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Decider -- A Fuzzy Multi-Criteria Group Decision Support System

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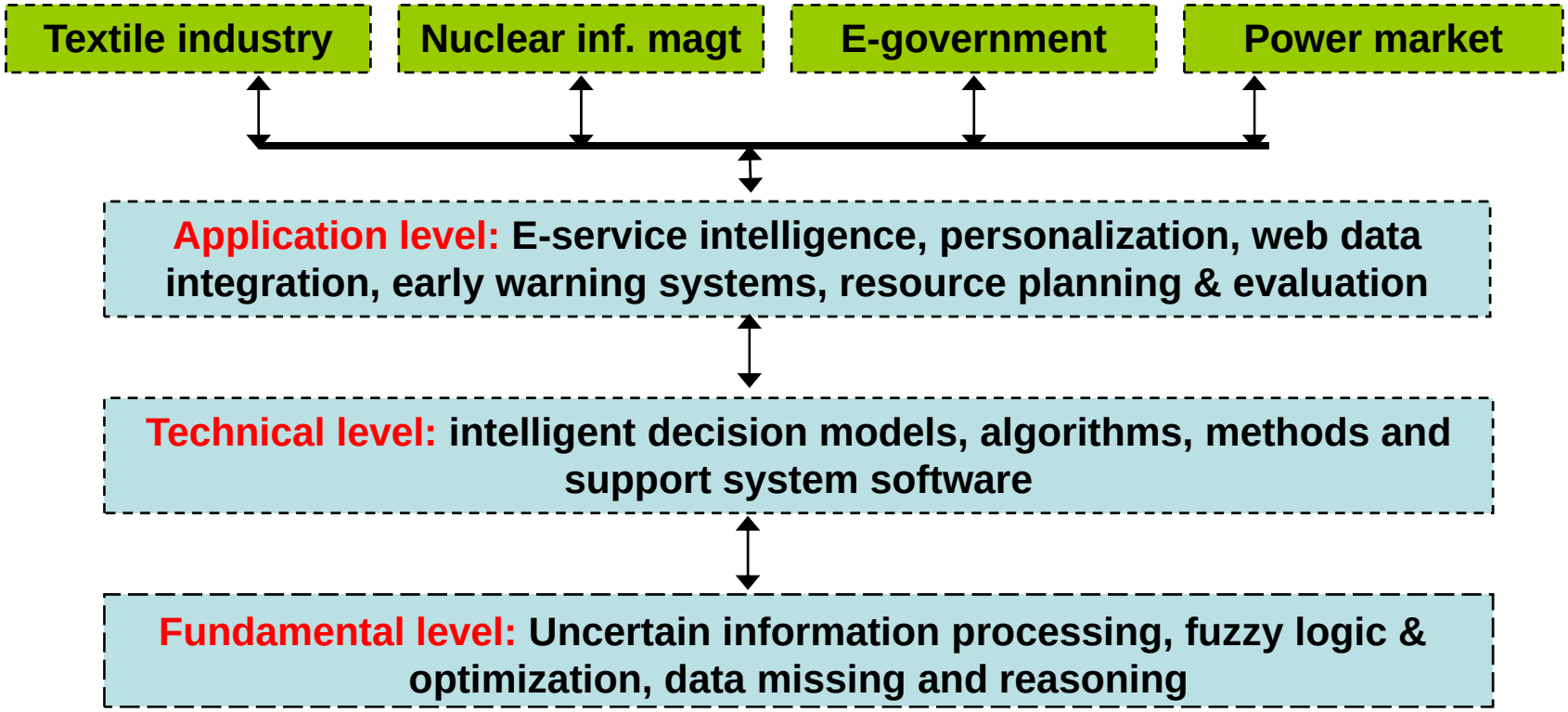
Research Interests of DeSI Lab



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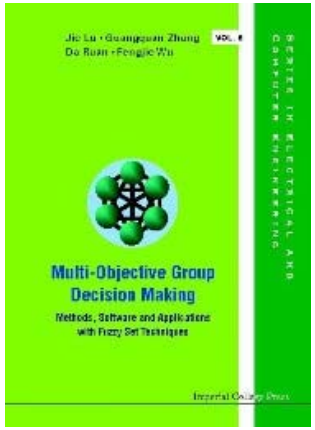
Decision models, algorithms & systems

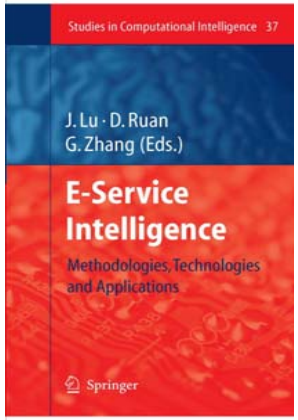
- Fuzzy multi-objective decision approaches
- Group decision methods in an uncertain environment
- Bi-level/Tri-level multi-followers decision making methods
- Rule-sets based bilevel models and algorithms
- Case-based reasoning prediction approaches
- Situation awareness and cognitive decision support models
- Web data integration and matching approaches
- Personalized recommendation methods
- Hybrid genetic & particle swarm optimization algorithms

(ARC 2002-2004) 'Group decision support systems for fuzzy multi-objective decision problem'
(ARC 2005-2007) 'Uncertain information processing for situation awareness and dynamic decision-making in emergency management'
(ARC 2005-2009) 'Generalizing multi-level decision support handling multi-objective, multi-follower and uncertainty for critical resource planning'
(ARC 1/2008-12/2010) 'A comprehensive platform for dynamic decision support in warning systems through better uncertain information management'

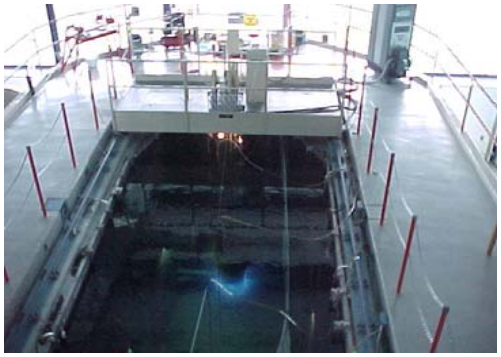
Decision support systems (DSS) developed

- Fuzzy multi-objective decision support system (FMOGDSS)
- Web-based fuzzy group decision support system (WFGDSS)
- Fuzzy multi-criteria (group) decision support system (**Decider**)
- Bi-level decision support system (FBLDSS)
- Personalised recommender system for E-government (G2B) services
- Cognition oriented decision support system (FACETS)





Application developments



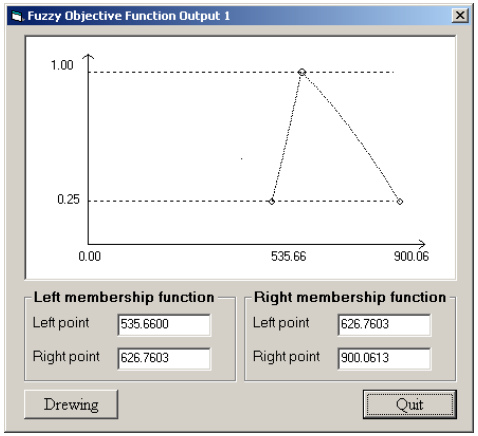
Belgian long-term sustainable energy (nuclear) strategy and safeguards

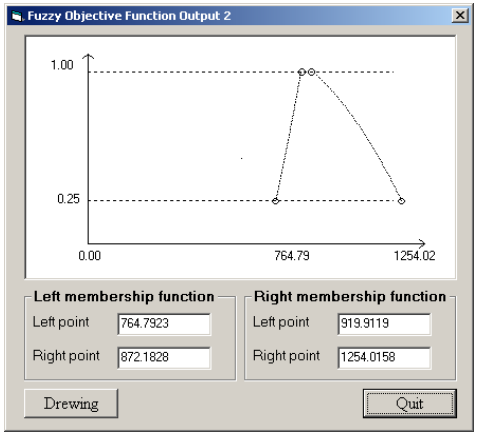
Nonwoven materials design and development

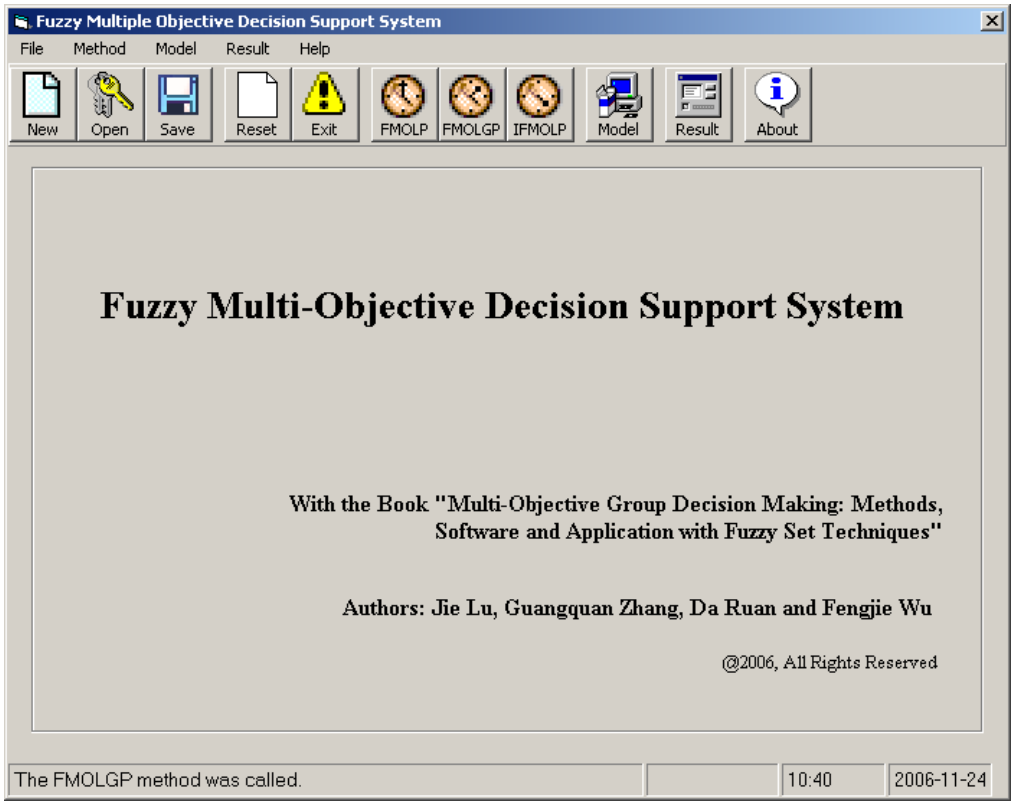
Well-being garment new product development evaluation (france)

Bilevel optimization in power market (electricity price/demand), transportation & logistics

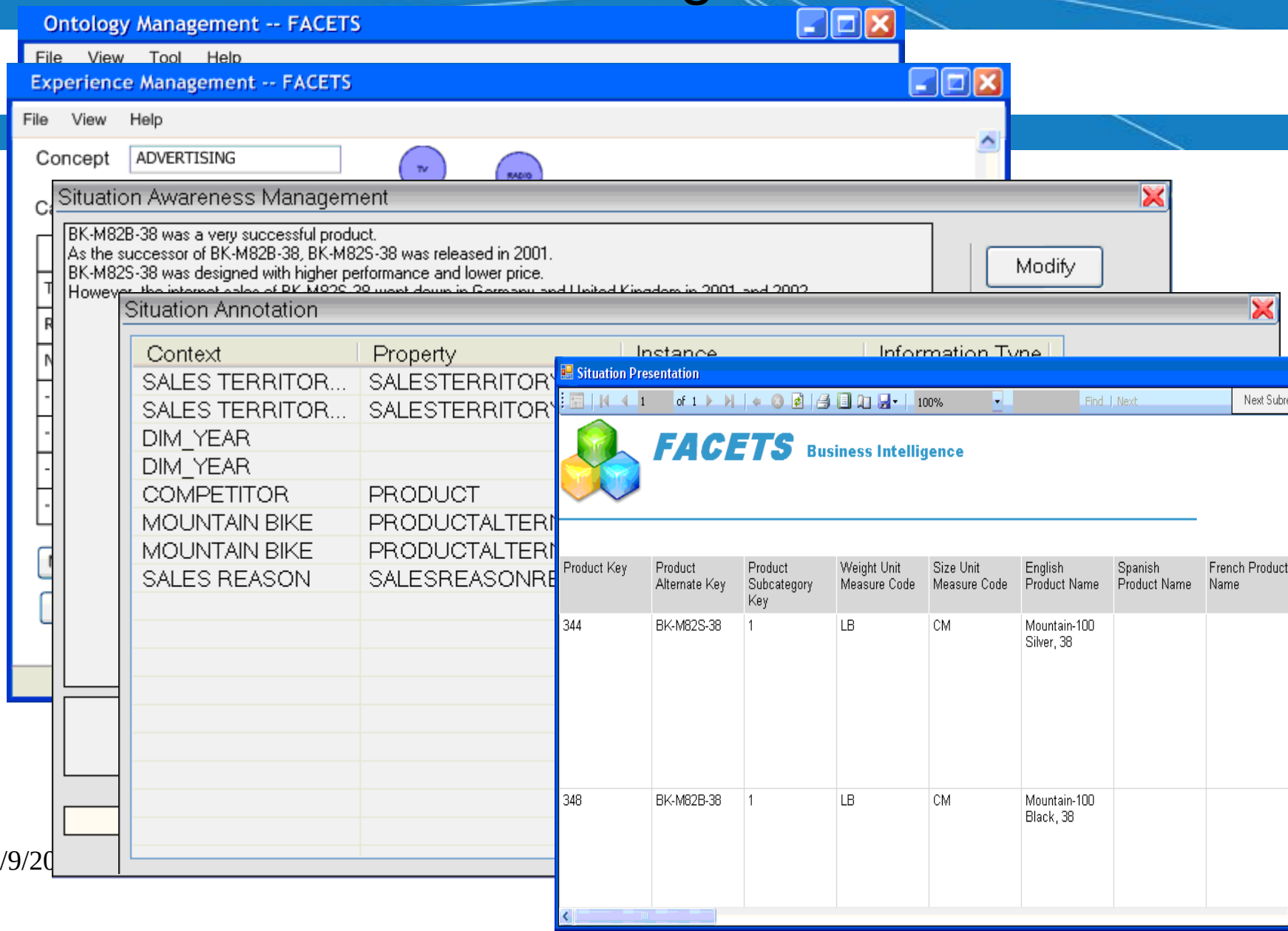
FMODSS: Nonwoven materials design



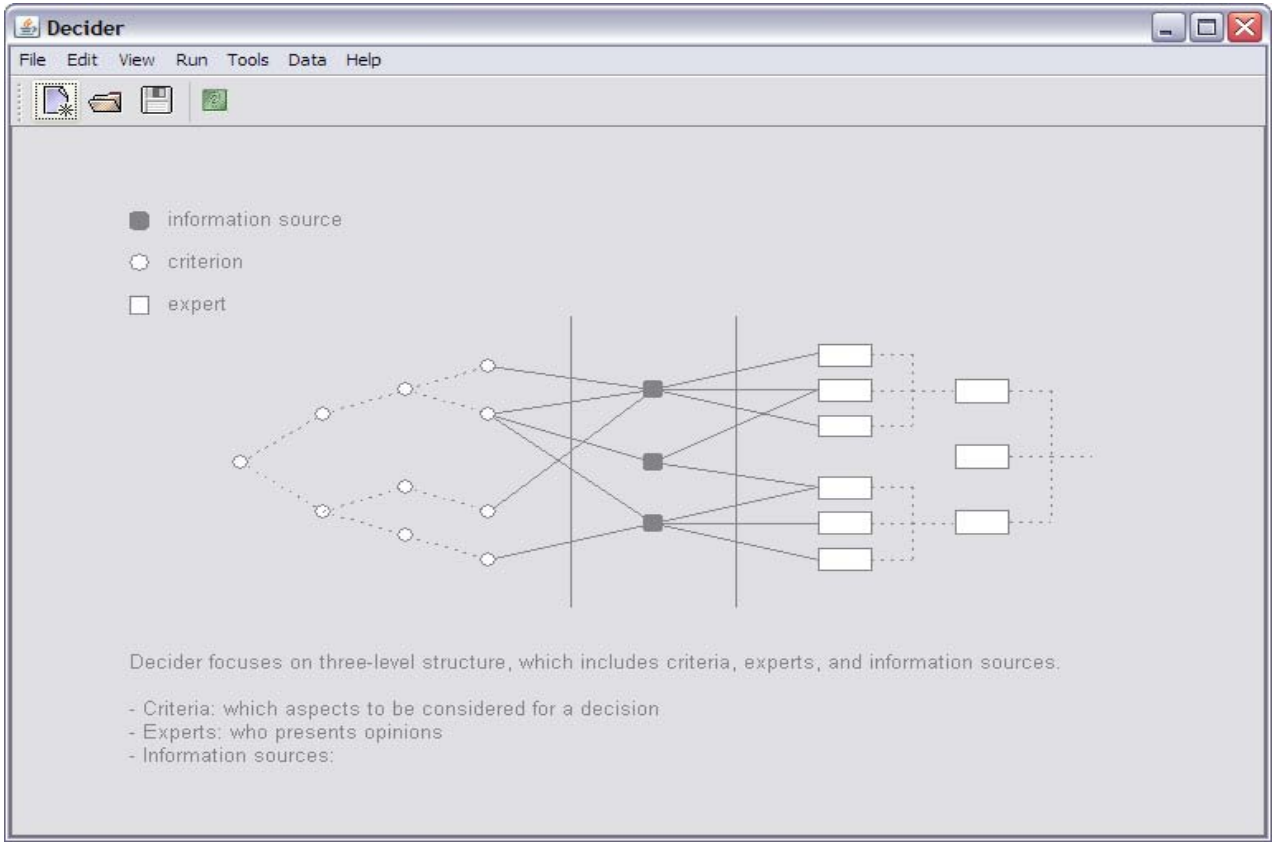




FACETS: business intelligence



Decider


Decider
File Edit View Run Tools Data Help
information source
criterion
expert
Decider focuses on three-level structure, which includes criteria, experts, and information sources.
- Criteria: which aspects to be considered for a decision
- Experts: who presents opinions
- Information sources:

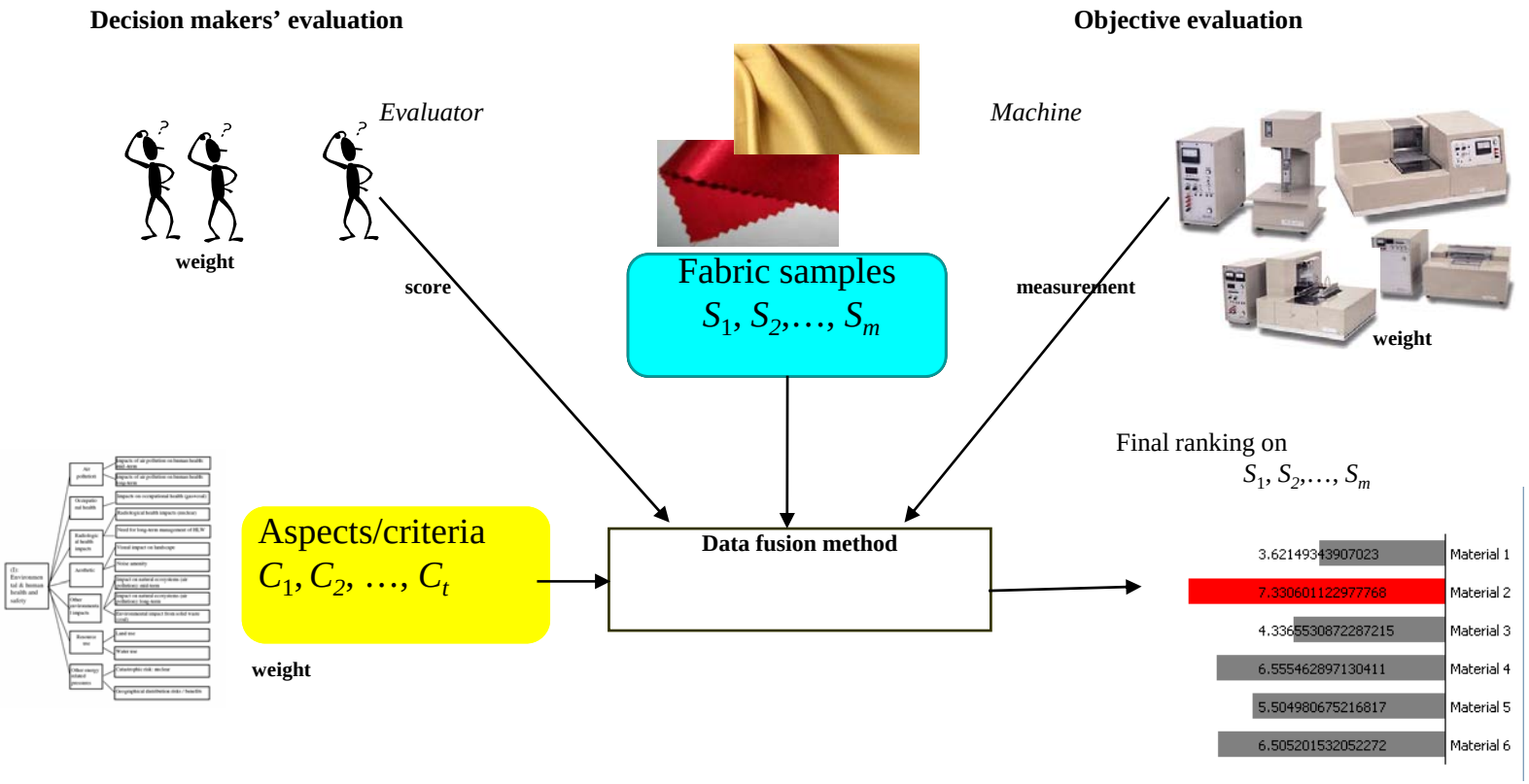
Background

- Main features in complex and dynamic decision-making situations
  - **Group decision making**
    - Hierarchy of decision makers
  - **Multiple criteria**
    - Hierarchy of criteria
  - **Difference data sources**
    - Subjective & objective data
  - **Uncertain and linguistic information processing**
    - Information sources with different believe degrees
    - Decision makers have different weights using linguistic terms
    - Assessment scores using linguistic terms

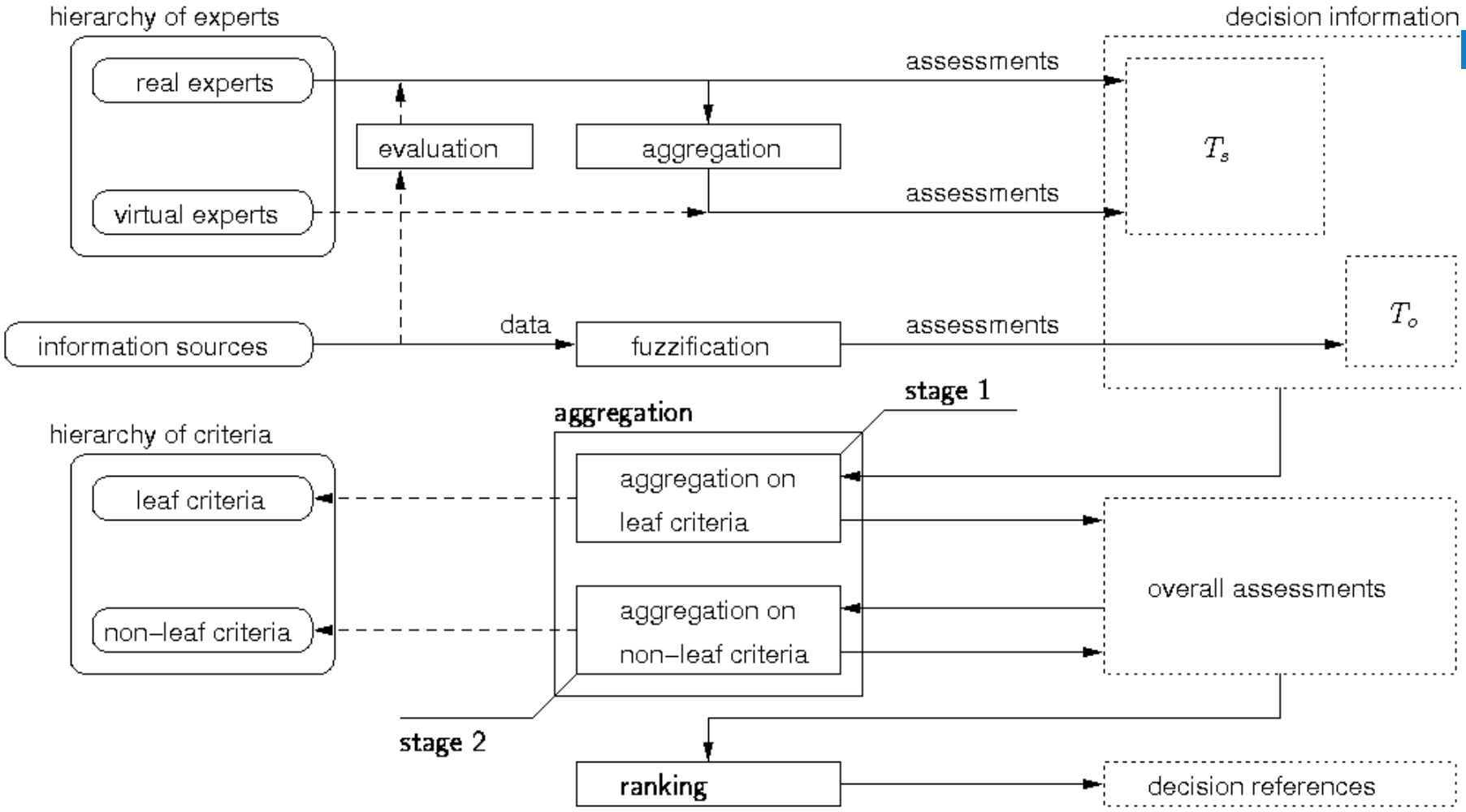
Features

- **Uncertainty and linguistic information processing**
  - Decider can partially handle uncertainty and linguistic information by using the fuzzy set techniques.
- **Methods integration**
  - Decider integrates a set of group decision-making methods.
  - Decider provides an operator-base and a method-base.
- **Flexible structure**
  - Decider uses trees to describe criteria hierarchy and evaluator hierarchy.
  - Decider can handle linguistic terms, boolean values, and numeric values
  - Decider implicitly/explicitly considers information sources.

Input (subjective & objective) and output



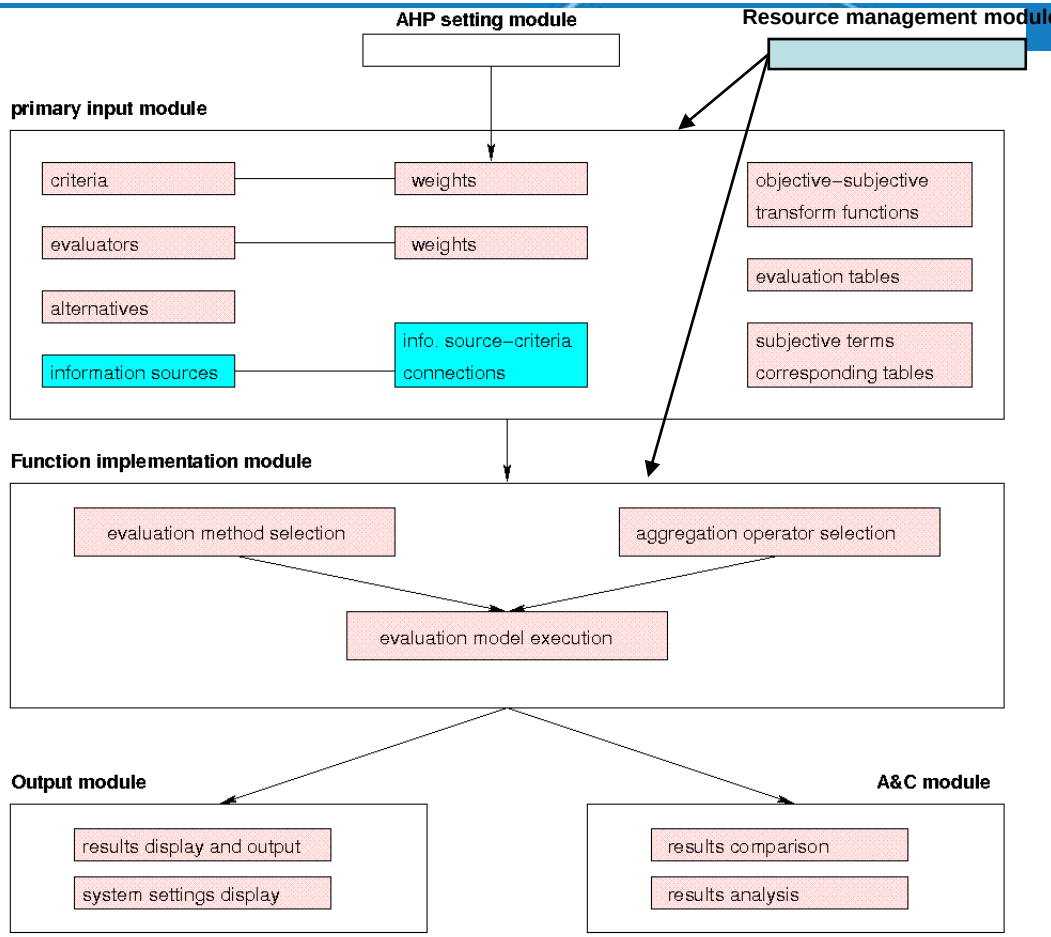
Structures (information flow)



Structures (processing modules)

The main modules:

- Input/Output module
- Function implementation module
- Resources management module
- Analysis & Comparison module



Algorithm specifications

Step 1: identify alternatives.

Step 2: identify hierarchy of criteria and their weights.

Step 3: identify evaluators and their weights.

Step 4: identify information sources and its connection with criteria.

Step 5: collect information from information sources.

Step 6: evaluators give options to generate initial decision matrix for each alternative.

Step 7: apply fuzzification method to the assessments in an initial decision matrix.

Step 8: apply a fuzzy aggregation method to obtain overall assessment on each alternative.

Step 9: generate ranking for alternatives by the fuzzy aggregation method and related ranking strategy.

Linguistic terms

Decision makers' wrights
Normal
Important
More important
Most important

Evaluation values from evaluators
Lowest
Very Low
Low
Medium
High
Very High
Highest

The importance degrees of criteria
Absolutely unimportant
Unimportant
Less important
Important
More important
Strongly important
Absolutely important

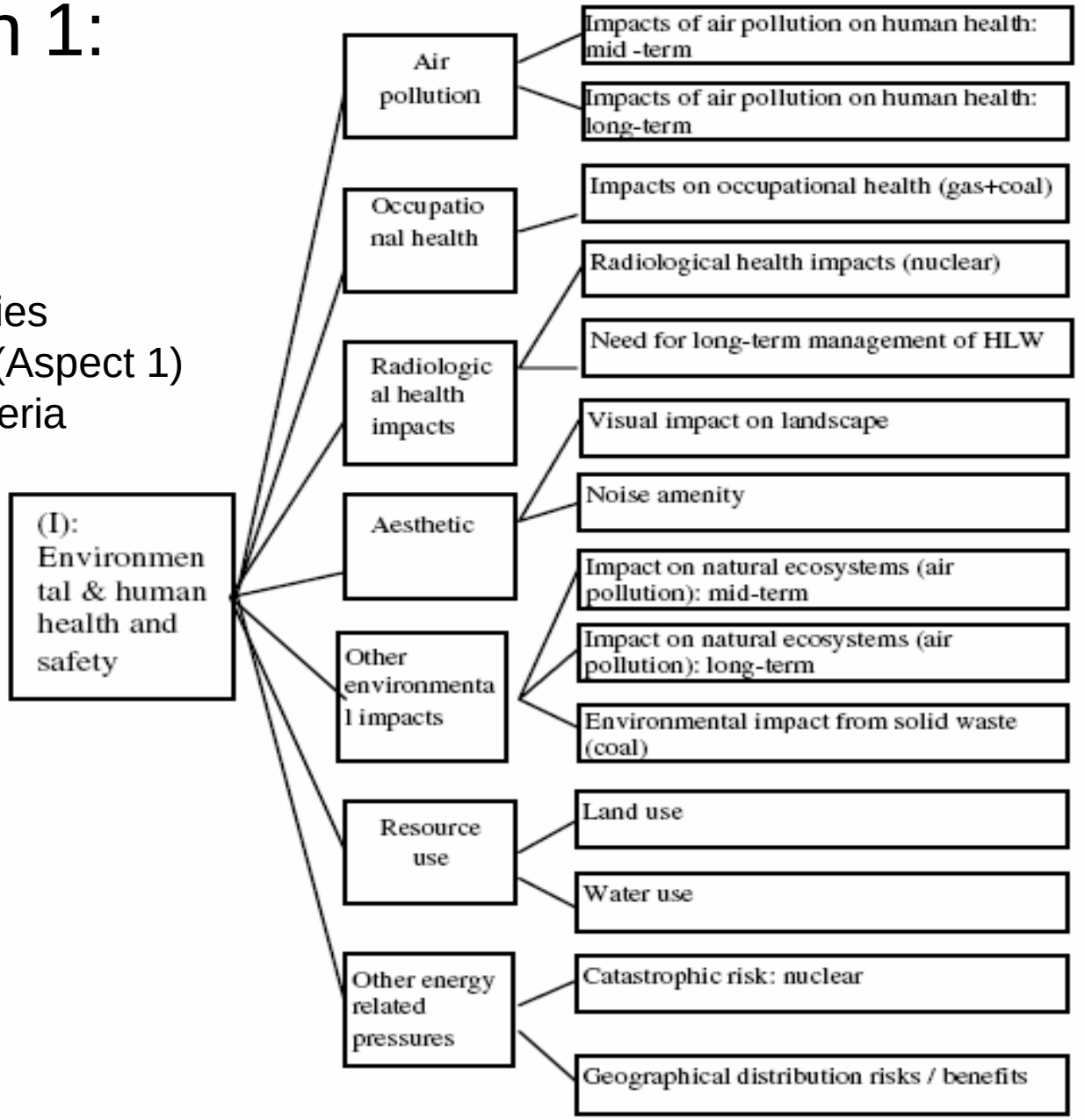
Criteria	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5
Product 1					
Thickness	very high	high	high	very low	low
Density	low	lowest	medium	lowest	lowest
Extensibility	very low	lowest	medium	low	high
Compressibility	low	lowest	highest	highest	lowest
Flexibility	very low	very high	very low	very high	low
Resilience	low	low	medium	high	very high
Surface friction	very low	very low	very low	very high	very low
Surface contour	very high	medium	medium	medium	very high
Thermal-wet sensation	low	high	low	low	low
Product 2					
Thickness	lowest	low	very low	very low	very low
Density	high	very low	highest	medium	medium
Extensibility	lowest	very high	low	lowest	high
Compressibility	medium	high	very high	high	very high
Flexibility	high	highest	medium	low	highest
Resilience	very high	very high	high	low	lowest
Surface friction	low	lowest	low	high	very high
Surface contour	very high	low	lowest	highest	high
Thermal-wet sensation	very high	very high	very low	low	medium

Application 1:
Belgian energy policy assessment

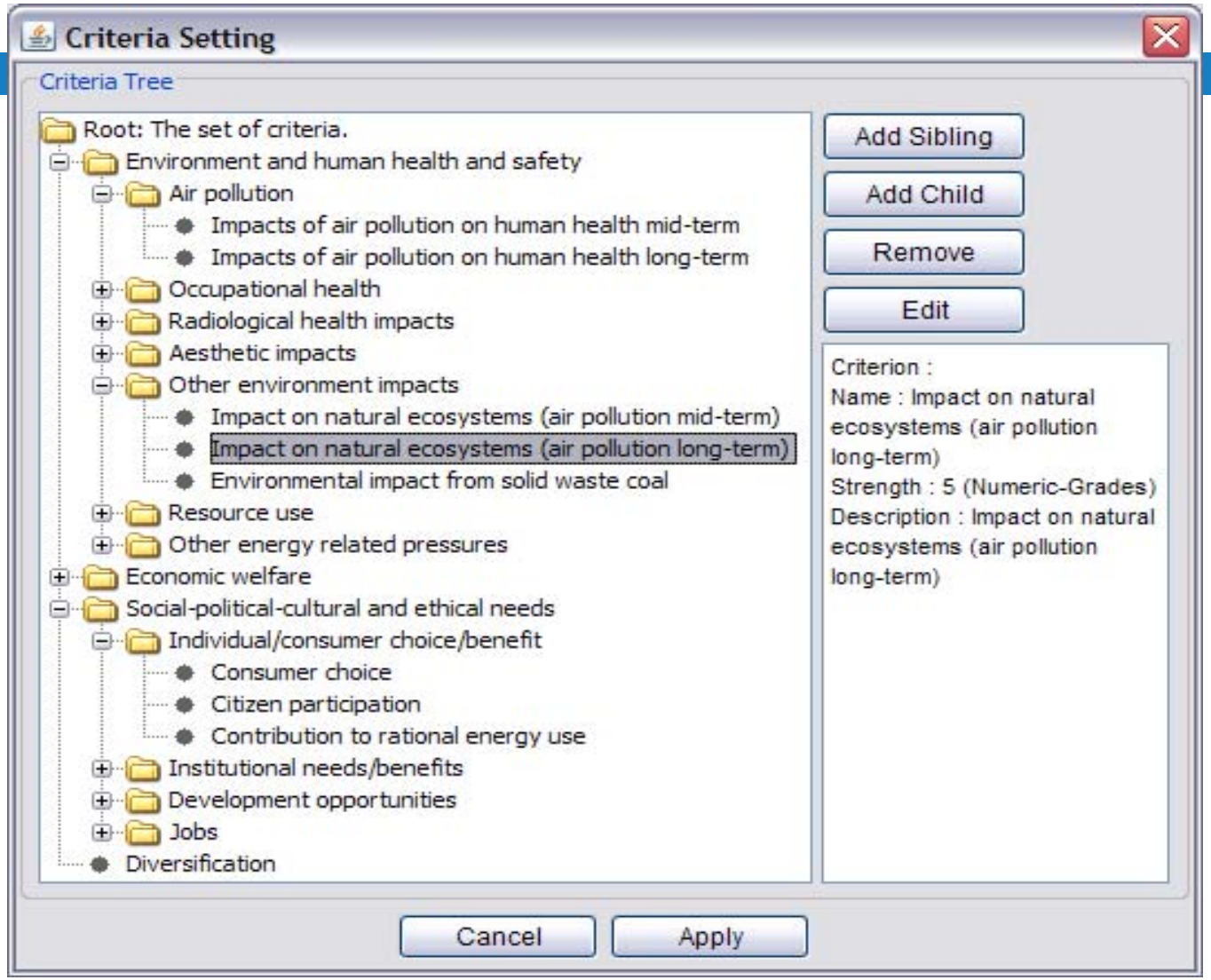
- It is an application in the cooperation with Belgian Nuclear Research Center (SCK-CEN).
- This application
  - Aims to rank 8 policies/scenarios
  - Has 10 experts/evaluators
  - Establishes three level of criteria
  - Has data with different ranges
  - Contains lots of missing data (N/A, I don’t know, not sure..)

Application 1:

Belgian Energy Policies
There are 4 aspects (Aspect 1)
Each has several criteria



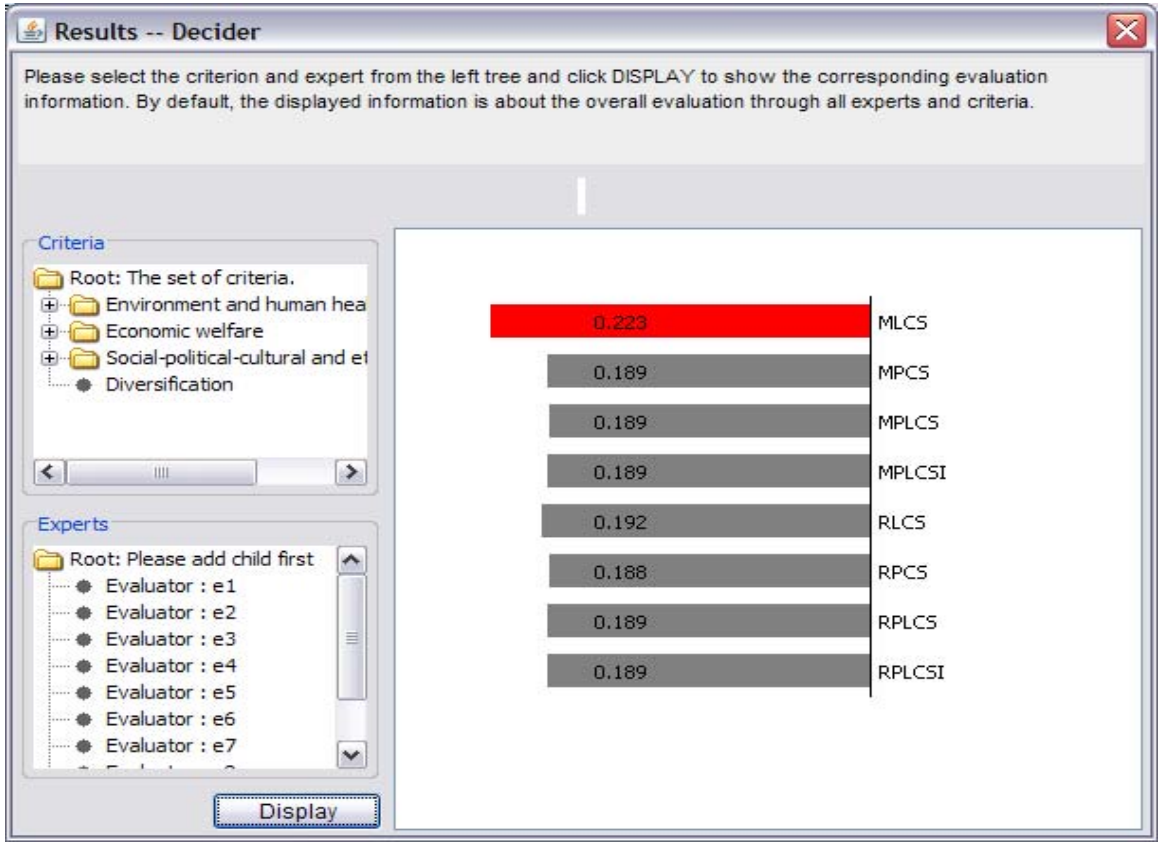
Application 1:



The tree-like multiple-level Hierarchy of criteria.

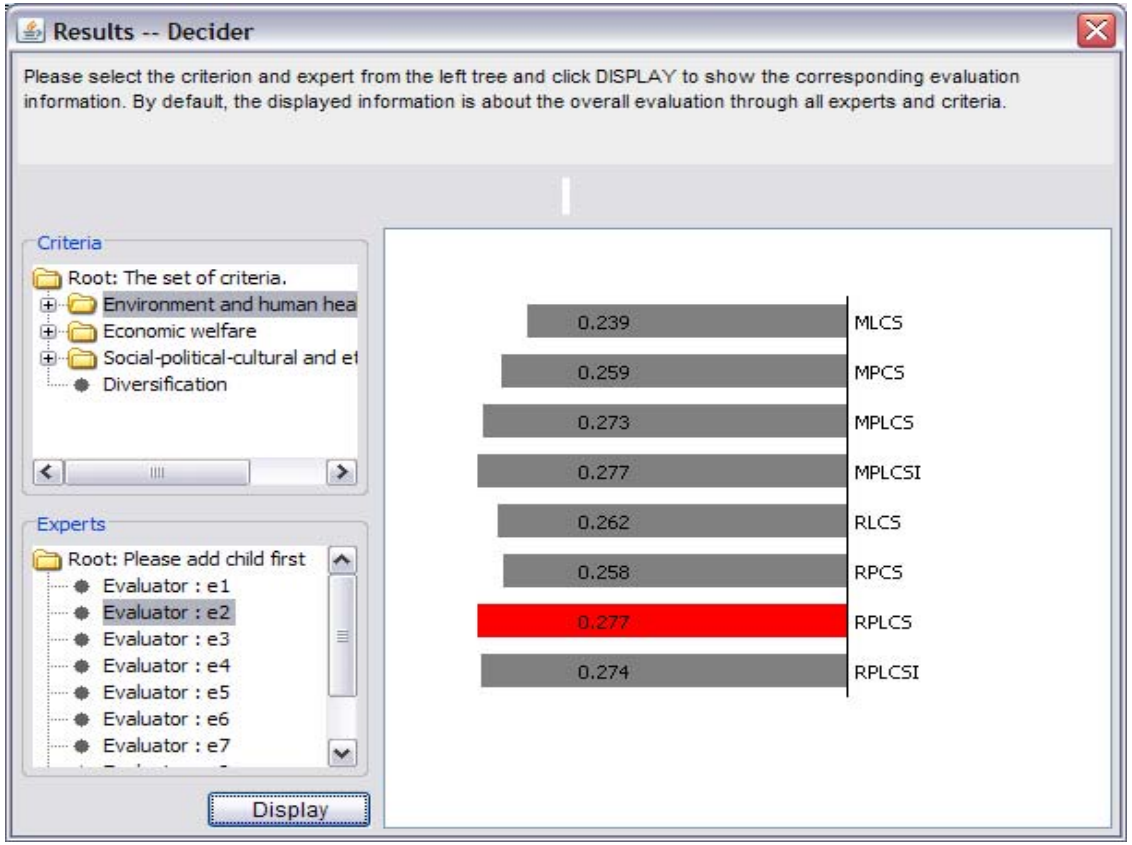
Application 1:

The overall assessments of ten experts.



Application 1:

The assessment of the second evaluator on criteria “Environment and human Health”



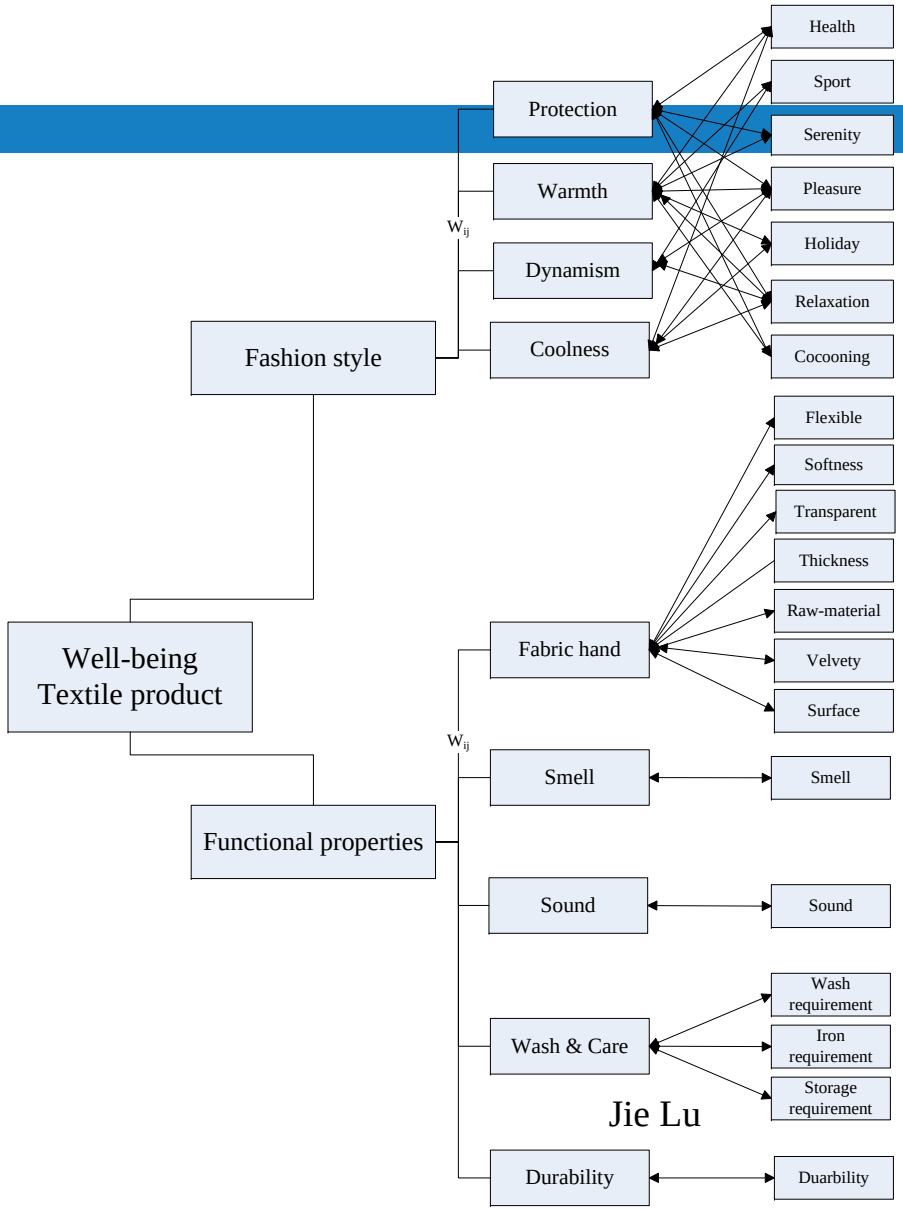
Application 2:
new fashion product development

This application is in the cooperation with Ecole Nationale Supérieure des Arts et Industries Textiles (ENSAIT), Roubaix, France

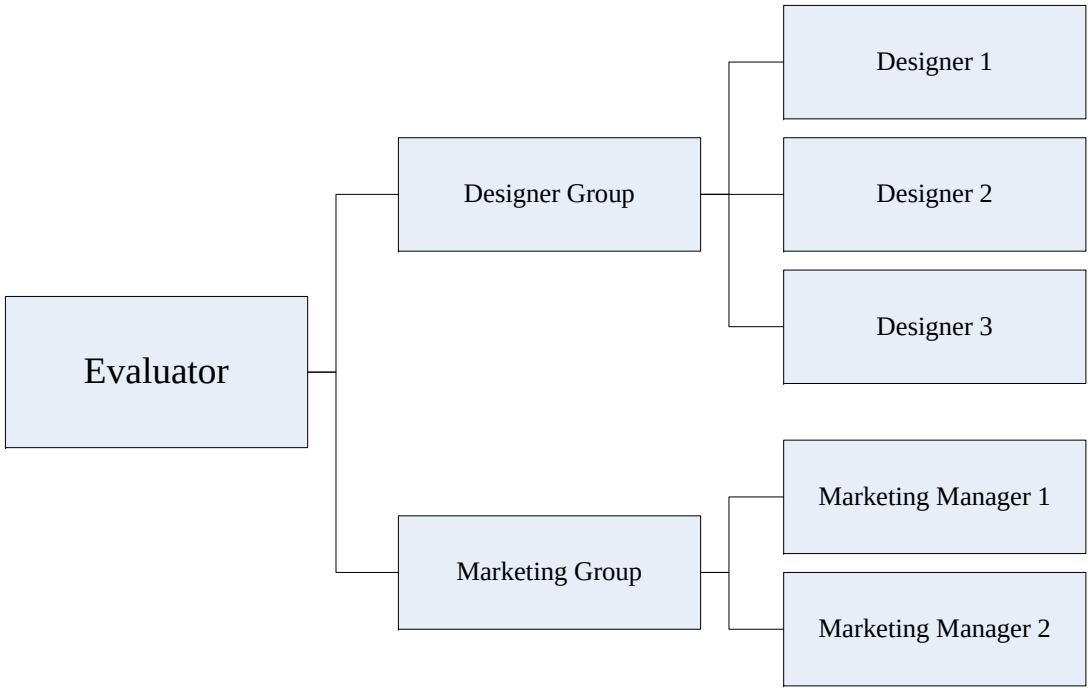
It

- deals with new fashion product development under the concept of well-being
- deals with both machine measurements data and evaluators' values
- has s set of product prototypes to be evaluated
- has multi-level multi-criteria for the evaluation
- has s group of evaluators with individual weights
- evaluators give their assessment by linguistic terms
- aims to rank these product prototypes

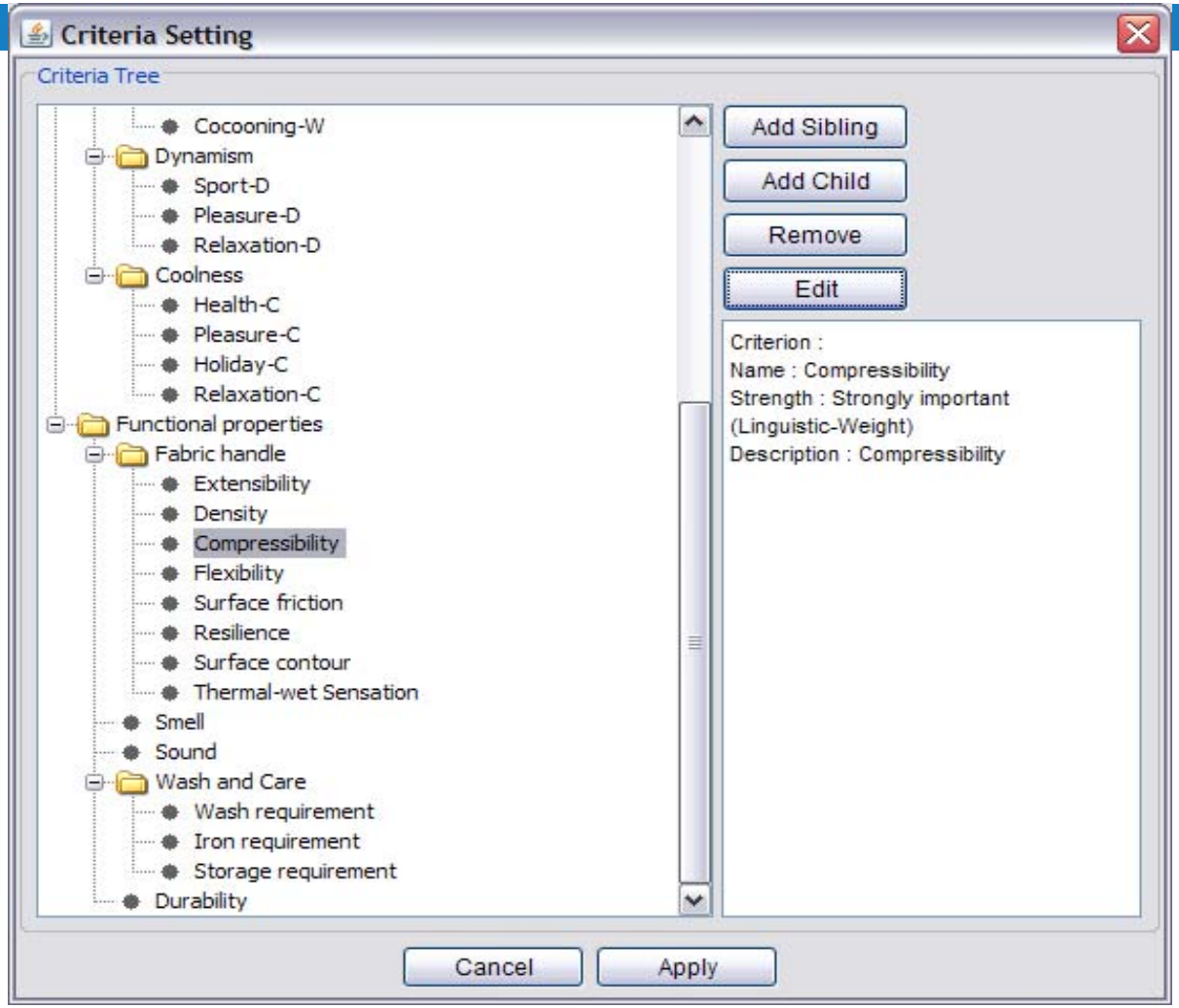
Application 2: criteria



Application 2: evaluators

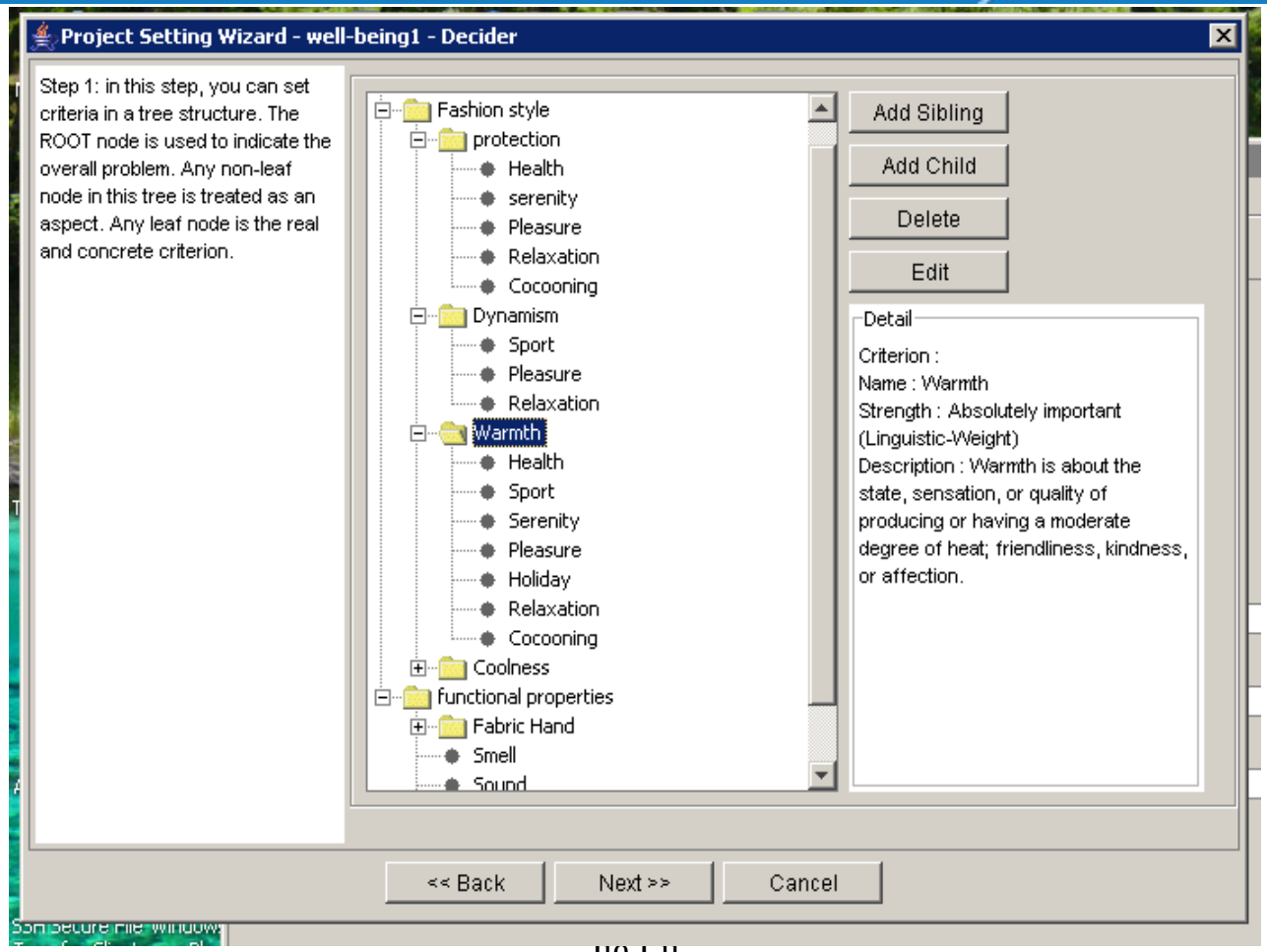


Application 2: criteria input



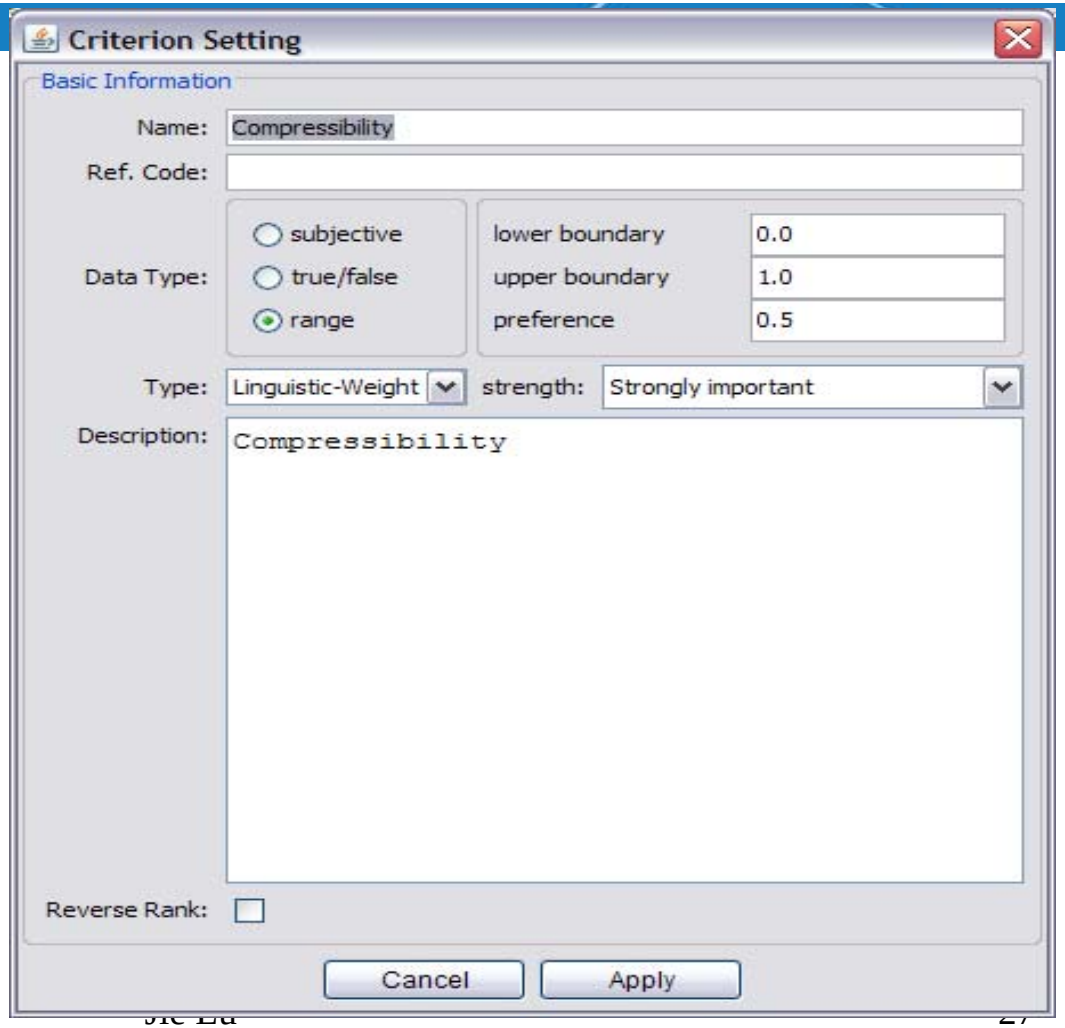
- Three-level multi-criteria
- Having different weights
- Using different range

Application 2

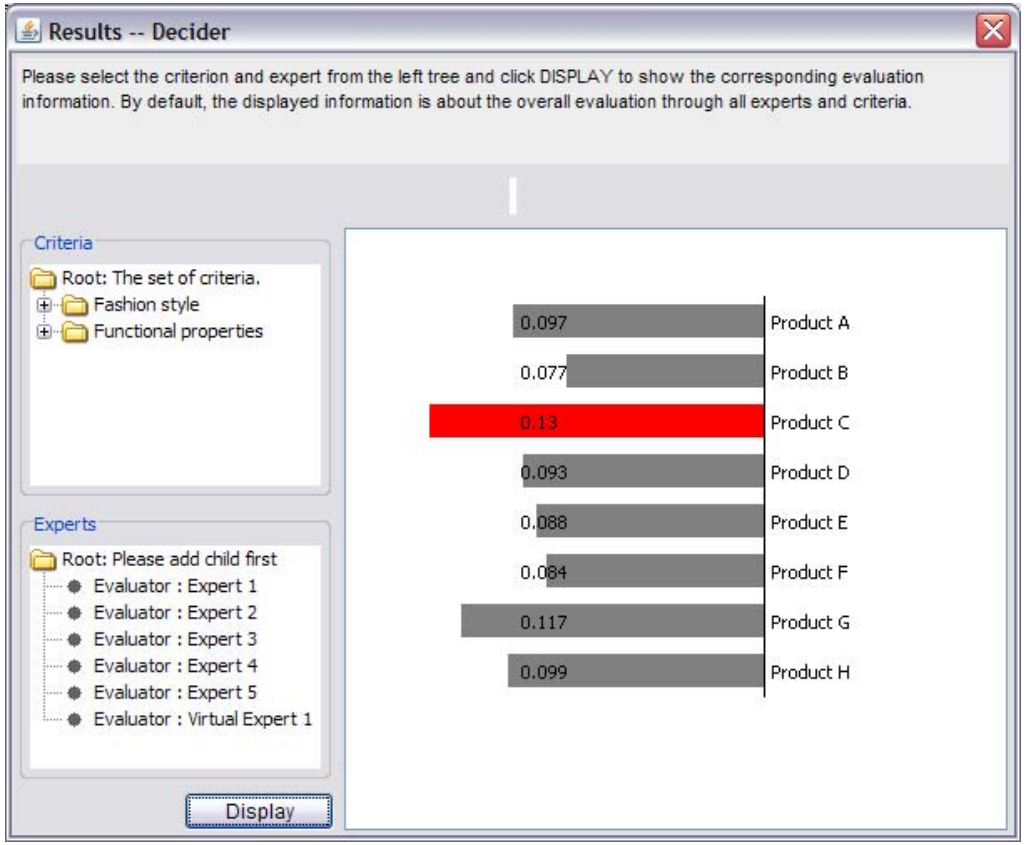


Application 2

Objective criteria settings.



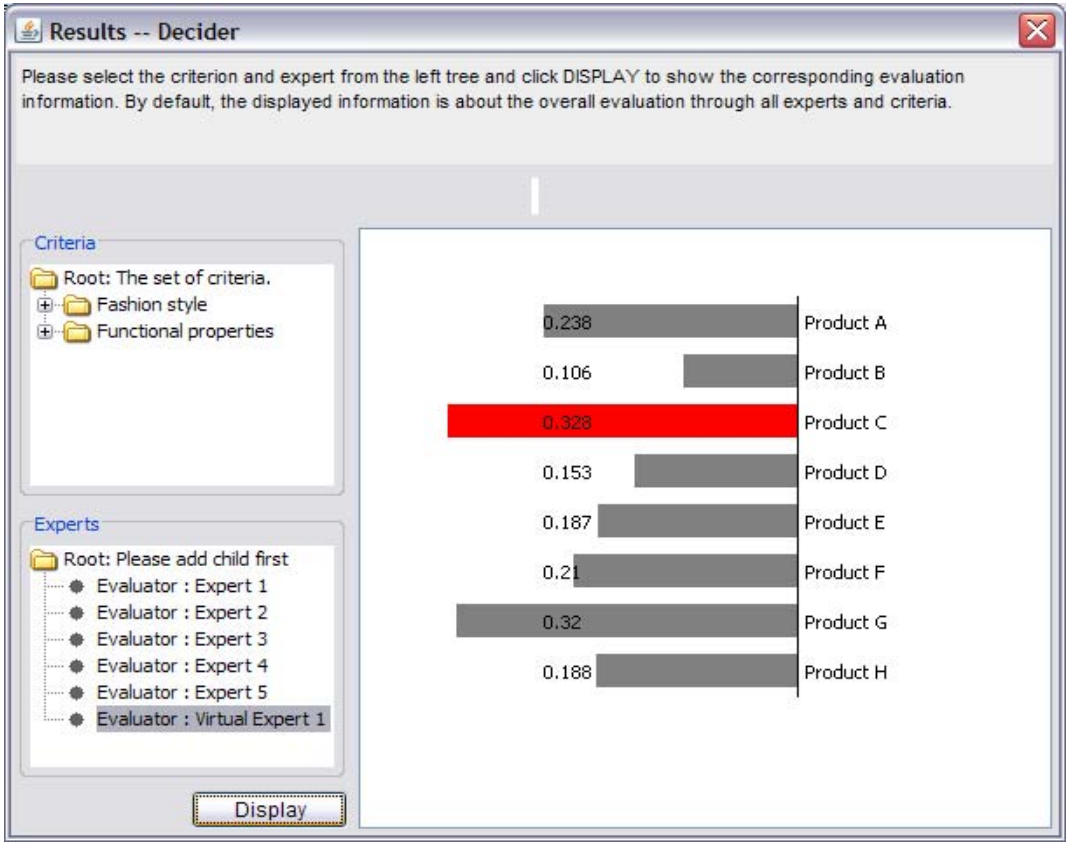
Application 2



Overall assessment result
Product C is the best one

Application 2

Overall assessment based on Virtual Expert which Representatives objective values.



Summary

- **Decider** is a powerful decision-making and evaluation software tool
- **Decider** can deal with
  - Subjective and objective data
  - Linguistic data and numerical data
  - Data with different ranges
  - A set of decision makers (decision group) with different weights
  - A set of alternatives
  - Multi-level criteria with different weights
  - Aggregate all evaluation data and find the “Best” option.
- **Decider** can be used in different domains
  - emergency management evaluation
  - risk level evaluation
  - strategy evaluation
  - performance evaluation and any other alternatives-based decision

  It can combine with other decision support system tools for more complex situations

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