Geog 461 Learning Objective Outline

LOO 04 Basic Capabilities and Workflow for GIS

04.1 What are two types of projects used in this course?
RUGIS Chapter 3 section 3.1

To undertake a GIS project we make use of one or more *methods*.

Method - sequence of steps in which data are processed to carry out *GIS workflow*

Method step - contains one or more techniques for collecting, storing, preparing, analyzing, and displaying data.

Technique - basis for performing an operation on data; a GIS capability, a software *tool*

Pull those ideas together into a "GIS decision support project". For this course, be aware of difference between a *GIS project* and a *community improvement project*.

The term *community project* has a special significance when it comes to improving communities, particularly to planners, public works directors, council people, and the stake holding public for that matter. For example, a wastewater treatment facility is a community improvement project, but the process of siting such a *community project* as presented in the case study provides a step by step method for undertaking a *GIS project*.

The GIS project is the data processing activity (i.e., analysis of information to identify facility location). "Project" will likely always require one or more adjectives in order to keep the idea straight. GIS *project method* is a workflow intentionally structured to carry out data processing activities. GIS projects make use of fundamental capabilities during a workflow.

04.2 What are some of the basic capabilities of GIS?
RUGIS Chapter 3 section 3.1.1 – 3.1.6

Types of GIS software capabilities perform decision support activities.
GIS software capabilities (also called functions) operate with data, transforming data into information. As such, GIS software capabilities perform GIS-based transformations.

GIS transformations - facilitate a transition "from data to information" by processing the elements of a database (as constituents of a map) and deriving their characteristics based on spatial properties and/or relationships, e.g., distance, direction, pattern, set membership, as well as non-spatial properties and/or relationships.

In ArcGIS, a user has access to GIS capabilities through wizard-like *tools*, i.e., software implementations of specific functions. The tools are grouped into *toolsets*, which in turn comprise *toolboxes*. **Table 3.1** identifies some general categories of GIS capabilities typical to most GIS. We can see that some toolboxes contain tools that operate on various aspects of the decision problem, content, structure, and process.

Counting the number of entries (X) for each toolbox across the table columns reveals that Data Management tools and the Map Visualization tools are the most versatile in terms of addressing the information needs.

Describe the tools in the order in which a GIS analyst might encounter them by general category.

Geocoding Tools : Geocoding also called georeferencing is the process of assigning a location, usually in the form of coordinate data values to a feature.
- assigns a coordinate to a feature, e..g, like assigning street addresses to coordinates.
- creation, maintenance, and deletion of address locators, including coordinates.

Linear referencing is a measuring system for linear features such as river mile and route milepost. These tools commonly are found in their own ArcGIS toolbox, but they are of the same general class of functions as geocoding tools. A linear reference is a geocode along a linear feature.

Data Management Tools : capabilities to perform tasks from managing basic structures, such as fields and workspaces, through projecting and reprojecting coordinates of features/raster cells comprising a geodataset, to more complex tasks related to topology and versioning.

Tools can be organized around toolsets, which are data management function-specific.
- Fields toolset contains tools that make changes to the fields (attributes) in the tables of a feature class
- Joins toolset contains tools that add and remove a table join;
- Relationship Classes toolset contains tools that create associations between feature classes, and between feature classes and tables, and the
- Raster toolset contains tools that create and manipulate raster datasets.

Map Visualization Tools : capabilities we use to compose displays. Although some GIS like ArcGIS have a separate software module for performing map visualization, the packaging of tool capabilities is really a result of a "product offering", i.e., how to make tools available within a product for supporting customer needs (aka marketing), rather than overall functional similarity.
- add, delete, and change data layers on a map.
- change the symbolization on a map.
- highlight features on a map, either by location or by attribute.
- pan, zoom, identify various features within a data layer, and measure distances between features.

Feature Analysis Tools : offer processing for feature (vector data model) spatial relationships. Commonly these contain sets such as Extract, Overlay, Proximity, and Statistics.
- Extract toolset contains tools employing attribute and/or spatial queries to extract features and their attributes;
    - attribute queries utilize relational (e.g. >, <, =) and/or Boolean (AND, OR, XOR) operators;
    - spatial queries utilize spatial relationships of distance, containment, overlap, and intersection to extract features.
- Overlay toolset contains tools to combine, erase, modify, or update spatial features. All of these tools involve transforming two or more existing sets of features into a new single set of features exposing spatial relationships between the input features.
- Proximity toolset contains tools to determine the proximity of features within a feature set. Tools can identify features that are closest to one another, calculate the distances around them, and calculate distances between them. A buffering tool to create an exclusionary or inclusionary zone around a feature is one of a distance-based tool.

- Statistics toolset contains tools for computing descriptive statistics on attribute data. The statistics include frequency count of each unique attribute value, mean, minimum, maximum, and standard deviation.

Grid Analysis Tools : contain capabilities for analyzing continuous surfaces represented by grid cell (raster data model) layers. Map algebra (Spatial Analyst extension) is the language of spatial analysis for continuous surfaces offering a set of functions for individual raster cells, cell neighborhoods, cell regions, and an entire raster layer.

Network Analysis Tools : support GIS analysts for performing tracing along networks. There are many different kinds of networks, based on the feature behavior. Electric networks are not the same as natural gas networks, which are not the same as highway networks, or sewer networks, or for that matter storm sewer networks are very different than water supply networks.

When to apply certain of the tools from the toolsets is a matter of GIS *project workflow that* is how we should sequence the application of the GIS functionality. We turn to GIS project workflow next.

04.3 How might we describe a basic GIS-based workflow approach?
RUGIS Chapter 3. Section 3.2.1

Let us use first explore a **simplified workflow approach** for a GIS project. What kinds of tools might be used?

1) Identify project objectives (e.g. concerns about growth of wastewater and what to do with it)
    e.g., What is the problem to be solved, e.g., in terms of criteria as in **Table 3.2**?
        Who is the intended audience?
        Will data be used again?
        What are the final products expected?

2) Create a project database (for examining the wastewater facility location problem)
    e.g., Designing the database (lab assignment is rather simple – naïve - in this regard)
        Acquiring the data (for example from various organizations as in **Table 3.3**)
        Automating/preparing the data for further analysis (as in **Table 3.4**)
        Managing the data

3) Analyze the data (to identify several options for location suitability)
    e.g., geometric modeling as in calculating distances, generating buffers, calculating area
        coincidence modeling as in overlaying data layers,
        adjacency modeling as in path finding, nearest neighbor, and allocating
        (Example analysis workflow **See Figures 3.1, 3.2, 3.3, 3.4**)

4) Present the results (of the analysis) to those interested
    e.g., create a particular type of map (Example sketch layout **See Figure 3.5**)