Technique for classifying the social network profiles according to the psychological scales based on machine learning methods

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Abstract. A technique for classifying the social network users and groups by psychological scales of the Ammon’s test has been developed. To analyze user profiles, we have used several types of artificial neural networks (support vector machine, linear regression, multilayer neural network and convolutional neural network), and for group analysis, we applied text classifiers (bag of words, weighted bag of words, continuous bag of words, skip-gram and fastText classifier). The scope of the technique is identifying deviations in the psychological state of users of social networks and monitoring these changes considering users’ groups to detect destructive influences. An experiment was carried out, as a result of which it was found that a multilayer neural network with an activation function of the ReLU type has the best accuracy.

1. Introduction

Social networks are Internet resources for communication, friends finding and digital exchange. Their popularity among the younger generation is high, and the spread of malicious information on social networks can have a destructive effect on the behavior of this group of users. In particular, the propagation of violent actions and bad habits can negatively affect the psychological state and worldview of Internet users. A variety of approaches have been proposed in the current literature to detect this influence.

The need to develop methods aimed at identifying and preventing destructive influences is an important task that requires the involvement of highly qualified specialists. To automate this process and reduce the costs associated with psychological examination, this paper proposes a method for classifying users of a social network according to the psychological scales of the Ammon’s test based on machine learning methods. Changes of scale in time can indicate the presence of destructive influences. Further analysis of users’ groups and their classes can help to detect the source of such influences.

In previous work we described the common idea of our approach to detection of destructive influences [1] and proposed the first version of technique for classifying the users of a social network according to the psychological scales of the Ammon’s test using machine learning methods [2]. This paper is an extended version of the paper presented at [3]. The contribution of this paper is enhancement of the classification technique; extension of the set of features for model training; and groups classification technique.
The paper is organized as follows. Section 2 analyzes related research in the area. Section 3 introduces the proposed technique. Section 4 describes the experiments. The paper ends with a conclusion.

2. Related works
To date social networks attract multiple researchers. Consider the papers devoted to the application of machine learning methods to the analysis of the psychological state of users of social networks.

In [3] convolutional neural networks are considered which are designed to detect deviations in the psychological state of Internet users. For this purpose, training of neural networks was performed using data that were collected from social microblogging services. Two types of features were identified that described the data stream analyzed by neural networks: (1) data within a message of limited length (tweet), which contained text or image, (2) statistical data, which included the number of messages from the user, the number of comments to the message (these data were collected within a specified period of time). In the experiments carried out by the authors, the best accuracy (over 78.5%) was shown by a four-layer neural network with the mean-over-time subsampling method.

In [4] a solution to the problem of determining the psychological portrait and individual characteristics of a person's character is proposed. For this purpose, photos collected from the corresponding profiles on the social network Facebook were used as input data, and Spearman's correlation coefficient analysis and logistic regression were used as an analysis method and classifier. As a result of the research carried out by the authors, it was noted that photos posted in the profiles of outgoing people contain light areas, while closed areas are observed in photos of uncommunicative people.

In [5] a naive Bayesian classifier is used, trained to identify the level of emotional impact that is produced on a person as a result of viewing pre-selected images. When forming the feature vector, various parameters were used concerning the color palettes of the image.

In [7] a machine learning approach is proposed for recognizing dispositions within the Big Five personality traits model. Information from the profiles of users of the social network Vkontakte was used as input data. In our research we consider the same social network, however to assess the user's psychological characteristics, we also take into account the environment of this user, represented in the form of groups in which he/she is a member.

Consider the papers devoted to the analysis of posts and messages published by users of social networks.

In [7] authors use a deep neural network built to predict the sender's mood. The feature vector supplied to the input of the neural network is formed hierarchically: some of the features are extracted from separate symbolic sequences, the other part, from sentences.

In [8] a research was carried out aimed at finding depression among users of the social network Facebook. Comments on the Facebook user’s page were used as input. It was shown that the most accurate classifier is based on a decision tree. In [9] a similar problem is solved in relation to a text in Chinese, and linguistic rules were used as an analysis tool.

The analysis of the considered works confirms the relevance of the problem of building systems aimed at detecting users' exposure to destructive effects. In contrast to these works, the research presented in this paper is aimed at developing an integrated technique covering the analysis of heterogeneous data (scalars, text, images) and combining artificial neural networks and classifiers focused on the analysis of text data.

3. Technique for classifying the social network profiles
The proposed technique uses the Ammon test [10]. This test contains 220 questions. The test is aimed at identifying constructive, destructive and deficient manifestations of six personality Ego-functions, namely aggression, anxiety, external Ego-delimitation, internal Ego-delimitation, narcissism and sexuality. The scales in this test are not interpreted individually, but in combination.
Within the developed technique, three steps are distinguished (Figure 1):
1. The first step is to collect data describing the profiles of users of the social network;
2. At the second step, a feature vector is formed to be processed using machine learning methods;
3. At the third step, classifiers are trained, or users/groups are classified according to the Ammon test scales.

![Figure 1. The scheme of the technique](image)

The first step of the technique. The collected data about the users of the social network were marked according to 18 psychological scales of the Ammon test (6 Ego-functions with a constructive component, 6 Ego-functions with a destructive component, 6 Ego-functions with a deficient component). Each scale has a T-score (T): if $0 \leq T \leq 39$, then the T-score is low; if $40 \leq T \leq 60$, then the T-score is medium; if $61 \leq T \leq 110$, then the T-score is high. The analyzed data set contains 460 unique records about the user profiles of the social network. Profiles are a set of records (attributes and their values) presented on a user’s page and available for other users to view. Examples include information about education, avatar photo, messages on the user's page.

The second step of the technique. After collecting data concerning the user profiles of the social network, the parameters that form the feature vectors were calculated. These vectors are used to train the machine learning classifiers and calculate the scale value of the Ammon’s test. The initial data describing the feature vector were grouped into three types: (I) numerical parameters (for example, the number of photos and friends in the user's profile), (II) a set of words (for example, the most frequently used words within each psychological scale), (III) parameters obtained as a result of image processing. Table 1 provides a detailed description of the features used.

The third step of the technique. Among three components of the psychological scales of the Ammon’s test, we have selected the destructive component; the support vector machine (SVM), linear regression (LR), multilayer neural network (MNN) with the ReLU activation function and convolutional neural network (CNN) were used as classifiers. The first two classifiers were trained
only on numerical parameters (parameters of the first type), for the MNN the feature vector included parameters of the first, second and third types, as well as posts, the CNN was trained only using posts posted by the user of the social network.

Five text-based classifiers were used to analyze the groups. In addition, due to their low performance, these classifiers were combined into ensembles. Using groups including the users of interest allows you to assess their environment including possible destructive influences and refine the results obtained from the analysis of individual profiles.

| #  | Feature description                                                                 |
|----|------------------------------------------------------------------------------------|
| 1  | Number of subscribers per user's page                                              |
| 2  | Number of user's friends                                                           |
| 3  | The number of groups in which user is included                                     |
| 4  | Number of photos located on user page                                              |
| 5  | The number of subscriptions from this user                                         |
| 6  | Number of video files located on the user's page                                   |
| 7  | User gender                                                                        |
| 8  | Number of posts per user page                                                      |
| 9  | Number of reposts on the user's page                                               |
| 10 | User's month of birth                                                              |
| 11-55 | The degree of semantic correspondence between the five most frequent words found in posts and characteristic of each of the three levels of the Ammon scale, and the three most frequent words in posts on the user's page |
| 56-100 | The degree of semantic correspondence between the five most frequent categories of photographs, characteristic of each of the three levels of the Ammon scale, and the three most frequent categories of photographs in the album on the user page |

4. **Experiments**

460 labeled profiles from the social network and 250 groups were used in the experiments. The first experiment was carried out to classify users’ profiles by the psychological scales, while the second experiment was carried out to classify groups within the social network.

4.1. **Experiment 1**

Table 2 shows the accuracy of the classifiers calculated for the destructive component of six Ego-functions. During the experiment, a 10-block cross-validation was used: the training and testing processes were performed 10 times, while the size of the training sample was 9 times greater than the size of the testing sample.

It can be seen from this table that the best accuracy (59.94%) when using a feature vector of I type is possessed by the classifier built on the basis of the MNN. While expanding the set of features, the accuracy of the MNN increases, with the exception of some cases, characteristic for the destructive component of the second and fifth Ego-functions. The second result in terms of accuracy (58.95%) when using the feature vector of I type belongs to the SVM. The worst result in terms of accuracy
(38.54%) is demonstrated by the LR. Using only textual content in posts provides an average accuracy of 52.97% with help of CNN.

| Classifier                  | MNN (I type) | MNN (I, II types) | MNN (I, II, III types) | MNN (I, II, III types, posts) | SVM (I type) | LR (I type) | CNN (posts) |
|-----------------------------|--------------|-------------------|------------------------|--------------------------------|--------------|-------------|-------------|
| Destructive component of the first Ego-function | 68.74% | 69.62% | 70.1% | 70.15% | 68.49% | 30.89% | 64.48% |
| Destructive component of the second Ego-function | 57.87% | 62.18% | 59.36% | 59.76% | 55.4% | 41.84% | 46.94% |
| Destructive component of the third Ego-function | 48.96% | 49.89% | 52.32% | 52.82% | 48.35% | 39.21% | 44.51% |
| Destructive component of the fourth Ego-function | 66.23% | 66.47% | 66.65% | 66.12% | 65.07% | 30.41% | 58.99% |
| Destructive component of the fifth Ego-function | 50.43% | 48.51% | 51.39% | 51.59% | 48.57% | 41.12% | 43.85% |
| Destructive component of the sixth Ego-function | 67.39% | 67.62% | 67.8% | 67.6% | 67.79% | 47.74% | 59.06% |
| Average value               | 59.94% | 60.71% | 61.27% | 61.34% | 58.95% | 38.54% | 52.97% |

4.2. Experiment 2

This experiment was carried out to assess communities (groups) on the psychological scale "destructive anxiety", while only the text content of posts was used as input data. Figure 2 shows the results of these experiments aimed at assessing accuracy, precision, recall and F1-score.

![Figure 2. Indicator values for different classifiers trained on posts within groups](image)

Bag of words, weighted bag of words, continuous bag of words, skip-gram and fastText classifiers were used as basic classifiers, and max-wins, weighted voting and soft voting ensembles were used as combining ensembles. Due to the usage of the soft voting ensemble, the F1-score indicator was increased by 0.89% in comparison with the best value of the same indicator demonstrated by the bag of words classifier.
5. Conclusion

The paper proposed a technique for classifying social network users and groups according to the psychological scales of the Ammon test. As a result of the experiment, several types of neural networks and text-based classifiers were investigated, among which the MNN and the bag of words classifier have the greatest accuracy. The direction of further research is to expand the set of calculated features, to enhance the results of groups classification and to research correlations among profile classes and classes of related communities.

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