Hydro Networks in GIS

- Connecting the Land and Water Systems
- Hydrologic networks
- Linear referencing on networks
Reading (1)

What are geometric networks, A quick tour of geometric networks, Essential geometric networks

What is linear referencing; Essential linear referencing vocabulary

Key Concepts from Exercise 4
Raster Analysis Layers

- Fill
- Flow Direction
- Flow Accumulation
- Stream Definition
- Stream Links
- Catchments
Vector Analysis Layers

- Vector streams
- Vector catchments
- Attribute feature with raster zonal statistics
- Geometric Network
- Tracing
- Selection statistics
Raster to Vector Transition

• During the first part of the Exercise on Geometric Networking (Ex. 4), you are dealing with the flow of water through the landscape based on the raster data structures.

• During the last part of Ex. 4 we are using vector network data to describe water pathways.

• We will connect the land and water flow systems by attaching the catchments and watersheds derived from raster data processing to our vector networks.
Flow Line

Traces movement of water in a one-dimensional flow system
Four Key Concepts

• Four key constructs
  – Cell to cell water movement on DEMs
  – Line to Line water movement on networks
  – Area flows to line (connect land and water systems – Reach to Catchments)
  – Area flows to point on line (Watershed delineation from designated points)
Cell Flows to a Cell

Core concept of flow on digital elevation models
Area Flows to a Line

Reach Catchments from NHDPlus

Flowlines and Catchments have the same COMID

In this example: COMID of flowlines = COMID of catchments
Area Flows to a Point on a Line

Tesselation using gage points
Topology

Topology (from the Greek τόπος, "place", and λόγος, "study") is the mathematical study of shapes and spaces. It is a major area of mathematics concerned with the most basic properties of space, such as connectedness, continuity, boundary. It is the study of properties that are preserved under continuous deformations including stretching and bending, but not tearing or gluing.

http://en.wikipedia.org/wiki/Topology

Connection by relationship
Connection by geometry
Connection by relationship

Area 354 flows to point 354
Connection by Geometry

- A network is a set of edges and junctions that are topologically connected to each other.
Network Model in GIS

• Three components
  – **Geometric model:** (x,y,z,m) coordinates of edges and junctions. Northing/Easting, Elevation and distance along edge (measure)
  – **Logical model:** which edges are connected to what junctions. Edge 10 is connected to edge 31.
  – **Addressing model:** location on the network using measure
Edges and Junctions

- **Simple feature** classes: points and lines
- **Network feature** classes: junctions and edges
- Edges can be
  - **Simple**: one attribute record for a single edge
  - **Complex**: one attribute record for several edges in a linear sequence

- A single edge cannot be branched

No!!
This single PolyLine feature will be converted to many SimpleEdge features when the network is built.
Junctions

- Junctions exist at all points where edges join
  - If necessary they are added during network building (generic junctions)
- Junctions can be placed on the interior of an edge e.g. stream gage
- Any number of point feature classes can be built into junctions on a single network
### Connectivity Table

<table>
<thead>
<tr>
<th>Junction</th>
<th>Adjacent Junction and Edge</th>
</tr>
</thead>
<tbody>
<tr>
<td>J123</td>
<td>J124, E1</td>
</tr>
<tr>
<td>J124</td>
<td>J123, E1, J125, E2, J126, E3</td>
</tr>
<tr>
<td>J125</td>
<td>J124, E2</td>
</tr>
<tr>
<td>J126</td>
<td>J124, E3</td>
</tr>
</tbody>
</table>

This is the “Logical Network”
Build Network Tables

- Establishes connectivity of Edge and Junction features
- Enables tracing
- Generates Generic Junctions

Geometric Network Wizard in ArcCatalog
Snapping Features

Before Snapping

After Snapping

New Geometric Network

Enter a name for your geometric network:
BasemapAlbers_Net

Snap features within specified tolerance:
- No
- Yes

0.001 Meters

Line ends and junctions must match up precisely for features to connect. If they do not match up they can be moved within the limits of the snap tolerance. The default value is based on the XY tolerance of the feature dataset.
Network Sources and Sinks

Each junction feature class in a network can have junctions which are sources or sinks for flow.

Use complex edge so that junction can be interior to edge.
Flow to a sink

Flow direction has been assigned direction of the arrowhead.

This loop could not be solved and the flow was left "indeterminate".
Flags
Trace Solvers
Upstream Trace Solvers

The selected junctions are the features the upstream trace ended at.

The set of all upstream features traced and returned as a graphic layer.

Flag
Addressing

Relative Addressing

0%  67.2%  100%

Absolute Addressing

0 ft  1434 ft  2134 ft
Coordinates of a 2-D Polyline
Coordinates of a 2-D Polyline M
### Setting Percent Measure

```
pMSeg.SetAndInterpolate MsBetween 0, 100

0 – 100 going upstream
```

```
pMSeg.SetAndInterpolate MsBetween 100, 0

0 – 100 going downstream
```
Point and Line Events
Summary Concepts

• Four key constructs
  – Cell to cell water movement on DEMs
  – Line to Line water movement on networks
  – Area flows to line (connect land and water systems – Reach Catchments)
  – Area flows to point on line (Watershed delineation from designated points)
Summary Concepts (2)

• A network is a connected set of points (junctions) and lines (edges) that supports tracing functions
  – Three data model components
    • Geographic (x,y,z)
    • Logical (point-line topology connections)
    • Addressing (position m along the line)