

TYPICAL STEPS IN DEVELOPING GIS APPLICATIONS AND MODEL BUILDERS

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Review of GIS Spatial Queries and Analyses Tools



Jacob Opadeyi Ph.D.

What is a spatial query ?

- the spatial manipulation of an object for a specific purpose
- the objects manipulated are geographically referenced
- the objects are cartographically represented
- spatial queries are executed within a cartographic context
- a spatial query may involve a single layer or multiple layers

Types of spatial queries supported by GIS

- Name - position and character
- Character - name and location
- Location - characteristics and names
- Measurement - area, distance, shape
- Spatial relationships - inclusion, direction, adjacency, connection
- Decision support - allocation, location, routing, layout
- Predictions - geometric inference, simulation, modelling

Query Operations

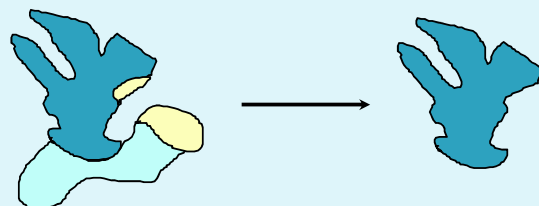
There are four main operations which can be used in many ways and different sequences

- Reselect
- Dissolve
- Buffer
- Overlay functions:
 - Union
 - Identity
 - Intersect

Reselect

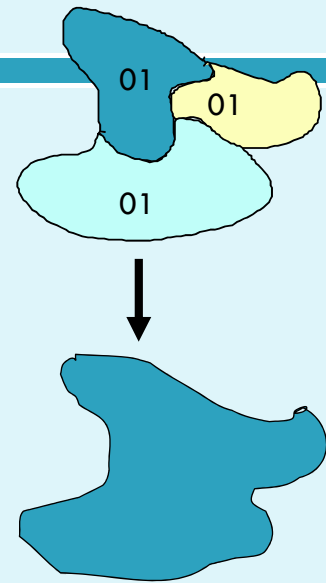
- 📄 Extracts map features from a coverage on the basis of attribute values
- 📄 Creates a new coverage with only 'selected' features

Eliminate can be used to select a subset of features and delete them from the coverage



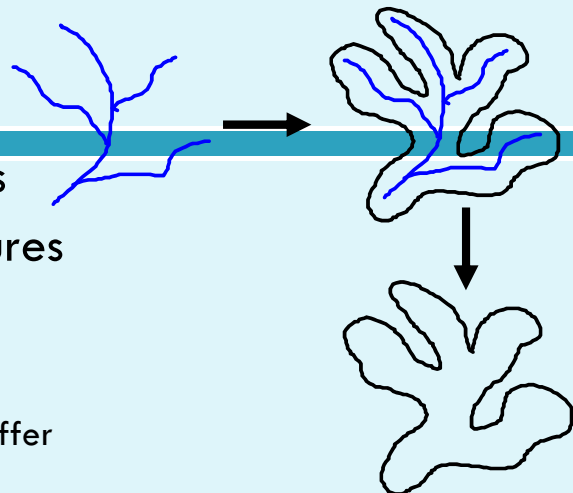
Dissolve

- Creates a new coverage with data extracted from a coverage
- Merges adjacent polygons which have the same value for a specified item
- Eliminates arcs between adjacent polygons
- Reduces size of .pat file by reducing number of polygons



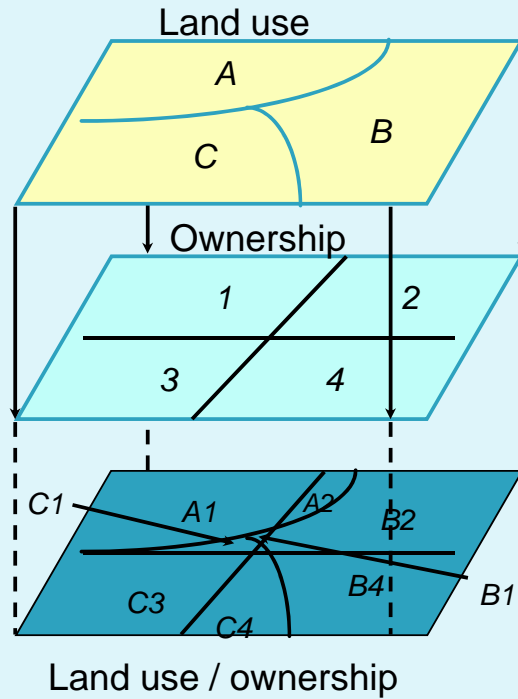
Buffer

- Performs proximity analysis
- creates zones around features
- requires feature item and buffer distance to be specified
- a buffer table can be utilised to vary buffer sizes on a single feature
- output coverages are polygon coverages
- output coverage includes item called 'inside'
Area inside buffer = 100 Area outside buffer = 1

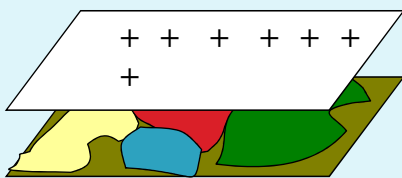


Overlay

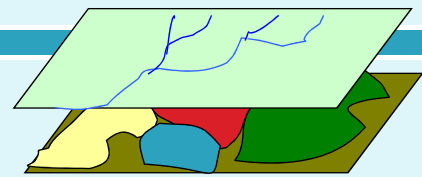
Layers are overlaid to produce multiple-theme layers.



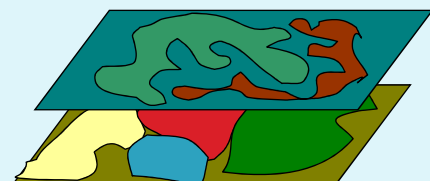
Types of overlays :



Point on Polygon

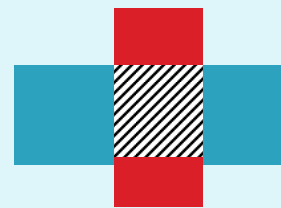
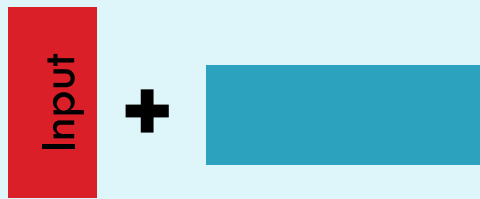


Line on Polygon

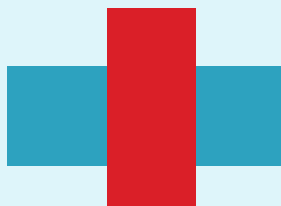


Polygon on Polygon

Overlay Operations :

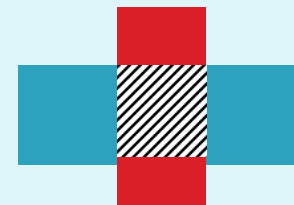


Intersect combines features of both coverages within the common area of both coverages



Union combines all features of both coverages

Identity combines features of both coverages which are within extent of input coverage



Overlay Functions

- Create new information by topologically combining coverages
- Coverages are overlaid two at a time (in ArcInfo™)
- Coverages are graphically and topologically intersected
- New geographic features are created
- New feature attribute table is created
- New table contains all information that was in *both* original tables

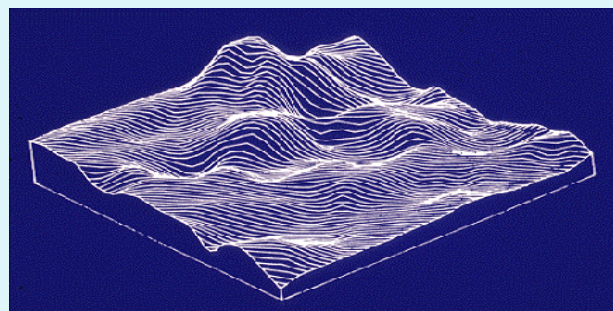
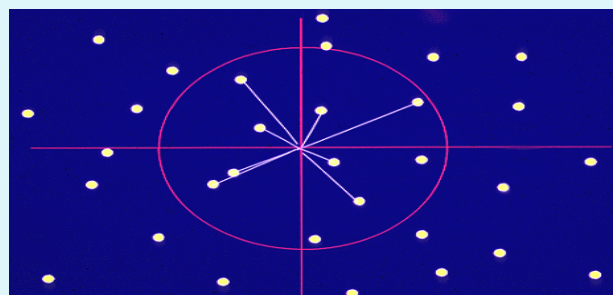
Interpolation: Point data

Values at discrete locations are point data.



Surface Interpolation

- Continuous surfaces can be derived from point data through interpolation.
- Issues
 - boundary values
 - sampling methodology



Source: GIS Workshop, IPM, CRSP

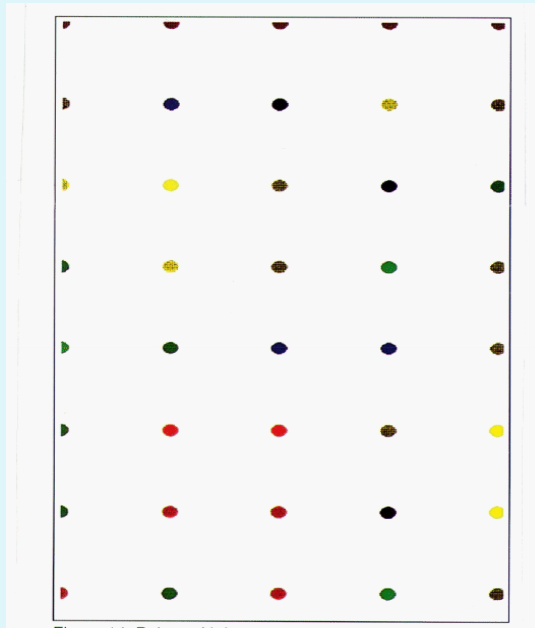


Figure 14. Points with known amounts of rainfall, ranging from high (yellow) to low (black). These points will be used to create a contour map.

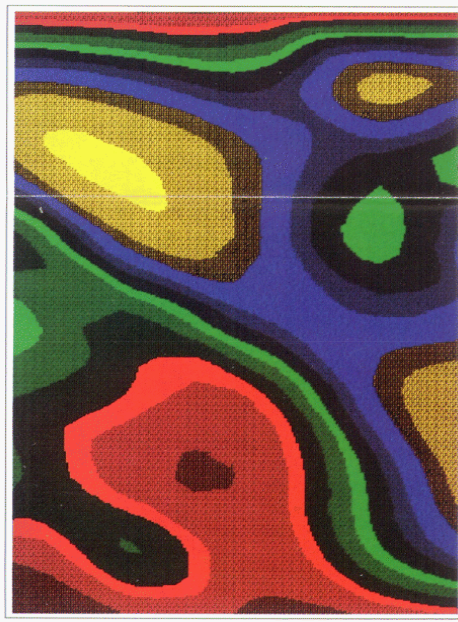


Figure 15. Contour map made from rainfall points shown in fig. 14. Areas with the highest amounts of rainfall are shown in yellow, and the lowest, in black.

Source: GIS Workshop, IPM, CRSP

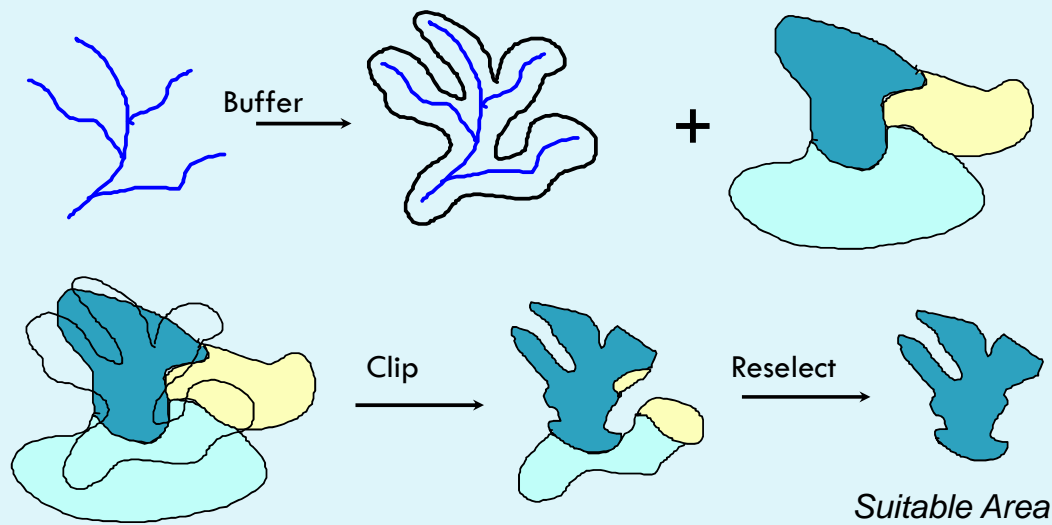
Spatial Analysis

- ✉ Spatial Analysis is a process which consists of a collection of spatial queries

It can:

- ✉ identify trends in data
- ✉ create new relationships in data
- ✉ view complex relationships between data sets
- ✉ assist in making more well- informed decisions

Buffer, Clip, Reselect

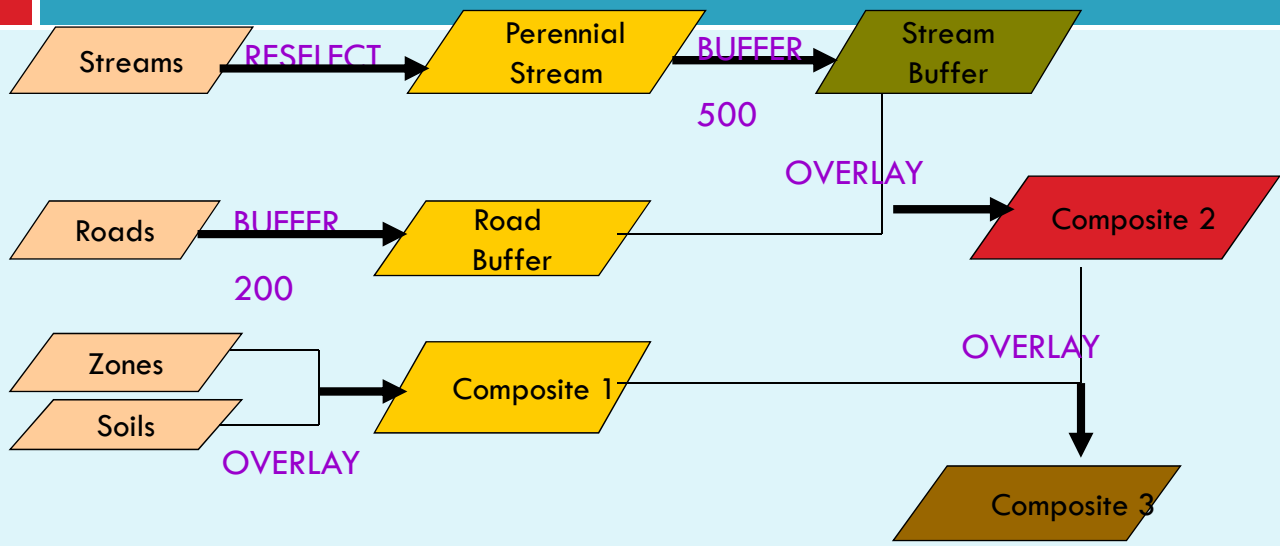


Cartographic Modelling

Cartographic modelling is the logical expressions and analytical procedures applied to a dataset in order to:

- simulate a process
- predict an outcome
- characterize a phenomenon

A Cartographic Model



TYPICAL STEPS IN DEVELOPING GIS APPLICATIONS

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Design Stage

1. What are the *objectives* and the *decisions* required to be made using this application?
2. What are the *criteria* for the decisions?
3. What *information* is needed in order to evaluate the criteria?
4. What *data* must be acquired to generate the information?
5. What GIS functions will turn the data into information?

TYPICAL STEPS IN DEVELOPING GIS APPLICATIONS

Development Stage

1. Prepare the data for spatial operations
2. Perform spatial operations
3. Prepare derived data for tabular analysis
4. Perform tabular analysis
5. Evaluate and interpret results
6. Refine the analysis as necessary
7. Produce the final maps and tabular reports of the results

EXAMPLES OF APPLICATIONS

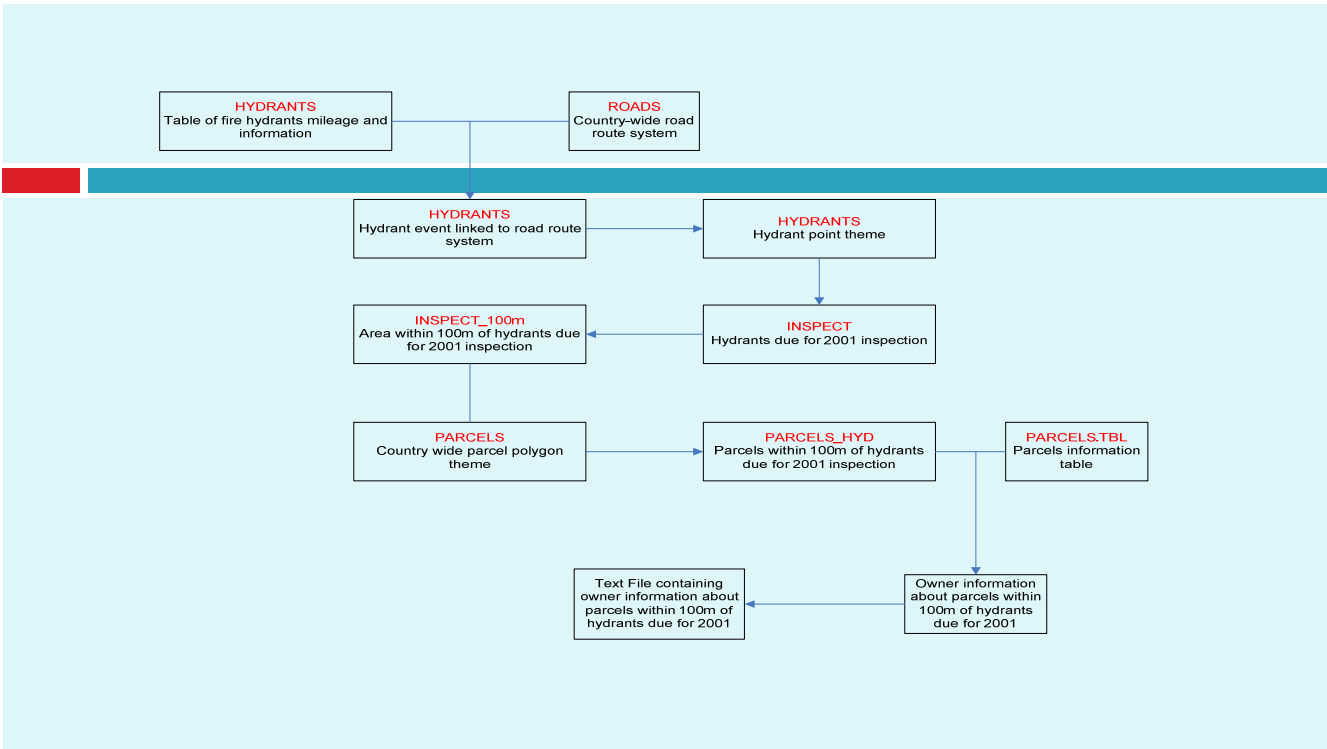
FIRE HYDRANT INSPECTION

You have a table of county-owned hydrants and their mileage recorded by driving along all country roads. The table contains information such as:

- date of last inspection**
- age of fire hydrant**
- maximum flow rate, and so on.**

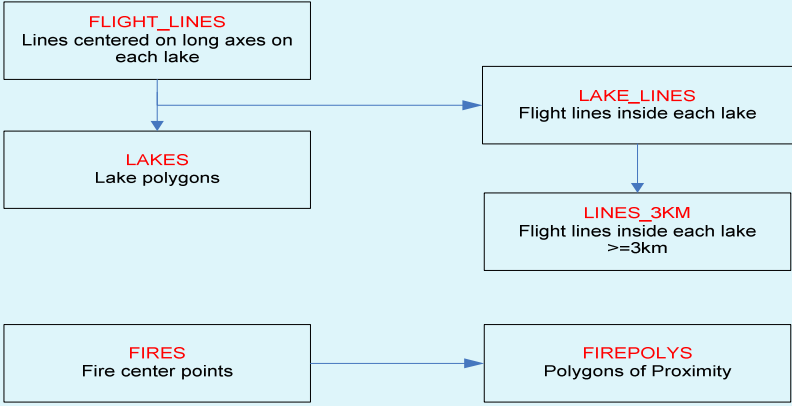
You also have country-wide roads line theme and a parcel polygon theme. You also have a table of parcel owners, the table contains parcel-ID's, owner names, addresses, and phone numbers. All hydrants in the country are inspected on a five year basis. Your job is to create a text file of names and addresses of parcel owners with property within 100m of a fire hydrant that is scheduled to be inspected in 2001

Fill in the following flowchart with the appropriate vector GIS tools to solve your problem



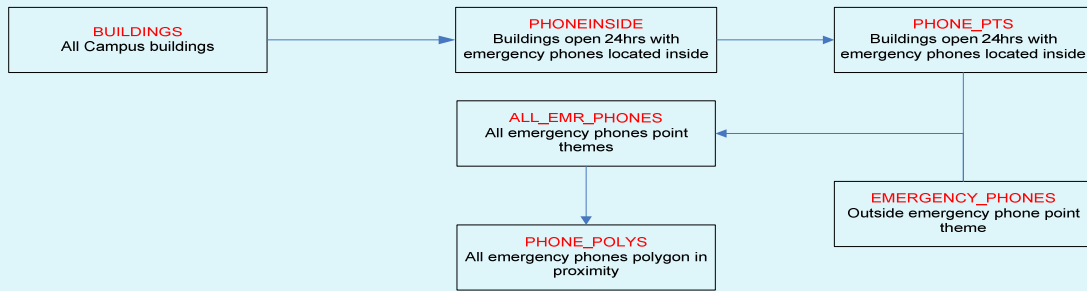
FOREST FIRE APPLICATION

You have a line theme of flight lines over the center of lakes, a polygon theme of lakes, and the point theme of the center of 5 currently burning wild fires. In order for tankers to reload water, they need a lake that is at least 3km long. Develop a map Showing all lakes available for tanker re-loading and which fire they are closest to.

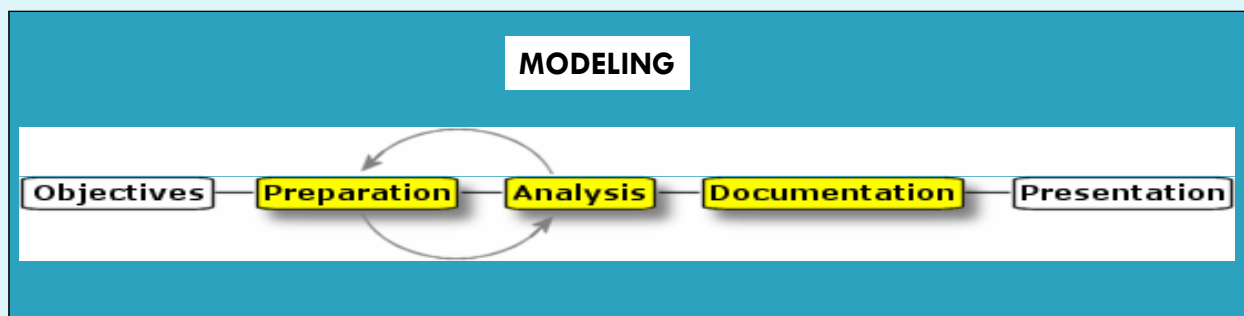


EMERGENCY PHONE APPLICATION

You are hired as a GIS guru for the facilities management department of a large university. You have a polygon theme of buildings, a line theme of sidewalks, and a point theme of outside emergency phones. Your job is to show the area of the campus that is most lacking in emergency phone service. Fill in the following flow chart with the appropriate GIS tools to solve your problem.

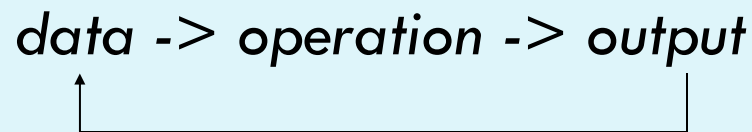


Geoprocessing as modeling



The core of Geoprocessing...

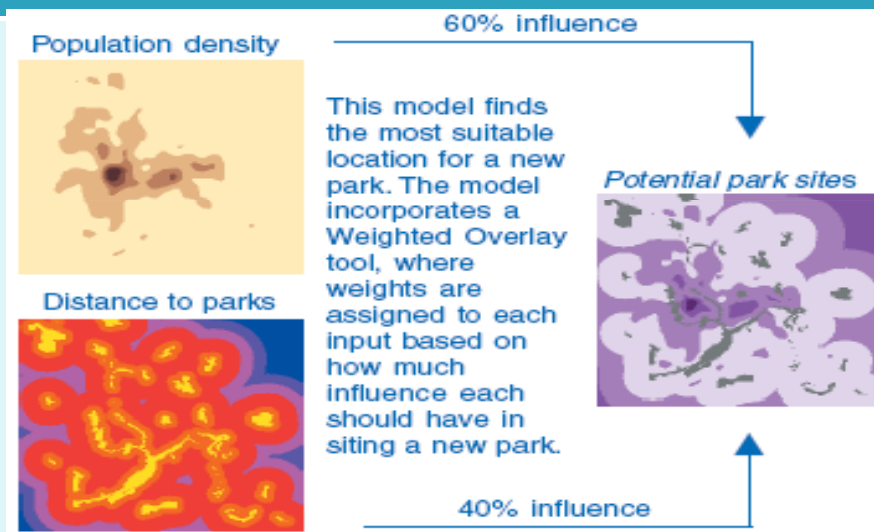
building data processing chains in GIS:



Types of Models in GIS (by function)

- Descriptive models – database
- Change models – before and after
- Impact models – what happens
- Explanatory models – process influence
- Predictive models – what will be like
- Prescriptive models – should be like

Example of Suitability Model

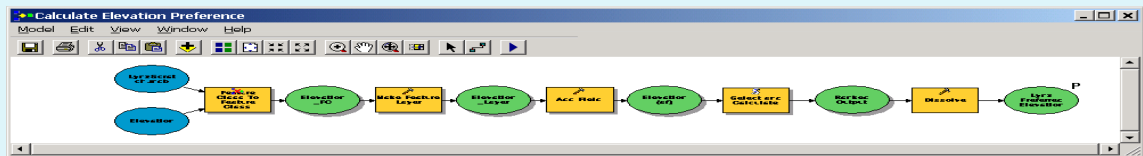


Developing Geoprocessing Procedures (*models*) with Model Builder

- Identify the components of a model
- Build and test models
- Edit existing models
- Simplify complex models using submodels
- Set up a model to run from its dialog
 - ▣ *model parameterization*
- Facilitate conditional processing (branching) with scripts
- Calibrate and validate

Model Components

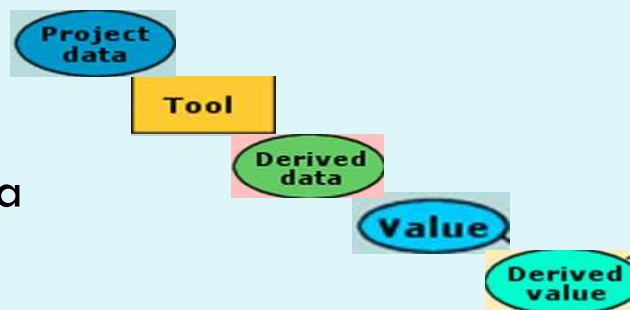
- In ModelBuilder, models are represented as flow charts with distinct symbols for each type of component



- Elements are connected together via connector lines that serve to create processes as well as show processing flow

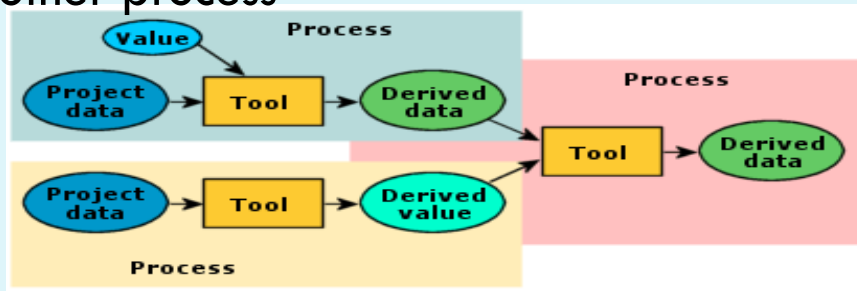
Model Components (*elements*)

- Data
- Tool
- Derived data
- Value
- Derived value



Data Process

Models typically contain several processes, and they can be chained together so that the derived output from one process becomes the input for another process

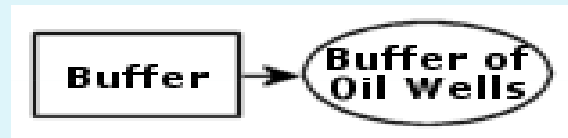


Variables

- Any element in a model that isn't a tool is a *variable* (project data, derived data, values, derived values)
- Variables can be thought of as **placeholders for datasets or tool parameters**
- Variable values can be easily changed, and they can be shared between processes in a model

Sources of Simple Errors in Models

A model's readiness to run can be affected by various factors. One factor is **connectivity**. A tool that is not connected to an input element will not be ready to run.



In this example, there is no input to the Buffer tool operation; therefore, it is not ready to run.

Sources of Simple Errors in Models

Another factor affecting the ability to execute a process in ModelBuilder is **specification**.



Although the input data element is ready to run, the parameters of the Add Field tool have not been defined; therefore, the process as a whole is not

Sources of Simple Errors in Models

The third factor affecting the ability to run a process is data **accessibility**.



In this example, the elements are connected and their parameters are fully specified. The problem is that ModelBuilder cannot find the input data it needs.

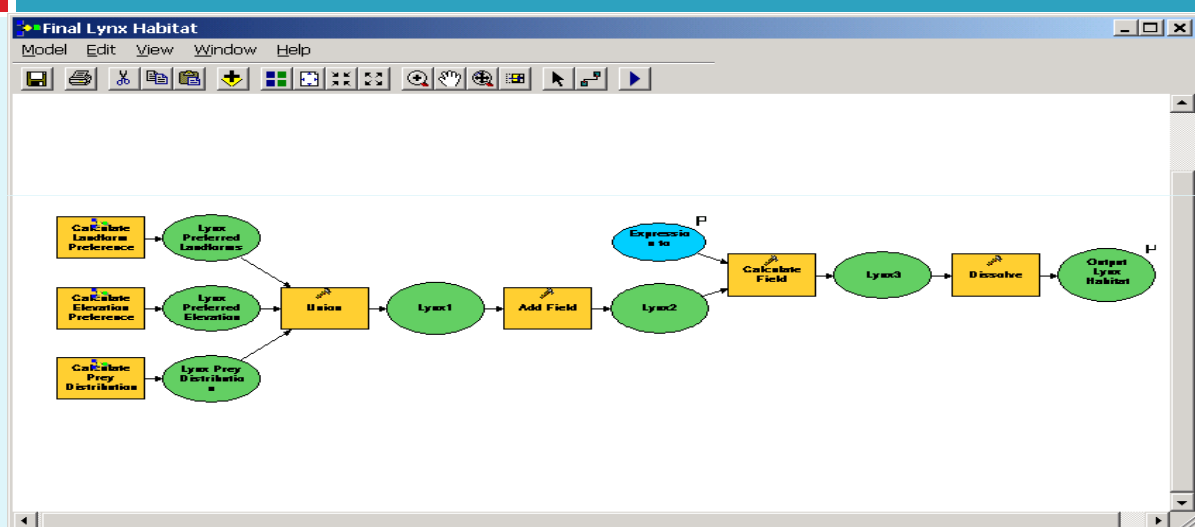
How to start building a model?

1. Identify functional relationships between the phenomenon and its variables
2. Identify the initial input variables
3. Identify the intermediate input variables.
4. Choose appropriate tools for implementing transformation functions as processes
5. Combine processes based on *cause-effect* relationships

Models and Submodels

- Using submodels allows you to divide parts of a larger model into smaller, more manageable pieces.
- Before a submodel can be added to a primary model, the output variable of the submodel must be *exposed as a model parameter*. This will allow the output variable to be shared between models.

Models and Submodels





Thank you