



Negotiation with the help of a negotiation agent
How the agent's negotiation style affects trust

Kostadin Penchev

Supervisor(s): Myrthe Tielman, Carolina Jorge

¹EEMCS, Delft University of Technology, The Netherlands

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Name of the student: Kostadin Penchev
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Thesis committee: Myrthe Tielman, Carolina Jorge, Rafa Biddara

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Abstract

Negotiation is a challenging process for people, which often results in suboptimal agreements between the negotiating parties. This issue leads to lost benefits that one of the negotiating parties could have obtained. To counteract this drawback artificially intelligent negotiation agents are developed. Their goal is to help negotiating parties increase the overall benefits from a negotiation. However, the main drawback of such agents is that people need to trust the agents in order to use them. In this research paper we investigate whether a negotiating agent with a hardliner negotiating style would be trusted more than a negotiating agent with a conceder negotiation style. We answer this question by conducting a user study, where we measure participants' trust in the two negotiation agents and compare the results. From the results we concluded that the assumption is correct for the sample group that participated in the user study.

1 Introduction

Negotiation is a process by which two or more parties attempt to reach an agreement regarding their conflicting goals (Brett, 2000). As "negotiation is a fundamental form of social interaction", it is essential for people to be able to effectively negotiate in order to achieve their goals in social environment (Thompson and Hastie, 1990, p. 99). However, there are many challenges that hinder people from effectively negotiating (Brett, 2000; Cohen, 2002). Thus, negotiating parties agree on suboptimal solutions and lose on benefits that one of the parties could have obtained (Thompson and Hastie, 1990).

To counteract this drawback negotiation support systems (NSS) are introduced. NSS are tools that help negotiating parties reach an agreement (Jelassi and Foroughi, 1989). Due to the fact that the definition of NSS is not specific, there are many different types of NSS that focus on different goals. Examples of such NSS are systems that manage communication between parties (Schoop et al., 2003), help negotiating parties model and evaluate the negotiation domain (Fu et al., 2017) or advice negotiating parties on decisions during the negotiation (Bellucci and Zeleznikow, 2006; Jonker et al., 2017).

In this research we focus on NSS that assist the negotiating parties on decision making during the negotiation. These systems usually achieve this through the use of negotiation agents - artificially intelligent decision making systems (Kersten, 1991; Baarslag et al., 2017). The purpose of such agents is to improve the negotiation process by removing some of the challenges that humans encounter in a negotiation. The negotiation agents accomplish this by negotiating on the behalf of the user or by providing guidelines to the human negotiator. However, the main drawback of such negotiation agents is that people need to trust them in order to use them effectively (Baarslag et al., 2017).

Research in the field of artificial intelligence (AI) explains that trust is affected by the ability of the system to accomplish a specific goal (Lee and See, 2004, Yagoda and Gillan,

2012). In the context of negotiation agents this is the negotiation style that the agent uses to represent/assist the human. As negotiation is a challenging process, there are multiple different styles that negotiation agents can utilize (Thomas, 1992; Lewicki and Hiam, 2007). Thus, it is important to ask what negotiation styles will people trust to assist/represent them during a negotiation. By understanding this we will obtain insight on what behaviour negotiation agents need to exhibit in order to be trusted and used in a negotiation.

In this research we will compare the effect of a negotiation agent with a hardliner negotiation style versus an agent with a conceder negotiation style on how much the user trust the negotiation agent. The two chosen negotiation agents have opposing negotiation styles. On the one hand, the negotiation agent with a conceder style attempts to make concessions with the opposing negotiators (Koeman et al., 2021). The agent does this by gradually conceding the interest of the party that it is representing, while gradually accepting the demands of the opposing negotiators until an agreement is reached. On the other hand, the negotiation agent with a hardliner style makes little to no consensus with the opposing negotiator (Hüffmeier et al., 2014). The agent does this by proposing offers that will greatly benefit the party that it is representing, while the interest of the opposing negotiators are not taken into consideration.

To answer this question, we need to have a clear definition of trust. Furthermore, we need to have empirical information about the trust that people have in the two conditions that we want to compare. At present there is already conducted research on what trust is and how to evaluate it in systems (Gulati et al., 2019; Lee and See, 2004; Yagoda and Gillan, 2012). However, empirical data regarding the research question was not found. Thus, in this research paper we will conduct a user study to collect the required information for the two conditions.

The rest of the research paper has the following structure. In Section 2 we describe the definition of trust that we have chosen to adopt and the research hypothesis that we will check. The experimental setup that we have used is explained in Section 3. In Section 4 we have listed the results that we have obtained. We discuss the results and how the data was collected in Section 5. Finally in Section 6 we summarize the research paper and mention topics for future research.

2 Problem Description

In this section we firstly give a definition of what trust will mean in this paper. Following this we elaborate what hypothesis we will assess.

2.1 Definition of trust

"Trust is a multi-dimensional construct" (Vereschak et al., 2021, p. 25). As a result, to avoid conflicts in terminology with different researchers in the same field, a clear definition of trust needs to be stated ((Vereschak et al., 2021)). Moreover, the definition of trust that we will be using in this paper will be taken from the literature that focuses on trust in automation as it measures trust in Human-AI interaction and thus is most applicable for this research.

The definition of trust that we have decided to adopt is from Cahour and Forzy (2009). Trust is defined as an attitude that the human has towards the system from direct or indirect experience with the system. Moreover, the two main elements that affect the human's attitude towards the system is the predictability and reliability of the system. In the context of negotiation agents the reliability monitors whether the assistance or the representation that the negotiation agent is providing is useful to the human. On the other hand, predictability monitors whether the human believes that the agent will not do something unexpected and thus be eligible to negotiate on their behalf. Thus, this definition is suitable for this user study as it covers the two essential usages of the negotiation agents.

2.2 Hypothesis

People prefer AI decision making systems that are personalized to the user's own preference than AI that displays a generic behaviour (Maroto-Gómez et al., 2022). Based on this fact we hypothesize that the negotiation agent with a hardliner negotiation style will be trusted more by users than the agent with a conceder negotiation style as the former will suggest more favourable offers for the user than the latter. Moreover, we also hypothesize that if the user and the negotiation agent have similar negotiation styles then the agent would have higher reliability than if the two negotiation styles were different from one another. However, as culture is a key factor that affects the negotiation styles of people (Caputo et al., 2019, Salacuse, 1998) it is hard to make a general conclusion about which negotiation style is more used by people. Thus, we will not hypothesis about peoples' negotiation style. Nevertheless, we can also hypothesize about the predictability of the two negotiation agents. We think that both negotiation styles are simple to predict and thus would have similar predictability. As a result predictability should not influence the trust that people have in the two negotiation agents. Thus, based on the above stated information we created the following hypothesis that we would like to assess:

The negotiation agent with a hardliner negotiation style will be trusted more by people than the agent with a conceder style.

3 Methodology

In this section we firstly give an overview of the participants in the user study. Following this, we explain the tools and the measures that we have used. Finally we explain the procedure and the sub-components that we have followed and used.

3.1 Participants

A total of 30 adult participants with technical background were recruited for the user study. 25 participants were male, while five of them were female. 29 participants were in the age group of 18-24 years old, while one participant was in the age group of 25-34 years old. 27 participants grew up in Europe, two participants grew up in Asia and one participant grew up in Africa. 18 of the participants answered that their highest level of education is high school, nine participants answered that they have bachelor degree and three participants

answered that they have master degree. 23 of the participants worked/studied in the field of computer science, three participants worked/studied in the field of mathematics and four participants worked/studied in the field of electrical engineering. Seven participants had theoretical knowledge about negotiation, while the other 23 participants did not. None of the participants had prior experience with the software that was used for the negotiation in the user study.

3.2 Tools

For the user study we used Pocket Negotiator (PN) (Jonker et al., 2017) as the NSS. PN allows users to engage in a bilateral negotiation with a human or an AI negotiation agent as an opponent. Moreover, it allows users to create and use a custom domain for the negotiation. Furthermore, PN was chosen as it supports both styles of negotiation agents mentioned in the research question. In addition, it is empirically shown that PN improves the negotiation results of the negotiating parties (Aydoğan and Jonker, 2023).

To create box plots of the measures that we collect in this user study we used DATAtab (DATAtab Team, 2023). For analyzing the data for normality (Shapiro and Wilk, 1965) we used Statistics Kingdom ("Statistics Kingdom", 2017). To analyze the data for significant difference we used either GraphPad (GraphPad Software, 2023) for a Unpaired T-test (Ross and Willson, 2017) or Social Science Statistics (Stangroom, 2018) for Mann-Whitney U Test (Mann and Whitney, 1947).

3.3 Measures

In this user study we have used two questionnaires to measure participant's trust and other confounding variables that can influence the level of trust. The first questionnaire that was given to the participants before the user study contained questions about confounding variables that can influence the trust in the negotiation agent. The questionnaire started with demographic questions as culture can have impact on the negotiation process ((Caputo et al., 2019), as well as on trust in AI (Hoff and Bashir, 2015). Furthermore, questions about negotiation skills were included as some participants might have practical or theoretical experience in negotiation and this can affect the final results as the expertise level in the field can influence trust (Hoff and Bashir, 2015). Moreover, participants were asked whether they are familiar with PN as if they have used it before than they would have already established some initial beliefs about the application and the associated negotiation agents. Finally, the participants were asked a single question about their general trust in AI as this can affect the final trust results as well. The questionnaire consisted of both nominal and ordinal questions, which are not validated for internal consistency (a copy of the questionnaire is presented in appendix A).

The second questionnaire, that was given after the user study, measures the participants' trust in the negotiation agents. The questionnaire was taken from a research paper that reviewed different research papers and articles that define and measure peoples' trust in autonomous systems (Hoffman et al., 2021). The authors of this paper concluded that most

of the scales that they have reviewed have overlapping questions. Thus, they assembled their own questionnaire about trust. Most of the questions in the questionnaire are taken from a study that measured the system's reliability and predictability. As a result, we felt this questionnaire should be appropriate for measuring trust for our user study. Although the questionnaire is not validated directly the authors of the paper argued that as the questions are overlapping with questionnaires with already proved validity it is safe to assume that the questionnaire is valid for internal consistency.

3.4 Procedure

The user study was designed as an online between subject study, where participants were divided into two equally large groups. All participants had to use PN with a negotiation agent as assistant and an AI opponent for the negotiation. Each group was assigned either an agent with a conceiver or hardliner negotiation style. Apart from this the groups followed the same procedure that is explained below.

The first task that each participant was required to do is to fill an informed consent about participating in the study. Following this they had to answer the first questionnaire. After this each participant was given a tutorial of PN to introduce the participant to the NSS that they will be required to use. Next, participants were read/given an explanation of the negotiation agent that was going to assist them during the negotiation. Following this they were asked to negotiate with a custom domain in PN that we had provided. Finally, they had to answer the second questionnaire.

3.5 Experimental scenario and domain

For the user study we created a custom domain. The goal of the domain was to be easily understandable by people and to allow them to easily engage with the negotiation of tasks. However, the domain had to be also complex enough so that the participants would find it challenging to negotiate and thus use the assistance of the negotiating agent. An important factor that influences the complexity in a negotiation is the number of negotiation tasks (Zhang et al., 2021). Furthermore, in previous research that needed a complex but easy to understand domain in PN, the researchers settled on domain with six tasks (Aydođan and Jonker, 2023). Based on these factors we created a scenario where the participants are told that they are going to have to make and eat a pizza with their best friend and need to negotiate how tasks will be allocated among themselves. The two friends that have to negotiate in this scenario are named Blue and Red and all the participants are requested to play as Blue in the negotiation. Although neither of the two characters have any predefined traits, it makes it easier to explain and play through the scenario if the characters are named. The domain of the scenario contained 6 sub-tasks in total. 5 of them are associated with preparing and making the pizza and the last one captures the distribution of pizza that each of the two negotiators will obtain to eat. For the tasks associated with making a pizza we set 3 possible values - Blue, Red or Both. The set value mean that this person will do the sub-tasks or when the value is Both it means that the sub-tasks will be done by the two negotiators together. To keep it consistent we added 3 possible values

for the last sub-task - 40% , 50% or 60% of the pizza will go to Blue to eat and the rest of the pizza will go to Red. The percentages for the last sub-task are set in this range so that the participants are less incline to decide to do all the sub-tasks of making the pizza alone and receive all of the pizza or vice-versa.

3.6 Pocket Negotiation parameters

Apart from defining the scenario and the domain of the experiment we also adjusted the following parameters of PN - the number of rounds of the negotiation, the negotiation agent style and the preference that the two negotiators (Blue and Red) will have. Firstly, the style of the negotiation agent was set either as a hardliner or as a conceiver depending on the group that the participant was allocated to - half of the participants received assistance from an agent with a conceiver style, while the other half received assistance from an agent with a hardliner style. To make the scenario more personal and engaging to the participants, we let them choose what sub-tasks they will prefer to prioritize in the negotiation. However, in order to remove the biases that could arise in the results due to the difference in preferences between participants we set the preferences of the opponent (Red) to be exactly the same as the preferences of the participant. This also ensures that Red will provide all of the participants in the two respective groups with offers that are worth similar value during the negotiation. Thus, there will not be any major biases that will have to be accounted as confounding variables. Furthermore, we decided to make the negotiation last 30 rounds (from 100 possible rounds) in order for the participants have to enough time to experience the negotiation agent suggestions.

3.7 Tutorial of the experiment

As the participants of the experiment were not expected to be familiar with the PN, we created a tutorial domain that followed the same scenario as the actual experiment. The tutorial domain contained 2 sub-tasks - who will prepare the pizza and how much pizza each negotiator will receive to eat. The tutorial negotiation is set to last a total of 10 rounds as the first five rounds are intended for the researcher to show to the participant the different features of PN and explain what they will have to do. The last five rounds are intended for the participant to try and use the system and ask if they still have question about the features of PN. In the tutorial negotiation participants are receiving help from a negotiation agent with Boulware strategy (Faratin et al., 1998) - a strategy that is a combination of the hardliner and the conceiver strategy. This negotiation agent was chosen because we did not want the participants to make assumptions about the negotiation agent during the tutorial as the tutorial was intended for learning purposes of the software. Furthermore, the participants were told that during the actual experiment they will receive another negotiation agent to assist them.

3.8 Explanation of negotiation agents

Explanations of autonomous agents need to justify the agent's actions. This can be accomplished through revealing the goals of the agent (Anjomshoae et al., 2019). Furthermore,

the wording of the explanations needs to be in a natural language similar to explanations in human society in order to be understandable (De Graaf and Malle, 2017). However, as explanations are an indirect form of experience of the negotiation agents they will affect the participants’ trust in the agents. To counteract this drawback we will use the same explanation for the two negotiation agents that we test in this paper. The explanation will not reveal the negotiation style of neither of the two agents but will only give a general explanation of what is the goal that the two negotiation agents have. Thus, we will avoid biases that can arise from using two different explanations for the two negotiation agents. Finally the explanation will also be written from second-person point of view as it can not be integrated into PN and it will be given/read to the participants. Based on these facts the following explanation for the two negotiation agents was created:

You shall be assisted by a negotiation agent in the following negotiation session. In the process of evaluating, the agent shall take your preferences in consideration and based on that it shall evaluate offers to and from the opposing party. The goal of the agent is to maximise the overall gain attainable for both parties.

3.9 Pilot Experiment

To test whether the above procedure and the associated components are feasible to do and that there will not be any major problems that will arise during the user study a pilot test was executed first. In the pilot experiment two individuals participated. They followed the procedure and after each component they were asked whether they have encountered any problems or have issues with the procedure.

Both participants complained that the actual experiment is too long/boring to do. The reasoning that they gave was that the opponent in the negotiation (Red) held dominant position in the negotiation for the first 15 to 20 rounds and thus they believed those rounds were wasted without achieving any progress to a consensus. One of the participants found the tutorial too long as they believed that they understood the features of PN in the first five rounds and did not need any more assistance from the researcher.

To counteract the first problem, we decreased the number of rounds in the negotiation from 30 to 20 as in current version of PN there is no option to change the opponent’s negotiation style. We believe that this change will reduce the number of rounds that the participants felt as wasted but at the same time the participants will have enough rounds to monitor the suggestion of the negotiation agent that assists them. For the second issue we reduced the total number of rounds in the tutorial from 10 to five. Thus, the researcher doing the experiment will show the features of PN in the first 2-3 rounds. The rest of the rounds will be left to the participant to test PN themselves. However, as some participants might still have questions about the features of PN, they will be given the option to redo the tutorial.

4 Experimental Results

Figure 1 displays a box and whiskers plot of the collected data from the four questions about negotiation (the dotted

line shows the mean, while the solid one display the median). To the four questions the Shapiro-Wilk Test is applied to check for non-normality of the data. The results from the Shapiro-Wilk Test are presented in table 1 (confidence level of 95%). According to the results only question 1 does not show evidence of non-normality (with p-value > 0.05) for both groups. Thus, Unpaired T-Test is applied on question 1. The result shows that there is not a significant difference between the negotiation styles ($t = 0.4971$, $df = 28$, $p = .6230 > 0.05$). For the other three questions a Mann-Whitney U Test is used. The results of the test are presented in table 2. According to the results there is not a significant difference between the sample from the two groups for the three negotiation questions.

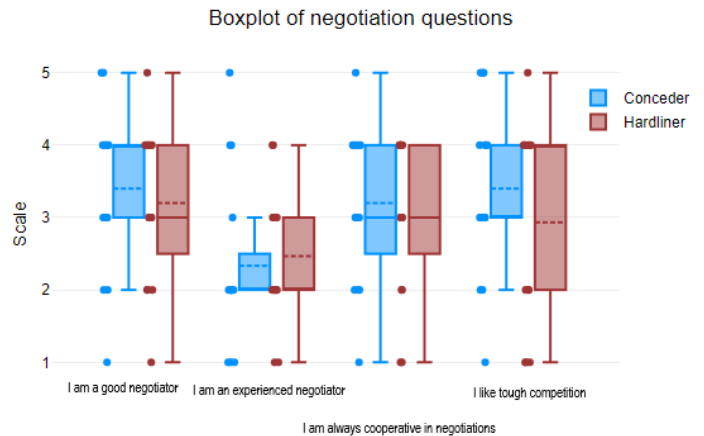


Figure 1: Boxplot of the 4 negotiation questions answers

Table 1: Results from the Shapiro-Wilk on the questions about negotiation skills

Question number	Negotiation style	W-value	P-value
Question 1	Conceder	0.9115	.1426
	Hardliner	0.9096	.1337
Question 2	Conceder	0.8227	.0073**
	Hardliner	0.8951	.0800
Question 3	Conceder	0.9096	.1337
	Hardliner	0.8257	.008**
Question 4	Conceder	0.9236	.2185
	Hardliner	0.8234	.0074**

Table 2: Results from the Mann-Whitney U Test on the question 2-4 about negotiation skills

Question number	U-value	P-value
Question 2	96.5	.5222
Question 3	102	.6818
Question 4	93	.4295

Figure 2 displays a box and whiskers plot of the question about general trust in AI that is asked in the first questionnaire. To check for normality of the data we again apply

the Shapiro-Wilk Test. The conceder group has w-value of 0.9359 and p-value of .3333, while hardliner group has w-value of 0.7045 and p-value of .0003***. According to these results the data is not normally distributed and thus Mann-Whitney U Test is applied. From the test no significant difference is found between the two groups (u-value = 112, p-value = 1.0 > 0.05).

Figure 3 displays a box and whiskers plot of the second questionnaire that is used to measure participants' trust after the user study. According to the Shapiro-Wilk Test there is no evidence of non-normality for this data (conceder: w-value = 0.9407, p-value = .3918, hardliner: w-value = 0.9337, p-value = .3092). Thus, we apply the Unpaired T-Test to the data. According to the results there is a significant difference between the conceder and hardliner group (t = 2.2997, df = 28, p = .0291*).

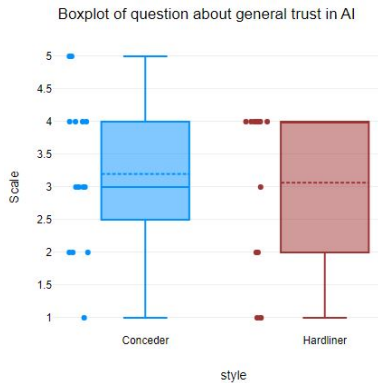


Figure 2: Boxplot of the negotiation question about general trust in AI

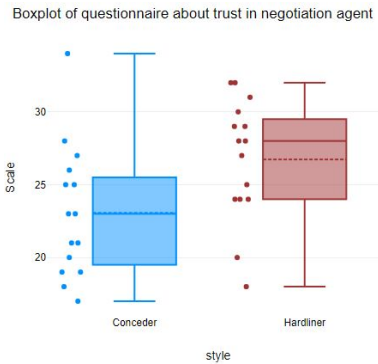


Figure 3: Boxplot of the second questionnaire used to measure participant's trust in the negotiation agent

5 Discussion

In this section we explain what factors were taken into account for the creation of the experiment and how the experiment can be re-created by other researchers. Moreover we conclude our findings from the results and also give possible explanations of the reached conclusions.

5.1 Responsible research

Firstly, it is important to say that as the experiment was conducted in a online environment we had to take into account the possibility of a data breach. As result we did not collect any personal data and made all the data collection anonymous. Furthermore, as the demographic questions from the first questionnaire could be used all together as identifiable data we tried to generalize them as much as possible. For example, we did not collect the specific age of the participants but only a range of their age group. Also we collected only the general region where they grew up instead of asking them to name a specific country. Apart from this we could not identify any other potential risks that could occur during the experiment. In the consent form we informed participants about the procedure that they will follow. Furthermore, we explained that the data they will provide is stored and will be used anonymously in the future.

With the above said we believe that we have mentioned every key aspect that was used in this research paper. We have described the definition and assumptions that we have made for the user study in Section 2. Following this, we explained why we have chosen PN as the NSS. Finally, we have explained the procedure of the user study and the associated components. Thus, we believe that the procedure that was used in this paper can be reproduced by other researchers in the future.

5.2 Results analysis

The results showed that there is a significant difference between the trust that the participants have in the agent with a hardliner negotiation style and the agent with a conceder negotiation style. Furthermore, from figure 3 we can see that the sample mean of trust for the hardliner agent is higher than the sample mean of trust for the conceder agent. Thus, we can accept the hypothesis that the agent with a hardliner style is trusted more than the agent with a conceder style. However, we can not conclude that this result was influence by the confounding variables that we analyzed. We did not find a significant difference between the results of the two group neither for their prior practical negotiation knowledge, nor for the prior trust that they had in AI. Nevertheless, we believe that there were other factors that we did not measure that lead to these results.

In general the participants expressed verbally less complains about the negotiation agent with the hardliner style than the agent with the conceder style. We think that this behaviour resulted from two different factors. Firstly most of the participants were inexperience negotiators and as a result they mainly relied on their instincts to distinguish whether the suggestions of the negotiation agents were reliable to use. This assumption is support by research in the field of negotiation that found that even experienced negotiators mostly rely on their intuition rather than on their expertise when negotiating (Herbst and Schwarz, 2011). Secondly, the negotiation style that the AI opponent used in the negotiation, which was combination of the hardliner and the conceder negotiation style but was overall more similar to the hardliner than to the conceder. Thus, we believe that the inexperienced participants intuitively trusted the hardliner agent more because

they felt that the assisting agent and the opposing negotiator were evenly matched in terms of negotiation skills. Thus, we believe that the hardliner agent was seen as a good negotiator/assistant that can be trusted, whereas the conceiver agent was perceived as a bad negotiators/assistant that should be trusted less.

6 Conclusions and Future Work

In summary, in this research paper we studied the effect that a negotiation agent with a hardliner negotiation style versus a negotiation agent with a conceiver negotiation style will have on people's trusts in the agent. We found that the agent with a hardliner strategy is trusted more than the agent with a conceiver strategy. This was found through conducting a small between-subjects user study.

As the conducted experiment was done with a small sample size, there is many possibilities for future and further research. For example, it will be helpful if the experiment is repeat with a bigger sample size and the results be compared to the results from this study. Furthermore, as culture has an important role in negotiation and people's trust in AI, an experiment with participants from different culture backgrounds can be conducted and a comparison between the results could be made. Moreover, the same study could be repeated but with a different NSS to see whether the NSS would influence the results. Finally, a systematic review on trust in negotiation agents could be done and findings from different researchers could be aggregated and new conclusions about the topic could be drawn.

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Appendix A

Questions about confounding variable that can influence the trust in negotiation agent.

1. What is your age group?
 - 18-24
 - 25-34
 - 35-44
 - >44
 - prefer not to say
2. What is your gender?
 - Male
 - Female
 - None-binary
 - prefer not to say
3. In which region did you grow up?
 - Asia
 - Europe
 - Africa
 - North-America
 - South-America
 - Oceania
 - prefer not to say
4. What is the highest level of education that you have completed?
 - Middle school
 - High school
 - Bachelor
 - Master
 - Higher than the above
 - Other
 - prefer not to say
5. What is your field of study/work?
 - Mathematics

- Computer Science
- Electrical Engineering
- Other
- prefer not to say

6. Do you have theoretical knowledge in negotiations?

- Yes
- No
- prefer not to say

7. Questions about negotiation skills

- I am a good negotiator
 - Strongly disagree
 - Disagree
 - Neutral
 - Agree
 - Strongly agree
- I am an experienced negotiator
 - Strongly disagree
 - Disagree
 - Neutral
 - Agree
 - Strongly agree
- I am always cooperative in negotiations
 - Strongly disagree
 - Disagree
 - Neutral
 - Agree
 - Strongly agree
- I like tough competition
 - Strongly disagree
 - Disagree
 - Neutral
 - Agree
 - Strongly agree

8. Have you used or seen Pocket Negotiator before the experiment?

- Yes
- No
- prefer not to say

9. Question about your view on Artificial Intelligence (AI)

- I generally trust artificial intelligence (AI) to make accurate and reliable decisions
 - Strongly disagree
 - Disagree
 - Neutral
 - Agree
 - Strongly agree