DEPARTMENT OF INFORMATION ENGINEERING
UNIVERSITY OF PADOVA

DATA ENRICHMENT FOR ROAD GENERALIZATION THROUGH ANALYSIS OF MORPHOLOGY IN THE CARGEN PROJECT

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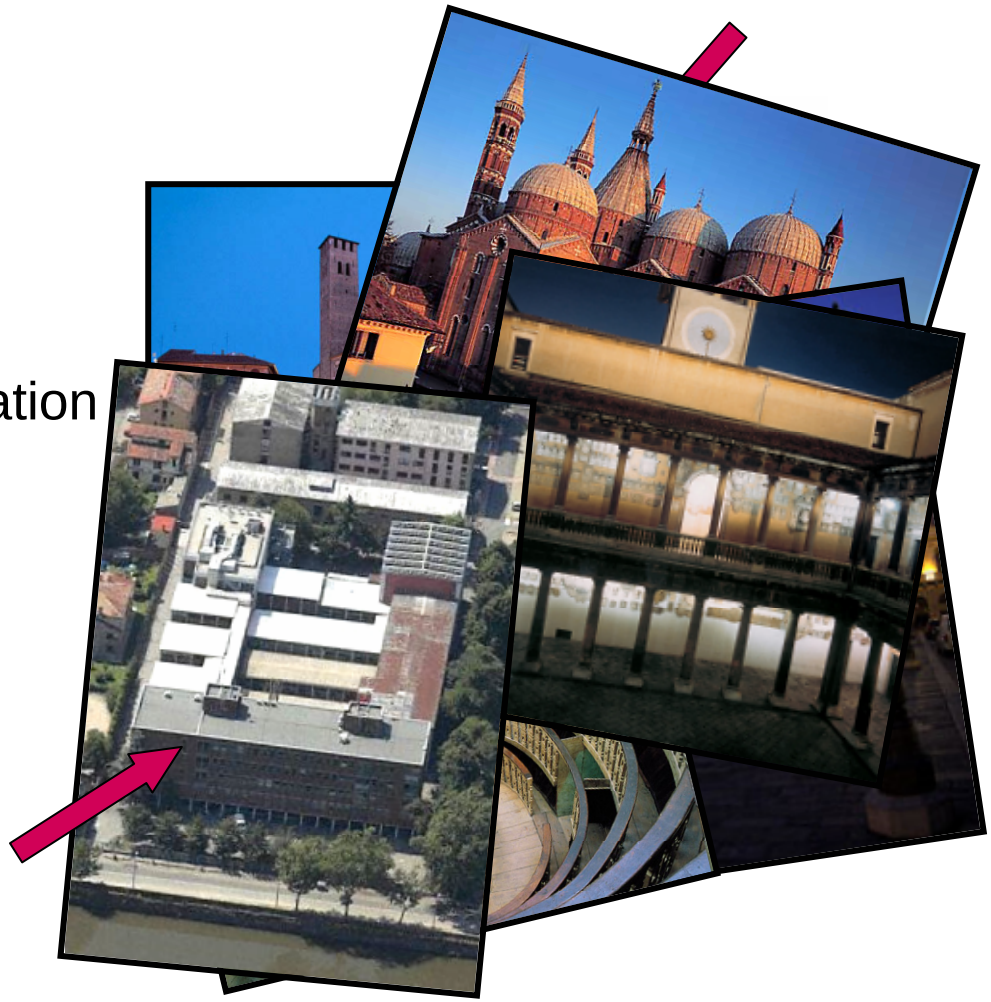
Introduction

- Italy
  - –Padova
    - University of Padova
      - – Department of Information Engineering
        - » GIRTS Lab



People:

- 2 professors
- 1 phd student + 1 full time GIS graduated
- Many students doing their master or bachelor thesis

CARGEN Project

AIM:

to develop an automatic process to generalize the IGM DB25 1:25000 and DB50 1:50000 geodatabase from the Regional GeoDBR 1:5000 geodatabase

(geodb to geodb generalization)

Involves:

- Regione Veneto
- IGMI (Istituto Geografico Militare Italiano)
- University of Padova

Data model challenges

If input data model is not rich enough:

- It’s difficult to select and classify the input features into the output model (model generalization)
- It’s difficult to select the features to generalize (cartographic generalization)

Data enrichment

Data enrichment through morphology

Reasons:

- Matter of necessity: it was not possible to access to other data
- Robustness to semantic error
- Wish to mimic human capability to read maps

Road Junctions

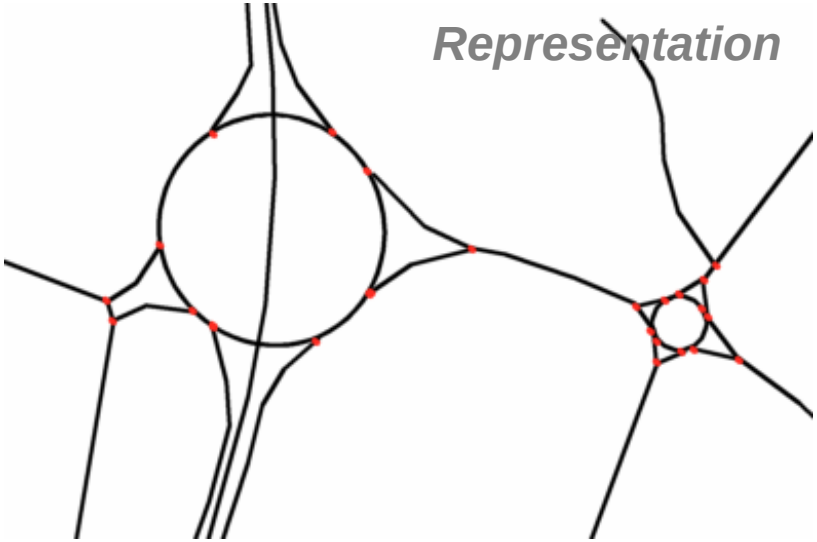
Different kinds:

- With grade separation (interchanges)
- At-grade (intersections)

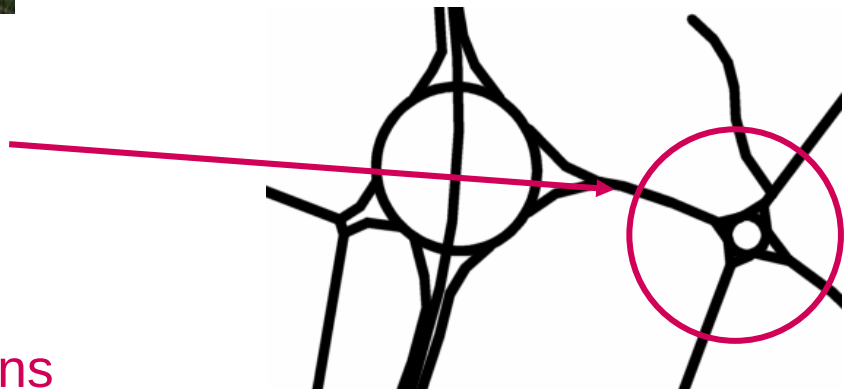
Different shapes:

- Crossroad
- T-junction
- Roundabout

The problem



As the scale reduces, symbol size (ie. lines width) grows (in proportions), space available reduces and the representation becomes cluttered



Need to find complex junctions
(and understand how to generalize them)

The problem

We need to classify the different road junctions in order to develop a generalization strategy

the input data model doesn't convey any information about the road junctions

…how to detect and classify them?

How to find a complex junction?

Complex road junctions come in many different shapes but they all share one common feature: they have redundant arcs (eg: a sliproad)

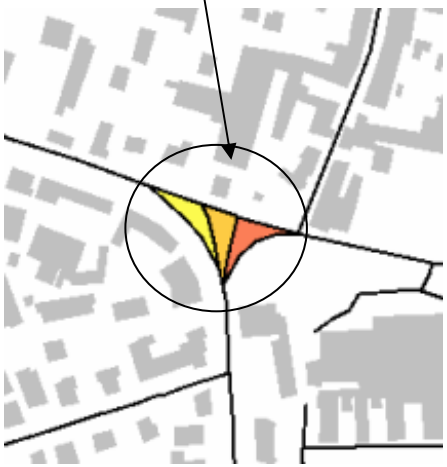
In a graph redundant arcs do form a cycle

Complex road junctions can be found searching the graph for (small) cycles!!
(ROAD LOOPS)

Road Loops

A single road loop

A cluster of road loops



Big junctions (e.g.. a cloverleaf interchange) fail the test on the maximum size and thus are not processed

Classification “tools”

We need to distinguish among the various kinds of road loops!

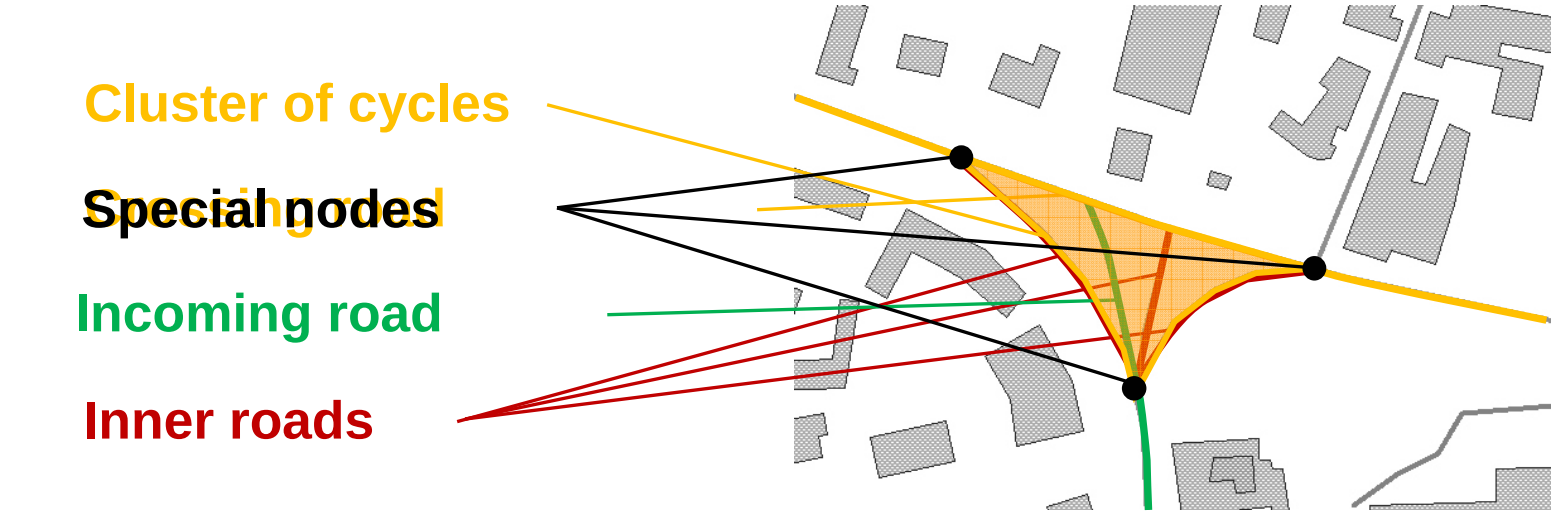
We enrich our data model using the following “tools”:

- Cluster of road loops
- Special Nodes
- Strokes
- Convexity test
- Circularity Ratio

Classification of complex road junctions

Using distinctive nodes and strokes we can characterize each junction by its:

- Crossing roads (begins and ends outside the road loop area, crossing 2 special nodes)
- Incoming roads (begins outside and ends inside, crossing 1 special node)
- Inner roads (begins and ends inside, no special node crossed)



Classification of roundabouts

Two tests:

- Circularity ratio (how much the ratio a/p resembles that of a perfect circle)

Perimeter p = 119,4 m

Area a = 827.7 m^2

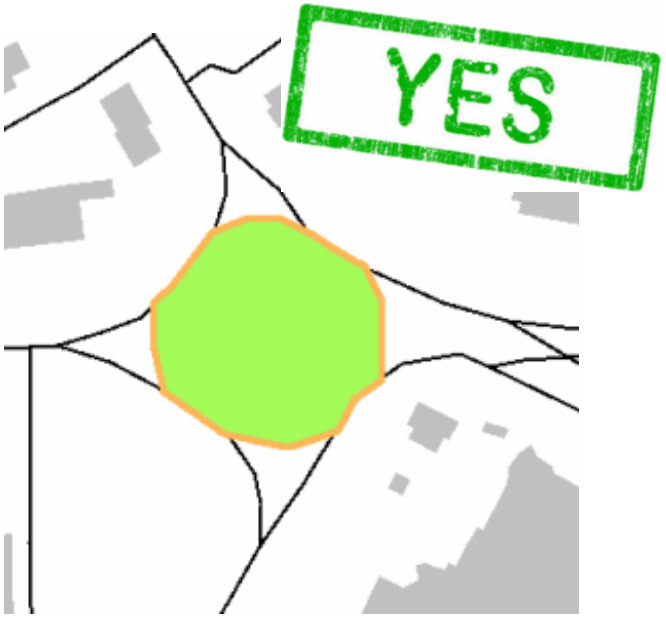
Virtual Radius ***vr*** = 18 m

Circularity ratio ***cr*** = 7.25

Classification of roundabouts

Two tests:

- Circularity ratio (how much the ratio a/p resembles that of a perfect circle)



Perimeter p = 216,4 m

Area a = 3539,7 m^2

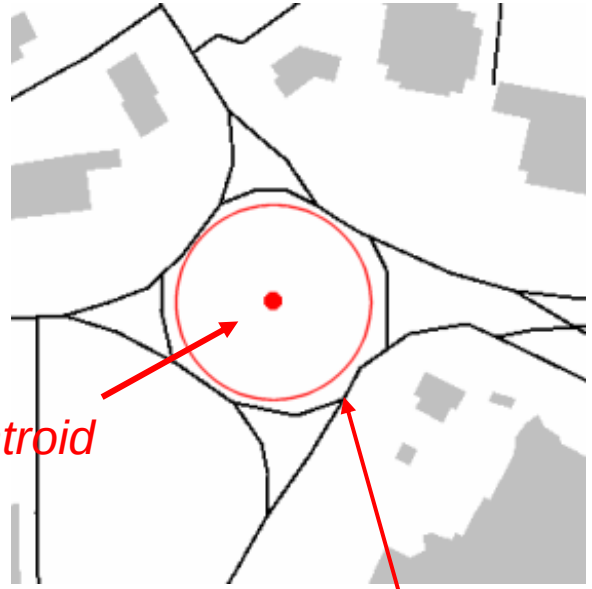
Virtual Radius ***vr*** = 34 m

Circularity ratio ***cr*** = 16,34

Classification of roundabouts

Two tests:

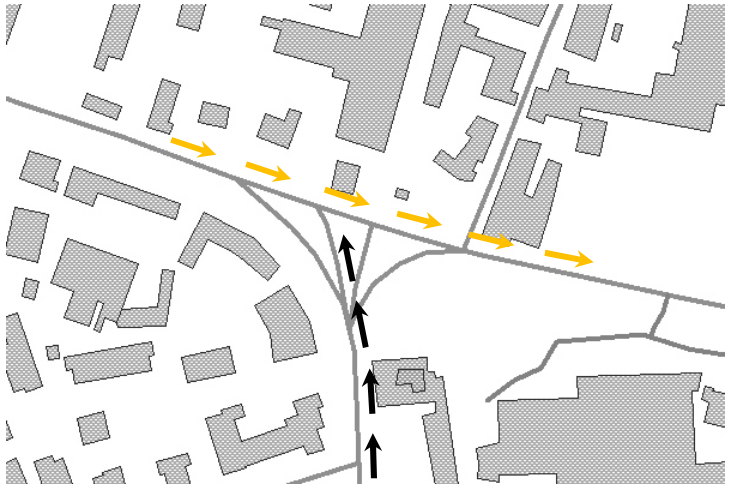
- Circularity ratio (how much the ratio a/p resembles that of a perfect circle)
- Inset circle



Classification of T-junctions

Delta junctions:

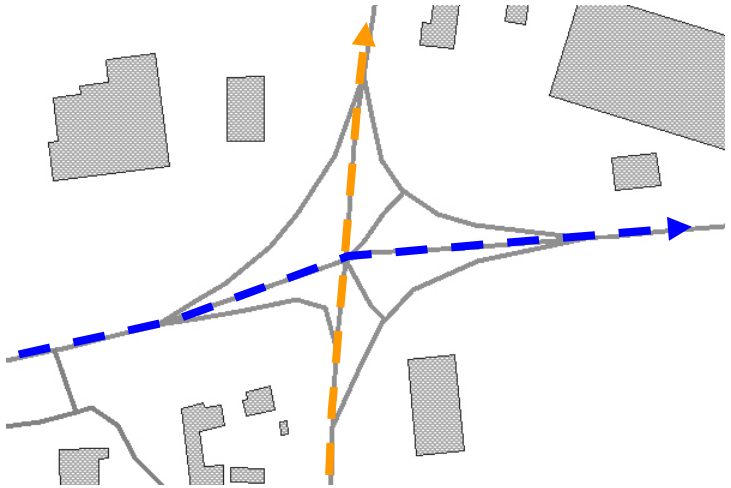
- one crossing road
- one incoming road



Classification of crossroads

Crossroads:

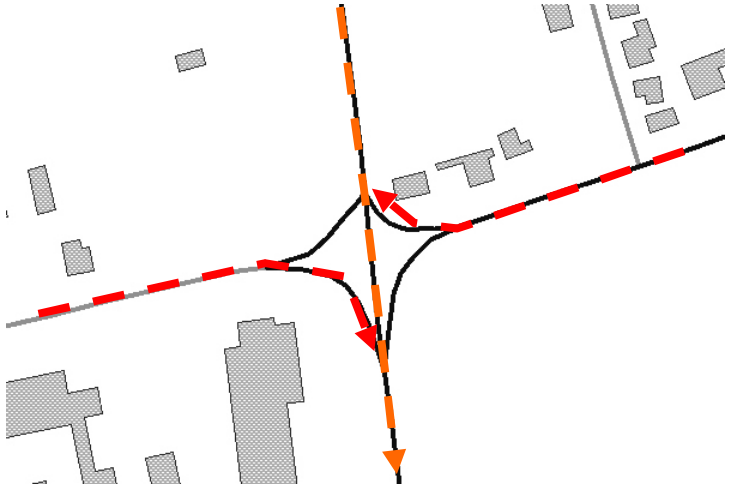
- two crossing roads



Classification of paired T-junctions

Paired T-junctions:

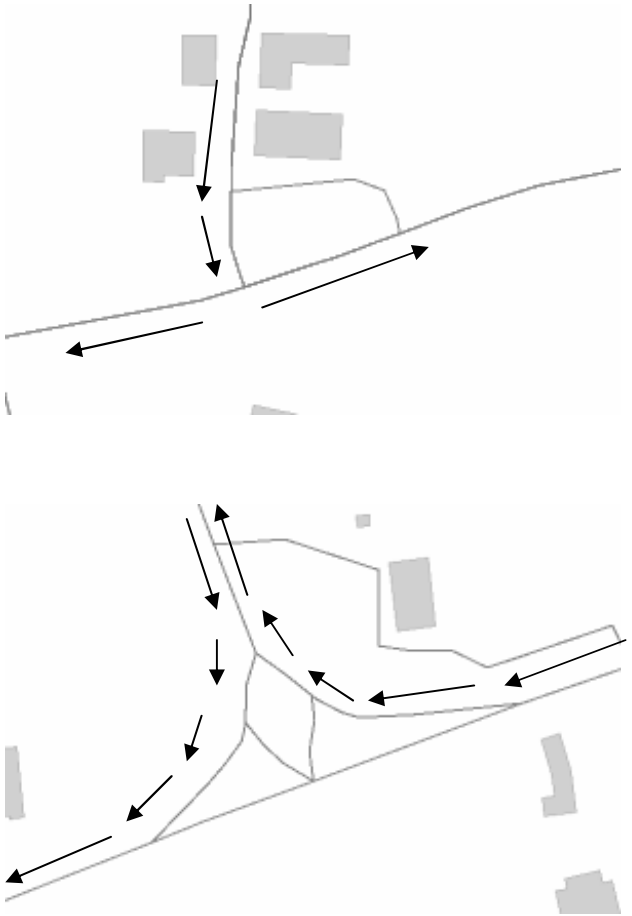
- one crossing road
- two incoming roads



False positives

In some cases some road loops are misclassified as T-junctions.

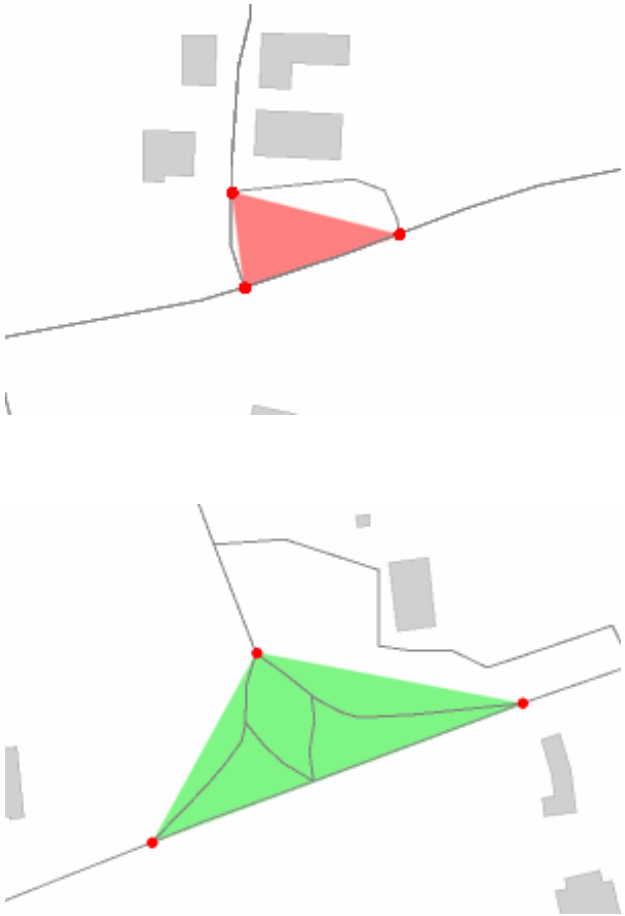
Perform a convexity test: real slip roads have a concave shape because the insertion of the traffic must be smooth



False positives

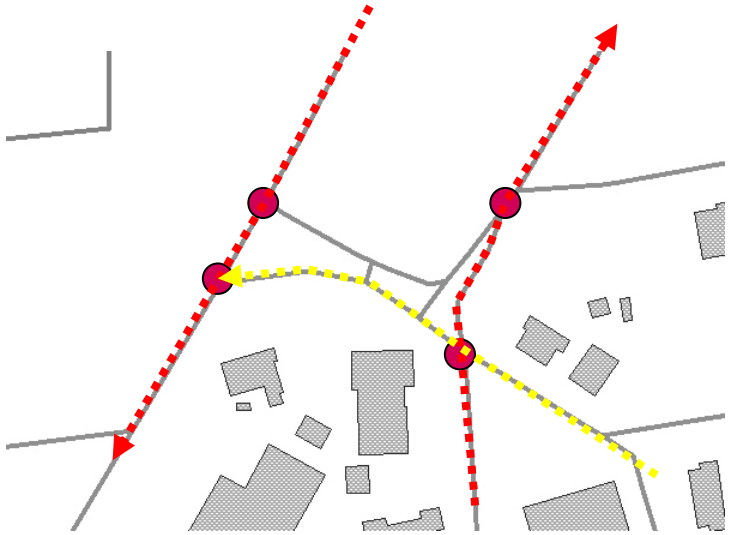
Drawing a triangle on the 3 special nodes we can check whether the area of the road loop is smaller or bigger:

- in the fist case the road loop is not a T-junction (convex)
- in the latter case it is a T-junction (concave)



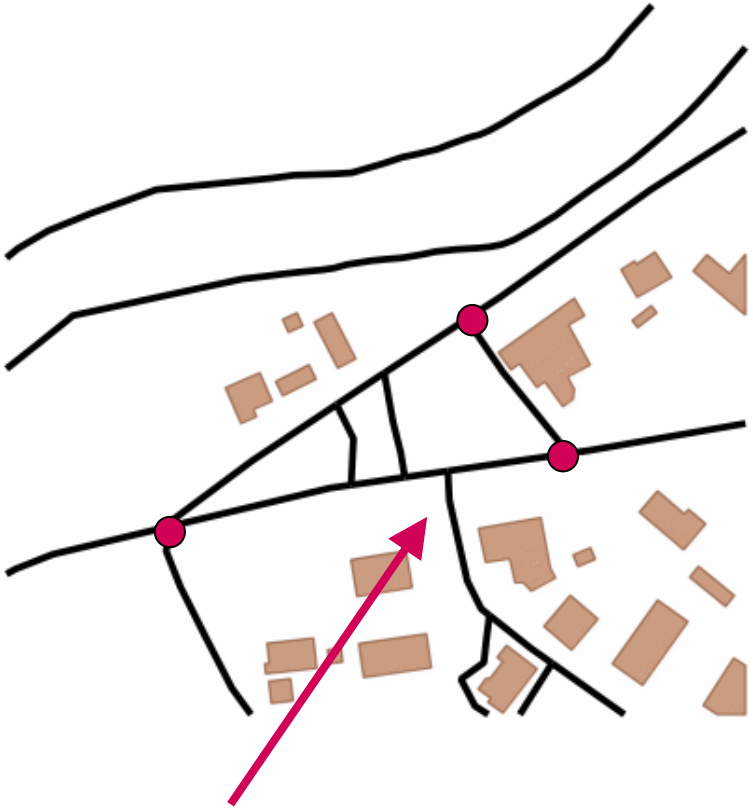
Classification of other junctions

All those road loops that are not one of the previous, are then tagged as “unclassified” junctions



False negatives

Some junctions are treated as “unclassified junctions” because the presence of some extra edges increases the number of special nodes



Highways

Composed by many elements:

- Carriageways
- Sliproads
- Toll stations
- Rest areas

The problem

We need to classify the different elements composing the highway network but the input data model doesn't convey this information

…how to distinguish them?

Classification

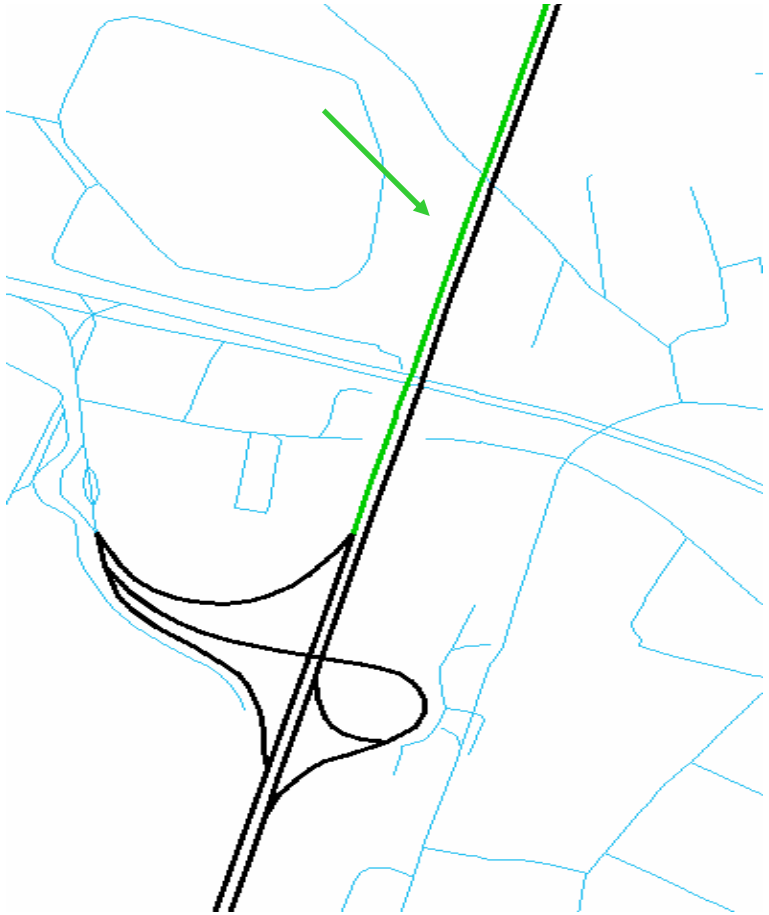
Carriageways are the most distinctive feature of a highway and act as the trunk (other elements stem from them)

Let’s find the carriageways first!

Carriageways

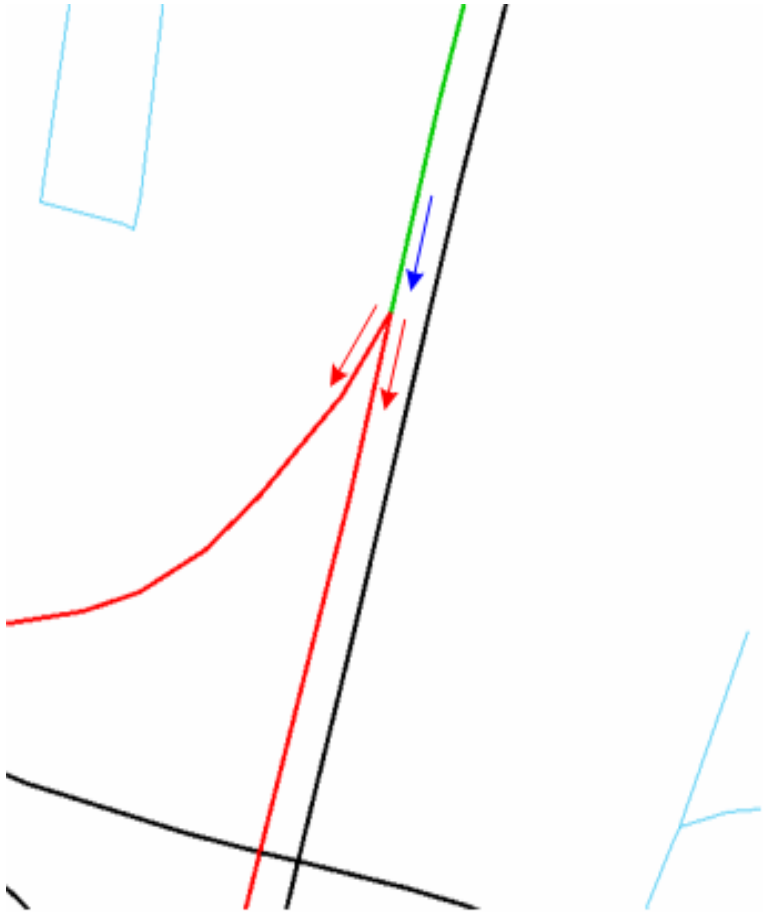
Highways are long and run straight

To find the carriageways, we search for the straigthmost segments



Carriageways

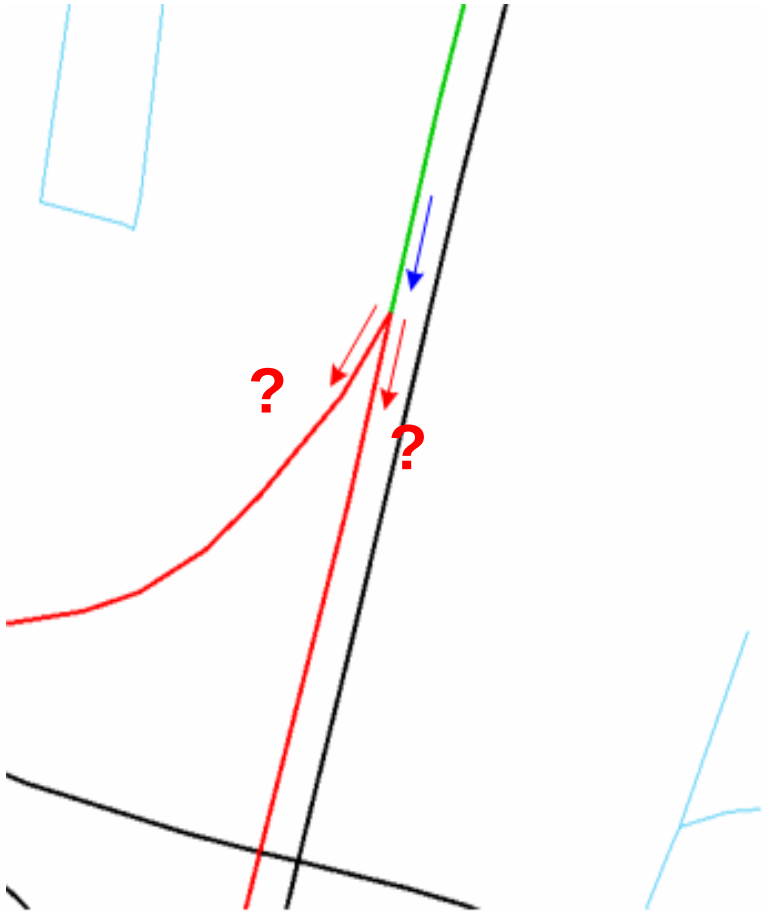
Carriageways can bifurcate



Carriageways

Carriageways can bifurcate

It is difficult to tell which is the next carriageway segment

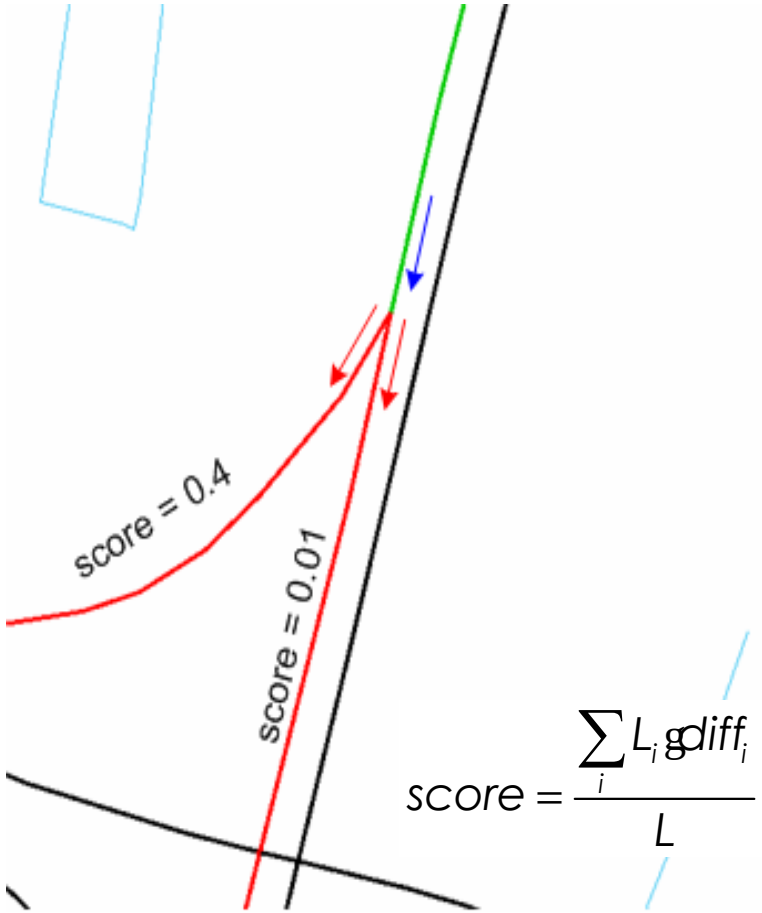


Carriageways

Carriageways can bifurcate

It is difficult to tell which is the next carriageway segment

Bend ratio: tells how much a line bends with respect to its length



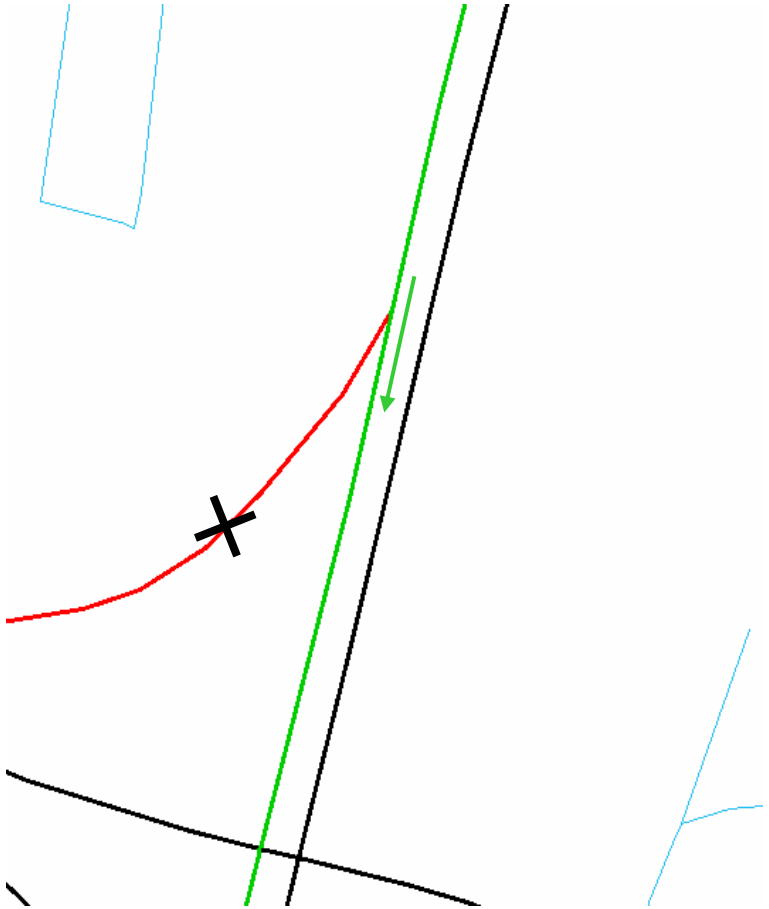
Carriageways

Carriageways can bifurcate

It is difficult to tell which is the next carriageway segment

Bend ratio: tells how much a line bends with respect to its length

The classification can continue



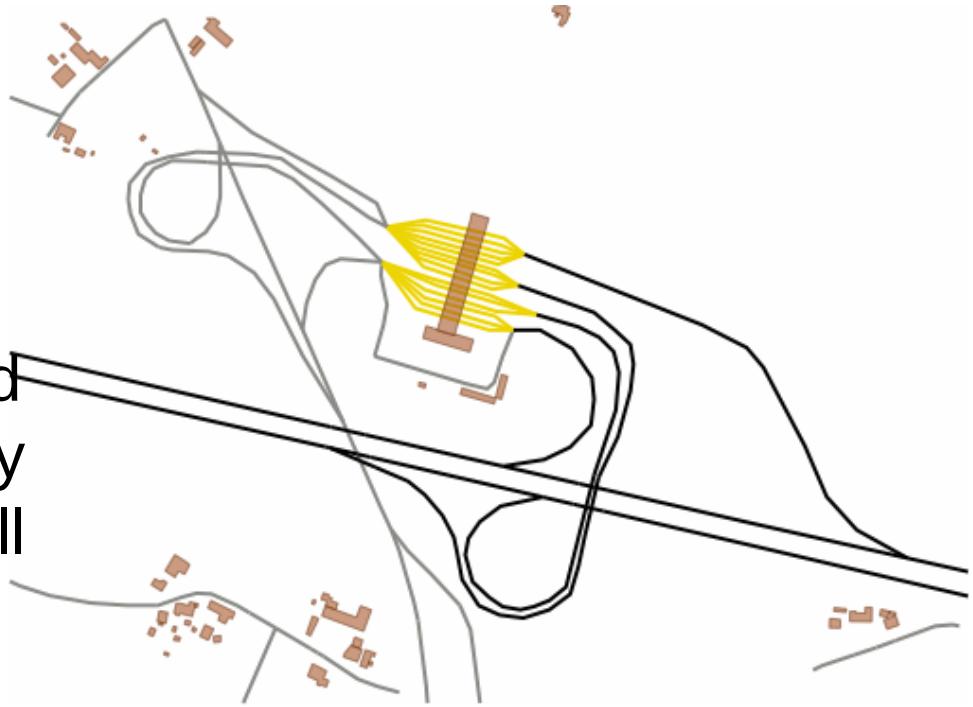
Sliproads

Sliproads connect two different carriageways and have a high bend ratio

Toll stations

Toll stations are the only way that highways are connected to ordinary roads:

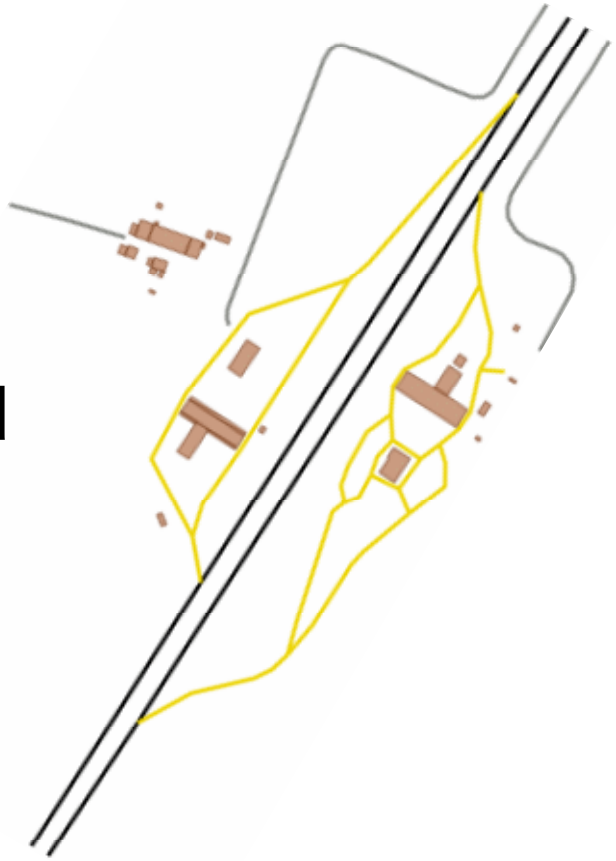
- All segments stemming out of a carriageway and connected to an ordinary road are classified as toll stations



Rest areas

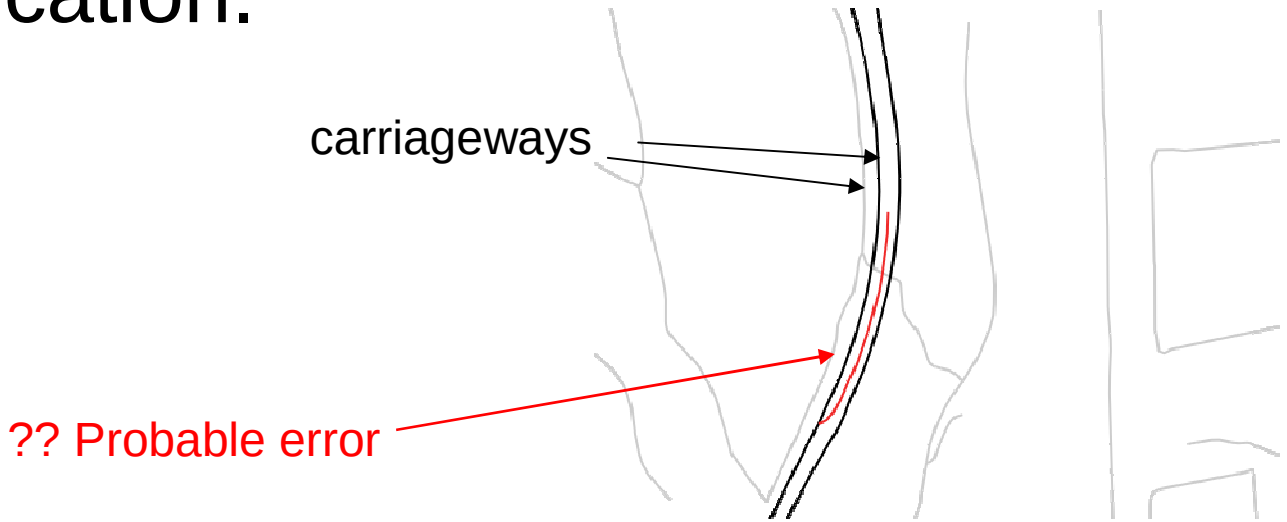
A rest area will have entrance and exit on the same carriageway:

- All the segments connected to the same carriageway are classified as rest areas



Robustness to errors

Once all the “interesting” elements of the highway have been found, we can ignore those segments that do not fit in the classification.



Conclusions

- Using only information gathered from the shape of the features it is possible to classify road junctions and the components of highways
- The process is robust against semantic errors in the input data
- The process mimics the way a human is able to detect these same objects just “looking” at a map
- A complete classification enables to find some errors in the input data