Taste It! Try It! – A Semantic Web Mobile Review Application

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***Abstract*—Web-based review systems provide a valuable service to consumers allowing them to share opinions on various goods and services. In order to improve the comparability of opinions as well as their retrieval and further application, systems more and more often take advantage of semantic annotations and Semantic Web technologies. However, as users are not really interested in delivering semantic annotations of content, specific tools incorporating incentives' mechanisms are needed to transform the syntactic content into the machine understandable one. This paper presents a Semantic Web mobile review application, supporting semantic-based user profiling and contextual semantic search, benefiting from linked data and equipped with Web 2.0 motivations mechanisms.**

Keywords – Semantic Web; semantic annotation; Linked Open Data; incentives; Web 2.0; review systems.

1. INTRODUCTION AND MOTIVATION

There exists an enormous amount of reviews on goods and services published by users on the Web every day. Reviews made by consumers, shared opinions and experience, have become an important source of valuable information that can be used by recommendation systems. However, as many consumers prefer to use free text to express their opinions, the difficulty in structuring these reviews using information extraction techniques [3] makes opinions' selection and retrieval processes as well as utilization of retrieved opinions not accurate enough [15].

Therefore, in order to improve the accuracy of mentioned processes, review systems more and more often take advantage of semantic annotations and Semantic Web technologies [6]. However, the interest of users to contribute to the creation of the semantic content is rather low, due to [8][9]:

- rather high barrier of entry - creation of semantic annotations requires specific skills and expertise in the domains such as ontologies, logic and knowledge representation;
- lack of incentives - most of the semantic applications are difficult to use and lack built-in incentives inducing users to use them;
- lack of clear benefits - the benefits of using semantic content are in many applications decoupled from the effort of creating the semantic content.

Thus, in order to address the problem of data structuring and engage users in the process of creating semantic annotations, tools need to incorporate adequate incentives, e.g., benefiting from the Web 2.0 paradigm [17].

In addition, the Web has evolved "from a global information space of linked documents to one where both documents and data are linked" [12]. This evolution is supported by a set of best practices for publishing and connecting structured data on the Web known as Linked Data. The most visible example of adoption and application of the Linked Data principles is the Linking Open Data project [13] aiming at identifying existing data sets that are available under open licenses, converting them to RDF [14] according to the Linked Data principles, and publishing them on the Web (as Linked Open Data (LOD)). Thus, instead of developing new standalone ontologies to be used within review systems, it is desirable to take advantage of the LOD paradigm. The machine-readable data coming from various data sets with explicitly defined meaning can provide better access to various information sources (by supporting comprehensive answers to queries over aggregated data), thus, leading to enhanced user experience.

In this paper we present a Semantic Web mobile application for reviewing objects supporting semantic-based user profiling and contextual semantic search, benefiting from LOD sets and equipped with Web 2.0 motivations mechanisms. The application is being developed within the INSEMTIVES project [10] focusing on mechanisms motivating users to dedicate more time and resources in the participation in the process of semantic content creation.

The goal of the developed application is to make annotating process sufficiently easy for end-users' acceptance while providing added value through the ease of integrating data and reasoning on it. The work conducted encompassed both the research and practical related aspects. On the one hand, the aim was to contribute to a general understanding of the problem and on the other hand, the aim was to develop a system that could not only be used as a proof for testing, but also could constitute a fully fledged tool to be used by users. Thus, the System Development Method (SDM) was utilized [11] that "allows the exploration of the interplay between theory and practice, advancing the practice, while also offering new insights into theoretical concepts" [11]. The approach

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followed consisted of three main steps. First, the concept building phase took place, which resulted in the theoretical concepts presented in this paper. The next step is the system building encompassing development of a system based on the theoretical concepts established. The last step will be the system enhancement and evaluation.

The paper is organised as follows. Next section presents shortly the related work. Within the following section, the general framework of the proposed solution is presented including the vision of the tool, approach to the semantic annotation followed, supported functionalities and the motivations mechanisms applied. Finally, the paper concludes with final remarks.

2. RELATED WORK

Recommendation systems attempt to predict items a user may be interested in, given some information about user's preferences and past behaviour i.e., a user profile [1][15]. Most existing recommender systems take advantage either of:

- collaborative filtering techniques i.e., analyzing past actions and behaviour of all users in order to identify interesting associations between them or between the objects, which can be used to make recommendations to a single person (memory-based collaborative filtering (e.g., [18]) and model-based collaborative filtering (e.g., [19]));
- content-based methods i.e., recommending objects by analyzing the associations between user's past choices and descriptions of new objects [2][16] or
- hybrid filtering methods combining two previous ones.

A typical recommendation mechanism analyzes the user context (a user profile, if available), and presents to the user one or more descriptions of objects that may be of their interest. Recommendation mechanisms may be used in pull (recommendations are explicitly requested) or push mode (recommendations are made when a user did not ask for them). In either way, the recommendation should be personalized [20]. Following [16], different levels of personalization can be distinguished starting from coarse grained ones (e.g., relying on the country of residence) to fine-grained (e.g., based on the recent search history). The process of personalization is accurate, if the system possesses accurate information on a user as well as the object/topic the user is interested in, and the information is machine-understandable.

As online reviews are increasingly becoming the de-facto standard for measuring the quality of various goods and services, their sheer volume is rapidly increasing so that processing and extracting all meaningful information manually in order to make an educated purchase becomes impossible [32]. As a result, there has been a trend towards systems automatically summarizing opinions from a set of reviews and displaying them in an easy to process manner [32][33][34]. One of the approaches followed is the aspect-based sentiment summarization taking as an input a set of users' reviews for specific goods and producing a set of relevant aspects, an aggregated score for each aspect, and supporting textual evidence [32]. The quality of this aspect-based summarization may be highly increased, if an a priori knowledge domain and the labelling of the portal are also considered [32].

Although much has been done, the current generation of recommender systems still requires further improvements including methods representing user behaviour, incorporation of various contextual information into the recommendation process, utilization of multi-criteria ratings [1] as well as extracting information from free-text comments left by customers [3]. Although much progress has been made in the area of tools automatically producing structured reviews from unstructured text [3][32][33][34], human involvement is still required. Therefore, the application of semantics and the idea to apply appropriate incentives to encourage people to create semantic annotations should be considered [9].

According to [5], semantics is one of top ten most promising technologies of the future. The Semantic Web paradigm constitutes a major step in the evolution of the Web. It is to enable machines to understand the meaning of information on WWW via extending the network of hyperlinked human-readable web pages by inserting machine-readable metadata about the Web content and information on how they are related to each other, thus, enabling automated reasoning [6]. Its main goal is to make the Web content not only machine-readable, but also understandable by using semantic annotations. A semantic annotation is machine understandable, if it is explicit, formal, and unambiguous and this goal is usually reached by using ontologies [7]. Semantic review systems are those whose performance is based on some knowledge base defined as e.g., ontology [1][4]. The application of ontology within the review system: semantically extends descriptions of user opinions; allows to complete the incomplete information through inferences; semantically extends descriptions of user contextual factors; allows for the dynamic contextualization of user preferences and opinions in specific domains; guarantees the interoperability of system resources and the homogeneity of the representation of information; improves communication processes between agents and between agents and users [4].

As already mentioned, the Web has also evolved into the Web of Data [12] by using a set of best practices for publishing and connecting structured data on the Web known as Linked Data. The Linking Open Data project [13] identifies existing data sets that are available under open licenses, converts these to RDF [14], and publishes them on the Web. The examples of datasets encompass well-known DBPedia, Geonames or Freebase. The content of the Linked Data cloud is diverse in nature, comprising e.g., [12]: data about geographic locations, people, companies, books [21], scientific publications, movies, music, television and radio programmes, genes, proteins, drugs and clinical trials, online communities, statistical data, census results, and reviews (Revyu system [22]).

Currently, because of the rising popularity of Web 2.0 tools, product review forums have become ubiquitous and

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more and more websites provide platforms and tools for customers allowing them to share with others their personal evaluations and opinions on products and services, e.g., Yelp, Goodrec Urban or Tripadvisor. These systems provide large amount of reviews and offer recommendations on goods and services. Although quite successful, the precision of browsing and searching the reviews previously submitted is far from being perfect and usually no summary of existing reviews is provided. However, there exists few solutions incorporating semantic technologies and therefore providing more precise search results e.g., [23][24][3]. However, they suffer from a lack of user-generated content. The most promoted semantic recommender system seems to be the Revyu system – a generic reviewing site based on the Linked Data principles and the Semantic Web technology stack. Although the tool itself is worth noting, it also lacks on focus (a user may review anything he wants) and on incentives mechanisms encouraging users to provide semantic content of high quality..

The social phenomenon of Web 2.0 is well recognised in the literature and well visible in the everyday life [17]. With mobile-multimedia devices capable of continuum data transmission, social interactions on the Web are to be moved to the new level as big numbers of different individuals who wish to contribute towards some joint project or community may be easily linked together [25][26]. This trend is also visible when it comes to social tagging sites like Flickr and Delicious or already mentioned various recommendation sites. People sometimes work for free, motivated either out of intrinsic enjoyment [27], social reward [28] or by using financial compensation (e.g., Mechanical Turk). The key for success of every user-contribution based system is the incentives mechanism applied. The gratification system should be as attractive as possible and each award should motivate a user towards further contribution. The success of Farmville on Facebook showed the power of funny badges and medals published on the Facebook wall. When it comes to review systems, some applications use simple flat points to award users for their contribution (e.g., Gastronauci), some use complex system of badges (e.g., Foursquare) or stamps (e.g., Gowalla). In addition, some of them offer publishing information on user activity on the Facebook wall (e.g., Urban spoon, mygoodeats), which additionally motivates users and is a great way of attracting new users to sing up.

Taste it! Try it! is to provide the following additional value in comparison to the currently existing solutions: structuring and disambiguation of the reviews by using domain knowledge, complex ontology-based description of objects integrated with the LOD cloud; semantic-based user profiling and personalization of search results; incentives to contribute to the system following appropriate usability and social design guidelines.

3. TASTE IT! TRY IT! APPLICATION

The Taste it! Try It! application is targeted at two groups of end-users: data producers (contributors) - providing reviews of places, and data consumers (beneficiaries) - interested in the content produced by the application, i.e., looking for opinions on various places.

3.1 STORYBOARD

The Taste It! Try It! Application supports the creation of semantically annotated reviews using mobile devices in a user-friendly manner. The storyboard supported by the system is as follows. A user goes to a restaurant. While being at the restaurant, the user decides to share his opinion on the restaurant and its quality of service factors with other members of the community. He uses Taste It! Try It! to express this opinion. The application starts from capturing the position of the place (using the GPS system in a mobile device). This enables associating the semantically annotated review that is created afterwards with a specific point in space. Then, the user creates a review by providing values to selected features suggested by the application. Additionally, the user may create a free-text comment regarding the object being reviewed. The review is then uploaded to a Taste it! Try it! server and in the background the semantic representation is created. Based on the quantity and quality of created annotations, the user may be awarded with a special title e.g., Polish-cuisine expert, International-food expert. This title is visible to his friends at the community portal, in our example the Facebook portal, with which the application is integrated. In addition, based on the user behaviour and data made available by the Facebook portal, the user profile is created, which is then used in the personalization process. As data acquired from Facebook and other sources is structured, it can be directly mapped to the ontology used by the application. The created annotations are then further on used by a semantic-based recommender system while searching for restaurants fulfilling certain criteria, e.g., vegetarian, low budget, and high quality, in the neighbourhood of a user. As the semantically annotated reviews are linked to LOD sets [12], some more sophisticated reasoning over the data is to be possible and extends the possibilities offered by the system.

Thus, the application is to fulfil the following goals:

- provide semantically-enabled reviews that are sufficiently easy to create for end-user acceptance - the process of attaching the machine understandable semantics should be invisible to the end user;
- keep a user entertained - integration of the proposed application with the social portal such as Facebook and badges, are some of the incentives that are utilised to make the system more attractive to users.
- offer the personalized, semantic, context-aware recommendation process (both push and pull).

3.2 SEMANTIC ANNOTATION AND SUPPORTED FUNCTIONALITIES

Within our work, we followed a hybrid approach to the review creation and in consequence, also to a semantic annotation process. Firstly, we decided to include into our model a feature-based review relying on labelling. Thus, the domain knowledge was utilised in order to identify the

most important dimensions of reviewed objects users may be interested in, e.g., details of the place, food (the quality of served food, how the food tastes, and comments about specific dishes, items or selection); service (such as mainly politeness and timeliness of order delivery); atmosphere (information on the venue such as: decoration, parking, cleanliness, music, etc.), value related (e.g., the quality of goods in comparison to their price).

Our dimensions encompass both the quantitative and qualitative information at the feature/aspect level. The quantitative ones are appropriately aggregated and translated into a "star rating" between one and five stars. The qualitative ones are represented by a set of possible values representing the key sentiments that may be used to express the value of the aspects. Thus, while delivering the review, besides providing specific rates of a restaurant in the various categories, users may specify the restaurant's cuisine, available entertainment, payment options, Internet-access possibility, etc., by selecting the appropriate values from the lists.

All information is expressed in a formal semantic manner in the background. The specific dimensions are linked to the internal ontology developed within the project, with the central concept review. The mentioned ontology provides flexible categorization scheme that assist in further integration of reviews (to produce a consistent description of an object e.g. restaurant) as well as recommendation and search. In addition, the specific concepts in the ontology are linked to the LOD cloud; e.g., the dimension object city is linked to concept city from GeoNames and local is linked to the restaurant concept from DBpedia. Each review made by a user produces additional RDF triples that may be published in the LOD cloud (e.g., 'Quality Restaurant' is located in Paris).

The second approach to the semantic annotation, allows users to introduce into the application the free-text comments regarding any selected aspect of an object being reviewed. While the user is typing the comments, the system on the fly checks the words used and tries to disambiguate them and link them to the existing concepts in the LOD. This is done on the mobile device, if a user is online or at the Facebook portal in other case. In this way additional RDF statements are created – annotating restaurants and their different aspects selected by a user. Free text comment is disambiguated using Wordnet or DBPedia and bootstrapping algorithm developed within the Insemtives project [31][35][36].

The above mentioned semantic annotations and additional information gathered about a user is then used in order to offer two groups of functionalities: personalized recommendations (push) and search (pull).

Within the system twofold personalization has been applied. The first one is solely based on the information known on a single user (so called atomic personalization [15]), e.g., geo-location, outcomes from analysis of preferences based on the previous reviews. Based on the current location of a user or his interests (user profile), the recommendations of different objects to visit are to be provided. While providing the context-based recommendation, this context influences the results. However, as atomic personalization may sometimes lead to over-specialization [15], also other information is considered e.g., users who similarly rated the given object, outcomes of analysis of the friends network. This is called collaborative personalization and it can also help overcome the problem of a cold start, when little or no information is known about an individual. In addition, semantic based clustering of users is performed, where the reasoning is to be applied in order to compute the distance between different tags and users. The information on which aspects a user usually points to is also used by a system in order to perform user clustering and conduct personalized search. This is to be used while providing suggestions of places to visit and ranking search results.

As semantic annotations allow overcoming problems derived from the ambiguous nature of the natural language and from the specificity gap between annotations and queries, the system may ensure a higher precision to its users (e.g., [35]). In order to take advantage of the semantic annotations, a specific search interface is to ensure the correspondence of the user query with the underlying semantic annotation model. Therefore, the bootstrapping algorithm is also used while formulating a query by a user. In addition, the interface allows a user to formulate a query using building blocks, thus, giving him a full control on the extent of personalization and constraints used in the query. In this way, the undesired limitation of the world is avoided (e.g., localised search is desirable when a user is searching for restaurants locally, but is not as desirable when one just wants to find the best restaurant worldwide). Once a user clicks the submit button, the formulated query is resolved, and the SPARQL query is created and executed on the Insemtives platform [37] that retrieves the recommendation results. Resolving spatial-queries, recommended by my friends, or people of similar interests or having some specific aspects annotated is also supported by the Taste it! Try it! application. The user is also able to influence the ranking of search results by ranking different search dimensions.

To summarize, the application exhibits the following features: ontology-based structuring of text reviews using additional domain knowledge and taking advantage of the LOD data sets, multi-layer semantic-based user clustering and context-aware personalization of search results.

3.3 MOTIVATION LAYER APPLIED

The social aspect of user gratification is expected to solve one of the motivational problems that social software based on user contribution is facing. This is the problem of decoupling users' roles of a contributor and beneficiary of the system. A written and submitted review of a given restaurant can, of course, be valuable for its author in the future. However, he is most likely to benefit more from

contribution of other users, not from his/her own. The time of investment is then often much different from the time of benefit, this is known as the "curse of prepayment" [29].

Within the INSEMTIVES project, the issue of motivating users to contribute to the semantic content creation was investigated and relevant guidelines and models have been provided [30].

As it was already mentioned, the goal of the Taste it! Try it! is also to motivate users to create semantic annotations of restaurants. The annotations assigned to a restaurant by the application, are derived from collective decisions of reviewers. Thus, it is required to motivate users to produce reviews in considerable amounts and with a substantial level of details. The incentives models and methods within the application may be summarised according to two dimensions: usability design related incentives, such as user-friendliness and easiness of creation of semantic annotations; and sociability design manifested through the integration of the application with the Facebook portal and usage of badges and points to award users for the activities.

The first mentioned dimension of incentives relates to the design of the application and its interface. It covers such usability design aspects as controllability, self-descriptiveness, error-tolerance, expectation conformity, suitability for task and individualization. While developing the application, our main motivation was to hide the complexity of semantics being the backbone of the application. The semantic annotations that are created are template based annotations, thus, the entire process of creating annotations is more user friendly and resembles typical interaction with the Web 2.0 application. Even the creation of the semantic annotations based on the free text concepts is more user friendly thanks to the application of the bootstrapping algorithm, already mentioned.

The second groups of mechanisms include the sociability design aspects, that manifest themselves by awarding badges to users being the most active or reaching certain thresholds e.g., for each review submitted, users are awarded with points. In turn, badges show the status of a user, his/her hobby as well as current achievements. The gratification rules define when a user is eligible to get a certain badge. Both badges and points are displayed in the profile and on the wall of the user on the Facebook portal. It allows taking advantage of the following motivation levers: reputation, competition, conformity to a group, usefulness, altruism, reciprocity and self-esteem.

3.4 Architecture and the Insemtives platform

To fulfil goals defined for the application, five major components of the application were distinguished, namely: server, Android client, Facebook client, Facebook and the Insemtives platform. The Android client provides a user with a mobile front-end to manage reviews. The server component performs the semantic annotation process and publishes the prepared LOD using the Insemtives platform. The server also provides an interface for the Facebook client that enables retrieval of information on the user interactions with the application, as well as on restaurants and reviews.

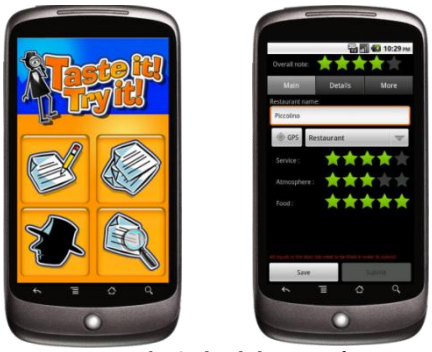

Figure 1. The Android client interface

The server also updates information on statistics, granted badges and uses the Facebook Graph API to post information on the Facebook wall of the user e.g., about a new review or a new badge granted to the user. The Facebook client is another front-end to the application and is embedded in the Facebook canvas. It uses the Facebook JavaScript API to retrieve basic information about the user including Facebook user ID, user name, friends, location, locale, etc. This data may be used in the Facebook side calls. The Insemtives platform enables publishing data in the LOD cloud, offers SPARQL support while accessing the data from the cloud, as well as provides the bootstrapping component.

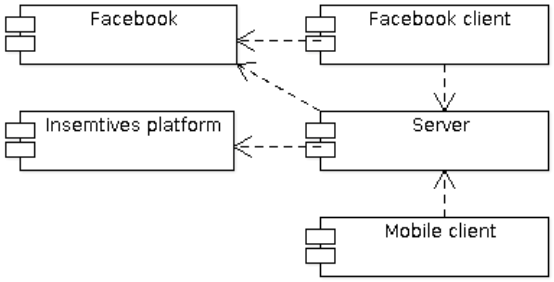

Figure 2. System schema

4. Conclusions and future works

The Taste It! Try It! application presented in this paper is to support users in creating semantically annotated reviews. This goal is achieved by providing an application similar to what users already use and applying incentives mechanisms to motivate them. These social incentives mechanisms taking advantage of the Web 2.0 ideas are to guarantee the appropriate quantity and quality of the created semantic annotations of objects. This will in turn allow offering personalised and more accurate search possibilities leading to creation of a valuable recommendation system, thus, constituting additional incentive for users to use the application. The Taste It! Try It! Application offers the added value towards the existing recommendation systems especially in the area of personalization of search results and contextual semantic search. Worth mentioning is also the integration with the

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LOD cloud. We believe that features of the Taste It! Try It! application provide a reasonable compromise between functionality, usability, simplicity and attractiveness from the user point of view. However, only an evaluation of the proposed solution being a part of our future work will show, whether the application constitutes a good compromise between the power of semantic annotations and difficulty of creating and maintaining them.

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