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Even Swaps Method for Developing Assessment Capabilities of E-Negotiation System

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Abstract. One of the features of the e-negotiation systems is the capability to support negotiators in evaluating and comparing the offers. It is usually conducted by means of an additive scoring system, which results in the abstract scores assigned to all the offers. However the process of assigning the scores to the issues and options, required by an additive scoring system, may be perceived by some decision makers as an affected and vague. In the paper we consider thus an alternative approach that basis on the even swaps method. It is a part of multiple attribute decision making methodology called PrOACT, proposed by Hammond, Keeney and Raiffa, and focuses on finding the equivalent amounts as the balances between the unit of one issue with respect to the units of the others. The method is adopted to the negotiation actuality and programmed in a spreadsheet as a prototype software.

1. Introduction

E-Negotiation Systems (ENSs) usually have various capabilities. They can facilitate communication, support decision process, aid concession making and agreement preparation, evaluate and select strategies and tactics, give an access to expert knowledge etc. Taking into account the overall role they play in negotiation process they may be divided into three classes [8]: passive systems, active facilitative-mediation systems and proactive intervention-mediation systems. The passive ENSs facilitate communication and provides users with simple data presentation. They neither process data nor give any help on the merits of the case. The active facilitative-mediation systems give support to both the negotiators and the process. They allow to formulate the problem, define the structures of preferences, construct and evaluate the offers and analyze them with some formal methods. The proactive intervention-mediation systems have the same capabilities as the active ones but also allow to explore the negotiation knowledge. They analyze negotiation history and try to predict the future deriving from external knowledge bases. They may maintain the negotiation protocol and predict the counterpart strategies and tactics.

As we can see all but the passive systems are equipped with some analytic tools that allow at least for the offers evaluation and their comparison according to the negotiators' preferences. This kind of support comprises the assessment capability of

the ENS, which is very important for analyzing multi-issue negotiations. If we browse through some widely known and well described in literature ENSs [2, 10, 14, 15], we find that to accomplish the assessment capability of the ENS an additive scoring system is usually implemented. An additive scoring system [6, 7, 11] is a simple mathematical tool that allows for the offers evaluation by means of single aggregated criterion. It derives from utility theory and requires the problem decomposition and evaluation of issues and resolution levels within the issues respectively. The evaluation is conducted by assigning the subjective scores that reflect the decision maker's preferences for each possible resolutions levels of each issue. The scores are then aggregated to obtain a single score for each offer. The substantial advantage of an additive scoring system is that it never allows the offers to be incomparable. However, it requires of the negotiators some analytical skills and a quantitative way of thinking. Some negotiators may feel uncomfortable with this approach since the scores that they need to assign are in fact the abstract values of not clear explanation. Furthermore some researchers emphasize that these numerical scores are simply assigned to the issues and options instead of calculating them basing on the negotiators verbal evaluation [3, 13]. Hence the combination of additive scoring system with other decision support tools are proposed [17].

Another approach to the offers evaluation can be derived from multiple attribute decision making and basis on a concept of outranking [12]. It requires evaluation of the issue importance and analyzing the dominance between the offers. Each pair of offers is described then with a score that reflects a strength of domination, which is a sum of weights of issues, for which one offer dominates another. It allows to construct the offers hierarchy that help to find whether one offer is better or worse then the other one but – which is a disadvantage of this approach – it does not give the information of how much it is better/worse.

There are as well some other analytic tools for negotiation support based on more advanced methods like multi-attribute linear programming [1, 9] or game theory [5, 16] designed mostly for facilitating the mediators or arbitrators. They are rarely applied to ENSs since either represent the negotiation problem in too generalized way or are to complicated to use them without any external help of the analysts.

Taking into consideration all the above we propose a new approach to the offers comparison and evaluation. It bases on the even swaps method, which is a tool for multiple attribute decision making connected with a more general PrOACT approach. In this paper we show the foundations of this method, its principles and adaptation to the negotiation actuality. The even swaps method is going to be implemented in educational ENS that is being constructed by the author of this paper. Since the ENS has not been working tool yet, in the paper we show only the prototype implementation of the even swaps programmed in a spreadsheet and simulating only the assessment capability of the future ENS.

2. PrOACT And Even Swaps In Multiple Criteria Decision Making

The even swaps method is a straightforward approach to multiple criteria decision making. It requires a decision problem to be well structured and therefore is applied as a part of the PrOACT methodology [4, 7]. PrOACT divides any decision situation

into the five elements: problem, objectives, alternatives consequences and tradeoffs and then reassemble the results of their analysis into the right choice[1]. The algorithm of the analysis requires:

1. *Defining problem.*
   The decision problem needs to be well stated with no unwarranted assumptions. It is a key issue of decision process since the analysis of wrong stated problem results usually with a wrong decision.
2. *Specifying objectives*.
   Objectives are the decision maker's criteria that it is going to use to evaluate each decision. It is crucial to find a right criteria at this stage of process. Adding new to the decision process or removing unnecessary ones later (during tradeoff analysis) may be troublesome and require some tiring calculations.
3. *Creating alternatives*.
   Alternatives reflect the possible decisions that can be made to solve the problem. The carefulness is required for discovering the possible courses of action and creating a new alternatives since the final decision would not be better then the best identified alternative.
4. *Understanding consequences*.
   Having identified all the feasible alternatives the decision maker needs to evaluate how well do they satisfy its objectives. Therefore for each of the alternatives the vector of payoffs has been constructed, which consists of the quantitative or qualitative description of the alternative's consequences with respect to each decision criterion separately. It is necessary to compare then the alternatives and make the final decision. The comparison is usually made using the table of consequences, which consists of the vectors of payoffs.
5. *Making tradeoffs*.
   Decision maker eliminates from the dominated alternatives. It rarely leads to the identification of sole best alternative, since the objectives are usually conflicting and while comparing any two alternatives we often realize that former one is better then the latter one on some objectives, but worse on others. To chose the best alternative the tradeoff analysis is required. It allows to find the balance between each pair of alternatives by comparing the quality of their reciprocal surpluses on some objectives and shortages on others.

The five above elements of PrOACT allow to structure the decision problem and are the starting point to implement the even swaps method. The even swaps derive mainly from the concept of the vector domination, which says that if alternative A is better then alternative B on some objectives and no worse then B on all other objectives then we can consider that alternative A dominates B. Each dominated alternative can be eliminated from the decision process since it is in total worse then at least one alternative from the set of all feasible ones. If all the alternatives result in equal consequence for any objective it can be also ignored in the decision making process.

The even swaps method tries to adjust then the consequences of all considered alternatives to make them equivalent in terms of a given objective. It requires an increasing the value of an alternative in terms of one objective while decreasing its value by an equivalent amount in terms of another objective. The equivalent amounts

1 The authors of PrOACT approach call the decision to be smart, wise or right, which obviously means it is an optimal one with respect to the decision maker structure of preferences.

are defined subjectively by the decision maker and reflect its structure of preferences. After such an adjustment the considered objective can be eliminated and domination analysis can be conducted once again with respect to the rest of objectives. The process of the objectives elimination is repeated until the decision maker is able to find the best decision (the one that dominates all the others). The even swaps method applied in the PrOACT approach consists then in alternately assessment of the dominance that enables to eliminate alternatives and elimination of the objectives to make the dominance assessment possible on the next stage of decision process.

There is one substantial advantage of even swaps in comparison with other methods of alternatives comparison. Even swaps allow to compare virtually every two alternatives and consider one to be better, worse or equal to another, while some other methods (i.e. outranking) fail to find them incomparable. What is more, the even swaps method uses the true criteria to compare the alternatives instead of analyzing the abstract scores (like utilities, desirability etc.), which make the decision analysis more intuitive and easy to decision maker and let us to believe that it may facilitate better the decision process in any decision support tool including the ENS.

3. Negotiation Support With Even Swaps

Structuring negotiations according to the PrOACT requirements may be perceived as a little troublesome but it is concordant with the analysis of the negotiation case that is being conducted during the pre-negotiation phase. In this phase parties hold the initial talks, formulate the negotiation subject and agree the negotiation set by suggesting the issues and their resolution levels, which allow to construct the table of consequences. Let us consider a simple example of business negotiation with four issues: price, time of payment, time of delivery and returns conditions. After four steps of the PrOACT analysis we obtain a consequences table the part of which is shown in Table 1.

Table 1. Table of consequences for business negotiations

Objectives	**Offers**			
	1	**2**	**3**	**4**
Price	$40	$37	$41	$45
Time of payment	10 days	Upon delivery	10 days	60 days
Time of delivery	3 weeks	5 weeks	4 weeks	4 weeks
Returns	Above 5% of spoilage	Above 10% of spoilage	Above 15% of spoilage	Above 2% of spoilage
Score	70	55	45	60

The table consists of four selected offers (for real-word negotiations it may consists of hundreds) described by the resolution levels assured for all the issues considered. The resolution levels can be interpreted as the offers consequences but applying traditional additive scoring system we can obtain a single payoff for each offer. The last row of Table 1 shows the score that was calculated on the basis of the buyer party preferences. With domination analysis (and scores excluded) we can eliminate from the consequences table the offer number 3, since it results with the payoffs no better then the offer 1. However that is all what the domination analysis allows for. Thus the

three remaining offers are considered incomparable. The situation becomes far more better when we include the aggregating scores into our comparison. We see then clearly, that the offer number 1 is the best negotiation offer. The second best is the offer 4 with the score of 60. The difference between these two offers is of 10, but the problem is how this difference can be interpreted. May we use the ratio scale to say that the offer number 1 is 1,17 times better (1,17 = 70 / 60) then the offer number 4? Is the difference of 10 worth of fighting and spoiling the parties relationship?

We can avoid such problems by using the even swaps method. To compare the offers we need to ask negotiator about the tradeoff values. Let us assume that at the first stage of analysis we will compare the issue of price with time of payment. Negotiator needs to assess then what change in price will compensate any change in time of payment. The problem is to set the basis of this comparison, because depending on the basis value of time of payment, we receive different amounts of equivalent prices. We recommend use the best resolution levels of the issues that are going to be set equal, for we can easily interpret the changes then as the additional costs we need to bear to make any considered offer best.

Negotiator will use then as the basis the best value of 60 days of delay in payment. It starts with comparing offer 2 with offer 4 and needs to find how many dollars it is going pay more for the contract to have the payment delayed of 60 days. Let us assume that the negotiator decided to pay $6 for 60 days. Comparing the offer 1 with offer 2 we could assume consequently that for the delay of 50 days the negotiator is going to pay $5 but it does not have to be true since the preferences usually are not distributed linearly. Assume that the negotiator decided to pay $6 for 60 days difference because it receives this amount as interest from 2 months bank deposit. If the difference is 50 days it is enough only for 1 month deposit with gain of $3. The tradeoff then will be of $3 instead of $5.

Table 2 . Making even swaps between price and time of payment

Issues/ Objectives	**Offers**			
	1	**2**	**3**	**4**
Price	~~$40~~ $45	~~$37~~ $43	~~$41~~ $46	$45
Time of payment	~~10 days~~ 60 days	~~Upon delivery~~ 60 days	~~10 days~~ 60 days	60 days
Time of delivery	3 weeks	5 weeks	4 weeks	4 weeks
Returns	Above 5% of spoilage	Above 10% of spoilage	Above 15% of spoilage	Above 2% of spoilage

To simplify our case we assume the linear distribution of preferences. We recalculate now the consequences from Table 1 to render them equivalent in terms of time of payment. The results we obtain are shown in Table 2.

According to the even swaps procedure we can eliminate from the further analysis the issue of time of payment, since it results now in equal consequences for every offer under consideration. The new table of consequences is shown in Table 3.

Table 3. Table of consequences after making the first swap

Issues/ Objectives	Offers 1	2	3	4
Price	\$45	\$43	\$46	\$45
Time of delivery	3 weeks	5 weeks	4 weeks	4 weeks
Returns	Above 5% of spoilage	Above 10% of spoilage	Above 15% of spoilage	Above 2% of spoilage

Let us assume that negotiator has compared the rest of the issues and defined the following swaps (with linear distribution): \$1 of price for 2 weeks of delay in delivery and \$1 of price for 3% of spoilage. After completing the tradeoff analysis between price and time of delivery we obtain the table of consequences as shown in Table 4. Please notice that to make the issue of time of delivery to be irrelevant (with equal consequences for all offers) we have chosen the best resolution level of 3 weeks.

Table 4. Making even swaps between price and time of delivery

Issues/ Objectives	Offers 1	2	3	4
Price	\$45	~~\$43~~ \$44	~~\$46~~ \$46,5	~~\$45~~ \$45,5
Time of delivery	3 weeks	~~5 weeks~~ 3 weeks	~~4 weeks~~ 3 weeks	~~4 weeks~~ 3 weeks
Returns	Above 5% of spoilage	Above 10% of spoilage	Above 15% of spoilage	Above 2% of spoilage

We remove now the issue of time of delivery from the further analysis and make the tradeoffs for two last issues: price and returns conditions, taking as a base the best result of the return at the spoilage of above 2%. After making this swap we obtain the table of consequences described with only one objective – the price. To show the effect of even swaps we return to full initial table of consequences and add in the last row of the table the overall scores of offers in terms of price (see Table 5).

Table 5 . Table of consequences with the overall score of in terms of price after

Objectives	Offers 1	2	3	4
Price	\$40	\$37	\$41	\$45
Time of payment	10 days	Upon delivery	10 days	60 days
Time of delivery	3 weeks	5 weeks	4 weeks	4 weeks
Returns	Above 5% of spoilage	Above 10% of spoilage	Above 15% of spoilage	Above 2% of spoilage
Score in terms of price	\$46	\$46,66	\$50,83	\$45,5

The negotiator can compare now the offers looking at the score in terms of price and choose the best one, which is the offer number 4. It can easily interpret the score since it is not the abstract value as desirability or utility. The score shows the true

price of each offer while assuming that it fulfills all the other objectives at the highest possible level. Deriving from the negotiator's equivalent amounts of swaps we can easily recalculate the table of consequences to present it with the overall score in terms of all other objectives. Such a presentation can help the negotiator to make a final decision since the differences in the overall prices are in fact very small.

5. Implementing Even Swaps In ENS

The above concept of applying the even swaps method into the negotiation support is being implemented into an ENS, the configuration of which comprises of:

- the web-based core acting as the data base storing information about the negotiation case structure, offers and messages exchanged and the negotiators' individual preferences and
- individual NSSs working as the Excel Add-In, exchanging data with the web-based core, supporting negotiators in PrOACT procedures, conducting even swaps and offers analyzing.

The key elements of the client-side NSS have already been programmed, including the problem definition, identifying the objectives and their resolution levels that are typical for the vast majority of ENSs. All characteristic elements of even swaps have been programmed as the Even Swaps Creator, including definition of the pairs of issues for declaring the swaps (Fig. 1.), evaluation of the equivalent values for each swap (Fig. 2.) and defining the issue to calculate the overall score (Fig. 3.).

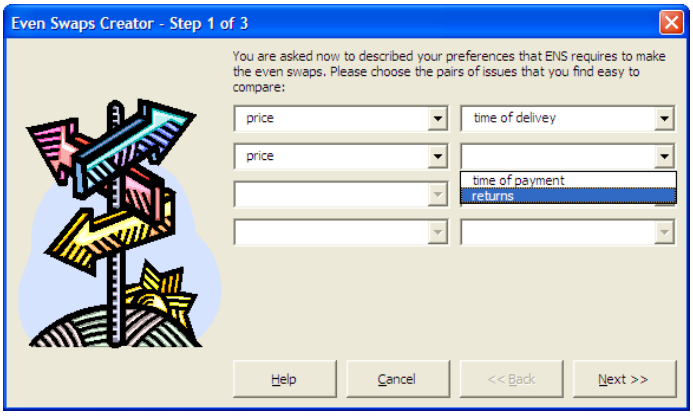

Fig. 1. Defining the pairs of issues to compare for even swaps evaluation

The Even Swaps Creator accomplishes the steps of the analysis we proposed in the section 4 and allows to structure the negotiator's preferences. The preferences describe all essential swaps and allow to compare the offers during the negotiation process. To make the comparison possible in the sense of overall scores the system forces the offers to be the compete packages that consist of all the issues with one feasible resolution level each. An example design of the offer exchange panel with the even swaps based scores is shown in Figure 4.

Further works over the ENS include developing the communication capability of the system by introducing the message panel, designing some graphical elements for data visualization (i.e. history graphs), programming the web-based core and it's connections with the negotiators' Excel Add-Ins. Diversification of evaluation methods is considered as well by introducing some classic approaches based on the concept of utility with more advanced extensions like AHP [17].

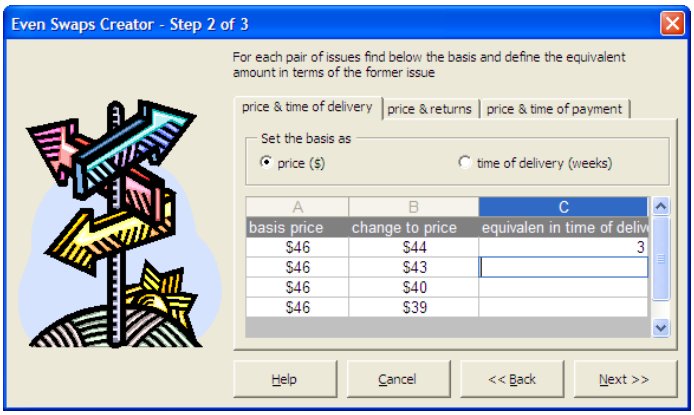

Fig. 2. Evaluating equivalent amounts for the swaps

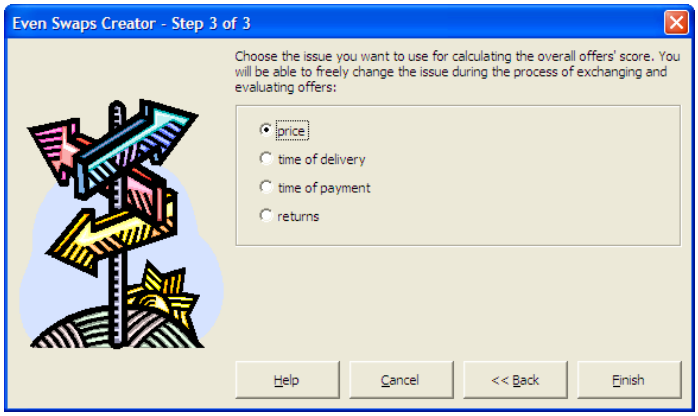

Fig. 3. Choosing the issue for creating the overall score of the offers

Fig. 4. Offer exchange panel

6. Summary

In this paper we have proposed the even swaps based approach for developing the assessment capability of ENS. It is an alternative to the classic methods based on the utility or desirability scores, especially an additive scoring system, that nowadays are commonly used in most of the ENSs. We have chosen the even swaps method since it allows negotiators to avoid comparing issues and resolution levels by means of some abstract values and requires only the analysis in terms of the objectives the parties decided to negotiate. The substantial merit of even swaps is they allow not only to consider one offer to be better or worse then another, but also to find the difference between them and present it as the overall score in terms of selected objective. That is remarkable since the outranking based multiple methods may result in incomparability, in which we are not able to consider one offer to be better, worse or even equal to another. Changing or adding new issues to the negotiation problem evaluated with even swaps is very easy. It requires only an additional swap analysis which boils down to find new equivalent values the number of which depends on the number of resolution levels declared for the new issue. It is a remarkable advantage in comparison with traditional additive scoring system, which requires both distributing scores among all new feasible resolution levels and rescaling the old ones.

To find the true value of the even swaps as a tool for negotiation support we need to complete the ENS. Since it is going to be equipped both with even swaps and additive scoring system we will be able to find how this two scoring methods are perceived by the negotiators and which of them is more acceptable and found easier by them.

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