Estimating Accuracy of a City Wide Parcel Fabric

Esri UC 2017
July 13, 2017

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• Our journey in adopting the Parcel Fabric
• Vision of an Accuracy Heat map
• The Process and Tools
• Summary
City of Calgary’s Journey using ESRI’s Parcel Fabric
City of Calgary’s Journey using ESRI’s Parcel Fabric

- Microstation / Oracle (custom)
- ArcGIS 10.0 (June 2011)
- ArcGIS 10.2.2 (January 2015)
- ArcGIS 10.4.1 (September 2016)
Vision of a City Wide Accuracy Heat Map – the beginnings
Vision of a City Wide Accuracy Heat Map – the goal
The Process and Tools
Software
The Process and Tools

Add-Ins

1. Parcel Fabric Quality Control
   - Created by: Esri
   - Date: 3/17/2016
   - Version: 1.0
   - Data quality assessment and editing tool for parcels.
   - Types:
     - Commands
     - Toolbars
     - Extensions

2. Smooth Radius
   - Created by: Esri Canada
   - Type in a description for this Add-in.

3. Extended Fabric Properties
   - Created by: Esri
   - Provides easy access to additional information.

4. ArcGIS Online
   - Created by: Esri
   - Creates a view into ArcGIS Online.

To install Add-Ins and configure the user interface with Add-In components, use the customize dialog.
The Process and Tools
High Level Process

Evaluate Current Data
Create Initial heat map
Fix data issues
Generate “Clean” heat map
The Process and Tools
Evaluate Current Data

- Evaluate Current Data
- Create Initial heat map
- Fix data issues
- Generate "Clean" heat map

- Ensure Accuracy Values
- Ensure ties to control
- Ensure connection lines
- Run SNAP
The Process and Tools
Ensure Accuracy Values
The Process and Tools
Ensure Ties to Control

- Evaluate Current Data
- Create Initial heat map
- Fix data issues
- Generate “Clean” heat map

- Ensure Accuracy Values
- Ensure ties to control
- Ensure connection lines
- Run SNAP

Scale Factor = 0.999739

<table>
<thead>
<tr>
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<th>Lats</th>
<th>Deps</th>
<th>N</th>
<th>E</th>
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<td>3</td>
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</tbody>
</table>
The Process/Tools
Ensure Connection Lines

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The Process and Tools
Run Snap

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- Generate "Clean" heat map
- Fix data issues
- Create Initial data
- Evaluate Current data
ArcGIS Parcel Fabric Core Adjustment

• Key aspect of ArcGIS Parcel Fabric Maintenance
• Least squares adjustment of weighted survey dimensions honouring control point locations
• Bearing error correction per parcel
  – Automatically handles grid and astronomic bearings
• Objective and repeatable
  – Same selection, same inputs => same result
• Some error metadata
  – Computed minus observed
  – Shape standard error (RMS)
ArcGIS Parcel Fabric
Core Adjustment Limitations

• Control is always treated as errorless
  – Accurate survey information could be distorted by inaccurate control
  – Cannot leverage ad hoc control
    (existing fabric point locations, ortho imagery)
  – Control is not errorless
• Core adjustment does not calculate error vector
  – Cannot estimate confidence in fabric
  – Cannot produce a reliable heat map
• Both are required for reliable error estimation
Options for Extending Core Adjustment

• **Within ArcMap using core adjustment (workaround)**
  – Displace control with connections (simulate float)
  – Connection accuracy is accuracy of control
  – Interpolate residuals for heat map
• **Use third party LSA**
  – Export selection to external LSA
  – Run external LSA
  – Import error metadata
• **In ArcMap workarounds were found to be insufficient**
Third Party Adjustment Options

- Commercial adjustment software
  - Star*NET, Move3, Geolab
- Free adjustment software
  - GAMA, SNAP

SNAP was found to be the most flexible and closest to core ArcGIS adjustment (identical adjustment with identical inputs)
Introduction to SNAP

• Survey Network Adjustment Program
  – Developed by Land Information New Zealand (LINZ) for NZ surveyors
  – Free to use without restriction (no support)
  – Computes both 2D and 3D adjustments
  – Interactive visualization and interrogation of adjustment (SNAPPLOT)

• Supports bearing error correction per group as part of adjustment
  – Critical for replication of core ArcGIS adjustment with unique bearing error computation per parcel (only adjustment so far discovered)
SNAP Adjustment Components

• Inputs
  – SNAP command File
  – SNAP coordinate (point) file
  – SNAP observation (line) file
  – Coordinate system file (coordsys.def)

• Outputs
  – Detailed report file
  – Adjusted stations file (with error metadata)
  – Adjusted observations file (with error metadata)
Generate Heat Map

- Custom Python Geoprocessing Tool
- Uses SNAP to compute estimated accuracy of selected parcels
  - Extracts fabric features
  - Runs SNAP adjustment
  - Summarizes accuracy statistics
    - Estimated error
    - Shift applied by adjustment
    - Error plus shift
  - Writes a heat map feature class (with history)

Error: average = 0.13, maximum = 0.26 (63% <= 0.15, 0% > 0.50)
Shift: average = 0.07, maximum = 0.24 (98% <= 0.15, 0% > 0.50)
E + S: average = 0.21, maximum = 0.36 (21% <= 0.15, 0% > 0.50)
The Process/Tools
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- Generate “Clean” heat map
The Process/Tools
Fix Data Issues

1. Evaluate Current Data
2. Create Initial heat map
3. Fix data issues
4. Generate "Clean" heat map

- Zero Radius Arc Issues
- Fix Misclosures
- Linepoint Issues
- Errors from the Snap Report
The Process/Tools Zero Radius Arcs

Evaluate Current Data → Create Initial heat map → Fix data issues → Generate "Clean" heat map

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The Process/Tools
Fix Misclosures

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Zero Radius Arc Issues
Fix Misclosures
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Errors from the Snap Report

Add-In Manager
Add-Ins
Options

Parcel Fabric Quality Control
Data quality assessment and editing tool

ArcGIS Online
Creates a view into ArcGIS Online

S.E.A.
The Process/Tools
Fix Linepoint Issues

- Evaluate Current Data
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Parcel Editor

esri Canada
S.E.A.
The Process/Tools
Fix Linepoint Issues

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The 14576 residuals from this data are classified as follows:

- Under 95.00% significant: Used: 14424, Unused: 0
- Under 99.00% significant: Used: 43, Unused: 0
- Over 99.00% significant: Used: 109, Unused: 0

Note: Only the overall residual for vector data is counted.

The following table lists the 10 worst residuals of used data:

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<th>To</th>
<th>Type</th>
<th>S.R.</th>
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The Process/Tools
Create Initial heat map

Evaluate Current Data
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Advanced heat map Visualization
Visualizing and Quantifying Accuracy Improvement

Balanced estimated accuracy of imported data (dimensions at 0.1m)

Error: average = 0.13, maximum = 0.26 (63% <= 0.15, 0% > 0.50)
Shift: average = 0.07, maximum = 0.24 (98% <= 0.15, 0% > 0.50)
E + S: average = 0.81, maximum = 0.86 (0% <= 0.15, 64% > 0.50)
Visualizing and Quantifying Accuracy Improvement

Initial accuracy estimate (control at 2.5m, dimensions at 0.4m)
- Error: average = 1.76, maximum = 2.23 (0% <= 0.15, 100% > 0.50)
- Shift: average = 0.00, maximum = 0.00 (100% <= 0.15, 0% > 0.50)
- E + S: average = 1.76, maximum = 2.24 (0% <= 0.15, 100% > 0.50)

Added integrated survey (control at 12.5cm, dimensions at 4cm)
- Error: average = 0.81, maximum = 1.59 (11% <= 0.15, 79% > 0.50)
- Shift: average = 0.09, maximum = 0.14 (100% <= 0.15, 0% > 0.50)
- E + S: average = 0.90, maximum = 1.64 (0% <= 0.15, 84% > 0.50)

Added second integrated survey (control at 12.5cm, dimensions at 4cm)
- Error: average = 0.76, maximum = 1.55 (13% <= 0.15, 77% > 0.50)
- Shift: average = 0.11, maximum = 0.31 (95% <= 0.15, 0% > 0.50)
- E + S: average = 0.86, maximum = 1.64 (0% <= 0.15, 82% > 0.50)

Added third integrated survey (control at 12.5cm, dimensions at 4cm)
- Error: average = 0.72, maximum = 1.54 (15% <= 0.15, 69% > 0.50)
- Shift: average = 0.08, maximum = 0.31 (95% <= 0.15, 0% > 0.50)
- E + S: average = 0.80, maximum = 1.61 (2% <= 0.15, 73% > 0.50)

Added fourth integrated survey (control at 12.5cm, dimensions at 4cm)
- Error: average = 0.67, maximum = 1.41 (16% <= 0.15, 61% > 0.50)
- Shift: average = 0.09, maximum = 0.31 (94% <= 0.15, 0% > 0.50)
- E + S: average = 0.75, maximum = 1.56 (2% <= 0.15, 64% > 0.50)

Added connections across long road polygons (dimensions at 0.4m)
- Error: average = 0.39, maximum = 0.85 (16% <= 0.15, 31% > 0.50)
- Shift: average = 0.07, maximum = 0.30 (97% <= 0.15, 0% > 0.50)
- E + S: average = 0.46, maximum = 0.89 (2% <= 0.15, 44% > 0.50)

Balanced estimated accuracy of imported data (dimensions at 0.1m)
- Error: average = 0.13, maximum = 0.26 (63% <= 0.15, 0% > 0.50)
- Shift: average = 0.07, maximum = 0.24 (98% <= 0.15, 0% > 0.50)
- E + S: average = 0.21, maximum = 0.36 (21% <= 0.15, 0% > 0.50)
• Our journey in adopting the Parcel Fabric
• Vision of an Accuracy heat map
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  • require effort but are worthwhile
Q&A and Thank You!