

Watershed Sciences 4930 & 6920 GEOGRAPHIC INFORMATION SYSTEMS

WEEK THREE- INTRODUCTION TO GEOPROCESSING

Joe Wheaton

HOUSEKEEPING

- I've got nothing...
- Any questions?



TUESDAY'S PLAN

- I. Brief Intro Review of Imagery (Rasters)
 - I. Satellite
 - II. Airborne
 - III. Oblique
- II. Data Sources: Capture & Collection

AERIAL PHOTOGRAPHY



NOAA 2004, Hurricane Ivan

AERIAL PLATFORMS

- Fixed Wing Platform
- Helicopter Platform

Sticks connected with control surfaces with sensor 2 axes and sensor 3 axes, 3 axes in total

POOR MAN'S AERIAL PHOTOGRAPHY

- As low-tech as it gets
- Ortho-rectification registration errors on the order of 25- 75 cm
- Flying height of up to 500 m

- Great for context (what does it mean? problem)
- Grain size extraction
- Habitat mapping / classification
- Drape over a DEM

BEFORE & AFTER

Repeat AP tells part of the story....

0 10 20 30 40 50 Meters

Legend
Analysis Extent

Imagery acquired with poor man's aerial photography (i.e. blimp, duct tape, digital camera)

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OTHER PLATFORMS

- Weather Balloons
- Drones
- Toy Helicopters
- Poles

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AGGIE AIR

Developed here at USU!

USU Water Research Lab

Reaven's autonomous landing

aggieair.usu.edu/index.html

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VERTICAL, LOW OBLIQUE, AND HIGH OBLIQUE AERIAL PHOTOS

Sand dunes, Mexico

Small island in Michigan

San Juan County, Utah
Jim Wark, 2000

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ORTHORECTIFICATION VS. GEORECTIFICATION

- *Orthorectification* - accurate method of correcting an image to align with realworld coordinates (x,y, & Z)
- *Georectification* (a.k.a. Georeferencing or rubber-sheeting) method of stretching and warping an image to align with a map in a GIS

0.5 meter resolution image from WorldView-1 Satellite

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FINDING DATA IN THE RIGHT FOMAT

- The single most time consuming part of operating a GIS
 - Approximately 80% of most project resources (time and money) are used for data collection and input



TYPES OF DATA CAPTURE

- Primary Data
 - Data created/developed/collected by the individual or organization that intends to use them.
 - Generally higher quality.
 - Strict QA/QC controls
- Secondary Data
 - Data created by individuals other than those that collected the data originally (i.e. derived).
 - Data quality may be lower than desired if standards are not set at the onset of data collection.

DATA COLLECTION

- Two types of data collection
 - #1 – Data Transfer
 - Importing existing digital data from a variety of sources (i.e. secondary data)
 - #2 - Data Capture
 - Refers to direct entry of acquired data to your GIS (i.e. primary data)
- We will focus mostly on Data Transfer Today...
 - Readily available
 - Familiar to most
 - Way more information than you'll ever use



INPUT METHODS:

- Digitizer
 - Two Types: Tablet vs. Digital Scan
- Optical Scanning
- Conversion from digital sources
- Conversion from other analog sources
- Aerial photos / Satellite imagery
- Global Positioning Systems

INTERNET SITES FOR DATA TRANSFER

- Geospatial Data Gateway: 'One stop source of natural resources data' – USDA
 - <http://datagateway.nrcs.usda.gov>
- Geospatial One-Stop: geoportal providing metadata and direct access to over 50,000 datasets
 - <http://www.geodata.gov>
- EROS Data Center: US government data archive
 - <http://edc.usgs.gov/>
- The Data Depot: extensive collection of mainly free geographic data
 - <http://data.geocomm.com/>
- GEON
 - <https://portal.geongrid.org/gridsphere/gridsphere>
- Seamless Data Distribution System
 - <http://seamless.usgs.gov>
- The Data Store: UK, European, and worldwide data catalog
 - <http://www.data-store.co.uk>

EROS DATA CENTER

USGS (U.S. Geological Survey) EROS, Sioux Falls, SD - Mozilla Firefox

USGS science for a changing world

Geography - The National Map

National Center for Earth Resources Observation & Science (EROS) Site Map Site Search

Products Science NASA LP DAAC Satellite Missions NHLRSDA About EROS

Image Gallery A leading source of land information for exploring our changing planet.

Aerial Map Elevation Satellite Land Cover

News

- SIR-C Processing System no Longer Operational
- EROS Home Contact USGS Research USGS
- USGS National Center for Earth Resources Observation & Science (EROS) Receives 2004 William T. Pecora Group Award
- Digital Line Graph (DLG) and Digital Elevation Model (DEM) Distribution

| Product | Description | Search/Order |
|--|---|--|
| Aerial Products | | |
| High Resolution Scanned | Digital aerial and satellite imagery created from film products in the USGS archive. Output produced by a high-resolution flatbed scanner. | Earth Explorer |
| Medium Resolution Digitized | Digital aerial and satellite imagery created from film products in the USGS archive. Output produced by a digital camera system. | Earth Explorer |
| National Aerial Photography Program (NAPP) | Recent high-quality aerial photos covering the conterminous U.S. on five- to seven-year cycles (1997 - present). | PhotoFinder Earth Explorer |
| National High Altitude Photography (NHAP) | High-altitude aerial photos for the conterminous U.S. (1960 - 1989). | Earth Explorer |
| Survey Photography | Aerial photos from a variety of sources (1939 - present). | Earth Explorer |
| Index Mapping Photography | Aerial photos referenced as photo indexes from a variety of sources (1940's - 1980's). | contact us |
| Digital Orthophoto Quadrangles (DOQQ) | Digital images of aerial photos which combine the image characteristics of the photo with the georeferenced qualities of a map (1997 - present). | Earth Explorer |
| High Resolution Orthoimagery | Recent (2002-2003) orthoimagery with a resolution of 0.3 meters to 0.75 meters for the major metropolitan areas and state capitals of the United States. As more areas are received, they will become available for distribution. | Seamless Data Distribution System (SDDS) Earth Explorer |
| Space Acquired Photography | Photos taken from the International Space Station (ISS), Shuttle, Skylab, Oerli, and Apollo missions (1965 - present). | NASA Earth Sciences & Image Analysis (Shuttle and ISS) |
| Scientific Committee on Antarctic Research (SCAR) | A large collection of aerial photography over Antarctica (1946 - present). | Contact SCAR |
| Aircraft Scanners | Digital imagery acquired from several multispectral scanners on board NASA ER-2, NASA C-130B, and NASA Learjet aircrafts (1982 - 1995). | Earth Explorer (Search Only) |

SEAMLESS DATA DISTRIBUTION SYSTEM

USGS science for a changing world

Seamless Data Distribution System, National Center for Earth Resources Observation and Science (EROS)

Home Background List of Products Frequently Asked Questions Links Contact Us

What this site has to offer:

- Free Data Downloads
- View Online Datasets and Area
- Elevation Point and Profile Tools
- Tutorials
- and much more...

News

- System Status

Supporting First Responders and Emergency Personnel working in the aftermath of Hurricane Katrina. In cooperation with FEMA, EROS is the clearinghouse for all aerial, satellite and

View and Download United States Data

View and Download International Data

Seamless Data Distribution

USGS Seamless Data Distribution Back to Main Page Tutorial

Scale Information

Layers

- Display
- Places (Names)
- Layer extent
- Transportation
- Boundaries
- Hydrography
- Orthoimagery
- Land Cover
- Elevation

UTAH GIS PORTAL

Utah GIS Portal

Home About Us Contact Us Feedback Site Map

Utah GIS Portal

One of the best state GIS centers

Wealth of free GIS data

UTAH GIS

- SGID (State Geographic Information Database) Data & Map Servers

Utah GIS

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UTAH GIS

Straight Download of Data Organized by Vector & Raster Data Sources:

- Vector (you name it)
- Raster (Aerials, USGS DRGs, Elevation/Terrain)

The screenshot shows the Utah GIS Portal interface. It features a search bar, a map viewer, and a list of data layers categorized by type (Vector, Raster, etc.). A 'DOWNLOAD GIS DATA FROM THE SDD' section is visible, listing various datasets like 'Aerials', 'Topographic', and 'Elevation'. The Utah State University logo and 'WATS 4930' are at the bottom.

DIGITAL RASTER GRAPHICS

- Multiple-scales available
- Just a high resolution scan of paper USGS Quads

Two examples of Digital Raster Graphics (DRGs) are shown. The left image is a low-resolution scan of a USGS quad showing a river and surrounding terrain. The right image is a high-resolution scan of a USGS quad showing detailed features like roads, buildings, and vegetation. The Utah State University logo and 'WATS 4930' are at the bottom.

DIGITAL LINE GRAPHS

- Just the digitized linework from the quads or DRGs
- Often 'seamless'

Three examples of Digital Line Graphs (DLGs) are shown: Hydrography (water features), Roads (road network), and Hypsography (elevation contours). A larger, more detailed DLG is shown below. The Utah State University logo and 'WATS 4930' are at the bottom.

DOQ – DIGITAL ORTHOPHOTO QUADS

- A orthorectified photograph corresponding in spatial coverage to a USGS quad map

A Digital Orthophoto Quad (DOQ) is shown, which is a high-resolution aerial photograph that has been orthorectified to match the spatial coverage of a USGS quad map. The Utah State University logo and 'WATS 4930' are at the bottom.

READING FOR THURSDAY

ADVANCED GIS COURSES
WATS 4930/6920, 4931/6921, 6915

Assignments > Reading Assignments >
Reading for Thursday, January 25th
posted a month ago by Joe Whitman

On Thursday we'll start talking about Geoprocessing. Please read the following ESRI help topics:

- What is Geoprocessing?
- A Quick Tour of Geoprocessing in Arc
- Essential Geoprocessing Vocabulary
- Using the Results Window

The screenshot shows a web page for an advanced GIS course. It lists reading assignments for Thursday, January 25th. A flowchart diagram is visible, showing the process of geoprocessing with inputs, outputs, and a results window. The Utah State University logo and 'WATS 4930' are at the bottom.

TODAY'S PLAN...

- I. Geoprocessing
- II. ModelBuilder
- III. Batch Processing
 - I. A right-click away
 - II. Scripting
- IV. Python Scripting
- V. Efficiency

The Utah State University logo and 'WATS 4930' are at the bottom.

WHAT IS GEOPROCESSING?

An ESRI term...

Introduction to Topic

From ESRI's Help:

"Geoprocessing is for everyone that uses ArcGIS. Whether you're a beginning user or a pro, geoprocessing will become an essential part of your day-to-day work with ArcGIS."

The fundamental purposes of geoprocessing are to **allow you to automate your GIS tasks and perform spatial analysis and modeling**. Almost all users of GIS involve the **repetition of work**, and this creates the need for methods to automate, document, and share multiple-step procedures known as workflows. Geoprocessing supports the automation of workflows by providing a rich set of tools and a mechanism to combine a series of tools in a sequence of operations using models and scripts. [READ MORE](#)

Why we're Covering it

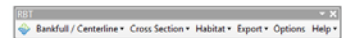
Geoprocessing is what helps make you efficient in your spatial analyses. Whether its combining multiple tools into one using model builder, batch processing a large quantity of data, writing some simple Python scripts, or leveraging the functionality of the Results window, geoprocessing is what can help you move from a novice GIS user, to a highly proficient power user.

Learning Outcomes

This topic supports **primary learning outcomes** 1, 2, 3 and 4 for the course.

TYPES OF GEOPROCESSING IN ARCGIS

- Tools
- Models
- Scripts
- Add-Ins
- Plug-Ins



- These differ from some of the Toolbars you've used...

PLACES TO GET GEOPROCESSING TOOLS

- Toolbox
- ArcGIS Resource... Gallery
- From Specific Places...

LOTS OF WAYS TO ACCESS A TOOL

WHEN A TOOL RUNS...

ENVIRONMENT SETTINGS

There are four levels of environment settings:

1. **Application level** settings are the default settings that will be applied to any tool when it is executed.
2. **Tool level** settings are applied to a single run of a tool and override the application level settings.
3. **Model level** settings are specified and saved with a model and override tool level and application level settings.
4. **Model process level** settings are specified at the model process level, are saved with the model, and override model level settings.

WHERE TO LEARN MORE ABOUT GEOPROCESSING

Additional Resources

Geoprocessing in ArcGIS

- Geoprocessing ArcGIS Resource Center - This is the main hub of information on Geoprocessing and getting yourself up to speed!
- The Geoprocessing Experts - Trying to do something with Geoprocessing and having trouble? Try posting a thread or searching the forum.
- Geoprocessing Blog - An overview of Geoprocessing in ArcGIS
- Using the Results Window - An essential new feature of Geoprocessing in ArcGIS

Batch Processing

- A Batch Tool of Batch Processing - ArcGIS 10 Help topic

Finding Existing Tools and Scripts

- Geoprocessing Models and Script Tool Gallery - A hub of tools you can identify and install in ArcGIS that other users have made. Very useful!
- See also this week's 101 Tutorial, Topic 1

Geoprocessing with Model Builder

- Designing and Building Geoprocessing Tools - This video walks you through the basics of building Geoprocessing Tools using Model Builder in ArcGIS 10
- A Batch tool of creating tools with ModelBuilder - ArcGIS 10 Help
- Tutorial for Building Tools with Model Builder - ArcGIS 10 Help

Add-ins

- Add-ins for ArcGIS 10 - Add-ins are a new feature in ArcGIS. This video describes them.
- Add-ins 101

Plug-ins

Plug-ins are typically tool-bars that are installed externally and produced by someone other than ESRI, to work

- Plus,
 - Other Classes
 - ESRI Courses
 - ESRI Tutorials

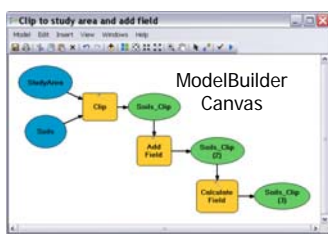
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THE MODELBUILDER INTERFACE

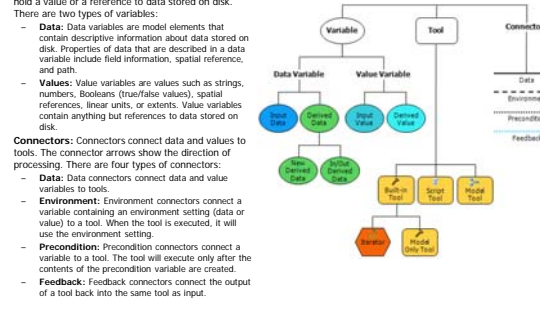
- ModelBuilder window: where you edit, test and run models



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MODEL ELEMENTS:

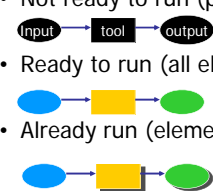
- **Variables:** Variables are elements in a model that hold a value or a reference to data stored on disk. There are two types of variables:
 - **Data:** Data variables are model elements that contain descriptive information about data stored on disk. Properties of data that are described in a data variable include field information, spatial reference, and path.
 - **Values:** Value variables are values such as strings, numbers, Booleans (true/false values), spatial references, linear units, or extents. Value variables contain anything but references to data stored on disk.
- **Connectors:** Connectors connect data and values to tools. The connector arrows show the direction of processing. There are four types of connectors:
 - **Data:** Data connectors connect data and value variables to tools.
 - **Environment:** Environment connectors connect a variable containing an environment setting (data or value) to a tool. When the tool is executed, it will use the environment setting.
 - **Precondition:** Precondition connectors connect a variable to a tool. The tool will execute only after the contents of the precondition variable are created.
 - **Feedback:** Feedback connectors connect the output of a tool back into the same tool as input.



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THE MODELBUILDER INTERFACE, CONT.

- Model elements have 3 states
- Not ready to run (parameters aren't defined)
- Ready to run (all elements are colored)
- Already run (elements are colored and shaded)



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BATCH PROCESSING

- I got to do this same thing 100 times
- AGHHH
- Brut force or Batch Process
- Write a script that loops through same thing (input varies)
- Use right-click in Arc Toolbox and click 'batch'

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SCRIPTING

- Sequences of GIS operations that can be stored and shared
 - Native languages: Arc Macro Language, Avenue
 - Software independent languages such as Visual Basic for Applications, Perl, or Python
 - a model can be written and executed as a script
- Scripts can be manipulated visually
 - e.g., through ESRI's ModelBuilder

PROGRAMMING?

- Lots of languages (syntax is critical to speak)
- Loops (for or do)
- Conditional (if, then, else)

IF Statement

```
IF condition THEN
  action(s);
END IF;

IF condition THEN
  action(s);
ELSEIF condition THEN
  action(s);
ELSEIF condition THEN
  action(s);
[ELSE
  action(s);]
END IF;
```

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PROGRAMMING - LOOPS

Simple Loops

```
LOOP
  EXIT [WHEN <condition>] ;
END LOOP;
```

SQL> declare
2 counter number := 0;
3 begin
4 LOOP
5 counter := counter + 1;
6 dbms_output.put_line(counter);
7 EXIT WHEN counter = 5;
8 END LOOP;
9 end;
10 /
1
2
3
4
5
PL/SQL procedure successfully completed.

Initialize counter!

Use the EXIT statement to exit loop

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BRUTE FORCE...

- If you do something once or twice, brute force may suffice...
- If you start doing it more than that, make yourself a tool
 - Limits opportunity for sloppy mistakes
 - Makes
 - If good enough, share it with others...



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THIS WEEK'S LAB

Lab 3: Reproducing Maps – Geologic Map

- Teach you how to manipulate display properties and symbology to reproduce a map in as close as possible a fashion to the original.
- Teach you how to extract summary statistics and data from existing data

