Experimental study of the functioning and quality of the developed artificial neural networks configurations according to the selected accuracy criteria

E Melikhova

1 Volgograd State Agricultural University, 26, Universitetskiy Avenue, Volgograd, 400002, Russian Federation
E-mail: mel-v07@mail.ru

Abstract. The significant volume, as well as the semantic and lexicological diversity of Internet content, necessitates the creation of new methods for its computer analysis in order to identify potential threats and undesirable content, in particular, using artificial intelligence (AI) methods. This scientific problem can be solved with the use of neural network technologies, including frequency preprocessing of text arrays, justification of the structure and construction of a domain-oriented database of text data bodies, justification and experimental study of the architecture and macroparameters of a hybrid neural network based on the vector representation of pre-formed dictionaries of terms.

1. Introduction
The legislative basis for ensuring information security (IS) is the national IS Doctrine, approved on 06.12.2016, although, according to researchers, some of its methodological provisions are debatable. The problem of classifying content, including identifying its belonging to the target category in the context of an exponentially increasing amount of information, is relevant for various socio-political spheres, including ensuring their information security [1,2]. Publications of domestic and foreign scientists-political scientists, sociologists, philologists-are devoted to substantiating approaches and methods of studying the content of Internet content [3,4]. Architectures for building hybrid ANN for text processing with different layers (recursive, LSTM with long-term short-term memory, convolutional, etc.) and their combinations are discussed in publications [5-7]. Artificial neural networks (ANN) researchers note the possibility of using neural network approaches for text processing in natural languages NLP (Natural Language Processing) and artificial intelligence (AI) methods to identify unwanted content [8-10].

What is embedding and how they help artificial intelligence to understand the world of people, the dimension of space, the optimal volume and the method of obtaining which, taking into account the architecture of the INS, represent a separate scientific and methodological task. Thus, taking into account the socio-political orientation of the discourse of the problem being solved and its specifics, it is necessary to conduct research in the field of justification and construction of corpora of typical texts of Internet content, methods of their frequency preprocessing and analysis using hybrid ANN based on embeddings of selected dictionaries of terms.

2. Methods and materials
As a convenient software tool for creating software prototypes, the authors used the popular Python v. 3.7 language. To quickly create a software prototype, they used Google Colaboratory – a cloud
platform from Google, created for the dissemination of machine learning technologies and deep neural networks. Many necessary libraries are already installed on the Colaboratory platform, as well as quite powerful Tesla K80 GPUs that significantly accelerate the learning process of neural networks. The object of the study is the corpus of socio-political texts downloaded from available Internet resources, including RSS feeds containing information about explicit or latent socio-cultural and cyber threats, as well as ideological extremism. The expert evaluation determined the categories of texts by keywords.

Any sentence in a natural language can be matched with a tuple of multidimensional embedding vectors for computer semantic analysis of the text. One of the problems of using the described embeddings is the possible absence in the generated dictionary of the term for which embedding is being searched. You can reduce the threat of this problem without using a special dictionary, but by numbering words in an arbitrary extensive set of texts, for example, in the BSE. For these purposes, special sets of texts are formed, called corpora - selected and processed according to certain rules of the set of texts used as a base for the study of natural language.

An evolutionary approach to text processing was to take into account how often each specific word of the language (term) occurs in the corpus and how important its appearance in this text is. So there was a frequency embedding, in which each word in the position corresponding to its number is put in accordance with the number-the frequency of the word.

More useful is an adjusted estimate of the value of frequency-the inverse frequency of the words of the document, (inversion of frequency), with which a certain word occurs in the documents of the collection, which allows you to reduce the weight of the most frequently used words-prepositions, conjunctions, general concepts. The value of the inverse frequency indicator will be higher if a certain word is used with a high frequency in a particular text, but rarely in other documents [8].

3. Conclusion

The fundamental difference between ANN and previously used expert systems is the ability to learn, rather than act according to strict rules. Effective training requires a significant amount of information – millions of examples of solutions. Therefore, training neural networks requires a large amount of specially prepared information, its storage and data analysis–Big data.

| Parameters | Dense1 | Dense2 | SimpleRNN | Convolution |
|------------|--------|--------|-----------|-------------|
| Language model | Bag of words | Embedding Flatten | 30; Embedding 100; Flatten | Embedding 180; |
| Hidden Layers (ReLU) | Dense 54; Dense 24; Dense 5; | Dense 72; Dense 24; Dense 6; Softmax | Flatten SimpleRNN 6; Dense 6; Softmax | Conv1D (18.5); Conv1D (12.5); Flatten; Dense(5;Softmax) |
| Output Layer | Dense 54; Dense 24; Dense 5; Softmax | Dense 72; Dense 24; Dense 6; Softmax | Flatten SimpleRNN 6; Dense 6; Softmax | Conv1D (18.5); Conv1D (12.5); Flatten; Dense(5;Softmax) |

We have created various network architectures and parameters. For training and data validation, specially designed text corpora containing data in the following 5 categories were used: 1. Intimidation, 2. Insult, 3. Socio-political text, 4. Disinformation, 5. Garbage. After training the network, a graph was constructed (Fig. 1) and the recognition of a set of tests by class was evaluated in % (Table 1).
Table 1 shows the results of the ANN training procedure with different architectures and hyperparameters. The best results were shown by networks with the architecture shown in Table 1.

During the training process (re-launch of the program) the network gave different results reflected in the table.

All the created networks showed different results. The best results were shown by the 1 Dance + Bag of Words model with a higher percentage of recognition (93%) using the data set, which includes a corpus of texts in 5 categories. Figure 1 shows the results of the network's training and prediction accuracy.

Figure 1. Graph showing the dynamics of training and the accuracy of network prediction (a,b,c,d).

All categories were correctly identified by the Denise 1 + Bag of Words model over 50 %. The second version of the network consisting of two convolutional layers and a language model with a vector space dimension of 30 (Dense2), showed recognition of the correct categories from 53...75%, while 3 of the five categories were correctly identified: 1. Intimidation, 2. Affront, 4. Disinformation.

Model 4, consisting of two hidden layers and a language model with a vector space dimension of 180, showed correct recognition from 53%, and the same categories were similarly correctly identified. The SimpleRNN 3 recurrent network did not cope with the task and at different stages of training determined one category out of five. The reason for the low percentage of ANN recognition
is probably not quite correct selection and insufficient data set volume Therefore, this network research will continue using large amounts of data.

Acknowledgements
The reported study was funded by RFBR and EISR, project number 20-011-31648.

References
[1] Atamanov G A 2017 On the correctness of the concepts of «threat model» and «violator model» In the collection: Ecological and meliorative aspects of rational nature management Materials of the International Scientific and Practical Conference 447-453
[2] Morozov V, Kalmichenko O, Proskurin M and Mezentseva O 2020 Investigation of forecasting methods of the state of complex it-projects with the use of deep learning neural networks Advances in Intelligent Systems and Computing 1020 261-80
[3] Shapochkin D V 2018 Political discourse: cognitive aspect: monograph Tyumen State University, Institute of Social and Humanitarian Sciences 292 p
[4] Gordeev D I 2017 Ways of verbalization of aggression (on the material of Russian-speaking anonymous forums) Computer Linguistics and Computational ontologies 1 175-181.
[5] Smirnova O S and Shishkov V V 2016 The choice of neural network topology and their application for classification of short texts International Journal of Open Information Technologies 4(8)
[6] Glazkova A V 2019 Comparison of neural network models for the classification of text fragments containing biographical information Software products and Systems 2 (32) 263-267
[7] Chernobaev I D, Skorynin S S and Surkova A S 2019 Application of recurrent neural networks in the task of detecting insincere messages in online services In the collection: System analysis in design and management. Collection of scientific papers of the XXIII International Scientific and Practical Conference 403-412
[8] Rogachev A F and Melikhova E V 2020 Automation of the process of selecting hyperparameters for artificial neural networks for processing retrospective text information IOP Conference Series: Earth and Environmental Science 577(1) 012012
[9] Rogachev A F, Melikhova E V and Belousov I S 2020 A set of data on retrospective grain yield for neural network modeling IOP Conference Series: Earth and Environmental Science 577(1) 012006
[10] K E Tokarev et al 2020 IOP Conf. Ser.: Earth Environ. Sci. 488 012046