J. Parallel Distrib. Comput. 75 (2015) 184–197

Contents lists available at ScienceDirect

J. Parallel Distrib. Comput.

journal homepage: www.elsevier.com/locate/jpdc

Reputation systems: A survey and taxonomy

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HIGHLIGHTS

- The concepts for reputation systems are discussed.
- A survey of existing reputation systems is presented.
- We construct a new taxonomy for reputation systems.
- We identify under-represented areas for research.

ARTICLE INFO

Article history:
Received 29 July 2013
Received in revised form
2 August 2014
Accepted 17 August 2014
Available online 23 August 2014

Keywords:
Reputation system
Survey
Taxonomy
Feedback

ABSTRACT

In our increasingly interconnected world, the need for reputation is becoming more important as larger numbers of people and services interact online. Reputation is a tool to facilitate trust between entities, as it increases the efficiency and effectiveness of online services and communities. As most entities will not have any direct experience of other entities, they must increasingly come to rely on reputation systems. Such systems allow the prediction who is likely to be trustworthy based on feedback from past transactions. In this paper we introduce a new taxonomy for reputation systems, along with: a reference model for reputation context, a model of reputation systems, a substantial survey, and a comparison of existing reputation research and deployed reputation systems.

1. Introduction

Online interactions between people and services that have no prior real-world relationships are increasingly common. Examples of interactive online sites include Social Networks (e.g. Facebook [27], Crowdsourcing [39,22], Wikis (e.g. Wikipedia [92]), Forums (e.g. Stackoverflow [80]), and modern paradigms such as F2F sharing (e.g. Dropbox [24]) and the Social Cloud [12,11]. All of these interactions can be considered to include an element of reputation, such as post-counts in forums, competencies in crowdsourcing and social linkages and endorsements in social networks and the social cloud. The need for reputation systems can only, in our view, grow in importance in our increasingly interconnected world.

A reputation system works by facilitating the collection, aggregation and distribution of data about an entity, that can, in turn, be used to characterize and predict [18,67,69] that entity's future actions. In essence, by referring to reputation data, users are able to decide whom they will trust, and to what degree. In addition, the existence of a reputation system is socially corrective, as the incentive of positive reputation and the disincentive of negative reputation will generally encourage good behavior over the longer term. Once reputation data is collected, it can be shared amongst users to closely emulate some of the characteristics of a long-term relationship [66], without ever having to have previously interacted.

The requirement for trust and reputation is evident in many online systems. In online banking systems for example, the reputation of the service is implicit. In more open online business systems and electronic markets such as eBay [25], we observe the explicit yet informal use of reputation through user feedback. Building and maintaining a good reputation can be a significant motivation for contributing to online communities, be they scientific, business or socially oriented. It has been shown that a good reputation leads to more sales, at a higher value than might otherwise be possible [68]. Existing online reputation models, while diverse, are still in their infancy and are generally limited in scope, usually focusing on a single context for information. There are, in addition, valuable lessons for reputation systems that can be taken from the real world, such as credit scoring systems. These systems allow banks to rank borrowers according to "historical data and statistical techniques" [55]. A credit score is based on multiple facets such as the

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http://dx.doi.org/10.1016/j.jpdc.2014.08.004
0743-7315/

borrower's address, time at that address, employment, time with that employer, income, savings, family size, and loan to debt ratio [9].

1.1. Contributions

In this work we have surveyed numerous reputation systems built for both academic and commercial purposes, and from these derived a set of dimensions that, in our opinion, best describe the definitive aspects of reputation systems. These dimensions have then been used to construct a new reputation taxonomy using the iterative methodology described in Nickerson et al. [59]. In the construction of the taxonomy we have also developed a new reference model for reputation context and a general model for reputation systems.

A desired outcome of any taxonomy is to identify opportunities for research, and to this end we have applied our taxonomy to a large body of existing work, and through this identified a number of new or under-represented research areas. In addition, our taxonomy provides a consistent unified descriptive reputation vocabulary, and the means to define and compare reputation systems with regard to their functionalities.

1.2. Organization

The rest of the paper is organized as follows. In Section 2 we discuss trust and risk, followed by Section 3 in which we present models for context and interactions, and the primary survey. We then use this survey to construct the taxonomy given in Section 4. In Section 5 we present the classification of reputation systems using our taxonomy. In Section 6 we present work related to reputation system taxonomies, and this is followed by supplementary characteristics in Section 7 and finally our conclusions are given in Section 8.

2. Trust, risk and reputation

While reputation is the main concern for this paper, the concepts of trust and risk are important considerations. Reputation and trust (or trustworthiness) are commonly confused [56] and used as synonyms, even though their meanings are distinctly different.

According to the Collins English Dictionary, reputation is *"the estimation in which a person or thing is generally held; opinion"*. Every person's opinion differs from every other person, making reputation a highly personal and subjective quantity [70]. Reputation is not what character someone has, but rather what character others think someone has. For this paper we will use the definition of reputation created by Mui et al. [57] *"the perception that an agent creates through past actions about its intentions and norms"*.

Jøsang et al. [42] define trust as *"the extent to which one party is willing to depend on something or somebody in a given situation with a feeling of relative security, even though negative consequences are possible"*. The key concepts in this definition are dependence and reliability; these values are measured, in part, through a person's reputation. It can therefore be said that trust can be established through the use of reputation. Arguably, a better reputation can lead to greater trust.

Risk is often undertaken in the hope of some gain or benefit. Risk can therefore be viewed as the situation where the outcome of a transaction is important to a party, however the probability of failure is non-zero [42]. Incorporating our previous notion of trust into this definition: the amount of risk that a party may be willing to tolerate is directly proportional to the amount of trust that the party has in the other party.

The main aim of reputation systems is therefore to support the establishment of trust between unfamiliar parties. Dellarocas [17] states that the aim of eBay's feedback mechanism, and in a generalized sense, all reputation systems, is to "generate sufficient trust among buyers to persuade them to assume the risk of transacting with complete strangers". Despotovic and Aberer [18] talk about "reducing the opportunism" and vulnerability of the two parties. Using a reputation system, a party may examine the history of another and decide that it will trust and interact with the other party. This decision is often called a "trust decision" [47].

3. A brief survey of reputation systems

In this section we present a survey of a number of reputation systems that were core in defining the dimensions of our taxonomy. However, in order to present these systems in a consistent and meaningful way, we must first present two reference models we have developed. The first reference model is needed to unify the description of reputation context, the second to describe the system model.

3.1. A reference model for reputation context

Reputation is context dependent and relies on contextual information to give data meaning [3]. The definition of context with respect to reputation systems is often difficult to determine and there is no common definition used by researchers.

Reputation systems are often discussed as utilizing additional contextual dimensions [71], facets [31], or attributes [13] to provide greater meaning and usability to the information generated during a transaction. In order to unify this concept we have adopted the term contextual attributes. Contextual attributes are like metadata, in that they help to describe the transaction in greater detail. For example, the date, the price, the buyer and the seller are all possible attributes of a transaction between two parties.

Contextual attributes however, are not the entire picture. For that, we require a context, which is the domain in which the information was generated. Most reputation systems employ a single, or personal, context. In other words, most systems consider only the reputation of an entity in the "function" of the system (whether that be e-commerce, expert advice, or file sharing).

Reputation systems employing more than one context often add additional domains of information. For example, the addition of a social context to an existing personal reputation context can help to determine if an individual contributes to his or community and therefore if they are more trustworthy.

In an effort to summarize and clarify the relationship between context and reputation, we have developed a reference model based on a psychological framework of personal identity [82]. Our reference model is presented in Fig. 1. Starting with the innermost ring, reputation context can be personal (who), professional (what), organizational (which/membership) and societal (where).

Most online reputation systems focus only on the personal reputation of a person, whilst many real-world situations deal with non-personal aspects, such as a user's professional and organizational membership.

3.2. A reference model for reputation systems

When discussing reputations systems, it is important to define the parties involved and their potential interactions. In Fig. 2 we present our generalized model of reputation systems that we have designed to accommodate both real-world and online approaches to reputation.

The Trustor is a party that wants to trust and interact with a target entity, called the Trustee [18,47]. In order to make a