Modelling Trade and Trust Across Cultures

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Abstract. Misunderstandings arise in international trade due to difference in cultural background of trade partners. Trust and the role it plays in trade are influenced by culture. Considering that trade always involves working on the relationship with the trade partner, understanding the behaviour of the other is of the essence. This paper proposes to involve cultural dimensions in the modelling of trust in trade situations. A case study is presented to show a conceptualisation of trust with respect to the cultural dimension of performance orientation versus cooperation orientation.

1 Introduction

"High quality! Traced and guaranteed!" Thus yells an American middleman in a session of the Trust and Tracing Game [1]. The man is buying and selling envelopes that have an invisible quality attribute. They can be either high quality or low quality, and of course the first variant fetches a better price. But why is he having his products traced up front? The producer he buys from knows the hidden quality of each envelope, and if the middle man trusted him he could save himself the tracing cost.

The answer has to do with trust. The middle man may or may not trust his provider, but he expects that no buyer will trust *him* to be sincere about the quality of his pretended high-quality envelopes unless he has them traced. So he makes the best of a cost factor and he uses the act of tracing as a marketing device.

The same game, played with Dutch participants, yields a different network. The game's pace tends to be slower and some negotiations are prolonged. Nobody traces anybody else, until the game leader reveals that consumers have been cheated and are stuck with low quality after having paid for high quality. This induces some tracing in the next round, but not much. By having his purchase traced, a Dutch buyer would indicate distrust of the seller, and that is not done. The seller himself would never think of tracing up front, because that would be throwing away money in vain, and he expects to be trusted anyhow.

K. Stølen et al. (Eds.): iTrust 2006, LNCS 3986, pp. 120 – 134, 2006.

We have been witness to the above events. In miniature, they mirror the unwritten rules of the game of real trade in the US and the Netherlands. The same game with the same explicit rules yields very different behaviour of the trade network because the hidden rules and assumptions differ.

Agent models of trade networks have been around for some years. The behaviour in an agent model is an emergent property resulting from the behaviour of all the agents. The role of the agents' preferences in such a model is not too hard to represent. But can we also incorporate the unwritten rules and expectations of culture? That is the subject of this paper.

The context of this study is research into social aspects of food supply chains and networks, as introduced in [2]. That research aims to increase insight in human behaviour in trade relations, with the goal to design efficient institutional environments for production and distribution of food, meeting high standards of to consumer satisfaction, health, food safety, and social responsibility. Especially for food with its potential hidden contaminations that can lead to severe health effects, trust is a key research item [3]. But this preliminary study abstracts from the food context and applies to any trade situation in which the products have hidden quality attributes. Human simulation games are used in combination with multi-agent simulations, to develop models for the role of trust in supply networks, by iteratively implementing models in multi-agent simulations, comparing simulation results with human simulations, and refining the models [4]. As illustrated by the example in the beginning of this section, observations of human games indicate that culture cannot be ignored.

Models of player's behaviour in simulation games entail models for deciding about agent's intentions, based on agent's beliefs and desires. According to March [5], decision making processes may be rational or rule following. Rational decision making aims to maximize a utility function. In rule following decision making, a decision maker classifies the situation and its own role in it; subsequently, she applies rules to answer the question: what is appropriate for a person like me to do in a situation like this? Human decision making processes often have both rational and rule-following aspects. Rule-following decision making can be seen as imposing moral boundaries on acceptable outcomes of rational decision making. It can also be seen as consolidated experience or an evolutionary outcome of rational decision making [5].

It is an interesting question to ask if artificial agents like human decision makers should apply both types of decision making. Agents that are designed to outperform people in rational decision making processes by use of superior computation power can probably do without rule-following. Agents that are designed to simulate human behaviour in some way will probably need to apply both processes of decision making simultaneously, although it may not strictly be necessary to follow equal procedures to get sufficiently resembling results. Especially in simulations that aim to increase understanding of human decision making, simulation of human rules is a sine qua non. This implies that the latter kind of agents must have cultural scripts.

Both a decision maker's desires (goals of the decision making) and its procedures for decision making are culture-dependent in several ways. First, the priority of goals depends on culture; for instance "maximize personal wealth" may have priority over "maintain pleasant interpersonal relations". Second, preferences for rational versus rule following procedures differ across cultures; e.g. in collectivistic cultures with large power distance, following the rules is more appropriate then in individualistic

cultures with little power distance where rational decision making will prevail. Third, if a rule following procedure is chosen, the rules depend on culture. Fourth, a decision may be interpreted offensive by an opponent having adifferent cultural background. Also, the appropriate reaction to inappropriate behaviour differs across cultures.

The focus of this paper is on the relation between culture and trust in human trade networks. We abstract from personality and select a single dimension of culture as a modelling case. The next sections describe the background of culture theory, the background of trust literature used for the case study, the Trust and Tracing Game, a case study of modelling a dimension of culture, its application to the Trust and Tracing Game, and conclusions.

2 Culture and Trust

Culture is what distinguishes one group of people from another [6]. This implies that culture is not an attribute of individual people, unlike personality characteristics. It is an attribute of a group that manifests itself through the behaviours of its members.

For a trading situation, culture of the trader will manifest itself in four ways. First, culture filters observation. It determines the salience of clues about the acceptability of trade partners and their proposals. Second, culture sets norms for what constitutes an appropriate partner or offer. Third, it sets expectations for the context of the transactions, e.g. the enforceability of regulations and the possible sanctions in case of breach of the rules. Fourth, it sets norms for the kind of action that is appropriate given the other three, and in particular, the difference between the actual situation and the desired situation.

Our US middle man, for instance, sees as acceptable a trade partner who has his products traced so that quality is out in the open. He will be keen to observe any offer of untraced high-quality goods and to distrust the one offering it. He expects his clients to think in the same way, and in order to be deemed respectable, he has traces performed himself. It also helps that he expects heavy-handed punishment in case of infringement of explicit laws.

Our Dutch trader, on the other hand, likes trade partners who are forgiving and friendly and who place implicit trust in one another's good intentions. He will perceive it when somebody asks for a trace and label that person as distrustful. In order not to be thought distrustful himself, he will not trace until proven wrong, and if proven wrong he will try to avoid the bad guy, or most likely (if it is the first offence) ask the cheater to be honest the next transaction and sell for a low price to make up the losses from the cheated transaction.

What is it that makes these two traders behave in such different ways? It could be their personalities, or their experiences, or it could be the way they were brought up, in other words: their culture. It turns out that in terms of culture, the USA and the Netherlands are unusually easily comparable, because they are rather alike but for one aspect. Culture at the national level is concerned with five big issues of social life: hierarchy, identity, cooperation-performance orientation, the unknown, and the gratification of needs. Hofstede and Hofstede [6] conceptualize each of these issues as a bipolar continuum ranging from about 0 to about 100: from small to large power distance, from collectivist to individualist, from cooperation oriented to performance

oriented, from weak to strong uncertainty avoidance, and from short-term to long-term orientation. As figure 1 shows, the Netherlands and the USA differ considerably on the Cooperation-Performance orientation dimension and little on the other four. Incidentally, this is not to say that culture only occurs at a national level – but the national averages in these two countries happen to differ. Of course, every individual is unique, and many subgroups with their own culture exist within any country.

In this article, we shall abstract from the real world in an important way. We shall describe agents as if the dimension of performance orientation were the only one. This is a deliberate choice, but it should be borne in mind that in reality, behaviour is always the outcome of a mix of factors: all elements of one's culture, all elements of one's personality and all contextual and historical coincidences.

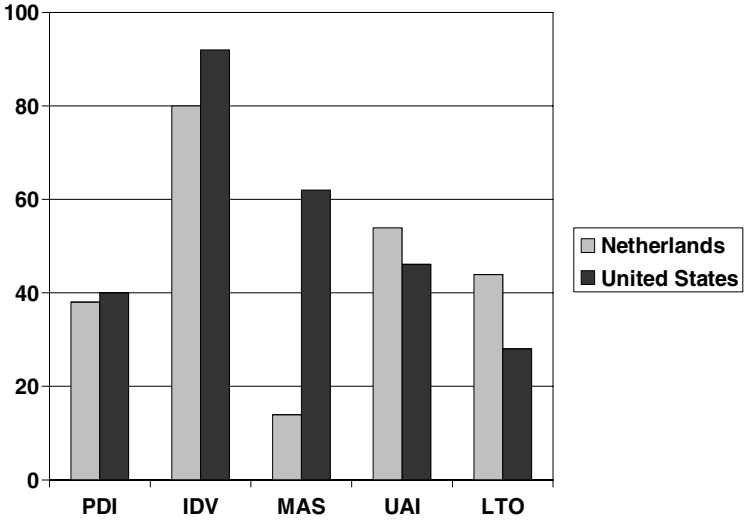

Fig. 1. The cultures of the Netherlands and the USA compared (PDI = Power Distance index, IDV = Individualism index, MAS = Masculinity index, also called the cooperation-performance orientation index, UAI = Uncertainty avoidance index, LTO = Long-term orientation index)

What does the dimension of performance orientation indicate? Let us describe the two extremes – more extreme in fact than any real-world culture – to give the big idea. Performance oriented cultures are cultures in which people are expected to place value on measurable performance criteria such as size, speed and quantity. Money is good and rich people are admired. Life is conceptualized as a series of contests and winning is paramount while losing is a disaster. Implicit trust is low; if you get cheated upon it is your own fault and you are a loser. If you do good, you also do it in a large way. If you commit crimes, they are large ones, not petty ones. Big is beautiful in everything.

Cooperation oriented cultures are the opposite. Winners are at risk of awakening feelings of jealousy. Small is beautiful, implicit trust is high, and cheaters are looked down upon. Yet small-scale cheating occurs a lot because society is permissive, and punishments are low or, in the case of small misdemeanours, you may be forgiven. Good intentions are more important than good performance.

These two descriptions are stereotyped extremes. Yet citizens from either of these two countries who have been exposed to the other one's culture probably recognize quite a bit of them. And because the Netherlands and the USA also have quite many contacts in actual business life, the comparison is meaningful in the real world.

The meaning of trust across cultures is related to this dimension of culture. In fact, the statement 'Most people can be trusted' was one of the constituents of the dimension in Hofstede's original research. In cooperation-oriented cultures, people agree with it more. Since then, many others have investigated the variations of the meaning of the concept across cultures. See e.g. chapter 8 in [3] for a discussion of the dynamics of trust and transparency across cultures, and [7] for a conceptualization of trust and a literature review. This latter article distinguishes *intrinsic trust* from *enforceable trust*. Intrinsic trust is trust that accepts vulnerability, while enforceable trust is trust in good performance that is backed up by the option of rewarding and punishing the trustee. To sum it up in a simplified way: the former is what people mean by trust in cooperation oriented cultures, and the latter is what they mean by trust in performance oriented cultures.

Some published results confirm the relevance of cultural difference for electronic trade, for instance Huang et al. [8] report relations between nationality, trust and internet adoption. Jarvenpaa and Tractinsky [9] report only slight differences in consumer trust in on-line bookstores across cultures. The latter results were based on observations in three countries with an individualistic culture: Australia, Finland and Israel. The authors assume that larger differences may exist between individualistic and collectivistic nations. They emphasize the importance of gathering more data. However, only few publications have appeared, presenting fragmented data of only a few countries. An example is the study by Vishwanath [10] that relates on-line auction participation and the effect of seller ratings in Germany, France and Canada. His findings confirm that in a country with higher masculinity index, trust is less relevant: bidders do rely on the information in seller ratings; they do not trust.

All available data suggest a relation between culture and trust in internet participation. However, available data are insufficient for foundation of cross-cultural models of consumer trust that can be used for agent design. Development of well-founded trust models incorporating culture requires empirical, preferably experimental, data.

3 Agent Based Simulations of Trust and Trade

Castelfranchi and Falcone proposed a model of trust that can serve as a basis for agent based simulations [11, 12]. The main issues in their model are:

- Trust is at the same time: a mental attitude towards another agent, a decision to rely on another agent, and a behaviour that entails a relation with another agent.
- Trust consists of beliefs about another agent's competence and willingness to fulfil some task. Willingness arises from a complex of motivations.
- A condition for trust is the belief that it is better to rely on the trustee than not.
- The decision to trust may be influenced by environmental factors: opportunities, obstacles, adversities, and interferences.

- In the decision whether to trust or not, an agent weights and prioritises the above influences and compares the result with a threshold of acceptable risk. Weight factors, priorities and risk threshold depend on context and agent's personality.

Although the authors do not relate trust with culture, their model offers opportunities to do so. When viewing trust as a mental attitude towards another agent, an agent's cultural background and the cultural context will influence its valuation of the motivations to trust. When viewing trust as an intention to rely on an agent, the criteria, priorities, and weight factors for the decision process reflect cultural background.

Trust models can be put into operation in a testbed. A recently proposed approach is the ART testbed architecture [13]. The authors propose a software architecture for testing and comparing reputation and trust models, either in experimentation or in competition mode. The testbed provides relative performance indicators for reputation and trust models. The testbed offers a java environment where researchers can implement java methods to implement the models. Thus, it can test any model with any cultural script in any cultural or cross-cultural setting. However, the testbed approach is not related to data from real human cultures.

Jonker et al. [4] present an approach to interrelate multi-agent simulations and human simulation games in order to validate and refine trust models, especially with respect to different cultural and institutional settings. The game focuses on the role of trust in supply chains with asymmetrical information about product quality between sellers and buyers. Playing this game with people from different countries showed different development of patterns of trust and co-operation between cultures. The approach is effective in producing empirical data. As it requires multiple game sessions of several hours with some twenty players, it is very time-consuming. This is the necessary cost of a controlled way to acquire empirical data for model formulation, parameter estimation and model validation in multi-agent systems.

Simpler experiments, e.g. those presented by Jonker et al. [14], could be used to compare isolated aspects of trust across cultures. The paper presents a method for measuring the effect of sequences of positive experiences and disappointments on the level of trust. Results are acquired from a single cultural setting. It would be interesting to compare dynamics of trust across cultures using this experimental approach.

Partner selection is a special point of attention in trade models, especially in multi-agent simulations. Partner selection starts with models for partner preference. Models based on experience with regard to negotiation success are describeded by, for instance, Tesfatsion [15] and Munroe and Luck [16]. Sen et al. [17] present a model for players that anticipate their opponents selecting partners based on experience. However, none of these models explicitly represents cultural dimensions.

4 Trust and Tracing Game

The Trust and Tracing [1] game for human players is a research tool for supply chain and network studies. This tool places the choice between relying on trust versus spending money on complete information in trade environments at the core of a social simulation game. The game is used both as a data gathering tool about the role of reputation and trust in various types of business networks, and as a tool to make participants reflect on their own daily experiences in their respective jobs.

In the game sellers of a commodity have more information about the quality of the goods than buyers, as quality is invisible and only known by the producers. This leads to information asymmetry and the opportunity for deceit. Meijer and Hofstede [1] describe the dilemma similar to the well-known Prisoners Dilemma in the so-called Trader's Predicament.

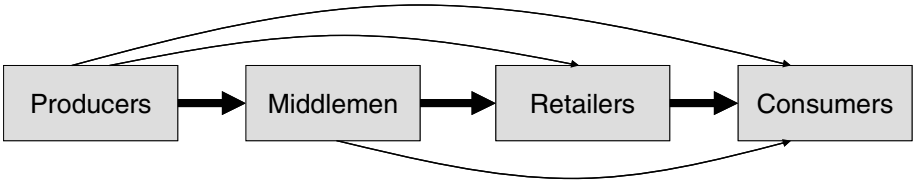

Fig. 2. Supply network configuration

In the human Trust and Tracing game 12 to 25 participants play roles in a supply network. There are producers, middlemen, retailers and consumers (see Figure 2). The producers receive an initial amount of goods. The good traded is a sealed envelope that comes in 3 different types (colours) and each of the types in two qualities (high and low). The quality is invisible, as it is hidden in the sealed envelope. Producers know which envelopes are high quality and which are low. The only person in the game allowed to open an envelope is the tracing agency. Table 1 specifies satisfaction values of each good for a consumer (utility).

Table 1. Consumer satisfaction value by the type and quality

Quality	Type		
	Blue	Red	Yellow
Low	1	2	3
High	2	6	12

An agent buying a high quality envelope takes a risk, as he cannot know the real quality. The buyer can check afterwards by doing a trace at the tracing agency, but this costs money. Tracing is cheaper early on in the network than for consumers. When consumers prefer traced goods (certified high quality) it would be economical to let a middleman do the trace and sell the traced product throughout the network along with the certificate. Successful deception is beneficial for a seller as he receives an additional income. (The difference between the price of a high and that of a low-quality product) However, if the deception is discovered the cheater has to pay a fine. Resellers of cheated products who did not check the quality themselves have to pay a smaller "ignorance" fine.

In the case study a situation is considered in which two traders meet for the first time and know nothing about each other. Trader P is very much performance oriented, trader C is the opposite, i.e., cooperation oriented. The traders negotiate about one envelop, said to contain a high quality commodity. The profile of trader P is such that he is willing to trade for a final price of about Q. The profile of trader C is such that he is willing to trade for a final price of about Q. Given that Q is an acceptable price,

everything is set in such a way that a deal is possible if the negotiations are performed in an acceptable manner, acceptable that is to the other party.

5 Modelling Cooperation- Versus Performance Orientation

The dimension of performance orientation versus cooperation orientation has its effect on the way people will behave in the Trust and Tracing Game. In this section this effect is described informally and then (partially) specified formally as prodcution rules).

A performance oriented trader is interested in fast trades, with as many goods as possible in one trade. This trader is rather impatient, and if bids are too far off from his profile, he will walk away quickly. The performance oriented trader always traces the goods after buying, since he expects the possibility of deception. He sticks to the contract of the deal, and will deceive the trade partner to the limits of the contract without any compunction. As a consequence, the performance oriented trader sees no problems in dealing again with a trader that conned him in the past: "It's all in the game". Each subsequent negotiation will be dealt with without taking past trustworthiness into account. Each new contract will be set up from scratch. The trader learns from mistakes to make sure that the contract will not lead to new and uncomfortable surprises on his side.

A cooperation oriented trader is interested in the relationship with the trade partner, building trust is important, the amount of goods is not of the most interest. The trader is also interested in negotiating about one envelope only, because the relationship built during that negotiation might pay off in future negotiations. Given the interest in the relationship with the trade partner, a first negotiation with a trade partner will take time that is willingly spent by the trader. During such negotiations, the trader appreciates a negotiation process in which both partners show a willingness to accommodate the other over time. Past negotiations do play an important role in subsequent negotiations. The trader is perfectly willing to see the current negotiation as a kind of continuation of the previous one. If the trade is about the same commodity, the trader will start the negotiation from the deal of the last one. If the other accepts, then the deal can be made in one round and in seconds, whereas the first deal might have taken a lot of rounds and lots of time. In principle, the cooperation oriented trader does not trace, since in his mind this would constitute ostentation of distrust. If conned, then the cooperation oriented trader will avoid the conman if possible, or give him one more chance. In the human games we observed that he then asks for a very good new deal to reaffirm the relationship. In the application of the rules to the setting described in Section 4, the following simplifications are made. The cooperation oriented trader C is content in a first ever trade with another trader T, if negotiation takes 5 rounds before a deal is found, and over the rounds T tries to accommodate C. A bad negotiation is one that is not satisfying. A performance oriented trader P is content in a first ever trade with another trader T, if negotiation is successful and fast (at most 2 rounds), and both P and T showed steadfastness in their bidding. Trader P respects and appreciates steadfastness in T and will show the same behaviour towards T. For trader P a satisfying negotiation is one that is short (at most 2 rounds) and in which both traders show steadfastness.

Both trader P and trader C prefer reaching a deal after a satisfying negotiation over a deal that was reached on the basis of a bad negotiation. Not reaching a deal after a satisfying negotiation is better than having no deal after a bad negotiation. Bear in mind that the traders differ strongly in what is considered a satisfying negotiation. Furthermore, note that their cultural scripting will also lead them to behave differently during the negotiations. Trader P might very well walk away (no deal) as soon as he receives a first bid of trader C that is very far off price Q. Whereas trader C might be put off by the steadfastness of trader P, and certainly by his walking away after few rounds. However, C will be forgiving and willing to negotiate with P one more time, although C will trust P less and avoid risk in the next deal.

Some essential parts of the specification are presented in the remainder of this section; more can be found in Appendix A, and a full specification can be obtained from the authors. The specifications are formulated as production rules.

The cultural dimension has performance orientation at one extreme of the spectrum, and cooperation orientation at the other. This dimension is modelled by one value, indicated by the function named pc_orientation. A value of 0 corresponds to extreme cooperation orientation, whereas value 1 corresponds to extreme performance orientation. A personality factor is used to account for individual differences in decision making.

```
(1)  If cultural_script_contains(pc_orientation(F: Real))
       And minimum_utility(M: Real)
       And personality_factor(impatience, I: Real)
     Then impatience_factor(F: Real * (I: Real + 0.5))
       And preferred_relative_deal_size(F: Real)
       And allowed_relative_gap_size(F: Real)
       And cut_off_value(M: Real * F: Real);
```

At each moment during the negotiation the trader can decide to cut off the negotiations without a deal, or to accept the opponent's last offer (deal), or to continue with the negotiations. The other party can of course also take the initiative to accept the deal of the trader or to cut off the negotiations without a deal. A deal corresponds to a contract that stipulates the conditions of the sale. His decisions after a negotiation has ended in a deal depend on the role that the trader is playing. As a seller, he has to decide whether or not to cheat upon his trade partner. This aspect is not considered in this paper, see [18] for a model on cheating in the Trust and Tracing Game. If the agent is a buyer, he has to decide whether or not to trace the commodities sold to him. Aspects of the negotiation process determine whether or not he changes his opinion of his trade partner. A change in opinion is regulated by change factors (values between 0 and 1). The change factors (big and small) and their dynamics are part of the personality profile of the trader, and not further elaborated here. The negotiations in the Trust and Tracing Game have a closed character, therefore, both negotiation partners only have their own utility function to evaluate both own bids and those of the negotiation partner. In reality many factors influence decisions to continue negiation, to trust or deceive a trade partner, etc. Where not all of the factors can be included in the model, random factors between 0 and 1 are used to obtain a more natural variability in behaviour.

Rule 2 describes that the trader will stop the negotiation if he considers the starting points of the bidding as too far apart. The impatience factor influences the decision; the higher F, the sooner the trader will stop for this reason.

```
(2)  If impatience_factor(F: Real)
       And current_negotiation(T: Trader, X: Integer, L: Commodity_List)
       And current_round(X: Integer)
       And others_bid_utility_in_round(U: Real, X: Integer)
       And cut_off_value(C: Real)
       And U: Real < C: Real
       And random(0, 1, S: Real)
       And 0.5 < S: Real * (F: Real + 0.5)
     Then stop_negotiation(T: Trader, X: Integer, L: Commodity_List, gap);
```

The lower the impatience factor, the higher the probability that the trader will stop the negotiation if progress is slow:

```
(3)  If impatience_factor(F: Real)
       And current_negotiation(T: Trader, X: Integer, L: Commodity_List)
       And current_round(X: Integer)
       And progress_in_bids(X: Integer – 3, X: Integer, P: Real)
       And minimal_progress_value(M: Real)
       And P: real < M: Real
       And random(0, 1, S: Real)
       And 0.5 < S: Real * (1.5 - F: Real)
     Then stop_negotiation(T: Trader, X: Integer, L: Commodity_List, no_accom);
```

Rule 4 is an example of using a random factor to obtain more natural behavior. The rule updates the acceptability of the negotiation partner. The impatience factor influences the decision whether or not a change is made. If a decision is made for change, the size of the change depends on the change factor, which is part of the agent's personality profile.

```
(4)  If stop_negotiation(T: Trader, X: Integer, L: Commodity_List, gap)
       And impatience_factor(F: Real)          And acceptability(T: Trader, R: Real)
       And change_factor(B: Real, big_change)  And random(0, 1, S: Real)
       And 0.5 < S: Real * (F: Real + 0.5)
     Then new_acceptability(T: Trader, R: Real * B: Real) ;
```

Rule 5 describes the effect of a negotiation in which the other partner did not accommodate our trader. The smaller the impatience factor, the more the acceptability will decrease; the bigger the impatience factor, the more the acceptability will increase (see rule 1 for the relation of impatience with culture and personality). The turning point is at 0.5 at which no change occurs. Normalisation functions can be added to maintain the acceptability value between 0 and 1, however, they are left out for reasons of transparency.

```
(5)  If stop_negotiation(T: Trader, X: Integer, L: Commodity_List, no_accom)
       And impatience_factor(F: Real)
       And acceptability(T: Trader, R: Real)
     Then new_acceptability(T: Trader, R: Real * (F: Real + 0.5) );
```

A buyer that is rather performance oriented will almost always trace the deal. Other aspects that play a role are his personality profile (for this example, only risk-attidude is taken into account) and the trustworthiness of the other party. Notice, that for a performance oriented trader the issue of trust is not that important as it is for cooperation

oriented traders. The changes he makes to partner's trustworthiness are small, thus impact of trust on the next item is related to his initial trust in people. For the cooperation oriented trader, trust is important. Thus, for the cooperation oriented trader, the trust he has in others has a higher impact on his decision to trace or not.

```
(6)  If cultural_script_contains(pc_orientation(F: Real))
       And deal_in_round(T: Trader, B: Bid, X: Integer)
       And my_role(buyer)
       And personality_factor(risk_attitude, I: Real)
       And trustworthiness(T: Trader, H: Real)
       And random(0, 1, S: Real)
       And 0.5 < S: Real * (F: Real – H: Real – I: Real + 1.5)
     Then to_be_traced(B: Bid);
```

Rules 7-10 model the opposite effects of the length of a negotiation on performance oriented and cooperation oriented traders. The p-round boundary used in rule 7 is the number of rounds that a performance oriented trader typically allows before cutting off. The c-round boundary is the number of rounds a cooperation oriented trader would minimally prefer in negotiation with a trader he has no experience with. The p-round boundary could, for example, be set to 2 and the c-round boundary to 5.

```
(7)  /* performance oriented trader appreciates a fast deal */
     If deal_in_round(T: Trader, B: Bid, X: Integer)
       And impatience_factor(F: Real)                    And p_round_boundary(A: Integer)
       And F: Real > 0.5                          And X: Integer ≤ A: Integer
       And change_factor(I: Real, big_change) And acceptability(T: Trader, R: Real)
     Then new_acceptability(T: Trader, R: Real * I: Real * (F: Real + 0.5) );

(8)  /* performance oriented trader dislikes long negotiation */
     If deal_in_round(T: Trader, B: Bid, X: Integer)
       And impatience_factor(F: Real)                    And F: Real > 0.5
       And change_factor(D: Real, big_change)            And p_round_boundary(A: Integer)
       And X: Integer > A: Integer               And acceptability(T: Trader, R: Real)
     Then new_acceptability(T: Trader, R: Real * D: Real);
```

A cooperation oriented trader appreciates a first long negotiation, even if it ends without a deal. To get a big increment, given change factors between 0 and 1, the change factor is mirrored in the line x=1, thus the factor 2 – I: Real.

```
(9)  If stop_negotiation(T: Trader, B: Bid, X: Integer, W: Reason)
       And number_of_earlier_negotiations_with(0, T: Trader)
       And not W: Reason = no_accom                      And impatience_factor(F: Real)
       And F: Real < 0.5                                 And acceptability(T: Trader, H: Real)
       And change_factor(I: Real, big_change)            And c_round_boundary(A: Integer)
       And X: Integer > A: Integer
     Then new_acceptability(T: Trader, H: Real * (2 - I: Real) );
```

A cooperation oriented trader dislikes a first short negotiation, even if it ended in a deal. Note that earlier rules can intensify this effect if during the negotiation the other party made no accommodations in his direction.

```
(10) If stop_negotiation(T: Trader, B: Bid, X: Integer, W: Reason)
       And number_of_earlier_negotiations_with(0, T: Trader)
       And impatience_factor(F: Real)                    And F: Real < 0.5
       And change_factor(D: Real, big_change)            And c_round_boundary(A: Integer)
       And X: Integer < A: Integer                       And acceptability(T: Trader, H: Real)
     Then new_acceptability(T: Trader, H: Real * I: Real);
```

The trader compares different negotiation options as offered by other traders. These offers can be made to him on the initiative of the other trader, or on his request.

(11) If offered(T: Trader, X: Integer, L: Commodity_List)
And my_wish_list(L': Commodity_List)
And subset_of(L: Commodity_List, L': Commodity_List)
Then possible_negotiation_with(T: Trader, X: Integer, L: Commodity_List);

Traders choose their trade partners on the basis of their acceptability value. As can be seen from the rules above, the performance oriented trader directly updates the acceptability value in many of these rules. The cooperation oriented trader decides mostly on trust, and only slightly updates the acceptability value directly. However, the cooperation oriented trader also chooses a trade partner on the basis of the acceptability values. In general, the acceptability value of a trade partner is an accumulation of several factors: effects as described by the rules above, personality traits, and other cultural dimensions. In this paper the only aspect modelled is the following. For the cooperation oriented trader the trustworthiness of the partner has a higher impact on the computated value of acceptability than for the performance oriented trader. Furthermore, the acceptability value used to determine new trade partners is recalculated after all negotiations have finished.

(12) If cultural_script_contains(pc_orientation(F: Real))
And no_ongoing_negotiations
And acceptability(T: Trader, R: Real)
And trustworthiness(T: Trader, H: Real)
Then new_acceptability(T: Trader, F: Real * R: Real + (1 – F: Real) * H:Real);

6 Application of the Model in the Trust and Tracing Game

Consider a performance oriented buyer P (pc_orientation 0.9) and cooperation oriented seller C (pc_orientation 0.1). The traders meet each other for the first time and start a negotiation about 1 envelope. Both traders have in mind to trade for a price of about 10 euro. The (relevant parts of the) profiles for the players are:

	Player C	Player P
Minimum utility	0.7	0.7
Personality factor impatience	0.4	0.6
Impatience factor	0.09	0.99
Cut off value	0.07	0.63
Minimal progress	0.1	0.01

In the first round P offers 9 euro for a high quality red commodity, and C replies with a bid including 16 euro and high quality. The utility of C's bid in the eyes of P is 0.6, which is below the cut-off value of 0.7. Now P has to decide whether he will continue or stop. Let us assume that P decides to continue (only rule 2 would apply, but assume the random factor determines otherwise), and bids 9 euro in the second round for high quality. C responds with 14 euro for high quality (none of the stopping rules apply). The utility is 0.62 which is again below P's cut-off value. We assume that P decides to continue the negotiation again (assume rule 2 randomly discarded), and he offers 10 for high quality in the third round. C continues and responds with 12 euro

and low quality. P's utility for that bid is 0.5, again below his cut-off value. We assume that this time P decides to stop the negotiation (rule 2). P evaluates the process using the "gap" rule (4), and considerably lowers the acceptability of C. C uses the "no_accom" rule (5) and considerably lowers the acceptability of P. A shame because the prices they had in mind allowed for reaching a deal, but this behaviour is in conformity with the culture scripts.

7 Conclusion

Trade situations in the real world can be better understood by taking into account the cultural background of the traders. Concepts like trust and honesty do not mean the same in different cultures, nor do practical aspects such as cheating, negotiation time and good relationships. To be able to model and test agents with culture scripts a comparable data set from real world trade is needed. The Trust and Tracing game provides a conceptualisation of trust in a well-defined laboratory trade environment to compare artificial agent behaviour with.

This case study models one of the culture dimensions of Hofstede, that of cooperation-orientation versus performance orientation. This dimension is obviously related to the meaning of trust. Although singling out one dimension is a deliberate distortion of reality, there is a look-alike real-world case. American and Dutch cultures are alike on all dimensions but this one and thus provide a good analogy.

The culture scripts of performance and cooperation oriented agents presented use the four ways in which a culture manifests itself: culture filters observation, culture sets norms for what constitutes an appropriate partner or offer, it sets expectations for the context of the transactions, and it sets norms for the kind of action that is appropriate given the other three.

This paper advocates the incorporation of culture scripts in the modelling of trade and associated aspects such as trust. As an example, the paper presents a model of the effects of the Cooperation-Performance orientation index of the culture scripts in the models of trustworthiness and acceptability of trade partners in negotiation settings. An application of the model to an extreme setting of performance orientated versus cooperation oriented traders shows the expected behaviour as sketched in Section 2.

Future research should test our scripts against data from human games to validate the approach and find plausible values for the parameters in the models. Then the model can be extended to take into account other dimensions of culture as well, increasing validity.

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Appendix A. Additional Parts of the Formal Specification

If a trader feels he has no more room to accommodate the other party, then he will stop the negotiations.

```
(13)  /* stop: no more room */
      If current_negotiation(T: Trader, X: Integer, L: Commodity_List)
        And current_round(X: Integer)
        And my_bid_utility_in_round(U: Real, X: Integer -1)
        And minimum_utility(M: Real)
        And U: Real - M: Real < 0.01
      Then stop_negotiation(T: Trader, X: Integer, L: Commodity_List, no_more_room);
```

If the trader has decided to stop the negotiation because his minimal utility was reached, then he also checks the progress made during the whole negotiation process.

Apparently, the negotiation originally did not stop for this reason, so this rule only affects the acceptability and trustworthiness once.

(14) If stop_negotiation(T: Trader, X: Integer, L: Commodity_List, no_more_room)
And progress_in_bids(1, X: Integer, P: Real)
And minimal_progress_value(M: Real)
And P: real < M: Real
Then stop_negotiation(T: Trader, X: Integer, L: Commodity_List, no_accom);

In negotiations the trader can accept the current bid of the other party if the utilities (according to his own function) of that bid and his own last bid are close enough. This notion of close enough is formalised by the acceptable_utility_gap.

(15) If current_negotiation(T: Trader, X: Integer, L: Commodity_List)
And current_round(X: Integer)
And others_bid_utility_in_round(U: Real, X: Integer)
And my_bid_utility_in_round(U': Real, X: Integer)
And acceptable_utility_gap(R: Real)
And | U: Real – U': Real | ≤ R: Real
Then stop_negotiation(T: Trader, X: Integer, accept_offer);

(16) If current_negotiation(T: Trader, X: Integer, L: Commodity_List)
And current_round(X: Integer)
And other_accepted_my_bid_in_round(T: Trader, B: Bid, X: Integer)
Then stop_negotiation(T: Trader, X: Integer, my_offer_accepted)
And deal_in_round(T: Trader, B: Bid, X: Integer);

(17) If stop_negotiation(T: Trader, X: Integer, accept_offer)
And other_bid_in_round(B: Bid, X: Integer)
Then deal_in_round(T: Trader, B: Bid, X: Integer);

Once the acceptability of the traders is determined, and the current negotiations have all stopped, new trade partners can be identified.

(18) If no_ongoing_negotiations And acceptability(T: Trader, R: Real)
And acceptability(T': Trader, R': Real) And R: Real > R': Real
Then more_acceptable_with_diff(T: Trader, T': Trader, |R: Real – R': Real|);

(19) If no_ongoing_negotiations And acceptability(T: Trader, R: Real)
And acceptability(T': Trader, R': Real) And R: Real < R': Real
Then more_acceptable_with_diff(T': Trader, T: Trader, |R: Real – R': Real|);

(20) If no_ongoing_negotiations
And possible_negotiation_with(T: Trader, X: Integer, L: Commodity_List)
And possible_negotiation_with(T': Trader, X': Integer, L': Commodity_List)
And more_acceptable_with_diff(T: Trader, T': Trader, R: Real)
And allowed_acceptability_difference(Epsilon: Real)
And R: Real > Epsilon: Real
Then to_be_ignored(T': Trader, X': Integer, L': Commodity_List);

(21) If no_ongoing_negotiations And preferred_relative_deal_size(F: Real)
And max_deal_size(M: Integer) And P: Real = M: Integer * F: Real
And possible_negotiation_with(T: Trader, X: Integer, L: Commodity_List)
And possible_negotiation_with(T': Trader, X': Integer, L': Commodity_List)
And | X: Integer – P: Real | < | X': Integer – P: Real|
And acceptability_difference(T: Trader, T': Trader, R: Real)
And allowed_acceptability_difference(Epsilon: Real)
And R: Real < Epsilon: Real
Then to_be_ignored(T': Trader, X': Integer, L': Commodity_List);