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AN OPTIMIZATION FRAMEWORK FOR CONTEXTUAL PROCESSING IN GENERALIZATION

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Esri has been releasing new generalization tools in ArcGIS 10. They are based on an optimization engine designed to support functionalities that are hard to implement as direct algorithms.

There are two main pieces in this engine: a geometry cache and an optimization framework.

The geometry cache is designed to load the geometric aspect of the data to be processed in memory, so that contextual tools can perform queries efficiently. It uses a topological model based on node, segment and geometry tables. It offers all the usual spatial queries and connectivity analysis. Node and segments are shared across objects but not across geometries, as they link back to individual geodatabase features. If features are symbolized in ArcGIS, two additional tables can model their graphic outline to consider graphic conflicts.

Those geodatabase features can also be added to the cache, as there is one unique table model for geometry and data. This table model can be extended with custom attributes which the optimization process can use to define and track the state of optimized objects. Those tables support multiple and efficient edit sessions so the optimization process can constantly modify the state of objects to move towards a better state. This is done inside the context of an optimizer edit session which can be discarded or validated depending if the modified state has improved.

The optimization framework is derived from simulated annealing techniques. It implements the notions of constraints, actions and reflexes as individual software components. Fortune wheel, global satisfaction, temperature, and rate of failing actions drive the optimization process.

The state of the system is stored in the cache tables. The engine can associate satisfaction measures to rows of any table. As the content of those table changes, the state of the system evolves. An optimization process can thus be associated to topological tables (node, segment, and geometry), geodatabase tables, any custom tables, or a mix of those.

Constraints are designed to measure how acceptable is the state of one row in the cache. This is a measure in the interval [0;1]. Those values are consolidated to provide a global satisfaction that the engine tends to increase. Actions are components which try to modify the state of rows towards a better satisfaction. They are always applied inside an edit session. Reflexes will enforce some data integrity rules after each individual action. They also apply inside edit sessions.

A fortune wheel component will then analyze the least satisfied individual row satisfaction values and apply the appropriate actions. The process will stop when there is no significant gain to expect for the global satisfaction, or after a predefined number of iterations.

New tools were developed using this approach to support the generalization of road and building features and deployed as geoprocessing tools available in ArcGIS 10. This new framework will be leveraged in the future as new tools will be added to provide generalization of other themes.