Working towards Supporting Multi-scale Databases Updating

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Introduction

More and more mapping agencies and GIS organizations are engaging in unifying the best data sources to enhance their large-scale master databases from which they derive smaller scale databases through model generalization (Müller et al., 1995). These multi-scale databases support a wide range of GIS analysis; and are the basis for map-making via cartographic generalization (Müller et al., 1995). The further questions they face are: what happens when changes or new data arrive; what tools are needed to manage the updating processes. Obviously, the changes need to be properly merged into the master database first and then propagated to smaller scale databases. The common challenges are: (1) data from new sources don't always line up with existing data; (2) the lack of linkages among corresponding features across multiple scales makes the propagation of changes difficult. The increasing needs for solving these problems remain.

Merging changes with existing data requires matching features between similar but different overlapping datasets and reconciling data differences for the optimal accuracy, completeness, and consistency. This process is known as conflation (similar definition can be found in Seth, 2008). This presentation discusses the essential roles that conflation can play in building master databases and in incorporating and updating changes across scales (Lee et al., 2018). It also shares our experiences in linking features in multiple data sources and in different scales as we are working towards supporting multi-scale databases updating.

Roles of conflation in multi-scale data integration and updating

Multi-source datasets are often unified to build large scale master databases. Conflation processes, such as spatial adjustment and attribute transfer between matched features in two datasets, can help reconcile data conflicts and discrepancies, therefore ensure the best possible data quality. Quality data is essential to deriving smaller scale databases and maps through generalization.

To keep a master database and derived databases and maps up to date, new changes must be incorporated into the master database from time to time. The changes between existing and new data can be identified through feature matching. Again, conflation can help resolve the differences. The changed features and areas can then be flagged in derived databases if linkages of corresponding features exist, triggering data and associated maps to be re-generalized.

Conflation plays essential roles in both stages, building master databases and incorporating and updating changes across scales (Figure 1). Detailed explanation will be given in presentation.

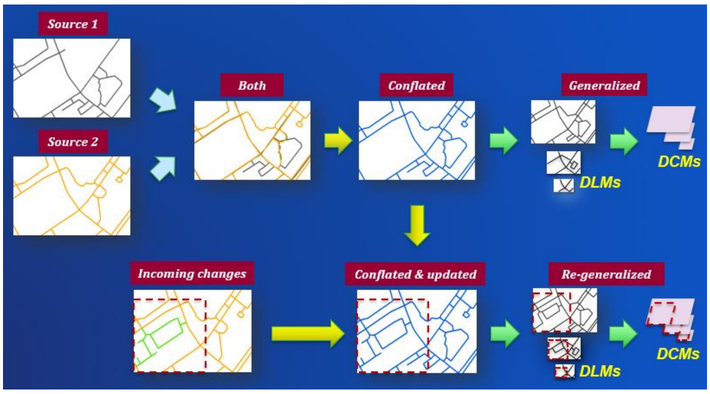

Figure 1: Conflation in multi-scale data updating and mapping. DLM = digital land model; DCM = digital cartographic model

Key conflation tools and use cases

Based on common use cases and requirements we have developed and released a set of geoprocessing conflation tools in ArcGIS Desktop, the GIS software by Esri Inc. Among them are feature matching based Detect Feature Changes (DFC), Transfer Attributes (TA), and tools for spatial adjustment.

The DFC tool takes two input line datasets and writes out features with change types, including no change, spatial or attribute change, and no match types (Figure 2). The TA tool transfers attributes from legacy data to new data or transfer unique IDs as linkages from base features to corresponding derived features across scales (Figure 2).

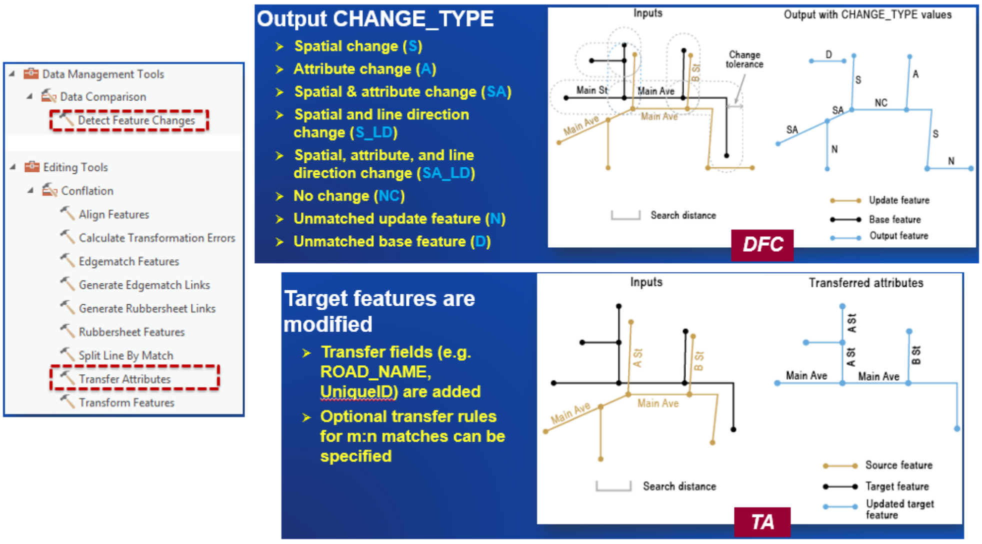

Figure 2: Illustrations of DFC and TA tools.

These conflation tools have been successfully used in various workflows by ArcGIS users. More details will be given in presentation.

Work in progress

Most of our current tools operate on linear features, such as roads or parcel lines. Further research and prototype are in progress, aiming at conflation for points and polygons or any combinations of feature types. Change detection between two sets of building features (points or polygons) is one of the common and challenging tasks; matching and linking buildings (polygons) at large scale with those derived at smaller scales is another (Baella et al., 2014) since they may have been simplified, aggregated, or even collapsed to points in generalization. Details will be given at the conference.

Conclusions

Conflation plays indispensable roles in data reconciliation, change detection, and multi-scale, incremental database and map updating. Changes in newly updated master databases can be propagated to smaller scales through linkages and re-generalization of the affected areas.

Our future efforts will continue aiming at further automation, formalization of workflows and increasing productivity to meet the growing demands for conflation.

- Fully integrated conflation management.
- New tools and improved feature matching.
- Efficient processing of large datasets.
- Contextual conflation.
- Incorporation of other data sources (imagery, lidar, GPS)

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References

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