



Converting a spatial network to a graph in R

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The R User Conference 2011

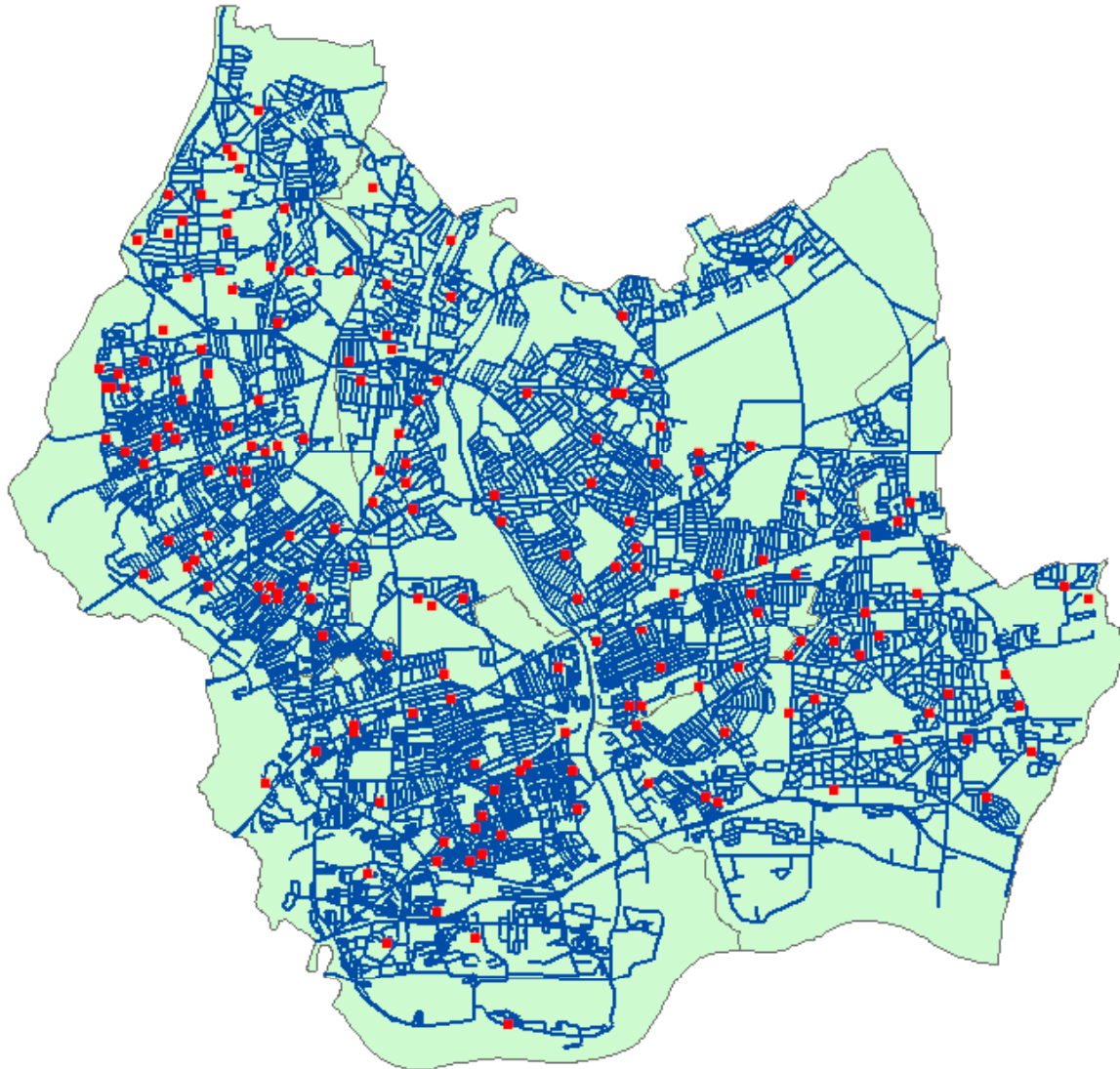


Contents

A 3D puzzle with several pieces. The puzzle pieces are white and have a subtle world map pattern on them. The puzzle is arranged in a way that suggests it is being assembled or is nearly complete. The background is a light, neutral color.

- Motivation
 - Key points in the conversion
 - R package “shp2graph”
 - Future work
-

Motivation



How should I get all the shortest paths between any pair of points?

SANNET

pgRouting

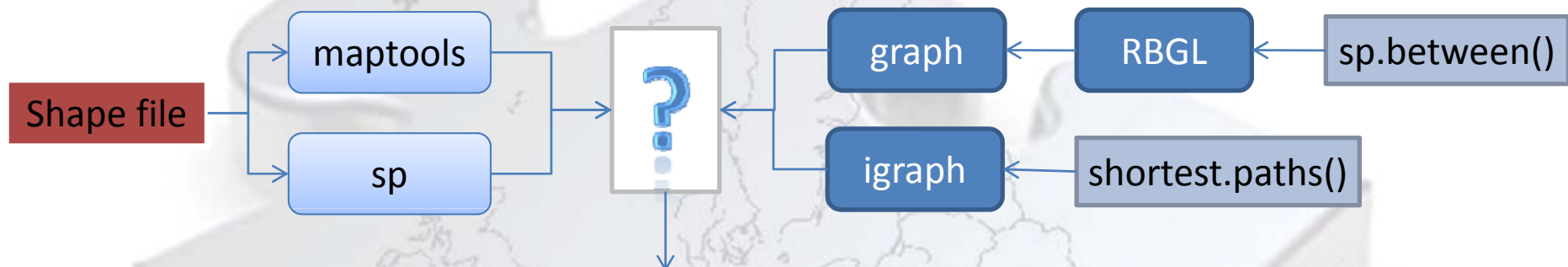
.....

Coding with Dijkstra algorithm

But

I am an R user and
I am "lazy"

Search in R packages...



Solution: Converting a spatial network to a graph object

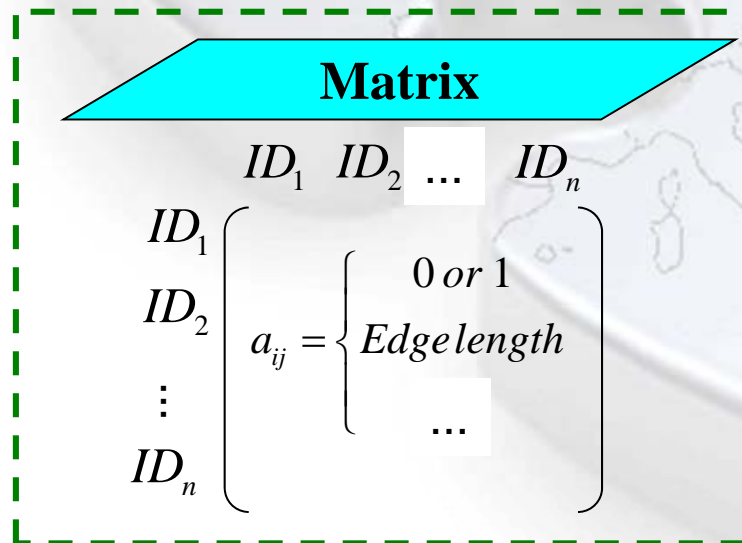
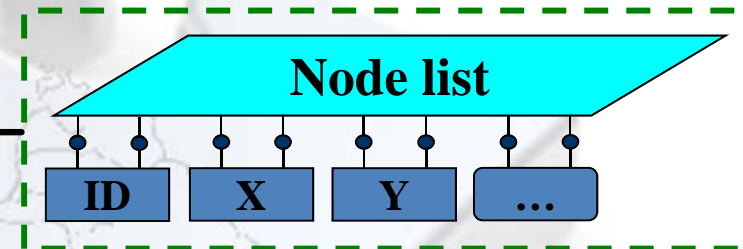
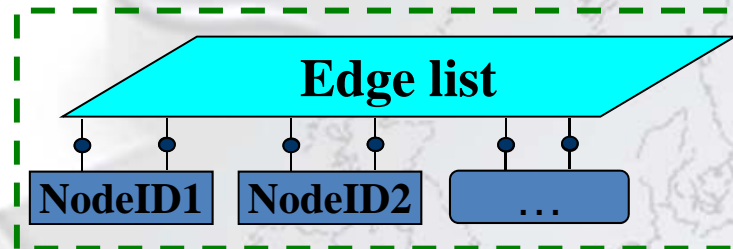
Key points for this conversion

- Modelling Road network with graph data model
- Attribute heritage
- Topology
- Structure optimization
- Integration of points into network

Graph data model

Edge (Arc)

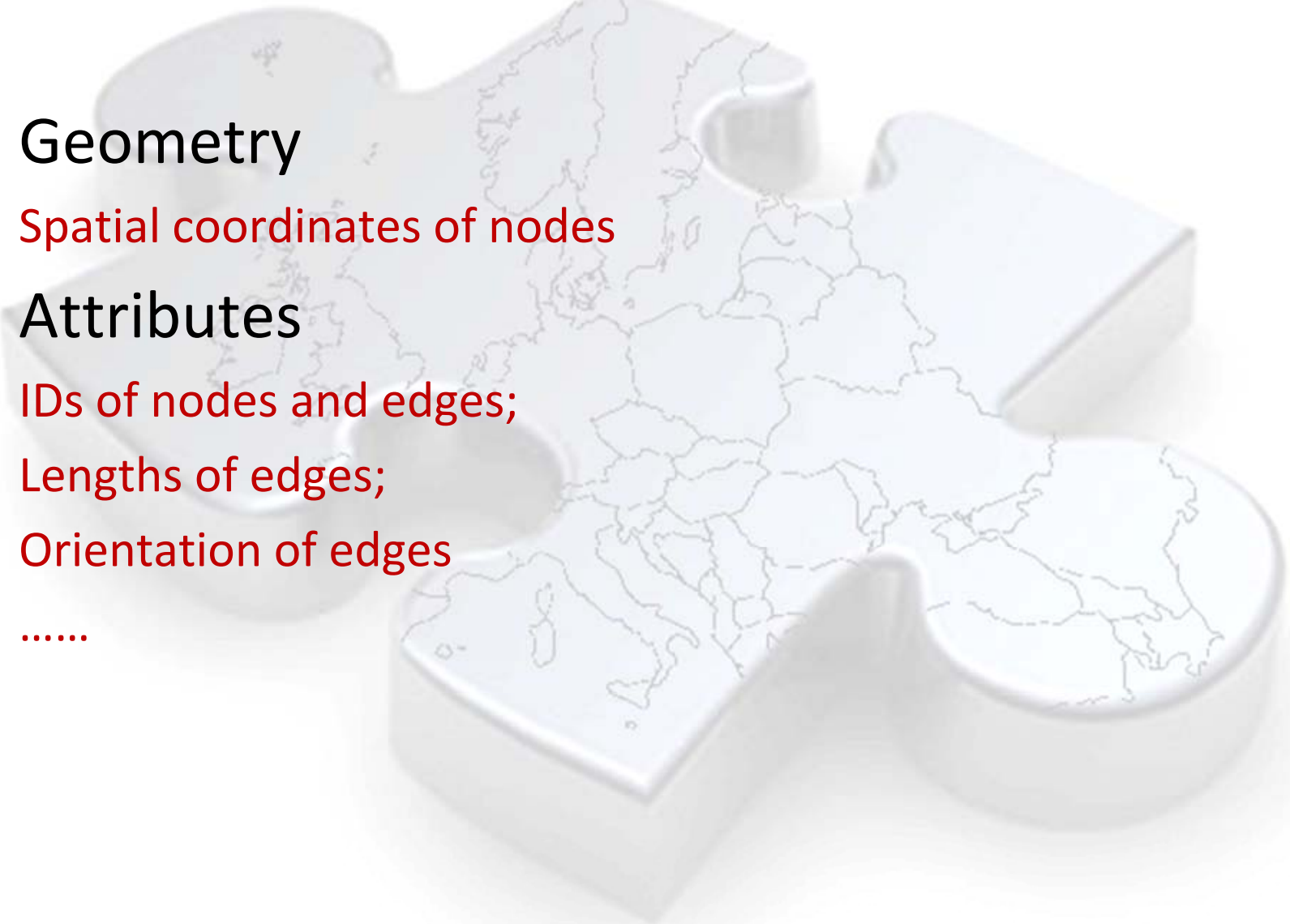
Node (Vertex)



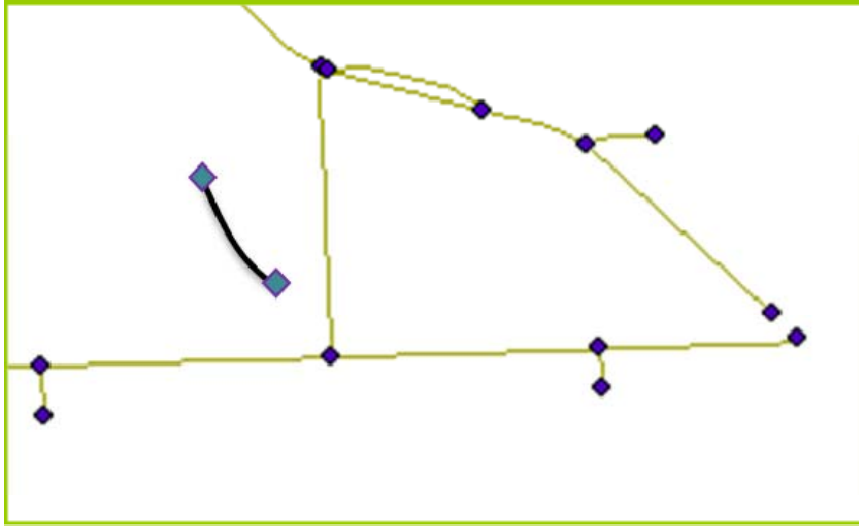
Graph data model:
A kind of data model to abstract away geographical details and represent a network as a graph, that is, as a finite set of points called nodes (i.e. vertices) and relations between these points called edges (i.e. arcs).

Attributes inheritance and translation

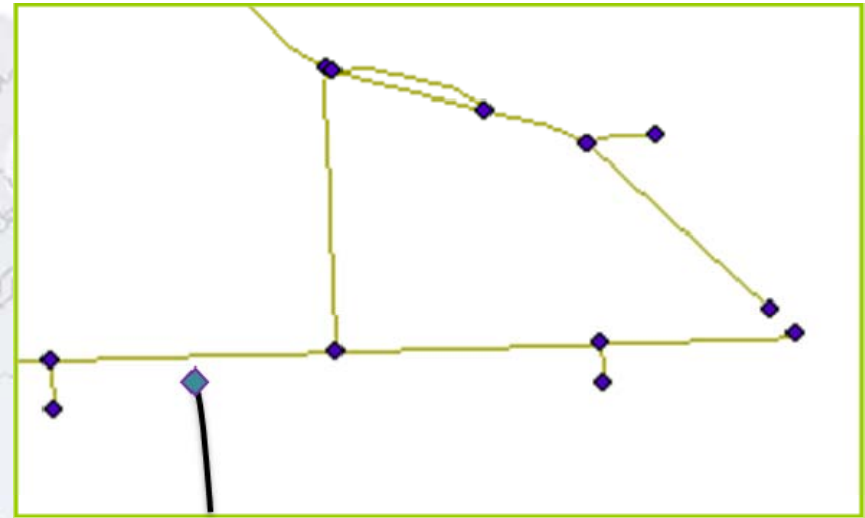
- Geometry
 - Spatial coordinates of nodes
- Attributes
 - IDs of nodes and edges;
 - Lengths of edges;
 - Orientation of edges
 -



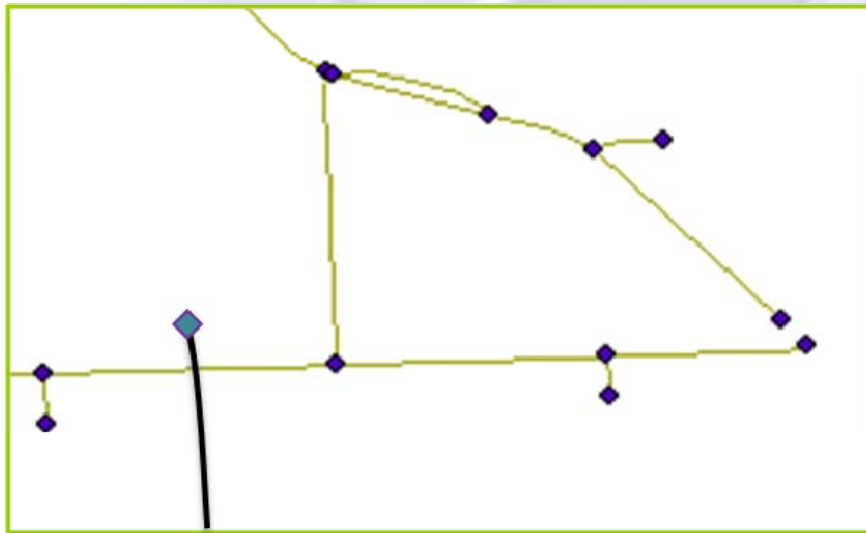
Topology errors



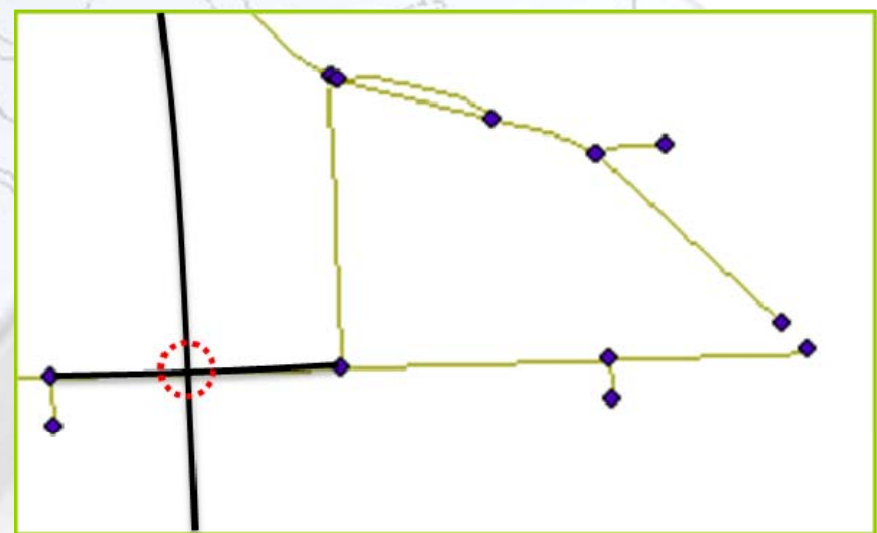
(a) Dangling arc



(b) Undershoot



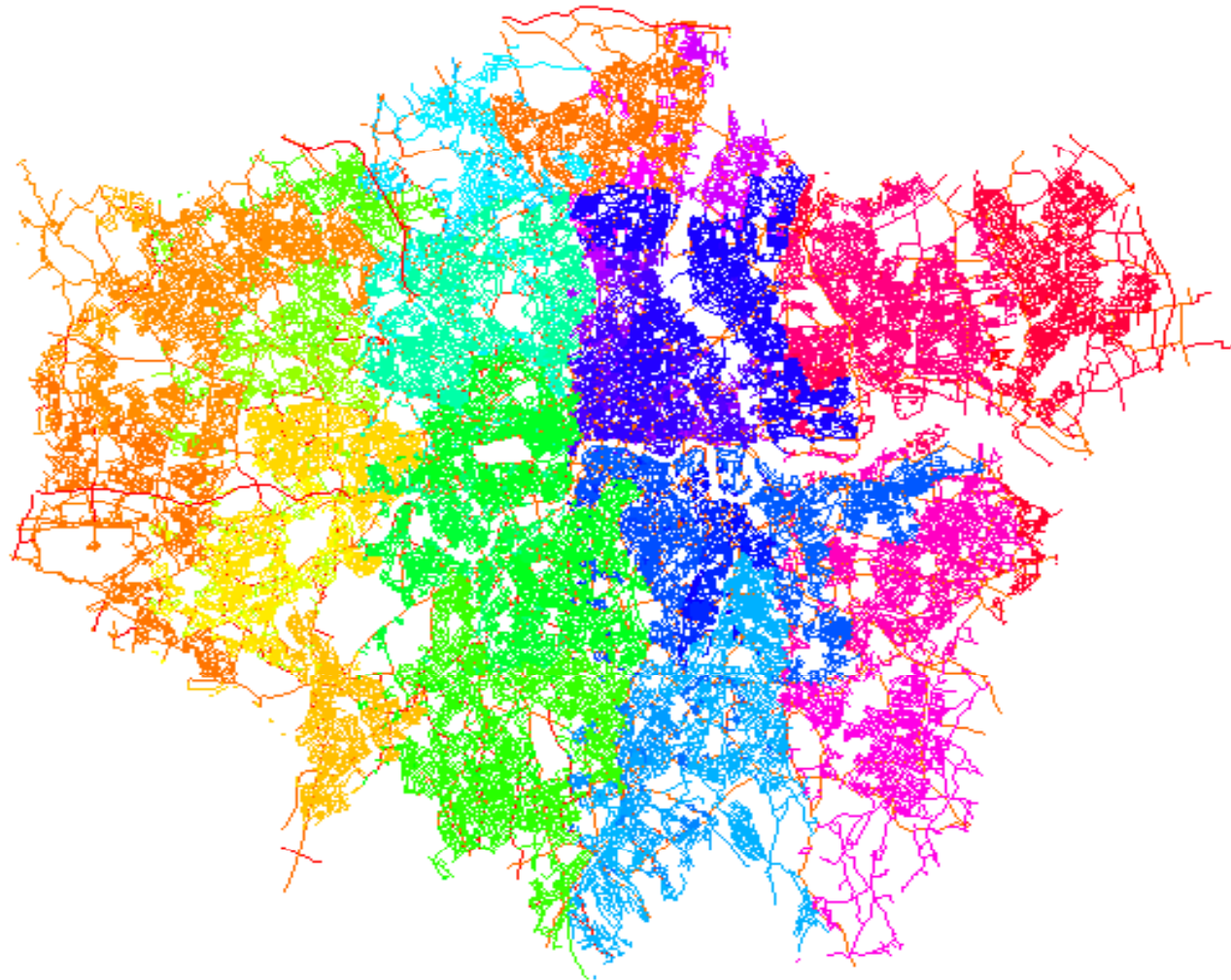
(c) Overshoot



(d) Missing intersection

Connectivity Problem

There are **2714** self-connected parts in this data set

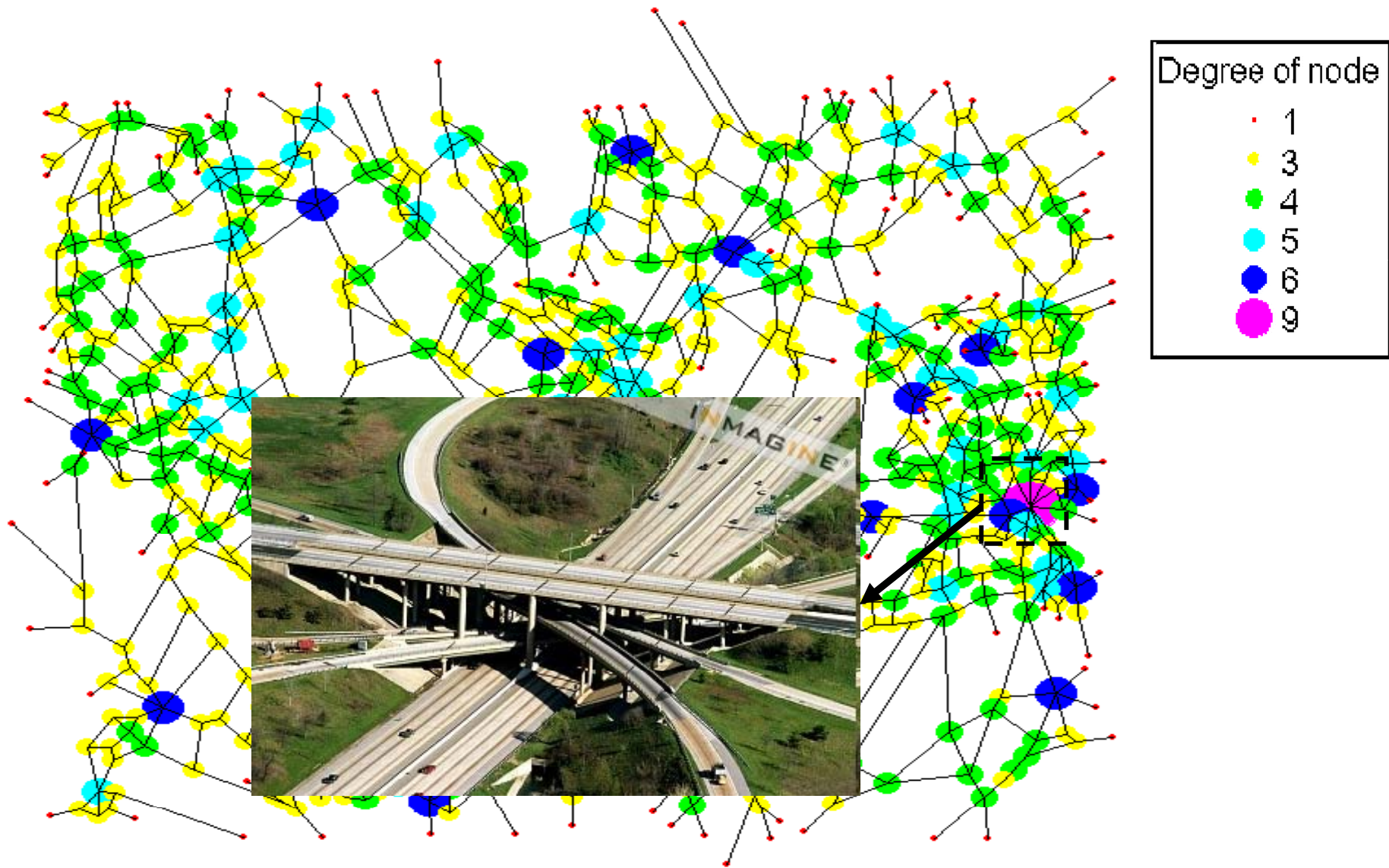


Solutions to correct topology errors

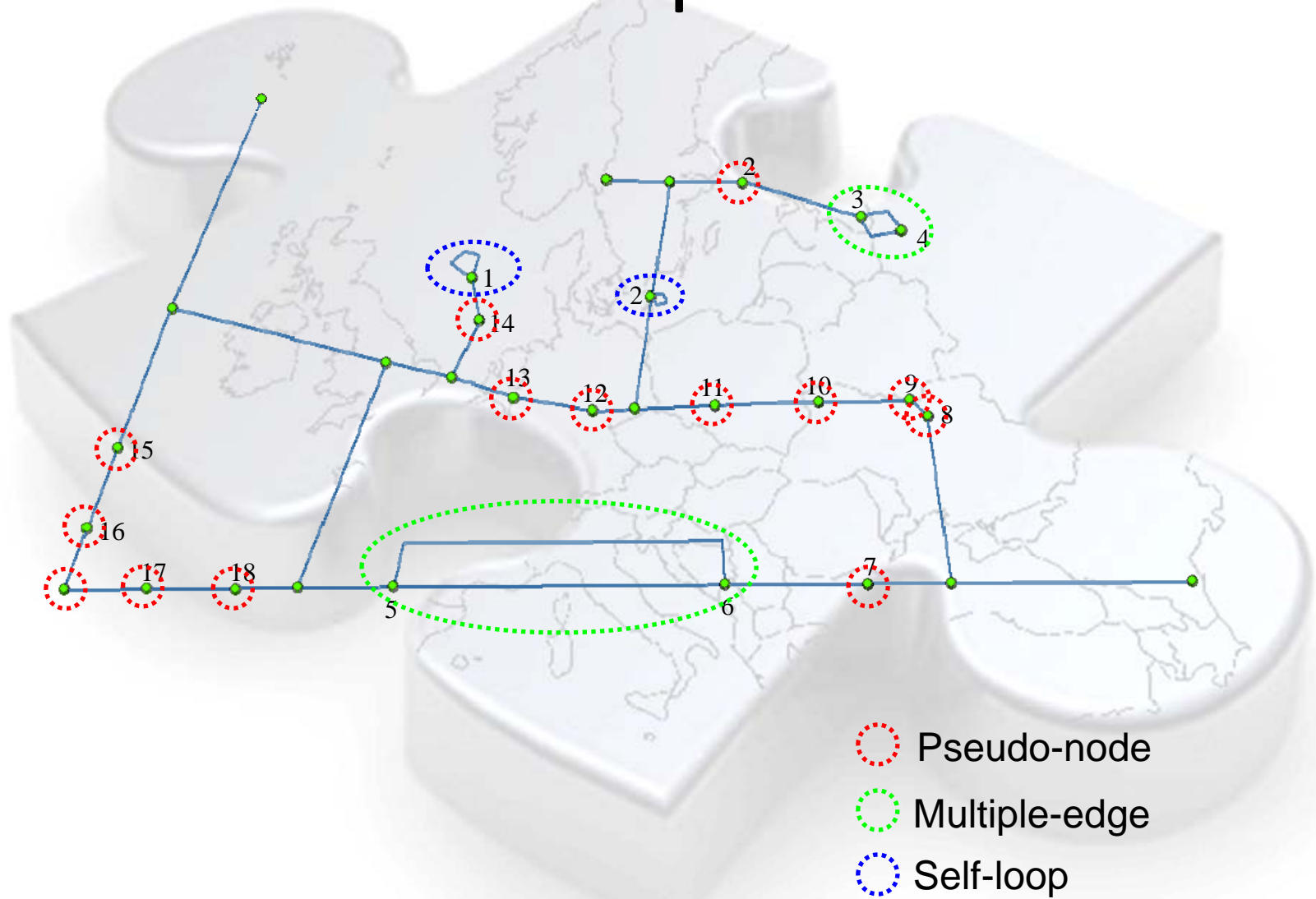
GIS software Topology correction tools/functions

ArcGIS	Extend Polyline Tool, Intersect Polylines Tool, Remove Redundant Nodes Tool and Clean Dangles Tool in ET Geo-tools Clean Polyline, Clean Dangling Nodes, Split Polylines(With a Layer) in ET Geo Wizards
ArcInfo	Clean {Coverage}, Validate Entire Topology tool, Fix Topology Error tool
GRASS	Cleaning tools in v.clean Toolset: break, rmdangle, snap
AutoCAD Map	Creating a network topology, Editing Topologies

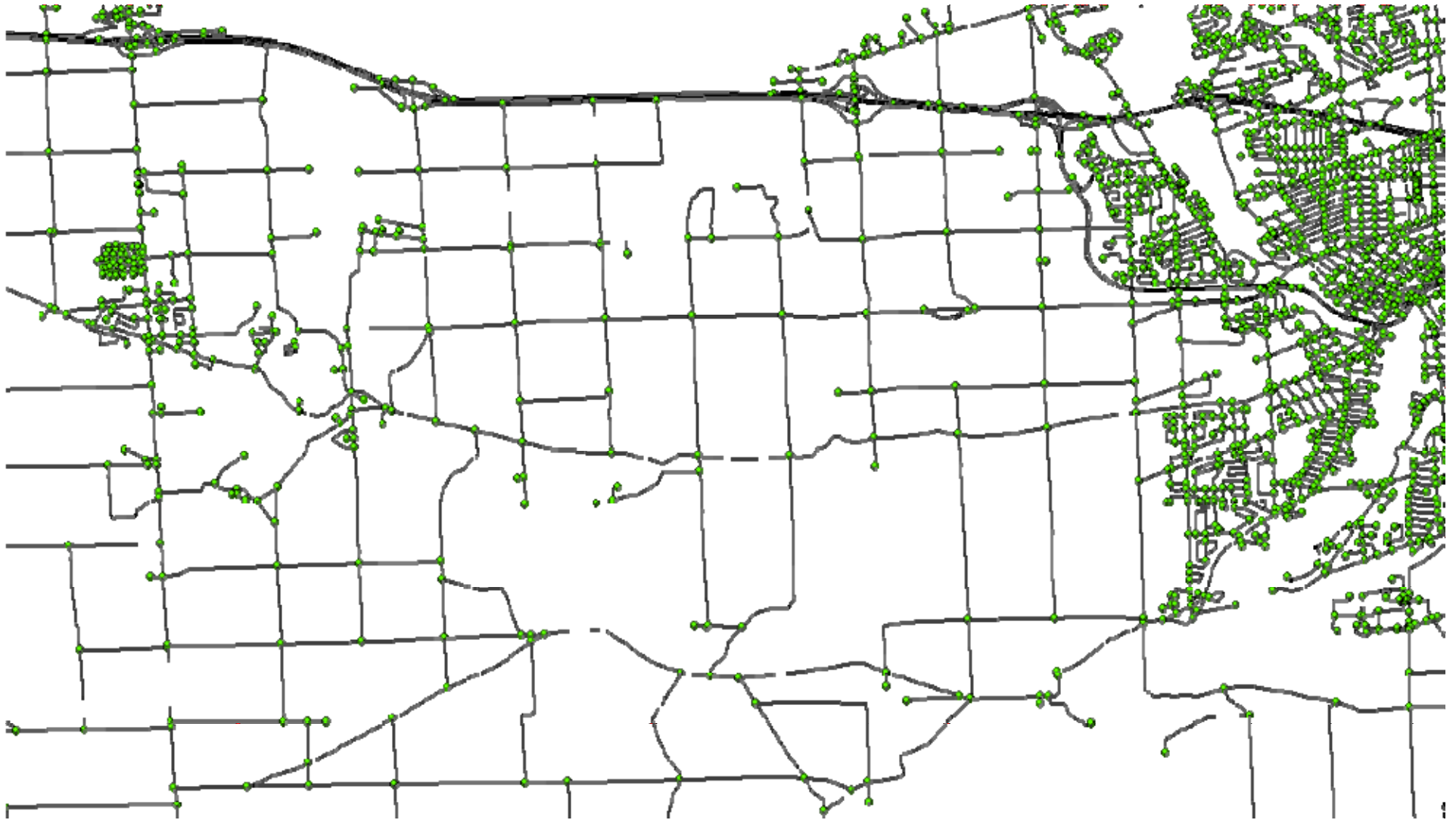
Over correction



Structure Optimization



Test on Ontario Road Network data



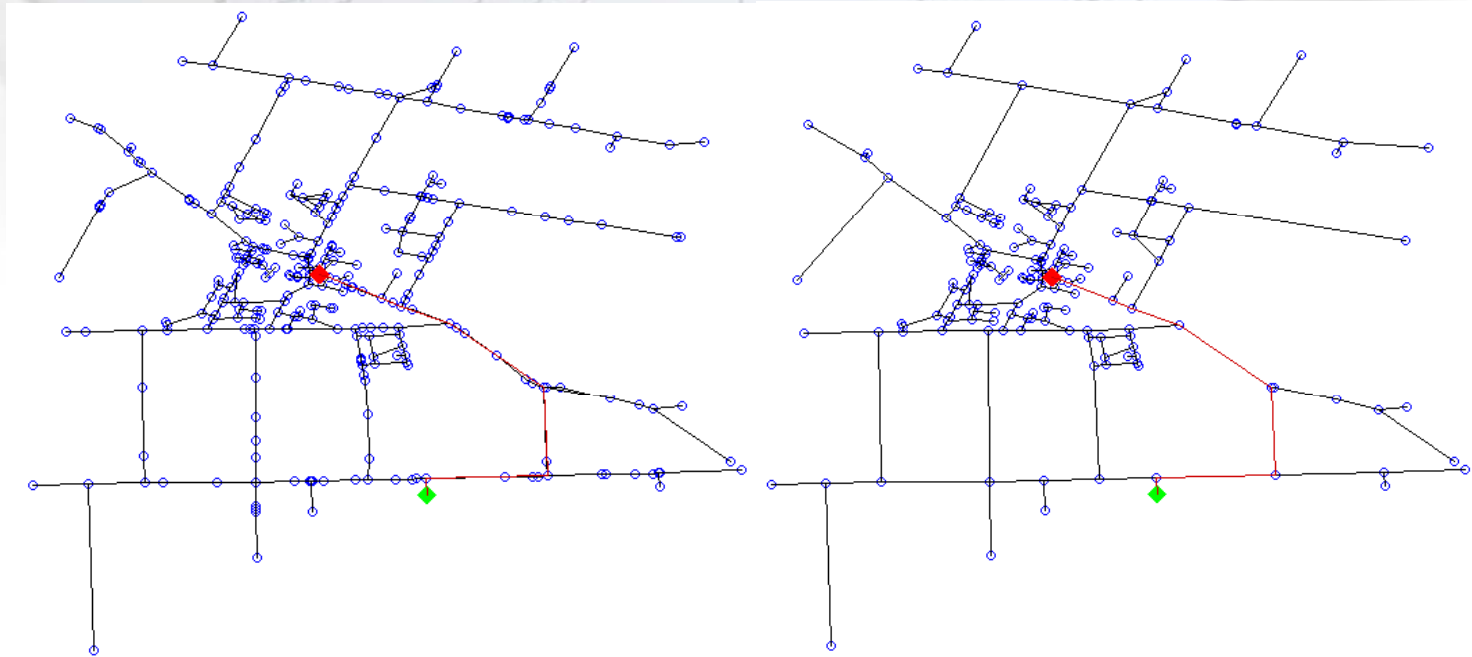
Test on Ontario Road Network data

Comparison between original ORN and optimized graph

Data	Number of nodes	Number of edges
Original vector data	37178	48765
Optimized graph	25928	36375

11250
30%

12300
25%



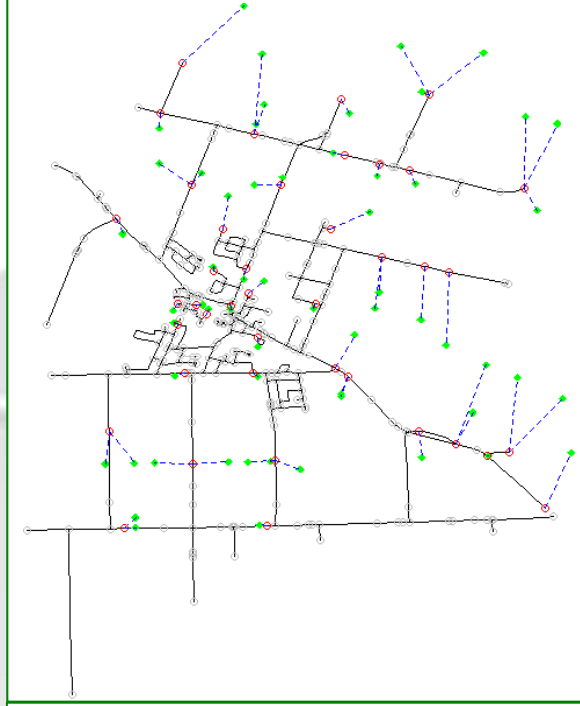
Integration of point data into network



Two guidelines:

1. Find a representative node for each point
2. Add a new edge to connect each point with the network

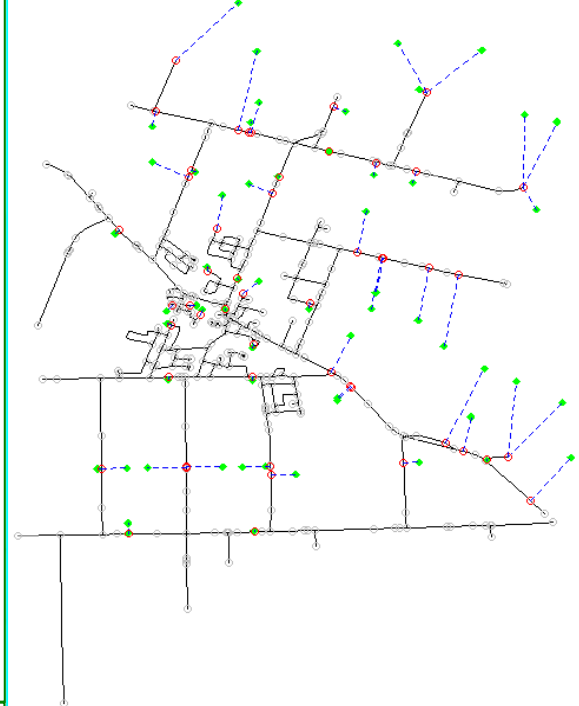
i. Mapping each point to the nearest node



iii. Add a new edge between each point and the nearest node



ii. Mapping each Point to the nearest point



iv. Add a new edge between each point and the nearest point



Edge Reconstruction

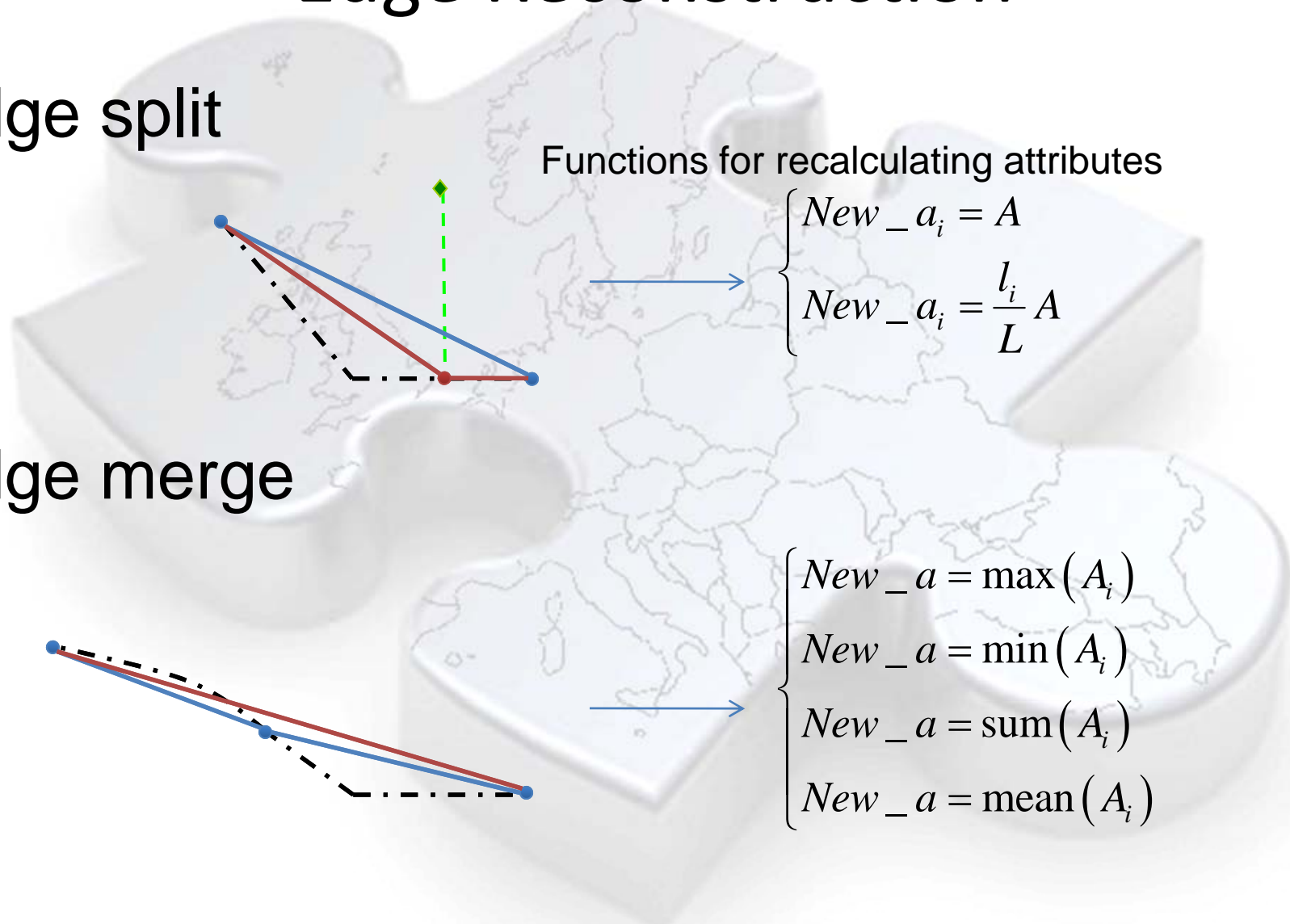
Edge split

Functions for recalculating attributes

$$\begin{cases} New_a_i = A \\ New_a_i = \frac{l_i}{L} A \end{cases}$$

Edge merge

$$\begin{cases} New_a = \max(A_i) \\ New_a = \min(A_i) \\ New_a = \text{sum}(A_i) \\ New_a = \text{mean}(A_i) \end{cases}$$



R package “shp2graph”

Package ‘shp2graph’

September 4, 2010

Version 1-0

Date 2010-08-31

Title Transform a road network data set from a SpatialLinesDataFrame object to a “graph-class” object

Author Binbin Lu

Maintainer Binbin Lu <lubinbin220@gmail.com>

Depends R (>= 2.10.0), maptools (>= 0.5-2), graph

Suggests graph

Description Functions for transforming network data from a SpatialLinesDataFrame object to a “graph-class” object, aiming at making preparation for conducting network computations in graph theories.

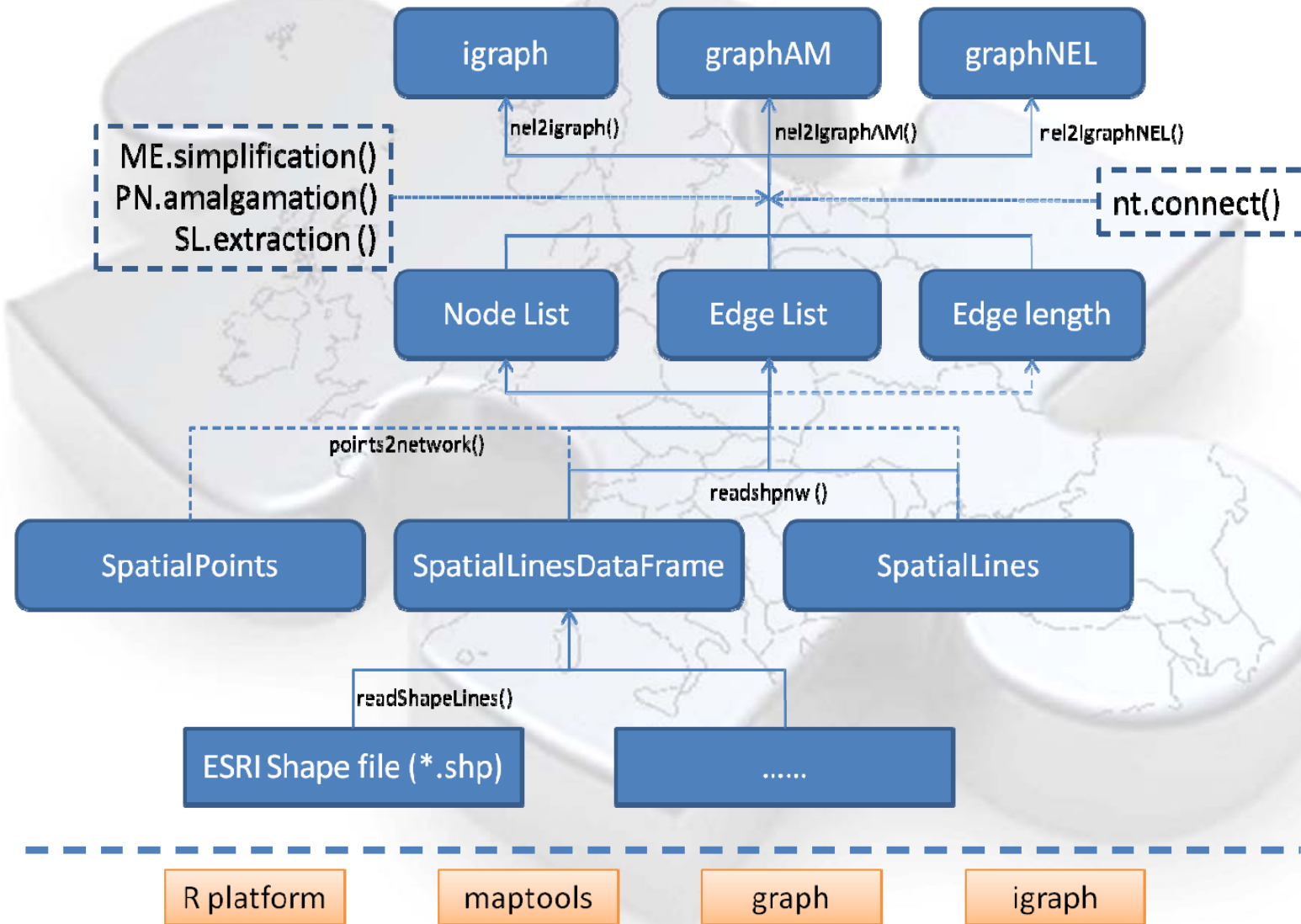
License GPL (>= 2)

URL <http://ncg.nuim.ie/redirect.php?action=staff/students/lubinbin>

Repository CRAN

Date/Publication 2010-08-31 16:22:41

R package "shp2graph"



After conversion, you can...

- compute the shortest paths
- visualize the graph with **igraph**, **shp2graph**, **pajek**
- do network analysis with various kinds of methods available in **graph**, **igraph**, **RBGL**, etc
-

Future work

I was an R beginner when I started to develop this package, so... I make lots of mistakes!

- Awkward parameter settings in functions
- Poor coding style

Topology correction functions will be developed in the near future.



I will keep working on this, and welcome any contribution, suggestions or comments.

Acknowledgments

- To Centre for Research into Statistical Methodology (CRISM) for funding me to attend this conference.
 - Research presented in this paper is jointly funded by a Strategic Research Cluster grant (07/SRC/I1168) by Science Foundation Ireland under the National Development Plan and China Scholarship Council (CSC).
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Thank you

Any comments or questions?

