Studying the Effects of Stress on Negotiation Behaviour

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Negotiation is a collaborative activity that requires the participation of different parties whose behaviours influence the outcome of the whole process. The work presented here focuses on the identification of such behaviours and their impact on the negotiation process. The premise for this study is that identifying and cataloguing the behaviour of parties during a negotiation may help to clarify the role stress plays in the process. To do so, an experiment based on a negotiation game was implemented. During this experiment, behavioural and contextual information about participants was acquired. The data from this negotiation game was analysed in order to identify the conflict styles used by each party and to extract behavioural patterns from the interactions, useful for the development of plans and suggestions for the associated participants. In sooth, the work highlights the importance of the knowledge about social interactions as a basis for informed decision support in situations of conflict.

Keywords: Intelligent Environments; Online Dispute Resolution; Negotiation; Context-Awareness.

1. Introduction

Negotiation (Raiffa 1982) is a collaborative and informal process by means of which parties communicate and, without external influence, try to reach an outcome that may satisfy both. This process is widely used in the most different fields, including legal proceedings, divorces, parental disputes or even hostage situations. It is a highly interdependent process in which each party continuously incorporates information from the other party(ies) to devise answers that might lead to the resolution of the conflict at hand, in the quest for understanding the process through which conflicts are settled. In this particular case, negotiation is incorporated in Online Dispute Resolution (ODR) software and used in a technological context, either supported by technology or under a virtual computational environment. Being able to capture behaviour patterns performed within a negotiation is very relevant to drive the process. Therefore, modelling this human activity must take into consideration the dynamic, adaptive, and interactive setting of the virtual computational environment in which the negotiation (related to ODR) occurs.

To acquire this kind of contextual and behavioural information, a set of models was developed. Indeed, the information from physical sensors, named low-level context, may be meaningless, trivial, vulnerable to small changes, or uncertain (Ye et al. 2007). A way to mitigate this problem is the extraction of high level context information from raw sensor values (Bettini et al. 2010) in order to attain descriptions of human behaviour that may be relevant to a negotiation. Such specifications include the negotiation style or strategy and the stress state of the parties (when facing a negotiation process). To assess this kind of information the models introduced in (Carneiro, Gomes, Novais, and Neves 2011) were used to classify the negotiation/conflict resolution styles along with a multimodal approach to identify and classify a party's stress progress during a negotiation in a contextually rich and dynamic environment (Gomes et al. 2012). This work illustrates the process used to extract behavioural patterns from data gathered in a negotiation, performed within an intelligent environment, using game theory. In particular, it focuses on the analysis of behavioural data related to the estimation of stress levels and negotiation/conflict approaches of the actors. The intention is to enrich the knowledge about user states in negotiation processes for the further development of a reasoning system that will generate proposals that may show the way to successful negotiation outcomes.

The paper is organized as follows. In Section 2 the principles underlying the systematic behavioural analysis are explained along with low-level context information relevant for the experiment and respective sensors. The conditions of the negotiation game, the main findings and their analysis are provided in Section 3. Section 4 reveals the development process of a Bayesian model for negotiation posture recognition. Finally, Section 5 details the main conclusions drawn from this study.

2. An Environment for Systematic Behavioural Analysis

Nothing characterizes an individual better than his/her behaviour. Knowing how an individual reacts to stimuli allows one to foresee their future states. Moreover, controlling stimuli may allow one to induce certain states on an individual (e.g. playing a specific type of music to calm someone down).

In this work, the interest is on knowing how a given party acts in response to specific scenarios (e.g. how does a party behave when under stress or during a negotiation) in order to allow the mediator to take better decisions. The approach followed focuses on acquiring context information that allows to characterize the behaviour of the human users of the negotiation tool. Moreover, it does it in an absolutely transparent and non-invasive way, i.e., rather than relying on traditional self-reporting mechanisms such as questionnaires in order to infer behaviours, it analyses the actions of the parties, in real-time. In order to implement such processes, procedures used in social science were analysed. In particular, an algorithm defined by (Cooper, Heron, and Heward 1987) was followed. It provides a complete description of the procedures and principles required to identify the behaviour sources and to perceive not only the relationship between sources and behaviors but also how to adjust them in order to influence the doings as preferred. This algorithm guided the development of a technologically empowered environment for behavioral analysis, now set up in the Intelligent Systems Lab of the University of Minho. It is constituted by a group of devices that can be found in most of current working or leisure environments that includes handheld devices (e.g. tablets, smartphones), computers (both desktop and laptop) and video cameras. These devices are able to provide data about the interaction patterns of the user and/or the environment. The data collected can be used to build a wide range of features describing the users' behaviors and interaction patterns, in an approach very close to Behavioural Biometrics (Yampolskiy and Govindaraju 2008).

Although a total of 18 features can be extracted from these devices (Carneiro et al. 2013), given the objectives of these studies, only the following six were selected (from now on designated sensors):

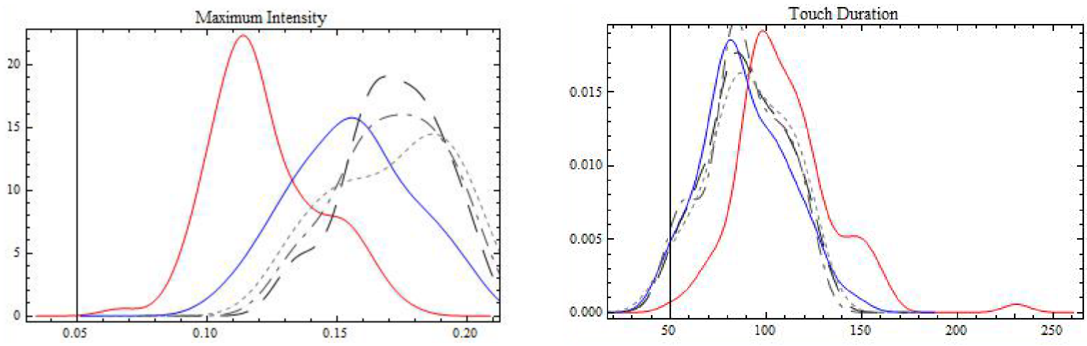
- Touch pattern - the touch pattern represents the way in which a user touches the device and represents a variation of intensity over a period of time. This information is acquired from touchscreens with support for touch intensity.
- Touch accuracy - a comparison between touches in active controls versus touches in passive areas (e.g. without controls, empty areas) in which there is no sense in touching. This information is acquired from touchscreens.
- Touch intensity - the intensity of the touch represents the amount of force that the user is putting into the touch. It is analysed in terms of the maximum, minimum and mean intensity of each touch. This information is acquired from touchscreens.
- Touch duration - this represents the time span between the beginning and the end of the touch event. This data is acquired from devices with touchscreens.
- Amount of movement - the amount of movement represents how and how much the user is moving inside the environment. An estimation of the amount of movement from the video camera is built. The image processing stack uses the principles established by (Castillo et al. 2011) and uses image difference techniques to calculate the amount of movement between two consecutive frames (Fernãndez-Caballero et al. 2010).

- Acceleration - the acceleration is measured from accelerometers in mobile devices. It is useful for building an estimation of how much the user is moving and how he is doing it (e.g. is the user having sudden movements?).

2.1. Assessing the level of stress

The study detailed further ahead in the manuscript used a stress detection model that considers these features to classify the level of stress of a user. Indeed, in previous work, we proved that stress does significantly influence our interaction patterns with technological device and that the features considered are appropriate to measure this influence (Carneiro et al. 2012). To attain these conclusions, participants were given tasks that included mental calculations and memorization. To perform these tasks, they interacted with smartphones, which allowed to collect data about the features considered. Participants performed similar tasks under different stressors, with different intensities, which resulted on differences in the interaction patterns.

Two examples of these effects are depicted in Figures 1 a) and b). In these figures, the red line depicts the feature without stress, while the remaining lines depict the effect of stressors of increased intensity (from solid blue line depicting low intensity to more dense dashing depicting increasing intensity). The data collected shows that increased levels of stress are associated with stronger touches (p-value = $1.94289 * 10^{-11}$, Mann–Whitney Test, $\alpha = 0.05$) that tend also to be shorter (p-value = $2.70933 * 10^{-8}$, Mann–Whitney Test, $\alpha = 0.05$). Similar conclusions were drawn for the remaining features, which at the end allowed to develop the real-time stress classification tool used in the study detailed in this document.



(a) (b)

Figure 1. Histograms of the intensity of the touch (a) and touch duration (b) when calm (red line) and when under stressors of increased intensity.

2.2. Assessing the Conflict Handling Style from the Utility of the Proposals

The style of dealing with a conflict that each one has must be seen as having a preponderant role in the outcome of a conflict resolution process, especially on those in which parties interact directly (e.g. negotiation, mediation). Different approaches can be followed to formalize the way that we respond to conflicts. A well-known definition was presented by Kenneth Thomas and Ralph Kilmann (Kilmann and Thomas 1977), which encoded the way that we react under a conflict into five different modes. To define these modes, they take into consideration the individual's assertiveness and cooperativeness. The five different conflict resolution styles defined are: competing, accommodating, avoiding, collaborating and compromising.

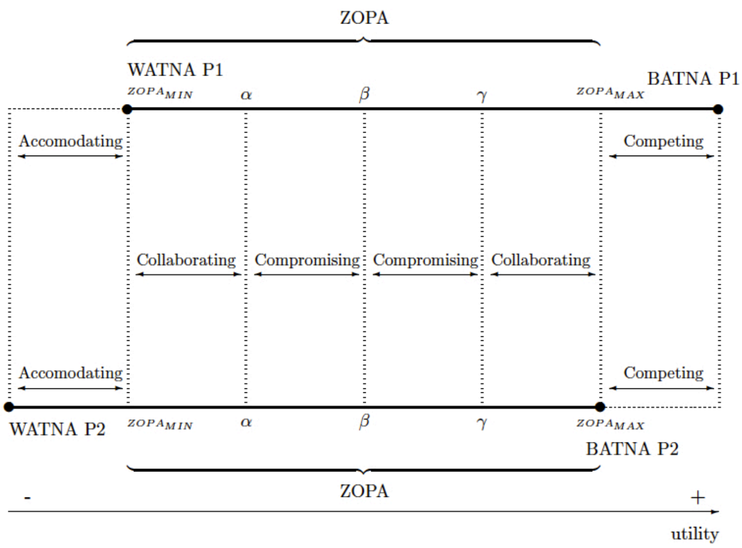


Figure 2. The relationship between the utility of a proposal and the personal conflict handling style.

In order to classify the conflict style, the proposals must be analysed, namely in terms of their utility. In that sense, in each stage of the negotiation the parties' proposals are analysed according to their utility value and a range of possible outcomes defined by the values of the Worst Alternative to a Negotiated Agreement (WATNA) and Best Alternative to a Negotiated Agreement (BATNA) of each party. This approach uses a mathematical model (Carneiro, Gomes, Novais, Andrade, et al. 2011) which classifies a party's conflict style considering the range of possible outcomes, the values of WATNA and BATNA as boundaries, and the utility of the proposal.

The utility quantifies how good a given outcome is for a party. In that sense, it is acceptable to argue that a competing party will generally propose solutions that maximize its own utility in expense of that of the other party (the utility of the proposal is higher than the BATNA of the other party), while for example a compromising party will most likely search for solutions in an intermediary region (the utility of the proposal falls within the range of the Zone Of Possible Agreement (ZOPA), the range of overlaped outcomes that would benefit both parties). Essentially, we were able to classify the personal conflict style of a party by constantly analysing the utility of the proposals created. The relation between the utility of the proposals and the conflict style is depicted in Figure 2 and further detailed in (Carneiro, Gomes, Novais, Andrade, et al. 2011).

3. Experimental Setup

Ten individuals participated in the study implemented to address the objectives of this work. The behavior under consideration was the individual's conflict handling style. The study was carried out at the Intelligent Systems Lab of the University of Minho.

The system for measuring conflict handling style and stress described previously was used.

The main aim is to study changes on the individual's behaviour due to stress while negotiating. To fulfil this aim, a negotiation game was implemented. This game simulates a business situation involving a *manufacturer* and a *reseller,* in which each party has to achieve a desired result in the negotiation or go bankrupt. The desired result was a win/win situation for both parties. The objectives and the *persona* for each party are depicted as:

- Role A - party A was a light bulb manufacturer who specialized in specific light bulbs. He was not the only supplier of this light bulb. In order to stay in business, he needed to sell 6,000 light bulbs at 1€ or more per light bulb. If he did not achieve this, he would go bankrupt. He was also given the information that Party B needed to make this deal.
- Role B - party B was the reseller of light bulbs. He had recently received a contract to supply a hotel chain 6,000 of these specific light bulbs. The hotel was prepared to pay 2€ per light bulb. If Party B did not manage to negotiate with Party A to buy the light bulbs at 1.20€ or less, then he would go bankrupt. Party B was told that party A was in a little financial trouble and needed to make the deal to survive.

The instructions to win the game were to negotiate a successful deal and make sure that the party in question didn’t go bankrupt. Each party’s instructions were clearly presented, visible to them through the application interfaces. The ZOPA was bounded by the BATNA (1€) and WATNA (1.20€) values. The range of possible agreement was

0.20€, but the parties were not aware of this detail. The game starts with a random draw of roles (i.e. manufacturer or reseller) for each party.

To capture the necessary behavioural and contextual information, the previously described environment was used. The participants played the game through Android devices that allowed the analysis of the described features. While playing, participants also seated in front of individual video cameras that allow analysing their movement patterns. This data is combined and synchronized with the one provided by the handheld device to fully describe several important aspects of the behaviour of the user, including the physical and the psychological.

Participants played the game in two different scenarios that took place in separate moments in time. The first scenario was a stress-free one: participants had plenty of time to play the game and no constraints at all. The second scenario was purposely modified to induce stress through several stressors: participants were told that they would now be participating in a competition involving the same game, with an attractive reward for the player with the best negotiation performance. This gave the participants the motivation to engage in the task and to perceive failure as a threat, thus enabling stress. Other participants were kept around while the game took place for each pair of players and were allowed to observe and comment on the current players' performance, inducing pressure through social comparison (Markus 1978). Stress was also induced in the form of "time pressure" or time-stress (Wallace, Anderson, and Shneiderman 1987), through the form of a time limit. The inability to pause the game induced a feeling of lack of control, also associated to stress (Dickerson and Kemeny 2004).

To compare the data of the two scenarios for each pair of players, measures of central tendency and variability were calculated for all variables of interest. The Mann-

Whitney-Wilcoxon Statistical test was used to test whether there are actual differences in the distributions of the data. A 0.05 level of significance was considered. The data analysis was performed using Wolfram Mathematica®, Version 8.0.

From the data collected it can be concluded that most of the time the parties are using a competitive style, whether in stress or calm scenarios. The evaluation of the progress of the conflict styles during the negotiation process was centred on the average slope of its numeric values. It was concluded that in a stressful state the parties tend to vary slowly their way of dealing with the conflict than when they are calmer.

Looking at proposal values made by the parties during the negotiation, similar conclusions may be drawn. At the training phase both parties change more quickly their conflict styles than during the stressful phase. In the same way, *manufacturers* present a more dynamic proposal evolution than the *resellers*. It may be concluded that in a stressful situation it is more likely that the parties propose more *uncooperative* offers than others in a different situation. This may be explained as a consequence of acting too quickly or relying too much on coercion. When parties are under pressure they may make strategic mistakes or unwanted concessions. It may also lead to bad agreements. These are the natural assumptions that one may draw from these results. Acting too quickly may be a response to external and internal stressors. Indeed, considering the duration of the rounds, one may state that a high percentage of the negotiation rounds performed were shorter under a stressful environment than a stress-free one. However, only a small amount of these cases were statistically significant.

Looking at the statistical data one notices that 80% of the participants used a competitive conflict style in the early moves, 55% improve their styles (shifting towards more cooperative solutions), 35% do not change their competitive style until the end, and 10% become even more competitive. It is stated that *competitors* often use power as the primary tool for handling conflict, and work to prove the importance of one side of the argument in order to win. This may be one of the explanations. Otherwise, they are usually more concerned with winning the game than finding the best solution. Taking into consideration the game pre-conditions, the second hypothesis seems more appropriate, but one may not extrapolate the given results. Additional insights are needed in order to have a better and a more broad explanation.

4. A Probabilistic Model for Negotiation Posture Recognition

Probabilistic models have been indicated as effective ways to deal with uncertainty (Sheridan 1991). Resorting to probabilities enables the ranking of predictions and the minimization of their expected cost (Witten, Frank, and Hall 2011). Graphical representations as a support for displaying probability distributions provide an effective way to interface models and data. They are not only appealing and intuitive, but also lend themselves naturally to the design of efficient algorithms (Jordan 1998). One of such support mediums are Bayesian Networks (BNs): graphical structures used for displaying a probability distribution along with an inference mechanism. Model development was based on the high level information derived from the data collected in the experiment

4.1. *The Bayesian Network Formalism*

BNs are graphical representations of statistical dependences and independences between variables (Jensen 2009). Other graphical representation models, such as decision trees, were considered, but given the literature research and the exploratory nature of this work, it was considered that BNs were a more powerful tool to manipulate dependence relationships (Jensen 2009). For instance, in decision tree models conditioning implies routing down the tree according to the values tested in successive nodes (Jordan 1998), whereas BNs respond better to external changes which are immediately translated in a reconfiguration of the probability distribution. Moreover, they allow the assertion of conditional independences between variables and deal better with nominal data. However, the possibility of other models outperforming BNs in this domain is not to be dismissed. The information gathered indicates that BNs have a set of desirable features that are worth pursuing in the context of this work.

4.2. *Learning the structure of Bayesian Networks*

BN structure learning consists in searching the space of possible networks until the one that best suits the data is found. The search strategy may follow two methodologies: *score-based* search and *constraint-based* search (Jensen 2009). *Score-based* algorithms search for a BN structure that better fits the data by starting with an initial network and then traversing the search space of structures, removing, adding or reversing arcs in each step. On the other hand, *constraint-based* algorithms carry out a conditional (in)dependence analysis on the data. Based on this analysis, an undirected graph is generated to be interpreted as a Markov network.

In order to assess the quality of the network it is necessary to calculate its score, measured as the probability of the data given the network. Let K be the number of parameters and LL the log-likelihood (explained in more detail in (Friedman, Geiger, and Goldszmidt 1997). The metric selected to compare the networks resulting from this work was the *Akaike Information Criterion* (AIC) (Witten, Frank, and Hall 2011) as defined in equation 1.

$$AIC\ score = -LL + K \qquad (1)$$

The algorithms used to learn the topology of the network include two *score-based* algorithms (the hill-climbing and the *tabu search* algorithms) and three *constraint-*

based algorithms (the *grow-shrink*, the *incremental association* and the *chow-liu* algorithms).

The structure learning process was carried out using the R language, version 2.15.2. Each of the above-mentioned algorithms was available in the *bnlearn* package for R. Before feeding the data to the learning algorithms, some pre-processing was needed, namely the conversion of continuous data to nominal data. Initially, the Minimum Description Length Method (MDL) (Witten, Frank, and Hall 2011) was used for this task, but, as it did not produce good results for all the continuous variables, one opted for the qualitative analysis of the data (mean, maximum and minimum values of each variable) and its partition in the most representative intervals from the experimenters' viewpoint. The dataset included 103 instances and the set of variables used consisted of the following: *ExperienceType*, if the experience occurred or did not occur under stress conditions; *Round*, the round to which the instance belongs; *Part*, if the role played in the instance was a manufacturer or a reseller; *ProposalValue*, the value, in euros, of the proposal; *ConflictStyle*, the conflict style detected in the negotiation; and *Duration*, the estimated duration of the round in terms of time intervals. The networks obtained from the learning process are represented in Figure 3 with their AIC scores.

4.3. *The Model for Negotiation Style Recognition*

From Figure 3 it is possible to observe that the networks obtained from the *score-based*, the *grow-shrink* and *incremental association* algorithms are sparser than the one produced by the *chow-liu* algorithm which, in turn, was able to link every variable in the graphical structure. Since the log-likelihood is negated in the AIC score formula, the objective is to minimize the score, so the network produced by the *chow-liu* algorithm is actually the one that best suits the data.

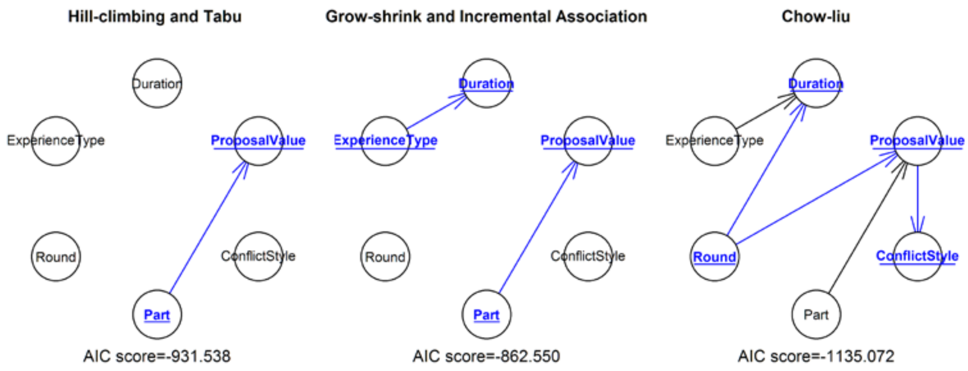


Figure 3. Representation of the different network structures obtained from the learning algorithms, along with their AIC scores.

Based on the topography of the *chow-liu* network one may draw some conclusions regarding the dependence/independence relationships. It is noticeable that most rounds have a duration between 10 to 15 seconds and that the value of this variable is influenced by the *ExperienceType* and the number of the *Round*. *ExperienceTyp*e and *Round* are independent, meaning that conditioning one of these variables will not affect the other because they are linked through an edge, *Duration*, with convergent arcs. Besides the *Duration*, the *Round* also influences the *ProposalValue* along with the *Part* the test subject is performing. The structure of the network, namely the convergence of arcs to *Duration*, indicates that *Duration* and *ProposalValue* are conditionally independent, which means that instantiating the edge between these two blocks the flow of probabilistic information. On the other hand, if no instantiation is made on *Round*, conditioning the *Duration* changes the marginal probability distribution of the *ProposalValue*. Two other cases of conditional independence occur between the *ConflictStyle* and *Round*, and between the *ConflictStyle* and *Part*, with the same interpretation as the previous case. The resulting network is in accordance with the previous analysis and provides a way to dynamically verify how the different variables affect each other. Moreover, it can also serve as a support for testing different scenarios and hypotheses.

5. Conclusions and Future Work

The behaviour and attitude of the individuals participating in a conflict resolution process is one of the most significant factors influencing its outcome. Stress, as one of the key factors in defining our behaviours and attitudes is consequently also very important. From the point of view of a mediator, having structured information detailing each party's behaviour towards negotiation may prove very useful when it comes to taking decisions. This way, the mediator can take decisions that aim at maintaining a positive attitude and a cooperative behaviour, paramount for the success of any negotiated process. This gains a greater importance in a time negotiations are largely undertaken online, with the participants communicating through virtual environments, which are cold and emotionless by nature. Without approaches such as the one presented here, it is difficult for the mediator to fully evaluate the state of the parties solely through the messages or proposals exchanged. Moreover, models like the BN presented in this work can improve the understanding of the negotiation process and help a mediator in real-time. The ability to learn patterns of behaviour actually became an essential aspect for the successful implementation of IEs.

This line of research will be further carried out with the performing of more studies that incorporate additional sources of information, such as the level of fatigue of the participants or the level of escalation of the conflict. The ultimate goal is the achievement of an intelligent environment that can be fully sensible to the state of the users and react accordingly, either by providing support to decision makers or by acting autonomously on aspects of the environment.

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