AHP Techniques for Trust Evaluation in Semantic Web

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Abstract

The increasing reliance on information gathered from the web and other internet technologies raise the issue of trust. Through the development of semantic Web, One major difficulty is that, by its very nature, the semantic web is a large, uncensored system to which anyone may contribute. This raises the question of how much credence to give each resource. Each user knows the trustworthiness of each resource. Top-down or global credibility values would not be assigned due to the subjective nature of trust. Trust policies and trust evaluation mechanisms are needed to filter untrustworthy resource. This problem was tackled in this research by employing a trust model for evaluating trustworthiness of each resource. This proposed model used semantic web metadata, recommendation, and reputation as based factor for evaluation algorithm. The weighting and combination methods are two main challenges for proposed trust evaluation algorithm. These factors have various type and semantic. Therefore analytical hierarchy procedure (AHP) technique was applied for trust evaluation that offers justification for trust decisions and controlled trust measurement.

Keywords: *Trust; Hybrid Trust Model; Semantic Web; Content Trust; AHP.*

1. Introduction

With the expansion of the internet, users and services are often required to interact with unknown entities. Thus, one of the great challenges of the web is the problem of trust.

It is important for each user to identify trustworthy entities or correspondents to interact, and untrustworthy correspondents to avoid interaction [1].

Trust models have emerged as an important risk management mechanism in online communities [2]. The main goal of trust model is detecting of malicious or unreliable entities in a network [3].

A wide variety of literature now exists on trust evaluation, ranging from specific application to general models. Most prior approaches on trust models focus on entity centered issue such as credential and reputation that does not take the content into account [4]. Credential –oriented trust model uses certificate authority for authentication and trust establishment [2,3,5].

Reputation- oriented trust model uses the experiences of others as recommendation, possibly combined to make a trust decision about an entity [1,6,7,8]. The next generation of the web is often characterized as the semantic web. In the semantic web,

resources will no longer only be intended for human consumers, but also for processing by machines, enabling intelligent information services, personalized web-site, and semantically empowered search-engines. [9]. At the core of semantic web technologies lays RDF and languages and formalism, most notably OWL[10]. Semantic web provides a new approach to trust model. Semantic makes to judge on provided resources which is called the content trust. Content trust is a trust judgment on a particular piece of information in a given context[3].

The main goal in this research is to develop a general trust model that can be used for making rational decision in order to make optimal choice. The proposed trust model applied AHP[11] technique to build a suitable trust model which used content and entity trust factors. The rest of the paper is recognized as follow: an overview of AHP technique was given in Section 2. Section 3 explained trust evaluation process. Section ۴ explained the AHP technique weighting mechanism to hybrid trust components. In section ۵, the experiment of proposed model was represented. Finally, the conclusion of paper was provided in section 6.

2. Analytical Hierarchy Procedure

The analytical hierarchy procedure (AHP) is proposed by Saaty[11]. AHP was originally applied to uncertain decision problems with multiple criteria, and has been widely used in solving problems of ranking, selection, evaluation, optimization, and prediction decisions. The AHP method is expressed by a unidirectional hierarchical relationship among decision levels. The top element of the hierarchy is the overall goal for the decision model. The hierarchy decomposes to a more specific criterion in which a level of manageable decision criteria is met [12]. Under each criteria, sub-criteria elements related to the criterion can be constructed. The AHP separates complex decision problems into elements within a simplified hierarchical system[13].

The AHP usually consists of three stages of problem solving: decomposition, comparative judgment, and synthesis of priority. The decomposition stage aims at the construction of a hierarchical network to represent a decision problem, with the top level representing overall objectives and the lower levels representing criteria, sub-criteria and alternatives. With comparative judgments, expert users are requested to set up a comparison matrix at each hierarchy by comparing pairs of criteria or sub-criteria. Finally, in the synthesis of priority stage, each comparison matrix is then solved by an eigenvector[17] method for determining the criteria importance and alternative performance. The purpose of the AHP enquiry in this paper was to construct a hierarchical evaluation system based on the resource attributes and entity reputation.

3. Trust Evaluation Process

The trust relation was created by a resource request issued by one entity to other entities of the network in order to fulfill a requisite. According to Fig.1 trust relation [1] includes 3 operators and labeled edge.

Entities in this relation are: Trustor, Trustee and Recommender Entities.

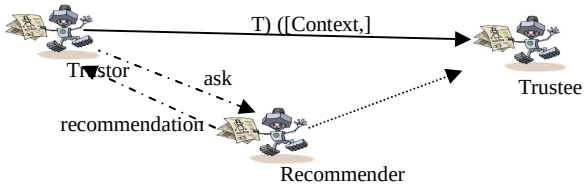

***Figure 1**. Trust Relation*

Trustees are resource providers and claim to provide the requested resource for the trustor. The trust evaluation model should evaluate the trustworthiness of each trustee entity. In traditional web, the resources are represented as an undeductionable structures.

Therefore the trust evaluation is a separate process. In this structure of web, after gathering the claims of resource providers, the mechanism of trust evaluation is used. In this group of trust models, reputation of an entity is used to evaluate the trustworthiness[1,7,14]. With the emersion of semantic web, resources are defined and represented based on their constituent factors[4,9,15].

In this new theory toward the web structure, some factors are defined for each resource. These factors are defined by RDF, OWL languages and resource presentation is done with the help of XML syntax. [16].

With the growth and development of semantic web, an opportunity is provided where instead of human processing resources such as reading, browsing, form-filtering intelligent services such as information filter, search agents and information broker can be provided[9]. In semantic web besides the syntactic form of resources, semantic content is also noted. Therefore the possibility of processing information contents by machine will be provided.

In the proposed trust evaluation model, the components of Hybrid Trust Model [3] were used. The fundamental difference resides in the way these factors were used. To use the components for evaluation trustworthiness of a resource provider, the AHP technique was used in this model.

These components include parameters of resource content[15] and the resource provider's reputation[9].In this section, the extraction of the effective factors in trust evaluation of a resource which were used in AHP technique, takes place. Afterward, the factors which were effective and play an important role in trust evaluation of resources, were investigated.

4. Gathering resource providers as AHP Alternatives

Trustee entities are used as AHP technique alternatives. Each of these entities is defined with an URL. Trustee entities are collected by web search engine as a result of processing a resource request[18].

Each entity represents one resource provider. In the proposed model, the trustworthiness of the resource provider and the submitted resource were both evaluated. Reputation and Content were used in evaluation of resource provider and submitted resource respectively. Trustee entities were used in the lowest Layer of AHP hierarchy as Alternatives.

5. Retrieving resource Attributes as AHP criterions

By offering resources in semantic web[18] , the constituent attributes of a resource can be retrieved by the semantic web search engines. In fact these constituent attributes of a resource are retrieved in form of RDF Graphs[19,9]. Each RDF Graph consists of the ternary object, Attribute, and value. The following sample, demonstrates a simple RDF Graph.

hasprice(http:// Book. Org/ISBN12515866, "$62")

In the demonstrated relation, hasprice is an attribute, http://Book.Org/ISB12515866 is an object and “$62” is considered to be a value.

The semantic web search engines, gather each resource, in a form of ternary RDF graph. The retrieved attributes are used as criterions for AHP technique. These attributes are used in investigating the priority of each alternative.

6. Using resource attributes to establish content trust

By retrieving resources with the semantic search engines[16,18,20] and extracting the resource attributes[9,15] the AHP technique features will be provided. In AHP technique, by retrieved features, the existing alternatives were pair compared according to these features. The criterions were used for pair comparison of each resource provider. With pair comparison; the pair matrix entries would be filled.

In the AHP technique for carrying out the pair comparison of the alternatives based on the criterions, the experts and personal experiences were used. The experts would fill pair matrixes according to their information and each criterion’s value. Intelligent Agents can be used for experts usage. For each by requesting from the agents to, their ideas about each criterion were retrieved from all of the providers. Personal experiences were also used as an agent in this pair comparison. These expert agents would gain necessary knowledge through a lot of interactions in a specific field.

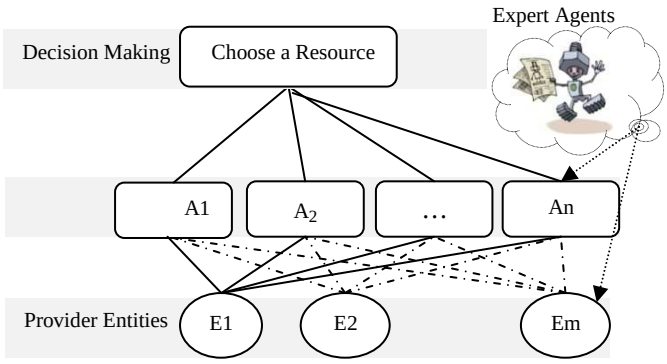

Figure 2. *AHP Structure for Trust Evaluation*

7. Using reputation to establish entity trust

Reputation is the basis for many trust evaluation models[2,21]. Reputation based models utilizes direct experience and other entity experiences called opinion

recommender[1]. Because the trust evaluation in this method is based on the provider's behavior, it is also called entity trust.

In AHP for evaluating the trustworthiness of each entity, the pair comparison was used. For pair comparison of the entities, recommender opinion and personal experiences were used as agents to construct pair matrix. Using AHP and performing operations on pair matrixes, the final weight vector for evaluating the trustworthiness of each provider entity was calculated.

8. Applying AHP Technique for Trust Evaluation

According to section 3, the process of trust evaluation can be represented as the Fig.2. According to Fig.2, $A_1..A_2$ are resource valued attributes and E_1 .. E_m are trustee entities. In this section, using of AHP technique to perform trust evaluation will be investigated.

A. Specifying expert Agents for weighting in AHP Algorithm

To specify relative weight in AHP algorithm, Experts were needed in order to make the weighting matrix. In this model of trust evaluation, two types of Expert Agents were used:

Group1: Reputation-oriented Expert Agents: these agents gained their knowledge through the direct experiences of the respective trustor entity in a period of time and then stored it in its local database.

Table1. *pair comparing matrix of criterions*

	A_1	A_2	…	A_n	W
A_1	1	b_{12}			w_1
A_2	$1/b_{12}$	1			w_2
.			1		.
A_n				1	w_n

Table 2. *pair comparing matrix of resource providers*

$A_{k\epsilon(1..n)}$	E_1	E_2	…	Em	W
E_1	1	a_{12}			w_1
E_2	$1/a_{12}$	1			w_2
.			1		.
E_m				1	w_m

Table 3. *matrix of trustee weights ratio for each criterion*

	A_1	A_2	…	A_n
E_1	w_{11}	w_{12}		w_{1n}
E_2	w_{21}	w_{22}		w_{2n}
.	.	.		
E_m	w_{m1}	w_{m2}		w_{mn}

These agents used direct observations of trustor entities for decision-making, therefore after each interaction these agents updated their knowledge. Statistical foundation can be used for calculation[1,7].

Group2: Recommender Expert Agent: Opinion of other Agents can be used into weighting process.
The opinions about the trustee can be gathered by acquiring information from Recommender Agents.

B. Specifying Each Criterion's Priority

Whenever a resource is provided, there are different criterions regarding the resource Attributes, each criterion's priority can be specified in choosing a resource. In order to specify the criterion's priority, pair comparing matrix is needed. Each entry of this pair comparing matrix denoted a weight ratio. The calculation of this value is through performing a pair wise comparison of trustee based on each criteria from the prospect of an expert agent. For specifying this value, the average of the agent's total scores was received. By performing AHP technique on the pair comparing matrix, weight of each criterion was extracted which is shown in last column of table 1.

C. Pair wise comparison of each resource according to the specified criterion

According to The AHP technique to calculate the weights ratio of each trustee entity, the following matrix was used. Expert Agent's opinion was used to perform pair wise comparison. The same matrix was used for other criterion. After calculating the above matrixes, the following matrix was formed. This matrix indicates the weights of each trustees ratio for each criterion.

D. calculating the final weight of each trustee

After specifying weight for each criterion and pair comparing matrix of each resource based on the specified criterions, the final weight of each resource was calculated using the following formula:

$$W_{E_1} = W_{A_1} * W_{11} + W_{A_2} * W_{12} + \cdots + W_{A_n} * W_{1n}$$

After calculating each resource weight, the resource's final priority was achieved which helps to select the resource with high priority.

9. Conclusion

In this research a Hybrid Trust Model for evaluating trustworthiness in semantic web was presented. Our scheme was based on AHP technique that it is applicable in Group decision-making. Considering trust a complex and multi-faceted thing, AHP technique was used to capture content and reputation and recommendation to trust evaluation. The benefit of Hybrid trust model was that it provided a mechanism to apply all effective features in trust. This trust model was a new approach to trust evaluation and in next step further semantic web feature would be applied.

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