

The Montreal Taxonomy for Electronic Negotiations

Ströbel Michael (mis@zurich.ibm.com)

IBM Research, Zurich Research Laboratory

Weinhardt Christof (christof.weinhardt@iw.uni-karlsruhe.de)

Universität Karlsruhe (TH), Information Management and Systems

Abstract. Research in the domain of electronic negotiations is a rather new and very interdisciplinary field, which gains more and more attention due to the industry hype and momentum regarding electronic commerce and electronic markets. Negotiations in a narrow sense (not taking into account simple forms such as "hit and take") have been identified as an advantageous coordination mechanism for the interaction of buyers and sellers in electronic markets that transcend the selling of commodities or uniform goods. Hence, support for negotiations may become a critical success factor for electronic markets, especially regarding the recent failures of many industrial ventures. This paper presents the Montreal Taxonomy, which allows not only for the exact characterisation and comparison of a broad variety of electronic negotiation designs and systems, ranging from auctions to bilateral bargaining tables, but could also lead towards a more structured approach for the design of electronic negotiations.

Keywords: Electronic Negotiations, Electronic Auctions, Taxonomy, Classification

1. Introduction

Research as well as practice related to electronic negotiations is a very new, dynamic, and interdisciplinary field. The problem we address in this paper is the prevalent difficulty of describing or characterising an electronic negotiation. Owing to the commercial hype around electronic auctions, electronic negotiations and auctions are sometimes considered to be the same. As a result of the widespread application and proclaimed efficiency of auction protocols in eCommerce, one might get the impression that all electronic transactions should be coordinated based on auctions (see the discussion in Kersten et al., 2000). The vocabulary

© 2002 *Kluwer Academic Publishers. Printed in the Netherlands.*

used to describe these systems is created to a large extent by the marketing departments of eCommerce companies, striving to differentiate their offering from the competition. Hence, a discussion or comparison of different electronic negotiation systems is often constrained by a confusion of terms such as multi-issue, multi-line, multi-attribute, or multi-dimensional auctions. Are these just the same words for the same property of an electronic negotiation or do systems with this property differ significantly?

Unfortunately, there does not exist a comprehensive taxonomy of traditional negotiations, which could be used as a foundation for the development of an electronic negotiations taxonomy. One reason could be that the disciplines examining traditional negotiations were focusing on specific aspects, such as issues of strategy, without the need for a complete classification of the field. Social science is contributing most of the studies regarding the nature of negotiations, but when the designers of electronic negotiations try to find a clear terminology and well-defined mechanisms they are often confused with the conflicting results and prescriptions of social science works. Gulliver noted already in 1979 that "the social science literature is somewhat confused and contradictory about the definition and application of some basic concepts that are used in the study of negotiations" (Gulliver, 1979 p.69).

However, this precise terminology is a necessary condition for the construction of flexible electronic negotiation support systems. On the basis of this motivation, just recently, two academic classification systems in the domain of electronic negotiations were suggested: Wurman et al. propose a parameterisation of the auction design space with the goal to define a number of parameters and associated values, which can be used to customise an electronic auction system. The authors state, "the task of designing negotiation rules is essentially that of designing auctions" Wurman et al., 2001 p.305. This can be related to the already mentioned dominance of auctions in eCommerce but, as illustrated in (Bichler and Strecker, 2002), we are aiming for a more generic understanding. Accordingly, the design space introduced is fo-

cused on structured electronic negotiations with competition on one side and does not take into account, for instance, electronic negotiations between two agents or protocols with multiple phases. However, the structure of this classification, which is based on three common activities in auctions (receiving bids, clearing and revealing intermediate information) contributed several starting points for the taxonomy presented in this paper (see Section 4), but was extended to achieve greater granularity. In addition, the Montreal Taxonomy distinguishes exogenous and endogenous criteria in order to separate the analysis and the design phase of electronic negotiations.

Lomuscio et al. proposed another classification scheme with the aim to "identify the possible parameters that can be used to classify any negotiation mechanism for electronic commerce" (Lomuscio et al., 2001 p.21). However, the authors argue from the perspective of automated negotiations among autonomous software agents and therefore stress the importance of negotiation strategies and agent characteristics. We consider the degree of automation or negotiation support as orthogonal to the classification criteria in our taxonomy, as it might vary within one system across the different tasks executed in a negotiation. Criteria suggested in this second approach, such as the computational efficiency or the distribution of computation are therefore not addressed in this paper (but in Benyoucef and Neumann, 2002).

In summary, the first classification scheme discussed, (Wurman et al., 2001), is focused on auctions whereas the second (Lomuscio et al., 2001) stresses automation aspects. Also in combination, the criteria suggested for both classification schemes are not sufficient in the sense that, for example, commercial electronic negotiations can be distinguished selectively. This lack of generic yet comprehensive classification schemes is the motivation for the proposed Montreal Taxonomy. The foundation for our taxonomy is the London Classification for electronic negotiations, which was initially developed as joint work of the participants at the London DEXA 2000 eNegotiations workshop (Field et al., 2000). This initial draft has been used by the workshop participants

to compare and evaluate a number of electronic negotiation designs or systems. As a result of this application the original classification scheme was jointly revised at a second workshop in Montreal. The new structure is presented as the Montreal Taxonomy in this paper.

The taxonomy is based on the general notion and understanding of negotiations as defined in (Bichler and Strecker, 2002): a negotiation is an iterative communication and decision making process between two or more sides (parties) represented by two or more agents who cannot achieve their objectives through unilateral actions and who search for a consensus decision. In addition, we only consider trade negotiations (see also Bichler and Strecker, 2002) in the Montreal Taxonomy, i.e. we focus on negotiation processes in electronic markets for the exchange of goods and services based on bargaining, bidding, or dispute resolution, and do not take into account non-commercial domains (politics, legal disputes) or other forms of negotiations such as group decision-making or voting.

The presented taxonomy should in combination with the other papers in this special issue be considered as a contribution to a more structured and methodological electronic negotiation engineering approach. In that respect the taxonomy can be used for a number of purposes. The goal of the Montreal Taxonomy is to

- provide a common set of terms describing electronic negotiations with a well-defined set of classification criteria,
- help analysing and understanding dimensions of electronic negotiations and their interdependencies,
- support the selection of the right electronic negotiation scenario or an appropriate electronic negotiation system,
- assist the conceptual design of specific electronic negotiations and support the abstraction necessary for the development of generic electronic Negotiation engines.

The Montreal Taxonomy has to be regarded as a normative proposal. The intention is to stimulate constructive feedback from the electronic negotiations community on the classification scheme in order to achieve a more general consensus.

This paper is structured in the following way: after the overview and high-level discussion of existing classification schemes in this section, a system of fundamental definitions is developed in Section 2, before Section 3 introduces an electronic negotiation process model, thereby completing the foundation for the taxonomy conceptualisation. The core of this paper is the Montreal Taxonomy defined in Section 4. Finally, various applications for the suggested taxonomy are presented in Section 5, which also outlines areas of future work.

2. Definitions

The basis for introducing the notion of electronic negotiations is the concept of media and the media reference model (MRM, Schmid, 1998). Media are platforms where transactions are coordinated through agent interaction. A transaction transfers the ownership of tangible or intangible objects (e.g. products, stocks, money etc.) or rights to services (e.g. insurance) from one agent to another and vice versa. An agent might be a human negotiator, an organisation, or an autonomous software agent. The specification for one or more transactions, for the objects of the exchange, and for the agents involved, constitutes a deal. An electronic medium in particular is a medium with electronic (digital) channels that transport data. If economic goods are exchanged through agent interaction, the medium constitutes an electronic market (EM). The MRM identifies several phases of interaction (see Figure 1 below).

- Knowledge (gathering information concerning products, market participants etc.)
- Intention (specifying supply and demand with offers to sell and offers to buy)

- Agreement (identifying the terms/conditions of the transaction and signing a contract)
- Settlement (execution of the agreed-upon contract, payment, post-sales support etc.)

The interface between the intention and the agreement phase is a bid. If at least one party submits an offer, the agreement phase is initiated. In the simplest case another party simply has to accept this offer in order to reach an agreement. In case of an agreement the transition to the settlement phase is marked by a signed contract plus execution of the agreed upon agreements.

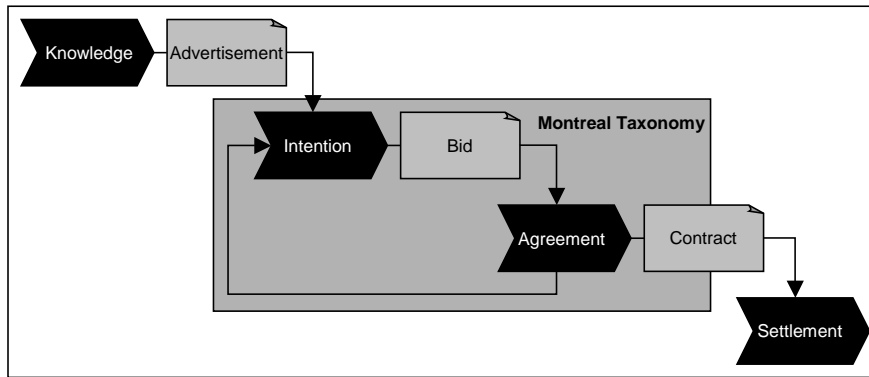


Figure 1. Interaction phases of electronic transactions.

For the purpose of this paper we focus on the intention and agreement phase of electronic transactions, limit the scope of the Montreal Taxonomy to these phases, and make the following distinction: an agreement process represents the complete agent interaction in the intention and agreement phase for the coordination of one or more transactions. The goal of an agreement process is to come to a mutual agreement between agents regarding the specification of one or more future deals. The agreement process might comprise a negotiation process, but an agreement can also be reached without any negotiation process. This will be the case if one or both agents merely accept the offer of any counterpart. A negotiation process takes place when the

first agreement phase fails - i.e. when based on the offers made in the intention phase, either an agreement cannot be reached or the agreement has potential for optimisation and the agents intending to carry out the transaction want to discuss their offers. From the perspective of one agent, negotiating is characterised by the modification of one's own offer or the efforts to change another agent's offer (Ströbel, 2000a). This relation of the agreement and the negotiation process can be compared to the definition of negotiations in the wider and the narrow sense suggested in (Runge, 2000 77ff.). In this understanding, a Request for Quote (RFQ) process with a single round of bidding is an agreement process and negotiation process in the wider sense, because the bidders do not have the option to modify their bids or to cause a change to the offer of the bid-taker. The Montreal Taxonomy proposed in this paper covers not only characteristics of the core negotiation process, but also of the overall agreement process.

If a negotiation process is executed, the core activity of revising offers requires agents to alternate between the intention and the agreement phase, for instance to generate a counteroffer. Within the agreement phase the agents will evaluate the offers of potential transaction counterparts and decide, based on their negotiation strategy, on the subsequent action. In summary, a negotiation process is always part of an agreement process, but an agreement process might not necessarily include a negotiation process.

An agreement scenario defines the environment for the execution of an agreement process. The description of an agreement scenario consists of a set of rules (or policies) restricting agent actions and agent interaction. An electronic medium supporting negotiation processes in the intention and agreement phase is denoted an electronic negotiation medium. An electronic negotiation medium provides electronic negotiation support, meaning the assistance or automation of at least one communication or decision task within the negotiation process.

If a negotiation process is conducted using an electronic negotiation medium, an electronic negotiation process is executed. If an agree-

ment scenario leads to a negotiation process and is supported by an electronic negotiation medium, it is referred to as an electronic negotiation scenario, or scenario for short. An actual scenario executed within a medium in a specific business domain is denoted an electronic negotiation instance.

To summarise the most important definitions developed in this section: an agreement process can, but does not necessarily have to, include a negotiation process. Accordingly, an electronic market medium must support agreement processes, but does not necessarily include support for electronic negotiation processes.

For the purpose of the Montreal Taxonomy, the fundamental definitions for negotiations, and electronic negotiations are extended with the notion of electronic negotiations in the narrow sense: an electronic negotiation conforms to this notion if it is restricted by at least one rule that affects the decision-making or communication process, if this rule is enforced by the electronic medium supporting the negotiation, and if this support covers the execution of at least one decision-making or communication task (c.f. Rangaswamy and Shell, 1997). The Montreal Taxonomy is intended for the classification of electronic negotiations in the narrow sense. Hence, electronic negotiations without explicit rules, such as interactions in a chat room, are not in our scope.

3. Electronic negotiation process model

The agents involved in the electronic negotiation process can be further characterised to be buyers, sellers, or intermediaries. A process definition typically also includes an electronic negotiation scenario, which specifies the set of rules, and the object of the negotiation (e.g. stocks, see Weinhardt and Gomber, 1999).

The media reference model was already used in Section 2 as a general foundation for the distinction of electronic transaction phases. The resulting definition claims that a negotiation process usually comprises

interactions in the intention and agreement phase of electronic transactions. In this section, typical tasks within these two phases are identified from a high-level perspective (c.f. Ströbel, 2000a), and each of these tasks may be split into several sub-tasks. The assumption for this task classification is that all interaction between negotiating agents is based on offers (c.f. Section 2).

For the intention phase the following tasks related to the offer exchange in electronic negotiations can be identified:

Offer specification: the agents have to specify offers indicating their constraints towards the transaction object. This specification may also include the provision of signatures or the definition of timestamps (to express offer validity).

Offer submission: submitting an offer can range from the active task of sending an offer to a specific agent or group of agents to the notification of completion of the offer specification and its provision in an accessible manner.

Offer analysis: upon reception, offers are usually not only stored and processed but also checked for compliance with certain conditions or rules.

For the agreement phase the execution of additional tasks may be necessary:

Offer matching: the goal for this task is to find pairs of offers that firstly classify as potential candidates for a transaction execution (e.g. by fulfilling mutual constraints defined in the offers). The scoring of candidates may also be part of the offer matching task. The extended goal for scoring is to find the "best" pair of offers among the set of candidates, taking into account criteria such as agent preferences for the comparison of a candidate pair towards competing pairs. Finally, a selection or resolution of conflict among the potential candidates might be necessary.

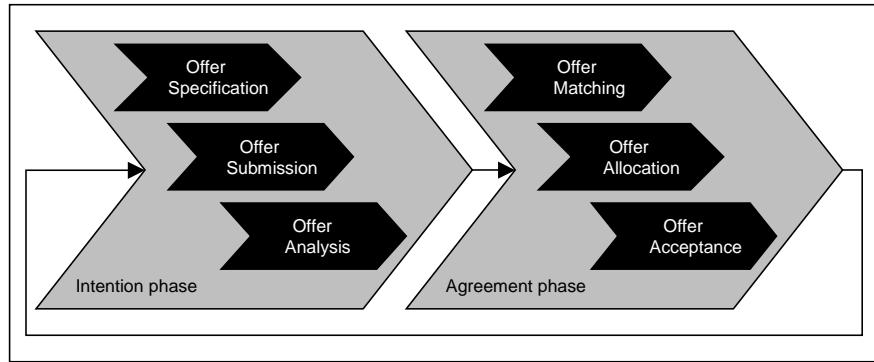


Figure 2. Negotiation process execution tasks.

Offer allocation: using the results of the offer matching and scoring, this task has to determine the result of the process execution ("who gets what") and thereby defines the duties of the agents involved in the manifested deal. If the selected offer still features value ranges or options, a final configuration is also part of the offer allocation task.

Offer acceptance: in this final task, buyers or sellers have the chance to accept or sign one or more offers in order to execute the transaction within the agreed-upon deal.

On the basis of the process model in Figure 2, scenarios and electronic negotiation media can be characterised and classified, as will be demonstrated in the next section.

The process model does not specify an absolute sequence of task executions. Depending on the scenario rules, some of these tasks can be passed over. Offer allocation, for instance, may not make sense in a negotiation between two agents where only the price is discussed, but is necessary in a scenario where the configuration of an offer is possible. Other scenarios however, could explicitly allow iterative cycles of task executions so that, for example, the sequence of offer matching and offer allocation is executed multiple times until one agent accepts an offer. Another example is a negotiation scenario where the offer acceptance

	Exogenous criteria	Endogenous criteria
Explicit criteria	Rules or quantifiable knowledge about the business context, e.g. laws or statistical data for agent behaviour or object transactions.	Choices made by the scenario designer, e.g. the termination of the negotiation process or a certain matchmaking algorithm.
Implicit criteria	Domain knowledge which cannot be directly determined or represented in a formal way, e.g. ethical standards.	Facts determined through assessing the negotiation process execution, e.g. the fairness or efficiency achieved.

Figure 3. Taxonomy criteria categorisation.

may precede the offer allocation. This might, for instance, be the case in negotiations with binding offers.

4. Taxonomy

The main goal for the taxonomy introduced in this section is to provide a common language for the descriptive characterisation and classification of mainly electronic negotiation scenarios, but also media and instances. Scenarios (see Section 2) can be regarded as models for negotiations with certain parameters. Electronic negotiation processes are typically executed according to a model.

The taxonomy distinguishes between *exogenous* and *endogenous*, as well as *explicit*, and *implicit* classification criteria. The combination of both categorisation approaches results in four criteria categories as illustrated in Figure 3. A criterion represents a distinctive electronic negotiation scenario property, which is represented as a rule and is associated with a number of potential criterion values (or rule expressions). These values embody the variation of the semantics that can be defined for an electronic negotiation scenario regarding a certain property or rule. The sum of all criteria values assigned to a specific electronic negotiation scenario, medium, or instance constitutes its type.

Typically, from a design-time perspective, exogenous criteria of an electronic negotiation scenario have to be analysed and mapped into corresponding endogenous explicit criteria, i.e. into a configuration for a specific electronic negotiation instance. Therefore the endogenous criteria typically depend to some extent on the exogenous criteria. The operation and results of this instance can then be evaluated with endogenous implicit criteria at run-time (or on the basis of a theoretical run-time approximation such as a simulation or experiment).

4.1. EXOGENOUS CLASSIFICATION CRITERIA

Exogenous criteria are mostly determined by the business context in which the electronic negotiation instance is supposed to be situated and cannot be influenced by a designer, but should typically be identified on the basis of the chosen business domain and business model before the design activity is initiated.

4.1.1. *Explicit criteria*

Explicit criteria are parameters with formal representations (e.g. quantifications, or the possible rule expressions or the dimensions of support, which an electronic negotiation medium could in principle provide). Research towards explicit classification criteria for the business context from an electronic negotiation perspective is still immature. Once a set of well-defined criteria becomes available, an analyst would be empowered to distinctively classify a target business domain and business model, and to suggest the corresponding most appropriate electronic negotiation scenario design. Since the focus of this paper lies on the endogenous criteria, the current state of the taxonomy only defines a high-level categorisation with some examples for potential low-level criteria. Two criteria categories are suggested:

Business domain: criteria for the business domain should cover the relation of the agents operating in the business domain (e.g. buyers and sellers). A set of explicit criteria could be based, for instance,

on microeconomic market structures (e.g. monopoly, oligopsony, polypoly, see Bichler, 2000) and the nature of the negotiation object (homogenous versus heterogeneous, private value versus public value, see Lomuscio et al., 2001). Other explicit criteria could assess the stability of the buyer/seller relation or the transaction volumes and frequency in the domain.

Business model: the business model defines the role of a business (e.g. electronic negotiation media provider) within the described business domain. More detailed explicit criteria may address the value creation and revenue generation process, or the effects of technology as an enabler or a constraint for the business model.

From these exogenous explicit criteria, the incentive structure for an electronic negotiation instance, including elements such as the value provided for and the fees collected from the participating agents, can be derived.

4.1.2. *Implicit criteria*

Implicit criteria assess the consequences of explicit criteria, e.g. the characteristics of the electronic negotiation process execution and the resulting agreements for a particular instance. These criteria are not "written down" or implemented but might be determined, for instance, through observation of the market customs. The high-level categorisation suggested in the previous section can also be used to structure the implicit criteria.

Business domain: exogenous implicit criteria might describe the culture of the market community (e.g. from a trust perspective) or the prevalent implicit ethical standards (for example regarding the disclosure of competitor information).

Business model: the definition of the business model usually comprises implicit criteria on a high level such as the mission with a value proposition (potential benefits) and strategic goals, or the sources of revenue (Alt and Zimmermann, 2001).

4.2. ENDOGENOUS CLASSIFICATION CRITERIA

Endogenous criteria represent the choices made, the parameters determined within the design of an electronic negotiation instance.

4.2.1. *Explicit criteria*

Criteria in this category constitute the primary contribution of the taxonomy. All criteria are orthogonal in the sense that the expressions (criterion values) can be combined arbitrarily in one classification effort. For non-dual criterion expressions only the extreme expressions are listed (e.g. anonymous versus exposed identity though different intermediate degrees of anonymity can be found). The definition of the potential rule expression is based on examples found in electronic negotiation research and practice (for the third party intermediation expression in the first criterion below see for example Ströbel, 2000b). For scope reasons, these examples are not included. The rule expressions in the taxonomy are marked through italic font setting.

The first set of explicit classification criteria examines the *roles* defined for an electronic negotiation.

1. Roles

a) Participation

- i)* Two (*bilateral*) sides, e.g. a buyer and a seller, enter the process.
- ii)* More than two sides (*multilateral*) engage in the process (for example an additional intermediary).
- iii)* In the *intermediated* case, one trusted impartial party joins the negotiation process, for instance to suggest a fair agreement.

b) Agents

- i)* *One* agent per side is negotiating.
- ii)* *Multiple* agents on each side are negotiating.

c) Admission

- i)* There is no restriction on the admission of agents (e.g. buyers and/or sellers) into the electronic negotiation (*open*). The negotiating agents can, for instance, simply meet.
- ii)* There are restrictions on the admission for agents (*closed*).

d) Identity

- i)* An electronic negotiation is said to be *anonymous* if any assignment of agents to their offers and identification of agents is impossible based on the information exchange provided within the process.
- ii)* Identification of agents is possible in an *exposed* case. Agents in a negotiation process with this characteristic have a unique identity, which can be used, for instance, to locate the agent.

e) Collusion

- i)* If collusion is *approved*, agents and/or sides can collaborate in order to achieve mutual benefits.
- ii)* Collaboration or coalition formation among agents is *prohibited*.

The categorisation for the second set of classification criteria refers to the process model execution tasks identified in Section 3. Hence, a process consists of several tasks, such as offer submission or offer allocation.

2. Process - Overall rules

a) Variation

- i)* The rules for the process are *fixed*.
- ii)* The rules are *flexible* within the process, but the range of possible rules is defined a priori. Active rules are selected from the predefined set of rules.
- iii)* During the process execution the rules themselves can be modified (*dynamic*) by agents (e.g. through a preference

specification), by exogenous parameters (e.g. timeouts), or by endogenous parameters (e.g. the liquidity of the market).

b) Rounds

- i)* In a *single*-round electronic negotiation the process is passed through only once.
- ii)* If a process to reach one single agreement is repeated (e.g. by re-starting the process with different information available to the agents), the electronic negotiation is of a *multi*-round type.

c) Stages

- i)* In a *single*-staged electronic negotiation the rules are the same from the beginning to the end of the process (i.e. from the offer specification to the offer acceptance). This is also the case if the process is of a multi-round nature.
- ii)* If rules are allowed to change, then each time they do, a new stage in the process is initiated and the electronic negotiation is *multi*-staged.

d) Concurrency

- i)* If one negotiator can only engage in one negotiation session with one other agent at a time, concurrency is explicitly *prohibited*.
- ii)* In a negotiation scenario with *possible* concurrency, one agent could also run multiple-bilateral or -multilateral negotiation sessions at the same time.

3. Process - Offer specification

a) Attributes

- i)* Only a *single* attribute (or dimension) describing the deal in the offer can become an issue of the negotiation.
- ii)* The *multiple* attributes case is met if more than one attribute of deal might be negotiated and used in the offer specification.

f) Object

- i)* An offer might be specified for only a *single* object (or alternative), or only for a single, fixed, and indivisible bundle.
- ii)* Agents can specify *multiple* homogeneous or heterogeneous objects in one offer.
- iii)* In the multiple objects case, the offer is *bundled*, if it allows an agent to specify different valuations for different quantities or different subsets of quantities.

4. Process - Offer submission

a) Sides

- i)* Only a *single* side (e.g. sellers or buyers) is allowed to submit offers within the process, i.e. buyers or sellers are offer-takers only.
- ii)* All (*multiple*) sides are allowed to submit and receive offers.

b) Position

- i)* In a *single*-positioned negotiation, agents can assume only one position (or role), such as buyer or seller.
- ii)* If the negotiation is of a *multi*-position type, one agent can, for instance, create offers-to-sell and offers-to-buy (potentially for the same object) in one negotiation process. A typical example is a double-auction.

c) Activity

- i)* In a process with *unrestricted* activity the agents might submit as many offers as desired - all offers are received and processed.
- ii)* For processes with restricted activity, the receipt of offers from one agent may be limited through a *time-based* termination, i.e. the process closes at a specified point in time and no offers are received or processed after this deadline.
- iii)* A process with a restricted *event-based* activity rule will end if a certain event occurs, such as a period of inactivity.

d) Direction

- i)* A *reverse* electronic negotiation takes place when there are two sides, buyers and sellers, and a buyer posts an offer (request) for a deal while sellers compete with offers for the best conditions that the buyer will accept.
- ii)* An electronic negotiation is said to be *forward* if sellers advertise a deal and buyers submit offers.
- iii)* In a *haphazard* negotiation process the direction of offer submission might change within one phase.

5. Process - Offer analysis

a) Value

- i)* A process is said to be *ascending* if, in a single-attribute case, a new valid offer has to provide a higher price than the current best offer. In a multi-attribute case this rule might refer to a revealed cumulative offer value (e.g. utility).
- ii)* The process is *descending* when new offers have to be lower than the current best offer.
- iii)* In an *undefined* case, there is no rule regarding the value relation of a new offer to other current offers.

b) Threshold

- i)* If the offer has to provide a higher value than a certain threshold (e.g. the reservation price) then the process is *low-cut*.
- ii)* The process is *high-cut* if the offer has to be lower than a defined threshold.
- iii)* A process with *undefined* threshold does not perform this kind of validation.

6. Process - Offer matching

a) Schedule

- i)* Offer matching takes place in defined time intervals (*clocked*).

- ii*) Offer matching is *triggered* by events (e.g. the submission of an offer).
- iii*) Permanent execution of offer matching (*continuous*).

b) Sorting

- i*) For a *satisfying* sorting agents can define in their offers constraints towards the potential transaction partners, which have to be evaluated for the offers to match. Depending on the type of match (full compliance, negotiable violations, etc.) matching pairs of offers are assigned to classes without further ranking.
- ii*) The process sorting is *broadcast* if no difference is made among the potential transaction partners - all are qualified in the same way for the consecutive process.
- iii*) In the case where potential transaction partners are a priori chosen by one or several agents, the sorting is *exclusive*.

c) Evaluation

- i*) In a *ranking* scenario, offers are ordered according to the preferences of an agent in order to find out the "best" offer among the set of matching offers. Ranking can be applied to the results of a preceding classification¹.
- ii*) If no offer scoring is executed, the electronic negotiation medium is just *listing* the matching offers (which still might be classified).

d) Resolution

- i*) The process has a *defined* resolution if a rule-driven selection (e.g. "one offer from each seller or class" or "only three offers") is executed for the set of classified or scored offers

¹ In theory and practice a huge variety of different scoring/evaluation algorithms is used. Depending on the algorithm chosen, the negotiation rules might vary significantly. However, for reasons of scope, the variety of evaluation approaches is not captured in this taxonomy definition.

and only suitable offers are considered for the consecutive process.

- ii)* A defined resolution may be complemented with a *tie-breaking* rule, which defines how selection conflicts are resolved. Conflicts arise if, for instance, there are multiple candidates for the execution of the transaction found through sorting and/or scoring, but only one can be chosen.
- iii)* If no resolution or tie-breaking rules are defined, conflicts are *forwarded* and have to be resolved by the agents.

7. Process - Offer allocation

a) Distribution

- i)* In a negotiation with *discriminatory* value distribution a distinct unique price (value) may be determined for each winning offer.
- ii)* On the basis of a *non-discriminatory* value distribution one uniform price (value) is set, and every originator of a winning offer has to pay the same price.

b) Provision

- i)* Through *offer-dependent* value provision a winning bidder has to pay the price (provide the value) specified in the winning offer.
- ii)* In a negotiation with *offer-independent* value provision, the price (value) specified in the winning offer is not necessarily the price the originator of the offer has to pay (provide). An example is a "second-price" auction.

c) Configuration

- i)* In an electronic negotiation with *mediated* configuration, candidate offers with defined value ranges (e.g. delivery date < 10/20/2002) or options are resolved to offers with single values (e.g. delivery date = 10/10/2002), for instance through third party mediation.

- ii)* If the configuration is *open*, agents can decide which final offer configuration to choose among the possible choices defined in the offer space.

8. Process - Offer acceptance

a) Commitment

- i)* The offers in a process might be *binding*, meaning that they cannot be retracted, and the agents are forced to execute the transaction according to the agreement.
- ii)* With an *indicative* offer the agent is not forced to execute a transaction as specified in the agreement, but rather still has the option to retract its offer.

Finally, explicit classification criteria for the information revelation and the strategy defined in a scenario are provided². A strategy represents the implementation of the exogenous business model and helps to fulfil the goals determined for an electronic negotiation instance³.

9. Information

a) Communication

- i)* The communication in the negotiation process maybe *offer-restricted*, which means that the agents can only exchange offers.
- ii)* In an *offer-extended* case, an offer might be complemented with additional remarks (e.g. comments, inquiries).
- iii)* A *free-form* communication allows agents to exchange all sorts of messages, e.g. offers or comments within certain rounds or stages.

² The following set of criteria expressions is not as strict and complete as in the preceding categories because the expressions for the identified criteria have to cover a potentially wide range of options, e.g. the specifically allowed number of open offers or closed contracts an agent has access to.

³ This notion of strategy from a negotiation designer's perspective should not be confused with a negotiating agent's strategy and tactics.

- b) Transaction
 - i)* The history of past deals resulting from previous processes is available to the agents (*logged*).
 - ii)* No deal history information is available (*unlogged*).
- c) Negotiation
 - i)* The interaction history of the current process execution is available to the agents (*logged*).
 - ii)* No interaction history can be accessed (*unlogged*).
- d) Transparency
 - i)* The current status of the process (e.g. the best offer) is available to all agents (*public*). A common term for public transparency is also "open-cry".
 - ii)* Only the agents involved in the actual process can access the status information (*protected*).
 - iii)* The status information is restricted (private) to the agent to the moment of offer submission, i.e. in the form of submission feedback, and to the third party evaluating the (*sealed*) offers.
- e) Trace
 - i)* In a negotiation with *exposed* trace, available information can be traced back to the associated agent (who still can be anonymous).
 - ii)* If the trace is *hidden*, an offer, for instance, cannot be traced back to the identity of the originating agent.
- f) Content
 - i)* The level of information is *unrestricted*, i.e. all elements of the winning offer, such as price quotes or constraints, are revealed.
 - ii)* Only *selected* offer or status information (e.g. only quality but no price information) is provided by the electronic negotiation medium.

g) Timing

- i)* If the information is revealed in defined time intervals, the timing is *clocked*.
- ii)* A scenario could also specify that the information is refreshed if a certain event occurs (*triggered*), e.g. a new "best" offer was received.
- iii)* If the information is always updated and can be accessed any time, a *continuous* timing is defined.

10. Strategy

a) Fees

- i)* The scenario defines fees for agent actions (e.g. offer submission) or electronic negotiation medium actions (e.g. the invocation of an offer matching service) within the process (*transaction-based*).
- ii)* Fees may only be defined for successful process completions (*success-based*).
- iii)* Through *access-based* rules, fees might vary depending on the views (available information) or functionalities provided to the agents.
- iv)* No fees related to actual negotiation processes are charged to the negotiating agents (*free*).

b) Arbitration

- i)* Violations of scenario rules result in penalties (e.g. exclusion, behaviour restrictions, or payments) for the agents (*punishing*).
- ii)* In case of a violation no related penalties are exerted - the action causing the violation might nevertheless be denied or rolled back (*tolerating*).
- iii)* Compliance to the rules is gratified with benefits such as additional rights (e.g. to take actions, to view specific information) or payments (*rewarding*).

c) Ratings

- i) Past behaviour of the agents results in the assignment of certain properties (e.g. recommendation levels or punishments) through the electronic negotiation medium provider or other agents (*appraisal-based*).
- ii) No ratings are assigned to the agents during or after the process (*neutral*).

4.2.2. *Implicit criteria*

Implicit classification criteria allow an analyst to evaluate an electronic negotiation instance or a number of instances (e.g. for classification purposes) and the agreements achieved by the agents using this instance. This evaluation might be useful to compare the instance with other active or potential scenarios or to assess progress towards predefined goals or requirements. In general, an instance (i.e. an electronic negotiation scenario and the associated medium within the business domain) support agents in finding a solution to a resource allocation problem and therefore can be compared to the notion of a mechanism in economics or game theory. The process of designing a protocol, which satisfies certain criteria, is known in game theory as mechanism design. Hence, implicit criteria for the classification could be derived from the set of criteria used in economics to evaluate mechanisms (see Hurwicz, 1973 and Wooldridge and Parsons, 2001 for the following). Other criteria such as fairness may be found in the field of negotiation analysis (c.f. Bichler and Strecker, 2002). The following list suggests potential criteria:

Pareto-Efficiency: a solution is economically pareto-efficient if, depending on the preferences of the agents, there is no other agreement (allocation) that is better for one agent without being worse for another agent.

Social welfare maximisation: if the negotiation process ensures that every resulting agreement maximises the sum of the utilities of

all negotiation participants, the solution is maximising the social welfare.

Fairness: a solution is fair if it is not more beneficial (advantageous) to one side of agents (e.g. buyers or sellers) than to the other. Hence no agent envies the counterpart - all sides have the same opportunities, rights, and obligations. Accepting the rules defined for the negotiation process is in the best interests of all negotiation participants.

Convergence: it is important to know whether an electronic negotiation process converges towards a solution/ compromise and if it produces a determined allocation. This solution or allocation might be unique. The speed of convergence - the time or number of steps needed until the electronic negotiation process converges towards solutions - or the uniqueness of the solution can also constitute an implicit endogenous criterion.

Stability: a solution is stable if there is no subset of agents who could have done better by coming to an agreement outside the electronic negotiation instance.

Truth revelation: each negotiating agent is motivated to reveal true preferences and to offer truthfully irrespective of the behaviour of other agents (incentive compatibility). No advantages can be gained by modeling other agents or having additional information (strategic behaviour).

Nature of gains: an electronic negotiation process is distributive (of zero-sum nature) if a gain for one agent is necessarily a loss for the other agent. In integrative (win-win) negotiations, joint gains are possible either through simultaneous improvements (trade-offs) based on opposing preferences or through extending the possible alternatives (e.g. addition/invention of new attributes/options) during the process.

As stated before, the focus for the taxonomy presented in this paper is on explicit endogenous classification criteria. The list of implicit criteria is a first suggestion, which requires further theoretical foundation, formalisation, and empirical evaluation. To evaluate specific electronic negotiation medium platforms, additional (more technical) criteria such as the performance, scalability, or security of the system also have to be evaluated (see Benyoucef and Neumann, 2002).

4.2.3. *Taxonomy application*

This section demonstrates with an example the application of the Montreal Taxonomy. The example is an electronic negotiation scenario, which is commonly used by online auction sites such as eBay: the English forward auction (see for example Kumar and Feldman, 1998). The type of this scenario can be determined as follows:

For the roles the English auction is classified as *bilateral-participation* with *multiple-agents* on the buyers side and *one-agent* on the seller side. Typically an *open-admission* is used with *exposed-identity* (e.g. to verify a seller rating) and *prohibited-collusion* (in order to avoid rings or shills, see for example Guttman and Maes, 1998).

The English auction process is *single-round* and *single-staged* with *fixed-variation* (i.e. the rules of the auction cannot change). Concurrency is usually *possible*, which means that one can participate in multiple parallel auction sessions. The scenario allows only for *single-attribute*, *single-value*, *fixed-relaxation*, and *fixed-structure offers*. One attribute with one value can be specified in the offers (bids), namely the price. In addition, offers are usually specified for *single-* or *multiple-objects*. As only the buyers are allowed to submit offers, the scenario is *single-sided* and *single-positioned*. Offers have to be submitted with *forward-direction*. In addition, the offer submission is typically subject to an *event-based-activity* rule (e.g. a timeout is defined dependent on a period of inactivity) and *ascending-value* restrictions (new offers need to have a higher price than the current best offer). If a reservation price is defined, the process is due to its forward-direction with a

low-cut-threshold. Offer matching occurs with *continuous-schedule* and *exclusive-sorting* - buyers submit their offers directly towards a specific offer-taker. A *ranked-evaluation* is used in the sense that the buyers' offers are ordered according to the offered price. Offers with the same price can still be selected based on a simple *tie-breaking-resolution* which establishes precedence through the submission timestamps. For the allocation, *discriminative-distribution* is used, i.e. the winner has to pay the price specified in the winning offer, the price to pay is *offer-dependent*, and *mediated-configuration* results from the fact that only single-values are allowed for attributes. Through *binding-commitment*, the auctioneer ensures that the winning bidder is forced to execute the agreed-upon transaction.

Concerning the information available within the process, an English auction is always with *offer-restricted* communication. In most cases the auction is *transaction-logged* and *negotiation-logged*, which means that the agents can lookup the past transactions as well as the bid history. Through *public-transparency*, an *exposed-trace*, and *unrestricted-content*, competing bidders know who submitted the currently winning offer and which price is specified in that offer. This information is updated each time a new offer comes in and therefore with *continuous-timing*. With regard to the business model implementation, English auction providers tend to impose *success-based-fees*, for instance by charging some percentage of the overall deal value to the seller. Another common example is *punishing-arbitration* where providers try to prevent sellers from bidding in their own auctions. In many cases *appraisal-based-ratings* are used to create a level of trust between buyers and sellers.

The explicit classification criteria for scenarios can also be used to evaluate and compare electronic negotiation media or negotiation support systems (see the examples in Benyoucef and Neumann, 2002). First of all, the dimensions of negotiation support (i.e. the flexibility of the electronic negotiation medium) can be assessed by checking whether a specific electronic negotiation medium supports any, which,

or all criterion values/rule expressions. Second, the level of automation or decision support can be evaluated based on the process execution reference model. Some electronic negotiation media might, for example, support offer matching with filtering and selection rules, whereas other types of media (or negotiation engines) leave the offer matching task to the offer-taking agent. In general, one electronic negotiation medium may host several scenarios and corresponding electronic negotiation instances with varying rules and, accordingly, different classification types. Depending on their requirements or intentions, agents might choose the most suitable instance. Often the electronic negotiation instances available to an agent are defined by the medium provider. A typical example is an electronic market for financial derivatives, where depending on the level of experience, agents may be gradually authorised to participate in negotiation processes for objects with increasing risks (e.g. options or futures).

5. Discussion

The contribution of this paper is two-fold. Firstly, it provides a framework comprising a set of related definitions and a prescriptive electronic negotiation process model. Secondly, a taxonomy for electronic negotiations is suggested on the basis of this framework, which can be used for descriptive as well as prescriptive purposes and covers aspects such as the roles, process, information revelation and business model implementation of an electronic negotiation. The taxonomy is intended to capture a great variety of electronic negotiations in the narrow sense, which means that these negotiations are characterised by at least one explicit and enforced rule, and are supported in a way that at least one communication or decision making task is assisted through the underlying electronic negotiation medium.

5.1. USAGE

Like any other information system, the creation of an electronic negotiation instance, comprising a scenario and a medium as negotiation support system, can be structured along the system development phases of analysis, design, and implementation. Choice and further specification of a scenario in the design phase will vary depending on requirements and guidelines identified in the analysis phase. In the implementation phase, the scenario has to be mapped to the architecture of the underlying electronic negotiation medium. The Montreal Taxonomy can provide substantial support especially for the analysis and design phase of the development process.

The main objective for the analysis phase is to derive, on the basis of a business context analysis and the set of business goals, requirements and recommendations for the design phase. These requirements and recommendations should guideline the design and implementation process, so that the business goals, such as the realisation of a specific business model, can be achieved. As will be shown, the results of this analysis phase can be structured according to the taxonomy structure.

An analyst will typically try to identify distinct properties of the business context. Exogenous classification criteria for the business domain and the business model represent one way of capturing the results of the assessment process. Given business goals, domain, and model classification criteria, the analyst has to derive guidelines and requirements. Unfortunately, current theory offers neither guidance nor a "cookbook" to help an analyst select, for example, the "right" type from the high number of potential auction types (Wurman et al., 2001). Assuming that a recommendation is found, these guidelines and requirements can partially be expressed with the set of implicit criteria suggested in Section 4.2.2. The analyst could come, for instance, to the conclusion that the future electronic negotiation process has to strive for efficiency and fairness with regard to all participating agents in order to be successful and attractive in the business context. To achieve these

properties, detailed design recommendations can be derived from the implicit criteria and be specified on the basis of the explicit classification criteria developed as criteria objectives. To foster fairness, the analyst could recommend, for instance, that all sides during the offer submission be allowed to submit offers (*multiple-sides*). Regarding the information revelation, a recommendation could demand that all sides have access to the same information (*public-transparency*).

For the design phase the explicit, for example endogenous, classification criteria for the scenario, which were determined in the analysis phase have to be translated into design decisions. Especially if the underlying electronic negotiation medium architecture is customisable in a declarative way, the criteria objectives could be directly encoded into the design as parameter settings. In principle, these parameters could be sufficient to instantiate protocols or to generate software agents for the chosen design. If this is not the case, the criteria objectives still provide explicit test conditions for the more detailed design, which allow validating the design for its completeness and accuracy.

Abstracting from the development view of single electronic negotiation instances, additional benefits can be achieved if the taxonomy is used to structure the development of a number of different electronic negotiation media and instances. Through the framework provided by the taxonomy, an electronic negotiation instance could be characterised distinctively and in a common language, which could enable and allow software agents, for instance, to participate in a number of different electronic negotiations, e.g. with different protocols, and to adapt their behaviour according to the classification provided by the taxonomy for this negotiation (see for example Tu et al., 2001). Eventually, one could establish an electronic negotiation directory service, which supports structured searching based on the criteria defined in the taxonomy, and which also allows for the download of a machine-readable representation of an electronic negotiation classification (e.g. to automatically generate a corresponding software agent and bind it to the negotiation instance

or to check whether the configuration/strategy of an existing agent is compatible with the scenario specification).

Finally, the Montreal Taxonomy may also support a standardised certification of already existing electronic negotiation instances with well-defined labels or overall "grades". On the basis of the defined classification criteria, trusted third parties such as auditing companies could certify an electronic negotiation, for example, to be "fair" in the sense of the Montreal Taxonomy definition or to adhere to a certain type of electronic negotiations, e.g. multi-attribute negotiations.

5.2. FUTURE WORK

On the basis of the current status of the Montreal Taxonomy we can identify three important areas for future research:

- Significant efforts are necessary to come up with a stringent scheme of exogenous explicit criteria, which allows characterising a business domain or a business model.
- Once these classification criteria are available the complex mapping of exogenous criteria to endogenous criteria, from implicit to explicit criteria can be undertaken, thus allowing a designer to choose the "right" scenario for a given business context, which might be characterised through exogenous classification criteria.
- A formal language for the explicit expression of an electronic negotiation type/classification is currently not available. This language could provide more explicit support for the design of electronic negotiation media as well as for the customisation of support mechanisms or software agents at run-time.

These potential future contributions, together with the foundation provided by the Montreal Taxonomy as presented in this paper, should illustrate that first steps towards an engineering approach for electronic negotiations are already undertaken (see the related papers in this special issue).

Acknowledgements

The authors would like to thank their colleagues from the electronic negotiations community for constructive suggestions and valuable feedback on the ideas presented in this paper, namely Morad Benyoucef, Martin Bichler, Gregory Kersten, Dirk Neumann, Stefan Seifert, Markus Stolze, and Stefan Strecker.

References

- Alt, R., and H.-D. Zimmermann. Guest Editors Note. *EM - Electronic Markets*, 11(1), 2001.
- Bassil, S., M. Benyoucef, and D. Neumann. A Comparison of electronic negotiation systems. *Group Decision and Negotiation*, Submission for this same issue, 2002.
- Bichler, M., G. Kersten, and S. Strecker Engineering of Negotiations. *Group Decision and Negotiation*, Submission for this same issue, 2002.
- Bichler M. A Roadmap to Auction-based Negotiation Protocols for Electronic Commerce. *In: Proceedings of the 33rd Hawaii International Conference on Systems Sciences (HICSS)*, 2000.
- Field, S., M. Stolze, and M. Stroebel. 1st e-Negotiations Workshop - Negotiations Beyond Price. *DEXA Workshops*, <http://www.zurich.ibm.com/mrs/dexa2000/>, 2000.
- Gulliver P. *Disputes and Negotiations: A Cross-Cultural Perspective*. Academic Press, New York, 1979.
- Guttman, R. and P. Maes. Agent-mediated Integrative Negotiation for Retail Electronic Commerce *Proceedings of the Workshop on Agent Mediated Electronic Trading*, Minneapolis MN, 1998.
- Hurwicz L. The Design of Mechanisms for Resource Allocation. *American Economic Review*, 63:1–30, 1973.
- Kersten, G., S. Noronha, and J. Teich. Are All E-Commerce Negotiations Auctions? *Proceedings of 5th International Conference on the Design of Cooperative Systems (COOP)*, Sophia Antipolis, France, 2000.
- Kumar, M. and S. Feldman. Business Negotiations on the Internet *Proceedings of INET*, Geneva, Switzerland, 1998.
- Lomuscio, A. R., M. Wooldridge, and N. R. Jennings. A Classification Scheme for Negotiation in Electronic Commerce. In F. Dignum and C. Sierra, editors, *Agent Mediated Electronic Commerce*, Springer LNAI 1991:19–33, 2001.

- Rangaswamy, A., and R. Shell. Using Computers to Realize Joint Goals in Negotiations: Toward an Electronic Bargaining Table. *Management Science*, 43:1147–1163, 1997.
- Runge A. *Die Rolle des Electronic Contracting im elektronischen Handel*. Dissertation No.2366, University of St.Gallen, Switzerland, 2000.
- Schmid B. *Was ist neu an der digitalen Ökonomie?* In M. Sauter and A. Hermanns, editors, *Handbuch Electronic Commerce*. Universität der Bundeswehr München Germany, 1998.
- Ströbel M. The Effects of Electronic Markets on Negotiation Processes. In H. R. Hansen, M. Bichler, and H. Mahrer, editors, *Proceedings of the 8th European Conference on Information Systems (ECIS)*, Vienna Austria, 1:445–452, 2000.
- Ströbel M. A Framework for Electronic Negotiations Based on Adjusted Winner Mediation. In *Proceedings of the 11th International Workshop on Database and Expert Systems Applications (DEXA)*, IEEE Computer Society, Los Alamitos CA, 1020-1028, 2000.
- Tu, T., C. Seebode, F. Griffel, and W. Lamersdorf. DynamiCS: An Actor-Based Framework for Negotiating Mobile Agents. *Electronic Commerce Research*, 1:101–107, 2001.
- Weinhardt C. and Gomber P. Agent-Mediated Off-Exchange Trading. In *Proceedings of the 32nd Hawaii Conference on System Sciences*, Maui 1999.
- Wooldridge M. and S. Parsons. Issues in the Design of Negotiation Protocols for Logic-based Agent Communication. In F. Dignum and C.Sierra, editors, *Agent Mediated Electronic Commerce*, Springer LNAI 1991:70–83, 2001.
- Wurman, P., M. Wellman, and W. Walsh. A Parameterization of the Auction Design Space. *Games and Economic Behavior*, 35:304–338, 2001.