Topology in ArcGIS

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Please! Turn OFF cell phones and paging devices
What is Topology

• Process to describe & maintain **spatial relationships** of map features
  – Adjacency
  – Coincidence
  – Connectivity
  – Containment
  – Others ...

• GIS uses
  – Analysis
  – Data integrity
Topology in the geodatabase

- Helps ensure spatial integrity of data
  - Finds errors in data
  - Fix with edit and topology tools
- Relationships not stored
  - Discovered on-the-fly by ArcMap
- Coincidence-based topology
  - Snaps feature vertices
    (user prioritizes through ranks)
  - Between one or two feature classes
- Requires an ArcEditor or ArcInfo license
Real-world examples

• Single feature class examples
  – Zip Code boundaries must not overlap
  – Sewer lines must not have dangles
  – Vegetation polygons must not have gaps

• Two feature class examples
  – Parcel boundary must be covered by parcel lines
  – Zoning must not overlap with water
  – Oil well must be in an authorized lease

Rule: Soil polygons must not overlap
Topology workflow

- **ArcCatalog**
  - Create topology
  - Dirty areas
    - Rules
    - Ranks
- **ArcMap**
  - Validate topology
  - Errors
    - Fix errors
  - Make exception
  - Exceptions
- **Edit features**
Creating a Geodatabase topology

• Created in feature dataset
  – Only “simple” feature classes (no annotation, multi-point, dimensions, etc.)
  – A feature class may be in only one topology at a time

• User specifies topology properties
  – Cluster tolerance
  – Participating feature classes
  – Ranks
  – Topology rules

• Creates and **enforces topological relationships**
  – Snaps feature vertices during validation

• Edited in ArcMap
Topology properties

• Cluster tolerance
  – A distance within which all geometry is made coincident, or “identical” in location

• Ranks
  – Control how vertices move during validation
  – Lower-ranked vertices move to higher-ranked vertices

<table>
<thead>
<tr>
<th>Equal ranks</th>
<th>Cluster tolerance</th>
<th>Unequal ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>H = Highest rank</td>
<td>L = Lowest rank</td>
<td></td>
</tr>
<tr>
<td>Which data should be ranked higher?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L line moves to H line</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Endpoints move to average location
Topology rules(!)

- Define valid **spatial relationships**
  - Between feature classes or subtypes
- 25 rules available [Program Files\ArcGIS\Documentation\topology_rules_poster.pdf]
  - Many rules for each type of feature (point, line, polygon)
- Set when creating topology; tested during validation

"Parcels … *boundary must be covered by* … Parcel Lines"

"Roads … *must not overlap with* … Railroads"
Some commonly used topology rules

- Must not overlap
  - Census blocks cannot overlap
  - Vegetation cannot overlap
  - Zoning cannot overlap
  - Soils cannot overlap

- Boundary must be covered by
  - Parcel boundary must be covered by parcel lines
  - Geologic rock formation boundary must be covered by rock formation line type
More commonly used topology rules

• Must not have gaps
  – No gaps in vegetation
  – No gaps in soils
  – No gaps in temperature

• Must not have dangles
  – Sewer lines
  – Parcel lines

• Points must be covered by line
  – Monitoring station must fall along streams
  – Monument corners must fall along PLSS corner
  – Manhole covers must fall along storm sewer line
Dirty areas

- Areas in the dataset that have not been validated
  - Entire extent is “dirty” when topology is first created
  - May contain existing or undiscovered errors
  - Edits create dirty areas

Before

Edit session

Insert vertex

Dirty area created
Validating a topology

- Checks dirty areas for errors
- Snaps coordinates using cluster tolerance and ranks
- ArcCatalog Validates entire topology
  - Cannot undo
- ArcMap has additional options
  - Can undo
- No new features are created
Topology errors

• Found during validation
  – Rule violations: Dangles, overlaps, etc.
  – If there are no rules, there can be no errors

• Stored in topology as specialized geometries
  – Use to locate errors in ArcMap

• Error properties
  – Which rule was violated?
  – Which features caused the error?
  – Where is the error located?
Displaying in ArcMap

- **Topology error symbology**
  - Red is default, can change

- **Dirty areas**
  - Not shown by default

- **Draw participating feature classes**
  - Required for feature editing

- **Display exceptions**
  - Area, line, point
Fixing topology errors

• Editing features that break rules
• Error Inspector
  – Search for errors of a certain rule
  – Search in current or full extent
  – Apply fix to multiple features
  – List of common fixes available

• Fix Topology Error tool
  – Interactive error fixing
  – No search capability
  – List of common fixes available
Common error fixes

- Trim: removes portion of line

- Extend: Adds segment to undershoot

- Merge: Combines multiple features into one
Editing coincident geometry

- Topology Edit tool
  - Selects and modifies edges and nodes
  - Press E to select only edges, N to select only nodes
- Show Shared Features tool
  - Pulls coincident geometries apart

Uncheck layers so they are not modified with the coincident geometry
Using topology edit tasks

- **Modify edge** with Topology Edit tool
  - Vertex modification

  ![Image of modifying a vertex](image1)

- **Reshape edge** with Sketch tool
  - Use sketch to modify coincident geometry

  ![Image of reshaping an edge](image2)

Select edge with Topology Edit tool

Add new line with Sketch tool
Creating polygons from lines in ArcMap

- **ArcMap: Construct Features tool**
  - Use *selected lines* to make polygons in target polygon layer
  - Considers existing polygons
  - Example: Create parcels from COGO lines

![Diagram showing new line splits polygons and new lines add polygon](image-url)
Topology for ArcView users - Map topology

- Topology available with an ArcView license
- Stored in map document (*.mxd)
- Temporary topology between shapefiles and feature classes
- No validation, no error checking
- Coincident boundary editing
- For data not in a geodatabase topology
Topology at the UC

Technical Workshop: Topology in the Geodatabase
Tues., July 14, 1:30 PM – 2:45 PM (Upper Level – Room 6C)
Thurs., July 16, 8:30 AM – 9:45 AM (Upper Level – Room 6C)

Technical Workshop: Geodatabase 9.4 Plans
Wed., July 15, 10:15 AM – 11:30 AM (Upper Level – Room 6B)
Thurs., July 16, 3:15 PM – 4:30 PM (Upper Level – Room 6B)

Demo Theater: Showcase Software Island – Geodatabase Management
Tues., July 14, 9 AM – 6 PM (Exhibit Hall C/D)
Wed., July 15, 9 AM – 6 PM (Exhibit Hall C/D)
Thurs., July 16, 9 AM – 6 PM (Exhibit Hall C/D)
Get a free 45-minute hands-on lesson At the Hands-On Learning Center

Topics include:
• Introduction to ArcGIS Desktop
• Creating a Map In ArcGIS
• Basics of the Geodatabase Model
• and more

Location: ESRI Showcase
GIS Training and Education Survey

http://www.esri.com/training

• Brief online survey to get your feedback
  – All survey takers get a free one-module Web course

• Helps us develop training products that:
  – Support your workflows
  – Cover the ESRI products you use
  – Focus on most common GIS tasks and roles

• Survey available at:
  – ESRI Showcase: Training and Education Island
  – ESRI Training Web site (until July 20th)
Questions?

Thank you!
Exercise

- **EXERCISE 1A:**
  - Explore coincident geometry
  - Create a geodatabase topology
  - Explore geodatabase topology in ArcMap

- **EXERCISE 1B:**
  - Create a new geodatabase topology
  - Identify and fix errors
  - Validate your topology

*Thank you!*