Introduction	Objectives	Strategy of integration	Implementation	Next steps

# Integration of ELECTRE TRI in a GIS Methodology and Implementation

# Olivier Sobrie

University of Mons Polytechnic Faculty

October 6, 2010



◆□▶ ◆□▶ ★□▶ ★□▶ □ のQ@

Introduction	Objectives	Strategy of integration	Implementation	Next steps



# Objectives

- Strategy of integration
- Implementation





Introduction ●○	Objectives	Strategy of integration	Implementation 000000000	Next steps
GIS and M	MCDA			



• GIS are used in lot of application from land suitability problem to geomarketing

▲□▶ ▲□▶ ▲□▶ ▲□▶ □ のQで

- Since 90's, works about GIS and MCDA
- Not a lot of work based on ELECTRE methods
- ELECTRE methods fit well for ordinal problems



#### Major interests

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

ヘロマ ヘロマ ヘロマ

2

Introduction 00	Objectives	Strategy of integration	Implementation 000000000	Next steps
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

・ロト ・ 日 ・ モート ・ 田 ・ うへで

Introduction 00	Objectives	Strategy of integration ●○○○○○	Implementation	Next steps
Strategy of	integration			

#### Reference

• Chakhar's thesis (2006)

# 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)

Introduction Objectives Strategy of integration Implementation Next steps

# Construction of the decision map



・ロト ・ 日 ・ ・ 日 ・ ・ 日 ・ ・ つ へ ()

Introduction 00	Objectives	Strategy of integration	Implementation 000000000	Next steps
Stop $1 \cdot C$	onstruction	n of critorion man	.c	

aps

・ロト ・ 理 ト ・ ヨ ト ・ ヨ ・ うへつ

# 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 :

$$egin{array}{rcl} {
m g}_j & : & S_j & 
ightarrow & E \ & s & 
ightarrow & g_j(s) \end{array}$$

Built with the GIS map algebra



 Introduction
 Objectives
 Strategy of integration
 Implementation
 Next steps

 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



54 2.6 12 2.6

 $C_{S}$ 

Introduction	Objectives	Strategy of integration ○○○○●○	Implementation 000000000	Next steps
Step 3 : E	LECTRE TI	RI 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



#### 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 :

$$\begin{aligned}
 \Gamma_{\omega} &: U \to E \\
 & u \to \Gamma_{\omega}[g_1(u), \dots, g_m(u)]
 \end{aligned}$$



(日)、(間)、(日)、(日)、(日)、

Introduction 00	Objectives	Strategy of integration	Implementation •••••••	Next steps
Choice of t	he GIS			

 $\bullet$  Lot of Open Source GIS (Grass, PostGIS, Quantum GIS, ...)

▲□▶ ▲□▶ ▲□▶ ▲□▶ ▲□ ● ● ●

• See http ://opensourcegis.org/ for complete list

Introduction 00	Objectives	Strategy of integration	Implementation ••••••	Next steps
Choice of t	the GIS			

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



Introduction Objectives Strategy of integration Implementation Next steps

# 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

Introduction	Objectives	Strategy of integration	Implementation	Next steps
Quantum	CIC Con	aration of a decis		

a uecisioi

#### Step 1 : Criteria map

 Quantum GIS includes lot of tools to construct different criteria map (fTools package includes map algebra)

alion

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

Introduction	Objectives	Strategy of integration	Implementation	Next steps
<u> </u>				

# <u>Quantum GIS - ELECTRE TRI module</u>

#### Main components

- ELECTRE TRI class
- User interface
- Decision map generator

# Technical details

• Programming language : 🛛 👌 python



- User interface : PyQT
- Version Control System : III git
- Project hosted on : github (http ://github.com/oso/qgis-etri)

Introduction Objectives Strategy of integration Implementation Next steps

# Quantum GIS - ELECTRE TRI module

## User interface conception

	Qt Designer		12 (D) 🔀
ile Edit Form Yiew Settings Window Help			
P 🖪 🕭   G 🖉 🐰 G 🏦 🖬 🖿 🖬 🖳	🔁 🔜 i III 🚍 HI 🏋 🕅 🕷 🌃 🔳		
idget Box III III III	Mainifindour - abfinainad		Object inspector 20 10
Filter> • Type Here			Object Class
Lawrots			• EtriMair/Window QMain
Vertical Lavout			🗢 🧱 centralwidget 🛛 📿 QN 👘
Horizontal Lavout	Minister		v = noht lavout = OV *
Grid Laws t	Input Layer		
Form Lavout	· · · · · · · · · · · · · · · · · · ·	Load	Property Eator Die
Spacers	1 . · · · · · · · · · · · · · · · · · ·		QMainWindow <8ker> • • •
W Horizontal Spacer	Profiles		Bronatty Value
Vertical Spacer	Add Broffle		7 00biert
Buttons	2 Had I telle		objectN EtriMainWindow
Push Button	->>> Del Profile		QWidget
Tool Button			windowM NonModal
Radio Button	Thresholds		enabled 🗹
f Check Box			geometry [(0, 0), 800 × 600]
Command Link Button	Use same for all profiles		sizePolicy (Preferred, Preferred, 0, 0)
Button Box			▶ minimu 0×0
Item Views (Model-Based)	U No veto		F maximu 16///215 x 16///215
List View	Indifference = Preference	e	b bateSize 0x0
18 Tree View	Affectation		palette Inherited
Table View	and the second s		▶ font A [DejaVu Sans, 10]
Column View	Lutting level:	0.75	cursor 🔤 Arraw
Item Widgets (Item-Based)	Procedure:	Pessimist +	mouseTr
List Widget			focusPolicy NoFocus
18 Tree Widget	-> Generate Decision Map		contextM DefaultContextMenu
Table Widget			acceptDr
Containers			> window Mainwindow
Group Box			h tealTin
Scroll Area			b statusTin
Tool Box			E whatsThis
Tab Widget			▶ accessibl
Stacked Widget			▶ accessibl
1 ×			lownethin LofthRight T

2 pyuic4 to generate python code

Introduction	Objectives	Strategy of integration	Implementation	Next steps

# Quantum GIS - ELECTRE TRI module

## Full coupling



 Introduction
 Objectives
 Strategy of integration
 Implementation
 Next steps

 00
 000000
 000000000
 000000000
 00000000000

# Quantum GIS - ELECTRE TRI module

# Now it's time for a demo...

Quantum GIS 1.5.0-Tethys					
Ele Edit View Layer Plugins Vector Cadiools Help					
] 🗃 🗄 🖬 🏹 🗄 🕷 🗞 🌾 🦧 🗞 🕼 🔣 🦉 💷 🔤 🧱 🖉 🖕 🏛 🖉 🖉 🖉 🖉 🖉 👘					
-   < 日 ◇ ボ ◎ 上 ◎ 面   ◇ ◇ ♥ 🛛 🗑 🕲 ガ 糸 〇 ♡   🦨 福 😤 石   🏠 ス					
Layers 500,000					
MainWindow	× = -				
Criterions Profies					
Criteria Weight					
	Input Layer				
	france - Load				
	Profiles				
	A std perfile				
	W Add Prolife				
	->> Del Profile				
	Thresholds				
	Use same for all profiles				
	No Veto				
	Indifference = Preference				
	Affectation				
	Cutting level: 0.75				
	Procedure: Pessimist +				
	Generate Decision Man				
	-				
S Coordnaw	-200504,0930474 Scale (1:050539086415 😡 🖉 Render 🔯				

Introduction 00	Objectives	Strategy of integration	Implementation ○○○○○○●○	Next steps
Demonstra	tion 1 - B	urkina Faso		

#### Goal

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

#### Actions

229 squares of 25ha

#### Criteria

- 11 criteria
- Ordinal scale :
  - Inadequate
  - 2 Moderately adequate
  - 3 Adequate

#### Categories

- Inadequate
- Weakly adequate
- Moderately adequate

・ロト ・ 戸 ト ・ ヨ ト ・ ヨ ト

э

4 Adequate

Introduction	Objectives	Strategy of integration	Implementation	Next steps
Demonst	ration 2 - V	alley of Ticino		

#### 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
- Quantatitave and qualitative scales

Categories	
Bad	1
Oood	
Very good	

Introduction 00	Objectives	Strategy of integration	Implementation 000000000	Next steps
Next stens				

▲□▶ ▲□▶ ▲□▶ ▲□▶ ▲□ ● ● ●

#### 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

• ...

 Introduction
 Objectives
 Strategy of integration
 Implementation
 Next steps

 00
 000000
 000000000
 000000000
 0000000000
 Next steps

# Thank you for your attention !

◆□▶ ◆□▶ ★□▶ ★□▶ □ のQ@