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Development of a mediation tool in Family Law: AssetDivider

Dr. Emilia Bellucci
School of Management and Information Systems
Faculty of Business and Law
Victoria University
Email: Emilia.Bellucci@vu.edu.au

Abstract  This article describes research in developing a new theory of decision support in negotiation in family law mediation. AssetDivider was based on the principles of Family_Winner. As a Negotiation Decision Support System Family_Winner take ratings assigned to items by the parties involved and develops a list of allocations to each party; based on trade-offs inherently present in the dispute. Given advice provided from our industry partners Relationships Australia (Queensland) - RAQ, AssetDivider uses an ideal "percentage split" to guide the development of an allocation list for parties. The system has been tested informally by our contacts at RAQ, and we now look forward to extensive testing and evaluation by mediators at RAQ in the near future. We expect observations and comments made by mediators evaluating the system to indicate future developments, in particular in developing new research into emotionally intelligent NDSS.

Keywords: Negotiation Support Systems, Mediation, Family Law

1. Introduction

The focus of this research is in extending our work in interest-based negotiation to developing research into systems for use in mediations. We have developed several Negotiation Support Systems (NSS) including DEUS, Split_Up and Family_Winner [1]. As a direct result of media interest in Family_Winner [Bellucci and Zeleznikow, 2006], we were contacted and have been in negotiations with Relationships Australia Queensland (RAQ) in developing research. Relationships Australia is a relationship support service which conducts support services across numerous areas, including family mediation, parenting courses, pre-marriage counselling, and special support services such as counselling to families affected by drought and flooding. Although the organisation operates throughout Australia, our contact is with the Queensland branch. We have been in contact with RAQ to develop a new methodology based on Family_Winner that will better represent the needs of the mediation sector.

Victoria University has provided us with funds to support research with our industry partners to develop research in negotiation tools used in family law negotiation. In [2] we initially investigated the issue of how to add notions of fairness to interests, which we have now developed more fully in AssetDivider.

Negotiation is a process by which two or more parties conduct communication or conferences with the view of resolving differences between them [1]. We believe
cooperation between parties as paramount to ensuring both parties are satisfied with the outcome of the negotiation. Their involvement in the decision-making process encourages agreement with the settlement. Mutually satisfying resolutions [3] describe settlements arrived at by the interaction and input of disputants. Mediators agree with the need for mutually satisfying agreements and are willing to use a NDSS if it can support the realities of the negotiation in the domain. We know this because RAQ are eager to use our software.

As mentioned above, AssetDivider uses the principles of Family_Winner. The underlying principle of each system is in their use of interests. The theory that best supports our definition of negotiation support is Principled Negotiation [20], developed under the Harvard Negotiation Project. It emphasizes parties’ look for mutual gains and focuses on the underlying values (or interests) that justify a disputant’s position, as opposed to attempting negotiation solely from their positions.

Family_Winner takes a common pool of items and distributes them between two parties based on the value of associated ratings. Each item is listed with two ratings (a rating is posted by each party), which signify the item’s importance to the party. A rating in Family_Winner is a number in value from 0-100 (0 being of no importance; 100 to signify absolute importance). The algorithm to determine which items are allocated to whom works on the premise that each parties’ ratings sum to 100; thereby forcing parties to set priorities. The program always checks this is the case, and if not, it realigns ratings to ensure all sum to 100. The basic premise of the system is that it allocates items based on whoever values them more. Once an item has been allocated to a party, the ratings of the remaining items are modified (according to the actions of trade-offs) to ensure the items (and their associated ratings) are ready for the next round of allocation [1].

Family_Winner was evaluated by a number of family solicitors at Victoria Legal Aid (VLA). Whilst the solicitors were very impressed with the way Family_Winner suggested trade-offs and compromises, they had one major concern – that in focusing upon negotiation, the system had ignored the issues of justice [2]. For example, Family_Winner simply allocates property to parties based on their interest in the item. It does not allow for monetary values to influence the allocation process. The dollar value of items is important to the dispute because each party wants to be allocated the right or ‘just’ amount of money. This concept contrasts with linking an interest value to an item, which is intrinsically different. An interest is an evaluation based on the significance of the item to a person. For example, party A maybe very fond of a lamp that has been passed down throughout the generations, and consequently they give it a rating of 50. The remaining items are not as important to party A, and so are given much lower ratings. Whilst using interests to negotiate is a very interesting exercise, it does in no way reflect the dollar value of the item. This is where Family_Winner fails to support the mediation process effectively. Whilst Mediators from RAQ believe Family_Winner’s approach to interest-based negotiation (through the setting of priorities) is very useful, they are also concerned with the missing influence of monetary values. Hence, our new theory of negotiation support (implemented in AssetDivider) incorporates the basis of Family_Winner’s allocation and trade-off strategy utilizing both interests and an item’s monetary value.

Section 2 will detail this new theory of negotiation support, and will in particularly outline differences between Family_Winner and AssetDivider. Section 3 will outline a common case and its process through AssetDivider’s screens and output. Mediators at
RAQ provided this example to us. In the next couple of months, it is expected mediators at RAQ will evaluate AssetDivider formally.

2. Negotiation Concepts

Early decision-support negotiation systems primarily used Artificial Intelligence techniques to model negotiation. LDS [4] used rule-based reasoning to assist legal experts in settling product liability cases. SAL [5] also used rule-based reasoning to help insurance claim adjusters evaluate claims related to asbestos exposure.

NEGPLAN [6] is a rule based system written in PROLOG which advised upon industrial disputes in the Canadian paper industry. Mediator [7] used case retrieval and adaptation to propose solutions to international disputes, while PERSUADER [8] integrated case based reasoning and decision-theoretic techniques to provide decision support to United States’ industrial disputes.

Negotiation Support Systems (NSS) were primarily responsible for tracking past preferences and informing disputants about progress being made towards a solution to a conflict. We refer to these systems as template systems. Template systems assume disputants take on a passive role after the initial intake of preferences and issues, since they fail to implement any strategies that incorporate change. Modelling the dynamic properties of negotiation infers the incorporation of decision support into a traditional negotiation support system. DEUS [9], INTERNEG [10], CBSS [11], Negotiator Pro and The Art of Negotiating [12] are all template based systems.

We are most interested in extending the primary role of a template based NSS to a system capable of providing decision support. We have classified these as Negotiation Decision Support Systems (NDSS). A Negotiation Decision Support System (NDSS) supports negotiation by modelling the properties of a template NSS as well as applying functions to interpret the goals, wants and needs of the parties to provide advice on how disputes can be settled.

Our earliest NDSS was Family_Negotiator [13]. It utilises a hybrid rule-based and case-based system to provides disputants with advice on how to best resolve the issues in an Australian Family Law dispute. Whilst evaluating the Family_Negotiator system, we discovered that Family Law negotiation was not an appropriate domain in which to apply either Case-based or Rule-based Reasoning, due principally to the open textured nature of the domain. Nor did the overall framework of Family_Negotiator provide in-depth solutions expected from real-life negotiations.

AdjustWinner [14] uses a utility function to achieve equal distribution of the common pool. The algorithm used in the system was the Adjusted Winner procedure [15]. AdjustWinner resolves a dispute by dividing issues and items among disputants, through a mathematical manipulation of numeric preferences. Although not classed as a NSS, AdjustWinner provided the framework for decision-making support that was later incorporated into a NSS to form Family_Winner.

Family_Winner is a negotiation decision support system that allocates items to one of two parties in the dispute. Family_Winner’s method of decision support involves a complex number of techniques, including the incorporation of an Issue Decomposition.

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1 Open textured legal predicates contain questions that cannot be structured in the form of production rules or logical propositions and which require some legal knowledge on the part of the user in order to answer
Hierarchy, a Compensation and Trade-off strategy, and an Allocation strategy. The trade-offs pertaining to a disputant are graphically displayed through a series of trade-off maps, while an Issue Decomposition Hierarchy enables disputants to decompose issues to any required level of specification.

Mediator, Persuader, NEGOPLAN and Family_Negotiator are considered to be intelligent systems since they can generate solutions using the system’s internal knowledge as well as users input. All incorporate some level of negotiation support, together with the ability to provide users with a resolution to the current problem.

Artificial Intelligence techniques such as case-based, rule-based and hybrid reasoning have had mixed degrees of success in providing negotiation support. The Mediator proved quite successful in its retrieval and adaptation of previous cases. NEGOPLAN used rule-based reasoning to successfully model Canadian industrial disputes, while PERSUADER successfully modeled US industrial disputes through the use of a hybrid case and rule-based methodology. Family_Negotiator however, did not perform to its initial expectations, primarily due to its relatively simple modeling of the domain.

Apart from AdjustWinner, most of the systems surveyed above do not make allowances for measuring the fairness or justness of the settlement. Further, most of the systems discussed are rarely based on theories derived from practice or empirical studies. For example, INSPIRE [10] and SmartSettle [16] use Pareto Optimisation techniques to suggest optimal solutions. Our goal is to provide feasible suggested solutions to the conflict that are acceptable to the user, rather than searching for optimal solutions.

AssetDivider is our latest development in negotiation support systems. It extends on Family_Winner by modifying its’ decision making theory to provide advice based on interests and the monetary value of items. Family_Winner provides advice based only on interests (known in the system as ratings) given by the disputants. The rest of the paper will discuss the architecture and theories behind AssetDivider. Section 3 will illustrate how the system works through an example.

3. Theory implemented into AssetDivider

This section will discuss the theory used to develop AssetDivider. Since the system was developed from the theories in Family_Winner; we will be drawing attention to AssetDivider’s differences and similarities in relation to Family_Winner. We will be assuming the reader has no prior knowledge of AssetDivider’s predecessor.

3.1 Family_Winner and AssetDivider’s input and output

Family_Winner takes a list of issues (usually items for distribution between two parties) and allocates them based on a rating given by the parties in dispute. Two sets of ratings are provide, one for each party in dispute. This rating (a numerical value between 0 and 100) does not represent the monetary value of the item, instead it symbolises how important the item is to the party. We assume a party wants to keep an item they feel is important to them.

Similarly, AssetDivider accepts a list of items together with ratings (two per item) to indicate the item’s importance to a party. In addition it also accepts the current monetary value of each item in dispute. We assume this dollar value has been
negotiated (if necessary) before AssetDivider is used\textsuperscript{2}. Hence, only one dollar value is entered per item. The proposed percentage split is also entered; this reflects what percentage of the common pool items in dispute each party is likely to receive in the settlement. The system is not capable of determining the percentage split; this figure has to be derived from the mediator’s knowledge in past cases or from computer systems such as SplitUp \cite{21}, which can provide a percentage split given certain characteristics and features of divorce cases.

3.2 Family\textunderscore Winner and AssetDivider’s Allocation Strategy

The order by which issues are allocated is of paramount importance in a negotiation. Professional mediators have indicated issues attracting little disputation should be presented foremost for allocation, so as to help foster a positive environment in which to negotiate. By summing the ratings of issues to 100, the level of discourse surrounding an issue can be measured by calculating the numerical distance between the ratings of an issue assigned by each of the parties. For example, if two parties assign the same high rating to an item, then it is expected the level of disputation surrounding the issue to be substantial (because both parties want the item), whereas large differences between the ratings of parties indicate the issue will be resolved much more quickly. Both Family\textunderscore Winner and AssetDivider use this strategy in deciding the order by which items are presented for allocation.

Family\textunderscore Winner allocates items to parties according to whoever values them the most. Once an item has been allocated to a party, the remaining ratings (of items still in dispute) are changed by trade-off equations. These modifications try to mimic the effect losing or gaining an item will have on the rest of the items still in dispute. The equations directly modify ratings by comparing each one against that of the item recently lost or won (each party’s set of ratings are modified as a result of an allocation). The equations update ratings based on a number of variables - whether the item allocated was lost or gained, the value of the allocated item in relation to items still in dispute and the value of the item whose rating will change as a result. In Family\textunderscore Winner, the extent to which ratings were modified was determined through an analysis of data we collected from mediation cases provided by the Australian Institute of Family Studies. These are detailed in \cite{1}.

AssetDivider accepts items, a rating per issue and the monetary value of an item (unlike Family\textunderscore Winner, which does not consider the monetary value of items at all). The allocation strategy as described above, is similar to that in Family\textunderscore Winner, except that the equations have been modified to reflect greater fairness by considering the price of an item. AssetDivider’s allocation strategy works by provisionally allocating an item to the party whose rating is the highest. It then checks the dollar value of items it has been allocated previously (that is, their current list of items), the dollar value of the item presently allocated and the dollar amount permitted under the percentage split given by mediators. If by allocating the item in question the party exceeds its permitted amount, the item is removed from its allocation list and placed back into negotiation. In this case, the item has not been allocated to a party. If the dollar value of the item was within the limits of the amount permitted under the percentage split

\textsuperscript{2} Sometimes the parties cannot agree on the monetary value of the item. In this case, mediators would reference standard objective tables and the like to reach a consensus. For example, if parties are arguing over the value of a car, then mediators may access websites that gave independent valuations, such as redbook.com.au.
rule, then the allocation proceeds. Once an allocation has occurred the ‘losing party’ is compensated by the trade-off equations modifying ratings (whereas in Family_Winner both winning and losing parties were affected).

The following psuedocode gives the reader an indication of what equations are fired and under what conditions. Where \( RR = \text{Rating(issue in dispute)} - \text{Rating(issue lost)} \).

if party has lost the issue

\[
\text{if issue's rating was } \leq 10 \text{ then } \text{graphlose0 } \backslash\text{/}
\]\
\[
\text{if } RR \text{ between } -10 \text{ and } 0 \text{ then } \% \text{change is } 0.5 \times RR + 5
\]\
\[
\text{if } RR \text{ between } 0 \text{ and } 10, \text{ then } \% \text{change } = 5
\]\
\[
\text{if } RR \text{ is between } 11 \text{ and } 25 \text{ then } \% \text{change } = -2/15 \times RR + 6
\]\
\[
\text{if } RR \text{ is between } 26 \text{ and } 100 \text{ then } \% \text{change } = -5/75 \times RR + 7
\]
Endif

\[
\text{if issue's rating was between 11 to 20 then } \text{graphlose1 } \backslash\text{/}
\]\
\[
\text{if } RR \text{ is } -20 \text{ to } 0 \text{ then } \% \text{change } = 5
\]\
\[
\text{if } RR \text{ is between } 0 \text{ and } 89, \text{ then } \% \text{change } = -5/89RR + 5
\]
Endif

\[
\text{if issue's rating was between 21 and 35 then } \text{graphlose2 } \backslash\text{/}
\]\
\[
\text{if } RR \text{ is between } -40 \text{ and } -10, \text{ then } \% \text{change } = -5/30 \times RR + 3
\]\
\[
\text{if } RR \text{ is between } -10 \text{ and } 0, \text{ then } \% \text{change } = 5/10RR + 10
\]\
\[
\text{if } RR \text{ is between } 0 \text{ and } 15, \text{ then } \% \text{change } = -5/15RR + 10
\]\
\[
\text{if } RR \text{ is between } 15 \text{ and } 44, \text{ then } \% \text{change } = -5/29RR + 8
\]
Endif

\[
\text{if issue's rating was between 36 and 55 then } \text{graphlose3 } \backslash\text{/}
\]\
\[
\text{if } RR \text{ is } -55 \text{ and } -25, \text{ then } \% \text{change } = 15\%
\]\
\[
\text{if } RR \text{ is between } -25 \text{ and } -20, \text{ then } \% \text{change } = -RR -8
\]\
\[
\text{if } RR \text{ is between } -20 \text{ and } 0, \text{ then } \% \text{change } = 5/20RR + 15
\]\
\[
\text{if } RR \text{ is between } 0 \text{ and } 70, \text{ then } \% \text{change } = -15/70 + 15
\]
Endif

\[
\text{if issue's rating was above 55, then } \text{graphlose4 } \backslash\text{/}
\]\
\[
\text{if } RR \text{ is between } -100 \text{ and } 0, \text{ then } \% \text{change } = 15\%.
\]
Endif

elseif */item was won*/

No change
EndIf

The above equations were developed using the equations in Family_Winner (that had been derived from data, as specified above). Results from some case studies using Family_Winner revealed it was not always fair to the losing side if the winning side received extra points (as was the case in Family_Winner). AssetDivider therefore makes no changes to the ratings of the winning side.

Family_Winner had also attracted some criticism concerning the scaling of ratings to sum to 100 only once (at the initial intake). After the system removed an item from the negotiation (upon allocation); it was argued that the remaining ratings in dispute should be scaled to 100 again. The reasoning here is to ensure that every item has been allocated with the same rules in place (that is all ratings add to 100) as in the first item’s allocation. Whilst theoretically this reasoning is quite sound; there was a problem with implementing this in practice. We found as the number of issues in dispute diminished, the difference between the ratings of the same item for both parties
was very similar. This result defeated the reasoning the essence of trade-offs. It is also a problem when ratings are dissimilar since we do not know to which party we should allocate the item. The reason why AssetDivider does not scale all ratings to 100 following allocation is to ensure the ratings still reflect the disputant priorities they set initially (in the first instance). The trade-off equations allow for some minimal change of ratings, which is most evident when the system compares small differences between ratings for an item.

3.3 User Interface Issues

Significant improvements to the user interface have been made to AssetDivider. There is more space on screen for users (we presume will be Mediators) to enter additional information about the case. In addition, we have added reporting services, which will print case details such as case identifiers (case number), initial ratings given by users, ratings upon allocation and a final summary of the solutions arrived at by the system. This summary will include, for each solution, the allocation list for each party and the monetary value of each ‘allocation list’.

In Family_Winner, diagrams were shown on screen to describe the current ‘state of play’, that is the items in dispute, their values (ratings), and Relationship Ratings (RR) between items. Relationship ratings are used to reflect the importance a party places on one item in relation to another. Mathematically, the RR is the absolute difference between the ratings of two items. We named these diagrams Trade-off Maps, which are based on the structure of Constraint Diagrams. They were shown on screen just before an allocation occurs, in the attempt to help users understand how Family_Winner allocates items. In developing AssetDivider, we decided not to include these Trade-off Maps, as informal discussions with users revealed they simply helped to confuse users – and contrary to the reason why they were developed – did not aid user understanding of how the system arrived at its solution. In conjunction with displaying Trade-off Maps, Family_Winner would display new ratings as they change; that is every allocation was displayed sequentially on screen. This made using Family_Winner quite tedious; as the user had to clear each screen for every allocation that occurred. AssetDivider displays the solutions it has arrived at only once; at which point the user can choose to print or save the solutions.

4. An Example using AssetDivider

This section will review the process and outcome of a Family Law case on AssetDivider. The aim of this exercise is to demonstrate the system’s operation in practice.

The following table (table 1) describes a divorce case provided by RAQ.

<table>
<thead>
<tr>
<th>Item Name (including assets and debts)</th>
<th>$ value</th>
<th>Husband’s ratings</th>
<th>Wife’s ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>House</td>
<td>450,000</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>Mortgage</td>
<td>(200,000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W car</td>
<td>10,000</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Boat</td>
<td>30,000</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Shares</td>
<td>50,000</td>
<td>30</td>
<td>10</td>
</tr>
</tbody>
</table>
### Table 1: Intake details of the negotiation

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Rating</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash (savings)</td>
<td>20,000</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>H Car</td>
<td>10,000</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td><strong>Totals:</strong></td>
<td><strong>270,000</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Suggested percentage split: 40/60 (where 40% to Husband and 60% to Wife). This means Husband is entitled to 108,000 and wife 162,000. This information is entered in screen 1.

**Screen 1: Intake screen for negotiation**

The next screen that appears lists the issues in dispute, their ratings and the allocation summary, which is populated when the user clicks the “Calculate allocations” button. In the Allocation Summary table, we can see that the ratings for Husband (party A) and Wife (party B) are scaled to add to 100 in columns `ComputedValuePartyA` and `ComputedValuePartyB` respectively. It is these ratings that are used to drive the allocation.

**Screen 2: Allocation list for each party and the percentage split achieved.**
According to AssetDivider, the preferred outcome, taking into account each party’s priorities (ratings) and percentage split indicated:

<table>
<thead>
<tr>
<th>Husband’s List of Allocated Items</th>
<th>Husband’s $ value of each item</th>
<th>Wife’s list of Allocated Items</th>
<th>Wife’s $ value of each item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boat</td>
<td>30,000</td>
<td>House</td>
<td>450,000</td>
</tr>
<tr>
<td>Shares</td>
<td>50,000</td>
<td>W Car</td>
<td>10,000</td>
</tr>
<tr>
<td>Cash</td>
<td>20,000</td>
<td>Mortgage</td>
<td>(200,000)</td>
</tr>
<tr>
<td>H car</td>
<td>10,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Allocation list for Husband (party A) and Wife (party B).

Totals for Husband: $110,000; and wife: $160,000; that is very close to the 40/60 split requested.

In analyzing the case, we can see that husband (Party A) wanted the shares (27.50), then the house (25) and savings (23.49). He valued the boat at 16.67, his car (Husband’s car) 8.68 and W(wife’s) car 0. Given he is entitled to only 40 % of the total, we consider he would be happy with his allocation of the boat, shares, cash saving and his car (H car). The wife valued the house quite considerably at 55.56. Obtaining the house was her priority above all else. The rest were valued quite minimally, with shares at 18.52, boat 11.11, her car (W car) and H car at 3.70 each and cash savings at 7.41. We believe she would also be happy with her allocation, as she was given the house (of utter importance) and her car (W car).

The reason why Husband and Wife were both allocated the cars was because each valued each other’s at 0. As long as their allocation did not violate the percentage split allowance, there was no real negotiation between who wanted the cars.

Due to space limitations, we are unable to detail the effect of trade-off equations on the negotiation. The reader can safely assume ratings did not influence the allocation greatly, as all items were allocated to those who wanted them the most.

5. Conclusion and future work.

This article aims to describe AssetDivider as a new Negotiation Decision Support System (NDSS) in family law mediation, and does so by making mention of its predecessor, Family_Winner. Family_Winner was developed from the theories in the author’s PhD, and AssetDivider represents an improved version. An obvious question to ask is how Asset Divider is different from Family_Winner. There are a number of similarities and differences, particularly in the decision making module of the system. In both systems the interest (rating given to symbolise the importance of the item to the party) is used to temporarily assign the asset to a party. AssetDivider tests whether the asset’s dollar value exceeds their allowable amount (given by the percentage split set by the mediator). We have also improved the trade-off strategy and have made extensive improvements to its user interface and reporting services.

AssetDivider has not been extensively evaluated at this point in time. It is expected mediators at RAQ will test and evaluate the system in the near future. We are expecting results from testing to indicate further improvements to the decision making
module and in particularly to the user interface. Our research has revealed a lack of negotiation support systems used in family law. We hope our collaboration with RAQ will enable AssetDivider to be used in their organisation, being one of the first negotiation support systems to do so.

6. Bibliography