13th Workshop of the ICA commission on

Generalisation and Multiple Representation

Zurich | 12-13 September, 2010

User-Directed Generalisation of Roads and Buildings for Multi-scale Cartography

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Generalisation Goals for Esri

- Esri aims to provide a suite tools to help users generalise cartographic data for print or web display
- To be commercially viable, the tools must
  - be robust, efficient, flexible, and easy-to-use
  - work at a variety of scales, and
  - adapt to a spectrum of map specifications and requirements
  - consider multiple themes contextually
- ArcGIS version 10 introduces new tools to generalise roads and buildings

An Optimization Approach

- **The ArcGIS solution uses an optimised approach where each task is made up of constraints, reflexes, and actions**
  - **Constraint:** "*building cannot be closer than x from another*"
  - **Reflex:** *"a building cannot be moved onto a road."*
  - **Actions:** *"move building away", "move building back", "mask building"*
- **An underlying optimiser kernel seeks to improve the satisfaction of constraints by applying actions**
  - **Compromises made to maintain satisfaction of all constraints**
- **Simulated annealing–where a greater degree of change and tolerance of unsatisfactory states is allowed early in the process–prevents the system from getting caught in local minima of progressively poor results**

Leveraging the Geoprocessing Framework

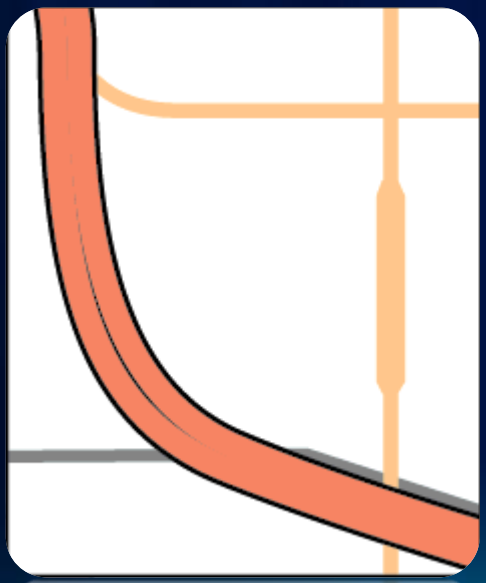
- The Geoprocessing framework is an established component of ArcGIS used to transform data
- Geoprocessing employs a functional decomposition approach where each workflow task is a discrete operation, represented by a separate tool
- Each tool is user-driven through variable parameters
- Users build custom workflows by specifying parameters and arranging tasks in appropriate sequences
- Modeling and scripting components of the framework provide automation and sharing

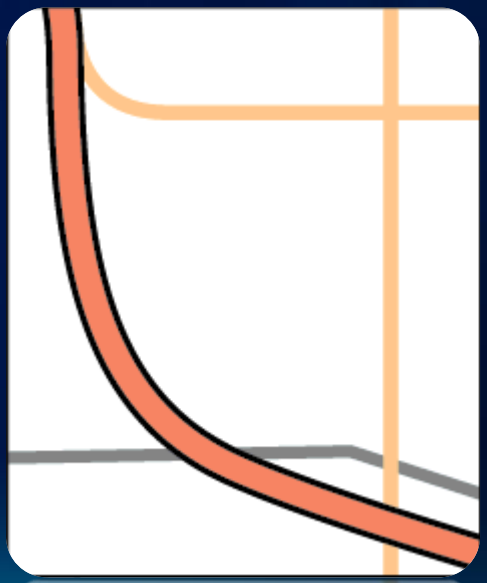
Thin Road Network tool

- Removes less significant roads, retains pattern and connectivity
  - Balanced by road classification
  - Retain specific features by locking
- Visibility controlled by a field, easy to modify
  - Use multiple fields for multiple scales in one dataset

Merge Divided Roads tool

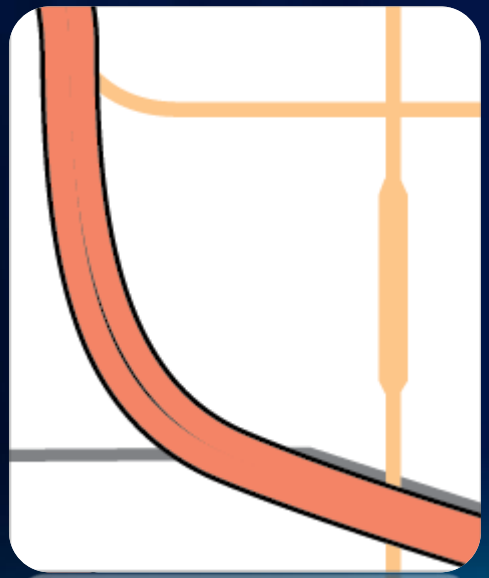
- Create a single highway feature from dual lanes
- Create a single road from a boulevard
- Merge only equal-class roads together
- Retain displacement for propagation to nearby features

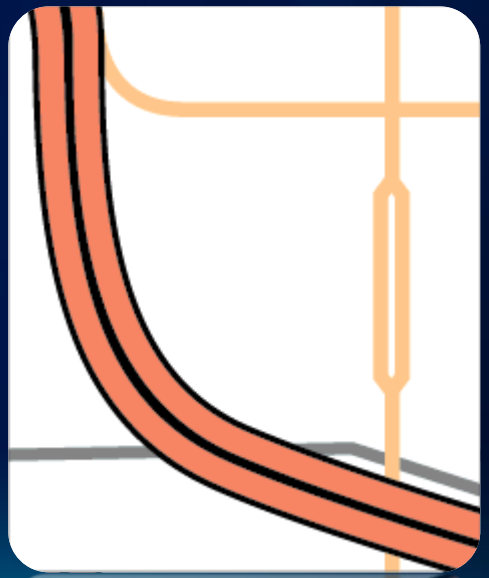




Resolve Road Conflicts tool

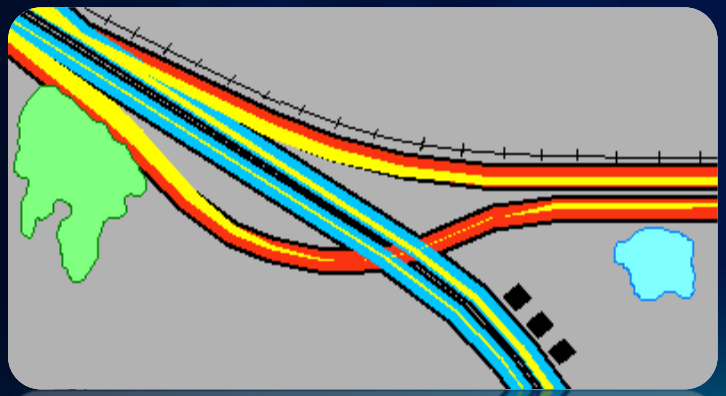
- Adjust roads to show visual separation
  - multi-lane highways, boulevards, dead-ends, roundabouts
- Less significant roads moved to accommodate more significant roads
- Retain displacement for propagation to nearby features

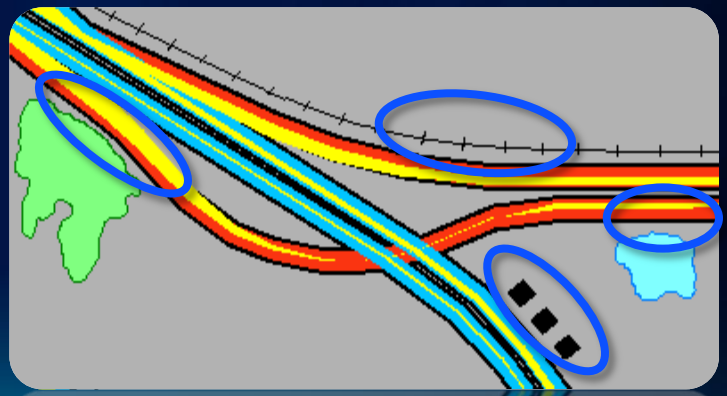




Propagate Displacement tool

- Conflict resolution may introduce spatial discrepancy
  - Adjust adjacent features to reestablish relationships
- Use displacement output from other tools
  - *Merge Divided Roads tool*
  - *Resolve Road Conflicts tool*





Resolve Building Conflicts tool

- **Separate buildings from each other and from barriers**
  - **Retain relative density and pattern**
  - **Enforce minimum building size**
  - **Adjust visibility, size, and spacing**
  - **Manage distance and orientation from barrier features**

Web-Mapping Application: Hamilton County, Indiana

- A workflow leveraging these tools was created to produce a multi-scale Web map service to verify results
  - Compare processed results to simple selection
  - provides a superior alternative, with room for improvement

- ~ 9k scale: No generalisation needed; data captured at ~2k
- ~ 18k scale: Building footprints simplified, roads thinned, parallel roads separated, displacement propagated to buildings, building conflicts resolved, buildings oriented to roads
- ~ 36k scale: Same workflow as 18k, but parameters modified
- ~ 72k scale: Buildings aggregated to built up area, roads thinned and merged, conflicts resolved on remaining roads

Future Research

- **Research is currently underway to extend the generalisation solution in ArcGIS**
  - **Improve details of the results, like ramps**
  - **Scale the tools to work on a nationwide or even a global dataset contextually**
  - **Create a building to built up area aggregation tool**
  - **Upgrade previously released generalization tools to work contextually**
  - **Address new themes, particularly hydrology and physiography**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