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Determining the interests of Social Network Users

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Abstract: The article is devoted to a brief review of approaches to the analysis of social relations in social networks using comments and credentials located in the profiles of social network users. The study aims to determine the interest and behavior of each user. The approach that we propose to determine the interests of social network users requires some methods of machine learning (classification analysis and data clustering). A method based on sentiment analysis and a naive Bayesian classifier is proposed. Determining the interests of social network users based on the intellectual analysis of comments can help to understand the logic of their behavior, and determine social relations between users and problems in society.

Index Terms: Social Networks, Big Social Data, Data Mining, Machine Learning, Naive Bayes Classifier, Ranking of Actors.

1. Introduction

Unstructured big data in various formats, rapid exchange of information, and a large number of users have made social networks a very popular and powerful tool for obtaining information. This characteristic of social networks has prompted various companies and political institutions to use them as a database for various types of research.

The purpose of the study is to identify the area of interest of social network users and the problems that concern them. Social networks are a mirror of society. By identifying the interests of social media users, we can more clearly see the social and economic problems of citizens in their daily lives. The activity of users in social networks (exchange of information, transfer of photo and video files, blogging, advertising, e-commerce, propaganda, information war, etc.) depends on their interests. Users of social networks gather around topics of interest to them, write comments, exchange information, and try to gain new knowledge. The interests of users can be diverse: medicine, business, sports, household, politics, art, etc.

Social networks are the most appropriate tool for studying the interests and behavior of people, analyzing social and historical processes, culture and values. On the basis of data about each of the persons who on their own initiative are presented in the public domain on the Internet and the comments collected in the database of these projects, it is possible to identify the interests of users and social relations between users. Further in the text, for brevity, such data will be referred to as personal data, in contrast to another, more strict definition of personal data, which uniquely and accurately identifies each Internet user. The model of social networks can be very complex: it includes a variety of levels of connections – from family to business and national. In the modern world, social networks are important for the socialization of people. On the other hand, social networks are the most powerful and convenient political, ideological and economic tools.

A social network is a social structure made up of various nodes brought together by area of interest. Nodes in social networks are formed by groupings. In modern times, social networks play an important role in the dissemination and impact of information, in the formation of public opinion, in the management of people's behavior, as well as in the study of problems associated with social networks, the issue of information security of the individual, the state and society. Behavior management refers to the influence of a subject on another subject, as well as the implementation of a set of measures in the adoption and implementation of managerial decisions.

All major open social networks such as Twitter, Facebook, etc. provide their data to the network community through their API – Application Programming Interfaces. Such interfaces conform to standards (usually HTTP

and REST) that are easily accessible and understandable. API plays a key role in the collection, delivery to users and analysis of personal data [1]. Using the API, you can identify your friends' friends, see the photos and comments they enter, and even their phone numbers. To determine the interests of users, you can use parameters such as the number of comments, the duration and volume of comments, the number of friends and groups, and the amount of demographic data indicated in each profile. These data are used as characterizing parameters [2].

The use of approaches based on the methods of Machine Learning (ML), allows you to adjust research to language features, and use additional features when processing text data. Currently, a large number of algorithms have been developed for machine learning for solving text-mining problems. ML studies algorithms that improve performance by gaining experience. The efficiency and accuracy of a machine-learning solution depend on the learning algorithms and characteristics of the data [3].ML is a part of artificial intelligence and a learning algorithm is used to discover and learn knowledge or properties from data. The quality or quantity of a dataset affects the effectiveness of data analysis. The main tasks of ML – classification analysis, data clustering, association rule learning, regression analysis, feature engineering for dimensionality reduction, as well as deep learning methods have been successfully applied to the analysis of social networks [3,4]. ML methods have proven to be very practical in many areas of application. The most popular of which include: the k-nearest neighbor (k-NN) algorithm; the algorithm for constructing decision trees (DT); the algorithm based on support vector machines (SVM); the Bayesian classifier or Naive Bayes (NB), and artificial neural networks (ANN) [4,5]. They are especially useful in poorly understood areas where there is little knowledge to develop efficient algorithms in areas where there is big data.

The use of ML to analyze the interests of social network users and predict their conduct provides a number of advantages. ML can improve accuracy by providing more accurate predictions than traditional methods. ML can also reduce the time and effort required for manual analysis and forecasting. In addition, machine learning can help identify potential opportunities for data improvement.

2. Related Works

The development of network technologies and social networks has led to the expansion of research in the field of Web Mining [6, 7] and Link Mining [8]. Among the methods used to analyze online social networks, these methods are considered the most effective [7,8]. Using the methods of Text Mining [9], you can process and analyze large amounts of social data and thus find valuable information.

The work [10] analyzes the behavior of users of social networks in order to identify criminals and terrorist groups. User behavior is determined based on the comments they write. The authors propose a method for abstracting documents by clustering sentences.

In [11], they try to study human behavior based on the analysis of texts written by him. The purpose of the study is to determine the psychological attitude, as well as to understand and predict behavior through text mining. Here the main task is to determine the mood in the comments written by users on social networks. The study used the ISI Web of Science, Engineering Village Compendex, ProQuest Dissertations, and Google Scholar databases as data sources. Analysis of unstructured texts on various topics is carried out by searching these databases by keywords.

In [12], it is stated that it is possible to instantly respond to unexpected changes in the virtual environment by determining in time the change in the mood of social network users. For this, it is more expedient to use the methods of natural language processing, social listening and cluster analysis.

To automatically determine the interests of users of social networks in [13], the authors propose two approaches: the first approach is an unsupervised multilingual approach called FRISK. Using the meaning of the words in the comments, he determines the interests of users. The second approach – ASCERTAIN is a schema that addresses the hidden aspects of words. The proposed approaches are able to reveal the sphere of interests and the psychological state of a person. For the experiment, data was obtained from Twitter.

In the article [14], to determine social network users' interests, their digital traces are presented for dynamic and static analysis. Topic models are built from user data stored in profiles. Multimodal graphs are built based on the conclusions obtained in solving the problem. The vertices of these graphs are the interests of users. With the trajectories of interests, authors can visually track changes in user interests and evaluate changes in the behavior of thers.

Comments collected from social media web pages are analyzed for decision making. This process is called social media analytics [15]. A lot of digital information appears on social networks every hour. And this means that there are BSD available to machines for analysis and "learning".

There are different approaches and methods for analyzing comments. Mostly clustering, classification and prediction algorithms are used. For analysis, intellectual analysis methods are often used, such as “text-mining”, content analysis, LIWC (Linguistic İnquiryand Word Count), ICA (Independent Component Analysis), topic modeling, etc.

Mining methods are used to discover hidden information and meaningful structures from large databases. For example, using the ICA method, one can identify hidden factors (relationships) from a set of random values [16].

Using "text-mining" you can process and analyze large amounts of social data and thus find valuable information from the data in the virtual world. To predict relationships, an approach based on the “semi-Markov” model [16] was proposed. The People Rank algorithm was proposed to rank the participants. This algorithm is very similar to the Page

Rank scheme and can predict the behavior of an actor that is in social relations with other network participants, giving it a lot of weight [17].

In none of these approaches, user interests were determined using a user group ranking method in addition to classifying written comments and information. In our approach, in addition to determining the interests of users, we also determine the most active users in the interest group.

The main reason for the complexity of the study is that social media data is big data. For this reason, it is important to study the nature and characteristics of big social data before starting research. This approach will allow us to choose a more suitable solution in the course of the study.

3. Big Social Data

A social network consists of specific users and their relationships on the Internet. The study of a social network is based on some provisions of the theory, where each such user is part of its structure [18]. Social network analysis is a set of analytical methods that combine sociology, social physics, graph theory, genetic algorithms, which are based on the study of the interaction between social actors.

There are two main approaches to the analysis of social networks:

- content analysis: sentiment analysis, text analysis, etc.;
- Structural analysis of social networks.

Social network analysis is not only a set of techniques for analyzing relationships or structures, but also a widely used theoretical method of structural analysis. The credentials and comments in each user's profile play an important role in the analysis of social relationships. According to researchers, big social data (BSD) is a combination of big data and social networks [19,20]. According to them, these data are needed to study society and predict social processes. They explain the concept as follows: "The BSD concept is a combination of big data and social networks. Here, big data is used as a processing paradigm, social networks are used as the main source of information, and data analysis is used to gain knowledge" [21].

One of the main commonalities of the BSD concept is the adoption of social media as the main source of information and its reliance on social media analytics. Here it is necessary to distinguish BSD from simple big data. It should be noted that it is difficult to determine how other sciences influence the scope and direction of BSD research. It is also difficult to determine what type of data is relevant and valuable for social media relationship analysis. For this reason, when starting a study, it is important to first determine the type of data being studied. The concept of BSD is considered to be a combination of the following four disciplines:

1. Social computing (including social networks and social relations) is an area of research and application that integrates social and computational sciences. Social computing powers technological social services and applications, which in turn generate vast amounts of complex social data. Such data is managed and processed using big data tools, then insights and recommendations are extracted based on data analysis methods and algorithms.

2. *Big Data Processing* – provides tasks for processing and managing big data resulting from social interactions.

3. *Social data analytics* allows you to extract information from existing datasets. Typically, it includes discovering unknown correlations in data, predicting events and trends, and suggesting methods to gain meaningful insights into different areas.

4. *Computational social science* as an interdisciplinary field seeks theoretically based models of social phenomena at the intersection of social and computational sciences, uses social data to gain knowledge in the field of sociology. Modeling society using computational approaches is aimed at understanding what causes influence social processes and how they occur.

4. Methodology of User Interests Analysis

To analyze social processes and identify the interests of users, based on the analysis of comments, as well as to solve problems with big data, first of all, it is necessary to determine the analyzed data and their sources. Data sources can be divided into three categories: data from the user's personal page, his comments under his publications (photo/video) and comments under the publications of other users. In publications, users share their opinion about an event or incident.

To solve problems with big data, data processing can be divided into five main stages (Fig. 1):

1. Data collection;
2. Data cleaning and aggregation;
3. The process of loading data into the data warehouse;
4. Data mining;
5. Data representation.

The variety of methods used and areas of research proves that the analysis of social relations depends on the type of data used, the availability and results of the research.

The social network mining task can be divided into the following categories:

1. Classification comment.
2. Clustering of actors.
3. Ranking of actors.

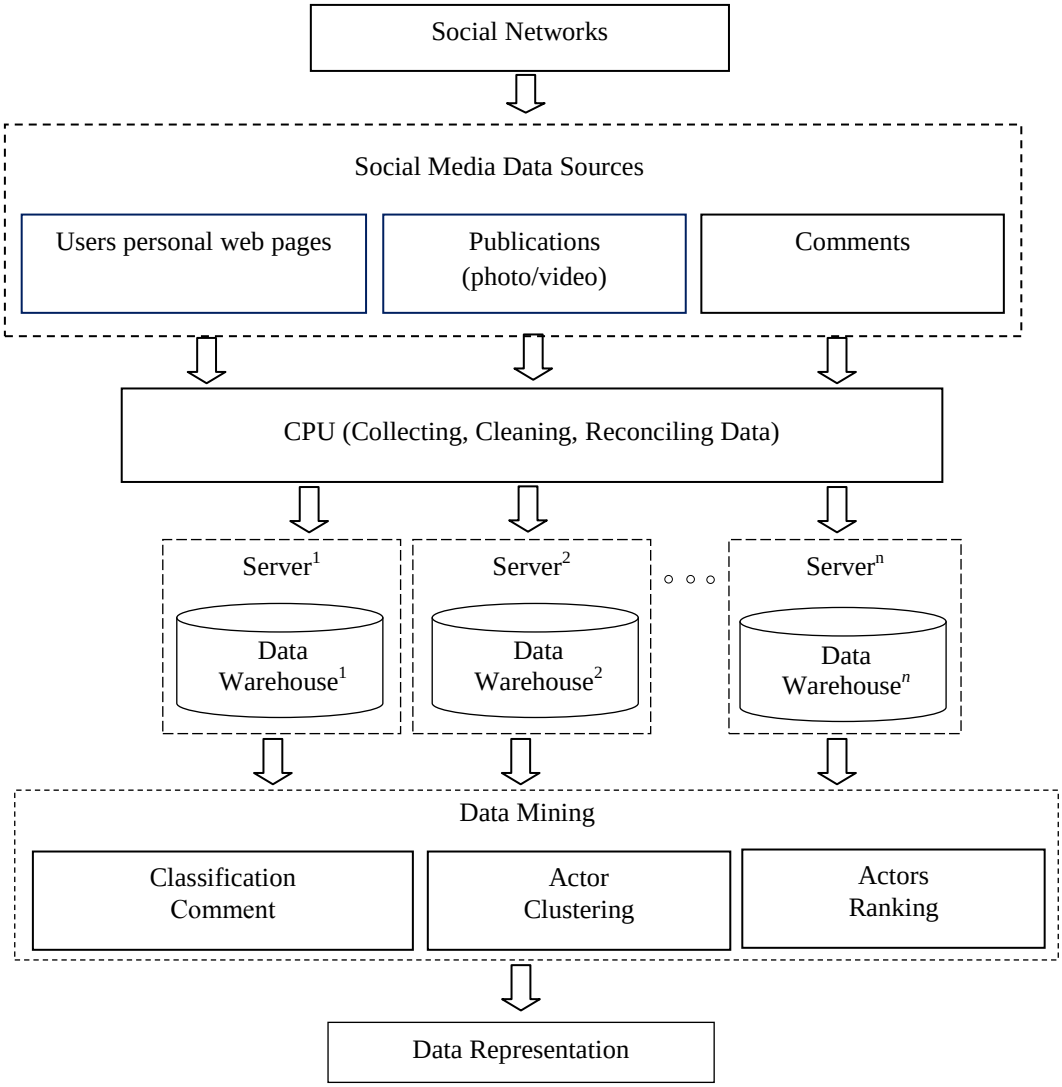

Fig. 1. Architectural diagram of a social network analysis system using comments and publications

4.1. Classification Comment

Classification can be considered as the initial stage of the analysis of social networks. The lexicon-based method is widely used in sentiment analysis of documents (commentary) and many researchers have adopted approaches such as word embedding to bootstrap lexicons for one particular area or language [21]. The initial set of words is created using tools such as WordNet, HowNet, etc. It is known that, depending on the characteristics of natural language, it is difficult to achieve high results in the analysis of text sentiment. Each document has a set of synsets:

$$w_i \in synset(w_i),\ i = 1,2,...,n \tag{1}$$

Comments can be divided into 3 groups: comments that form a negative opinion about the object (negative comments, C^-), comments that form a positive opinion (positive comments, C^+) and neutral opinions (C^0). A comment can be presented as follows:

$$C_i = C_i^+ \cup C_i^0 \cup C_i^-, i = 1,2,...,n \tag{2}$$

In [22], a positive or negative document (comment) is determined by mathematical calculations of words using the Semantic Orientation CALculator. The vocabulary of subjectivity is used here, i.e. the difference between weak and strong words expressing a thought is calculated. Weak words are rated on a scale of 2 (positive) or -2 (negative). Strong words are rated on a scale of 4 (positive) or -4 (negative).

The approach uses the lexical database "Senti-WordNet". The Senti-WordNet dictionary was created using WordNet and contains the "synset" structure. Using this experience, the sentiment of each word is determined based on the evaluation of the words.

After determining the sentiment of the words in the document, we find the overall sentiment of the document using the following formula:

$$Score(T) = Sign(\sum_{w_i \in D} Score(w_i)) \tag{3}$$

where, $Score(w_i)$ – the degree of tonality of the words in the document *C*.

To achieve efficiency in the analysis of large amounts of data, it is planned to simplify the object of study as much as possible. Using a naive bayesian classifier, one can classify a comment by sentiment and user interests. The Naive Bayes classifier allows you to create your own custom classifier.

Naive Bayes is a simple and fast classification method that is very suitable for analyzing large amounts of data [23]. The main idea of the study is to use the terms in the document to estimate the probability of which class the documents belong to.

The probability that comment C is negative based on words w_i can be determined using a Naive Bayes classifier as follows:

$$P(w_i \mid C^-) = \frac{P(C^- \mid w_i) + P(w_i)}{\sum_{i=1}^{n} P(C^- \mid w_i) P(w_i)} \tag{4}$$

where, $P(C^- \mid w_i)$ – the probability that a document containing the words w_i, is negative.

4.2. Clustering of actors

Let's consider each user who writes a comment as an actor.The grouping of individuals in social networks according to certain characteristics is called cluster analysis of social relations. In these groups, which are called clusters, the relationships between users (actors) are closer than between the rest of the network. For example, within an organization, employees may be grouped according to interests or work discipline. It is possible to identify these groups by analyzing the comments and assessing the intensity of the relationship. For this, the theory of probability and statistical methods are mainly used [24].

Using clustering algorithms, we divide comments into clusters by topic to determine the range of users' interests. The introduction of ML methods for analyzing big data in social networks is, of course, a technological improvement that makes it possible to optimally use this data to solve various social and economic problems.

4.3. Ranking of actors

Ranking can help identify leaders among actors and groups that unite on the basis of any interests. Ranking means sorting a set of items by relevance. In our case, the user is the element, the web page is the object, and relevance is the number of comments the user writes on that web page. Suppose that the set of comments in clusterP_k is of theform $C^k = \{C_1^k, C_2^k, ...C_{m_k}^k\}$, m_k – is the number of articles in cluster $P_{k,.}$

If we denote the set of user swriting comment C_j^k incluster P_k as $U(C_j^k)$, it willbe:

$$U(C_j^{\,k}) = \{U_{j1}^k, U_{j2}^k, ...U_{jn_k}^k\},\ j=1,...,m_k;\ k=1,...,c.$$

Then, $U(P_k) = \{U_1, U_2, ...U_{n_k}\}$

$U(P_k)$– isthe set of userswhowritecommentsinthecluster P_k.

n_k – is the number of users in cluster P_k.

Then,

$$U(P) = U_{j=1}^{mk} U(C_j^k)$$
$$Q_{jl}^k = U(C_j^k) \cap U(C_l^k) \tag{5}$$

Q_{jl}^{k} – the group of users who wrote the comment.

$C_j^k \in P_k$ and $C_l^k \in P_k$; $l \neq j = 1,....m_k$; *k=1,...c;*

$$R_{kp} = U(P_k) \cap U(P_p) \tag{6}$$

R_{kp} – thegroup of users who write commentsincluster P_k *and* P_p; $k \neq p = 1,...,c;$

$$T_{jl}^{k,p} = U(C_j^k) \cap U(C_l^p) \tag{7}$$

$T_{jl}^{k,p}$ – group of share dusers who write comments $C_j^k \in P_k$ and $C_l^p \in P_p$;

$p \neq k = 1,....c$; *j=1,...,*m_k*;; l=1,....,*m_p*;*

İf, $Q_{jl}^{k} \neq 0$, then, alink (internal) isestablished between the elements (users) of the set Q_{jl}^{k}.

İf, $T_{jl}^{k,p} \neq 0$, then, an (external) link is established between the elements (users) of the set $T_{jl}^{k,p}$

The following formula is used to find the rank of users in the social network:

$$\omega_i^k = \sum_{\substack{s=1 \\ s \neq i}}^{n_k} \omega_{is}^k , \tag{8}$$

$$\omega_{is}^k = \sum_{j=1}^{m_k-1} \sum_{l=j+1}^{m_k} I\left(U_i \in Q_{jl}^k \,\&\, U_s \in Q_{jl}^k\right) \tag{9}$$

if *x* is true

$$I(x) = \begin{cases} 1, \\ 0, \end{cases}$$

Users in the network are rankedbased on thevalue of ω_i^k. A general social network can be obtained by synthesizing topic networks. This approach can be applied in the analysis of many social networks in the Internet environment.

For effective comment analysis, machine learning (ML) can help by using supervised and unsupervised algorithms to accurately interpret user behavior patterns [25]. The ML system, known as user simulation, is a direct result of human-computer interaction. Classification, cluster analysis, regression, association rules, time series analysis, distributed optimization, topic modeling are some of the popular ML methods [26].

Classification of comments, clustering and ranking of actors allows you to conduct research systematically and consistently. The fact that data is big data and most of it is unstructured makes it relevant to use artificial intelligence and big data technologies to determine user interest based on comment analysis. ML can speed up this process with decision-making algorithms. It can classify incoming data, recognize patterns, and transform the data into insights useful for social media analysis.

5. Conclusion

Studies have shown that machine learning technologies make it possible to use the data accumulated in social networks as efficiently as possible and obtain more accurate results in determining the interests and behavior of users. Research such as determining user interest based on the analysis of comments on social networks using ML algorithms is important mainly for obtaining knowledge about society, in the fight against terrorism, in healthcare, and in many other areas. The main condition here is to ensure the confidentiality of information. Thanks to the analysis of comments from social networks, you can extract hidden social connections between users, their areas of interest. Determining the user's interest based on the analysis of comments allows you to more accurately determine the socio-economic situation of citizens, trends in the development of society and predict social and economic development in society.

To determine the user's interest, first of all, data is used that reflects the behavior of each person in the virtual space. Given the complexity and versatility of the socio-demographic context, and its impact on social relations, we propose a system for distributed data analysis. Methods based on mining algorithms are an integral part of big data processing, allowing to discover new knowledge and increase the efficiency of research.

The accuracy obtained when classifying text data using a Naive Bayes classifier is in the range of 85.5%–87.5%. This result applies to many ML algorithms. The disadvantage of this approach is that the algorithms used depend on the quantity and quality of training. Also, this approach does not take into account the sequence of words in the text. But, despite the shortcomings, the naive Bayes classifier provides an effective solution to the task of classifying documents and allows you to simplify the object of study as much as possible, especially when analyzing unstructured, big data.

The proposed approach can be widely used in the collection and analysis of data for decision-making systems. The approach can be used not only to identify the interests of social network users and the relationship between them but also to analyze the relationship between organizations and events.

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