Creating reputation systems

Lessons from theory

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Abstract

In society many people search for information about someone or something. A reputation about someone or something can provide such information. Often a reputation is created, with a mechanism to measure and distribute this reputation: the reputation system. Scholars provide information about reputation systems to classify them, based on: computation engine, governance model and supervision, intended users, communication of a reputation, and cheating. They do not provide an approach towards creating a reputation system. In this paper an approach was provided to create such a reputation system. This approach is derived from combining and integrating different literature about reputation systems. Next steps are to expand and evaluate the approach.

Keywords: Reputation, reputation systems, creation, developing, evaluation

1. Introduction

Reputation is something many talk about, without knowing what it exactly is. It is often said that someone, or something has a good or bad reputation, but what does this mean, and how did they derive this conclusion?

Determining what reputation exactly is, is difficult because reputation is not an exact concept. Reputation is ambiguous and intangible [1, pp. 11-12], this makes reputation hard to define and to measure on one scale. Although reputation is hard to define, it is important to have a good reputation [2]. A reputation can be used to show how well i.e. a company is doing.

A reputation is often used, to provide information about something or someone. Usually, the amount of public information is much lower compared to private information. Such an information difference is called an information asymmetry. Stakeholders want and more information. The information difference often drives stakeholders to search for more information about the company [1]. A reputation can be used to provide such information. Many people form opinions about something because of a reputation [3, p. 397]. This suggests that companies rely on their reputation to compete [1].

Stakeholders search for information. On the internet there are ever more sites which provide reputations. This can be an institute as Forbes showing corporate reputations, or on a websites as eBay, Amazon or discussion fora [4]. There is easy access to such platforms for people and it is easy to provide feedback. It is therefore no surprise many new reputations arise. For this reason research into how such reputations can be determined should be done.

Literature on reputation often shows how it can be assessed and what reputation consist of. The literature does not give guidelines in how to create a reputation. In literature the concepts of reputation and reputation systems are discussed, but many authors derive different conclusions. Some authors have provided characteristics of reputation systems or describe existing reputation

systems [5] [6] [7] [8], but authors mostly leave aside how to design and develop such a system. For this reason this paper researches how these systems should be created. The research question therefore is:

"How can a reputation system be created?"

This research question will be answered using a literature review. In a literature review the relevant scientific papers for this topic will be used to see what is known about reputation systems and how this can be turned to design criteria for reputation system.

Since this is a literature review, the arguments and conclusions will all be based on other scientific research. This review can therefore be interpreted as a combination and integration of a set of different papers. By combining and integrating papers a new view is created from previous research. Various different research articles were gathered by using online search databases of Scopus, Web of knowledge, JSTOR, IEEE and Google Scholar.

In these databases several search criteria were used such as:

- Reputation
- Reputation systems
- Comparing/comparison
- Defining/definition
- Characterization
- Building reputation
- Designing reputation
- Measuring/measurement systems

Many times search criteria were used together. In Resnick et al (2000) the concept of reputation systems is defined. Many of the authors describing reputation and reputation systems refer back to Resnick.

This article is structured in the following way: the next section provides the background information. Several concepts as reputation have already been introduced, but not defined. Section 2 defines and relates these topics to each other. The knowledge from section 2 is in turn used in section 3 to show an overview over what is known about the topics of reputation and reputation system and how this knowledge can be turned into a design approach. Section 4 gives criteria for quality assessment. Finally: section 5 gives concluding remarks.

2. Background information and concepts

Reputations can arise in two ways. First of all, reputations can arise because many have an opinion about something or someone. Over time such a reputation arises spontaneously, i.e. because many have talked about something and formed an opinion [2]. An example of this is someone saying that he or she has a good reputation.

The second way a reputation can arise, is because it is specifically designed. Feedback is gathered to form a reputation for something or someone. In such a case reputation is part of reputation system. With such a system a score for someone or something is computed based on a set of indicators [9]. An example of this is the reputation buyers and sellers on eBay receive [4]. The first one occurs spontaneous, where the second is designed. The rest of this article focusses therefore on the second one.

The designed reputation system uses a mechanism to determine and convey the reputation. This is called a reputation system. The rest of this section defines and explains the concepts of reputation and reputation systems concepts. First the concept of reputation is described, followed by the concept of reputation systems.

The concept of reputation

Determining how a reputation can be defined is a point of discussion in literature between many scholars. The many differences in the definitions suggest that the definition is dependent on how the reputation will be used and what or who is given a reputation based on what criteria. There are large differences in the reputations, they can be classified by the

context [7] and the purpose of the reputation [4]. The information sources for the reputation are also a factor which influences the type of reputation; either reputation is based on machine feedback or based on human perceptions [6].

Definitions of reputation

The definition of reputation can differ significantly, i.e. a corporate reputation can be defined as:

"A perceptual representation of a company's past actions and future prospects that describes the firm's overall appeal to all of its key constituents when compared with other leading rivals" [1]

In the case of corporate reputation, reputation is already determined to be subjective and set in a specific context.

Where a reputation in general can be defined as:

"In general reputation is the opinion of the public toward a person, a group of people, an organization, or a resource" [8]

Or

Reputation is what is generally said or believed about a person's or thing's character or standing [4]

In this case the reputation is already less specific to the field of corporate reputation, but reputation is still dependent on human feedback. A definition for reputation, either based on human or machine feedback can be:

"A reputation is the degree to which one party has confidence in another within the context of a given purpose [8, p. 3]*".*

Reputation is based on a context and purpose, as well as the type of feedback used. These concepts are described below.

Context and purpose

A reputation is set in a context. A good reputation for somebody as a doctor does not mean that this doctor is also a wine connoisseur. If a reputation is determined for something, it does therefore not mean that it applies to everything [7]. A reputation has therefore a purpose. The context and purpose determines how specific or general a reputation should be [4]. Should it apply to multiple situations, or just one?

Information types

A reputation can result from both direct and indirect information [5]. This means that a reputation can be based on direct encounters (first-hand information), or indirect encounters. With indirect reputation, the information is gathered indirectly (i.e. by word-of-mouth), where with direct reputation data is gathered based on direct information or observations (so data is measured).

This is related to the type of information used. Is human feedback used, or is reputation based on machine feedback. The information sources drive the level of subjectivity of a reputation.

Subjective information usually means perceptions about a concept, were objective information measures the concept itself. There is thus a strong link between the information source and the way the information is extracted. Human feedback is definitively subjective, where machine feedback can be less subjective. With machine feedback the subjective element comes from the human selecting which data to extract and use, making it subjective. A pure objective reputation is therefore hard to derive.

In the introduction of this section was already mentioned that reputation is closely related to reputation systems. The next subsection connects reputation to reputation systems.

<u>Reputation systems</u>

A reputation system, is an automated method that collects, distributes, and aggregates feedback about a participants' past behavior

[9, p. 2]. In other words, it is the underlying mechanism that determines the reputation from the collected feedback. A reputation is distributed into some kind of "grade" or ranking.

Generally a reputation system is formed in three stages: Data transformation, calculation and dissemination [8]. The figure below shows the process of turning data into a reputation metric.

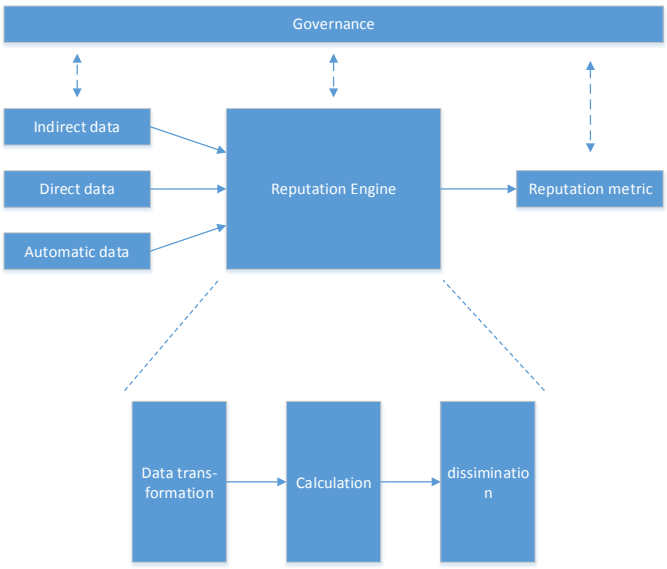

Figure 1 Data to reputation

Next to the process from data to reputation, it can be seen in the figure that there is another factor in a reputation system: the governance. Somehow decisions about a reputation system have to be made. Different types of governance structures will result in other reputation systems.

The section about reputation already identified context and information sources to be dimensions for reputation. For reputation systems there are a few others on which such a system can be based, these are: the computation engine [4], governance model, governance supervision [4], intended users, communication of a reputation [8] and cheating [7].

Governance model

Reputation can be governed in different ways. Either a reputation system is an initiative from multiple stakeholders, or it is an initiative from some organization alone. The difference is the way decisions can be made. Either it is done central or distributed.

Governance supervision

In turn the reputation is set in a scene where it has to apply to rules. Such supervision can either be direct, or indirect.

Intended users

Who is going to use the reputation? What level of knowledge do they have? The intended users should be known to determine how they could be reached. Possible intended users are:

- The reputation receiver itself: Benchmarking and spreading information signals,

- Competitors or stakeholders: Benchmarking and to determine information about someone or something,
- Consumer and business: Is someone or something reliable? Can we do business with them,
- Government: Information signals

The intended users determine how they can be reached for communication of a reputation.

Communication

How should the reputation be distributed and stored [8]? Multiple options to communicate the reputation include:

- Reading and printed text
- Social media
- Word-to-mouth

This is an important step, since a reputation which people cannot or do not use is useless.

Context and Information

Already introduced in the section about reputation, the context and information are important for the reputation system since they influence other dimensions, this will be shown in section 3. The context is important as it should be known where the reputation is to be used for. What should the reputation metric be (a score, a ranking). This is related to intended users and data availability.

The information source is also important. What kind of data is available? How is it measured (i.e. Positive/negative information, Discrete/continuous values or binary values). The type of information available influences the criteria as the computation engine.

Dealing with Cheating

An important difference between reputation systems is how they deal with cheating, manipulation and strategic behavior. Three options into which a reputation system can be distinguished when talking about cheating:

1. Cheating is not considered
2. It is assumed that agents can hide vital information, but they do not lie
3. Cheating is considered, but there are mechanisms to deal with liars [7, p. 40]

Dealing with cheating is specific to a reputation system and the context into which it is set. The mechanisms to deal with cheating have to be determined for every reputation system. For this reason it has to be determined for a reputation system how it is susceptible to cheating and what can be done to mitigate this.

Computation engine

The computation engine is the method of calculating the reputation. Five different types are identified in Josang et al (2007):

- Summation: a summation over different sources of data
- Bayesian: a probabilistic approach
- Belief: Similar to Bayesian, but measuring confidences in data instead of probabilities to metrics.
- Discrete: organized scales as good-neutral-bad
- Flow: computes reputation by iteration through looped or long chains, one's reputation can only go up, if the others goes down.

Different computation engines fit different situations. A computation engine is first of all based on the type of data which is available. For example numerical data versus discrete data (good, neutral, bad) have different engines. As discrete data limits calculation possibilities. For this reason it is related to the information sources.

This section described the concepts of reputation and reputation systems. In the next section an overview is provided which shows all the dimensions and corresponding options.

3. Approach for creating a reputation system

The previous section discussed 7 dimensions in a reputation system. These dimensions are not unrelated. Selecting a value in one of the dimensions has effects on other dimensions. In the text below references are made to numbers in figure 2; i.e. "(1)" would refer to the first number in the figure.

In this section the dimensions are ordered in a way they could be used as guidelines to create a reputation system. The starting point of creating a reputation system is that there is an actor which intends to create such a system. The first step would be to determine how, by whom [10] such an initiative should be governed (1, figure 2).

The involved stakeholders influence the dimensions of a reputation system, as they have to take decisions together and account for each other's demands. Such decisions would influence the target for the reputation (the intended users) and further down the line, the context into which a reputation is set. For example: stakeholder A might want something else out of the reputation system than stakeholder B. Or different stakeholders have different views into what kind of data is to be used.

After the governance structures are determined the intended users can be identified (2, figure 2). It is important to know the intended users before creating a reputation, i.e. by determining the information sources and the output of the reputation.

Knowing who the intended users are, identifies how much knowledge they have, where they are, how they can be reached. For this reason the intended users are identified with communication methods (3).

For example if the target audience is the general public, the reputation would differ than if the audience are specialists in a field (as the second one has more knowledge already). A specialist might be possible to reach by a journal/website on a specific field. General public would not read such a journal/website.

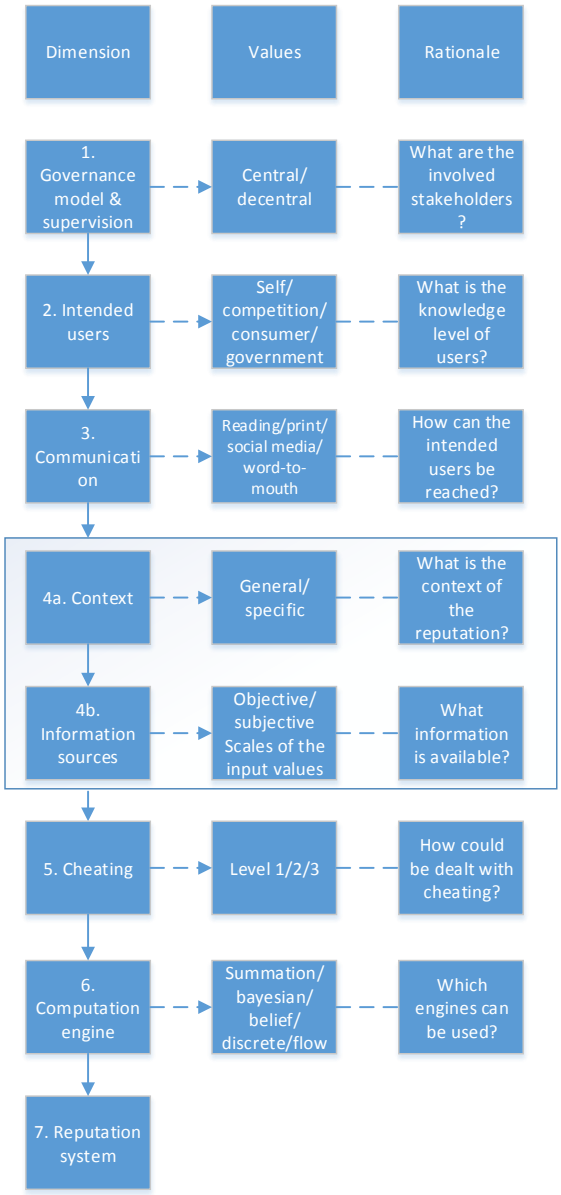

Figure 2 approach for creating a reputation

Knowing the target audience and how they can be reached narrows down the context for the reputation (4). It also helps to determine what kind of reputation should be developed. For example should reputation be based on human feedback, thus measuring perceptions or should it be based on objective information. On the one hand this depends on the intended users and for what the

reputation should be used (2 & 3 figure 2). On the other hand it would also determine on the availability of data sources the stakeholders have access to (1, figure 2).

Different data sources are more susceptible to misrepresentation of data. For example, Human feedback is more susceptible than machine feedback [6]. The type of data is also important: is data in the form of positive negative values, binary, discrete or continuous [8].

In (4) it can also be determined, using the knowledge from (1,2,3) what the reputation score should be like. Is the score a ranking, or a grade? The output should match with the context of the reputation, available information, but also the knowledge of the intended users and the intended use (2, 3).

From the information sources and where they originate from it should be determined how the reputation model should deal with cheating. In the data selection corrections can be made for cheating. The method of calculating the reputation can also help mitigate cheating. For this reason the selection of the reputation engine can be selected last, based on all the information above.

What kind of data is available (1)? On which scales are data measured (4)? What is the knowledge of the intended users (2, 3)? This all drives the way a reputation engine can be selected. Together these dimensions should form a reputation.

This section has shown an approach to creating a reputation system. However it does not specify how the quality of a reputation should be evaluated, section 4 describes this.

4. Assessing the quality of a reputation system

In this section criteria for quality assessment are described. There are four objectives to assess such a quality of a reputation system [11]:

Accuracy

Accuracy for long term performance is an important objective for a reputation system. It means that over a long time the reputation should represent the actual performance of the underlying entity: in other words the reputation should measure what it is supposed to measure. Validation is important to determine this. Also it must have the capability to distinguish between a new entity, thus with little data, and an entity which has a poor performance over time [4, p. 640].

Weighting toward current behavior

An entity can be the best performer for the past years, but if it is recently performing badly, then a reputation system should also depict that. The system should thus recognize and represent the recent trends in performances [11]. For example, there are two entities: an entity with a bad reputation for the last years, but which is doing better at the moment and second an entity which a good performance, but which is recently doing very badly. It can be argued that the second one is doing worse than the first one.

Robustness against cheating

People will try to manipulate the system. Therefore the robustness against these manipulations or attacks should be important [11]. If a system is easily manipulated by the entities, it is worthless. It can be noted that the robustness against attacks also affects the accuracy, since a system with a low robustness, also has a low accuracy. In section 2 a dimension of reputation systems is specifically identified to overcome the issue of cheating. The output of those anti-cheating efforts are assessed here.

Smoothness of the reputation

If a new observation is added to the data and the rating changes very much it becomes a very volatile system. An entity cannot have a good reputation and the next minute have a bad reputation. This means that a new

observation in the data should not change the rating significantly [4, p. 640].

5. Conclusions

In the introduction the topic of reputation was introduced. Reputation is a difficult concept as it has many different definitions. On the one hand a reputation can spontaneously arise. It can also be created with a reputation system.

Using literature the concepts of reputation and reputation systems have been discussed. Literature provided many operationalization's of reputation and different dimensions for reputation systems. In general a reputation is based on two dimensions: General/specific and objective/subjective. Depending on how the reputation is positioned on these two scales many different definitions could apply (section 2). In general the following definition could be used: *"A reputation is the degree to which one party has confidence in another within the context of a given purpose* [8, p. 3]*"*

A reputation system has many dimensions: computation engine, governance model and supervision, intended users, communication of a reputation, and cheating.

Scholars in the field of reputation systems as Josang, Hoffman or Resnick, identified many different aspects of reputation systems. They use these dimensions to classify reputation systems. The aspect of creating a reputation system is less publicized by them. This paper provided an approach to creating a reputation system based on the dimensions identified by these scholars. The relationship between the dimensions has been discussed in section 3. Based on this relationship figure 2 shows an ordering of the dimensions, to create a reputation system.

The dimensions are related to each other, selecting something in one dimension has consequences for others. The stakeholders and the intended users are important drivers for the reputation system, as they determine what kind of information should be used, what the output of a reputation system should be and how these stakeholders can be reached.

This approach is an answer to the research question: "how can a reputation system be created".

Finally section 4 shows also four criteria for quality evaluation: accuracy, weighing towards current behavior, robustness against attacks and smoothness.

Discussion

Although this article has provided an approach into creating a reputation system, it is possible that using the approach does not result in a successful reputation system. It is also possible that not using this approach, but no approach or another approach can result in a successful reputation system. This does not mean that this approach is i.e. incorrect or unusable, it simply means that there are many other options and many other situations.

This approach is theoretical and identified from other articles. By integrating them this view is derived. However, this approach is not tested yet, this can be done as a next step. The result of testing it, i.e. by applying it to a few cases, can be that it becomes clear when this approach is most useful.

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