Geographic Information Systems (GIS)

An Introduction to Geospatial Analyses

Thursday, May 29, 2014

Maryland Traffic Records Forum
The Conference Center at
The Maritime Institute
Introductions

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  - GIS Project Manager with Albrecht Engineering, Inc., Baltimore, MD
  - Engineer by training, GIS Professional by trade
    - Focus on GIS for Transportation & Public Safety
Objectives

- Offer a basic understanding of the technology and framework
- Highlight some uses and applications of GIS
- Investigate some of the primary sources for readily available data
- Discuss how to build a business case
- Discuss how to evaluate data prior to use
- Outline a course of action to learn more
What is GIS?

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What is GIS?

- **Textbook Definition**
  - Acronym for *geographic information system*.
  - An integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes. A GIS provides a framework for gathering and organizing spatial data and related information so that it can be displayed and analyzed.
  - More simply: A computer based tool for problem solving and information management.
What is GIS?

- Computer system that captures, stores, analyzes, manages and presents data that are linked to location.

Google Maps is a GIS Application!
Three key characteristics of GIS

- Features are **georeferenced**
- Features are organized in **layers**
- Features have **attributes**
Why do we use GIS?

IT

Geography

GIS

Application Area
Why do we use GIS?

- **Tables**
  - Input and Manage Data

- **Charts**
  - Investigate Patterns

- **Maps**
  - Analyze Spatial Relationships
Spatial Analysis

- Allows a user to manipulate data to examine location, attributes and relationships of geographic features

- 3 types of spatial relationships
  - Proximity
    - How close one feature is to another
  - Direction
    - Relative and absolute relationships of one feature to another
  - Topology
    - Overlaps, adjacency, containment, connectivity, contiguity of features
What can you do with GIS?

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Map Where Things Are

2013 Colorado Floods Crisis Map
Map Quantities

BGE Power Outage Map
Map Densities

ArcGIS.com (Free Login Required)
Find What’s Inside

Case Study: Impacts of High Speed Rail on Fire Station Access
Find What’s Nearby

Case Study: Petco Improves Location Selection
Map Change

Case Study: One year changes in asking rents for Baltimore
Who uses GIS?

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Roadwork Planning

- Maryland State Highway Administration
  - Office of Highway Design (OHD)
- Assess and Report ADA Compliance
- ADA Prioritization System
  - Non-Compliant Sidewalk
  - Trip Generators
  - Crash Data
- Roadway Projects
Safety Improvement Studies

- Maryland State Highway Administration
  - Office of Preliminary Planning and Engineering (OPPE)
- Identify candidates for safety improvements
- Analyze crash history
  - PDF Reports
  - Line diagrams
  - GIS data aggregated to street segment
- Perform field observations to analyze existing conditions
- Make recommendations for remediation
- Forecast congestion impact of recommendations
Mobility Performance Indicators

- Maryland State Highway Administration
  - Office of Preliminary Planning and Engineering (OPPE)
- i-TMS
  - Traffic volume (counts)
  - Historical data
  - Truck percentages
- Mobility Dashboard
  - Traffic Performance Metrics
    - Congestion
    - Reliability
    - Volume
  - Based on INRIX data
Transit Planning Studies

- Maryland Transit Administration
- Baltimore Red Line
  - Demographic Analysis
  - Employment Analysis
  - Land Use Analysis
  - Population Build Out
    - Forecasts to 2030
Asset Management

- Prince George’s County, MD
  - Department of Public Works & Transportation
  - Department of Inspections, Permitting & Enforcement

- Pavement Assessment & Management System (PAMS)
  - Condition Survey
  - Pavement Rating
  - Needs Lists
  - Project Formulation
  - Work Coordination
  - Cost Estimation
E911 Routing

- Anne Arundel County, MD
- **Structure Address Verification**
  - Physical location for every address in County
  - Physical location for every phone number in County
- ** Routable Street Centerline for E911 Computer Aided Dispatch System**
  - Address Ranges
  - Speeds
  - Limited Access/One Ways
  - Elevation
  - Travel Cost
Crash Reporting - CrashStat

- Transportation Alternatives, New York, NY
  - View locations of pedestrian and bicyclist crashes on a map
  - Query or Filter crashes
    - Location
    - Type of Crash
    - Year
    - Demographics (age/sex)
    - Crash Details
    - Contributing Factors
  - Generate Reports
How do I build my business case?

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Define The Question

- What are you trying to model?
  - Ask questions about what things go where?
  - Quantify an existing pattern to better understand it?
  - Examine relationships between different events?
  - Identify trends, clusters or hotspots?
  - Show how things change through time?
  - Predict or forecast something?
  - Find best places, routes or scenarios for a type of activity?

- Remember: All traffic activities involve a location
Identify Data Needs

- **What types of data do you need?**
  - Crash data, volume data, roadway characteristics, trip generators, demographics
  - Base data – boundaries, parcels, street centerline, edge of pavement, street names, buildings, utility data

- **What level of detail do you need?**
  - How aggregated or disaggregated?
  - What type of location identifier?
    - County, Street Address, Intersections, Routes and Mile Points
  - What attributes do you need?
Identify Data Needs

- What data format do you need?
  - Points
  - Lines
  - Polygons
  - Table that includes a location field

- Note: Data can be manipulated to the format that your model requires
  - E.g. Tabular data with well-defined locations can be converted to GIS data!
  - E.g. Points can be aggregated to polygons
Frame the Data Request

- Clearly state your objectives
  - What are you studying? What are you using the data to do?

- Be specific about the location of interest
  - Statewide, District, County, ADC Grids, Corridor, Intersection, Radius around a location

- What type of data do you need?
- What type of attributes do you need?
- How detailed or generalized should the data be?
Sample Data Request Form

This template is only used to guide you in creating a good data request. You are NEITHER limited NOR bound to these categories.
Evaluate The Data

- **Quality and Currency**
  - Acquire and review any metadata from source
  - How frequently is the data updated?
  - What lag time is expected from the time of the actual event until it is published as data for analysis?
  - How accurate is the data?

- **Suitability for Analysis**
  - If the data is a sample, how well does it represent the population?
  - Are there known outliers?
Evaluate The Data

- Very important to evaluate data in context
  - Data will likely have inherent bias
    - Who created it and for what purpose?
  - Be wary of assumptions that have already been made
    - Just because a dataset is common doesn’t mean it has clean capture rules
  - Understand the short comings of the dataset to have an appropriate confidence level
  - Not all data is collected the same way—individual counties may have different policies
  - Appreciate the idea that sometimes datasets will really be “close enough”
Develop Your Model

- What is the analytical approach?
- What are some of the tools and techniques that apply?
  - Reclassify, Overlay, Intersect, etc.
  - Weighted analysis
  - Proximity analysis
- What are the assumptions?
- How likely is it that the independent variables are actually causing the changes to the dependent variable?
Considerations

- Different conceptualizations of spatial relationships will yield different results
- Near things are more alike than far away things—spatial dependence
- Effects of sample size
- Effects of boundaries
- What is significant at one spatial scale may not be significant at another
- Clustering based on space, clustering based on space and time
Where can I get data?
Data Sources

- **Local**
  - Cities, Counties, Educational Facilities (e.g. UMD, Towson University)

- **State**
  - Department of Information Technology, MDOT Agencies

- **Regional**
  - Regional Planning Commissions

- **Federal**
  - National Atlas, Census, FHWA

- **Commercial**
  - Esri, INRIX
Local Example: **MCTSA Data Services**

- Maryland Center for Traffic Safety Analysis
  - Census data
  - Crash data
  - Citation data
Local Example: UMD CATT Lab - RITIS

- Center for Advanced Transportation Technology Lab
- Available to Public Safety & DOT employees

- No Cost
- Historical Data
- Live events
- Incidents
- Traffic
- Weather
Local Example: **Open Data Baltimore**
State Example: **MD iMap**

- Comprehensive List of Data Sources in MD
State Example: CHART

- Coordinated Highways Action Response Team
  - Feeds Dynamic Messaging Signs
State Data: **iTMS**

- Traffic Count reports in PDF or Excel Format

Federal Example: **FHWA Resources**
Federal Example: National Atlas

Have you ever dropped a stick in a river and wondered where it might go if it floated all the way downstream? Now you can trace its journey using Streamer.
Federal Example: Census
Commercial: **Esri Data Products**

### Demographics and Lifestyle Data

Analyze markets, evaluate competitors, and identify opportunities. Get demographics and lifestyle data using any of these methods:

**Map Services**

ArcGIS Online Map Services use the latest available data to give you access to demographic and lifestyle maps for the United States and several other countries.

**Business Analyst**

Business Analyst provides reports and maps to help you with market planning, territory design, and customer segmentation.

**Community Analyst**

Community Analyst provides people working in government agencies or involved with public planning with reports and maps to help optimize and allocate resources.

**DVD**

Demographic, Consumer, and Business Data DVDs are available. Select the data you need and at what level of details, such as by ZIP code.

### Imagery

Access high-resolution global satellite imagery and Global Land Survey (GLS) datasets. Get imagery in one of the following ways:

**Map Service**

ArcGIS Online World Imagery map service gives one meter or better satellite and aerial imagery in many parts of the world.

**Image Services**

ArcGIS Online Image Services offer you the best continuous
Ramona GIS Inventory
ArcGIS.com

The Mapping Platform for Your Organization

Create interactive maps and apps and share them with the rest of your organization. Be productive right away with ready-to-use content, apps and templates available for the web, smartphones, and tablets.

Reach Your Users
Share your maps and data on your web pages, blogs, social media, or custom apps.

Go Mobile
Access your maps and information from anywhere.

Get Started Quickly

Powerful out-of-the-box Apps

A Living Atlas of the World
ArcGIS includes a living atlas of the world, with beautiful and authoritative maps on hundreds of topics.

Integrate
What training opportunities exist?
Training Opportunities

- **Review Case Studies**
  - Magazines, Journals, [Websites](#)

- **Technical Guidance**
  - [ArcUser Magazine](#)

- **How To Books**
  - [Getting to Know ArcGIS](#)
  - GIS Tutorial

- **Online Training Opportunities**
  - [Esri Free](#) Training
  - [Esri Paid](#) Training
  - [MIT Open Courseware](#)

- **Formal Classes**
  - Online
    - [Penn State World Campus](#)
  - In the Classroom

- **Meetings**
  - Local GIS groups
  - MSGIC
  - Esri MUG
  - Esri CMUG
  - MAGTUG

- **Conferences**
  - [Esri Events](#)
  - [FOSS4G](#)
  - [Where](#)
  - [GIS-T](#)
Questions?

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