How to support Cooperative Decision Making ?

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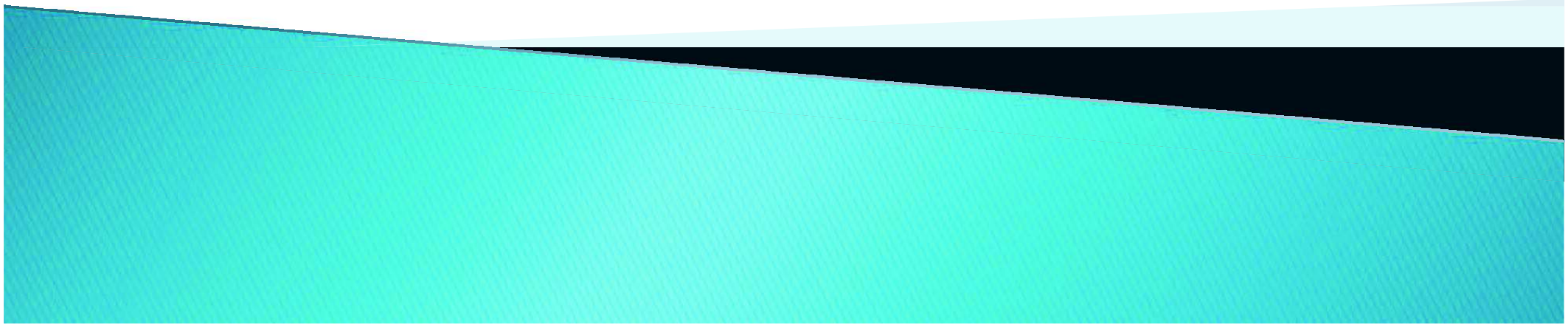


Decision Support

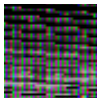
- Decision Making Rational Methodologies
  - Alternatives perfect evaluation, criteria
  - Limited Rationality Principle

➢ Decision Making Non Rational Methodologies

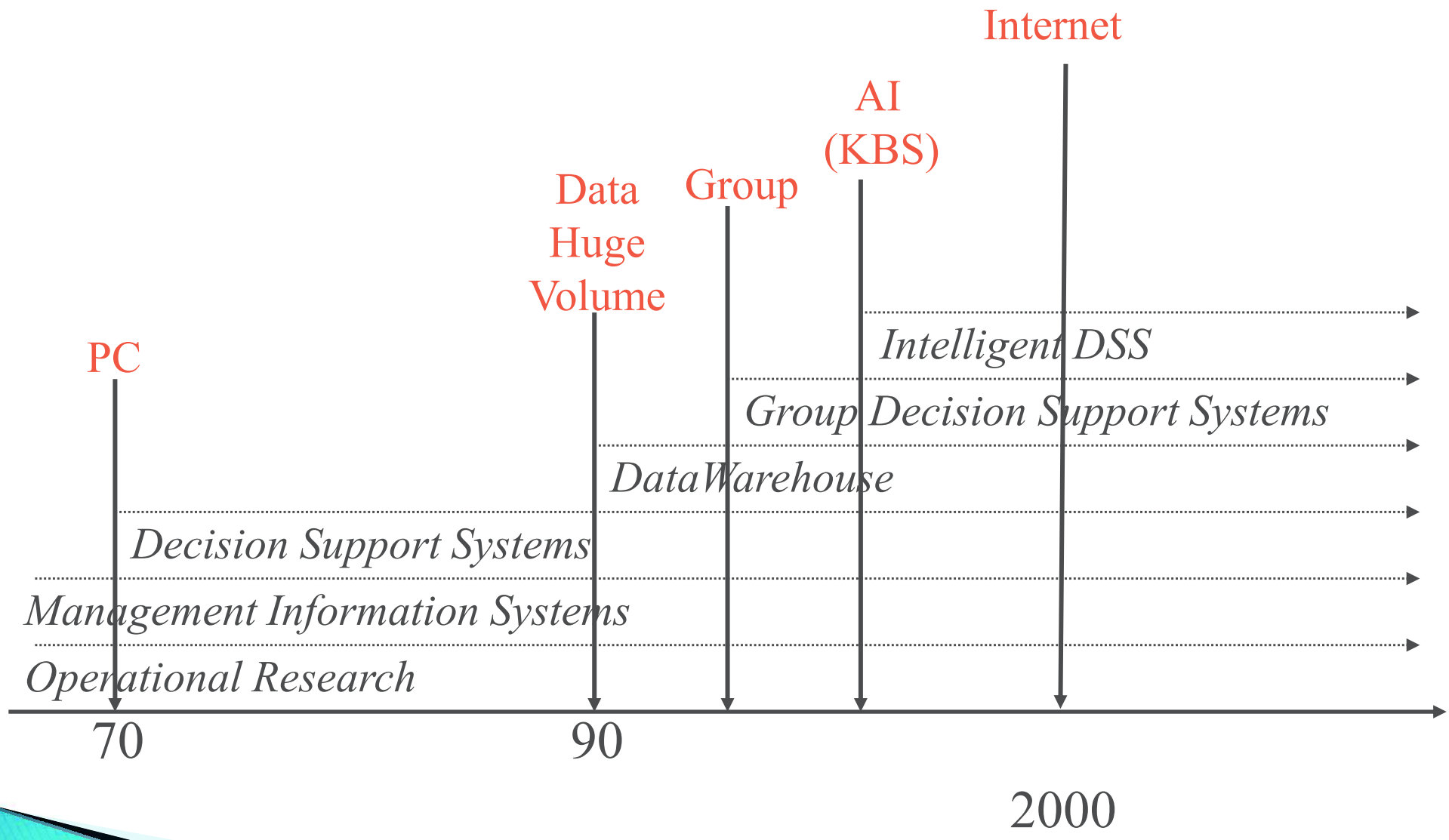
- Implicit Favorite Model
- Organizational Anarchy

➢ *Roy and Bouyssou (1993)* :

- First Order Reality Postulate
- Decision Maker Postulate
- Optimum Postulate



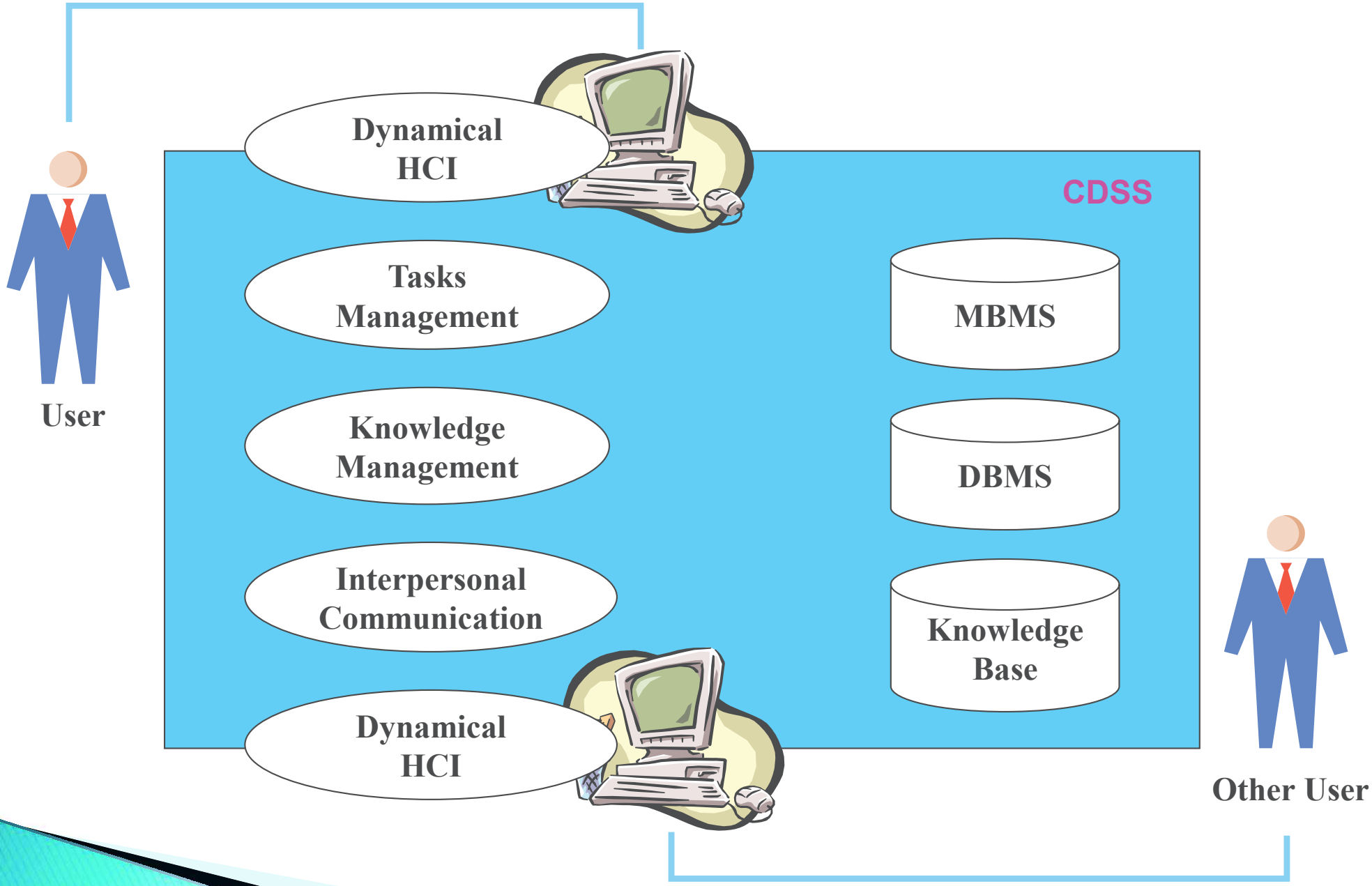
Decision Support Systems (DSS)



ICT Introduction

- ICT : Decision Making processes modification
  - Organizational : Multi-actors
  - Cognitive : Sorting Step reinforcement
- Cooperative Decision

Cooperative DSS



Two Approches

- A Group Perspective
- A recommendation perspective

One paradigm

- A Multi-Criteria Approach
  - MCDM
  - MCDA

Group Decision Support Systems

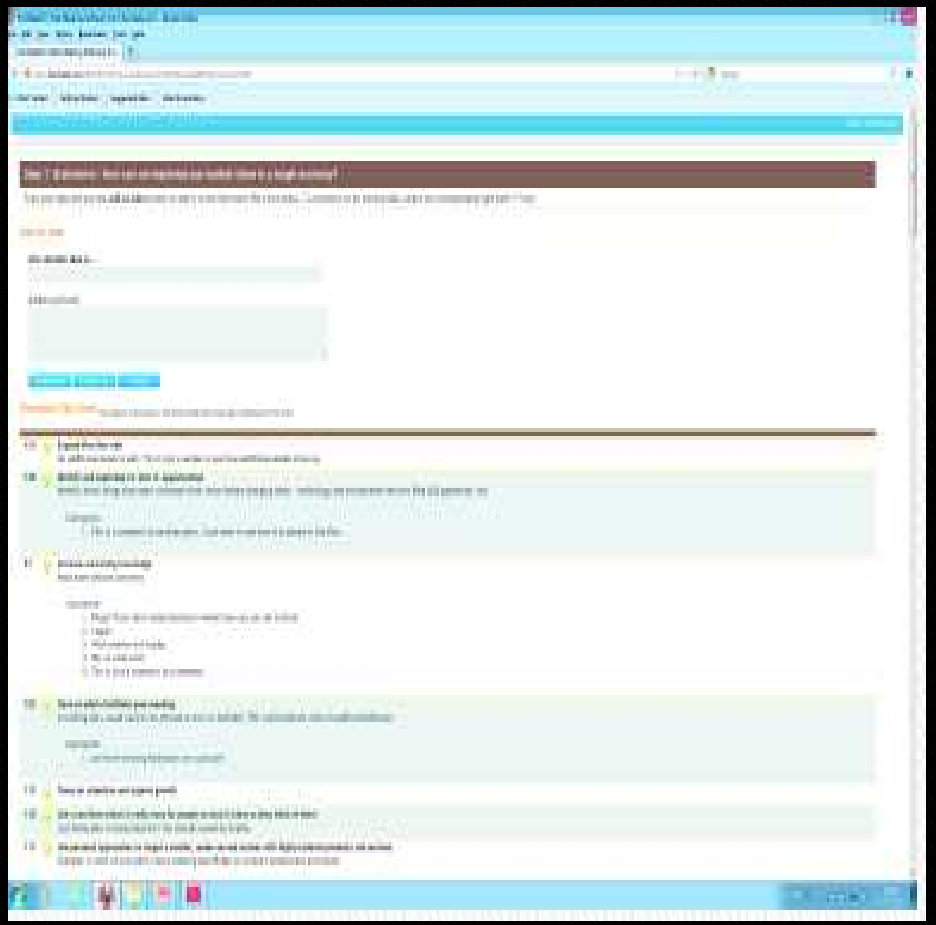
- "… mix of devices, software, persons, processes, allowing collaboration among group of persons." *(Sprague and Carlson, 1982)*
- …mix of computers, communications, technologies of decision working together to support problems identification, formulating and generating solutions during work meetings." *(DeSanctis and Gallupe, 1987)*

GDSS Advantages

- Improve groups efficiency
- Tangible
  - Time reduction
  - Increasing the number of good ideas
- Intangible (difficult to quantify)
  - Improve group cohesion
  - Improve problem definition
  - Good group commitment

Kinds of DSS

Decision Rooms



Web Systems

Facilitation – Definitions

- Important impact on the group outputs and productivity
- "…activities done, before, during and after a collective decision meeting to support the group to reach their objectives defined during the decision process." *(Bostrom, Anson and Clawson, 1993)*
- "… defined as a process through which an external person of the group, non concerned by the decision, officially recognized and accepted by the group, is employed to support a group engaged in a decision making process." *(Adla, 2010)*

Kinds of Facilitation

- Technical
  - Assist stakeholders with the technology use
- Process
  - Moderate the stakeholders and their interactions in the tasks achievement in order to make arising the meeting objectives, and to guide the participants
- Content
  - Imply to directly deal with the problem to solve

Tools for Facilitation

- Content oriented
  - Dynamical Text Guide in a Multi-Criteria GDSS *(Limayen, De Sanctis, 2000)*
  - Cooperative Knowledge Based System *(Adla, 2011)*
  - Automatic ideas clustering *(Yuan, 2008)*
- Process oriented
  - Agent Based System *(Nunamaker at al., 2002)*
  - Group activity analysis (indicators analysis) *(Nunamaker et al., 2002; Vivacqua et al., 2011)*
  - Facilitation Process *(Adla, 2010)*
- Difficulties to agree on common criteria used for Decision Making

Facilitation Process

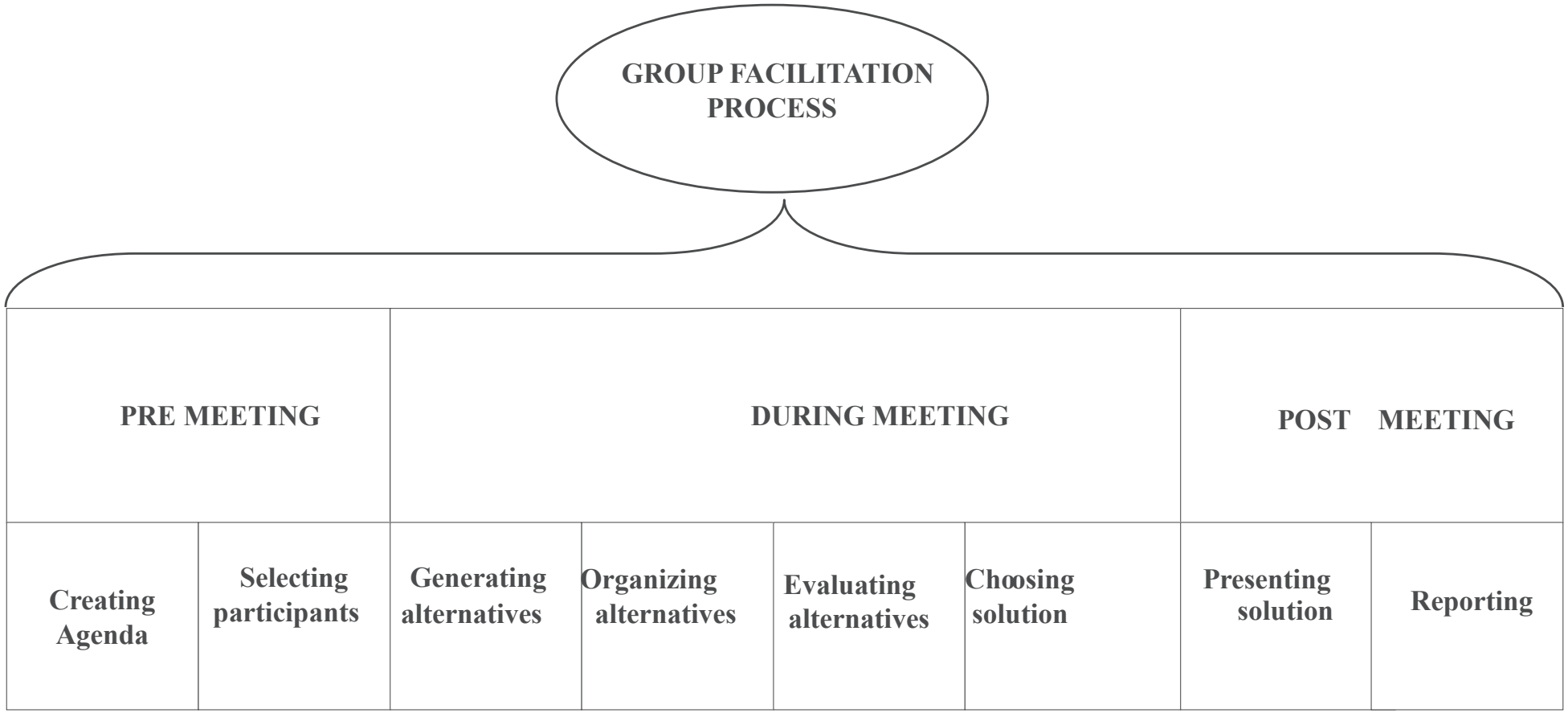


Fig. 1: Group facilitation process

(Adla, 2010)

MCDM Group Decision Making

- Macharis et al. (2018)
  - GDSS: Promethee
  - Decision Makers
    - Individual Preferences
      - Private Criteria
      - One performance matrix by Decision Maker
  - Global aggregation for the group ➔ Weighted Sum
- MAMCA
- Advantage: Sensitive Analysis among Stakeholders
- Limit: No Collaboration, No Co-Decision, No Common Share

GRoUp System (GRUS)

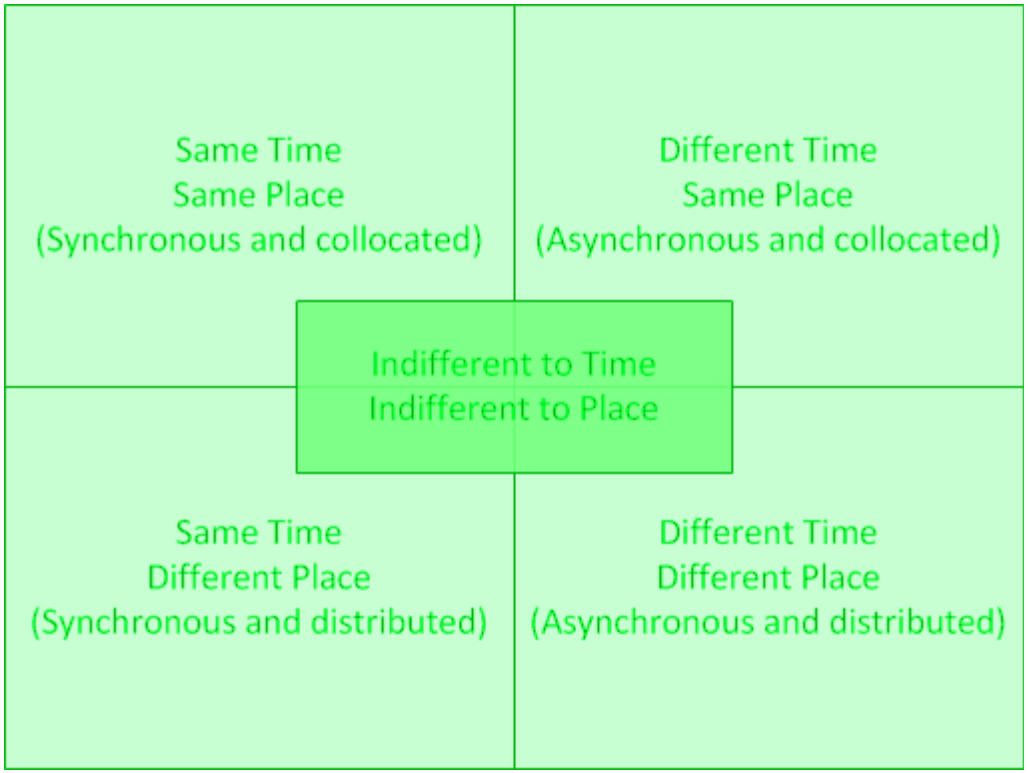
- Web Application : ToolBox
  - Raphael Chatellet
  - Adama Coulibaly
  - Morteza Yazdani
  - Collaboration Jacqueline Konate – Université Bamako Mali

- Based on Grails web application framework
  - Open Source Framework

- GRUS is a fully open source system : available upon request

GRUS Features 1/2

» Can be used in several situations



» In GDSS, 2 roles of user

> One facilitator (meeting manager)

> Several Participants (meeting contributors)

GRUS Features 2/2

- 2 kinds of meetings are available
  - Public meetings
    - All registered users in GRUS system can participate
  - Private meetings
    - Only invited users can participate to a private meeting
- Some collaborative tools are available
  - Electronic Brainstorming
  - Categorizer
  - Vote
  - Agenda
  - Report…
- User with the role of facilitator can for her/his meeting
  - Define the meeting type
    - Group process (sequence of collaborative tools)
  - Invite users
  - Manage the group process (stop, add, delete,…) tools

GRUS Objectives

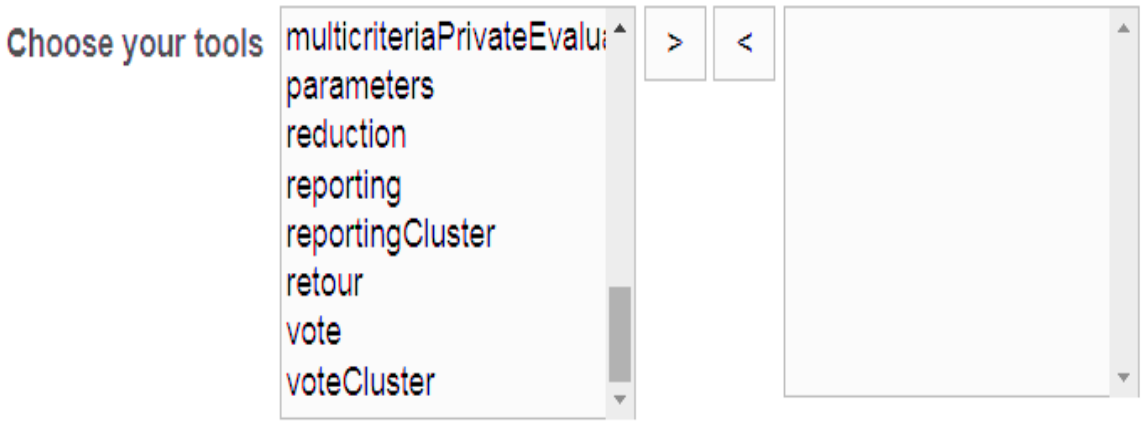
- Open System for
  - Sharing collaborative tools
  - Sharing group processes

- Promote the use of GDSS in organizations

- Improve the efficiency of group work

GRUS as a Tool-Box

- Several tools
- Combine them
- Flexible process



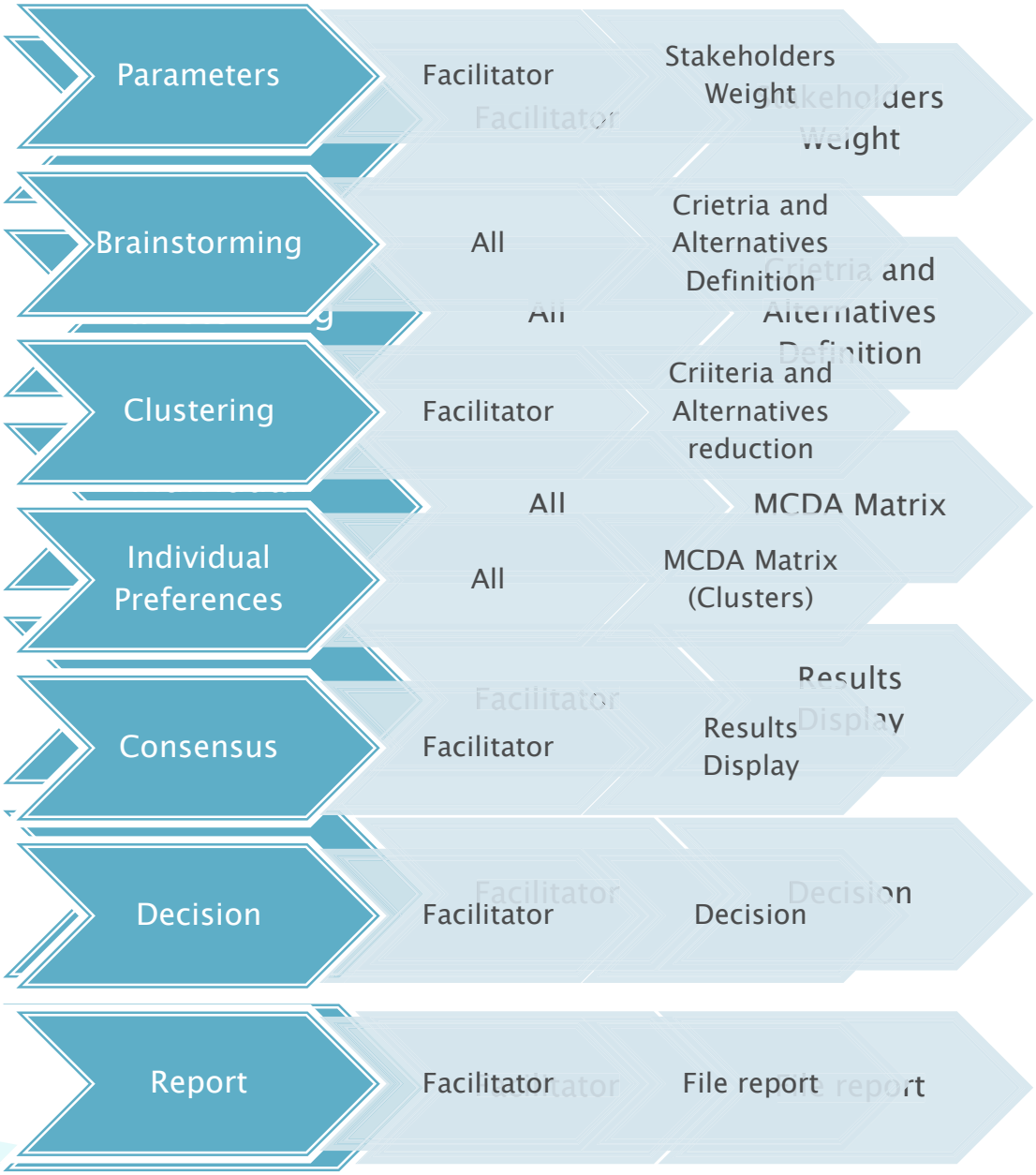
GRUS : Process oriented

- Process
  - Several steps
  - Several tools

step3	► parameters ► criteriaAlternativesGeneration ► criteriaReduction ► alternativesReduction ► multicriteriaClusterEvaluation ► directChoiceCluster ► reportingCluster
test	► parameters ► retour
test01	► parameters ► brainstorming ► vote
test2	► parameters ► criteriaAlternativesGeneration ► multicriteriaEvaluation ► directChoice ► retour ► reporting
testttt	► parameters ► criteriaAlternativesGeneration ► vote
testttttttttt	► parameters ► criteriaAlternativesGeneration ► vote ► consensusB
test_argentine	► parameters ► criteriaAlternativesGeneration ► multicriteriaEvaluation ► vote ► feedback ► reporting
Tomato_Schedule	► parameters ► criteriaAlternativesGeneration ► alternativesPrivateReduction ► alternativesReduction ► criteriaReduction ► criteriaPrivateReduction ► multicriteriaClusterPrivateEvaluation ► multicriteriaClusterEvaluation ► directChoiceCluster ► feedback ► conclusion ► reportingCluster
Vote - Etape 1 - ER	► consensusB

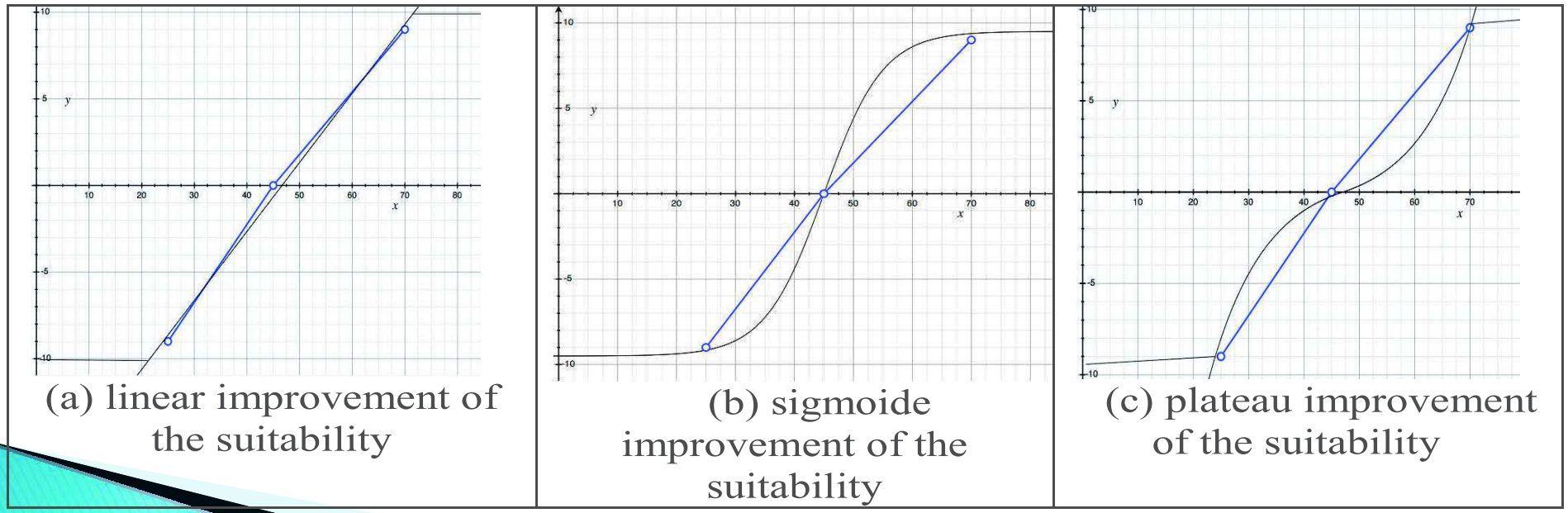
MCDM Processes

Weighted Sum
Choquet Integral

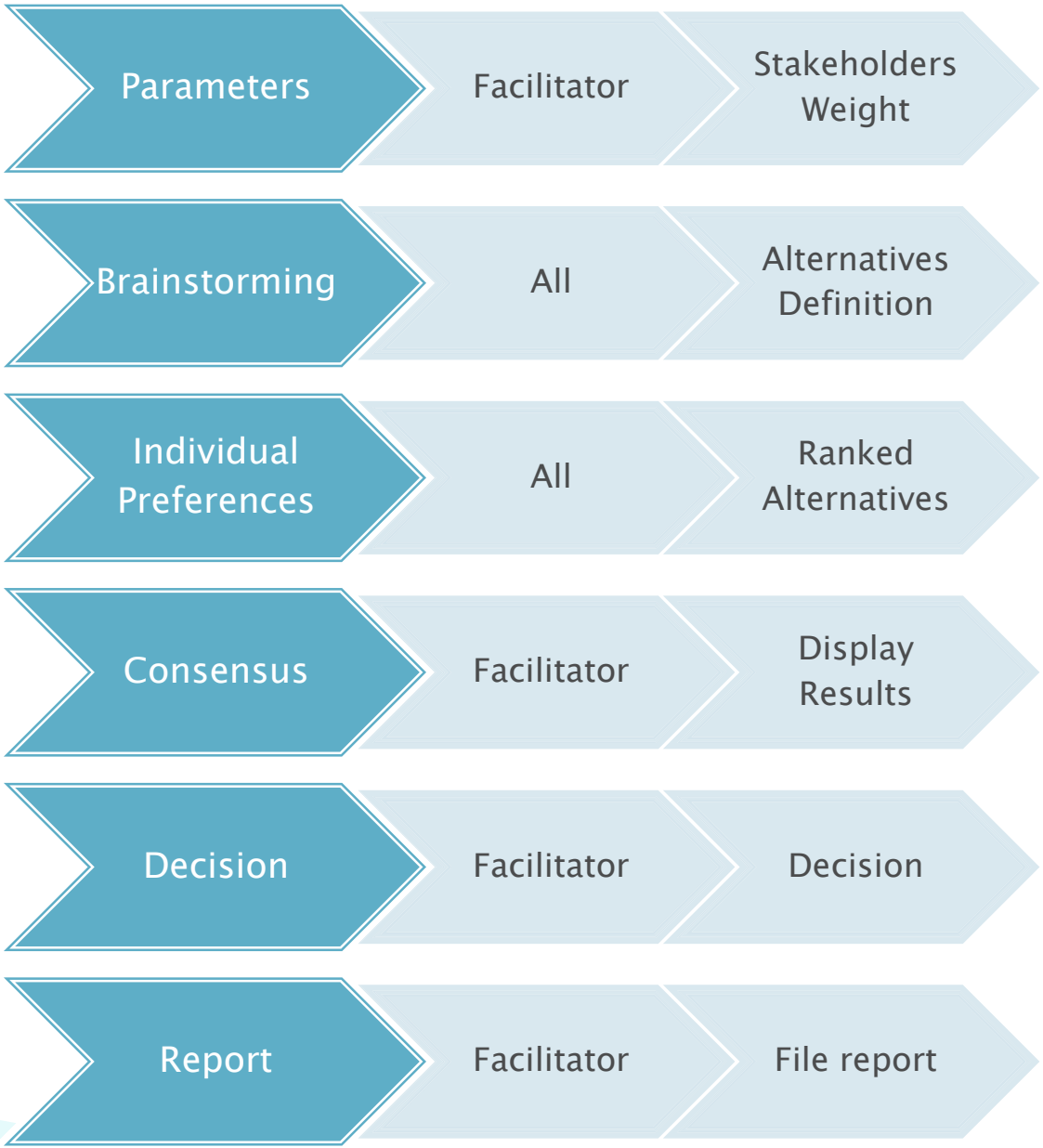


Criteria

- Suitability Function
  - Scoring Scale
  - Indifference Score
  - Reject Score
  - Shape of Interpolation
  - Shapley Indice (Bi-Capacity)



Vote Processes



Borda
Condorcet

Proposed Methodology

- Sharing information for Co-decision Processes
- 2 levels of preferences
  - Common Criteria discussed among the stakeholders
  - Individual Criteria

Toulouse - Waterloo - Recife

- Face to face
- 3 Experiments
  - Master / PhD Students
  - 3 sessions / 5 students
    - Toulouse
    - Waterloo
    - Recife
- Evaluated process:
  - Brainstorming
  - Clustering
  - MultiCriteria Evaluation
  - Discussion
  - Report

Cultural Effects

University of Waterloo

RUC-APS

https://ruc-aps.eu/

PROJECT DESCRIPTION

Acronym: RUC-APS

Project name: Enhancing and implementing Knowledge based ICT solutions within high Risk and Uncertain Conditions for Agriculture Production Systems

Call: H2020 RISE-2015

Time: 2016-10-03/2020-10-02 (48 months)

Coordinator: The University of Liverpool, UK

Total cost: EUR 1 332 000

Consortium: 16 participants from 5 EU countries (France, Italy, Poland, Spain, and United Kingdom) , and 3 partners from 2 third countries (Argentina and Chile)

- WP12
- Support Group Decision Processes
- Find the appropriate methodology

Experiments

- Synchronous / Distributed
- 15 Experiments
  - Non Academics / Academics
- Process
  - Parameters
  - Brainstorming
  - MultiCriteria Evaluation
  - Discussion
  - Report

Simplify

UT1C, France – UNLP, Argentina – 06/04/2018

VGI4Bio

https://www.vgi4bio.fr/

The conservation of biodiversity currently represents a major challenge, since it impacts environmental, social, economical and other human activities features. Observation data may be needed at large spatial or temporal scales to encompass a wide range of situations in order to achieve meaningful results.

This implies that hundreds or thousands of observers need to be mobilized, at a cost which would be prohibitive if they had to be paid. Therefore, in this project we will define an R package offering a set of frequentist and bayesian statistical tools and observer behavior modeling to extract and visualize accurate and relevant data from the mass of opportunistic data (VGI data), in order to produce meaningful biodiversity indicators.

Moreover, since VGI systems do not provide advanced analysis tools, we will use Spatial OLAP to analyze those bioindicators. Since final users are different and numerous, we will define a new group decision-making SOLAP design methodology to implement Spatial OLAP models for bioindicators.

Projet PRCE (http://www.agence-nationale-recherche.fr/AAPG2017)

Challenge 1 « **Gestion sobre des ressources et adaptation au changement climatique** »

Application « **Smart Monitoring** » de l'axe 4 "**Innovations scientifiques et tech.**"

Orientation 1 "**Suivi intelligent du système terre**"

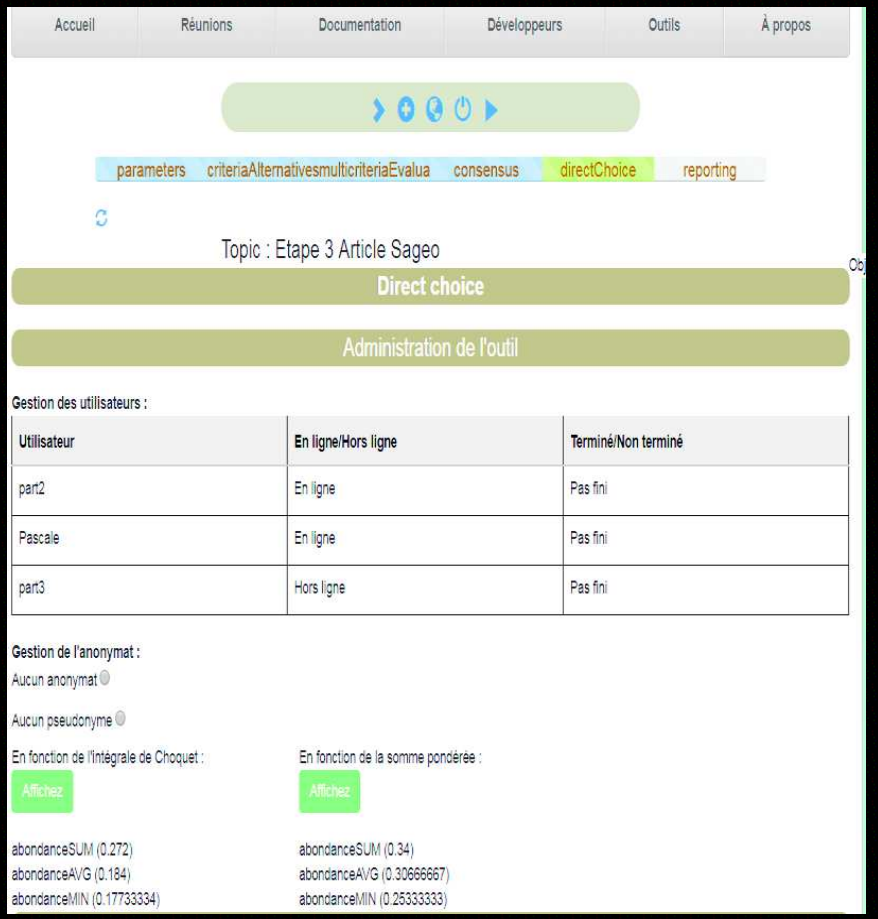
Budget 431 000 Eur

Durée 48 mois

Début: 1 Décembre 2017

Experiments

- Synchronous / Distributed
- Experiment
  - 3 Ornithologists
  - 2 Facilitators
- Process : 5 sub-processes
  - Vote (Borda)
  - Vote (Borda)
  - MultiCriteria Evaluation
  - Vote (Borda)
  - Vote (Borda)



Adapt methodology

Clermont-Ferrand, Bordeaux, Toulouse, Paris, Montpellier - France

Methodology

- Step 1: Collective Evaluation

Agreement on

- Collective Criteria Definition
- Scoring scale
- Score of each alternatives for these common criteria
- Weight of each participant
- Which level of sharing information
- How many iterations

Methodology

- Step 2: Individual evaluation
  - Individual Criteria ➔ private no shown
  - Personal Weights for all criteria
  - Personal Suitability Functions for all determinant criteria
  - Dependences of all criteria

Methodology

- Step 3: Aggregation and Analysis

System computes

- Global Weight ➔ Sum of all weights (individual and collective)
- Statistics: Average and Standard deviation of weight of collective criteria
- Statistics of Suitability Function for Collective Criteria ➔ Average, Standard Deviation, Min, Max
- Collective Assessment of each alternatives (median, standard deviation and extremum values)
- Sensitivity Analysis

Methodology

- Step 4: Discussion
  - Allow participants to see all data
  - Discussion fed by the results computed by the system
  - Justification of some preferences
  - Come back to step 2 if necessary

Conclusions and Perspectives

- GRUS allows a participatory decision making process including 2 levels of preferences
  - Individual: Users could be involved in the Individual preferences evaluation
  - Collective: Users could be involved in the decision making process and problem definition
- Different methodology for different context
- Iterative / Successive processes

- Remark: Small number of stakeholders

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Thank you !

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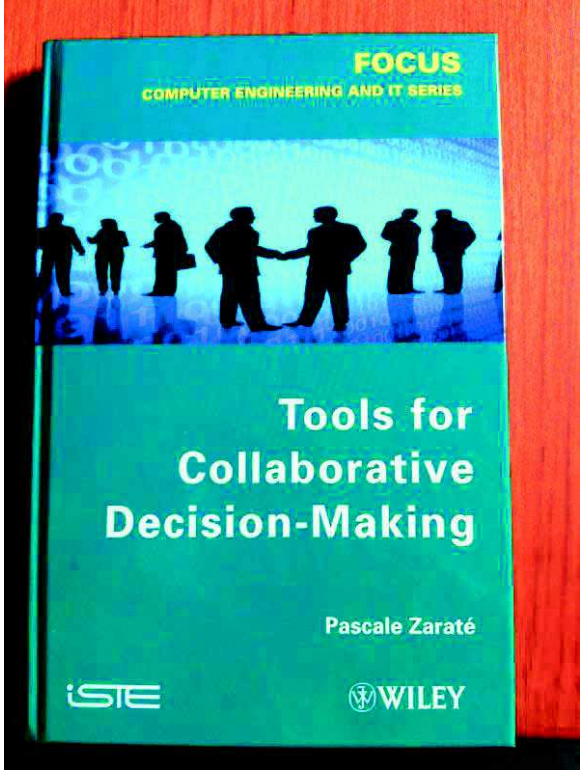
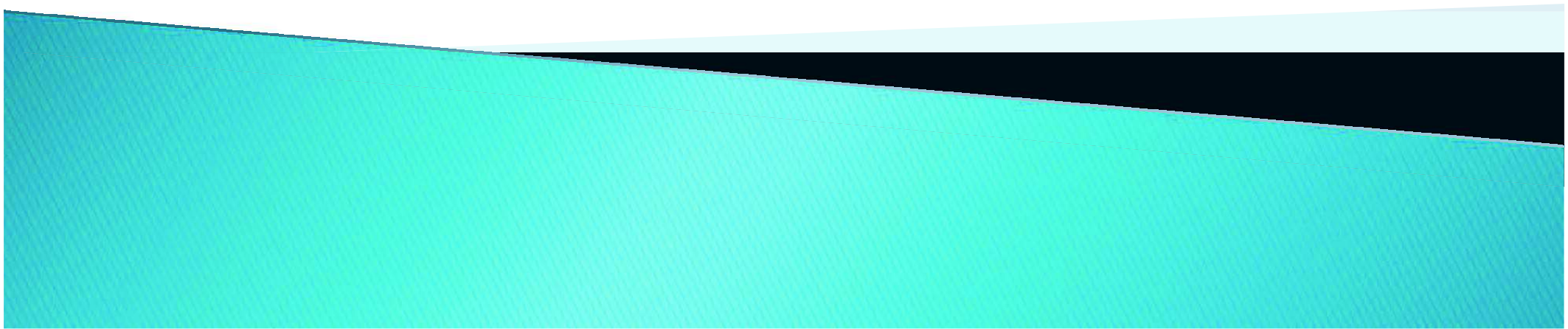


Recommender System

Multi-Criteria Approach



Context definiton

- Multi-Criteria paradigm
- Several aggregation operator
- Recommend the most suitable aggregation operator depending on several parameters

Recommender Systems

- Better support Decision Makers
- Learn Users' Preferences
- Learning based on Users' Profiles
- 3 Kinds of Recommender Systems
  - Content-based [*Pazzani & Billsus, 1997*; *Zhang et al., 2002*]
  - Collaborative [*Billsus & Pazzani, 1998*; *Breese et al., 1998*]
  - Hybrid [*Basu et al., 1998*; *Schein et al., 2002*]

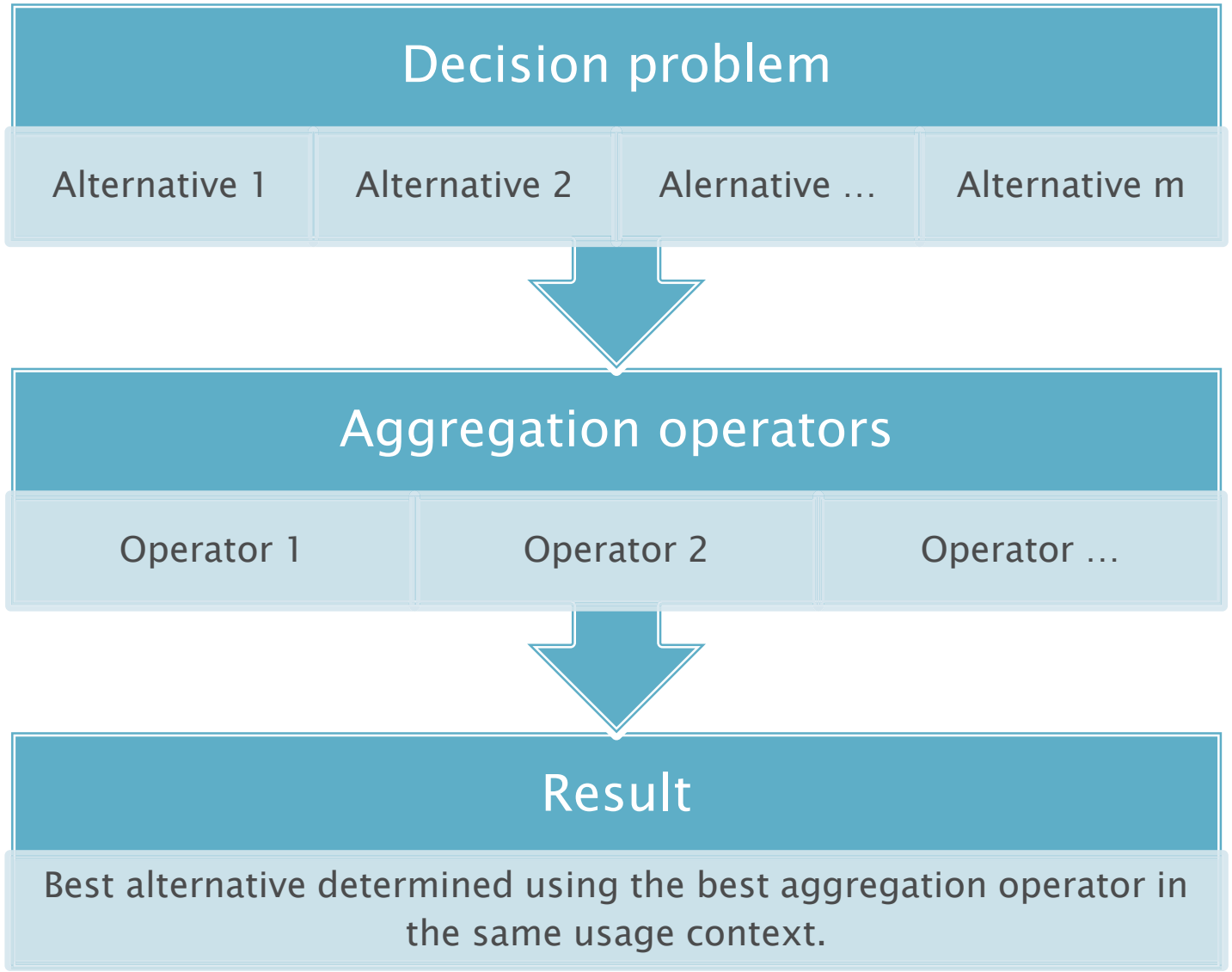
Introduction

- Several aggregation operators implemented:
  - Weighted Sum
  - Choquet Integral
  - Sugueno Integral
  - MOORA
  - COPRAS
  - TOPSIS
  - EDAS
  - WASPAS
- Recommend the better operator depending of the decision context

Introduction

- Operators are classified into 2 categories
  - Quantitative
  - Qualitative
- Decision problems are quantitative or qualitative
- Use of a collaborative recommendation model and a similarity model between decision problems

Introduction



NOTATION AND PROBLEM FORMALIZATION

We have the following data:

- Set of alternatives $A=\{a,b,c..\}$ with $|A|=m$.
- Set of criterions $\mathbb{N}=\{1,2,3,..\}$ with $|\mathbb{N}| =n$.
- Numerical values taken by the alternatives for each criterion : $\forall j \in \mathbb{N}, \forall a \in A, a_j \in \mathbb{R}$
- Set of the profiles of the alternatives which is **a** set of vectors such that $\forall a \in A$ we associate the vector $a=(a_1,a_2, \ldots, a_n) \in \mathbb{R}^n$
- Let $\succeq$ be a relation on *X* representing the decision-maker's preference. ($\succeq$ is usually pronounced "at least as good as".). For alternatives *a* and *b*, $a \succeq b$ to mean that *a* is preferred to *b*.

The Choquet integral

- *Definition: A fuzzy measure μ on N is a function μ: $2^N \rightarrow [0, 1]$ which is monotonic, that is, μ(S) ≤ μ (T) whenever S ⊆ T, and satisfies the limit conditions μ(∅) = 0 and μ(N) = 1*

- Let μ be a fuzzy measure on N. The Choquet integral of x $\in R^n$ with respect to μ is defined by :

$$C\mu(x) := \sum_{i=1}^{n} x_{(i)}[\mu(A_{(i)}) - \mu(A_{(i+1)})]$$

where (.) denotes the permutation of the components of $x = (x_1, \ldots, x_n)$ such that $x_{(1)} \leq \ldots \leq x_{(n)}$. As well, $A_{(i)}=\{(i), \ldots, (n)\}$ and $A_{(n+1)} = \emptyset$.

- The Choquet integral gives the possibility to calculate the index of interaction between the criteria and the global importance of each criterion, called the Shapley value.

The Sugeno integral

- Unlike the Choquet integral which uses quantitative evaluations, the Sugeno integral is used for qualitative evaluations.
- Sugeno integral is defined with respect to a capacity on the set N by the following expression:

$$S_{\mu}(y_1, y_2, \ldots, y_n) = \bigvee_{i=1}^{n} \left(y_{(i)} \bigwedge \mu(\{(i), \ldots, (n)\}) \right)$$

where (.) denotes the permutation of the components of $y = (y_1, \ldots, y_n)$ such that $y_{(1)} \leq \ldots \leq y_{(n)}$.

Choice of aggregation operator

- The selected aggregation operator is tested by trying to determine its parameters from the preferences of the user.
- If the parameters of this operator happen to be elicited respecting the set of preferences of the user, then it is proposed to the user, if not, another operator in the same category is chosen on the same bases.
- This procedure allows the user not to worry about the choice of the aggregation operator in the face of a decision problem and to obtain the best operator in the context of the use of the system.

How to recommend ?

- Decision problem definition
  - Code
  - Name
  - Number of criteria
  - Problem type: quantitative or qualitative
  - Problem ctaegory: Choice, Sorting, Ranking
  - Criteria list
  - Alternatives list
  - Preferences « list »
  - User

How to recommend ?

- Criteria definition
  - Code
  - Name
  - Weight
  - Direction (Min or Max)
  - Unit of measure
  - Description
- Alternatives definition
  - Code
  - Name
  - Scale

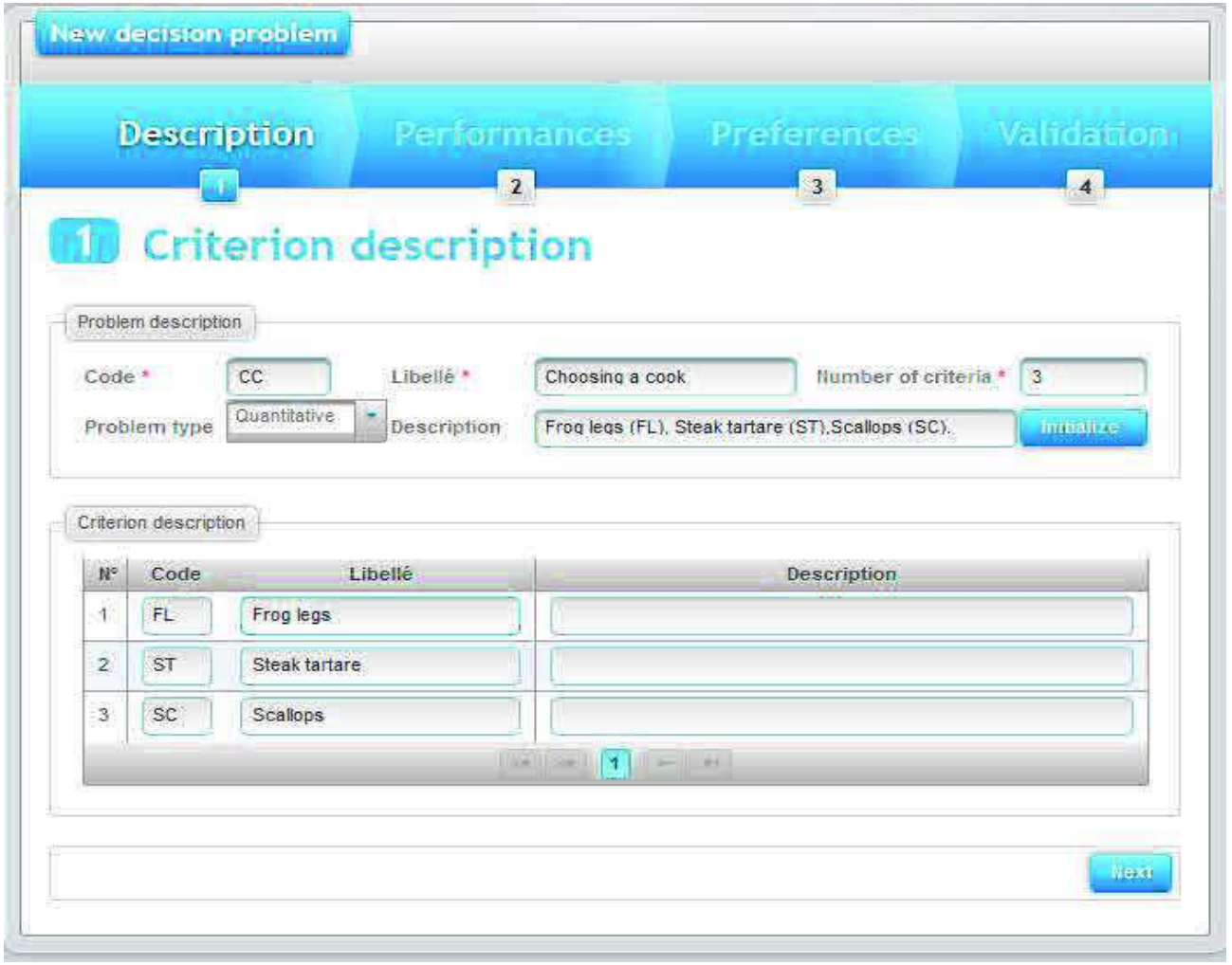
Recommend Aggregation operator

- Choice of the operator
  - Manual
  - Automatic
- User feedback on the operator
  - Explicit : Notation scale 0..6 (final ranking)
  - Implicit : Choice of an operator
- Notation of the operator by the system
  - Manual : Notation of the operator given by user
  - Automatic : Automatically assigned by the system (depends of the users' feedback)
  - Choice : Choice of the operator by the user (good notation)

Users' inputs

- Before the recommendation
  - Description of the problem: qualitative/quantitative and Category (Choice / Sorting / Ranking)
  - List of criteria / Weights
  - List of alternatives
  - Preferences / Performances matrix
  - Partial order (optional)
  - Aggregation operator (or not)
- After the recommendation
  - Notation of the operator

STROMa


New decision problem
Description
Performances
Preferences
Validation
1
2
3
4
1 Criterion description
Problem description
Code *
CC
Libellé *
Choosing a cook
Number of criteria *
3
Problem type
Quantitative
Description
Frog legs (FL), Steak tartare (ST),Scallops (SC).
Initialize
Criterion description
N°
Code
Libellé
Description
1
FL
Frog legs
2
ST
Steak tartare
3
SC
Scallops
Next

STROMa

- Example: 4 Chefs
- Evaluate 4 chefs based on their ability to prepare 3 dishes
  - Frog legs (FL),
  - Steak tartare (ST),
  - Scallops (SC).
- Evaluation of the 4 chefs A, B, C, and D for 3 dish (performance matrix – Scale 0..20)

	FL	ST	SC
A	18	15	19
B	15	18	19
C	15	18	11
D	18	15	11

STROMa

Reasoning of the decision maker:

- When a chef is known for his preparation of Scallops, it is better that he prepares Frog Legs well, as compared to Steak Tartare;
- Conversely, when a chef does not do a good job preparing Scallops, it is better that he prepares Steak Tartare well, as compared to Frog Legs.
- Thus we can conclude than the decision-maker's ordering is $A \succeq B$ and $C \succeq D$ (partial order used for Choquet bi-capacity)

STROMa

Decision problem : Choosing a cook - Choquet integral

Choquet integral | Previous

Choquet integral values

Alternative	FL	ST	SC	Aggregate value	Ranking
A	18	15	19	17.83334	1
B	15	18	19	16.83334	2
C	15	18	11	15.16666	3
D	18	15	11	14.16666	4

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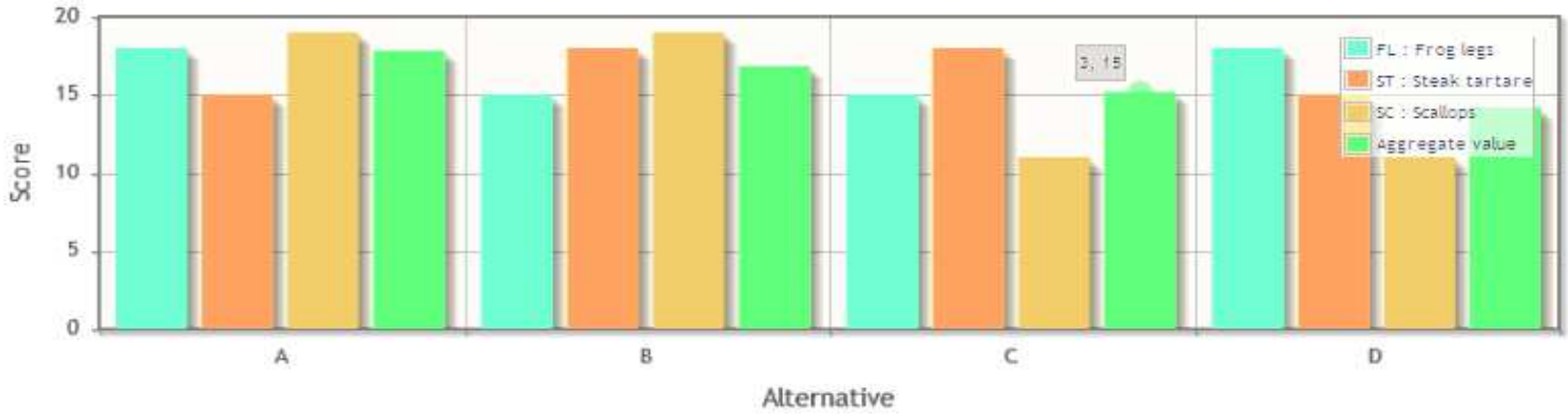


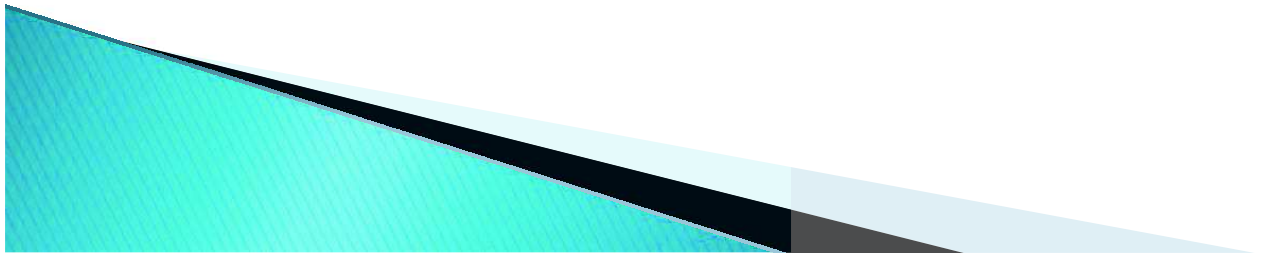
Previous

Conclusion

- Recommender systems
  - Guide for decision making problem solving
  - Enhance decision makers' cognitive capacities
  - Responses time remains still a constraint

Conclusion

- Aggregation operator automatically assigned transparent for the user
- User's Degree of satisfaction of the chosen operator
- It would also be interesting to propose new fuzzy measurement identification algorithms, faster and more robust, which tends to be greedy in time with a high number of criteria.



DSS : Publications

- International Journal of Decision Support System Technology
- IGI Global Publisher