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The Negotiation of Privacy Policies in Distance Education[1]

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ABSTRACT

This paper presents an approach for the negotiation of privacy policies for an e-learning service. Both negotiating under certainty and uncertainty are treated. The type of uncertainty discussed is uncertainty of what offers and counter-offers to make during the negotiation. The approach makes use of common interest and reputation to arrive at a list of candidates who have negotiated the same issues in the past, from whom the negotiator can learn the possible offers and counter-offers that could be made. Negotiation in this work is done through human-mediated computer-assisted interaction rather than through autonomous agents.

1 INTRODUCTION

Most distance education innovations have focused on course development and delivery, with little or no consideration to privacy and security as required elements. However, it is clear that there will be a growing need for high levels of confidentiality and privacy in e-learning applications, and that security technologies must be put in place to meet these needs. The savvy of consumers regarding their rights to privacy is increasing; new privacy legislations have recently been introduced by diverse jurisdictions [17,18]. In addition, the move to corporate outsourcing of distance learning will lead to requirements of confidentiality of student information, to protect company sensitive information that might be disclosed if training records were obtained by competitors.

A promising solution to the lack of privacy and security for e-learning systems is to put in place a policy-based management system, i.e. formulate privacy and security policies for the e-learning system and back them up with security mechanisms which ensure that the policies are respected. Policy-based management approaches have been used effectively to manage and control large distributed systems. As in any distributed system, e-learning may also use a policy-based framework to manage the security and privacy aspects of operations. However, policies must reflect the wishes of the e-learning consumer as well as the e-learning provider. In this paper, we describe an approach for the negotiation of privacy policies between an e-learning consumer and an e-learning provider. We examine negotiation under certainty and uncertainty (where the offers and counter-offers are known or unknown, respectively) and propose a scheme for resolving the uncertainty using the experience of others who have undergone similar negotiation. The choice of whom to call upon for negotiation experience is resolved through the identification of common interest and reputation.

The negotiation approach presented in this paper does not employ autonomous agent negotiation (AAN). We find that: a) AAN is not necessary for our application area, b) current AAN technology would be unable to capture all the nuances and sensitivities involved with privacy policy negotiation, including cultural impacts [13], and c) the level of trust that consumers would have in autonomous agents negotiating privacy policy would be low.

In the literature, most negotiation research is on negotiation via autonomous software agents. This research focuses on methods or models for agent negotiation [1,2,3] and can incorporate techniques from other scientific areas such as game theory [4], fuzzy logic [5,6] and genetic algorithms [7]. The research also extends to autonomous agent negotiation for specific application areas, such as e-commerce [8,9] and service level agreements for the Internet [10]. Apart from negotiation by autonomous software agents, research has also been carried out on support tools for negotiation [11,12], which typically provide support in position communication, voting, documentation communication, and big picture negotiation visualization and navigation.

Regarding privacy negotiation, there are related works such as P3P [14], APPEL [15], and PSP [16], which provide ways of expressing privacy policy and preferences. Service providers use P3P to divulge their privacy policies to consumers. APPEL is a specification language used to describe a consumer's privacy preferences for comparison with the privacy policy of a provider. PSP is a protocol in the research stage that provides a basis for policy negotiation. These works are not necessary for the purposes of this paper. They only serve as illustrations of what has been done in the related area of capturing privacy preferences in a form amenable to machine processing.

The remainder of this paper is divided as follows. Section 2 considers the mathematical structure of negotiation. Section 3 examines negotiation under certainty and uncertainty. For the latter case, we explore using the experience of others in making decisions. Section 4 gives a scheme for negotiating privacy policy under uncertainty. Section 5 presents our conclusions.

2 NEGOTIATION – STRUCTURE AND REPRESENTATION

Negotiation Example

This example illustrates negotiation to produce a privacy policy for a person (consumer) taking a course from an e-learning provider. Suppose the item for negotiation is the privacy of examination results. The employer would like to know how well the person performed on the course in order to assign the person appropriate tasks at work. Moreover, management (Bob, David and Suzanne) would like to share the results with management of other divisions, in case they could use the person's newly acquired skills. The negotiation dialogue can be expressed in terms of offers, counter-offers, and choices, as follows (read from left to right and down, as shown below).

As seen in this example, negotiation is a process between two parties, wherein each party presents the other with offers and counter-offers until either an agreement is reached or no agreement is possible. Each party chooses to make a particular offer based on the value that the choice represents to that party. Each party chooses a particular offer because that offer represents the maximum value among the alternatives.

PROVIDER	***CONSUMER***
OK for your exam results to be seen by your management?	*Yes, but only David and Suzanne can see them.*
OK if only David and Bob see them?	*No, only David and Suzanne can see them.*
OK. Can management from Divisions B and C also see your exam results?	*OK for management from Division C but not Division B.*
How about letting Divisions C and D see your results?	*That is acceptable.*

Each party in a negotiation shares a list of items to be negotiated. For each party and each item to be negotiated, there is a set of alternative positions with corresponding values. This set of alternatives is explored as new alternatives are considered at each step of the negotiation. Similarly, the values can change (or become apparent), based upon these new alternatives and the other party's last offer.

Let R be the set of items r_i to be negotiated, $R = \{r_1, r_2, \ldots, r_n\}$. Let $A_{1,r,k}$ be the set of alternatives for party 1 and negotiation item r at step k, k=0,1,2,..., in the negotiation. $A_{1,r,0}$ is party 1's possible opening positions. Let $O_{1,r,k}$ be the alternative $a \in A_{1,r,k}$ that party 1 chooses to offer party 2 at step k. $O_{1,r,0}$ is party 1's chosen opening position. For example, for the first negotiation above, the provider's opening position is "exam results can be seen by management". Then for each alternative $a \in A_{1,r,k}$, $V_k(a)$ is the value function of alternative a for party 1 at step k, k>0, and

$$V_k(a) = f(I, O_{1,r,k-1}, O_{2,r,k-1}, \cdots)$$

where I is the common interest or purpose of the negotiation (e.g. negotiating privacy policy for "Psychology 101"), $O_{1,r,k-1}$ is the offer of party 1 at step k-1, $O_{2,r,k-1}$ is the offer of party 2 at step k-1, plus other factors which could include available alternatives, culture, sex, age, income level, and so on. These other factors are not required here, but their existence is without doubt since how an individual derives value can be very complex. Let $a_m \in A_{1,r,k}$ such that $V_k(a_m) = max\ \{V_k(a),\ a \in A_{1,r,k}\}$. Then at step k, k>0 in the negotiation process, party 1 makes party 2 an offer $O_{1,r,k}$ where

$$O_{1,r,k} = a_m \quad if \quad V_k(a_m) > V_k(O_{2,r,k-1}), \qquad (1)$$

$$= O_{2,r,k-1} \quad if \quad V_k(a_m) \leq V_k(O_{2,r,k-1}). \qquad (2)$$

Equation 1 represents the case where party 1 makes a counter-offer to party 2's offer. Equation 2 represents the case where party 1 accepts party 2's offer and agreement is reached! A similar development can be done for party 2. Thus, there is a negotiation tree $\vec{r}$ corresponding to each item r to be negotiated, with 2 main branches extending from r at the root (Figure 1). The 2 main branches correspond to the 2 negotiating parties. Each main branch has leaves representing the alternatives at each step. At each step, including the opening positions at step 0, each party's offer is visible to the other for comparison. As negotiation proceeds, each party does a traversal of its corresponding main branch. If the negotiation is successful, the traversals converge at the successful alternative (one of the parties adopts the other's offer as his own, equation 2 above) and the negotiation tree is said to be *complete*. Each party may choose to terminate the negotiation if the party feels no progress is being made; the negotiation tree is then said to be *incomplete*.

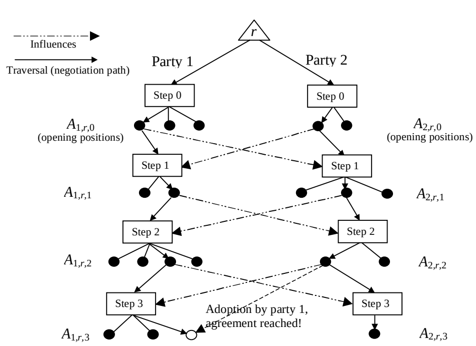

Figure 1 – Negotiation tree $\vec{r}$ for a policy negotiation.

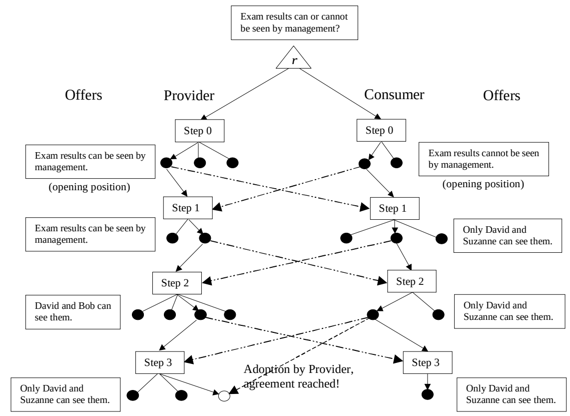

Figure 2 – Negotiation tree for the first part of the above negotiation.

In Figure 1, the influences arrows show that a particular alternative offered by the other party at step k will influence the alternatives of the first party at step k+1. Figure 2 illustrates the negotiation tree using the first negotiation above.

3 NEGOTIATION IN CERTAINTY AND UNCERTAINTY

The following definition defines the meaning of negotiating in certainty and uncertainty.

Definition: Party i *negotiates in certainty* if for every negotiation step k, party i knows both $A_{i,r,k}$ and $O_{i,r,k}$. Otherwise, party i *negotiates in uncertainty*.

Negotiation in certainty is therefore the type of negotiation illustrated in the example of section 2. At each negotiation step, each party knows the alternatives and knows what offer he is going to make. What is more interesting, however, is negotiating in uncertainty. What if a negotiating party does not know what the alternatives are or what offer or counter offer would be appropriate, at any particular step? This party may arrive at such a state as follows:

a) The other party's last offer may be a surprise (e.g. it is not understood).
b) He does not fully appreciate the value of the item under negotiation.
c) He may not be able to discern the values of his alternatives (not be able to compute $V_k(a)$).

In this case, the negotiating party may make use of the experience or decisions of others who have already negotiated the same item.

Negotiation in Uncertainty Example

Suppose you have been offered new employment and it is time to negotiate your benefits, including your salary. You know what you want in terms of vacation, sick leave, and training. However, when it comes to salary, you find it difficult to know what would be a fair salary, since both the job and the company are new to you. You have to negotiate in uncertainty. In this case, and what you may do naturally, is seek out others who you trust and who have negotiated salaries with this company in the past, for similar types of jobs. You would like to know how they negotiated their salaries, what alternatives they considered, and what counter-offers they made based on offers made by management. You may not use their figures exactly but you may use their alternatives with different figures.

3.1 Reputation

As the previous example shows, negotiating an item in uncertainty may be facilitated through the use of knowledge from other parties who have negotiated the same item in the past. The question now is "Which other parties' negotiations knowledge should be used?" This is where reputation is employed.

Definition: The *reputation* of a provider or consumer is a quality that represents the degree to which he has fulfilled the commitments that he has made, either explicitly or implicitly. The commitments could be in everyday life (e.g. commitment to be faithful to a spouse) or in commerce (e.g. commitment to deliver work on time, commitment to respect a privacy policy, or commitment to pay for goods received).

The idea is to use the relevant knowledge of those having sufficiently high reputations. These parties would need to have a sufficiently high reputation and share your interest or purpose for the negotiation (*I* above). There may be other factors too, such as whether or not you know the party personally or have dealt with the party in the past. For manageability, we do not consider these other factors here.

A party's reputation is built-up over time from transactions with other parties. A particular transaction *t* occurs between 2 parties and has associated reputation factors that contribute to determining the reputation of either party from the point of view of the other party. So for example, if party 1 purchases a book from party 2, factors contributing to party 2's reputation (from party 1's point of view) include whether or not the book received was the one ordered, whether or not the book was delivered on time, and party 2's performance history with other buyers. Factors contributing to party 1's reputation (from party 2's point of view) include party 1's credit history, the nature of past dealings with party 1, and party 1's performance history with other sellers.

One way to compute reputation is simply to rate the performance of a provider or a consumer on the associated reputation factors for a given transaction *t*. Let $t_{i,j}$ represent a transaction that party *i* has with party *j*. Let $q_1(t_{i,j})$, …, $q_n(t_{i,j})$ be the associated *n* reputation factors for transaction $t_{i,j}$ assigned by party *i* to party *j*, where each reputation factor (rating) is ≥0 and ≤1 (each factor is an assigned score such as 3/5 or 6/7). Then party *i* assigns party *j* a reputation component $p(t_{i,j})$ corresponding to transaction $t_{i,j}$, where

$$p(t_{i,j}) = \frac{1}{n}\sum_{k=1}^{n} q_k(t_{i,j}) \quad .$$

Over the course of *m* transactions $t_{i,j}$, party *i* assigns party *j* a reputation $P_{i,j}$, where

$$P_{i,j} = \frac{1}{m}\sum_{t_{i,j}} p(t_{i,j}) \quad .$$

Notice that $0 \le p(t_{i,j}), P_{i,j} \le 1.$ Suppose now that there are *h* parties that have had transactions with party *j*. Then party *j* has reputation P_j, $0 \le P_j \le 1$ where

$$P_j = \frac{1}{h}\sum_{i} P_{i,j} \quad .$$

In calculating the P_j by averaging over the $P_{i,j}$, we are in effect building consensus, so that any bias by a particular party is mitigated to some extent. Of course, the degree of mitigation is greater the greater the number of parties averaged.

In the literature, there has been much research done on reputation [19]. Our formulas are consistent with what other researchers have done. In particular, Zacharia and Maes [20] have claimed that reputation in an online community can be described in terms of ratings that an agent receives from others. As a well-studied example, eBay client transaction ratings [21] are not too unlike our proposal above. As another

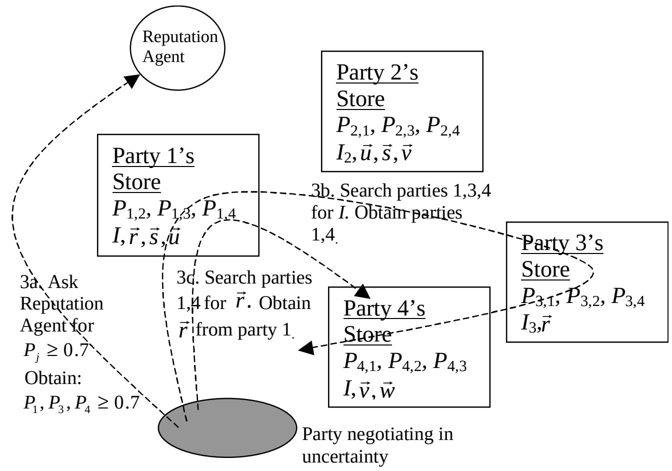

Figure 3 – Using the negotiating experience of others.

example, Cornelli et al [22] used a rating system to allow servents (a servent is an entity that is both a server and a client) to accumulate reliability reputations for other servents from which they download in a P2P network. These reputations are then use by resource requesters to assess the reliability of a potential provider before initiating a download.

4 SCHEME FOR NEGOTIATING PRIVACY POLICY UNDER UNCERTAINTY

We now describe an overall scheme on using the experience of others for negotiating privacy policy under uncertainty, as follows:

1. Every e-learning participant (both providers and consumers) accumulates negotiation experience in the form of negotiation trees (section 2).
2. Every e-learning participant calculates and stores the reputations $P_{i,j}$. A *reputation agent* can access these $P_{i,j}$ to calculate and store the P_j. This can be done periodically to keep the P_j fresh.
3. A participant who is negotiating in uncertainty would obtain assistance, in the form of negotiation alternatives and offers made, from other reputable participants who have negotiated the same issue. The participant would:
   a. Identify which parties are reputable by asking the reputation agent for reputations P_j which exceed a reputation threshold *H*. Call this set of reputable parties *J*. That is, $J = \{j : P_j \ge H\}$. The value of *H* can be set according to the level of reputation desired.
   b. Among the parties in *J*, search for parties that have the same interests *I* as the participant. This produces a subset J_s.
   c. Among the participants in J_s, search for negotiated items *r* that match the item the participant is currently negotiating. This produces a subset $J_r \subseteq J_s$.
   d. Retrieve the matched negotiation trees $\vec{r}$ of participants in J_r. Use the alternatives and offers in these retrieved negotiation trees to formulate alternatives and offers. This is a manual step, supported by an effective user interface for displaying (or summarizing) the information to the participant for a decision on the alternatives. Note that the retrieved trees may be complete or incomplete (section 2).
   e. Update his current negotiation tree.

Step 3 may be done in real time if reputations and past negotiation trees are all in place. Hence a negotiator can receive help in this manner at any negotiation step, if desired. Figure 3 illustrates the above scheme, using *H = 0.7*.

5 CONCLUSIONS

This paper has presented an approach for negotiating privacy policy in distance education using negotiation trees and reputations. The paper categorized two types of negotiations: negotiating in certainty and uncertainty. The problem of negotiating in uncertainty was discussed and a solution given – that of using the negotiation experiences of reputable people with matching interests as aids in deciding which negotiating alternatives and offers should be employed. A scheme on how this could be done was presented. Our application of negotiation trees in tandem with a reputation approach to policy negotiation is unique. It should facilitate the implementation of privacy mechanisms, which are key to the wide spread adoption of distance education.

A prototype of a reputation-based negotiation mechanism for privacy policy in an agent-based e-learning application is currently under development. A separate paper will report on the results of this project.

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ENDNOTE

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