Integration of ELECTRE TRI in a GIS
Methodology and Implementation

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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
ELECTRE TRI

Assignment problematic

- $p$ categories
- $n$ criteria

Major interests

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

Main goal

Implement ELECTRE TRI in an Open Source GIS to facilitate the study of multicriteria spatial problems

Requirements

- Use GIS capabilities to represent the problem and the result
- User friendly
- Support for classic and Bouyssou-Marchant ELECTRE TRI models
## Strategy of integration

### Reference

### Coupling strategy
- Malczewski (2006) reports only 10% of works using a strategy of full coupling of the MCDA method in the GIS
- Full coupling

### Actions
- Vector layer
- Represented by spatial units on the map (Points, lines, polygons)
Construction of 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
Step 1: Construction of criterion maps

Definition

A criterion map $c_j$ is a set $\{(s, g_j(s)) : s \in S_j\}$ where $S_j$ is a set of spatial units and $g_j$ a criterion function associated to $c_j$ and defined as:

$$g_j : S_j \rightarrow E$$

$$s \rightarrow g_j(s)$$

Built with the GIS map algebra
Step 2: Construction of an intermediate map

Definition

An intermediate map is a map where each spatial unit is associated to a vector of $n$ evaluations relative to the $n$ criteria of evaluation.

Built using GIS $union$ operation
Introduction Objectives Strategy of integration Implementation Next steps

Step 3: ELECTRE TRI module

Goal
Introduction of ELECTRE TRI parameters

Parameters
- Weights of criteria
- Reference profiles
- Profiles thresholds (indifference, preference, veto)
- Assignment procedure and cutting level

Inference module
From assignment of some spatial units made by the decision maker, determine the parameters of the ELECTRE TRI model
Step 4: Generation of decision map

Definition

A decision map $M$ is a set $\{(u, \Gamma_\omega(u)) : u \in U, \omega \in \Omega\}$, where $U$ is a set of homogeneous spatial unities and $\Gamma_\omega$ is a multicriteria classification model defined as:

$$\Gamma_\omega : U \rightarrow E$$
$$u \rightarrow \Gamma_\omega[g_1(u), \ldots, g_m(u)]$$

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<tr>
<th>Obj.</th>
<th>Attributes</th>
<th>A</th>
<th>B</th>
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Intermediate map

Decision map

ELECTRE TRI

<table>
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<tr>
<th>Obj.</th>
<th>Cat.</th>
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<tr>
<td>$c_8$</td>
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</tr>
</tbody>
</table>
Choice of the GIS

- Lot of Open Source GIS (Grass, PostGIS, Quantum GIS, ...)
- See http://opensourcegis.org/ for complete list
Choice of the GIS

- Lot of Open Source GIS (Grass, PostGIS, Quantum GIS, ...)
- See http://opensourcegis.org/ for complete list

And the winner is:

- Linux and Windows compatible
- Written in C++ and Python
- Plugin mechanism included
- Using QT library
- Map algebra included
Quantum GIS - User interface

QT library

- Owned by Nokia
- LGPL license
- Available on a lot of platforms (Linux, Windows, ...)
- QT bindings for a lot of language (C++, python, java, ...)
- Lot of GUI possibilities
- QT Designer for user interface design
Quantum GIS - Generation of a decision map

Step 1: Criteria map
- Quantum GIS includes lot of tools to construct different criteria map (fTools package includes map algebra)
- Vector layers only

Step 2: Intermediate map
- *Union* tool included in Quantum GIS fTools package

Step 3: ELECTRE TRI module
- Implemented as a plugin for Quantum GIS

Step 4: Decision map
- Generated by the ELECTRE TRI module
- Use of Quantum GIS rendering capabilities
Quantum GIS - ELECTRE TRI module

Main components
- ELECTRE TRI class
- User interface
- Decision map generator

Technical details
- Programming language: Python
- User interface: PyQT
- Version Control System: git
- Project hosted on: github (http://github.com/oso/qgis-etri)
Introduction

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Quantum GIS - ELECTRE TRI module

User interface conception

1

2

pyuic4 to generate python code
Quantum GIS - ELECTRE TRI module

Full coupling

![Quantum GIS interface showing the ELECTRE TRI module plugin manager and the map view. The ELECTRE TRI logo is highlighted in a circle.]
Quantum GIS - ELECTRE TRI module

Now it’s time for a demo...
Demonstration 1 - Burkina Faso

Goal
Evaluation of landscape degradation in the watershed of Loulouka (Metchebon 2010)

Actions
229 squares of 25ha

Criteria
- 11 criteria
- Ordinal scale:
  1. Inadequate
  2. Weakly adequate
  3. Adequate

Categories
1. Inadequate
2. Weakly adequate
3. Moderately adequate
4. Adequate
Goal
Choose the best location for the installation of a waste treatment plant in the valley of Ticino (Maystre and al. 1994)

Actions
7 actions (points)

Criteria
- 5 criteria
- Quantitative and qualitative scales

Categories
1. Bad
2. Good
3. Very good
Next steps

**Inference module**
- Conception of the UI for the inference module
- Integration with a solver and XMCDA web services

**Improve User Interface**
- Simplify some actions
- Better error handling

**Add features**
- Draw profiles
- ...


Thank you for your attention!