SOLUTION FOR HOMEWORK NO. 1

CEEGR 4800/6965 - Special Topics
Geographic Information Systems and Hydrologic & Hydraulic Modeling
Professor Uzair (Sam) Shamsi, Ph.D., P.E.
Department of Civil / Environmental & Chemical Engineering

General Comments:

- *Writing less is more! Just copying long paragraphs from the book does not help.*
- *Question1: This question required a definition of "GIS Applications" which was not included in some solutions.*
- *Question 2: This question required describing "your" GIS needs (or interests) and relating them to potential future applications of GIS. This was not addressed in many solutions. If the question was not clear, you should have contacted the instructor.*

1. What are GIS applications and how are they developed?

GIS applications are the applied or actual use of the technology of geographic information systems and science. They are specific and concrete ways that the potential of GIS is tapped and utilized. Four categories of GIS applications utilized by the water sector are mapping, monitoring, modeling, and maintenance.

GIS applications are developed by employing the following six typical steps:
1. Strategic planning
2. Specifications (system design)
3. Application programming
4. Testing (pilot project)
5. Installation (hardware, software and data)
6. Ongoing operation and maintenance (includes training)

GIS applications can also be developed by extending the core capabilities of a GIS software. Application functions are then incorporated in the GIS.

Application programming means writing the computer programs for GIS applications. There are two methods of application programming:

1. GIS-Based Approach: In this method, application functions are incorporated in a GIS. Application programs can be developed in GIS or called from a GIS. This approach provides more GIS capability than the application-based approach. The application capability depends on the GIS software and the method of developing and integrating the application. The flexibility, adaptability, and openness of a GIS software are key to developing applications for that GIS platform. Depending on the complexity of application, GIS-based approach can be implemented using one or more of the following four methods:
   1. GIS customization: implemented by customizing the GIS software's Graphical User Interface.
   2. Scripting: requires programming using scripting language such as Microsoft Visual Basic or Autodesk's AutoLISP. This method is suitable for creating a link to an H&H model.
   3. Extensions: These are special scripts that are loaded into a GIS software to increase its capabilities. This method is suitable for developing complex applications.
   4. External programs: External programs can be called from inside GIS in cases when converting an existing code to a script might be error-prone and cumbersome.

2. Application-Based Approach: In this method functions are developed in or are called from an existing application. This method offers limited GIS and complete application functions. The end result is a database-driven desktop mapping application that provides visual data on demand. In-house development of applications requires computer programming skills. For advanced applications, purchase price of commercial packages is usually less than the labor cost of in-house software development.

Pilot testing is highly recommended because it provides an opportunity to test the system design for a small pilot project area and fine tune the design and computer programs, if necessary. It allows the system designers and programmers to alter the design to meet the user needs. Pilot testing can even save money because the data or software can be changed before full system-wide implementation at which time it might be too expensive to make major changes.

2. What are the pros and cons of GIS applications and how can you avoid the potential pitfalls?

Pros of GIS Applications

1. GIS applications save time and money - GIS allows us to perform routine work more efficiently. An increased efficiency saves time thereby saving money due to an increased productivity.
2. GIS applications are critical to sustain GIS departments - For GIS departments to sustain their existence in an organization, the GIS departments have to use GIS to develop cost-effective solutions that will make the people's life easier.
3. GIS applications provide the power for integration – GIS integrates all kinds of information and applications with a geographic component into one, manageable system. GIS also allows disparate data sets to be brought together to create a complete picture of a situation.
4. GIS offers a decision support framework – GIS has the ability to integrate and analyze all spatial data to support a decision making process. GIS also provides the uniformity of data usage and the flexibility to test and evaluate multiple scenarios.
5. GIS applications provide effective communication tools – GIS can be used to communicate with different audiences using visually different views of the same data.
6. GIS applications are numerous – GIS is limitless, its applications are only limited by our imagination and the availability of data.

Cons of GIS Applications

1. Much time and cost is required to compile and analyze the necessary data.
2. Initial costs for purchasing the hardware, software and for ongoing maintenance are generally high.
3. Designing and planning GIS applications improperly can result in costly and time-consuming efforts.
4. Capturing more data than required by the application during the development of a GIS application will result into errors.
5. Use of inappropriate data in GIS applications may lead to misleading results.

How to Avoid Pitfalls

There is a possibility that a GIS application may not be implemented well, but proper design and planning through determining the end goals and type of data sources actually needed can help avoid this pitfall. The true needs of the system or organization should be adequately assessed before further development of a GIS application. Potential pitfalls of GIS applications can be avoided by:

1. Defining a vision, understanding the vision requirements, defining the tools needed to attain the vision and selecting appropriate technology to integrate those tools.
2. Fully understanding GIS with proper training and education.

3. Not capturing more data than required by the application during the development of the GIS application.
4. Using the appropriate data in GIS implementation to avoid misleading results.
5. Being extremely conscious of the nature of the source information to avoid abusive extrapolations and generalizations.

3. What technologies are fueling the popularity of GIS applications?

The development of computer hardware and software has helped fuel the growth of GIS. Desktop computers are powerful, readily available, and lower in cost for running GIS software applications, and GIS software has become more user-friendly and thus accessible to a wider segment of the population. Those technologies that have provided greater availability, accuracy, and access to geospatial information would seem naturally to strengthen the growth and popularity of GIS, including GPS, remote sensing imagery, and the Internet. Development of related technologies, including wireless communication and networks, have also contributed to its growth.

4. List your ten favorite GIS applications.

1. Web-based mapping for driving directions and shortest paths
2. Navigation systems coupled with GPS
3. Creation of maps with remotely sensed imagery as a backdrop
4. Viewing and modeling of terrain in 3D
5. Input layers for data sources in physical modeling of environmental processes
6. Mapping and attribute storage for water/wastewater/stormwater systems and other entities in a community such as private septic systems
7. Possible use with water quality studies and research
8. Creation and modeling of different scenarios in decision-making and planning such as land use/land cover changes
9. Quick and accurate locating of areas to respond to areas where maintenance and repair are needed in a utility system
10. Analysis of spatially referenced data with GIS visualization and tools

5. How will your current GIS needs benefit from potential future GIS applications?

My GIS interest is in business applications includes sales and marketing. Potential future GIS applications will benefit my current needs by being inexpensive and user-friendly. Also instead of purchasing the GIS data permanently, future GIS users will be able to subscribe to pay-per-view type plans and pay based on the extent and duration of their usage.

If doing sales work, perhaps improvements in car navigation systems for providing directions when traveling and other information such as traffic reports and weather conditions could at some point be of benefit. The greater availability of real-time data inputs to such systems might provide benefit. Also, advances and improvements—including lower cost— in mobile GIS applications and devices might also be beneficial at some point, perhaps providing access to helpful information when needed, although these applications may already be available for use.

The advances in GIS and GPS-related technologies and applications may also provide benefit in terms of potential sales of such products, as in land surveying applications and GPS/GIS field data collection. Lower cost, greater accuracy, and more functionality might increase demand among surveyors and engineering firms, as well as sectors of the construction market. Also, lower cost and greater availability and accuracy of geospatial data and remote sensing imagery may fuel sales in GIS-related products such

as software and mobile devices for the land development market, utility sectors, and state and local government.

If doing engineering projects in stormwater and flood modeling, greater availability and accuracy of DEMs and other geospatial data may be beneficial.

CEEN 4800 – GIS and H&H Modeling Scott C. Martin
Spring, 2009 - Homework #1
Questions from Chapter 1 of Shamsi (2005)

1. *What are GIS applications and how are they developed?*
   GIS applications are the practical uses of software to display and/or analyze spatial data. Applications are developed by first identifying a need, then designing a GIS-based system to meet the need, performing the necessary computer programming, pilot testing the system on a limited scale, modifying it if necessary, then installing, operating and maintaining the full-scale system.

2. *What are the pros and cons of GIS applications? How can you avoid potential pitfalls of GIS applications?*
   GIS technology greatly expedites the process of accessing, displaying, and analyzing spatial information. This saves time and money for individuals, companies, or government organizations. It provides the capability to analyze complex problems involving many geographic criteria or factors that would be essentially impossible without GIS technology. And, it provides the mapping capabilities to clearly display and communicate results to a diverse audience.

   The main pitfalls of GIS applications are:
   1) There is an initial cost to purchase hardware (computers, printers/plotters) and software.
   2) Trained operators are needed to run the software and maintain the GIS system. It can be a challenge to recruit qualified workers, and their ongoing training will be an expense for an organization.
   3) Without proper planning and pilot testing, a GIS application may not fulfill the intended need.
   4) GIS data must be viewed with a skeptical eye. Sometimes there can be inaccuracies in the layers of spatial information, leading to incorrect conclusions.

3. *What technologies are fueling the popularity of GIS applications?*
   Many of the most interesting and popular innovations make use of wireless devices such as cell phones, PDAs, etc., in combination with GPS. Increases in computer processing speed and storage capacity, and internet bandwidth, allow rapid display of information in 3D, to allow virtual reality representations of landscapes and infrastructure. Also, the increasing availability and detail/accuracy of data facilitates new applications.

4. *List your ten most favorite GIS applications.*
   Some (not quite ten) of my favorite GIS applications include:
   - Planning trips with Yahoo Map.
   - Checking satellite images for lake effect storms before travelling to New York.
   - Using a Garmin GPS to find directions or locate restaurants when travelling in an unfamiliar city.
   - Using the Mahoning County GIS to check sale price of properties.
   - Locating soil maps for a development site for stormwater management projects.
   - Looking at a point of interest with Google Earth.
   - Checking rainfall and snowfall statistics from the US Weather Service.
   - My graduate students have used GIS in research projects to identify good locations for constructed wetlands and to rate and map the condition of riparian corridors along local streams.

5. *How will your current GIS needs benefit from potential future GIS applications?*
   I am interested in research on watershed management and stream restoration. I think the ability to acquire, store and display field data in real time will create opportunities for greater efficiency and more detailed analysis than currently possible. This technology also has the potential to excite young students about water resources and environmental engineering.