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

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1. Quick reminder
2. Objectives update
3. New developments
4. Demo
5. What’s next?
GIS and MCDA

- GIS are used in lots of applications 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.
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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- Choice of the MCDA method
- Single criterion synthesis
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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

Step 1: Construction of criterion maps
Step 2: Construction of an intermediate map
Step 3: ELECTRE TRI model
Step 4: Generation of the decision map
Status at the previous workshop
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 globally and partially
- 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**

Set of random alternatives

Random ELECTRE TRI model

Sorted alternatives

- $C_k$ to $C_{k+1}$
- $g_1$ to $g_n$
Similar methodology as the one used by Agnès Leroy in her thesis

**Step 1 : Generate random data**

- Set of random alternatives
- Random ELECTRE TRI model
- Sorted alternatives

**Step 2 : Pick learning alternatives**

- Set of random alternatives
- Learning set
ELECTRE TRI BM inference experimentations

Methodology

Step 3 : Inference of ELECTRE TRI model

Set of learning alternatives

Learned ELECTRE TRI model

Inference Program
Step 3: Inference of ELECTRE TRI model

Set of learning alternatives

\[ C_k \]

\[ C_{k+1} \]

Inference Program

Learned ELECTRE TRI model

\[ C_k \]

\[ C_{k+1} \]

\[ g_1 \]

\[ g_2 \]

\[ g_j \]

\[ g_{n-1} \]

\[ g_n \]

Step 4: Analysis of learning model

Set of random alternatives

Original ELECTRE TRI model

Alternatives sorted by the original model

\[ C_k \]

\[ C_{k+1} \]

\[ g_1 \]

\[ g_2 \]

\[ g_j \]

\[ g_{n-1} \]

\[ g_n \]

Learned ELECTRE TRI model

Alternatives sorted by the learned model

\[ C'_k \]

\[ C'_{k+1} \]
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 ↓
Quick reminder
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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
**Remarks**

- Less alternatives needed to get good results
- Less computing time needed than for global inference
- Generally 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
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

Quantum GIS

Main functionalities of the GIS

ELECTRE TRI plugin

XMCDA files

Solver

XMCDA webservice

SOAP messages
It’s time for a demo...
Original model
Actions of reference
Global inference

- Mauvaise
- Moyenne
- Bonne
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)

± 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!