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THE ACCURACY OF SYMMETRIC NEGOTIATION SUPPORT BASED ON SCORING SYSTEMS BUILT BY HOLISTIC APPROACH AND DIRECT RATING

Abstract

In negotiations, the parties can be offered decision support based on formal scoring systems. These systems can be determined by means of various preference elicitation techniques and multiple criteria decision aiding (MCDA) approaches. In most situations the simplest tool is used, namely the direct rating technique (DR). In this paper we analyze to what extent the scoring system obtained by means of a mix of MARS (Measuring Attractiveness near Reference Solutions) and UTASTAR (Utilités Additives) holistic preference elicitation approaches accurately reflects the negotiator's preferences; and how much its potential inaccuracy may affect the symmetric support given to the parties. We compare the differences in the recommendation of Nash bargaining solutions offered to the parties when the bargaining analysis is determined by means of holistic and DR approaches and analyze which of them misrepresent the actual negotiation situation more. The results show that there are no significant differences when the quality of average recommendations are compared, yet the DR-based scoring system recommends the true Nash bargaining solution for more negotiation instances than the holistic one does.

Keywords: negotiation support, bargaining solutions, efficient frontier, direct rating, holistic preference elicitation, UTASTAR.

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1   Introduction

Decision theory offers many analytical approaches, methods and techniques to support decision makers in their individual and group decisions (Figueira et al., 2005; Anderson et al., 2018). It is also used in negotiation support, to assist the parties in finding mutually satisfying, fair and efficient compromises (Raiffa et al., 2003). Such negotiation support can be offered to the negotiators provided that they prepare themselves accurately in advance, i.e. in the prenegotiation phase. There are many different check-lists of the prenegotiation activities the parties should follow to make sure that they are prepared comprehensively (Zartman, 1989; Simons and Tripp, 2003). They focus on the problem definition, defining its structure (called the negotiation template), eliciting the negotiator's preferences and building the formal negotiation offer scoring system (Raiffa, 1982; Wachowicz, 2010). Since most of the negotiation problems involve multiple issues, the prenegotiation protocols usually implement methods and techniques from multiple criteria decision aiding (MCDA). The direct rating (DR) technique (Keeney and Raiffa, 1976) is considered to be one of the least cognitively demanding and technically least complicated MCDA approaches, and hence it is widely used in negotiation teaching, experiments, simulations and also in negotiation support systems (Raiffa, 1982; Kersten and Noronha, 1999; Schoop et al., 2003).

Using an adequate and efficient MCDA tool for preference elicitation and determination of an accurate negotiation offer scoring system is of critical importance for negotiators. Such a scoring system is used individually by the parties (asymmetric support) to analyze the profitability of the offers submitted, allows to compare the balance of the concessions made by each of the negotiators, analyzing the dynamics of the negotiation process, offering proactive support by a third party in suggesting the counteroffers as well as to analyze the negotiation process from the mutual perspective and to maximize the joint value of the contract or, if deadlocks occur, to determine the arbitration solutions for the parties (symmetric support). Inaccurate scoring systems result in misinterpretation of the negotiation process and lead to agreements that do not meet the true aspiration levels of the negotiators. The problem of determining an accurate scoring system is also very important in representative negotiations (Hanycz et al., 2008). When the agents negotiate on behalf of their principals, they must be sure that the support offered to them takes into consideration their principals' preferences precisely. Hence, the preference elicitation tool should be designed in a cognitively easy way that helps human decision makers to generate an accurate scoring system, assuming the agents (and, in general, the negotiators) are willing to declare their true preferences (Lee and Thompson, 2011). Otherwise, the

negotiation contract, despite being considered satisfying on the basis of the ratings provided by the support tool or system, may happen to be weak, if not unprofitable.

Unfortunately, despite its simplicity, the DR approach is sometimes misused by negotiators. As shown in a series of representative negotiation experiments conducted in the Inspire system (Roszkowska and Wachowicz, 2014; Roszkowska and Wachowicz, 2015) the agents (who negotiated the contracts on behalf of their principals) were often unable to determine the scoring systems that were ordinally accurate and the ratings they used did not represent their principals' preferences well. Such inaccuracy also impacted significantly the quality of contracts. What is also important, later analyses did not allow to draw binding conclusions linking these inaccuracies with the motivations and goals of the agents (Kersten et al., 2017). Thus, the misuse of the DR mechanism may be also caused by low cognitive capabilities, a limited number sense or insufficient mathematical background of the negotiators. Hence, a new question arises: whether implementing alternative preference elicitation mechanisms can reduce preference misrepresentation and ensure more reliable decision support for the negotiators.

Alternative MCDA techniques, such as Analytic Hierarchical Process (AHP), even swaps or TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution), have been suggested for use in multi-issue negotiation support (Mustajoki and Hamalainen, 2000; Wachowicz, 2010; Roszkowska and Wachowicz, 2015). One group of methods that appear best predisposed for use in negotiation support are disaggregation methods (Jacquet-Lagreze and Siskos, 2001; Doumpos and Zopounidis, 2011), which aim at deriving the preferences of the decision maker from their holistic declarations of priorities using examples of potential solutions. The decision maker does not need to operate with quantitative evaluations and express their preferences qualitatively by considering which of the examples are better, and which are worse. This eliminates the negative effects of the negotiator's lack of decision making and mathematical knowledge and therefore the holistic approach is regarded as easy and intuitive (Siskos and Grigoroudis, 2010; Ghaderi et al., 2017). The holistic approach has already been proposed to support group and negotiation decision making problems, e.g., in the Mediator system, where the UTA (Utilités Additives) technique was implemented (Jarke et al., 1987); or in the MARS (Measuring Alternatives Near Reference Solutions) approach, where elements of ZAPROS (Closed Procedures near Reference Situation[1]) and MACBETH (Measuring Attractiveness by

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[1] An acronym from Russian words.

a Categorical Based Evaluation Technique) were used (Górecka et al., 2016). These were, however, theoretical proposals only, and their applicability was not tested empirically. In a previous paper we showed that UTASTAR linked with certain notions of MARS can be used to determine the scoring systems that do not differ significantly in terms of accuracy from the ones determined by means of the DR technique (Kersten et al., 2017), therefore it is a potentially interesting and efficient tool in asymmetric individual support.

The goal of this paper is to analyze how the potential inaccuracy of the scoring systems determined by means of a mix of MARS and UTASTAR holistic approach may affect the symmetric negotiation support that can be offered to the negotiators by a third party such as an arbitrator or a negotiation support system. We analyze the records of the bilateral representative negotiation experiments conducted in the Inspire negotiation support system (Kersten and Noronha, 1999) and compare the same negotiation instances in which the preference information was provided by the agents on the basis of the information they received from their counterpart. Using the agents' preference declarations, the scoring systems were built in two ways: (1) by means of DR and (2) simulated using the MARS-UTASTAR approach. For both types of scoring systems Nash bargaining solutions are determined and compared to the one that would be the true recommendation if the principals negotiated themselves.

The paper consists of four next sections. Section 2 discusses the issue of negotiation support together with the importance of the scoring systems for symmetric and asymmetric negotiation support. In section 3 the problem of measuring the accuracy of the scoring systems is briefly presented in the context of individual and representative negotiations. In section 4 our experiment is discussed along with our approach, while in section 5 the results are presented. We conclude with a discussion and suggestions for future research.

2   Negotiation support

2.1 Negotiation template and the scoring system

Many researchers emphasize the importance of the prenegotiation preparation (Stein, 1989; Zartman, 1989; Simons and Tripp, 2003). It allows to gather all required information, prepare the negotiation strategy, analyze the potential solutions and assign to each of them a clear motivation line that can be used in the bargaining phase. It is also important from the viewpoint of the scope and quality of the negotiation support that can be offered to the negotiators by software systems or third parties. Both the individual (asymmetric) and mutual (symmetric) support may be offered to the negotiators if the negotiation problem

is structured in the form of the so-called negotiation template (which is a detailed description of the structure of the negotiation problem) and if the parties' preferences are elicited for each element of the template (see Raiffa et al., 2003; Roszkowska et al., 2017).

To define a template, the countable sets X_i of salient options (x_i^j) are defined for each negotiation issue g_i, for $i = 1, \ldots, m$ and $j = 1, \ldots, |X_i|$. The template is defined as the set of issues and their resolution levels (options)

$$T = \left\{ \{g_i\}_{\forall i}, \{x_i^j\}_{\forall i,j} \right\}. \tag{1}$$

The negotiation offer scoring system is a system of cardinal ratings that represent the negotiator's preferences for all the elements of template T. Formally, it is represented as a the set of issue weights v_i and option ratings $v(x_i^j)$

$$S = \left\{ \{v_i\}_{\forall i}, \{v(x_i^j)\}_{\forall i;j} \right\}. \tag{2}$$

We will assume that the preferences are additive, therefore each feasible negotiation offer a which consists of selected salient options x_i^j can be evaluated using the scoring system S according to the following formula:

$$V(a) = \sum_{i=1}^{m} \sum_{j=1}^{|X_i|} z_i^j(a) \cdot v(x_i^j), \tag{3}$$

where $z_i^j(a)$ indicates if the jth option of the ith issue contains offer a (1) or not (0).

2.2 Using scoring systems in negotiation support

The negotiation template scoring system may be used during the whole negotiation process to support various activities of the negotiators (Young, 1991; Raiffa et al., 2003) in their individual activities, i.e. to offer an asymmetric support. In the prenegotiation preparation phase, after the scoring system has been built, the negotiator may use it for planning the concession strategy. They may be also used in the actual conduct of negotiations to visualize the negotiation progress by means of a negotiation history graph with concession paths of both parties. The subsequent offers submitted by the parties are scored according to $V(\cdot)$ of the scoring function of the negotiator and represented in the graph as separate data series. The negotiator may analyze the graph and consider if the concessions of both parties are reciprocal and which elements of the negotiation strategy should be implemented as an adequate response to the counterpart's moves. A negotiator's own concession paths show his/her true concessions when falling, and reverse concessions when rising. Conversely, the counterpart's concession paths show his/her concessions when rising and reverse concessions when falling. The scoring systems can also be used by negotiation support systems (NSS) to assist the negotiators in the construction of their offers in an

actual conduct of negotiations (Kersten and Noronha, 1999; Schoop et al., 2003; Wachowicz, 2008) by implementing offer generators which find packages of various trade-offs (consisting of the options that vary as much as possible among the offers) for rating levels declared by the negotiators themselves.

The scoring systems of both negotiators may be applied to provide mutual symmetric support to suggest a fair solution in the negotiation process if the parties are unable to reach it themselves. This situation can occur when the aspirations of the parties are set extremely high and their willingness for concessions is limited. This may lead to deadlocks and impasses, for which the only solution is the intervention of a third party suggesting a fair solution (a compromise contract) designed on the basis of the scoring systems of both parties and taking into account their reservation levels declared as BATNA (Best Alternatives To Negotiated Agreements). Symmetric support may also be used when the parties negotiate their contracts themselves. The analysis is then focused on the verification of the efficiency of the negotiated agreement and on searching for the possible fair improvements.

In a symmetric negotiation all the feasible negotiation offers resulting from the template are presented in the rating spaces of the negotiating parties simultaneously. Consequently, each offer is represented as a vector of ratings, as shown in Figure 1.
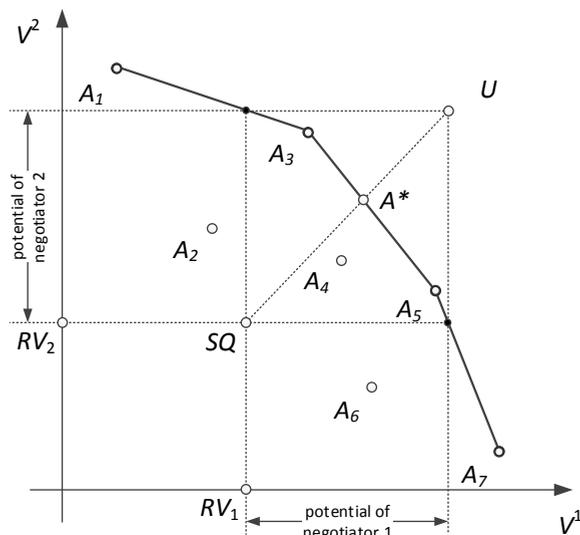

Figure 1: Symmetric analysis of the fair negotiation agreement

The status quo point (SQ) represents the reservation levels of the parties (RV_1 and RV_2, respectively), i.e., the worst outcomes that they are going to accept in these negotiations. The negotiators will not accept the contract of the values worse than their reservation levels, since they prefer to accept their BATNA (the solutions external to the negotiation process) instead. Therefore the search for a fair bargaining solution should be focused solely on the offers that outperform the SQ point and are located on the efficient frontier, i.e., are not outperformed by any other offer from the set of feasible offers.

In Figure 1 an efficient frontier consists of offers A_1, A_3, A_5, A_7. For the status quo SQ the third party may easily conclude that it is inferior and outperformed by A_3, A_5 and A_4. The first two are at the same time the efficient ones, and if the third party suggested a fair bargaining solution that left no gains at the bargaining table, only these two could be considered. Unfortunately, one of the offers (A_3) benefits more negotiator 2, while the other one (A_5) favors more negotiator 1. To identify a single and adequately balanced negotiation agreement one of the notions of fair solutions may be applied (Nash, 1950; Kalai and Smorodinsky, 1975; Gupta and Livne, 1988).

Figure 1 presents a notion of such a solution suggested by Raiffa (1953). Raiffa's idea is based on maximizing the proportion of the negotiators' potentials, which are the differences between the rating of the contract resulting from the joint reservation level (the status quo point) and the rating of the potential maximal improvement of this contract, assuming that no gains are granted to the second party. These maximal improvements are represented as an utopia point U. The intersection of the line joining SQ and U with an efficient frontier constitutes the fair Raiffa solution A^*. Note that A^* can be obtained by randomizing between A_3 and A_5. Since these two packages differ in one issue only, the randomizing amounts to finding a fair option between two neighboring salient options of these issues.

Another option is to use the notion of the Nash bargaining solution (1953). The Nash bargaining agreement is the unique solution to a two-person bargaining problem that satisfies the axioms of scale invariance, symmetry, efficiency, and independence of irrelevant alternatives. Nash proved that the solutions satisfying these axioms can be obtained by solving the following maximization problem

$$\max_{V_1(a), V_2(a)} (V_1(a) - RV_1) \cdot (V_2(a) - RV_2) \tag{4}$$
$$\text{s.t } V_1(a) \geq RV_1, V_2(a) \geq RV_2.$$

In many negotiation situations the Nash and Raiffa solutions are located close to each other (Raiffa et al., 2002).

Note that this symmetric negotiation analysis can also be implemented in the post-negotiation phase for those negotiators who negotiate their own contracts. In this case instead of using the point SQ, an actual contract is selected and subject to improvements. However, further in this paper we will analyze the problem of identifying the fair bargaining solution based on the scoring system of the agents, instead of improving the actually negotiated agreement.

3   Representative negotiations and scoring system accuracy

As shown in section 2, the scoring system offers a wide range of support possibilities. However, to ensure the reliability of the support, the scoring systems need to be accurate, i.e., they should reflect the negotiators' preferences correctly. In the preference elicitation process, each negotiator has implicitly defined their system of preferences S (usually in the form of non-organized and non-structured declarations and verbal descriptions) in the form of the scoring system S^N. However, during this process the negotiators' cognitive limitations related to their skills and/or the specificity of the preference elicitation technique can manifest themselves. As a result, the scoring system S^N can inaccurately represent S. More specifically, if we assume that there is an ideal formal representation of S in the form of a reference scoring system S^R, then S^N can be different or discordant from S^R.

A similar problem can occur in representative negotiations, i.e., when negotiations are conducted by external negotiators (agents) on behalf of their principals. In representative negotiations the preference system S^P of the principal, is communicated to the agent who builds the scoring system S^A reflecting the principal's preferences best[2]. As previously, it can be assumed that a theoretical formal representation of S^P in the form of the scoring systems S^P can be formulated, but the principal, due to his/her limited skills and formal knowledge, cannot operate with S^P directly or impart their preferences using S^P[3].

The accuracy or concordance of S^A with respect to S^P (or S^R) may be measured in two ways, at the ordinal or cardinal level (see (Roszkowska et al., 2017)). Ordinal accuracy checks if S^A represents the same rank order of preferences as

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[2]   We will assume that no other incentives play a role here since the agents want to represent their principals in the best possible way, being aware that they will be evaluated on the basis of the results and their efforts during the negotiation process (Lee and Thompson, 2011).

[3]   If the principal were able to define S^P, the problem would not exist for the agents, since they would only have to copy S^P into S^A.

S^P, while the cardinal accuracy measures the differences in the strength of preferences in both scoring systems. The ordinal inaccuracy index is defined by the following formula

$$OI(S^P, S^A) = |L| - \sum_{l=1}^{|L|} r_l, \tag{5}$$

where L is the set of all possible pairs of the negotiation template elements and r_l is a binary indicator describing concordance (1) or discordance (0) of the ranks resulting from the ratings for lth pair in S^P and S^A.

The cardinal inaccuracy index is defined as

$$CI(S^P, S^A) = \sum_{i=1}^{m} \sum_{j=1}^{|X_i|} |v^P(x_i^j) - v^A(x_i^j)|, \tag{6}$$

where $v^P(x_i^j)$ and $v^A(x_i^j)$ are the ratings of jth option of ith issue in S^P and S^A, respectively.

In the next sections we will try to find the difference in the accuracy of S^A as determined by means of DR and the holistic approach, and how using these approaches affects the results of the symmetric support as regards the recommendations of fair bargaining solutions

4 Organization of the negotiation experiment

4.1 Problem

We will consider the problem of representative negotiations, in which the scoring systems of the agent (S^{A1}) and their counterpart (S^{A2}) are used by the third party to suggest the efficient and fair solutions, as it was described in section 2.2. In our analyzes we will use the dataset from the bilateral negotiation experiments organized in the Inspire system (see Kersten and Noronha, 1999; Roszkowska et al., 2017).

In this negotiation the representative of a musician (Fado) negotiates a contract with the representatives of an entertainment company (Mosico). The template consists of four issues: number of promotional concerts, number of songs, royalties and contract signing bonus. For all these issues the sets of salient options are predefined. The principals provide their agents with the preference information described verbally and additionally visualized using bar graphs (see Appendix 1). Since the visualization is fairly precise the reference scoring systems of the principals (S^P) can be easily determined by measuring the bar sizes separately for the Fado and the Mosico parties. In Inspire the agents build their individual scoring systems by means of a hybrid conjoint approach (Angur et al., 1996) and the major focus is put on declaring the ratings using DR. The negotiation support offered to the parties is based on their scoring systems.

When analyzing the issues related to symmetric negotiation support and suggesting the fair bargaining solutions for the parties, one may assume that if the inaccuracy of S^{A1} and S^{A2} is not large, the negotiation spaces and efficient frontier obtained for S^{A1} and S^{A2} do not differ significantly from the ones that would be obtained from the actual preference systems of the principals, i.e., from S^{P1} and S^{P2}. Conversely, for the agents' scoring systems with high inaccuracy indexes the efficient frontiers may be totally different. This may therefore affect the final recommendation as regards the fair solution (Figure 2).
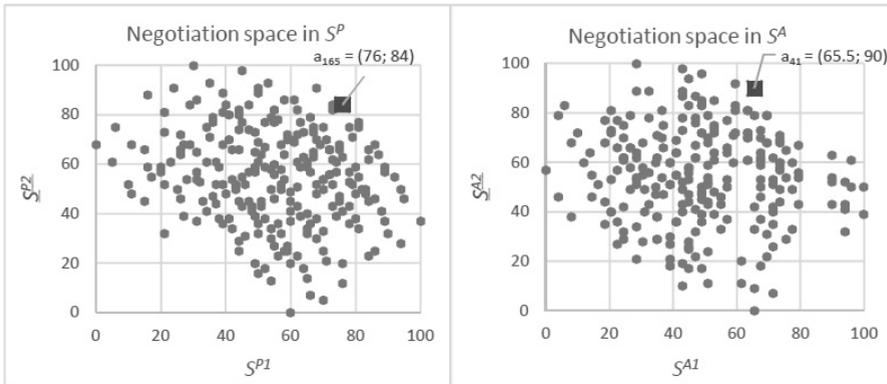
Figure 2: Negotiation space for the principals' (S^{P1} and S^{P2}) and agents' (S^{A1} and S^{A2}) scoring systems

Figure 2 shows examples of the negotiation spaces of the 240 feasible negotiation offers for the two Inspire negotiators. All feasible offers were scored separately using the principals' (S^P) and the agents' (S^A) scoring systems. S^{A1} and S^{A2} appear to be quite inaccurate, since the entire negotiation space as seen by the agents (right chart) differs significantly from what their principals see (left chart). The shapes of the efficient frontiers are also different. Finally, the fair solutions determined using the notion of the Nash bargaining solution (with $SQ = (0,0)$) are also different. For the principals, this is another offer, a_{165}, which specifies the following contract: {7 concerts; 14 songs; 2.5% of royalties; $200K of contract value} and results in ratings 76 and 84 for principal 1 and 2, respectively. For the agents, the Nash solution identifies as the fair solution offer a_{41}, which specifies the following contract: {5 concerts; 14 songs; 2% of royalties; $150K of contract value} with 61.5 and 90 rating points for agent 1 and agent 2, respectively. Thus, we see that the inaccuracy of the agents' scoring systems may lead to a significant change in the recommendation of the bargaining solution. The question is: how often this happens when the holistic approach is implemented to elicit the scoring system, and how often, when the classic DR approach is used.

4.2 Method

As mentioned previously, in Inspire the scoring systems are determined individually using the conjoint hybrid approach. One of the phases of this algorithm requires the agents to provide the preference information by direct assignment of ratings. Therefore we can easily find the DR-based scoring systems (S_{DR}^A) and determine their accuracy (Roszkowska et al., 2017). In this paper we will also use S_{DR}^A's to simulate the symmetric negotiation support and identify the recommendations of fair solutions.

The preference information provided in Inspire by the agents will also be used to simulate the scoring systems determined by means of the holistic approach. The holistic approach tested in this paper implements the modified UTASTAR algorithm (Siskos and Yannacopoulos, 1985). In UTASTAR, instead of assigning the numerical scores $v(x_i^j)$ directly, the negotiator ranks the selected offers defined in the reference set $A_R \subset A$ and this information is used to build a linear program that minimizes errors in the estimations of offers from A_R. By solving the program, the ratings of salient options $v(x_i^j)$ are determined. It is assumed that the marginal scoring functions are piece-wise linear between the neighboring salient options. Hence, for a quantitative issues any option from between x_i^j and x_i^{j+1} can be evaluated using a linear interpolation between their ratings, i.e. between $v(x_i^j)$ and $v(x_i^{j+1})$.

Taking into account the method of preference elicitation in UTASTAR, this approach seems well suited to the problem of low cognitive capabilities or decision making skills of potential negotiators. They do not need to operate with numbers while declaring their priorities, nor are they are forced to declare the importance (weights) of the negotiation issues directly. On the contrary, they define only the examples of offers that can appear on the negotiation table and are asked to rank order them. There is also no need to provide the information on strength of preferences.

One of the problems with using UTASTAR is the definition of the reference set A_R. In our earlier papers we show that depending on the informativeness of such a set, the scoring system can happen to be more or less accurate (Roszkowska et al., 2017). In this paper we will therefore use a reference set of example alternatives determined according to another MCDA holistic approach called MARS (Górecka et al., 2016). In MARS the alternatives are built on the basis of the negotiation template and a general declaration by the negotiators of the best negotiation option for each issue. Using this information the alternatives are composed that consist of the best options for all the issues but one. Such

a composition of offers allows the negotiators to easily compare any two offers, since it requires to analyze a trade-off between two issues only. An example of the MARS-based reference set for the Mosico party is shown in Table 1.

Table 1: The MARS-based offers close to the ideal one for the Mosico party
in the Inspire negotiation

Offer	Concerts	Songs	Royalties	Contract
1	5	14	2.0	125 000
2	6	14	2.0	125 000
3	7	14	2.0	125 000
4	8	11	2.0	125 000
5	8	12	2.0	125 000
6	8	13	2.0	125 000
7	8	14	1.5	125 000
8	8	14	2.0	125 000
9	8	14	2.0	150 000
10	8	14	2.0	200 000
11	8	14	2.5	125 000
12	8	14	3.0	125 000
13	8	15	2.0	125 000

In our experiment we will use the preference information provided by the Inspire agents for their S_{DR}^A's to rank the MARS-based alternatives; the resulting rank order will be used to feed the UTASTAR linear programming model. Since the preferences specified by the Inspire principals are non-monotonous (see Appendix 1) the final LP model needs to be set up according to its extensions that handle unimodal preferences. We will implement the UTA-NM algorithm tuned to produce normalized results (Despotis and Zopounidis, 1995). By solving the final LP model we will obtain the holistic-based (MARS-UTASTAR) rating system S_{UTA}^A.

The systems S_{DR}^A and S_{UTA}^A will be used independently to determine the negotiation spaces for each negotiation dyad. Next, for each negotiation space the Nash arbitration procedure will be run to identify the fair bargaining solution (Nash, 1950), as described in section 2.2. The solutions determined for S_{UTA}^A- and S_{DR}^A-based spaces will be compared to the actual Nash bargaining solution in the principals' negotiation spaces (the S^P-based ones) and the deviations will be measured. A direct comparison of the efficaciousness of the support provided by means of DR- and UTA-based scoring systems may also be performed by comparing the average Nash products.

Note that in our experiment we focus on the problem of searching for the fair bargaining solutions independently from the actual results the agents obtained in

their negotiation in Inspire. For the scoring spaces of both agents we determine the Nash arbitration recommendation simulating the situation in which the negotiators are unable to find the contract themselves. As there is no additional information about the BATNA or the reservation levels of the principals in preference description, we used $SQ = (0,0)$. In this way we eliminate other factors that can affect the results when the improvements of the actual negotiation agreements are analyzed, such as the differences in negotiation skills, strategies and motivations that made the agents end their negotiation in a particular zone of the negotiation space for which there exists a limited number of improvements (e.g., one) which are identical regardless whether the agent's or the principal's scoring systems are considered, and – consequently – the recommendations are also identical and 100% accurate.

As mentioned before, in our analyses we use the dataset from the Inspire system's bilateral negotiation experiments conducted in a few rounds between spring 2015 and spring 2017. From the whole dataset we removed the incomplete records of those dyads which did not reach an agreement. This allowed to gather a database of 706 records of agents (353 representatives of Mosico and 353 of Fado).

5   Results

We analyzed the Inspire dataset using a special-purpose spreadsheet add-in using the VBA code that implemented the modified MARS-UTASTAR approach with the NM rescaling method. The results we obtained from our dataset indicate that the agents had a great problem with determining the accurate scoring systems using the hybrid conjoint algorithm with the DR approach. Only 23% of the Fado agents and 31% of the Mosicos were able to build a scoring system ordinally fully accurate with the preferences of their principals. The accuracy of the DR-based scoring system resulting from the conjoint hybrid algorithm and the simulated UTASTAR-based one for the whole group of experiment participants is shown in Table 2.

Table 2: Average ordinal and cardinal inaccuracy of the DR- and UTA-based scoring systems for all participants of the Inspire experiment

Agent	Ordinal inaccuracy		Cardinal inaccuracy	
	S_{DR}^A	S_{UTA}^A	S_{DR}^A	S_{UTA}^A
Mosico	3.45	2.91	73.32	108.88
Fado	3.34	2.94	67.07	86.72

Note: All differences significant for p<0.001 in the Mann-Whitney test.

Interestingly, the scoring systems determined by the modified MARS-
-UTASTAR algorithm appeared ordinally more accurate to S^P than the ones
determined by means of the DR technique, but they were cardinally more
inaccurate than the latter. The poor results of the holistic scoring systems in
terms of cardinal accuracy may result from the fact, that the MARS-UTASTAR
LP model was tailored for a specific situation, with an assumed (and correct)
order of preferences for options. This can also be a reason for the better ordinal
fit of the UTA-based scoring system whose model enforced a particular
monotonicity of marginal scoring functions and only in an extreme situation
could this monotonicity be violated, i.e., when a monotonically increasing
marginal rating function was represented by the MARS-UTASTAR LP model as
a monotonically non-decreasing one. Therefore, to eliminate the negative effects
of the model setup we limited our further analysis to the subset of agents that
were ordinally accurate with $OI(S^P, S_{DR}^A) = 0$, i.e., who met the requirements of
monotonicity of marginal utility functions required by our UTASTAR model.
This allowed us to avoid the collision of assumptions of the preference
elicitation technique with the true structures of the agents' preferences.

For the dataset limited to the initially ordinally accurate agents, the scoring
systems determined by means of the modified MARS-UTASTAR algorithm
(S_{UTA}^A) appeared as accurate with respect to the principal's preferences (S^P) as
the ones determined by means of DR in terms of ordinal accuracy. When
cardinal accuracy is considered, the results are not so evident. The UTASTAR-
and DR-based scoring systems seems significantly different in accuracy
depending on their role (see Table 3). They differ significantly for the Mosico
party, but not for the Fado one.

Table 3: Average ordinal and cardinal inaccuracy of the DR- and UTA-based scoring systems
for the initially accurate agents

Agent	Ordinal inaccuracy		Cardinal inaccuracy	
	S_{DR}^A	S_{UTA}^A	S_{DR}^A	S_{UTA}^A
Mosico	0.00	0.00	37.68[*]	51.40[*]
Fado	0.00	0.01	33.26	33.58

[*] p<0.001 in the Mann-Whitney test

Within the reduced subset of Inspire's database we have selected the dyads of
agents that negotiated with each other (i.e. those who were simultaneously
ordinally accurate) to find the possible results of symmetric support for them.
Surprisingly we found out that there were only 32 such dyads (out of 353 of all
negotiating pairs). For these dyads we determined the alternatives that can be

recommended as Nash bargaining solutions if the negotiation fails (for d_1 and d_2 equal to 0). The results of the symmetric support recommendations for the DR- and MARS-UTASTAR-based scoring systems are shown in Tables 4 and 5.

Table 4: The fair solution recommendations in S_{UTA}^A

Offer no.	Offer				Number of recommendations	Principal's ratings	
	concerts	songs	royalties	contract		Mosico	Fado
164	7	14	2.5	150 000	10 (31%)	81	77
165	7	14	2.5	200 000	5 (16%)	76	84
162	7	14	2.0	200 000	5 (16%)	81	75
104	6	14	2.5	150 000	3 (9%)	73	84
101	6	14	2.0	150 000	3 (9%)	78	75
225	8	14	2.5	200 000	2 (6%)	84	66
161	7	14	2.0	150 000	2 (6%)	86	68
222	8	14	2.0	200 000	1 (3%)	89	57
102	6	14	2.0	200 000	1 (3%)	73	82
Sum:					32 (100%)		

Table 5: The fair solution recommendations in S_{DR}^A

Offer no.	Offer				Number of recommendations	Principal's ratings	
	concerts	songs	royalties	contract		Mosico	Fado
165	7	14	2.5	200 000	9 (28%)	76	84
162	7	14	2.0	200 000	6 (19%)	81	75
102	6	14	2.0	200 000	4 (12%)	73	82
164	7	14	2.5	150 000	4 (12%)	81	77
101	6	14	2.0	150 000	3 (9%)	78	75
105	6	14	2.5	200 000	2 (6%)	68	91
161	7	14	2.0	150 000	2 (6%)	86	68
228	8	14	3.0	200 000	1 (3%)	69	68
104	6	14	2.5	150 000	1 (3%)	73	84
Sum:					32 (100%)		

It is worth noting that the Nash recommendation for S^P is the following offer: {7 concerts; 14 songs; 2.5% of royalties and 200 000 of contract signing bonus} (shaded in the tables). We can see that such a solution was not a common recommendation among other fair solutions suggested by the Nash procedure when the DR and MARS-UTASTAR scoring systems are used. Only in five negotiations (16%) conducted by the agents supported according to S_{UTA}^A and in nine (28%) supported by S_{DR}^A the symmetric support is the same as it would be for the principals (if S^P were used). The fraction test would confirm that these proportions are significantly different, but the sample is too small for this conclusion to be accepted as binding.

On the other hand, when the efficiency of such fair solution recommendation is considered we find out that for S_{DR}^A the Nash algorithm indicated the inefficient solutions, i.e., the Pareto-dominated ones, for six negotiating dyads (19% of cases). These are offers 102, 104 and 228. For the symmetric analysis based on S_{UTA}^A there were only four negotiating dyads that would receive inefficient recommendation (offers 102 and 104).

To find a single scalar measure of the efficiency of the symmetric support that can be offered to the parties as the consequences of their using S_{UTA}^A and S_{DR}^A we decided to determine the Nash product of the fair solution recommendation for each dyad. Note that this product is determined in the scoring spaces of their principals (S^P) to find out how the inaccuracy of both S_{UTA}^A and S_{DR}^A affects the true result of the key stakeholders. The results are shown in Table 6.

Table 6: The fair solution recommendations in the S_{DR}^A- and S_{UTA}^A-based negotiation spaces

S_{UTA}^A-based negotiation space					S_{DR}^A-based negotiation space				
Offer id	No. of offers	**Principal score**		Nash product	Offer id	No. of offers	**Principal score**		Nash product
		Mosico	Fado				Mosico	Fado	
164	10 (31%)	81	77	6237	165	9 (28%)	76	84	6384
165	5 (16%)	76	84	6384	162	6 (19%)	81	75	6075
162	5 (16%)	81	75	6075	102	4 (12%)	73	82	5986
104	3 (9%)	73	84	6132	164	4 (12%)	81	77	6237
101	3 (9%)	78	75	5850	101	3 (9%)	78	75	5850
225	2 (6%)	84	66	5544	105	2 (6%)	68	91	6188
161	2 (6%)	86	68	5848	161	2 (6%)	86	68	5848
222	1 (3%)	89	57	5073	228	1 (3%)	69	68	4692
102	1 (3%)	73	82	5986	104	1 (3%)	73	84	6132
Average:				6077	Average:				6101

When we look at the average distance from the Nash fair solution observed in the negotiation spaces determined by means of each type of scoring systems, we find out that the rating products are similarly distant from the true Nash solution determined for the principals, which is equal to 6384. Interestingly, the average products for S_{DR}^A- and S_{UTA}^A-based support, equal to 6101 and 6077, respectively, are insignificantly different ($p = 0.97$ in Wilcoxon test).

6   Discussion and conclusions

As shown in the previous section, the holistic approach for generating the negotiation offer scoring system may be perceived as an interesting alternative to the classic direct rating. It is commonly perceived as being cognitively less demanding than DR, so in practical applications it should be evaluated by the

negotiators highly with respect to its usefulness and ease of use. And here, in our research we were able to show that it also is capable to determine the scoring systems of the accuracy not lower that obtained in DR. Such a conclusion cannot be, naturally, derived from the results presented in Table 2, where the cardinal accuracy of the holistically determined scoring systems is much worse (significantly at $p < 0.001$) than of those determined by direct rating. However, one needs to be aware that this is partially an effect of a fixed MARS-UTASTAR LP model used in deriving the scoring systems from the rank orders of example offers. In our design we assumed that the agents are willing to represent the principal's preferences accurately, so they declare the best and worst options for each issue (which is necessary to construct the LP model) according to the principal's best and worst choices. In fact, in the experiment some of them might have made mistakes in such declarations, so the assumptions of the LP model did not fit their true declarations and hence produced a scoring system with greater inaccuracies. This is confirmed by the results presented in Table 3, where we limited the analysis to those agents who declared the preferences in ordinal accordance to their principals' preference information. Here, the general structure of the preferences fit the model's assumptions and the results show that the holistic and the DR-based scoring systems perform similarly.

There are, however, differences in performance between the groups of agents playing different roles. The scoring systems determined by DR and by the holistic approach do not differ significantly for one group of agents, i.e., the Fados; but they do for the Mosicos. In a typical decision-making situation, in which human agents use different methods to elicit their preferences there may be many reasons for such differences. The group of agents playing one role may have different decision making skills and cognitive capabilities and hence may be able to declare their preferences in an equally accurate way using DR or the holistic approach (such as the Fados in our experiment) than the other group (the Mosicos). On the other hand, there may be nuances in the structure of preferences that may cause problems in accurate disaggregation of them by the agents, which may result in better accuracy of the DR-based scoring systems than of the holistic ones. The latter may also cause problems for technical reasons, i.e., in the appropriate setup of the MARS-UTASTAR LP model. For instance, setting too few equidistant breakpoints for the determination of the marginal value function may result in false ratings for some resolution levels that are important to the agent but lie between any two neighboring breakpoints. Since in our experiment the UTA-based scoring systems were simulated using the numerical preferences defined earlier by the agents, no behavioral issues related to a cognitive limitation could have caused the differences in accuracy of

the scoring systems for the Mosicos but not for the Fados. Therefore we presume that they could result from the differences in the structures of preferences between the roles that the agents had to represent, which (in the case of the Mosicos) may not fit well the structure of the LP model we used.

From the viewpoint of the symmetric support that can be offered to the parties in bilateral negotiation, the holistic approach does not seem very efficacious. It appears that based on the holistically defined scoring systems the third party's recommendation of the fair negotiation agreement differs for a vast majority of instances of negotiating agents (84%) from the one that could be offered to their principals. Note that we have studied the most optimistic situation, i.e. the one in which two parties negotiate, both having ordinally accurate scoring systems. The situation for more inaccurate agents can be even worse. A risk was also identified (12.5%), only slightly worse than the change for the best fair solution recommendation (16%), that an inefficient final contract can be suggested to the agents! When the average quality of recommendations was measured as the Nash product for the holistic approach (6077) it appeared significantly different from the "optimal" product value of 6384 resulting from the principal's recommendations ($z = -6.025$, p < 0.001). But again, if we compare these results with the ones obtained in a similar analysis for S_{DR}^A (the average Nash product equal to 6101) it appears that the differences between the recommendations do not differ significantly. Both the holistic and the direct rating approaches reveal the same level of efficaciousness (unfortunately, somewhat poor) in providing the negotiators with a reliable symmetric support. This clearly shows that while offering to the negotiators (and agents) various decision support tools one needs to make sure that the users are able to use this tool and to ensure a good quality of preference information to be provided.

A checkup mechanism should be introduced in the prenegotiation preference elicitation protocols that would analyze the reliability of the preference information provided by the negotiators and ensure additional runs of interactions if the detected accuracy is too low.

We need to emphasize that the results obtained in our experiment come from a purposely designed negotiation experiment in which the S_{UTA}^A were obtained in a simulation to ensure their comparability with S_{DR}^A that were derived from the hybrid conjoint measurement approach implemented in the Inspire system. Consequently, we did not test here the users' individual ability to generate the scoring systems in a holistic way. The situation we analyzed assumed only that some level of accuracy is feasible. Some unpublished results from our in-class prenegotiation experiments show that the negotiators may be unable to determine holistically the scoring systems of good quality when unsupported in

the construction of A_R or in the declaration of certain parameters of the UTASTAR LP model. If such an additional support is offered, and the prenegotiation protocol is additionally designed to hybridize the holistic approach with the possibilities of a manual tuning of S_{UTA}^A, the accuracy of the support may be even higher than those obtained by means of single DR- or UTA-based approaches. This has been already proved by the initial experiments conducted in the eNego system (https://web.ue.katowice.pl/enego/).

Future research dealing with designing the prenegotiation protocol ensuring an efficient asymmetric and symmetric negotiation support should be therefore focused on identifying the determinants and characteristics of the negotiators (agents and principals) that make them prone to misinterpret the preference information and to declare it incorrectly in the preference elicitation process. Identifying the groups of agents of various cognitive capability who are able to go through the preference elicitation smoothly and correctly will allow to adjust the potential protocols and methods to reduce or extensively eliminate the potential errors, biases and heuristics.

Acknowledgments

References

Anderson D.R., Sweeney D.J., Williams T.A., Camm J.D., Cochran J.J. (2018), *An Introduction to Management Science: Quantitative Approach*, Cengage Learning, Boston.

Angur M.G., Lotfi V., Sarkis J. (1996), *A Hybrid Conjoint Measurement and Bi-criteria Model for a Two Group Negotiation Problem*, Socio-Economic Planning Sciences, 30(3), 195-206.

Despotis D., Zopounidis C. (1995), *Building Additive Utilities in the Presence of Non-monotonic Preferences* [in:] *Advances in Multicriteria Analysis*, Springer, 101-114.

Doumpos M., Zopounidis C. (2011), *Preference Disaggregation and Statistical Learning for Multicriteria Decision Support: A Review*, European Journal of Operational Research, 209(3), 203-214.

Figueira J., Greco S., Ehrgott M. (2005), *Multiple Criteria Decision Analysis: State of the Art Surveys*, International Series in Operations Research & Management Science, 78.

Ghaderi M., Ruiz F., Agell N. (2017), *A Linear Programming Approach for Learning Non-monotonic Additive Value Functions in Multiple Criteria Decision Aiding*, European Journal of Operational Research, 259(3), 1073-1084.

Górecka D., Roszkowska E., Wachowicz T. (2016), *The MARS Approach in the Verbal and Holistic Evaluation of the Negotiation Template*, Group Decision and Negotiation, 25(6), 1097-1136.

Gupta S., Livne Z.A. (1988), *Resolving a Conflict Situation with a Reference Outcome: An Axiomatic Model*, Management Science, 34(11), 1303-1314.

Hanycz C., Zemans F.H., Farrow T.C. (2008), *The Theory and Practice of Representative Negotiation*, Emond Montgomery Publications, Toronto.

Jacquet-Lagréze E., Siskos Y. (2001), *Preference Disaggregation: 20 Years of MCDA Experience*, European Journal of Operational Research, 130(2), 233-245.

Jarke M., Jelassi M.T., Shakun M.F. (1987), *MEDIATOR: Towards a Negotiation Support System*, European Journal of Operational Research, 31(3), 314-334.

Kalai E., Smorodinsky M. (1975), *Other Solutions to Nash's Bargaining Problem*, Econometrica: Journal of the Econometric Society, 513-518.

Keeney R.L., Raiffa H. (1976), *Decisions with Multiple Objectives: Preferences and Value Trade-offs*. Wiley, New York.

Kersten G.E., Noronha S.J. (1999), *WWW-based Negotiation Support: Design, Implementation, and Use*, Decision Support Systems, 25(2), 135-154.

Kersten G.E., Roszkowska E., Wachowicz T. (2017), *The Efficacy of Using the UTA* Technique for Prenegotiation Preparation*, 24th International Conference on Multiple Criteria Decision Making Univeristy of Ottawa*, July, 10-14.

Kersten G.E., Roszkowska E., Wachowicz T. (2017), *When Agents Negotiate on Principals' Behalf, Why Do They Misrepresent Principals' Preferences and what are the Implications?* InterNeg Research Seminar Concordia University, Montreal, 2017.

Lee S., Thompson L. (2011), *Do Agents Negotiate for the Best (or Worst) Interest of Principals? Secure, Anxious and Avoidant Principal-agent Attachment*, Journal of Experimental Social Psychology, 47(3), 681-684.

Mustajoki J., Hamalainen R.P. (2000), *Web-HIPRE: Global Decision Support by Value Tree and AHP Analysis*, INFOR, 38(3), 208-220.

Nash J. (1953), *Two-person Cooperative Games*, Econometrica 21(1), 128-140.

Nash J.F. (1950), *The Bargaining Problem*, Econometrica, 18, 155-162.

Raiffa H. (1953), *Arbitration Schemes for Generalized Two-person Games*, Annals of Mathematics Studies, 28, 361-387.

Raiffa H. (1982), *The Art and Science of Negotiation*, Cambridge, Harvard University Press.

Raiffa H., Richardson J., Metcalfe D. (2002), *Negotiation Analysis: The Science and Art of Collaborative Decision Making*, The Balknap Press of Harvard University Press, Cambridge (MA).

Raiffa H., Richardson J., Metcalfe D. (2003), *Negotiation Analysis. The Science and Art of Collaborative Decision Making*, Harvard University Press, Cambridge.

Roszkowska E., Wachowicz T. (2014), *Inconsistencies in Defining Preferences and Their Impact on the Negotiation Outcome of eNS Inspire Users*, InterNeg Research Seminar, Concordia Universrity, Montreal, October 14th, 2014.

Roszkowska E., Wachowicz T. (2015), *Application of Fuzzy TOPSIS to Scoring the Negotiation Offers in Ill-structured Negotiation Problems*, European Journal of Operational Research, 242(5), 920-932.

Roszkowska E., Wachowicz T. (2015), *Inaccuracy in Defining Preferences by the Electronic Negotiation System Users*, Lecture Notes in Business Information Processing, 218, 131-143.

Roszkowska E., Wachowicz T., Kersten G. (2017), *Can the Holistic Preference Elicitation be Used to Determine an Accurate Negotiation Offer Scoring System? A Comparison of Direct Rating and UTASTAR Techniques*, Lecture Notes in Business Information Processing, 293, 202-214.

Schoop M., Jertila A., List T. (2003), *Negoisst: A Negotiation Support System for Electronic Business-to-business Negotiations in E-commerce*, Data & Knowledge Engineering, 47(3), 371-401.

Simons T., Tripp T.M. (2003), *The Negotiation Checklist* [in:] R.J. Lewicki, D.M. Saunders, J.W. Minton, B. Barry (eds.), *Negotiation. Reading, Excersises and Cases*, McGraw-Hill/ Irwin, New York, 50-63.

Siskos Y., Grigoroudis E. (2010), *New Trends in Aggregation-disaggregation Approaches* [in:] *Handbook of Multicriteria Analysis*, Springer-Verlag, Berlin–Heidelberg, 189-214.

Siskos Y., Yannacopoulos D. (1985), *UTASTAR: An Ordinal Regression Method for Building Additive Value Functions*, Investigação Operacional, 5(1), 39-53.

Stein J.G. (1989), *Getting to the Table: The Triggers, Stages, Functions, and Consequences of Prenegotiation*, International Journal, 44(2), 475-504.

Wachowicz T. (2008), *NegoCalc: Spreadsheet Based Negotiation Support Tool with Even-Swap Analysis*, Group Decision and Negotiation 2008: Proceedings – Full Papers, J. Climaco, G.E. Kersten, J.P. Costa, Coimbra, INESC, 323-329.

Wachowicz T. (2010), *Decision Support in Software Supported Negotiations*, Journal of Business Economics and Management, 11(4), 576-597.

Young H.P. (1991), *Negotiation Analysis*, University of Michigan Press.

Zartman I.W. (1989), *Prenegotiation: Phases and Functions*, International Journal, 44(2), 237-253.

Appendix 1
Principal's preference information in the Inspire experiment

Mosico

Before meeting Fado you discussed the Agency's priorities and requirements with senior management. Senior managers could not give you very detailed information regarding the importance of the negotiated issues and options, but during a few short meetings they gave you many indications as to the relative importance of the issues and the agency's preferences. To help visualize the relationship between the issues you drew bars with their height indicating the issues' importance. You did the same for the options of each issue.

Note: The bars are only indicative of the management's preferences as you did not measure precisely the height of each bar. You drew them quickly to show to the management so that they could see whether you correctly understood their intentions.

Importance of the four issues:

- It is clear that the most important issue is the **number of promotional concerts**. This is because successful concerts are critical to the artists' popularity and approval ratings. Without the concerts the agency cannot establish the artist in a particular market.

- The second most important issue is the **number of new songs**. Obviously the artist has to produce new songs to be recognized and accepted.
- **Royalties for CDs** are less important than the number of songs. The management considers the royalties to be a motivating factor for the artist to produce good CDs.
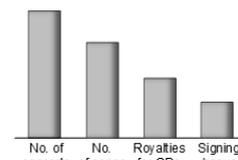
- The **contract signing bonus** is the least important issue. It is less important than the royalties for CDs. This is because the agency views a contract as an investment opportunity that can bring in many of millions of dollars. The bonus size is seen as a token of appreciation, but obviously within limits.
- The illustration of the issue importance is given in the figure.

1. Number of promotional concerts

This is the most important issue for the management. The more concerts the better for WorldMusic. From your discussion with the management, it follows that:

- The most preferred option is 8 concerts.
- The difference between 7 and 8 concerts is almost the same as between 6 and 7 concerts.
- 5 concerts is significantly worse than 6.
- Less than 5 concerts cannot be accepted because it makes little sense in the entertainment business.
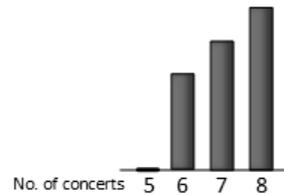
2. Number of new songs

It is a long established practice that too few songs are disastrous but too many are also not profitable. The best number of songs is 14; 14 songs make two full CDs.

- 15 songs are worse than 14 because it is considered somewhat too many.
- 13 songs are a little worse than 15.
- 12 songs are worse than 13 because 13 songs allow the discarding of the worst song if necessary.
- Having 11 new songs is the worst option because only one CD can be produced.
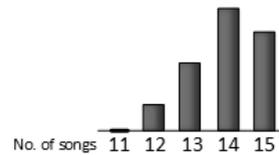
3. Royalties for CDs

Royalties strongly depend on the artist's present standing. Typically, WorldMusic pays between 2.0% and 2.5% royalties. If the artist is very well known during contract signing, the royalties can go up to 3%. Based on the research done regarding Ms. Sonata's standing, the management considers:

- 2.0 % the best option;
- 2.5% is considered somewhat too high.
- The management prefers 2.0% much more than 1.5% because of the artist's standing. And it makes little sense to try and save a little now and loose the artist's interest in cooperating with the agency.
- The research done convinced the management that 3.0% is too much.
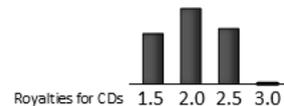
4. **Contract signing bonus**

This issue is considered the least important, although the agency does not want to be seen as throwing money away. The management's preference is to pay less rather than more.

Signing bonus 125 150 200
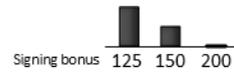
The information you obtained about the agency's top management preferences is your guide in your negotiations with Fado. It reflects WorldMusic strategic directions in the next three years and will provide guidance not only for this negotiation but also for negotiations with other artists. Therefore the ratings are quite sensitive and you were told not to discuss them with anyone.

Fado

You organized a meeting with Ms. Sonata to discuss these issues. Based on your experience, you know that artists have difficulties expressing their preferences over these issues. You used simple software to help Ms. Sonata visualize her preference on issues and options in the negotiation. During the meetings she was able to give you many indications as to the relative importance of the issues and her preferences. To show Ms. Sonata the relationship between the issues you drew bars with their height indicating the issues' relative importance. You did the same for the options of each issue.

Note: The bars are only indicative of Ms. Sonata's preferences as you did not measure precisely the height of each bar. You drew them quickly and show to Ms. Sonata so that she could see whether you correctly understood her intentions.

Importance of the four issues:

- You asked Ms. Sonata to think aloud the importance of issues. She said that this is quite easy, every issue is important to her. But, she added, she really does not want to have too many **promotional concerts**, so it is very important for her that she has as few concerts as possible.

No. of concerts   No. of songs   Signing bonus   Royalties for CDs

- Ms. Sonata says that she must write as many **new songs** as she can, because this is her only way to enrich her fans. This issue of new songs is equally important to the first issue, promotional concerts.
- **Signing bonus** is less important than the first two issues. Although she would like to make money, she must remain true to herself; that is, write and sing songs.
- She is the least concerned with the **royalties for CDs.**
- The illustration of the issue importance is given in the figure.

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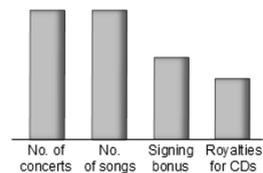
1. Number of promotional concerts

This issue is very important because Ms. Sonata would rather have no concerts at all. She understands that it is not possible so her preference is the fewer concerts the better.

No. of concerts   5   6   7   8

- She finds that between 5 and 7 concerts, every additional concert is equally bad for her.
- But she considers giving 8 concerts a lot worse than 7.

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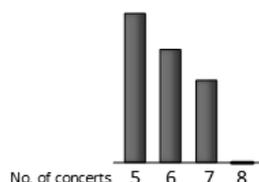
2. Number of new songs

Ms. Sonata likes writing songs. After you noted that the maximum number of songs is 15 in the contract form, she was surprised.

No. of songs   11   12   13   14   15

- She said that the best for her would be writing 14 songs because she also writes poetry and short stories.
- 15 songs somewhat worse than 14, because she thinks it is a bit too many.
- Her preference for 13 is a little lower than 15.
- She added that 12 songs is barely acceptable, while 11 is not enough.

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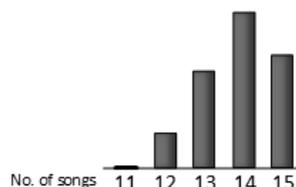
3. Contract signing bonus

Ms. Sonata considers this issue much less important than the first two issues. This is not to say that the bonus is not important; her obvious preference is to obtain a higher bonus rather than a lower one.

Signing bonus   125   150   200

She notes, however, that the difference between 125 and 150 thousand dollars is greater than between 150 and 200 thousand.

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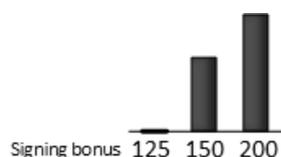
4. Royalties for CDs

This is the least important issue for Ms. Sonata but, she notes it does not mean that royalties for CDs is unimportant.

Royalties for CDs   1.5   2.0   2.5   3.0

She naturally prefers higher royalties rather than lower. However, her preference for 1.5% and 2.0% are much lower than her preference for 2.5% because she thinks that receiving a very low royalty insults her musical talents. The 3.0% is obviously the best but not so different form 2.5%.
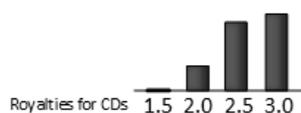
Your ratings will guide you in your negotiations with Mosico. Because they reflect Ms. Sonata's preferences and also describe her attitude towards monetary and non-monetary issues, she instructed you not to discuss them with anyone.