APOPSIS: A Web-based Platform for the Analysis of Structured Dialogues

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Abstract. A vast amount of opinions are surfacing on the Web but the lack of mechanisms for managing them leads to confusing and often chaotic dialogues. This creates the need for further semantic infrastructure and analysis of the views expressed in large-volume discussions. In this paper, we describe a web platform for modeling and analyzing argumentative discussions by offering different means of opinion analysis, allowing the participants to obtain a complete picture of the *validity*, the *justification* strength and the *acceptance* of each individual opinion. The system applies a semantic representation for modeling the user-generated arguments and their relations, a formal framework for evaluating the strength value of each argument and a collection of Machine Learning algorithms for the clustering of features and the extraction of association rules.

Keywords: Debating platforms; Opinion analysis; Association rules; K-means algorithm; Multi-aspect evaluation

1 Introduction

Social networks, debate platforms and forums have become major sources of knowledge sharing, interaction and collaboration among participants through the Web, where users express and share their opinions over a plethora of topics. Due to the lack of methods for analyzing and capturing the structure of the argumentative discussions in conjunction with the vast amount of available information encountered on the Web, users are often overwhelmed when trying to understand and make sense of the user-generated opinions. This makes the task of analyzing and identifying useful patterns of relationships among contributors and opinions difficult.

Amongst social networking platforms, debate portals are becoming increasingly popular in recent times (*e.g., Debate.org, Quora*). These applications provide features for collecting differing opinions related to goal-oriented topics of discussion where users exchange their views in the form of agreement or disagreement. People rebut to other user's posts by defending and justifying their

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opinions with the purpose of persuading the audience. However, it is difficult and time consuming to browse through the useful opinions expressed within a dialogue when a large amount of comments is provided. Hence, it is essential and helpful to analyze the users opinions in a more comprehensible form, so that useful patterns of relations among online users can be identified and extracted from dialogues, helping contributors understand the dynamic flow of a community.

In this paper, we introduce and describe a web-based debating platform for modeling and analyzing online discussions. The system, called *APOPSIS*[1], motivates users to participate in goal-oriented topics of dicussions by raising issues, posting ideas or solutions, posting comments in the form of (supporting or attacking) arguments and voting. Moreover, the platform offers the opportunity for a variety of groups of people to work and collaborate with each other with the goal of suggesting and sharing new ideas, regarding different open issues. Towards this contribution, the system can produce and extract useful conclusions and opinions expressed in a dialogue, that help sense-makers and expert users who wish to take advantage of the system, to understand the dynamics of social communities and make decisions on specific issues and problems.

Furthermore, our platform provides a range of functionalities which are presented next. An argumentation-based approach is applied for organising the conceptual components of a dialogue, based on the Issue-Based Information System (IBIS) model [1]. Then, a Semantic Web ontology is used for representing the conceptual components and their relations in the form of RDF[2] statements. Considering users' reactions (comments and votes), answers are evaluated through a general formal framework for computing the strength value of each argument, considering one or more aspects *(i.e. incorrect, irrelevant, insufficient)*, as proposed in [2]. The main part of this work concerns the opinion analysis, where clustering and associations techniques are used for the clustering of features and the extraction of association rules, such as Expectation-Maximization (EM), K-means and Apriori algorithms, implemented in [3].

Example. Let's consider a city, where the City Council needs to take some important desicions about the city planning and the implementation of the city's actions, enabling residents to be involved in dialogues by expressing their agreements or disagreements and vote on other citizens' comments. The system aims at giving the opportunity to the citizens of the municipality to work together for designing policies for a municipality. A platform such as Apopsis can assist the City Council and decision-makers to understand and make decisions on specific problems and issues by identifying and extracting useful suggestions. As desicions made by the city council are rarely on a black-or-white basis, it is essential to identify the different trends and driving forces of the various groups that are formed, in order to try to accomodate as many of their needs as possible. *For instance, the system could identifies different groups of citizens (e.g., groups of civil society, other bodies) who share similar opinions on specific suggestions that can help the City Council decides on the effective governance of the city.*

[1] http://www.ics.forth.gr/isl/apopsis
[2] http://www.w3.org/RDF/

The rest of this paper is as follows. In Section 2, we present the relevant background followed by the related work. Section 3 introduces the ontology and continues with the methodology used for modeling and analyzing users' opinions. Section 4 presents the basic concepts and features of the web application. The last section draws some conclusions by emphasising the key points of our work and identifying issues for further research.

2 Background and Related Work

2.1 Computational Argumentation

Argumentation [4] is the research field dealing with the formal study of agreement and disagreement that people express with the goal of defending their opinions or convincing themselves and others. The theory of argumentation plays an important role in understanding, analysing, formalising and structuring both online and everyday human deliberation and discussions. This creates the need for effective formalizations and automated mechanisms that can model and valuate the users opinions. Some of the problems are approached by researchers, mostly in computational argumentation where well-defined frameworks are provided. Computational argumentation theories have found beneficial applications in the fields of Artificial Intelligence, desicion-support systems and recently on the Social Web for facilitating online dialogues among multiple participants.

Many efforts have been proposed for the evaluation of arguments using a graded (numerical) acceptability ranking. Such works include the QuAD (Quantitative Argumentation Debate) [5] framework for quantifying the strength of opinions based on the aggregation of the strength of attacking and supporting arguments. Another framework that has attracted research attention is the SAAF (Social Abstract Argumentation Framework), proposed in [6]. SAAF incorporates a voting mechanism to calculate the strength of arguments by considering both votes and the attack strength that an opinion has received. The approach was later extended in [7], by incorporating also supporting relations among arguments, and a social voting for aggregating votes in order to identify the strongest answers.

2.2 Machine Learning

Machine Learning algorithms (ML) have been already an integral part of computing systems for exploratory data analysis. In this work, a collection of machine learning software is used for clustering analysis, including techniques for data pre-processing, clustering and association rules.

K-means algorithm. One of the commonly used unsupervised learning algorithm for solving clustering problems. The algorithm aims to assign a set of data objects to clusters, in order to achieve a high intracluster similarity and a low inter cluster similarity. The K-means algorithm is adapted to many problem domains and can be applied to many fields, such as Marketing for product selling,

Social Networks for online users behavior etc.
Expectation-Maximization (EM) algorithm. An iterative probalistic clustering algorithm that can be used as a pre-processing procedure of the K-means algorithm with the goal of deciding the optimal number of clusters that need to be generated for the clustering analysis.
Apriori algorithm. An association rule mining algorithm that identifies frequent itemsets over a given set of observations. A prior knowledge of data is required in order to generate the next set of itemsets. Associations rules are useful for discovering interesting relationships among attributes of a dataset.

2.3 Existing tools for online debates

Several online platforms have been developed to serve the need of modeling, evaluating and querying arguments in an informative and interactive way. A plethora of tools on the Web focus on user actions, allowing them to raise issues or ask questions about public concerns and post comments in support of or against a specific topic of interest.

Quaestio-it.com [7] is a web-based Q&A debating platform that offers an interactive way of engaging users in conversation regarding any question within the platform. The system provides a computational argumentation framework, called ESAAF (Extended Social Abstract Argumentation Framework), for modeling online discussions and identifying the strongest comments prevailing within debates. Best answers and arguments are highlighted and visualised as bubbles with their sizes indicating the participation rate. Compared to our system, Quaestio-it offers a comment-rating algorithm similar to ours in order to identify the most acceptable opinions, but does not consider clustering or any other types of dialogue analysis techniques for generating groups of related opinions. We use an evaluation algorithm that considers both arguments and votes strength score but more importantly, APOPSIS allows an automated opinion analysis that extracts useful conclusions to sense-makers in order to help them make sense of the discussions in social communities.

e-Dialogos [8] is a web application for open public debates that enables citizens to connect with other people and discuss problems related to the design and implementation of policies related to municipalities. Despite the fact that this system provides the ontological infrastructure for modeling discussions that are taking place in deliberations, they do not evaluate the users' answers, neither provide a voting mechanism for supporting or attacking other answers. Furthermore, the application provides a summarization form that displays all opinions shared during the deliberation process but there is no implementation of an opinion analysis algorithm. Our methodology can provide a reliable approach for evaluating and analyzing the users' answers by combining both argumentation theories and Machine Learning techniques to facilitate the users' reactions.

Many other social networks exist in the form of *question & answer* systems that are similarly related to Apopsis platform, such as *Quora*[3], *Answers*[4], *an-*

[3] http://www.quora.com
[4] http://www.answers.com

swerbag[5], *Yahoo Answers*[6] and *StackExchange*[7]. However, these systems lack some of the defining characteristics of a debating platform, such as the organization of opinions into pro and con, the formalization of well-defined methods for evaluating the strength value of each opinion individually and the analytical features (e.g., clustering) that would enable users to make better sense of the discussions and the opinions expressed within the dialogue.

3 A Methodology and Platform for Opinion Analysis

3.1 A platform methodology

Apopsis is a web-based debating platform that aims to motivate online users to participate on well-structured discussions by raising issues and posting ideas or comments that support or attack other opinions. The main goal of the system is to offer an automated opinion analysis that determines and extracts the most useful and strongest opinions expressed in dialogue, that help decision-makers understand the discussion exchange process.

In our platform, dialogues proceed in two different levels of discussions allowing the strongest arguments, based on their score value, to proceed in the next level of the dialogue with the help of moderators that ensure the quality of debate. Users may navigate amongst different dialogues existing within platform and debate on a particular topic of interest by providing their statements in the form of agreements and disagreements. Discussions are presented in the form of trees where subsequent levels of comments respond to the parent comment (position or argument). In the second phase of the dialogue, participants are not allowed to post new ideas (positions) but only provide positive or negative answers on existing positions. The nature of comment (positive or negative) is predefined by the system, allowing users to select whether support or attack an opinion. The system offers well structured dialogues and a voting mechansim for evaluating each argument considering one or mores aspects. Conversations are organized and represented by using the MACE-ontology for making the discussions available in the form of RDF statements and users' answers are evaluated based on a quantitative evaluation algorithm that takes into account both, arguments and votes. Then, a clustering analysis of opinions can be applied that aims to discover different trends (users and opinions), helping contributors to obtain a clear picture of the opinions expressed in social communities.

3.2 Knowledge map representation

The knowledge map is designed to structure the argumentation process by allowing five different types of elements: *issue*, *topic*, *position*, *pro-argument* and *con-argument* for facilitating online debates, see Table 1. Most of our concepts

[5] http://www.answerbag.com
[6] http://www.answers.yahoo.com
[7] http://www.stackexchange.com

have their roots in the IBIS-style argumentation model [1] with slightly different semantics. In our approach, each type of element is represented as a node that denotes a specific meaning. For instance, an *issue* represents a question or statement that initilize a conversation where users can share and contribute ideas in a positive or negative way, a *topic* represents label or aspect of the issue matter where an argument is a response to specific topic related to that issue. Direct answers in the form of solutions or ideas to the initial point of conversation are considered as *positions* while the arguments that support or attack a position are defined as *pro-arguments* and *con-arguments* respectively. Each dialogue is represented as a directed graph with each node representing an argument and each directed edge indicating a support or attack relation. An overview of the knowledge map introduced in this work is given in Table 1.

Table 1. Knowledge Map.

Node Element	Description	Stereotype
Issue	A question or statement that initialize a conversation.	?
Topic	A label or tag that is closely related to issue.	—
Position	A solution or idea that respond to the initial point of conversation.	
Pro-argument	The ability to support a position or another argument.	+
Con-argument	The ability to attack a position or another argument.	—

3.3 The MACE - ontology domain

The need for understanding and investigating how communities interact and argue in the context of specific domains, led many researchers in modeling ontological formalizations for structuring the information exchanged in these communities. We briefly mention them, which can model and represent online communities and relations related to online activity. The OPM (Opinion Mining Core Ontology) [10] proposed by Softic and Hausenblas (2008), describes concepts related to online discussions with the connection of two existing vocabulary, the SIOC (Semantically-Interlinked Online Communities) [9] and the SKOS (Simple Knowledge Organisation System Reference) [11]. Another important ontology that should be considered is the CiTO[8] ontology, which expresses some similar relation semantics (*e.g., agrees with/support, disagrees with/attack*) with MACE[9] ontology by allowing a more complex set of interaction among users.

In Apopsis, we designed and implemented an RDF ontology (MACE) for organizing and representing online discussions and their relations that aims to ac-

[8] http://www.sparontologies.net/ontologies/cito/source.html
[9] http://www.ics.forth.gr/isl/mace/

commodate complicated opinions found in online debates by semantically querying and presenting them to the audience. The main goal of MACE-ontology is to represent dialogues and opinions through Semantic Web technologies, which are organised according to specific types of argumentation elements as shown in Table 1. Although many ontologies are applied in specific domains, our ontology is powerful and generic enough to represent the content produced and exchanged within the platform for online communities. The formal ontology (MACE) can also be accessable through the Apopsis platform. An overview of our ontology and its properties for making the content and their relations available in the form of RDF statements is given next.

A taxonomy of ontological concepts and properties

Our ontology consists of 12 classes and 27 properties. Properties that start with the prefix (P) are the main properties of ontology that describe the relations among classes hierarchies while properties that start with the prefix (RP) contain information that can be derived from the composition of other properties.

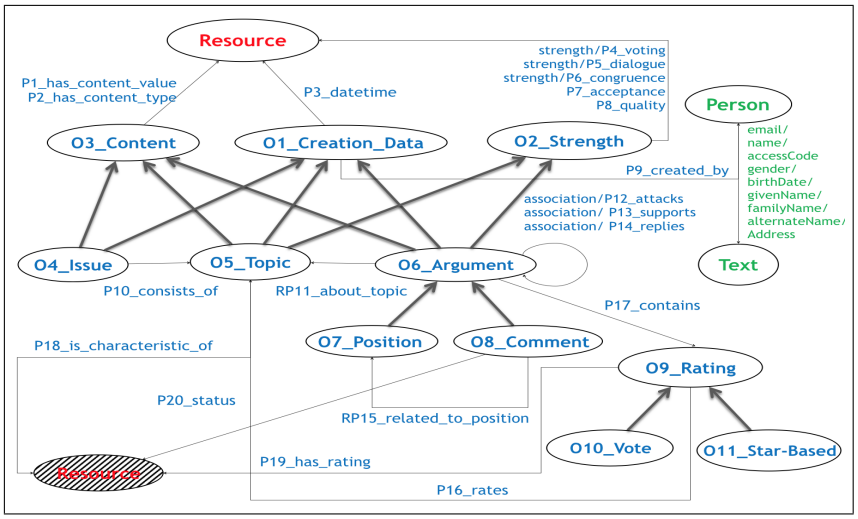

Fig. 1. The MACE - Ontology Domain.

A core idea behind the design of the ontology is to have top classes (*O3_content*, *O1_Creation_Date*, *O2_Strength*) that represent different functionalities. This way, the other entities (sub-classes and sub-properties) inherit features and functionalities from the top classes, as shown in Fig. 1. For instance, the Content class contains information about the data related to each object, and is a superclass of those entities that have content (Issue, Topic, Argument). Similarly, the Creation Data class contains information about the provenance of each object,

including datetime and author, and is also a superclass of the entities (Issue, Topic, Content). Finally, the Strength class comprises information about the calculation of the score value of each argument and is a superclass of (Topic. Argument). Considering the *O6_Argument* hierarchy, an argument can be either a position or comment. Positions are not allowed to respond to other positions (as they are, essentially, top-level comments), whereas arguments can be positive or negative related to positions or other comments. We have used and extended the Person class from the *schema.org*[10] ontology that describes people and provides information about their profiles. Moreover, since the system offers a voting mechanism, the ontology includes a class, named *O10_Vote* that stores the votes (positive or negative) that an argument has gained.

All class entities are associated with other classes through aproppriate properties. Some properties contained in this schema are more complex than others. These properties are the *strength property* and the *association property*. The strength property denotes the score calculation of arguments (comments and positions) and is based on the calculation of five more relations: *voting*, *dialogue*, *congruence*, *acceptance* and *quality*, as shown in Table 2.

Table 2. Dialogue properties.

Dialogue	Description
Voting	The value of the voting strength for both (acceptance and quality).
Dialogue	The overall dialogue strength by combining the arguments and votes strength.
Congruence	The strength of an argument considering only the supporting votes of an argument, normalized by the attacks.
Acceptance	Represents how acceptable an argument is, based on the strength of arguments that support or attack other arguments.
Quality	Determines how well-justified the arguments are presented in dialogues.

Similarly, the association property consists of three more relations including the *P12_attack relation*, the *P13_support relation* and the *P14_replies* relation, denoting an attack or support relation between two arguments that disagree or agree with other arguments. The P14_replies property identifies a simple relation between two arguments denoting that the argument of the property replies on the object without denoting if it agrees or disagrees.

3.4 Evaluating opinions

This work builds on a multi-dimensional framework (s-mDiCE) for estimating users' reactions (comments and votes), based on different metrics. The frame-

[10] http://schema.org/Person/

work introduces interesting functions and properties that can guarantee an intuitive behavior for interlocutors who wish to react on social discussions by commenting or vote on other's answers. This quantitative algorithm is generic enough to capture the features of online communities on the Social Web and may benefit several platforms from debate portals to decision-making systems by providing a more reliable and effective approach for the score calculation of both, comments and votes. For a more comprehensive overview of the quantitative framework, we refer the reader to [2].

s-mDiCE properties

The framework consists of a set of internal and generic functions that allows the evaluation of users' reactions (comments and votes). Each argument is characterized by two different values for a given strength, the *quality* (QUA) and *acceptance score* (ACC) of an argument in each aspect, based on the reactions (responses, positive and negative votes) related to that aspect (e.g., *incorrect*, *irrelevant*, *insufficient*). Moreover, the framework introduces concepts such as the *base score* and the *blank argument* metaphor. The notion of the base score is used for capturing the initial rating over users opinions, where the score value may change either positively or negatively through users arguments and votes. Votes are considered as arguments *(blank arguments)* without carrying any content on its own, rather share the content of the arguments they support or attack. The reliability of these opinions that can support or attack a target argument can be estimated by adding those opinions into supporting or attacking blank arguments, respectively.

A set of generic functions is introduced for calculating the acceptance and the quality score of an argument by considering the *dialogue strength*, and the *congruence strength*. Positive and negative votes are aggregrated into a single strength score of votes while supporting and attacking arguments are aggregated into a strength score of arguments. In this approach, arguments have a greater impact than votes on a dialogue as they remain a strong belief for an opinion on a given aspect, asserted in order to add more information or explain better the opinion stated. The overall strength value of an argument is calculated by aggregating the strength score of votes and the strength score of (supporting and attacking) arguments on a given aspects.

4 Methodology: Analysing User-Generated Opinions

We propose an approach for analysing the user behavior in social communities, where a plethora of people express their opinions with the goal of defending their ideas or convicing other people by providing well-justified opinions. The ultimate goal of applying a clustering analysis is to offer different means of opinion analysis, allowing contributors to obtain a clear and complete picture of the validity, justification strength and the public acceptance of each opinion expressed in large-volume discussions. The rest of this section goes through all the features and implementation of the opinion analysis methodology.

User-generated opinions estimation. In order to facilitate opinion analysis, we need to evaluate the users' arguments, according to their agreements and disagreements on a particular position. Different relations are defined which represent the users' viewpoints, considering: *support relation* (s), *attack relation* (a) and *unknown relation* (?), as shown in Table 3. Specifically, a relation (s) represents a positive answer to the target position (P), a relation (a) denotes a negative answer to the target position (P) and a missing value (?) relation represents the unknown answers of users to the target argument (P). Fig. 2. shows how combinations of attack/support relations propagate across the dialogue.

Table 3. Combinations of support/attack relations.

Argument (**aj**)		Argument (**ai**)		Argument (**P**)
Support (s)	➡	Support (s)	➡	Support (s)
Support (s)	➡	Attack (a)	➡	Attack (a)
Attack (a)	➡	Attack (a)	➡	Missing Value (?)
Attack (a)	➡	Support (s)	➡	Missing Value (?)

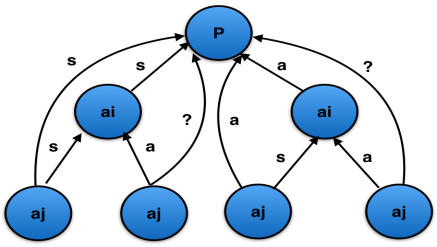

Fig. 2. Scenarios illustrating the argumentation graph of debates

4.1 Clustering Analysis

A key component of this work is the clustering analysis of users' opinions that aims to help users identify useful trends and patterns relationships among participants, towards the better sense-making of the dialogues and the opinion exchange process. Machine Learning algorithms are used for the clustering of features and the extraction of association rules. Based on users reactions and their profiles, both algorithms (K-means and Apriori) are used to identify users behavior in online discussions. Next, we present and describe all information needs introduced in this platform.

Sharing similar opinions with specific users. This opinion analysis aims at identifying trends of users whose opinions are closely related to particular authors. The input to this analysis is, a) the topic of discussion that need to be determined and b) a set of users, where u={u(i),u(2),.....u(n)}. The output determines and extracts groups of users whose opinions are similar to particular authors u(i). *For example, if we consider groups of users who participate and collaborate on a topic of discussion that concern the regeneration of the city center, then different trends of users are identified such as {Isabella,Karmen} who share similar opinions with the predefined group of users {Kate,Brian} on improving the city with new parks and intuitive arts, but they also disagree with the group of users {Mathew,Oliver,Andrew} who do not suggest any regeneration for the city.*

Algorithm 1: Sharing similar opinions with specific users

input : Topic of discussion, set of authors.
output: Several groups of users, sharing similar opinions with specific authors.
begin
1: Determine **K** clusters using EM algorithm
2: Define groups of users based on positions, using **K-means** algorithm.
end

Same profiles with similar opinions. This debate analysis aims at identifying and extracting user profiles that share similar views with other contributors involved in online discussions. The input to the analysis is a) a subject of discussion that needs to be determined and b) a set of positions, where p={p(1),p(2),.....p(n)}. The output identifies several groups of user profiles. Each such group shares similar or dissimilar opinions considering other groups on particular positions. *For example, if there is a group of users who participate and suggest solutions on how to make a city more livable, then the debate analysis identifies and extraxts trends of user profiles where (single and young men) share similar opinions among them, concerning the regeneration of the new parks and arts within a city, but they express dissimilar opinions with groups of users who are (young, single and well-educated) and disagree on these measures fo improving the city.*

Same users with dissimilar opinions. This type of analysis determines dissimilar opinions among participants who share similar profile characteristics. The input to this analysis is a) the topic of discussion that need to be determined and b) a set of positions, where p={p(1),p(2),.....p(n)}. The output extracts several groups of users that share dissimilar opinions and similar profile characteristics with other groups on particular positions p(i). *For example, if there exist groups of users who express their opinions in support of or against other's opinions*

on a topic of discussion of how to make the city more livable, then the opinion analysis identifies and extracts groups of users {Matthew,Oliver,Andrew} who are (young and single men) and share dissimilar views with the group of users {Brian,Kate,Isabella,Karmen} on regenerating the city with green parks and arts.

Similar opinions based on different profiles. This opinion analysis identifies relevant opinions expressed by users with different profiles characteristics. The input to this type of analysis is a) the topic of discussion that need to be identified and b) the profile characteristics that users choose in order to perform debate analysis. The output determines similar opinions that different users profiles share with each other on positions p(i). *For example, if we consider groups of users who suggest and post new ideas on a subject of how to improve and generate the city, then the clustering analysis identifies similar opinions expressed by young women such as {Kate,Isabella,Karmen} that concern solutions on improving the city center with new green parks and arts.*

Algorithm 2: Same profiles with similar opinions / Same users with dissimilar opinions / Similar opinions based on different profiles

input : Topic of discussion, [set of positions or different profile characteristics].
output: Several groups of users or users profiles, sharing similar or dissimilar opinions

```
begin
    Determine K clusters using EM algorithm
    Define several groups of users, using K-means algorithm.
    For each cluster
        Apply Apriori algorithm to identify similar profile characteristics or
        relevant opinions.
    end
end
```

Same users with similar preferences. In this analysis, we need to identify trends of users that share not only similar opinions with other groups but also similar profile characteristics. The input of this analysis is the subject that need to be specified by users in order to perform debate analysis. The output identifies several groups of users who share similar preferences (opinions and profile characteristics). *For example, if there exist groups of users who express their agreements and disagreements on how to make a city more livable, then the opinion analysis determines groups of users {Brian,Kate,Isabella,Karmen} who are (young,single and well-educated) and share similar opinions on improving the city but they have dissimilar opinions with the group of users {Matthew,Oliver, Andrew} who do not support the regeneration of the city center.*

Algorithm 3: Same users with similar preferences

input : Topic of discussion.
output: Several groups of users, sharing similar opinions and profiles.
begin
1: Determine **K** clusters using EM algorithm.
2: Define groups of users based on positions, using **K-means** algorithm.
3: **For each** cluster
4: Perform **Apriori** algorithm to identify similar opinions.
5: Perform **Apriori** algorithm to identify similar profile characteristic.
6: **end**
end

Different user profiles with similar/dissimilar opinions. This information need identifies several groups of users who can either have similar or dissimilar opinions to share with other groups. The input to this analysis is a) the topic of discussion that need to be determined and b) the type of relation which can be either similar or dissimilar opinions. The output determines different trends of groups with different profile characteristics, sharing either similar or dissimilar views with other groups found in opinion analysis. *For example, if there exist groups of users who contribute with each other on how to improve the city, then the output determines trends of users {Matthew,Oliver,Andrew} who share disimilar viewpoints with the group of users {Kate,Isabella,Karmen} on suggesting solutions for the regeneration of the city. Both groups share different profile charcteristics with each other.*

Algorithm 4: Different users profiles with similar/dissimilar opinions

input : Topic of discussion, a relation (similar or dissimilar opinions).
output: Several groups of users, sharing different profile characteristicsand either similar or dissimilar opinions.
begin
1: Determine **K** clusters using EM algorithm.
2: Define groups of users based on their profiles, using **K-means** algorithm.
3: **For each** cluster
4: Perform **K-means** algorithm to identify similar or dissimilar opinions.
5: **end**
end

5 Apopsis implementation and architecture details

5.1 Debating functionality

The system enables users to interact and collaborate with other people by providing functionalities such as: *creating new topics of discussion*, *posting new*

positions and *posting new arguments*. Users may navigate amongst existing dialogues or create new topics of interest in order to initiate a conversation. Within a dialogue, online users exchange opinions by posting comments in the form of supporting or attacking opinions on a particular topic of discussion. When a disagreement takes place, users need to explicitly state the reason that disagree with others by justifying their arguments based on a particular aspect. In case of an agreement, the user does not need to justify their stance over a comment as it is considered that the user totally agrees with the content of the argument. Our platform is offering threaded representation style when it comes to represent online discussions. In Fig. 3., we provide a screenshot of a dialogue about how to make a city more livable where users participate and suggest their viewpoints for improving the society.

Fig. 3. Debating functionality.

5.2 Debating on different levels of discussions

The platform offers different levels of discussions where contributors can participate and collaborate in different ways. At first, each dialogue is open for discussion where users can post comments (positions or arguments) and vote on existing arguments. The strongest positions and answers proceed in the next stage by a moderator, where users continues to post their positive or negative opinions and vote upon them but they are not allowed to post new positions on particular topic of discussion. The second level of dialogue is a necessary procedure in order for users to apply opinion analysis that are interested in.

5.3 Voting mechanism

Our platform provides a voting mechanism by allowing users to express their positive or negative votes over arguments. Votes indicate users beliefs over par-

ticular answers and are reduced on the argument level of each discussion. When a negative vote takes place, users need to state the reason why they vote negatively, considering one or more aspects. In case of a positive vote, we consider that the user who votes positively does totally agree with the argument and its content. The rating mechanism is presented in the form of *like or dislike* an opinion. Fig. 4. presents a screenshot about voting on a particular level of argument.

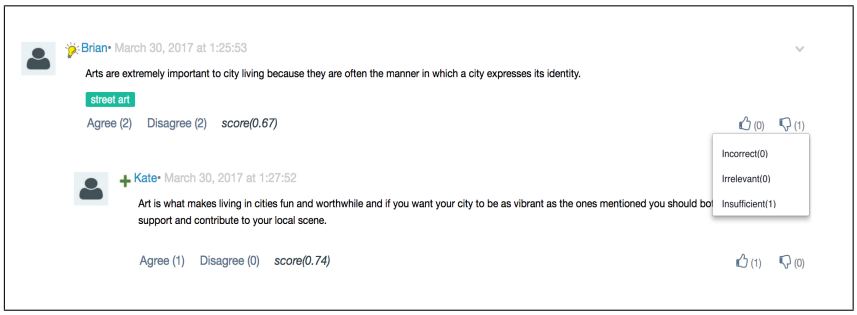

Fig. 4. Voting mechanism.

5.4 Searching mechanism

The system provides a searching functionality on topics, authors, positions and arguments (supporting or attacking arguments) for a particular subject of discussion. We designed and implemented several searching types of querying that enable users to extract information about different aspects of a dialogue. Each searching type has a different input and output, depending on the type of query that users of the system are interested at. *For example, the user u(i) can choose to query the arguments that can either support or attack other opinions, expressed by a specific author, such as Matthew*, as shown in Fig. 5.

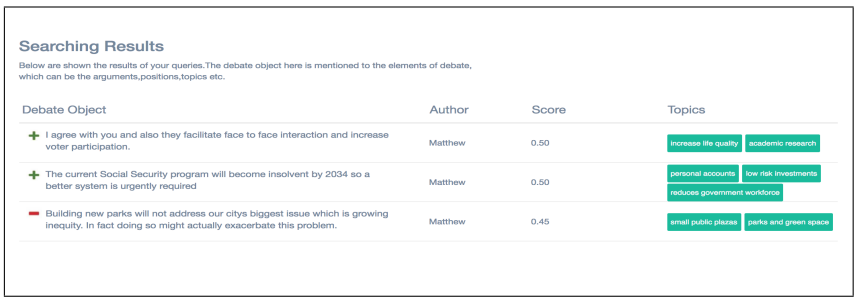

Fig. 5. Searching functionality.

5.5 General features

The platform offers several other features that enrich the system's usability. As a web system, it provides a logging and registration mechanism that allows online users to actively participate in online discussions. A logging mechanism was developed in order to store additional information about user profiles and their actions in each debate. Users' profile characteristics are of prime importance when a debate analysis takes place as they provide a rich description for different trends of users found in opinion analysis. Another feature is the group of users, named *moderators*, who ensure the quality of debates by proceeding the strongest arguments to the next level of discussion for later use in debate analysis. Within each debate, additional statistics information are provided about users' action over a topic of discussion.

5.6 Technical Information and Architecture

We designed and implemented a web-based platform as a web application project, using the platform Netbeans and the Tomcat server for its deployment. The front-end side is designed based on web technologies such as jQuery, HTML5, CSS3, JSP, JSON and AJAX requests while for the server-side we used the JAVA language to implement all features and functionalities of the web-system. We implemented the Apopsis system on a MacBook Pro (OS X Yosemite). The platform consists of three main tiers: the *Server Tier*, the *Client Tier* and the *Data Tier*, illustrated in Fig. 6.

Server Tier: Considering the back-end implementation of the system, we designed a web platform as part of a Java application, developed to provide a complete API of all provided features and capabilities. It was designed as a servlet Web-based service, using Java API and Semantic Web Standards such as RDF statements. An important aspect of the server side is that our platform uses WEKA's implementation methods and functionalities, used as libraries into the system.

Client Tier: The client-side environment constitutes the interface of our system which is desinged using a bootstrap[11] template. It is implemented based on modern design patterns, following the basic user interface design principles. The client-side of the web application consumes the servers services as JSON data and provides representations using all the latest Web features that all modern browsers support. The Ajax Requests work as intermediary between client and server, orchestrating data exchanges.

Data Tier: The data-tier represents the Virtuoso repository, a cross-platform universal server that acts as a virtual database engine for combining the functionality of a traditional databases in a single system. The system was developed over jdbc Virtuoso provider, allowing users of Virtuoso to leverage the jdbc framework to modify, query, and reason with the Virtuoso triple store using Java language.

[11] http://colorlib.com/polygon/gentelella

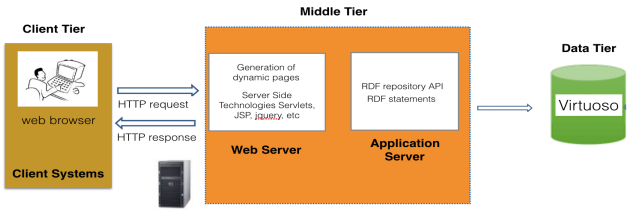

Fig. 6. Basic Architecture of APOPSIS.

6 Conclusion and future work

A plethora of opinions are presented on the Web where users exchange their viewpoints and argue over different problems and issues, thereby raising the need for modeling well-structured arguments and analysing online user opinions. Well-defined formalisations are needed for evaluating and analysing the user-generated arguments. This work addresses the problem by introducing a web-based debating platform, called Apopsis, that facilitates and analyzes well-structured dialogues in support of social communities.

Apopsis is a web-based application for modeling and analyzing user opinions found in social discussions. Recent efforts have used quantitative methods to assess the credibility and acceptability of arguments, based on computational argumentation models [5]. Our platform uses a formal framework, named s-mDiCE [2], which offers intuitive methods for (numerical) evaluation of the argument's quality and acceptance, according to users' reactions (comments and votes). In Apopsis, argumentation models are used for organising the different argumentative elements of the dialogue, which are presented in the form of RDF statements through the MACE - ontology. An important aspect of this work is the opinion analysis where our methodology applies clustering and association techniques in order to extract useful trends and relations among users and different clusters of opinions. This way, decision-makers can obtain a clear picture of the *validity*, the *strength* value and the *acceptance* of the opinions expressed throughout the discussion exchange process. Moreover, the platform offers and implements many other functionalities that enrich the system usability.

Regarding future work, there are several aspects that are worth investigating. An important future direction would be to evaluate our system with real users and large datasets of discussions. Specifically, the process will include expert walk through evaluation of the prototype, adjustments based on expert evaluation results, user-based evaluation with UI experts and with real-users in a laboratory setting, and further adjustments of the prototype based on the results of the evaluation. Another important aspect would be the representation of the dialogue and the different clusters of opinions through different visualizations. Finally, we plan to work on making the system interface more usable and intuitive in order to improve the engagement of users in conversation regarding any topic of discussion.

References

1. W.Kunz, and Horst W. J. Rittel. Issues as elements of information systems. Vol. 131. Berkeley, California: Institute of Urban and Regional Development, University of California, 1970.
2. T.Patkos, G.Flouris, and A.Bikakis. "Symmetric Multi-Aspect Evaluation of Comments." ECAI 2016-22nd European Conference on Artificial Intelligence, The Netherlands. Vol. 285. IOS Press, 2016.
3. Machine Learning Group at the University of Waikato, `http://www.cs.waikato.ac.nz/ml/weka/`.
4. J.Schneider, T.Groza, and A.Passant. "A review of argumentation for the social semantic web." Semantic Web 4.2 (2013): 159-218.
5. Baroni, P., Romano, M., Toni, F., Aurisicchio, M., Bertanza, G.: Automatic evaluation of design alternatives with quantitative argumentation. Argument Comput.6(1), 24–49 (2015).
6. J.Leite, and J.Martins. "Social abstract argumentation." Twenty-Second International Joint Conference on Artificial Intelligence. 2011.
7. Evripidou, V., Toni, F. Quaestio-it.com – a social intelligent debating platform. Journal of Decision Systems
8. G.Anadiotis, P.Alexopoulos, K.Mpaslis, A.Zosakis, K.Kafentzis, and K.Kotis. Facilitating dialogue-using semantic web technology for eparticipation. In Extended Semantic Web Conference, pages 258–272. Springer, 2010.
9. Passant, Alexandre, et al. "The SIOC project: semantically-interlinked online communities, from humans to machines." Coordination, Organizations, Institutions and Norms in Agent Systems V. Springer, Berlin, Heidelberg, 2010. 179–194.
10. S.Softic and M.Hausenblas. Towards opinion mining through tracing discussions on the web. In The 7th International Semantic Web Conference. Citeseer, page 79. Citeseer, 2008.
11. Miles, Alistair, and S.Bechhofer. "SKOS simple knowledge organization system reference." (2009).
12. Wilson, Edwin B. "Probable inference, the law of succession, and statistical inference." Journal of the American Statistical Association 22.158 (1927): 209-212.