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A group multi-criteria analysis model of routing methods for telecommunication networks

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Introduction - Motivation

- We address a decision problem focused on the comparison and selection of *flow-oriented routing* models in telecom networks evaluated through multiple global network performance measures

- The fact that flow oriented routing optimization models are applied in a per demand basis and use, 'surrogate objective functions' in relation with the "real" objective functions (see refs[1, 3]), requires them to be evaluated through *global network performance paramet*ers, corresponding to the attributes of our decision problem, often conflicting and incommensurate

Introduction - Motivation

- A major contribution of our study is to show the usefulness and potential, from a methodological point of view, of using *a multi-attribute analysis model* for tackling this problem of network design, assuming *an additive value function under imprecise information*

- The features of the considered multi-attribute analysis tool, the *VIP Analysis package,* will enable the achievement of a compatibility of the *incomplete information* supplied by different DMs

Outline of the Decision Problem

- The first six ***alternatives*** *of* the decision problem a_i are **variants of a bi-criteria flow-oriented routing model**, in a transport telecommunication network, all using as path metrics, to be optimized, the load cost and the number of arcs and differing in the method of automated route choice (among the non-dominated solutions), as described in [5]. The other *two alternatives* are the **single criterion routing m**odels which use as as path metric to be minimized, either the load cost or the hop count
- The ***attributes*** of the problem are global network performance metrics involving three fundamental types: mean **total residual bandwidth (TRB**) mean **total carried bandwidth (TCB)**, and mean **number of accepted node-to-node VCs (TAC)**. Each of these fundamental metrics is decomposed into three attributes corresponding to the associated performance values obtained while the blocking probability of a connection request remains in zero (Br1=0%) or attains the thresholds of Br2=5% or Br2=10%

Outline of the Decision Problem

- The values for these 9 *attributes - global network performance metrics* - in the network case study were estimated through stochastic discrete event simulation, considering incremental offered traffic

- The developed decision multi-attribute model, assuming an *additive value function under imprecise information*, may involve more than one decision maker, in a specific application context of network routing design

- The *imprecise information* feature of the multi-attribute model stems from the fact that the scaling constants associated with these attributes are not fixed a priori, although various inequality relations between them can be set a priori as agreed among possible decision makers

VIP analysis software – essential features

➢ **Multicriteria aggregation with an additive value function V:**

$$V(a_i, k) = \sum_{j=1}^{n} k_j \, v_j(a_i) \qquad (i=1,\ldots,m)$$

- a_i and v_j represent the i^{th} alternative – a specific routing method in our decision problem - and the j^{th} normalized global network performance measure - value of the associated attribute, of one of the types described above, k_j is the *scaling constant/importance parameter* of v_j, and k represents the vector of scaling constants
- T the *set of acceptable values* of the vector k of scaling constants in a given decision scenario is defined in various ways , for instance

VIP analysis software - *dealing with partial information*

- For instance :

Order constraints	$k_i \geq k_j \geq \ldots$
Bounds on scaling constants	$l_j \leq k_j \leq u_j$
Bounds involving trade-offs	$L_{ij} \leq k_i / k_j \leq U_{ij}$
Holistic comparisons	$V(a_i) \geq V(a_j)$

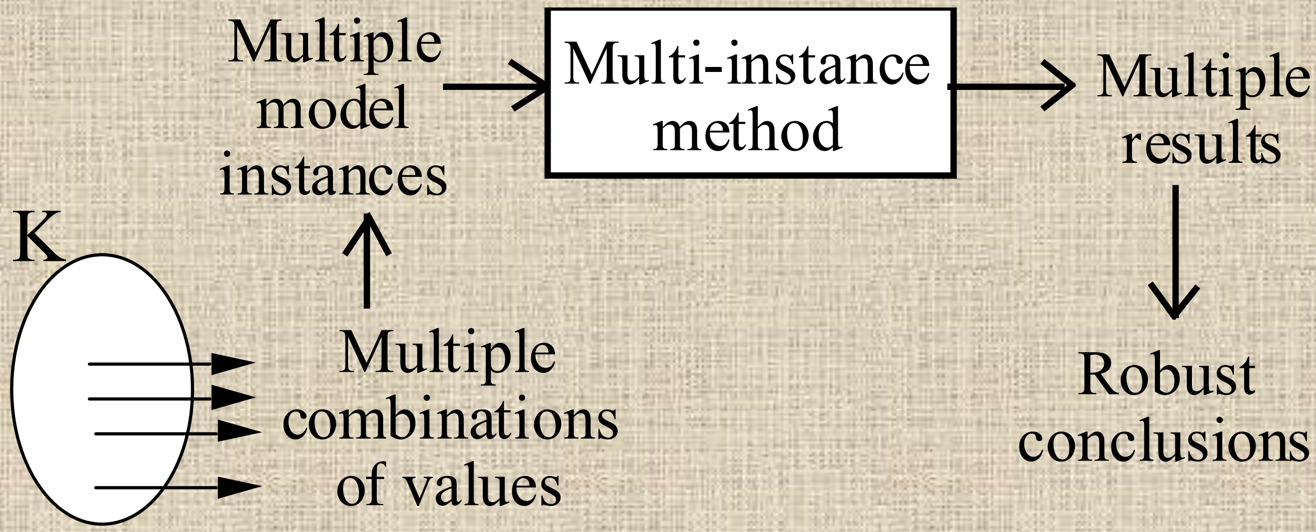
VIP analysis software – essential features

Four *<u>different tools</u>* offered by VIP Analysis software for the evaluation of alternatives:

- Optimality evaluation
- peer-to-peer comparison of alternatives,
- the value ranges...
- pessimists rule (maximum regret)

VIP analysis - dealing with partial information

Robustness analysis:



•VIP Analysis may be used to discover *robust conclusions* - those that hold for every combination in *K*- and to identify which results are more affected by the imprecision in the importance parameter values.

•VIP-Analysis incorporates different procedures to support the progressive reduction of the number of alternatives, introducing a *concept of tolerance* that lets DM's use of some of the procedures in a more flexible manner.

VIP analysis software – basic concepts

- The *regret*(a_i,a_j) associated with alternative a_j, when compared with a_i – defines a *pair-wise confrontation table*:

$$reg_{ij} = \max_{k \in T} \left\{ V(a_i,k) - V(a_j,k) \right\}.$$

- If $reg_{ij} \leq 0$ then and a_j dominates a_i , *in the Bernouilli sense*
- a_i *is absolutely dominated by* a_j iff:

$$V(a_j,k) \geq V(a_i,k') \;\; \forall k,k' \in T \wedge \exists k,k' \in T : V(a_j,k) > V(a_i,k')$$

- a_j quasi-dominates a_i with tolerance ε iff:

$$V(a_j,k) \geq V(a_i,k) - \varepsilon \;\; \forall k \in T.$$

VIP analysis method - basic concepts:

• a_i is optimal if the maximum regret associated with it, $reg_{max}(a_i)$, is negative or null:

$$reg_{\max}(a_i) = \max_{j \neq i}\left\{reg_{ji}\right\} = \max_{k \in T}\left\{\max_{j \neq i}\left\{V(a_j,k)\right\} - V(a_i,k)\right\}.$$

• if $reg_{max}(a_i)$-ε is negative or null then a_i is quasi-optimal with tolerance ε

• If these conditions are true only for a subset K* of T then a_i is optimal (or quasi optimal) at K*

• the VIP module also calculates the *range of values* for any a_i

$$\left[\min_{k \in T}\left\{V(a_i,k)\right\}, \max_{k \in T}\left\{V(a_i,k)\right\}\right].$$

Outline of the Case Study

- Reference network based on the **France telecommunication transport network**, described in [5], where all arcs have 10 Gb/s capacity and three connection service types, between all node pairs.

- A **normalized performance matrix** with the 9 network performance attributes and the 8 alternatives was calculated from results in [5].

- We considered a **cooperative group decision** environment, based on [7] - with 3 DMs – this approach should in general neither propose a definite ranking of the alternatives nor, in many situations, determine an aggregated model from the individual ones.

Outline of the Case Study

- The system is designed *to reflect to each DM the consequences of his/her inputs*, confronting them with analogous images of the DMs inputs, namely by showing all the results that are compatible with the input provided and the agreed comparison criteria
- Nevertheless, *in the addressed network design decision problem, a final alternative must be chosen* so, either one alternative becomes the one accepted by all the DMs - as a result of its inherent merits clearly shown by the VIP analysis process – or two or more alternatives should finally be considered by the DMs in the group, a case in which the DM - head of the network design team- or 'last resort DM', will have to make a ultimate selection among a final short list of alternatives.

Outline of the Experimentation

Performance matrix

Criteria:	Crit1	Crit2	Crit3	Crit4	Crit5	Crit6	Crit7	Crit8	Crit9
Importance:									
a1	1	0.96	0.94	0.42	0.34	0.31	1	0.96	0.94
a2	0.93	0.68	0.65	0.26	0.49	0.51	0.92	0.69	0.66
a3	0.98	0.96	0.94	1	0.71	0.6	0.98	0.95	0.93
a4	1	0.96	0.94	0.91	0.65	0.56	1	0.95	0.93
a5	0.99	0.7	0.67	0.3	0.51	0.53	0.98	0.71	0.67
a6	0.94	0.7	0.66	0.29	0.51	0.53	0.94	0.7	0.66
a7	0.9	1	1	0	0	0	0.9	1	1
a8	0	0	0	0.33	1	1	0	0	0

Outline of the Experimentation

<u>First set of experiments associated with DM1</u>

- 15 **constraints** on the scaling constants, which are either inequality relations (13 constraints) or equality relations (2 constraints) usually assumed by most network designers when evaluating routing methods:

i. TCB and TAC measures are more relevant than TRB measures for the same level of blocking probability;

ii. for a given type of performance metric the measure for 0% b.p. is more important than the measure for 5% b.p. and similarly for measures for 5% b.p and 10% b.p;

iii. the equality relations concern the measures TCB and TAC, for 0% b.p and 5% b.p

First set of experiments associated with DM1 summary of solutions

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Data | Bounds | Constraints

Crit1	Crit2	Crit3	Crit4	Crit5
1	1	1	1	1
1	-1.01			
	1	-1.01		
1			-1.01	
	1			-1.01
		1		
			-1.01	
				-1.01
			-1.01	1
				-1.01
1				
	1			
		1		

Commit | Rollback

Summary | Range | Confrontation | Max Regret

Alternative	Value	Min Value	Max Value	Max Regret	Dominated?
a1		0.767	1	0.128	
a2		0.646	0.925	0.249	YES
a3		0.883	0.98	0.02	
a4		0.876	1	0.016	
a5		0.677	0.985	0.219	YES
a6		0.662	0.94	0.233	YES
a7		0.651	0.966	0.245	YES
a8		0	0.254	1	YES (Abs)

First set of experiments associated with DM1 confrontation table

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Data | Bounds | Constraints

Criteria:		Crit1	Crit2	Crit3	Crit4
Importance:					
a1	A	1	0.96	0.94	0.42
a2	A	0.93	0.68	0.65	0.26
a3	A	0.98	0.96	0.94	1
a4	A	1	0.96	0.94	0.91
a5	A	0.99	0.7	0.67	0.3
a6	A	0.94	0.7	0.66	0.29
a7	A	0.9	1	1	0
a8	A	0	0	0	0.33

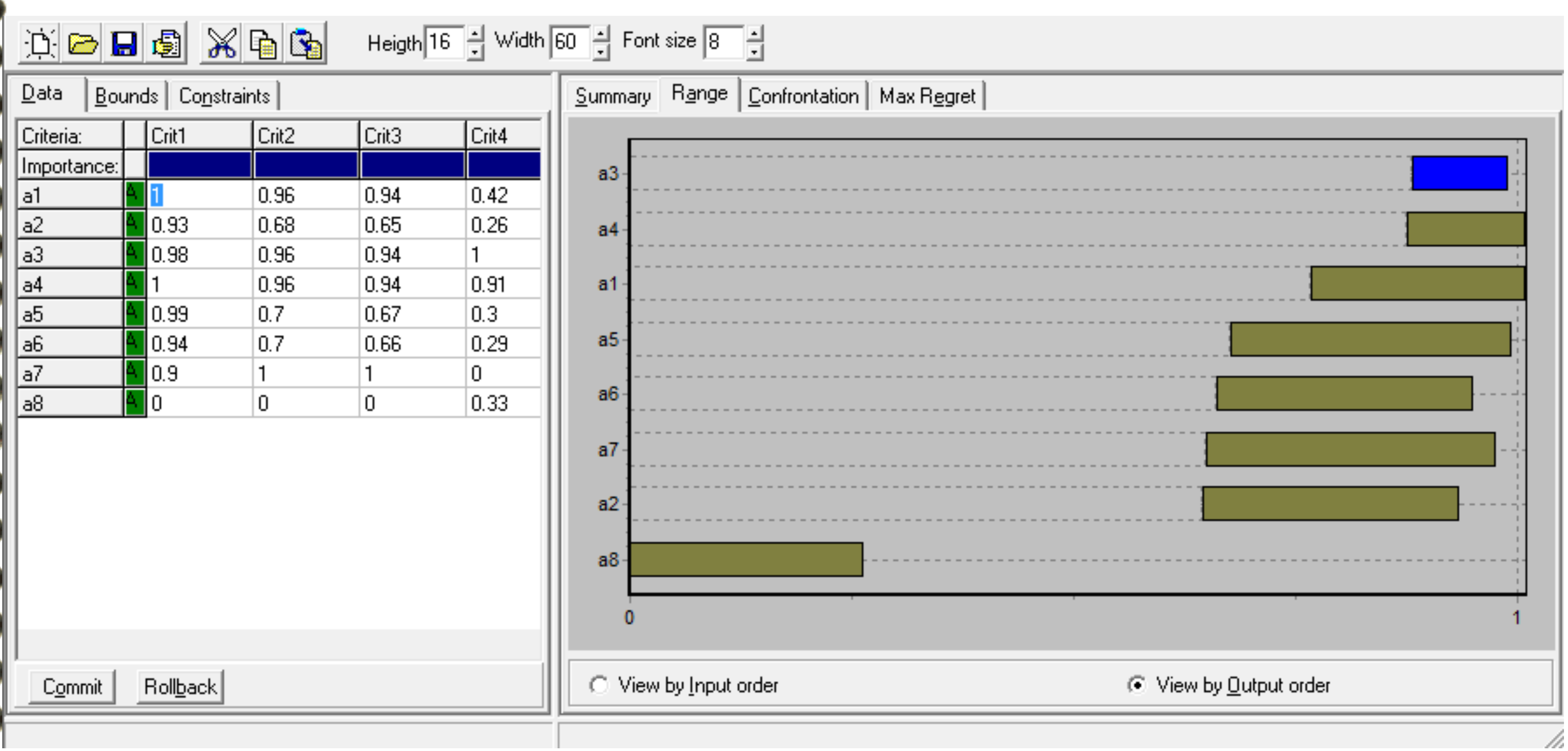
Commit Rollback

Summary | Range | Confrontation | Max Regret

	a1	a2	a3	a4	a5	a6	a7	a8
a1		0.211	0.02	0.003	0.179	0.199	0.117	1
a2	-0.075		-0.055	-0.075	-0.029	-0.012	0.025	0.925
a3	0.128	0.249		0.016	0.219	0.233	0.245	0.98
a4	0.112	0.233	0.02		0.203	0.217	0.229	1
a5	-0.015	0.06	0.005	-0.015		0.045	0.085	0.985
a6	-0.06	0.015	-0.04	-0.06	-0.015		0.04	0.94
a7	-0.001	0.21	0.01	0.003	0.179	0.199		0.966
a8	-0.513	-0.392	-0.637	-0.625	-0.422	-0.407	-0.396	
Max Regret:	0.128	0.249	0.02	0.016	0.219	0.233	0.245	1

Tolerance x10 /10

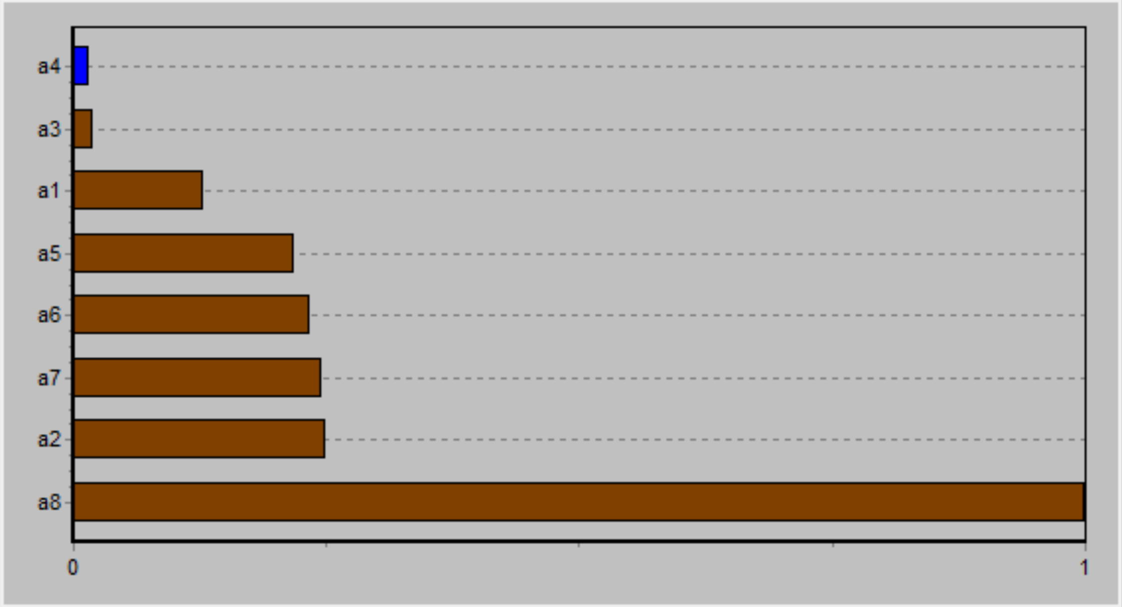
First set of experiments associated with DM1 min-max range



Criteria:		Crit1	Crit2	Crit3	Crit4
Importance:					
a1	A	1	0.96	0.94	0.42
a2	A	0.93	0.68	0.65	0.26
a3	A	0.98	0.96	0.94	1
a4	A	1	0.96	0.94	0.91
a5	A	0.99	0.7	0.67	0.3
a6	A	0.94	0.7	0.66	0.29
a7	A	0.9	1	1	0
a8	A	0	0	0	0.33

First set of experiments associated with DM1 max regret

Criteria:	Crit1	Crit2	Crit3	Crit4
Importance:				
a1	1	0.96	0.94	0.42
a2	0.93	0.68	0.65	0.26
a3	0.98	0.96	0.94	1
a4	1	0.96	0.94	0.91
a5	0.99	0.7	0.67	0.3
a6	0.94	0.7	0.66	0.29
a7	0.9	1	1	0
a8	0	0	0	0.33



First set of experiments associated with DM1 summary of conclusions

- 5 alternatives are *dominated*, one being absolutely dominated (a_8), and the others dominated by a_3 (which has *maximal minimal value*) or by a_4 (which has *minimal maximal regret*);

- a small *relaxation to dominance* revealed, - see the next summary and confrontation tables - that all 6 alternatives (other than a_3, a_4) were *quasi-dominated* by a_3 or a_4, for $\varepsilon \geq 0.01$;

- a major conclusion is that a_3 and a_4 are the *most promising solutions*

First set of experiments associated with DM1 complementary tests

Other tests, of sensitivity/robustness analysis, were carried out:

- *"filtering"* procedure: elimination of alternative $a_{8;}$
- *robustness analysis* of non-dominance by consideration of negative values of ε;
- analysis, in separate, of the performance of the two most promising alternatives (a_3 or a_4), with respect the remaining ones, trough two experiments involving the elimination of either a_3 or a_4 - enabling the conclusion that, in isolation, a_3 and a_4 are *quasi optimal* with respect to a_1, a_2, a_5, a_6 for $\varepsilon > 0.02$ and $\varepsilon > 0.003$, respectively.

Second set of experiments
cooperative group decision

- A second set of experiments, concerning *cooperative group decision* considers two more DMs working *face-to-face* with the former, DM_1

- the 2nd DM, instead of four of the inequality relations considered by DM_1, assumes specific proportion relations between the corresponding scaling constants (*e.g.* instead of $k_1 >= k_2$, DM_2 considers $k_1 = b_{12} k_2$ with a specific value $b_{12} > 1$ and similarly for three other constraints on (k_7, k_8), (k_5, k_4) and (k_3, k_9))

Second set of experiments

cooperative group decision

- The third DM, DM_3, is, in a sense, out of the 'main stream', in terms of common preferences, and considers that some of those inequality relations should be reversed, by considering that TRB is more important than TCB for the same level of blocking probability, that is favouring short term minimisation of the usage of networks resources, instead of total mean carried bandwidth.

-This may favour other types of routing solutions as compared with the ones favoured by the analysis of the DM_1 and DM_2

Second set of experiments *cooperative group decision* analysis by DM_2

Major results:

•5 alternatives are dominated by a_3 or a_4 as for DM_2, four being absolutely dominated

• a_3 (with max-min value) and a_4 (with min max regret) are *still the most promising solutions*, as for DM_1

• *relaxation to dominance* tests revealed that a_4, beyond dominating a_2, a_5, a_6, a_7, a_8, quasi-dominates a_1 and a_3, for $\varepsilon \geq 0.01$ ie a_4 is *quasi-optimal* for $\varepsilon \geq 0.01$.

Second set of experiments *cooperative group decision* analysis by DM_3

Major results:

• 6 alternatives are dominated by a_3 and 5 by a_4;

• a_3 has *max-min value and min max regret* and *dominates* a_4 in contrast with the analysis of DM_1 and DM_2 and a_4 is the second more favourable in term of max-min value and max-min regret;

• the only alternative not dominated by a_3 is a_8;

• a *major conclusion* is that, for DM_3 alone, *a_3 is overall the best compromise alternative*;

Second set of experiments *cooperative group decision* aggregation of preferences

From the combined analysis process by the 3 DMs an exercise of ***aggregation of preferences at the output level**,* according to the methodology in [7], was carried out, based on the following elements:

- ***Sets of results*** R_d (d=1,2,3), where R_d is the set of results, function of the set T_d which, each of the DMs, considers as an *acceptable set of values for the parameters* k;
- Consideration of a ***α-majority rule***: this aggregation rule means that a result r is considered acceptable – thence belonging to a set $R_{(\alpha)}$ - if at least αD (D=3 in our case) DMs (α=1/3,2/3,1) include it in their set of results, R_d;

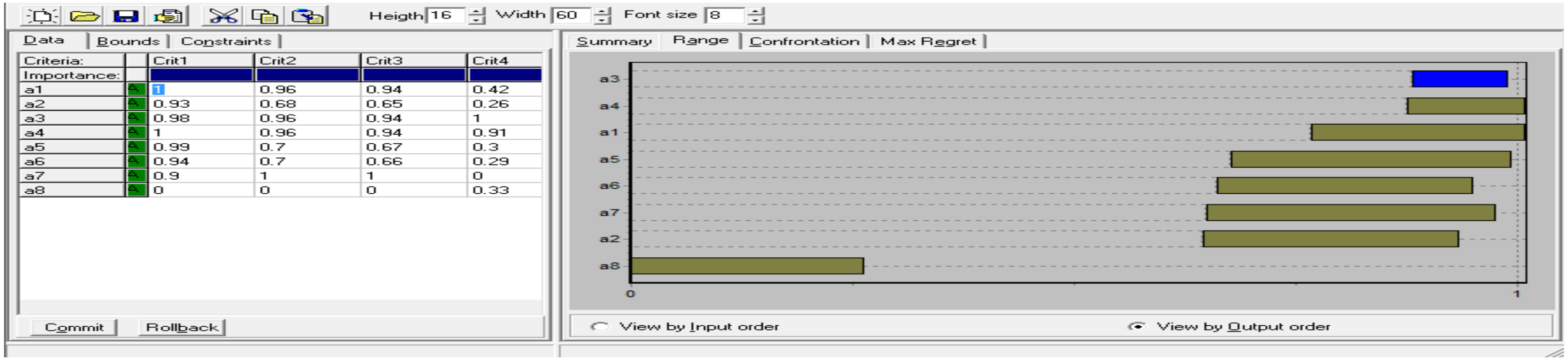
Second set of experiments *cooperative group decision* aggregation of preferences

- Note that the purpose of calculating the set of results $R_{(\alpha)}$ is not to 'impose' a consensus set of results but to provide feedback to the DMs so that they may confront their separate results with the ones accepted by a fraction α of he group ($\alpha=1$ in the particular case of acceptance by all DMs);

- Global ranges acceptable by at least 1 DM, 2 DM and 3 DM can easily be calculated…

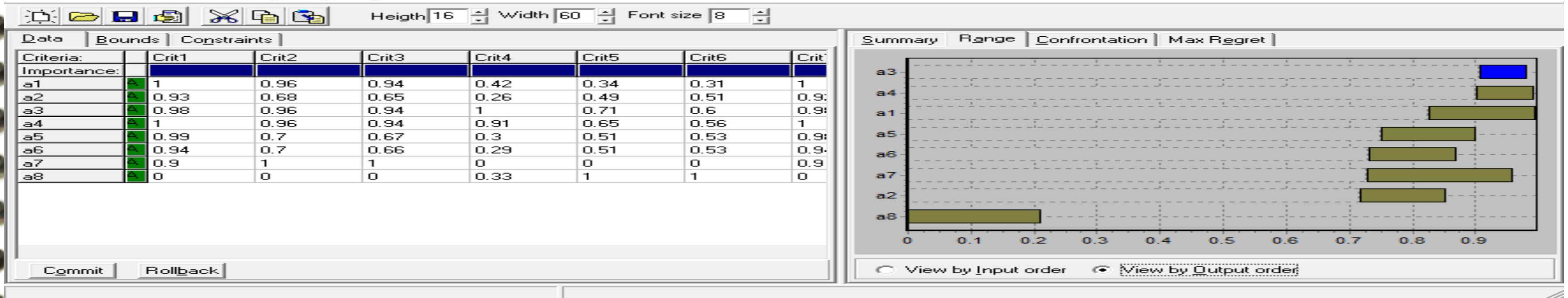
$$V(a_j)_{i/3}, i = 1,2,3; j = 1,2,3,4,5,6,7,8$$

Min-max range graphics for DM1



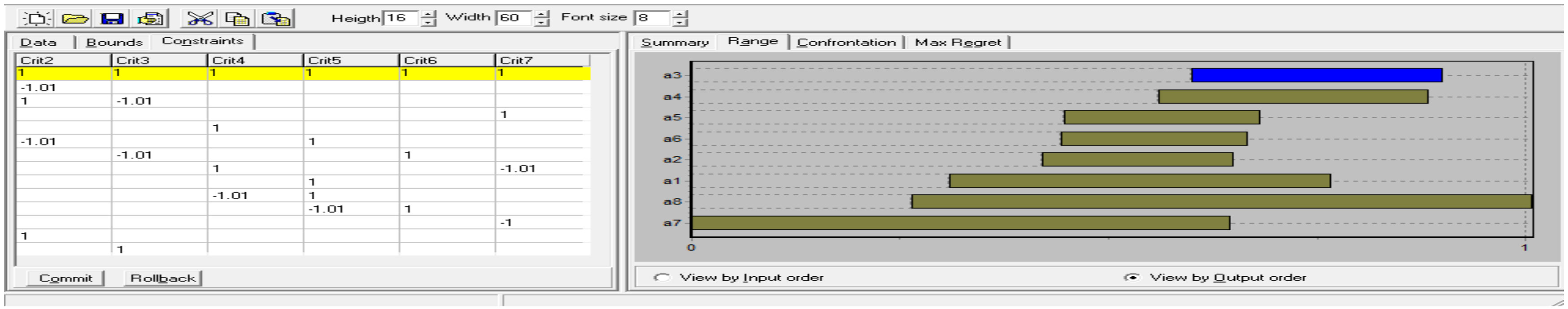
Criteria:		Crit1	Crit2	Crit3	Crit4
Importance:					
a1		1	0.96	0.94	0.42
a2		0.93	0.68	0.65	0.26
a3		0.98	0.96	0.94	1
a4		1	0.96	0.94	0.91
a5		0.99	0.7	0.67	0.3
a6		0.94	0.7	0.66	0.29
a7		0.9	1	1	0
a8		0	0	0	0.33

Min-Max range graphics for DM2



Criteria:		Crit1	Crit2	Crit3	Crit4	Crit5	Crit6	Crit[illegible]
Importance:								
a1		1	0.96	0.94	0.42	0.34	0.31	1
a2		0.93	0.68	0.65	0.26	0.49	0.51	0.9[illegible]
a3		0.98	0.96	0.94	1	0.71	0.6	0.9[illegible]
a4		1	0.96	0.94	0.91	0.65	0.56	1
a5		0.99	0.7	0.67	0.3	0.51	0.53	0.9[illegible]
a6		0.94	0.7	0.66	0.29	0.51	0.53	0.9[illegible]
a7		0.9	1	1	0	0	0	0.9
a8		0	0	0	0.33	1	1	0

Min-Max range graphics for DM3



Crit2	Crit3	Crit4	Crit5	Crit6	Crit7
1	1	1	1	1	1
-1.01					
1	-1.01				
					1
		1			
-1.01			1		
	-1.01			1	
		1			-1.01
			1		
		-1.01	1		
			-1.01	1	
					-1
1					
	1				

- # Summary of results for DM_1

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Data | Bounds | Constraints

Crit1	Crit2	Crit3	Crit4	Crit5
1	1	1	1	1
1	-1.01			
	1	-1.01		
1			-1.01	
	1			-1.01
		1		
			-1.01	
				-1.01
			-1.01	1
				-1.01
1				
	1			
		1		

Commit | Rollback

Summary | Range | Confrontation | Max Regret

Alternative	Value	Min Value	Max Value	Max Regret	Dominated?
a1		0.767	1	0.128	
a2		0.646	0.925	0.249	YES
a3		0.883	0.98	0.02	
a4		0.876	1	0.016	
a5		0.677	0.985	0.219	YES
a6		0.662	0.94	0.233	YES
a7		0.651	0.966	0.245	YES
a8		0	0.254	1	YES (Abs)

- # Summary of results for DM_2

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Data | Bounds | Constraints

Criteria:		Crit1	Crit2	Crit3	Crit4	Crit5	Crit6	Crit
Importance:								
a1		1	0.96	0.94	0.42	0.34	0.31	1
a2		0.93	0.68	0.65	0.26	0.49	0.51	0.9
a3		0.98	0.96	0.94	1	0.71	0.6	0.9
a4		1	0.96	0.94	0.91	0.65	0.56	1
a5		0.99	0.7	0.67	0.3	0.51	0.53	0.9
a6		0.94	0.7	0.66	0.29	0.51	0.53	0.9
a7		0.9	1	1	0	0	0	0.9
a8		0	0	0	0.33	1	1	0

Commit | Rollback

Summary | Range | Confrontation | Max Regret

Alternative	Value	Min Value	Max Value	Max Regret	Dominated?
a1		0.827	0.987	0.079	
a2		0.717	0.845	0.19	YES (Abs)
a3		0.907	0.972	0.015	
a4		0.901	0.985	0.006	
a5		0.752	0.892	0.154	YES (Abs)
a6		0.732	0.86	0.175	YES (Abs)
a7		0.728	0.95	0.179	YES
a8		0	0.203	0.987	YES (Abs)

- # Summary of results for DM_3

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Data | Bounds | Constraints

Crit2	Crit3	Crit4	Crit5	Crit6	Crit7
1	1	1	1	1	1
-1.01					
1	-1.01				
					1
		1			
-1.01			1		
	-1.01			1	
		1			-1.01
			1		
		-1.01	1		
			-1.01	1	
					-1
1					
	1				

Commit | Rollback

Summary | Range | Confrontation | Max Regret

Alternative	Value	Min Value	Max Value	Max Regret	Dominated?
a1		0.31	0.759	0.69	YES
a2		0.421	0.642	0.5	YES
a3		0.6	0.893	0.4	
a4		0.56	0.876	0.44	YES
a5		0.447	0.673	0.48	YES
a6		0.444	0.658	0.48	YES
a7		0	0.637	1	YES
a8		0.265	1	0.628	

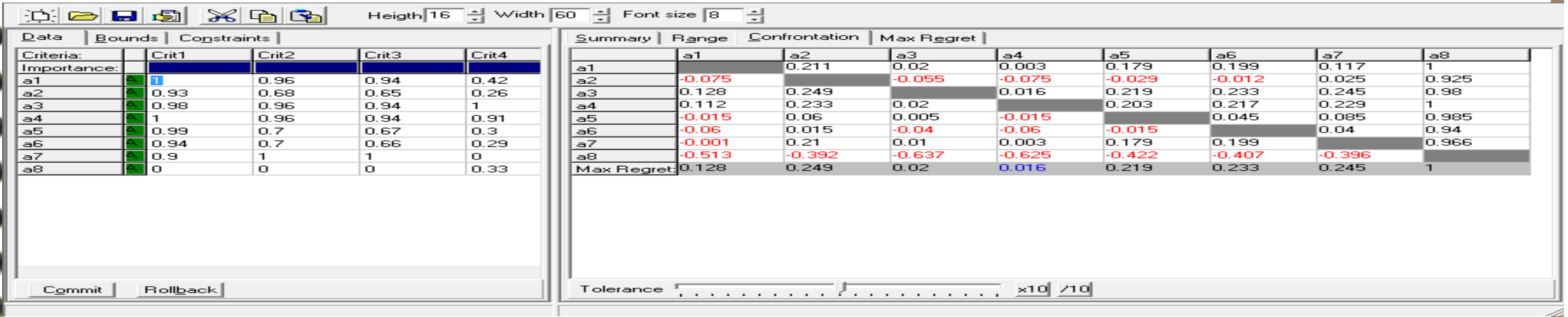
<u>**Second set of experiments** *cooperative group decision*</u> **- aggregation of preferences**

- If we denote by $a_i \Delta_{\varepsilon(\alpha)} a_j$, the assertion " a_i *quasi-dominates* a_j" with tolerance $\boldsymbol{\varepsilon}$ for a majority of $\boldsymbol{\alpha}$, it is obvious that one may need a higher tolerance to obtain a wider majority supporting the conclusion…

➢ The interplay between the tolerance ε, defining a quasi-dominance relation between two solutions and α-majority relations, may be analysed.

- The interplay between the tolerance ε, and α-majority relations is illustrated in terms of the relevant dominance properties of the two globally more favourable alternatives a_3 and a_4 w.r.t alternatives a_2, a_5, a_7 and a_8, as shown next.

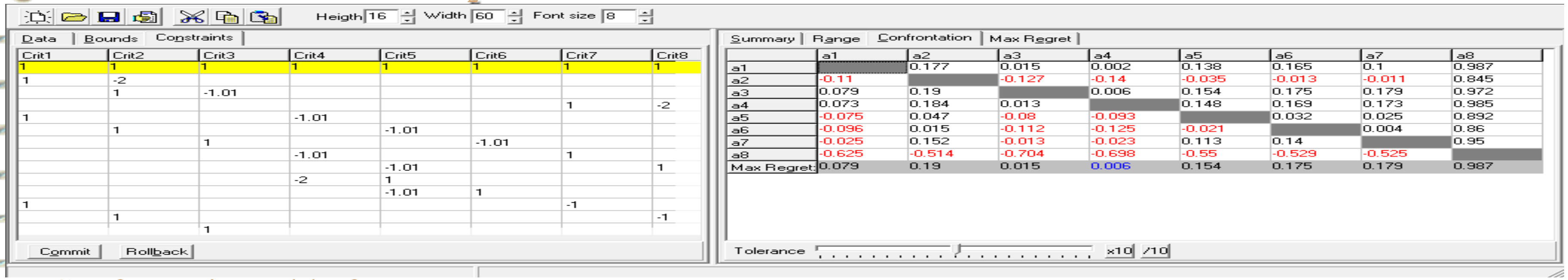
Confrontation table for DM_1



Criteria:	Crit1	Crit2	Crit3	Crit4
Importance:				
a1	1	0.96	0.94	0.42
a2	0.93	0.68	0.65	0.26
a3	0.98	0.96	0.94	1
a4	1	0.96	0.94	0.91
a5	0.99	0.7	0.67	0.3
a6	0.94	0.7	0.66	0.29
a7	0.9	1	1	0
a8	0	0	0	0.33

	a1	a2	a3	a4	a5	a6	a7	a8
a1		0.211	0.02	0.003	0.179	0.199	0.117	1
a2	-0.075		-0.055	-0.075	-0.029	-0.012	0.025	0.925
a3	0.128	0.249		0.016	0.219	0.233	0.245	0.98
a4	0.112	0.233	0.02		0.203	0.217	0.229	1
a5	-0.015	0.06	0.005	-0.015		0.045	0.085	0.985
a6	-0.06	0.015	-0.04	-0.06	-0.015		0.04	0.94
a7	-0.001	0.21	0.01	0.003	0.179	0.199		0.966
a8	-0.513	-0.392	-0.637	-0.625	-0.422	-0.407	-0.396	
Max Regret:	0.128	0.249	0.02	0.016	0.219	0.233	0.245	1

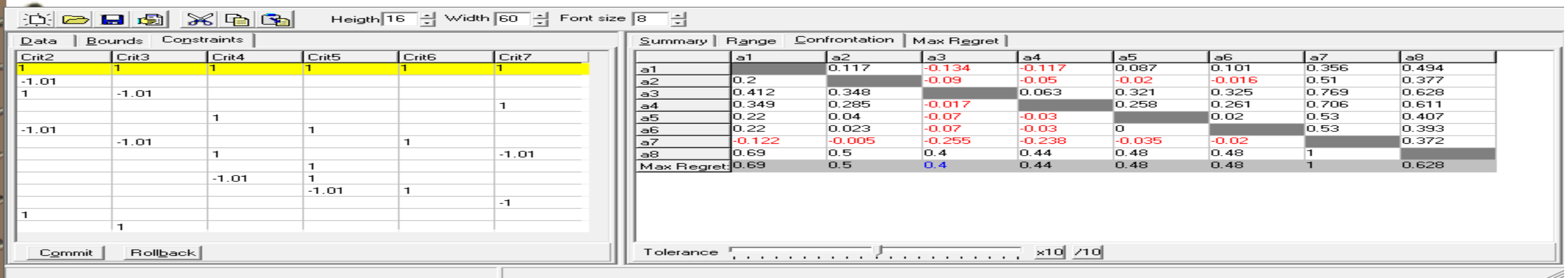
Confrontation table for DM_2



Crit1	Crit2	Crit3	Crit4	Crit5	Crit6	Crit7	Crit8
1	1	1	1	1	1	1	1
1	-2						
	1	-1.01					
						1	-2
1			-1.01				
	1			-1.01			
		1			-1.01		
			-1.01			1	
				-1.01			1
			-2	1			
				-1.01	1		
1						-1	
	1						-1
		1					

	a1	a2	a3	a4	a5	a6	a7	a8
a1		0.177	0.015	0.002	0.138	0.165	0.1	0.987
a2	-0.11		-0.127	-0.14	-0.035	-0.013	-0.011	0.845
a3	0.079	0.19		0.006	0.154	0.175	0.179	0.972
a4	0.073	0.184	0.013		0.148	0.169	0.173	0.985
a5	-0.075	0.047	-0.08	-0.093		0.032	0.025	0.892
a6	-0.096	0.015	-0.112	-0.125	-0.021		0.004	0.86
a7	-0.025	0.152	-0.013	-0.023	0.113	0.14		0.95
a8	-0.625	-0.514	-0.704	-0.698	-0.55	-0.529	-0.525	
Max Regret:	0.079	0.19	0.015	0.006	0.154	0.175	0.179	0.987

Confrontation table for DM_3



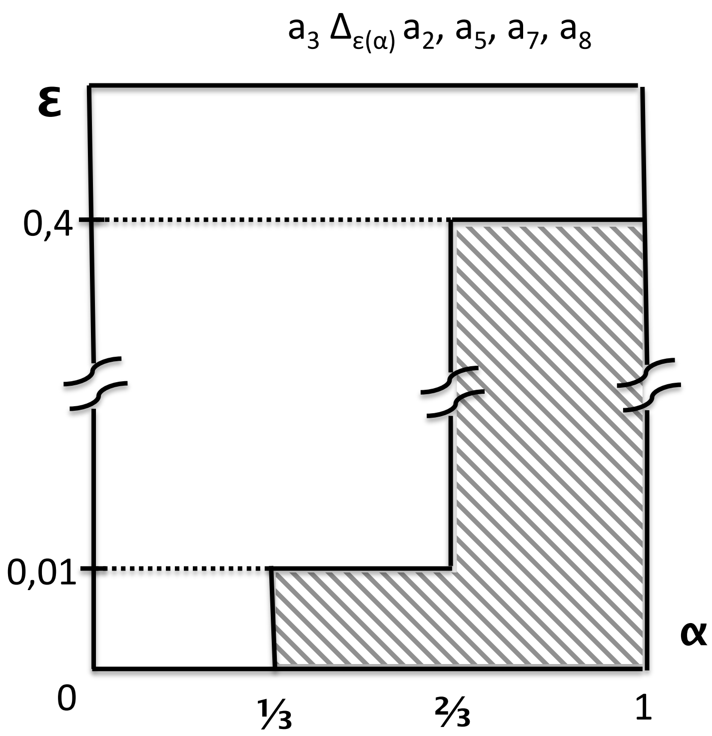
Crit2	Crit3	Crit4	Crit5	Crit6	Crit7
1	1	1	1	1	1
-1.01					
1	-1.01				
					1
		1			
-1.01			1		
	-1.01			1	
		1			-1.01
			1		
		-1.01	1		
			-1.01	1	
					-1
1					
	1				

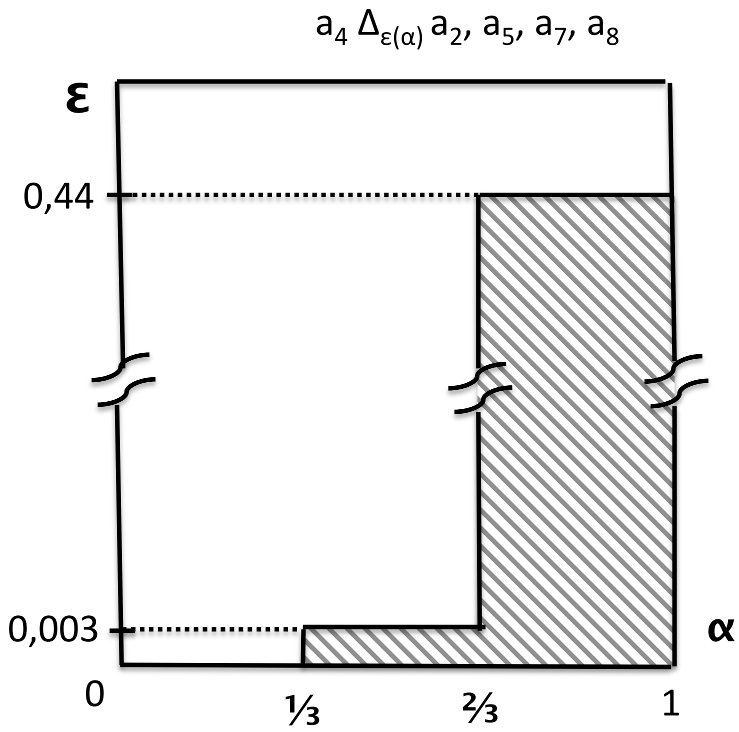
	a1	a2	a3	a4	a5	a6	a7	a8
a1		0.117	-0.134	-0.117	0.087	0.101	0.356	0.494
a2	0.2		-0.09	-0.05	-0.02	-0.016	0.51	0.377
a3	0.412	0.348		0.063	0.321	0.325	0.769	0.628
a4	0.349	0.285	-0.017		0.258	0.261	0.706	0.611
a5	0.22	0.04	-0.07	-0.03		0.02	0.53	0.407
a6	0.22	0.023	-0.07	-0.03	0		0.53	0.393
a7	-0.122	-0.005	-0.255	-0.238	-0.035	-0.02		0.372
a8	0.69	0.5	0.4	0.44	0.48	0.48	1	
Max Regret:	0.69	0.5	0.4	0.44	0.48	0.48	1	0.628

<u>Second set of experiments</u> <u>*cooperative group decision*</u>

aggregation of preferences - illustrative example

From the confrontation tables of the 3 DMs it results:





Conclusions

- The *adequacy* and *advantages*, from methodological and practical points of view, of using multi-attribute analysis, based on VIP-G methodology, for tackling similar complex decision problems involving the comparative evaluation and choice of engineering/technological alternatives *in telecom network design*, when *multidimensional, potentially conflicting*, often *incommensurate performance metrics, involving imprecise information*, are at stake.

- The methodology VIP-G can hence be used to *simplify the problem*, by a progressive elimination of the less interesting alternatives.

Conclusions

- Despite the lack of precision and imperfect consensus, in face-to-face cooperative group decision with a facilitator, application of this VIP-G methodology is adequate to see the emergence of a *more advantageous routing solution*…

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