

# Trust Building in Recommender Agents

Li Chen<sup>1</sup>, Pearl Pu<sup>2</sup>

Human Computer Interaction Group, School of Computer and Communication Sciences,  
Swiss Federal Institute of Technology at Lausanne (EPFL), Switzerland

<sup>1</sup> EPFL IC IIF GR-PU, BC-144, Station 14, CH-1015 Lausanne, Switzerland  
[li.chen@epfl.ch](mailto:li.chen@epfl.ch)

<sup>2</sup> EPFL IC IIF GR-PU, BC-107, Station 14, CH-1015 Lausanne, Switzerland  
[pearl.pu@epfl.ch](mailto:pearl.pu@epfl.ch)

**Abstract.** Trust has long been regarded as an important factor influencing users' decision to buy a product in an online shop or to return to the shop for more product information. However, most notions of trust focus on the aspects of benevolence and integrity, and less on competence. Although benefits clearly exist for websites to employ competent recommender agents, the exact nature of these benefits to users' trusting intentions remains unclear. This paper presents some preliminary results of these issues based on a trust model that we have developed for recommender agents. We describe a carefully constructed survey in an attempt to reveal the relationship between users' perception of the agent's trustworthiness based on its competence and consumer trusting intentions, and more importantly, the role of explanation-based recommendation interfaces and their media format on trust promotion.

**Keywords:** recommender agents, trustworthiness, explanation-based interfaces, competence, trusting intentions, e-commerce

## 1 Introduction

In online commerce (or e-commerce), the traditional salesperson is often replaced by a product recommender agent (or a virtual salesperson). Given the lack of face-to-face interaction consumer, trust is difficult to build and easy to lose in a virtual store, which has impeded customers from participating in e-commerce environments. Thus, trust has been established to be a key factor to the success of e-commerce [4, 8]. It is widely accepted that trust in a technological item (like the recommender agent) is based on competence, benevolence, and integrity, just like trust in a person [10].

Although trust-related issues have been explored broadly in the fields of e-commerce and human computer interaction, many limitations still exist. As a matter of fact, most notions of trust have concentrated on how to improve the online shop's security, privacy policy and reputation, i.e. the benevolence and integrity of trust constructs, and less on its competence. As recommender agents have been increasingly employed in websites to assist users in choosing products and making decisions, it is necessary to pay attention to how an agent's competence influences and builds consumer's trust. That is, it is meaningful to investigate how the system design fea-

tures, such as its interface display techniques, recommender algorithms, and user-system interaction models interact within the trust building process.

Another main limitation of the field is the lack of empirical studies detailing the exact nature of trust-induced benefits. In the electronic environment, trust is widely defined as a kind of behavioral intention [5], referred as “trusting intentions” by McKnight et al. [14]. It has been established that customer trust is positively associated with customer’s intention to transact, purchase a product, or return to the website [4, 8, 11]. However, there is no further exploration of which construct of trust most contributes to one specific intention. Moreover, it is unclear whether users, rather than e-stores, can actually benefit from the trust. For example, can users actually improve their task performance due to their increased trust in the recommender agent?

The contribution of this paper is the development of a trust model, which identifies a set of system features that contribute towards building competence-inspired trust in recommender agents. It considers different aspects of the system design, in particular the role of explanation-based recommendation interfaces and their media format on building trust. To understand the effect of these design issues, we have conducted a survey among 53 users to understand the benefits of trusting a recommender agent based on its competence and the effective means to develop trust using explanation-based interfaces. The results showed that a positive perception of a recommender agent’s competence increases users’ intention to return to the agent, but does not necessarily affect their intention to purchase. The explanation facility integrated in the recommendation interface was positively correlated with users’ trust-building in the agent. The survey further demonstrated that an alternative organization-based explanation technique was more effective than the simple “why” construct used in most e-commerce websites.

This paper is organized as follows: section 2 presents our trust model for recommender agents and its different constituents; section 3 introduces different explanation techniques applicable in recommendation interfaces; section 4 reports our hypotheses and survey results; and section 5 concludes the paper’s work followed by several directions for future research.

## 2 Trust Model

We have conceptualized a general trust model for recommender agents. It consists of three components: system features, trustworthiness of the agents, and trusting intentions (see Fig. 1). The system features mainly deal with those design aspects of a recommender agent that can contribute to the promotion of its trustworthiness. We classified them into three groups: the interface display techniques, the recommender algorithms (e.g. collaborative filtering, case-based reasoning, and preference-based search techniques), and user-system interaction models such as how an agent elicits users’ preferences. In this paper, we focus our treatment of systems features on interface display techniques, especially explanation-based interfaces, and we detail how to select content, media format and richness for such interfaces.

The agent trustworthiness is a trust formation process based on users' perception of the agent's competence, reputation, integrity, and benevolence, which has been regarded as the main positive influence on the trusting intentions [6, 13]. In this paper, we primarily consider the competence perception and its essential contribution to trust-induced benefits.

The trust intentions are the benefits expected from users once trust has been established by the recommender agents. Trusting intentions include the intention to purchase a recommended item, to return to the store for more information on products or purchase more recommended products, and to save effort. The intention to save effort is of particular interest to us because it examines whether upon establishing a certain trust level with the agent, users will exert less effort to process all information themselves by selecting the recommended items much earlier in the recommendation cycles.

In addition to the agent trustworthiness, another influence on trusting intentions would be the individual propensity to trust. Studies of trust as a purely psychological attribute revealed that each person possesses a stable personality characteristic, which influences one's willingness to extend trust in specific situations [3]. We are interested to know whether this factor will make an impact on users' behavior intentions in recommender agents.

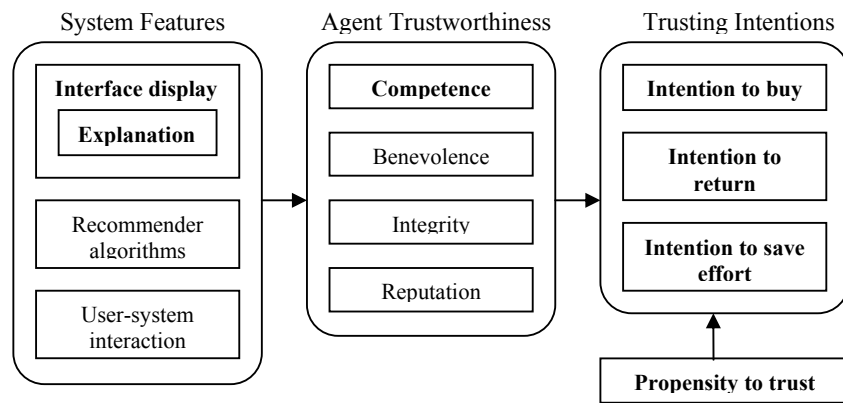


Fig. 1. Trust model for recommender agents

### 3 Building Trust Using Explanation-based Interfaces

Explanation has long been employed as one main approach to improve system's transparency in the domains of expert system [9], recommender systems [7], and interactive data exploration systems [1]. Practical application of explanation-based interfaces can be found in decision support systems (Logical Decisions: [www.logicaldecisions.com](http://www.logicaldecisions.com)), and commercial web sites (Active Decisions: [www.activedecisions.com](http://www.activedecisions.com)).

However, the benefits of explanation for trust formation have not been well established. Herlocker et al. [7] have shown that in automated collaborative filtering (ACF)

based recommender systems, providing explanation facility of recommendations can improve the acceptance of the system and filtering performance of users, but no further work on the relationship between explanation and trust building. More specifically, it is still unclear whether explaining how recommendations are computed can increase user's trust in the recommender agent. In this section, we therefore primarily consider trust building by the different design dimensions of explanation-based interfaces. In particular, we investigate the modality of explanation, e.g., the use of graphics vs. text, the amount of information used to explain, e.g., whether long or short text is more trust inspiring, and most importantly whether alternative explanation techniques exists that are more effective in trust building than the simple "why" construct currently used in most e-commerce websites.

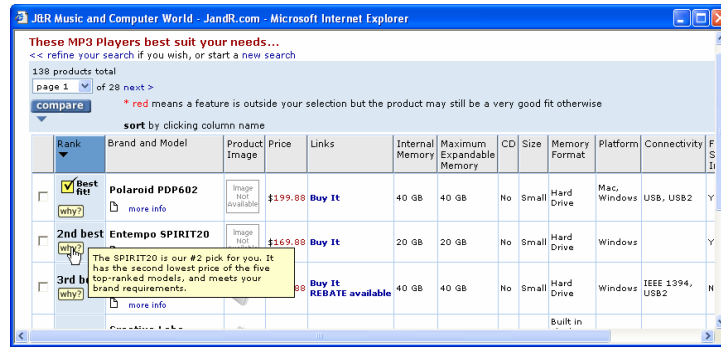


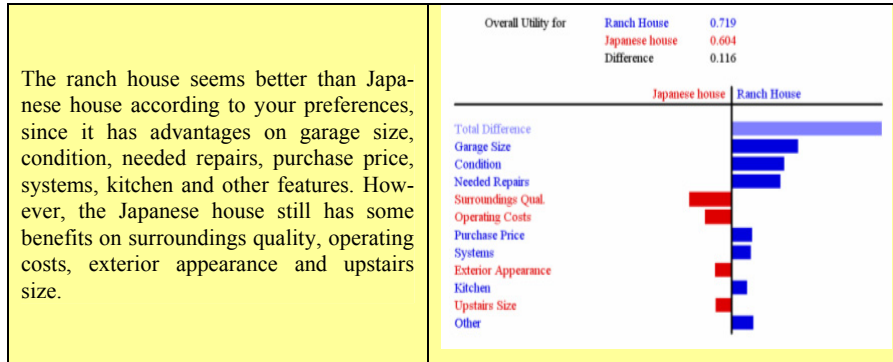
Fig. 2. The "why" explanation facility used in most e-commerce websites

The explanation generation comprises the steps of content selection and organization, media allocation, and media realization and coordination [1]. Content selection determines what information should be included in the explanations. For instance, the neighbors' ratings can be included to explain the recommended items in the collaborative filtering based recommender systems [7]. Once the content is selected, we must know how to organize and display it. The simplest strategy is to display the content in a rank ordered list with a "why" tool tip for each recommendation (see Fig. 2).

Search Results							
There are three apartments satisfying your preferences on price, bathroom and distance							
ID	Type	Price (Fs)	Area (m <sup>2</sup> )	Bathroom	Kitchen	Distance (mins)	
27	room in a house	500	15	private	private	5	Basket
30	room in a house	500	22	private	not available	10	Basket
71	room in a house	490	18	private	not available	10	Basket
Although these apartments are slightly expensive, they offer superior benefits on some of the other attributes							
ID	Type	Price (Fs)	Area (m <sup>2</sup> )	Bathroom	Kitchen	Distance (mins)	
77	shared apartment	550	20	private	not available	10	Basket
34	room in a house	550	25	shared	private	10	Basket
More							
These apartments satisfy your price need, but not on all other preferences							
ID	Type	Price (Fs)	Area (m <sup>2</sup> )	Bathroom	Kitchen	Distance (mins)	
69	shared apartment	470	15	shared	shared	10	Basket
72	room in a house	500	12	shared	private	15	Basket
More							

Fig. 3. Organization-based explanation interface, where the category title replaces the "why" component

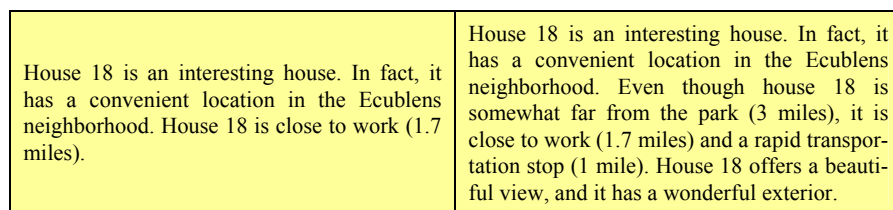
As an alternative and potentially more effective technique, we have designed an organization-based explanation interface where recommendations that provide trade-off alternatives are grouped in one category (see Fig. 3). This idea was inspired by McCarthy et al.'s work [12] which showed that suggesting products in groups of compound critiques enabled users to reach their decisions much faster.



**Fig. 4.** Explanation realized in text vs. graphics. The right figure (adapted from logical decisions software) is using graphics to explain the difference between two houses in terms of their attribute values. The left text gives the same content in the style of conversational sentences

Media allocation and realization considers the concrete mapping between the different portions of the selected content and the corresponding media. Currently, there are mainly two media used to implement explanation. One medium is text (see Fig. 4), which is used in many commercial web sites (see Fig. 2) and expert systems [9]. The research direction has been to make the explanation more conversational and argumentative to make people feel at ease.

Another medium uses graphics for realizing explanation content (see Fig. 4). The advantage is that visual information can allow people to develop a deep understanding of the data. Herlocker et al. have proven that the histogram with grouping of neighbor ratings was the best performing explanation component for collaborative filtering recommendations [7]. However, their experiment didn't compare the histogram with text for the same explanation content. In general, few existing works indicate which media is more preferred by users in general or in a specific circumstance.



**Fig. 5.** Short and concise explanation sentences vs. Long and detailed ones

The issue of media richness of explanation is also not well understood. For example, is a short and concise explanation text preferred to a long and concise one (see Fig. 5)? Carenini and Moore [2] have developed one method to generate argumenta-

tive text tailored to the user's multi-criteria preference model. They also indicated that the effective arguments should be concise, presenting only pertinent and cogent information. However, their evaluation was specific in the domain of searching for a house, and did not measure the effectiveness from the aspect of trust building.

## 4 Survey

We have conducted a survey among 53 users in order to understand the interaction among the three components of our trust model: the effect of an agent's competence in building users' trust, the influence of trust on users' problem solving efficiency and other trust intentions, and the effective means to build trust using explanation-based interfaces. The result of this survey will hopefully help us focus our future direction in conducting empirical studies to understand the quantitative relationships among these components of trust.

### 4.1 Hypotheses and Survey Questions

We have developed 9 hypotheses and divided them into three categories: agent trustworthiness in terms of its competence, trusting intentions assessment, and explanation techniques on trust formation. For each hypothesis, we have designed a question for participants to respond on a 5-point Likert scale (see the hypotheses and corresponding questions in the following tables). To illustrate the hypothesized scenarios, a set of pre-designed interfaces was used as references. For instance, the interface integrated with the "why" construct (adapted from a website powered by Active Decisions, see Fig. 2) was shown along with another similar display without such explanation facility (see Fig. 6) to our participants when they were asked whether they would trust more in the recommender agent which could explain how it works than the agent without any explanation.

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<input type="checkbox"/> 4th	LP600 <a href="#">More Info</a>		\$1799.00	<a href="#">Buy Online</a> <a href="#">All Buy Options</a>	2,000 lumens	XGA (1024x768)	5.2 lbs
<input type="checkbox"/> 5th	LP540 <a href="#">More Info</a>		\$1499.00	<a href="#">Buy Online</a> <a href="#">All Buy Options</a>	1,700 lumens	XGA (1024x768)	7.5 lbs

Fig. 6. The recommendation interface without "why" explanation facility

The first hypothesis tested in our survey was about the direct relationship between the recommender agent's competence and users' trust in the agent.

Hypothesis	Question
<b>Hypothesis 1:</b> A positive perception of the recommender agent's competence will induce the user's tendency to trust that agent.	<i>The recommender agent gave me some really good suggestions. Therefore, the agent can be trusted.</i>

We further predicated that a positive perception of the agent's competence could increase a user's intention to return and save effort, but not his/her intention to purchase because purchase intention would depend on other variables as well. Therefore, we have developed the following three hypotheses related to the effect of agent's competence on trusting intentions.

Hypothesis	Question
<b>Hypothesis 2:</b> A positive perception of the recommender agent's competence may not be the only element contributing to users' disposition to buy a product from the website.	<i>Even though I got some really good suggestions from the agent, I am not yet inclined to buy the product from the website where I found the recommender agent.</i>
<b>Hypothesis 3:</b> A positive perception of the recommender agent's competence may necessarily lead to users' intention to return to the agent for other product recommendation.	<i>The recommender agent gave me some really good suggestions. Therefore, I will return to this website for other product recommendations.</i>
<b>Hypothesis 4:</b> A high level of trust in the recommender agent may necessarily lead to users' intention to completely rely on the agent to make a decision.	<i>If I trust the recommender agent, I will rely on it more to help me make a decision, rather than processing all of the information myself.</i>

Then we measured the effectiveness of explanation-based display techniques on trust building in recommender agents. The hypotheses 5 and 6 were about the benefits of explanation on trust promotions, and the remaining hypotheses aimed at determining the effect of media format and the richness of explanation, and more importantly whether an alternative organization-based explanation technique (see Fig. 3) would perform better than the simple "why" construct (see Fig. 7).

Hypothesis	Question
<b>Hypothesis 5:</b> Explanation is positively correlated with user's trust in the recommender agent.	<i>If there are two recommender agents, one with an explanation of how it works (see Fig. 2), and another one without (see Fig. 6), I will definitely trust the first one more.</i>
<b>Hypothesis 6:</b> Explaining how suggestions are computed increases users' trust in the agent.	<i>If I know how the suggestions are computed and ranked, I will be less likely to want to see the alternatives the agent does not suggest.</i>
<b>Hypothesis 7:</b> The explanation of suggestions in text form is more effective than in graphics.	<i>I prefer to see an explanation in familiar language rather than in diagrams such as a histogram or a table (see Fig. 4).</i>
<b>Hypothesis 8:</b> Explanation in short and concise sentences is preferred to long and detailed ones.	<i>I prefer short and concise explanation sentences to long and detailed ones (see Fig. 5).</i>
<b>Hypothesis 9:</b> Well-organized recommendations are more effective than a simple list of suggestions with explanations.	<i>If the suggestions are well organized into different groups according to their differences (see Fig. 3), it will be easier for me to compare them and make a quicker choice, compared to a rank-ordered suggestions with detailed explanations (see Fig. 7).</i>

Search Results									
Ranking	ID	Type	Price	Area	Bathroom	Kitchen	Distance		
1	why?	27	room in a house	500	15	private	private	5	Basket
2	why?	30	room in a house	500	22	private	not available	10	Basket
3	why?	71	room in a house	490	18	private	not available	10	Basket
4	why?	77	shared apartment	550	20	private	not available	10	Basket
5	why?	69	shared apartment	470	15	shared	shared	10	Basket
6	why?	34	room in a house	550	25	shared	private	10	Basket
7	why?	72	room in a house	500	12	shared	private	15	Basket
								More	

Fig. 7. The recommendations with simple “why” explanation component

## 4.2 Survey Participants and Procedure

A total of 53 (7 females) undergraduate students taking the Human Computer Interaction course participated in the survey for partial course credit. To make sure that all of them have had some experience in online shopping environments before the survey, we have instructed these student participants to search for a Tablet PC at PriceGrabber ([www.pricegrabber.com](http://www.pricegrabber.com)).

This survey was conducted in the form of a carefully constructed questionnaire, based on a series of hypothesis and corresponding applicable questions. In the beginning, participants were required to attend a pre-test of their familiarity with e-commerce environment and propensity to trust, with the aim to check whether these factors would influence their survey answers. Afterwards, the survey started by asking users to respond to each of the nine questions on a 5-point Likert scale from “Strongly disagree” to “Strongly agree” respectively. Since most of the students’ native language is French, each question was accompanied with a corresponding translation so as to avoid any language misunderstanding.

## 4.3 Results and Discussion

The survey results give us some useful implications on trust building in recommender agents (see Table 1). It indicates that the competence of recommender agents would not be the only contribution to users’ trust formation process (hypothesis 1: median =3 “not sure” and mode=3), but it is positively correlated with the trusting intention to return. In fact, most of participants agreed with the items measured for hypothesis 2 and 3 (mean>3, median=4 “agree” and mode=4). This indicates that if users possessed a high perception of the recommender agent’s competence, they would be more inclined to return to the agent for other products’ information and recommendation, but they would not necessarily intend to buy the product from the website where the agent was found. Post-survey discussion indicated that they would visit more websites to compare the product’s prices before making a purchase. The website’s security, reputation, delivery service and privacy policy were also their important considerations in buying a product. As for the trust benefit to users’ problem solving efficiency (hypothesis 4), the most frequently recurring answer was “disagree”



(mode=2), implying that many participants would still want to take time to process information themselves, rather than entirely relying on the agent to choose an item.

**Table 1.** The analysis results of survey on hypotheses (possible range from 1: strongly disagree to 5: strongly agree)

	Mean (St.d.) N=53	Median N=53	Mode N=53
Hypothesis 1	3.15 (0.73)	3	3
Hypothesis 2	3.55 (0.94)	4	4
Hypothesis 3	4.23 (0.63)	4	4
Hypothesis 4	2.89 (1.09)	3	2
Hypothesis 5	3.64 (0.99)	4	4
Hypothesis 6	3.06 (0.98)	3	4
Hypothesis 7	2.38 (0.94)	2	2
Hypothesis 8	2.85 (1.12)	3	2
Hypothesis 9	3.91 (1.03)	4	4

The positive responses to hypothesis 5, 6 and 9 (mean>3 and mode=4) indicate that explanation can be an effective means to achieve user’s trust, and the organization would be a more effective explanation technique than the simple “why” construct. However, the other two aspects of explanation, i.e. the modality (hypothesis 7) and richness (hypothesis 8), were not conclusive in this study (mean<3 and mode=2). That is, it is unclear whether graphics or text is more effective to realize explanation, and whether long or short explanation text would be more trust inspiring. From the participants’ viewpoints, these two aspects were mostly dependent on the concrete product domain. Users would prefer a short and concise conversational sentence for the so-called low-risk products such as movies and books, but if they were looking for products carrying high financial and emotional risks such as cars and houses, a more detailed and reasonable explanation would be favored. In addition, people from different educational background seemed to have different preferences on the media richness. For example, students majoring in mathematics were more likely to prefer the explanation using graphics than explanation in text form.

The correlations between pre-tested variables with measured hypotheses indicated that participants’ propensity to trust and familiarity levels with the e-commerce didn’t have significant correlations with their resulting ratings on the hypothesized items, except the frequency of using online shopping tools was significantly positively correlated with the hypothesis 9 ( $p<0.05$ ), which suggests that if participants had more online shopping experience, they would more likely prefer a well-organized recommendations to a simple list with the “why” explanation construct.

## 5 Conclusion and Future Work

This article describes the early stage of our investigation of trust issues in recommender agents and the qualitative relationship between consumers’ perception of trustworthiness based on an agent’s competence and their trusting intentions. Through a carefully designed survey, we have shown that a recommender agent’s

competence is positively correlated with users' intention to return, but not necessarily with their intention to purchase. Further, explanation-based interfaces provide a promising approach to build a competence-inspired trust relationship. More importantly, an organization-based explanation technique is likely to be more effective than the simple "why" construct.

These initial results provide useful insights to several directions for future work. For example, we have recently started a large-scale empirical study to quantitatively measure the difference of user's speed in identifying their most preferred items between the interface using the "why" construct and the interface using the information organization strategies. We are also planning a controlled experiment to measure if users can improve their decision accuracy using the explanation-based interface. In addition, we also believe that users will likely save their decision-making effort with agents which are trustworthy.

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