Integration of ELECTRE TRI in a GIS
Coupling with a XMCDA webservice for inference

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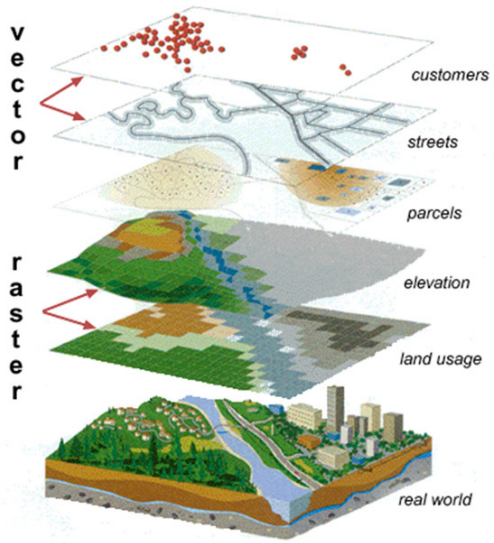
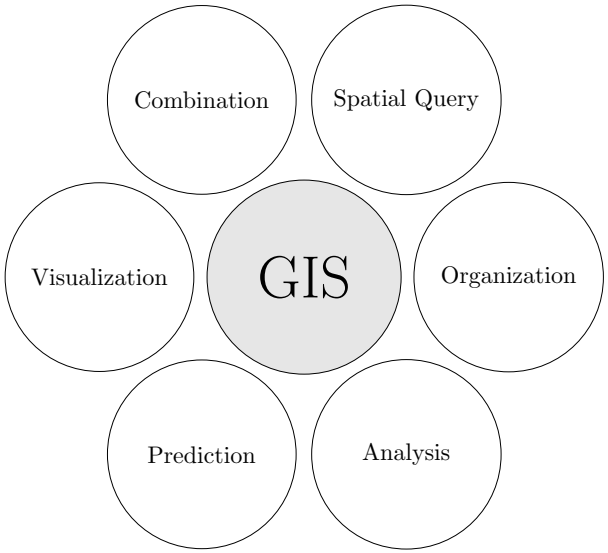
UMONS

GIS and MCDA





- GIS are used in lot of application from land suitability problem to geomarketing
- Since 90's, works about GIS and MCDA
- Not a lot of work based on ELECTRE methods
- ELECTRE methods fit well for ordinal problems

GIS and MCDA

Limitations of GIS-MCDA works according to S. Chakhar :

- Weak coupling
- One MCDA method integrated
- Choice of the MCDA method
- Single criterion synthesis
- User's knowledge of SIG and MCDA

GIS and MCDA

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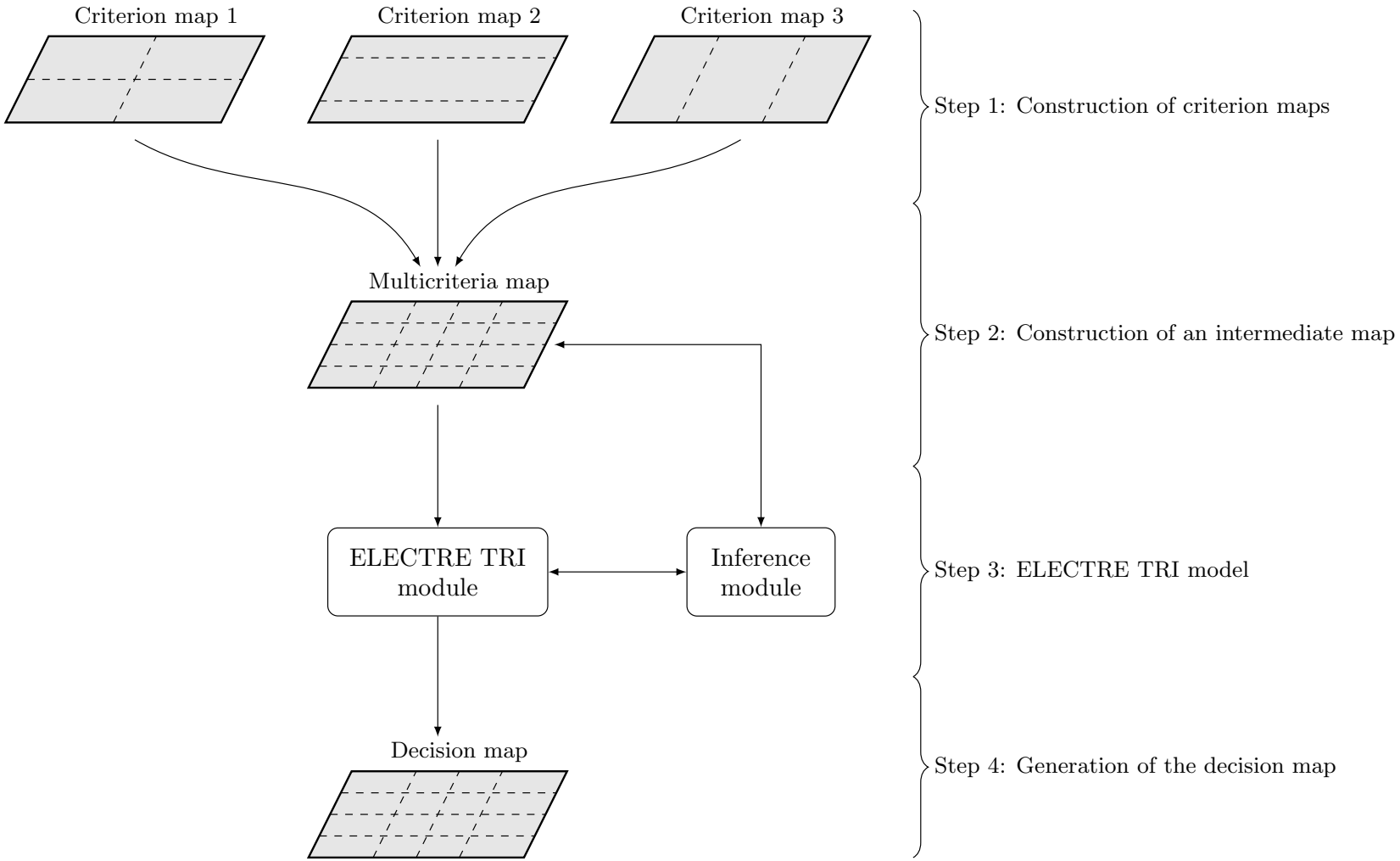
We add an extra one :

A good number of GIS-MCDA tools were abandoned or never surpassed the stage of prototype

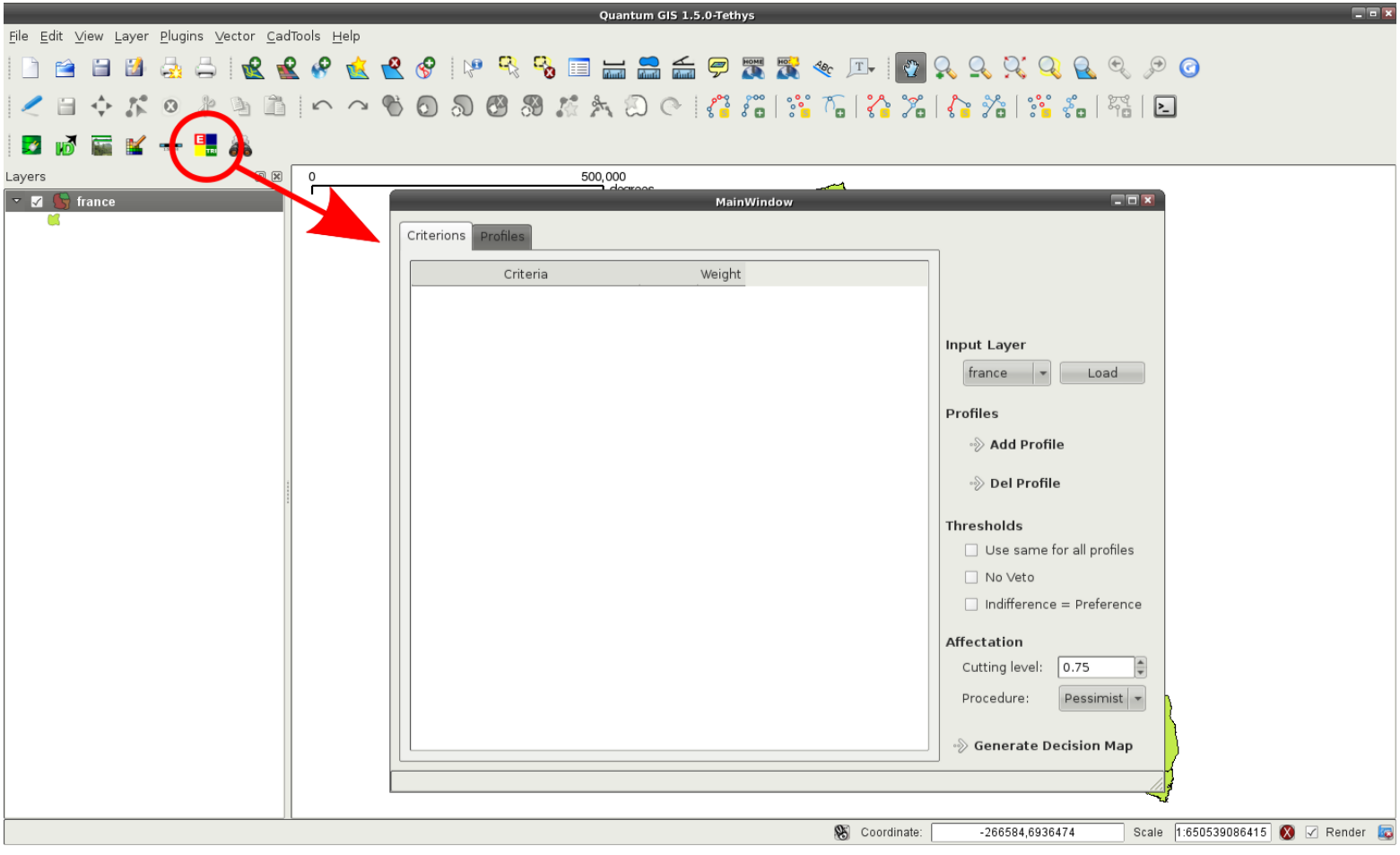
Objectives of our GIS-MCDA integration

- ELECTRE TRI implementation
- Tight coupling
- User friendly interface
- Open Source GIS (and implementation)
- Support for standard and Bouyssou-Marchant methodology

Strategy to build the decision map



Status at the previous workshop



Demo : Densification of Quebec city

Subject

Quebec city wants to create a program to densify its population in the centrum and around the small crown. The program consists to build rental properties at low prices for young families in empty areas.

Objectives

- Densify central sectors where the there are more public transports
- Sustain a good social diversity by choosing in priority the sectors where young people and immigrants are not well represented
- Favor sectors with a lot of small shops

Demo : Densification of Quebec city

Actions

786 actions (polygons)

Criteria

- Density of 0-14 years old [%] (min)
- Density of shops [shops/ha] (max)
- Density of people [residents/ha] (min)
- Level of public transports (average) [bus/hour] (max)
- Ratio of immigrants [%] (min)

Categories

1. Bad
2. Medium
3. Good

Objectives update

Save/Load parameters

Add the possibility to save an XMCDA model and restore it in the plugin

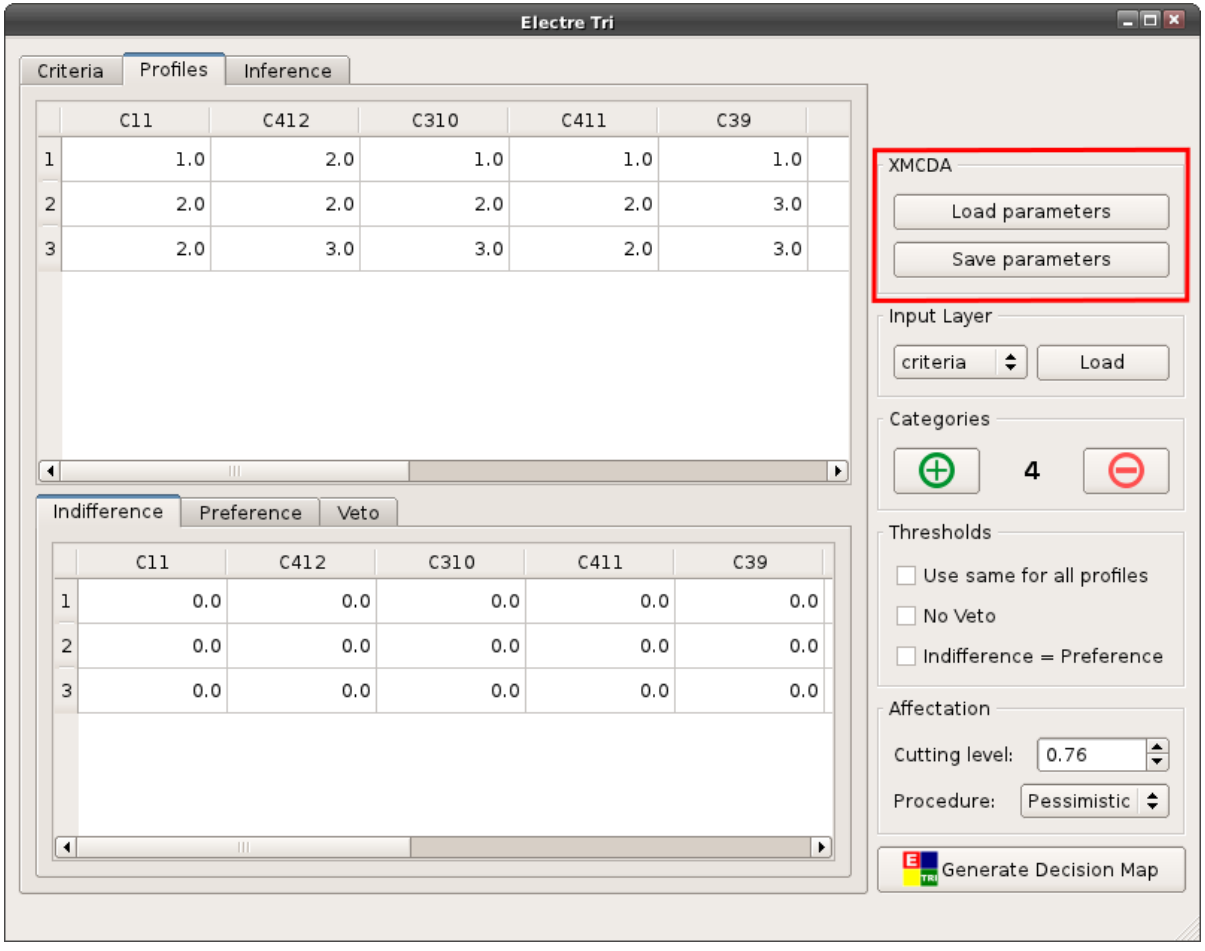
XMCDA webservice for parameters inference

- Create a new webservice to infer parameters of the ELECTRE TRI model globaly and partialy
- Make some experiments

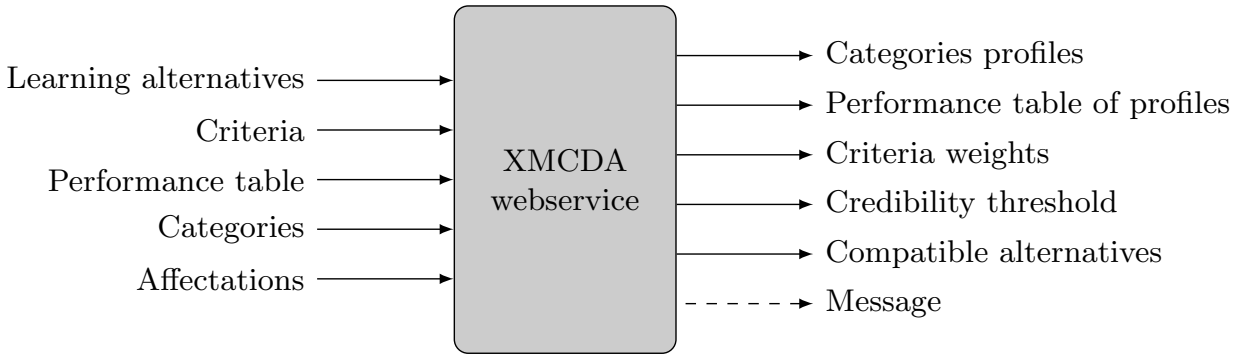
Coupling the webservice with our ELECTRE TRI plugin

Create user-friendly interface to use the webservice with our Quantum GIS plugin

Save/Load parameters



ELECTRE TRI BM inference webservice



Characteristics

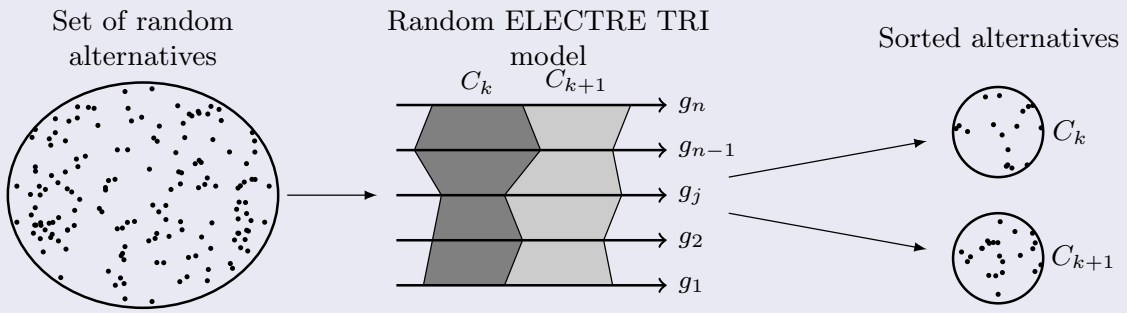
- Bouyssou-Marchant ELECTRE TRI model
- Accept non-admissible set of learning alternatives
- Maximize number of compatible alternatives
- MIP problem
- Use GLPK

ELECTRE TRI BM inference experimentations

Methodology

Similar methodology as the one used by Agnès Leroy in her thesis

Step 1 : Generate random data



ELECTRE TRI BM inference experimentations

Methodology

Similar methodology as the one used by Agnès Leroy in her thesis

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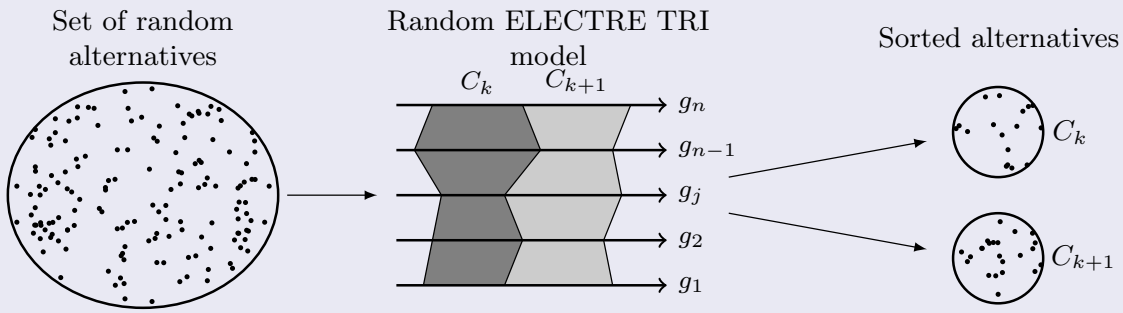
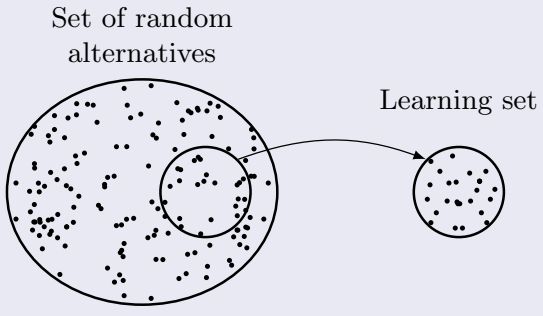


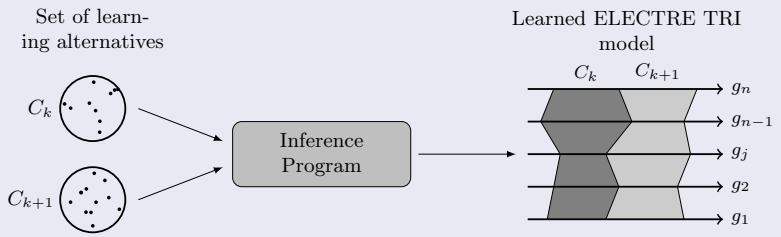
Step 2 : Pick learning alternatives



ELECTRE TRI BM inference experimentations

Methodology

Step 3 : Inference of ELECTRE TRI model



ELECTRE TRI BM inference experimentations

Methodology

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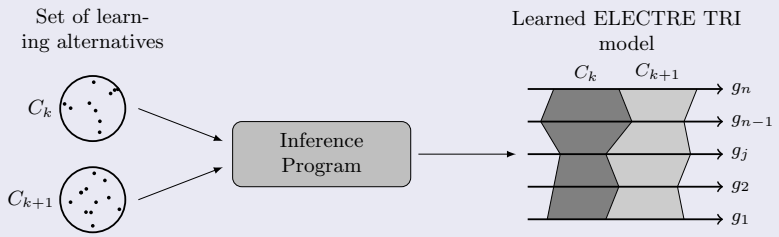
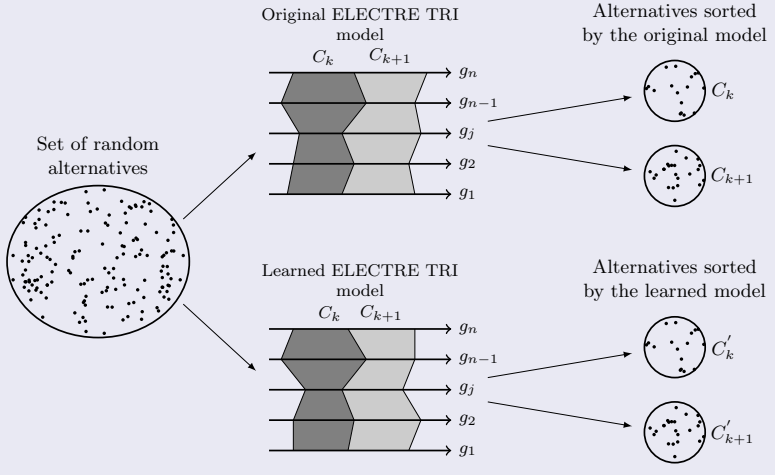
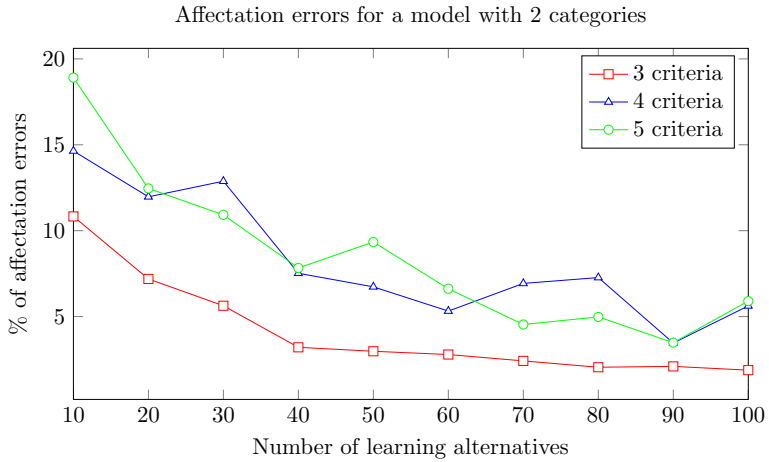


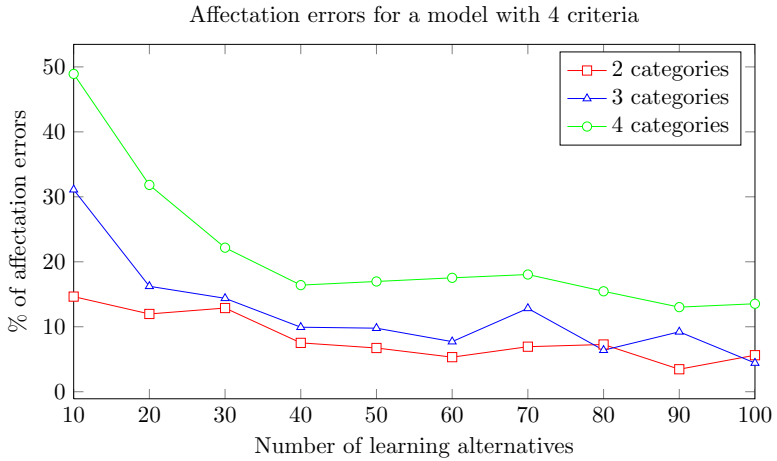
Step 4 : Analysis of learning model



ELECTRE TRI BM inference experimentations

Results - Affectation errors



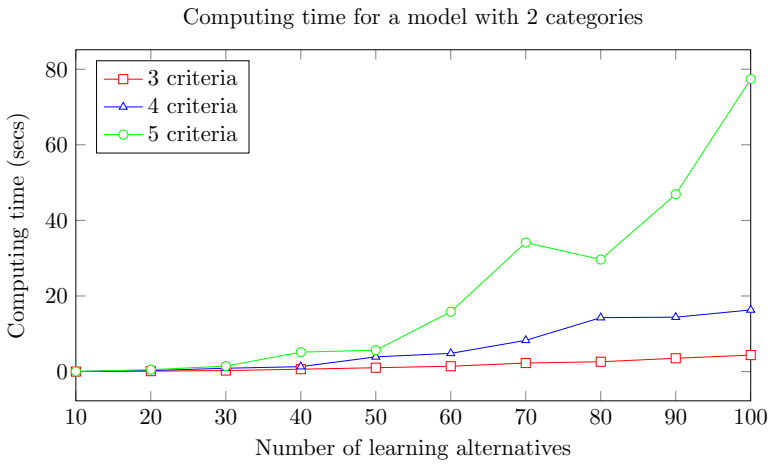


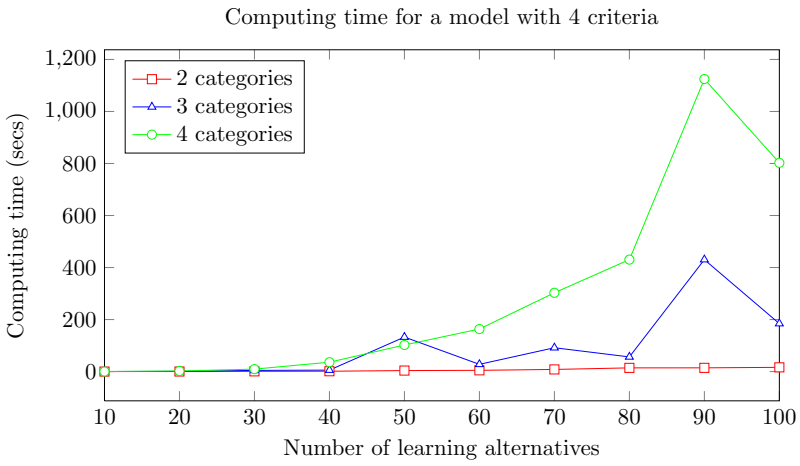
Remarks

- Number of criteria ↗ ⇒ Affectation error ↗
- Number of categories ↗ ⇒ Affectation error ↗
- Number of learning alt. ↗ ⇒ Affectation error ↘

ELECTRE TRI BM inference experimentations

Results - Computing time



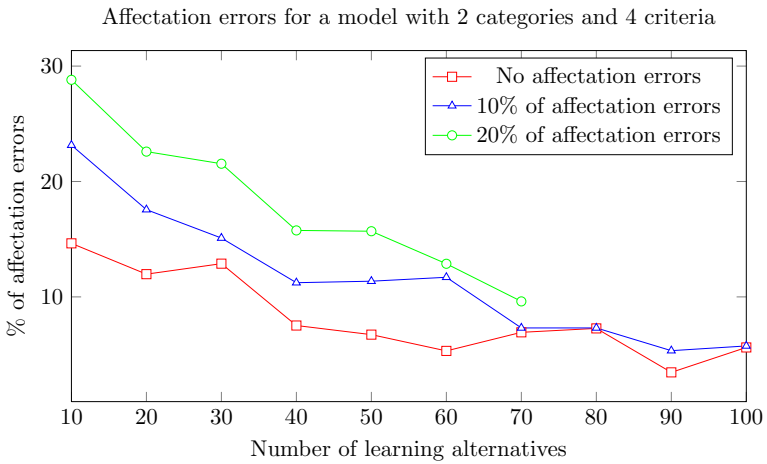


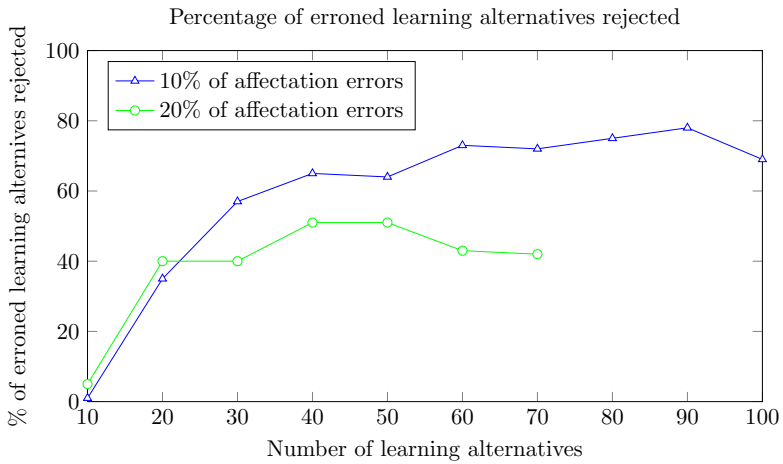
Remarks

- Number of criteria ↗ ⇒ Computing time ↗
- Number of categories ↗ ⇒ Computing time ↗
- Number of learning alt. ↗ ⇒ Computing time ↗ ↗

ELECTRE TRI BM inference experimentations

Results - Influence of errors in learning set





Remarks

- Number of erroned learn. alt. ↗ ⇒ Affectation errors ↗
- Number of learning alt. ↗ ⇒ Affectation errors ↘
- Number of learning alt. ↗ ⇒ Err. learn. alt. rej. ↗

ELECTRE TRI BM inference experimentations

First conclusions and ideas for improvement

First conclusions

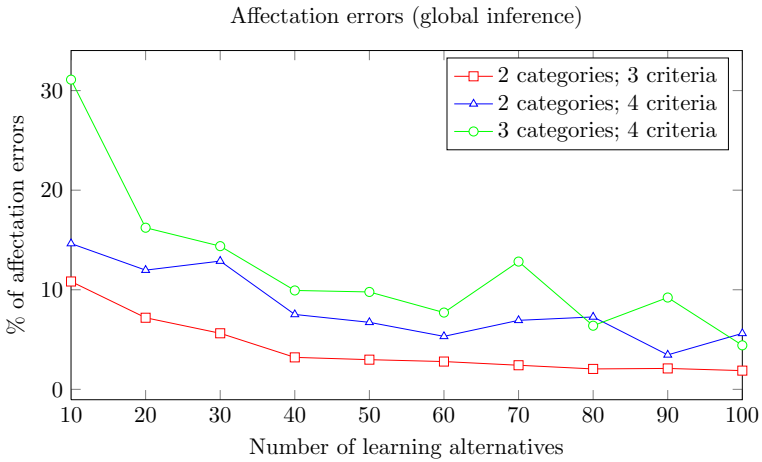
- Lot of learning alternatives needed to get good results
- With errors in the learning set, more alternatives are needed
- Computing become huge when number of learning alternatives increase

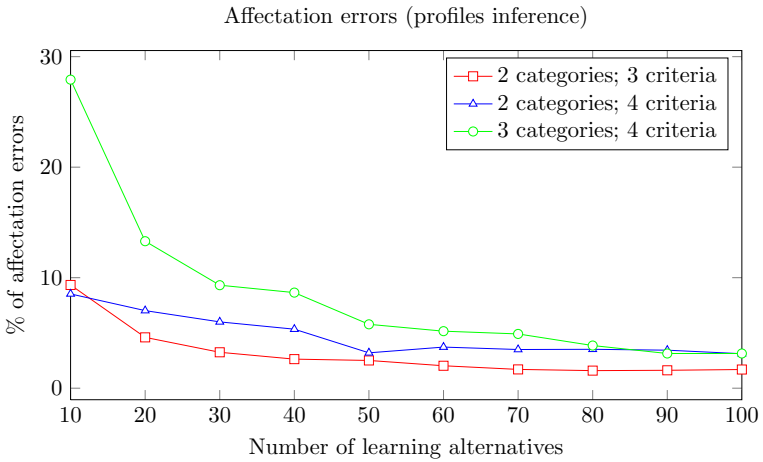
Ideas for improvement

- Two step inference
- Improve objective of the inference program
- Partial inference

ELECTRE TRI BM inference experimentations

Partial inference of the parameters - Profiles



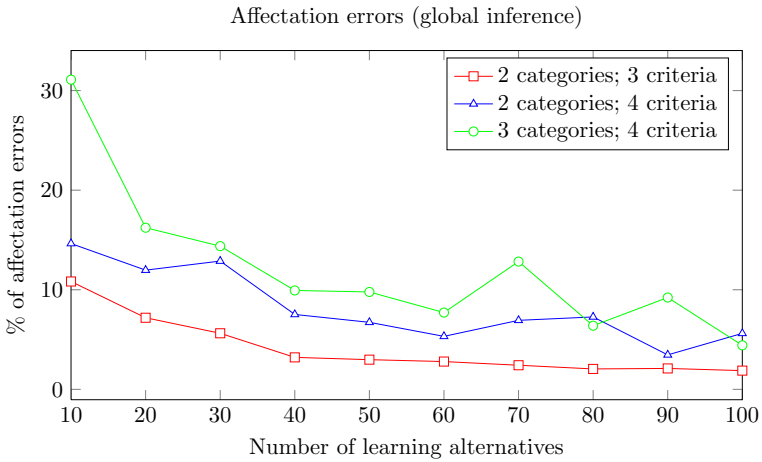


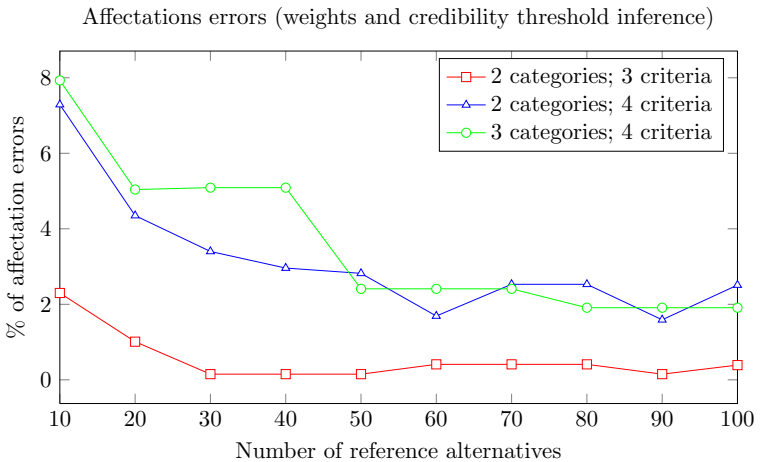
Remarks

- Less alternatives needed to get good results
- Less computing time needed than for global inference
- Generaly better than global inference for the same number of learning alternatives

ELECTRE TRI BM inference experimentations

Partial inference of the parameters - Weights and credibility threshold

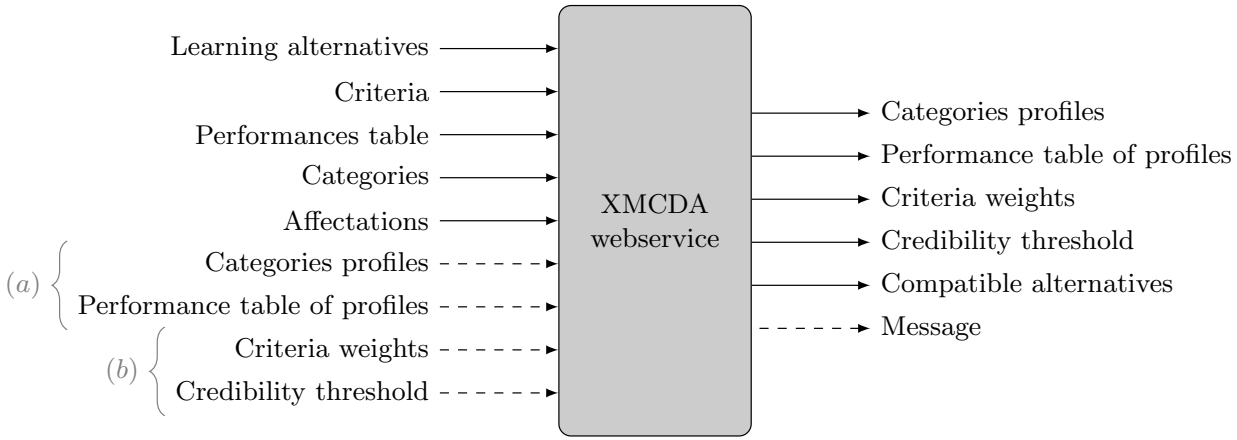




Remarks

- Less alternatives needed to get good results
- Less computing time needed than for global inference
- Generaly better than profiles inference for the same number of learning alternatives

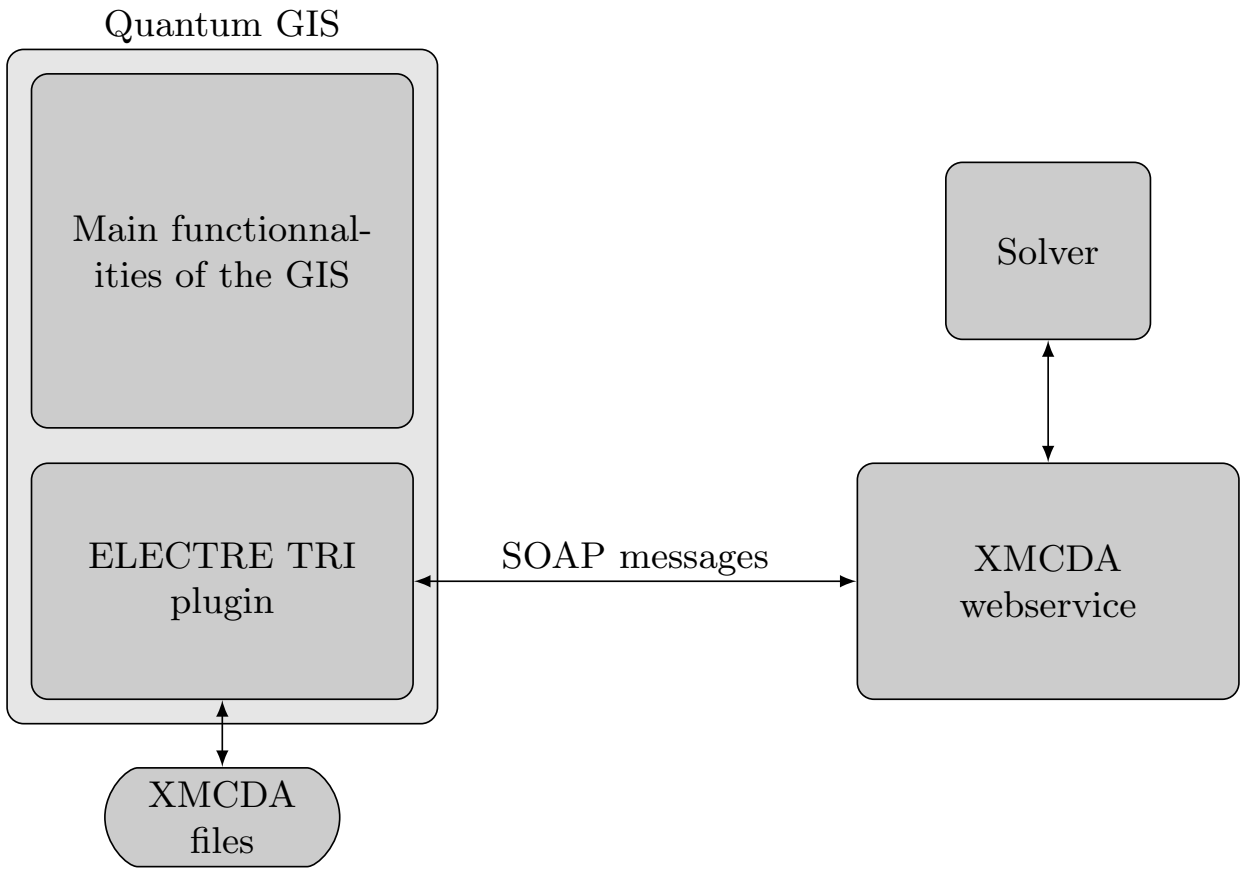
ELECTRE TRI BM inference webservice update



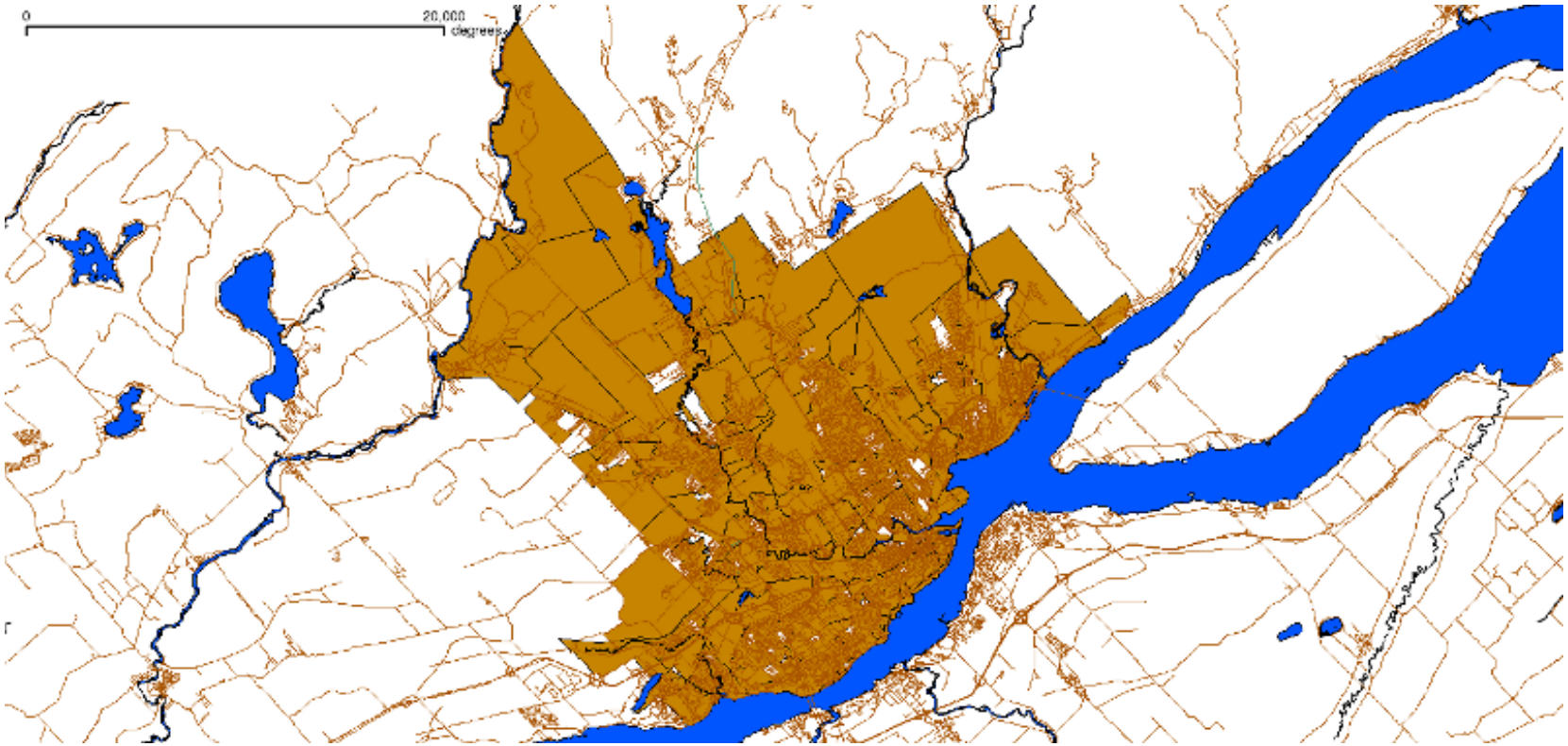
Characteristics

- Two entries added to do partial inference of the weights and lambda threshold
- Two entries added to do partial inference of the profiles

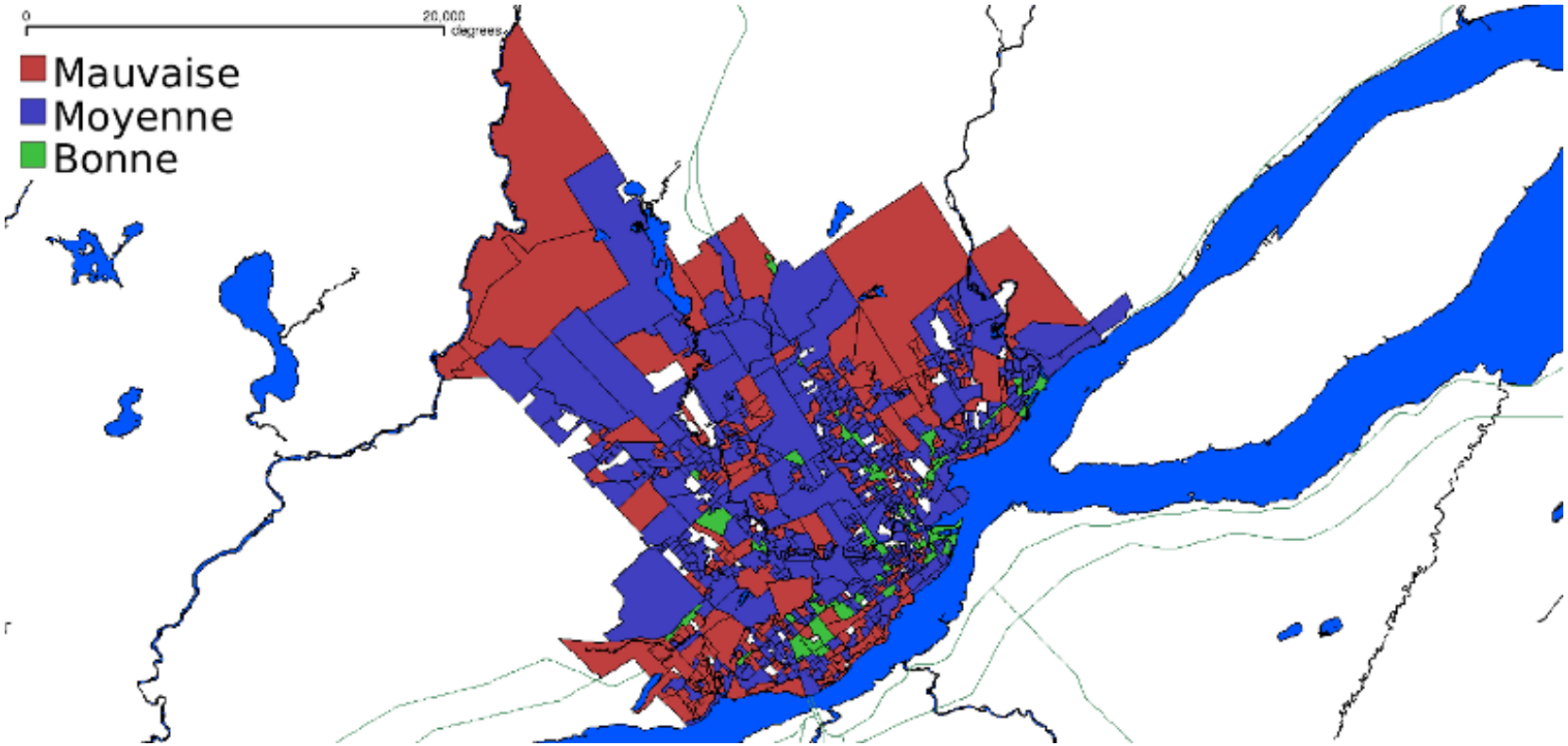
Coupling of XMCDA webservice with Quantum GIS ELECTRE TRI plugin



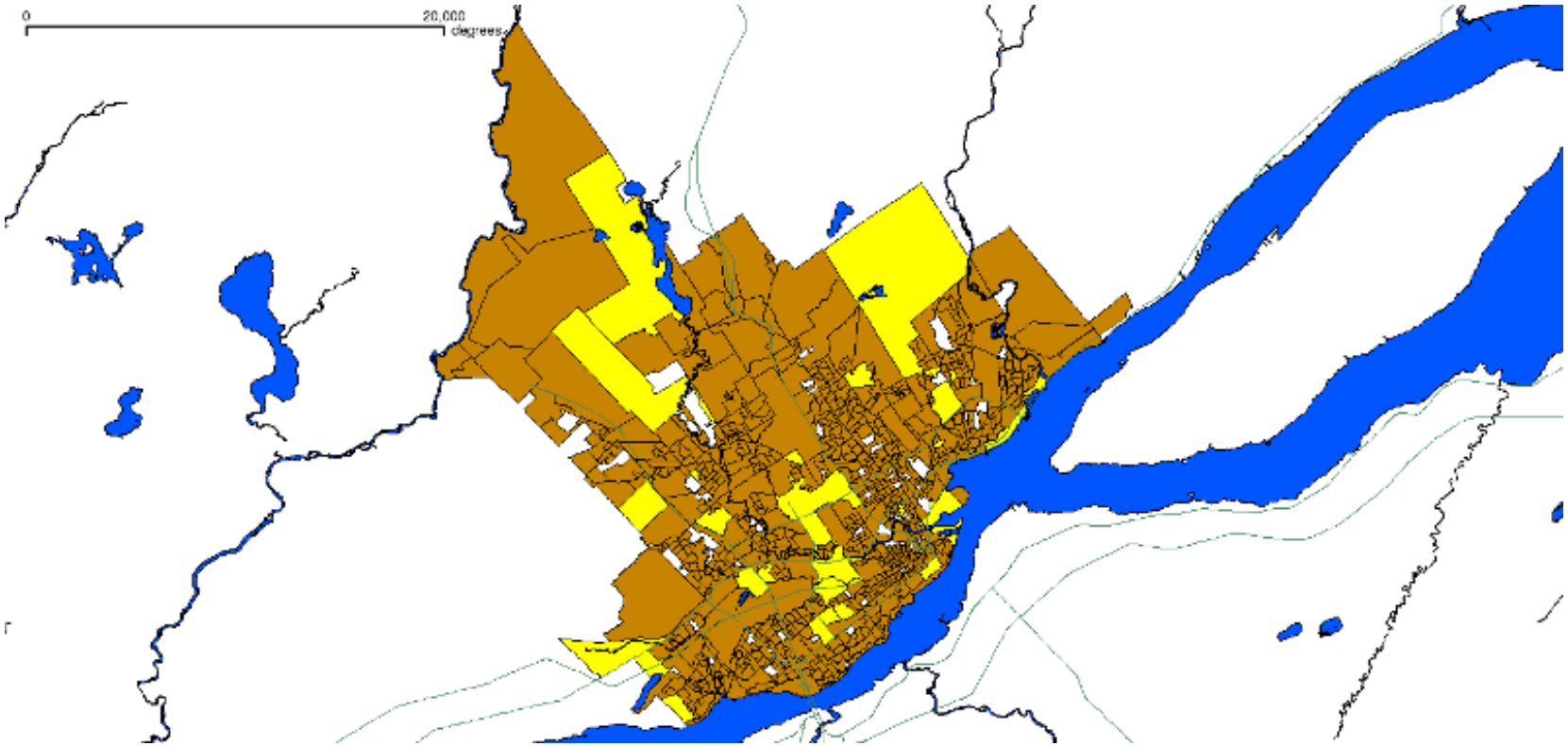
It's time for a demo...



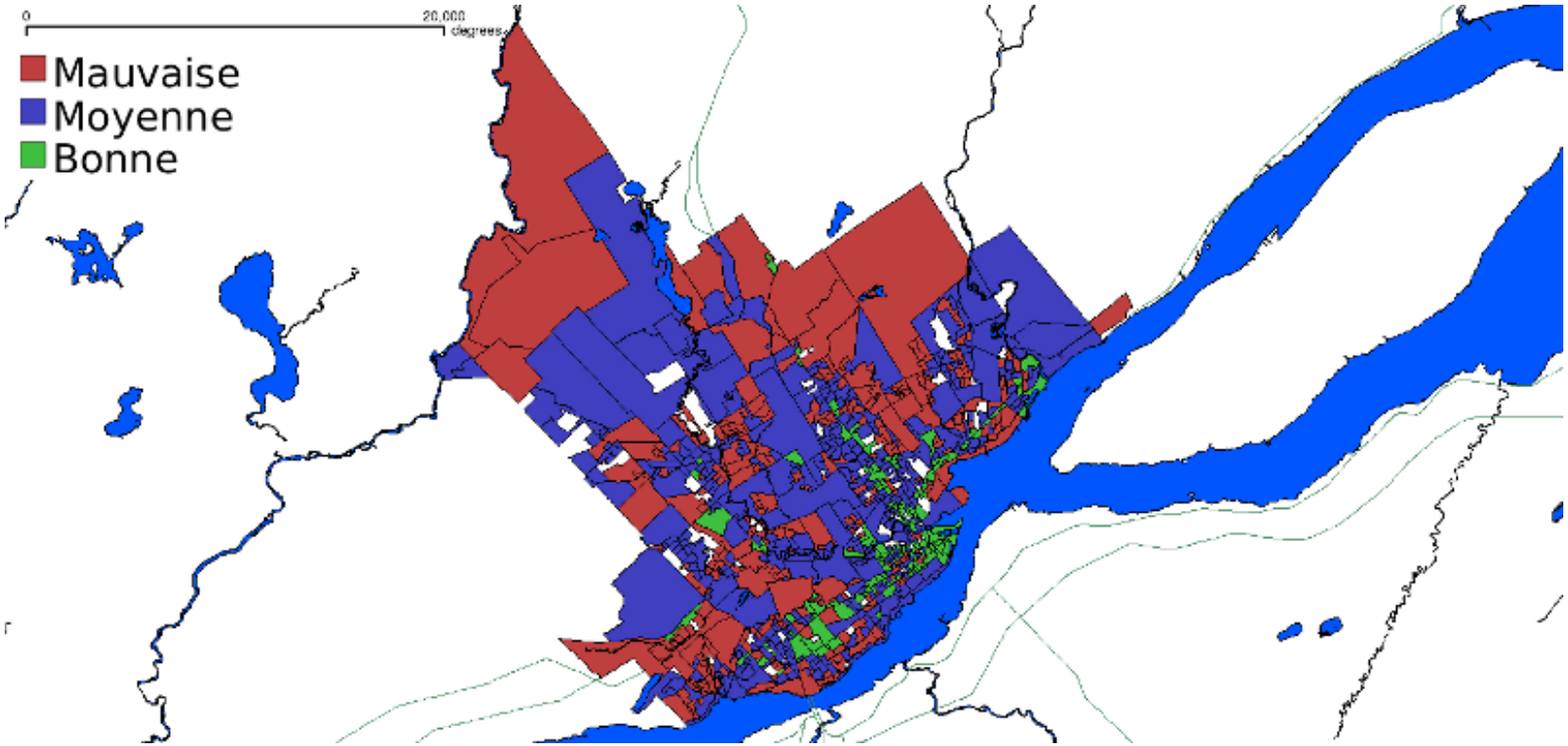
Original model



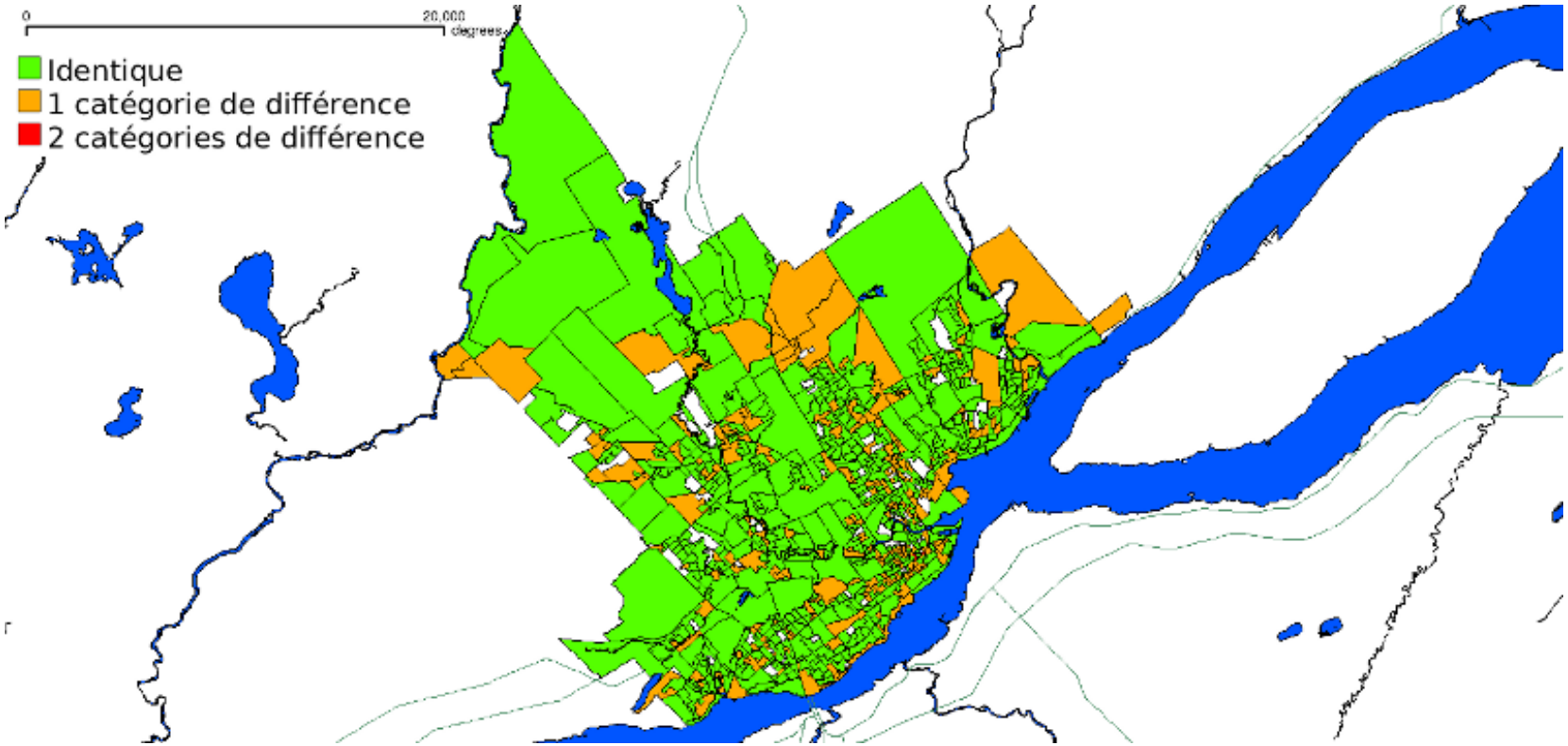
Actions of reference



Global inference

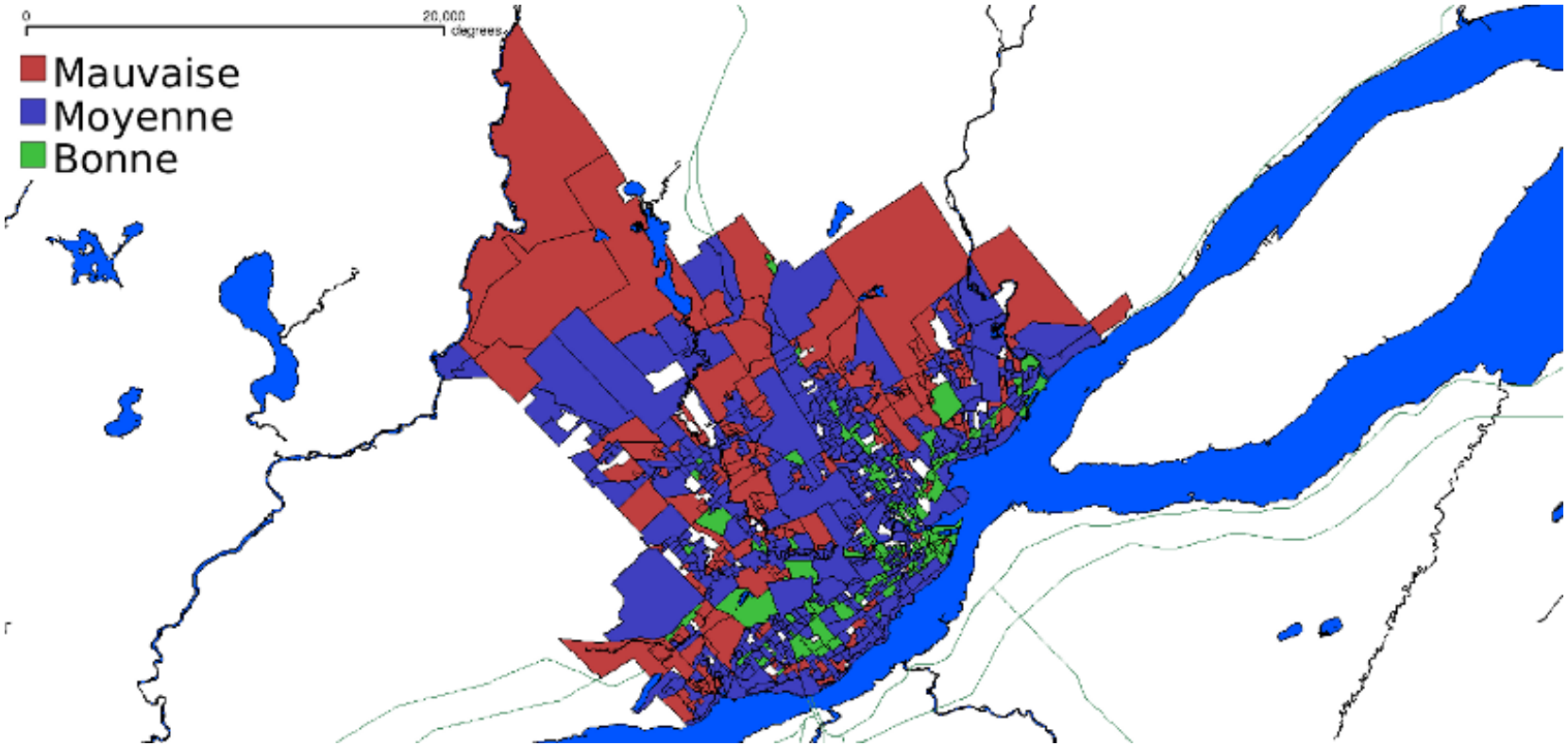


Global inference (difference)

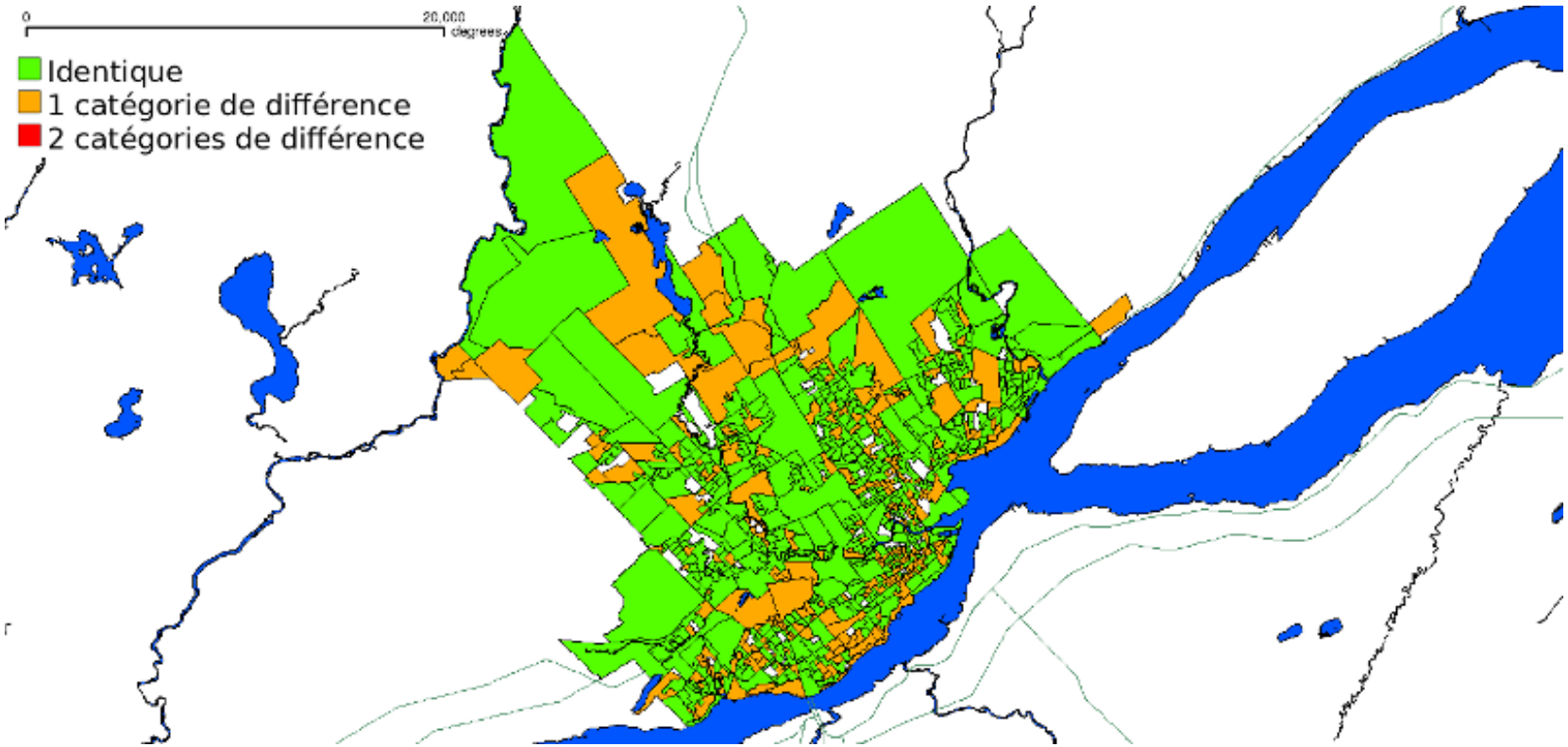


± 29% of invalid affectations

Profiles inference

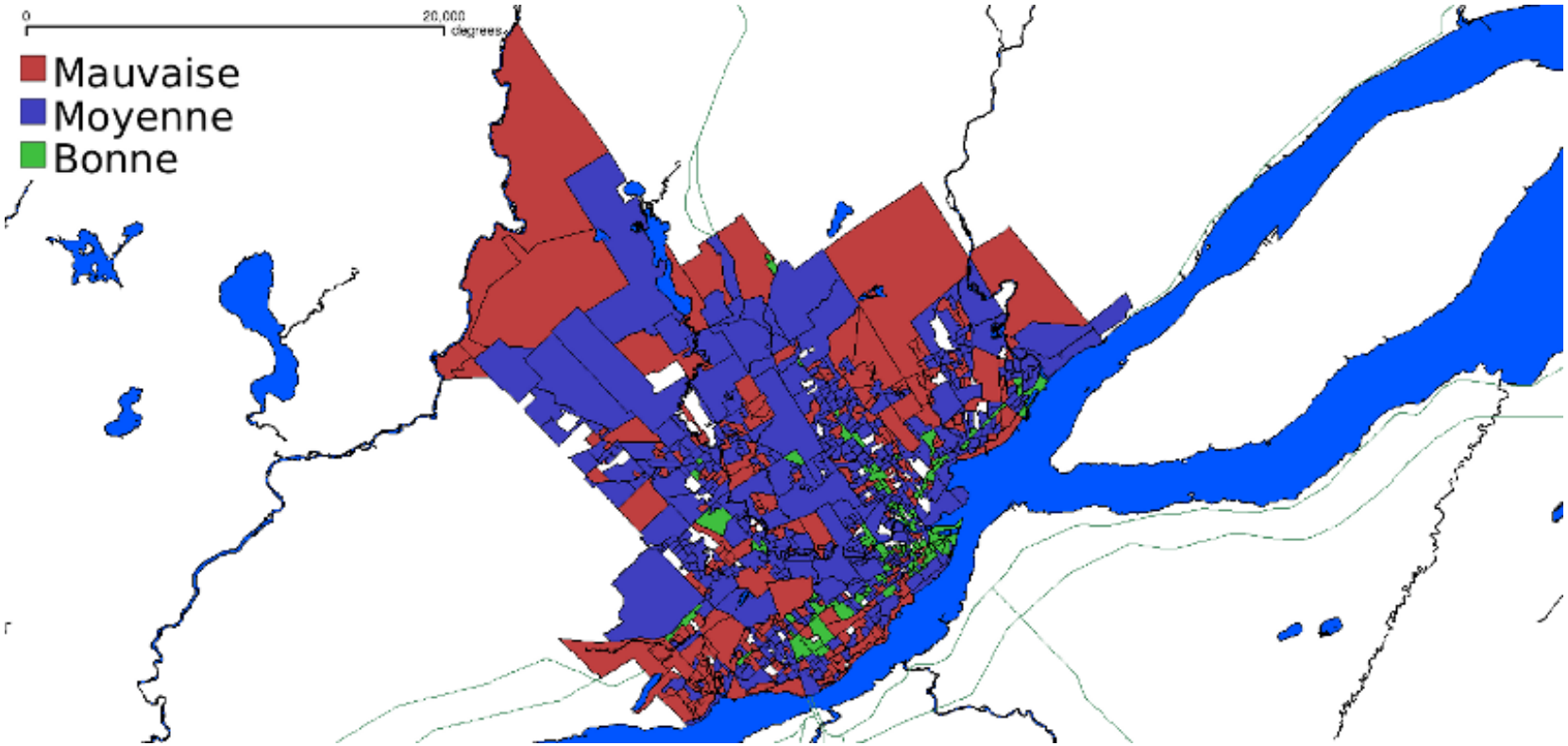


Profiles inference (difference)

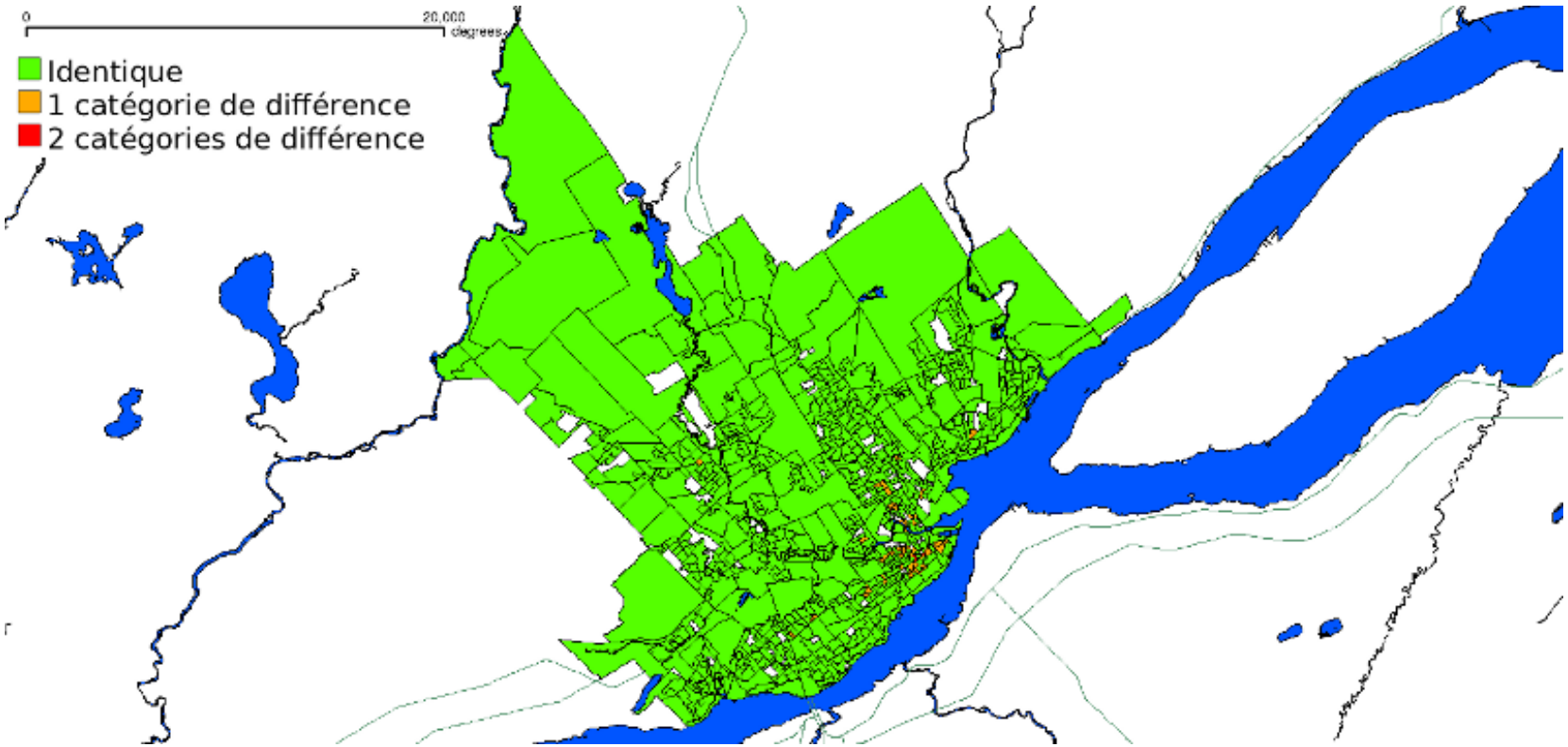


± 33% of invalid affectations

Weights and lambda inference



Weights and lambda inference (difference)



$\pm$ 6% of invalid affectations

Next developments and ideas...

Plugin improvement

- Add plot of the profiles
- Add the possibility to choose a spatial entity by clicking on it in the inference module

Coupling with IRIS webservice

Be able to perform ELECTRE TRI inference with the IRIS webservice

Smart selection of spatial entities for inference

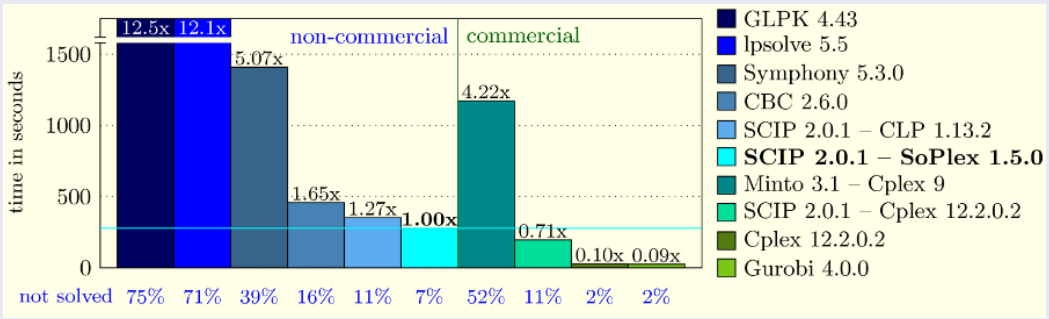
Add a button to select by default an optimal set of spatial entities to use as learning alternatives with the inference program

To discuss...

Webservice compatibility

Currently it is not possible to connect the inference webservice with the ELECTRE TRI one

Replacement of GLPK by SCIP



Inclusion of XMCDA functions in PyXMCDA

- Some generic functions included in the Quantum GIS ELECTRE TRI plugin might be integrated in the PyXMCDA library
- lxml module ?

Thank you for your attention !