distribution:** Create digital maps for use in reports, presentations, websites, and mobile applications.

# Map Generation in GIS: Interactive and Dynamic Mapping

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- **Web Maps:** Publish maps online using platforms like ArcGIS Online, Google Maps, or Mapbox, allowing users to interact with the data.
- **Dashboards:** Create interactive dashboards that integrate maps with charts, graphs, and other widgets for real-time data exploration.



# Question ?

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- Describe the process of generating high-quality maps using Geographic Information System.

# Question ?

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- GPS
- What are the main components of a Global Positioning System?
- Explain the working principles of Global Positioning System technology.

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THANK YOU