# Integration of decision aid tools in a Geographical Information System

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#### 1 Introduction

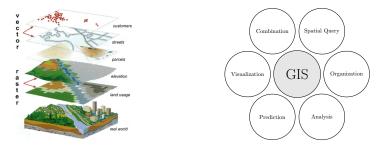
- 2 Methodology
- 3 Implementation

#### 4 Inference

- Demonstration 5
- 6 Conclusion

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## **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 [Chakhar, 2006] :

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

## **GIS and MCDA**

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- User's knowledge of GIS and MCDA

#### We add an extra one :

A good number of GIS-MCDA tools were abandoned or never surpassed the stage of prototype. Moreover it has been done in commercial GIS.

## **Objectives of our GIS-MCDA integration**

#### **First objectives**

- ELECTRE TRI implementation
- Full integration
- User friendly interface
- Open Source GIS (and implementation)

## **Objectives of our GIS-MCDA integration**

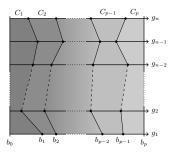
#### **First objectives**

- ELECTRE TRI implementation
- Full integration
- User friendly interface
- Open Source GIS (and implementation)

#### Second objectives

- Learning of parameters
- Implementation of a XMCDA webservice
- Experimentations
- Coupling with the ELECTRE TRI plugin

## ELECTRE TRI



#### Parameters

- weights
- profiles
- credibility threshold

## Approach

. . .

- Classical
- Bouyssou-Marchant

#### **Major interests**

- Judge an action independently from the others
- Allow to consider more actions than other ELECTRE methods
- Reference values fixed : profiles

## Application : Densification of Quebec city

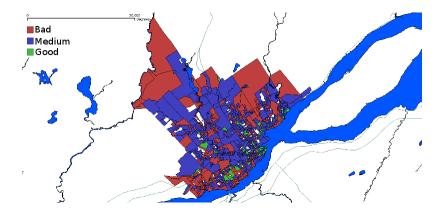
### Subject

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 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

Application : Densification of Quebec city
Application : Densification of Quebec city
Decision map



## Application : Densification of Quebec city Definition of the problem

#### Actions

786 districts (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)

## Application : Densification of Quebec city Performance table

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## Strategy of integration

#### Reference

▶ [Chakhar, 2006]

#### Coupling strategy

- [Malczewski, 2006] reports only 10 % of works using a strategy of full integration of the MCDA method in the GIS
- Full integration

#### Actions and criteria

- Vector layer
- actions = points, lines, polygons
- criteria = attributes

## Strategy to build the decision map

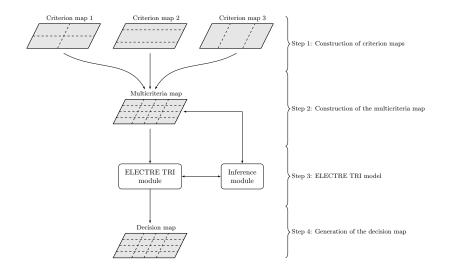


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## Choice of the GIS

#### Requirements

- Open Source GIS and implementation
- User friendly interface
- Support of vector layer
- With map algebra tools

## Choice of the GIS

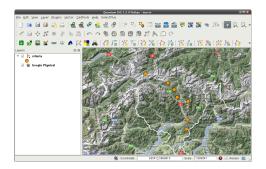
#### Requirements

- Open Source GIS and implementation
- User friendly interface
- Support of vector layer
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#### Lot of open source GIS

- GRASS, PostGIS, Quantum GIS
- http://opensourcegis.org/

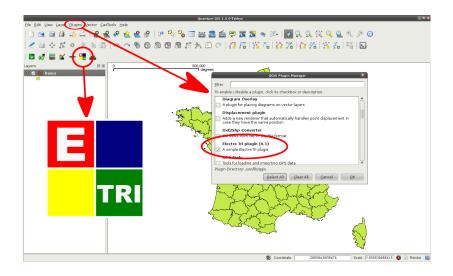
## Quantum GIS



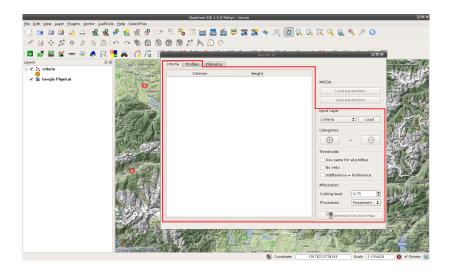
#### **Characteristics**

- Great portability (Linux, Windows, Mac OS)
- Plugin mechanism
- Lot of functionnalities (GRASS, map algebra, ...)
- User-friendly interface

#### **Full integration**



#### User interface



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#### User interface

	Electre Tri	
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		Generate Decision Map

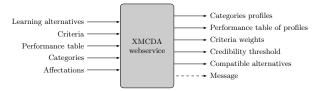
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#### User interface

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						Cutting level: 0.75
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## XMCDA webservice



#### Characteristics

- Based on [Leroy, 2010]
- ► Learning of ELECTRE TRI Bouyssou-Marchant parameters
- Accept non-admissible set of learning alternatives
- Maximize number of compatible alternatives
- MIP problem
- Use GLPK

## **ELECTRE TRI BM inference experimentations**

#### First conclusions

- Lot of learning alternatives needed to get good results
- Difficult to get good set of params when learning set not completely compatible with ELECTRE TRI model
- Computing time becomes huge when number of learning alternatives increases

## **ELECTRE TRI BM inference experimentations**

#### **First conclusions**

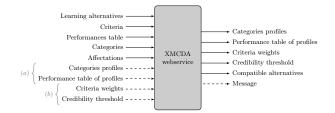
- Lot of learning alternatives needed to get good results
- Difficult to get good set of params when learning set not completely compatible with ELECTRE TRI model
- Computing time becomes huge when number of learning alternatives increases

#### New experimentations

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

Inference XMCDA webservice

## ELECTRE TRI BM inference webservice update

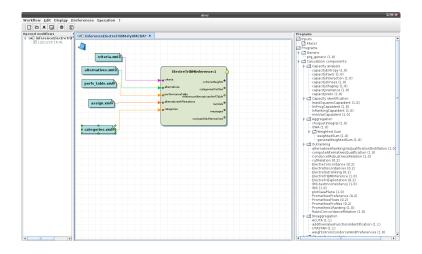


#### Characteristics

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

Inference Webservice available in diviz

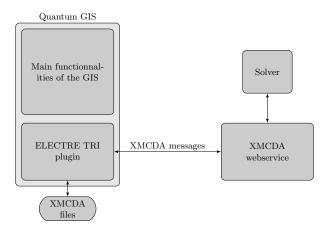
## Webservice available in diviz



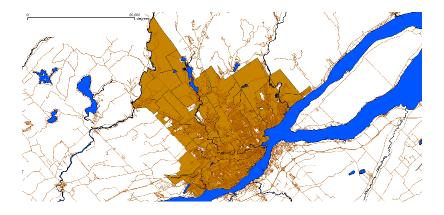
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Inference Coupling of XMCDA webservice with Quantum GIS ELECTRE TRI plugin

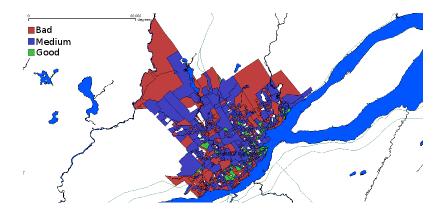
# Coupling of XMCDA webservice with Quantum GIS ELECTRE TRI plugin



## It's time for the demo...



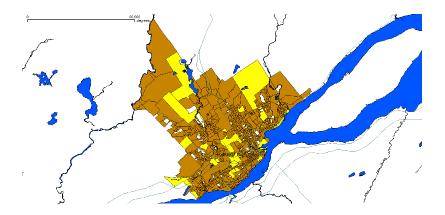
## **Original model**



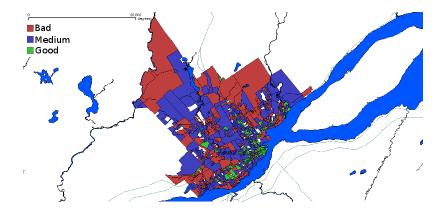
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## Actions of reference



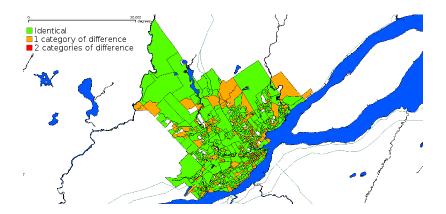
## **Global inference**



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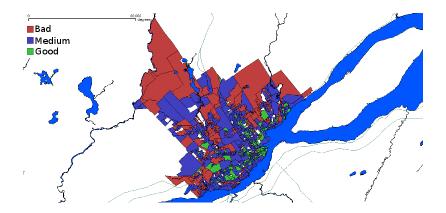
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## **Global inference (difference)**



#### $\pm$ 29% of invalid affectations

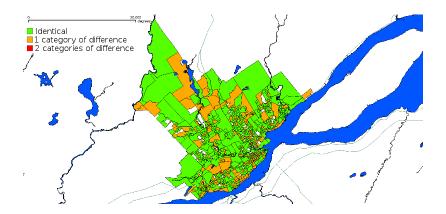
## **Profiles inference**



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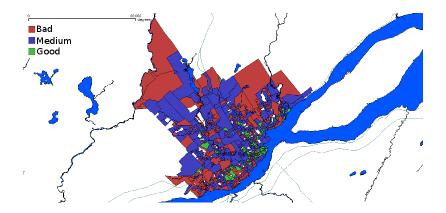
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## Profiles inference (difference)



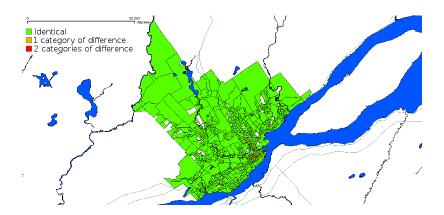
#### $\pm$ 33% of invalid affectations

## Weights and lambda inference



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## Weights and lambda inference (difference)



#### $\pm$ 6% of invalid affectations

## Conclusion

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- ► Full open source solution running on several OS
- ► Limitations of GIS-MCDA overcome by the full integration
- Several spatial decision problems treated

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#### Ideas for improvements

- Improve userfriendlyness of the plugin
- Improve the inference procedure
- Better take into account geographical aspects
- Algorithm to choose an optimal learning set

# Thank you for your attention !

## References

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