Ministry of Education and Science of Ukraine

Odessa National Academy of Food Technologies

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2021

Information Technology, Automation and Robotics

Proceedings

Odessa, ONAFT 2021

UDC 004.01/08

Editorial board:

Black Sea Science 2021: Proceedings of the International Competition of Student Scientific Works. Information Technology, Automation and Robotics. / Odessa National Academy of Food Technologies; B.Yegorov, M. Mardar, S.Kotlyk (editors-in-chief.) [*et al.*]. – Odessa: ONAFT, 2021. – 526 p.

These materials of International Competition of Student Scientific Works «Black Sea Science 2021» contain the works of the contest participants in the section «Information technologies, automation and robotics» (not winners).

The author of the work is responsible for the accuracy of the information.

Organizing committee:

Prof. Bogdan Iegorov, D.Sc., Rector of Odessa National Academy of Food Technologies, Head of the Committee

Prof. Maryna Mardar, D.Sc., Vice-Rector for Scientific and Pedagogical Work and International Relations of Odessa National Academy of Food Technologies, Deputy Head of the Committee

Prof. Stefan Dragoev, D.Sc., Vice-Rector for Scientific Work and Business Partnerships of University of Food Technologies (Bulgaria)

Prof. Baurzhan Nurakhmetov, D.Sc., First Vice-Rector of Almaty Technological University (Kazakhstan)

Prof. Mircea Bernic, Dr. habil., Vice-Rector for Scientific Work of Technical University of Moldova (Moldova)

Prof. Jacek Wrobel, Dr. habil., Rector of West Pomeranian University of Technology (Poland)

Prof. Michael Zinigrad, D.Sc., Rector of Ariel University (Israel)

Dr. Mei Lehe, Ph.D., Vice-President of Ningbo Institute of Technology, Zhejiang University (China)

Prof. Plamen Kangalov, Ph.D., Vice-Rector for Academic Affairs of "Angel Kanchev" University of Ruse (Bulgaria)

Dr. Alexander Sychev, Ph.D., Assoc. Professor of Sukhoi State Technical University of Gomel (Belarus)

Dr. Hanna Lilishentseva, Ph.D., Assoc. Professor, Head of the Department of Merchandise of Foodstuff of Belarus State Economic University (Belarus)

Prof. Heinz Leuenberger, Ph.D., Professor of the Institute of Ecopreneurship of University of Applied Sciences and Arts (Switzerland)

Prof. Edward Pospiech, Dr. habil., Professor of the Institute of Meat Technology of Poznan University of Life Sciences (Poland)

Prof. Lali Elanidze, Ph.D., Professor of the Faculty of Agrarian Sciences of Iakob Gogebashvili Telavi State University (Georgia)

Dr. V. Kozhevnikova, Ph.D., Senior Lecturer of the Department of Hotel and Catering Business of Odessa National Academy of Food Technologies, Secretary of the Committee

The jury for the section «Information technologies, automation and robotics»

Head of the jury:

Sergii Kotlyk – Ph.D., Associate Professor, Director of the P.M. Platonov Educational-Scientific Institute of Computer Systems and Technologies "Industry 4.0" of Odessa National Academy of Food Technologies (Ukraine)

Members of the jury:

Piotr Artiemjew - Dr hab., Associate Professor in Decision Systems of the Faculty of Mathematics and Computer Science,University of Warmia and Mazury in Olsztyn (Poland)

Francisco Antonio Augusto – Dr., International Relations Manager of Higher Institute of Information and Communication Technologies (Angola)

Andrey Kuprijanov – Ph.D., Associate Professor of the Department of Software for Computers and Automated Systems of Belarusian National Technical University (Belarus)

Simon Milbert – Vice-President of Xtra Information Management, Inc. (USA)

Ivan Palov – D.Sc., Professor of University of Ruse "Angel Kanchev" (Bulgaria)

Degla Gérard Hugues – Communications and Training Manager of "MAPCOM solutions informatiques" company group (Benin)

Nugzar Kereselidze - Academic Doctor of Informatics (Computer Science), Associate Professor of the Department of Natural Sciences, Mathematics, Technology and Pharmacy, Sukhumi State University (Georgia)

Etibar Seyidzade - Associate Professor of the Department of Computer and Information Technolohies, Baku Engineering University (Azerbaijan)

Vladimir Golenkov, D.Sc., Professor of the Department of Intelligent Information Technologies, Belarusian State University of Informatics and Radio Electronics (Belarus)

Zhanar Omirbekova - Ph.D., Associate Professor of the Department of Automation and Management, Satbayev University (Kazakhstan)

Ivan Palov - D.Sc., Professor of the Department of Power Supply and Electrical Equipment, University of Ruse "Angel Kanchev" (Bulgaria)

Siarhei Palavenia - Ph.D., Associate Professor, Head of the Department of Telecommunication Systems, Belarusian State Academy of Communications (Belarus)

Alexander Goloskokov - Ph.D., Professor of the Department of Software Engineering and Information Technology Management, National Technical University "Kharkiv Polytechnic Institute" (Ukraine)

Peter Nikolyuk - D.Sc., Professor of the Department of Computer Technology, Vasyl Stus Donetsk National University (Ukraine)

Vladimir Palagin - D.Sc., Professor, Head of the Department of Radio Engineering, Telecommunications and Robotics Systems, Cherkasy State Technological University (Ukraine)

Viktor Khobin – D.Sc., Professor, Head of the Department of Technological Processes Automation and Robotic Systems of Odessa National Academy of Food Technologies (Ukraine)

Valeriy Plotnikov – D.Sc., Professor, Head of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

Sergii Artemenko – D.Sc., Professor, Head of the Department of Computer Engineering of Odessa National Academy of Food Technologies (Ukraine)

Fedir Trishyn - Ph.D., Associate Professor, Vice-Rector on Scientific and Educational Work, Odessa National Academy of Food Technologies (Ukraine)

Valerii Levinskyi – Ph.D., Associate Professor of the Department of Technological Processes Automation and Robotic Systems of Odessa National Academy of Food Technologies (Ukraine)

Viktor Yehorov – Ph.D., Supervisor of the Laboratory of Mechatronics and Robotics of Odessa National Academy of Food Technologies (Ukraine)

Pavlo Lomovtsev – Ph.D., Associate Professor of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

Yurii Kornienko – Ph.D., Associate Professor of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

Serhii Shestopalov – Ph.D., Associate Professor of the Department of Computer Engineering of Odessa National Academy of Food Technologies (Ukraine)

Anatoly Galiulin - Ph.D., Associate Professor, Acting Head of the Department of Electromechanics and Mechatronics, Odessa National Academy of Food Technologies (Ukraine)

Secretary of the jury:

Oksana Sokolova – Senior Lecturer of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

5.Kravets O. Innovative processes and their impact on the efficiency of the enterprise. [Text]: Part 1. - K .: NMC "Ukooposvita", 2016. - 184 p. - P.140-143.

6.Tech Thursday: Inside the Latest Hospitality Technology Innovation [Electronic resource] - URL: https://www.socialtables.com/blog/hospitality/technology-innovation/ (access date: 08.11.2020).

7.Tkachuk T., Ustymenko S. Adaptive innovative solutions in the practice of hotels and restaurants. - I International Scientific and Practical Internet - Conference "Innovative Solutions in Modern Science, Education and Practice", Kyiv, November 17-18, 2020.

8.HRS - Hospitality & Retail Systems. Access mode: http://www.hrsinternational.com/ (access date: 30.09.2019).

RESEARCH APPLICATION OF THE SPAM FILTERING ALGORITHM ON SOCIAL MEDIA

Author: ***Vasyl Oliinyk***
Advisors: ***Andrii Podorozhniak, Nataliia Liubchenko***
National Technical University «Kharkiv Polytechnic Institute» (Ukraine)

Abstract: Today there are a lot of different social networks and messengers, which in today's society, especially in times of pandemic corona-virus have become an integral part of our daily lives, including work activities. At the same time there is a lot of unnecessary information coming to users every second, so the problem of dealing with spam messages in social networks and messengers is now very relevant.

By spam we mean any messages that a person, or an entire company, considers unnecessary in a particular text stream.

The project is devoted to solving the scientific and applied problem of detecting spam messages in the text context of any social network or messenger using various spam detection algorithms. Three algorithms were implemented and investigated: an algorithm using naive Bayesian classifier, Support-vector machine and multilayer perceptron neural network.

The main idea is to develop a spam detection algorithm that is fast and easy to integrate in a messenger (social network). It is proposed to use the obtained solutions for IT companies. The developed algorithm should recognize spam based on the context of a particular firm and quickly remove or mark it. Since the spam detection task is essentially the task of sorting messages into A and B classes, the developed algorithm can be used not only for spam filtering but also, for example, for monitoring chat rooms for the messages that are important to a particular employee of the company.

Keywords: spam, social network, naive Bayesian classifier, Support-vector machine, multilayer perceptron neural network.

I. INTRODUCTION

In 2019, the percentage of spam in global mail traffic was 56.51%, which is 4.03% more than in 2018 [1] (Fig. 1.1).

Fig 1.1. Percentage of spam in email traffic in 2019

Unlike inboxes, most social media chat rooms do not have built-in anti-spam algorithms. Although there is not as much spam in chat rooms as in email services, the cost of an extra message can cost a particular firm a lot of money. For example, when a spam message contains a link to a resource that infects a user's computer and penetrates a company's internal network. The effects of such interference can be very costly for a firm. Therefore, there is the issue of monitoring the incoming text stream in social networks and messengers arises.

By being able to filter spam messages in messengers and social networks, firms can save their employees' time and prevent losses information.

To solve the problem we were used algorithms using naive Bayesian classifier, support vector method and multilayer perceptron neural network. An approach with integrated application of the investigated algorithms can begin to solve the problem of spam in social networks and messengers.

II. LITERATURE ANALYSIS

2.1 Characterization of spam. Ways to deal with spam

Spam is a mass mailing of correspondence of an advertising to people who have not expressed a desire to receive it [2].

The various types of spam generally include: advertisements; Nigerian emails; phishing; other types of spam. Other types of spam include: mass mailings of letters with religious content; mass mailings to put the mail system out of service (causing

the system to fail); mass mailings on behalf of another person in order to cause a negative attitude towards that person; mass mailings of letters containing computer viruses (for their initial spread).

The basic ways of spam spread today include [2]: e-mail; Usernet; messengers; substitution of Internet traffic; SMS messages; phone call, etc.

Spam messages cost the perpetrator virtually nothing, but the recipient of the spam usually has to pay the Internet provider for the time used to receive the spam. The mass spread of spam also complicates the operation of information systems and resources, and there is a very large amount of unnecessary load on them. Due to mass mailings the user has to spend unnecessary time filtering the messages. To avoid this, users use anti-spam filters to save time. But spam filters can also accidentally erase an important message by recognizing it as spam.

The surest way to deal with spam is to prevent spammers from getting hold of your email address.

Auto-Spam Detection Software is called Anti-Spam Filters. They can be applied by end-users or on servers. This software has two main approaches [3]:

1) the content of the message is analyzed and based the algorithm decides whether it is spam or not. If a message is classified as spam, it can be marked, moved to another folder, or even deleted. Such software can run both on the server and on the client computer. With this approach you don't see the spam filtered, but you continue to pay the full cost for receiving it, because the anti-spam software receives each spam message anyway (wasting your money) and only then decides whether to show it or not;

2) it classifies the sender as a spammer without looking at the text of the message. This software can only work on the server which directly receives the messages. With this approach it's possible to reduce the cost - money is only spent on communicating with spam mailers (i.e. refusing to accept the messages) and on contacting other servers for verification. The gain, however, is not as great as you might expect. If the recipient refuses to accept the message, the spammer program tries to bypass the protection and send it another way. Every of such attempt has to be handled separately, which adds to the overhead on the server.

This project discusses a statistical Bayesian spam filtering, method using a support vector method and a multilayer perceptron neural network.

2.2 Analysis of spam detection algorithms. Naive Bayesian classifier

A naive Bayesian classifier is a probabilistic classifier that uses Bayes theorem to determine the probability of an observation (sample element) belonging to one of the classes under the assumption of (naive) independence of the variables [4]. Examples of how this method works are: recognizing spam, analyzing emotional coloring of texts, detecting racism in text voters, any information processing systems and the like.

If it is possible, based on the values of the variables, to unambiguously determine which class an observation belongs to, the Bayesian classifier will report the probability of belonging to this class [5].

In other cases, when an observation can belong to different classes with different probabilities, the result of the classifier will be a vector whose components are the probabilities of belonging to one or another class [6].

The advantage of this approach is that the sample size requirements are reduced from exponential to linear. The disadvantage is that the model is accurate only when the assumption of independence is satisfied. Otherwise, strictly speaking, the calculated probabilities are no longer accurate (and even more, their sum may not equal one, making it necessary to normalize the result).

The probabilities involved in Bayes' theorem may have different interpretations. In one of these interpretations Bayes' theorem is used directly in a particular approach to statistical speculation. In the Bayesian interpretation of probability, this theorem expresses how a subjective measure of certainty should rationally change when accounting for evidence: it is a Bayesian view that is fundamental to Bayesian statistics [7]. However, Bayes' theorem has numerous applications in a wide range of calculations involving probability, not just Bayesian using.

Mathematically Bayes' theorem is [8]:

$$P(A \mid B) = \frac{P(B \mid A)\, P(A)}{P(B)} \quad (2.1)$$

where A and B are events:

– P (A) and P (B) are the probabilities of A and B without relation to each other;

– P (A | B) is the probability of observing event A if B is true;

– P (B | A) is the probability of observing event B if A is true.

2.3 Analysis of spam recognition algorithms. Support-vector machine

In machine learning, Support Vector Method (SVM) is a data analysis technique for classification and regression analysis using supervised learning models with linked learning algorithms, called support vector machines [9, 10]. For a given set of training samples, each marked as appropriate to one or the other of two categories, the SVM training algorithm builds a model that assigns new samples to one or the other category, making it a probabilistic binary linear classifier. The SVM model is a representation of samples as points in space, reflected in such a way that samples from individual categories are separated by a net gap, which is the widest. New samples are then mapped into the same space and predictions are made about their category membership based on which side of the gap they fall on (Fig. 2.1).

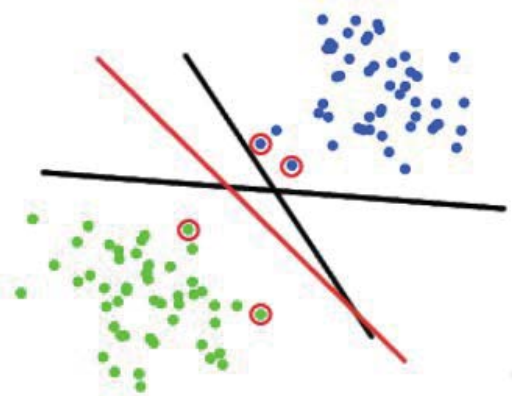

Fig. 2.1. Operation of the method with linearly separate data

But there are situations where the data are not linearly separable. For this reason, it has been proposed to map the primary finite-dimensional space into a space with more dimensions, presumably making splitting easier in this space (Fig. 2.2).

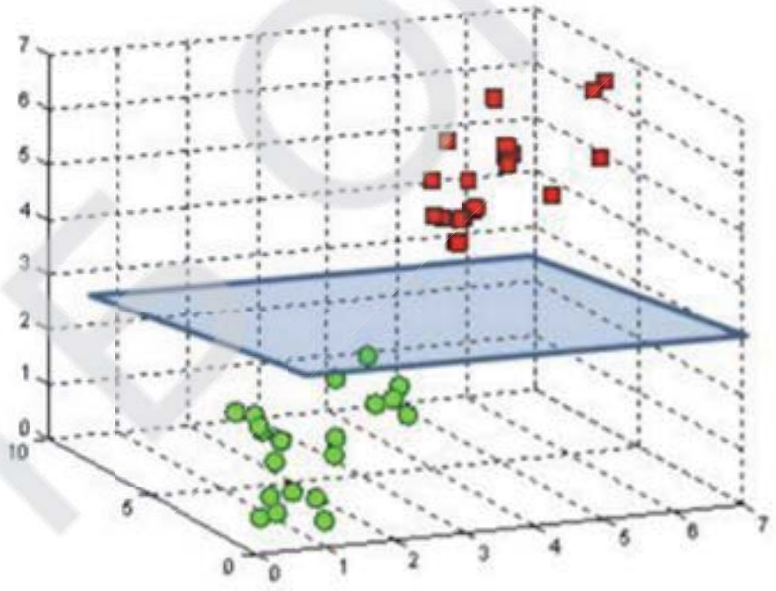

Fig. 2.2. Linearly inseparable data

You can also visually see the algorithm work (Fig. 2.3).

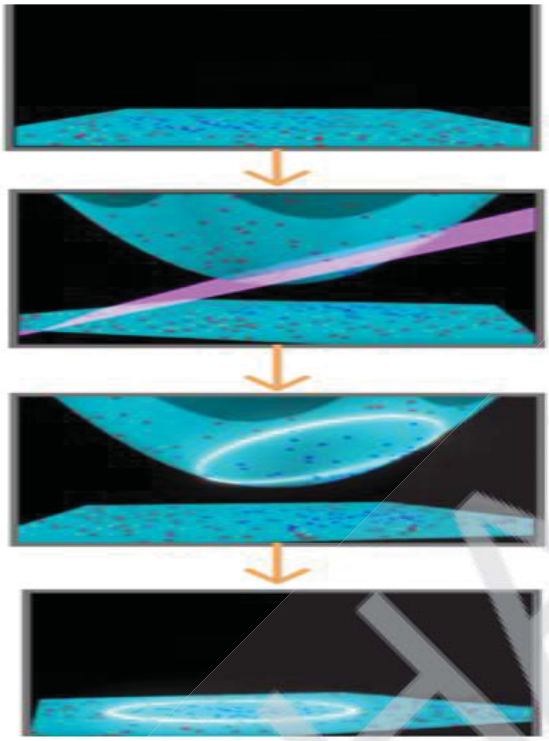

Fig. 2.3. The SVM method operation

2.4 Analysis of spam recognition algorithms. Perceptron

The Perceptron is a mathematical or computer model of information perception by the brain (cybernetic brain model), proposed by Rosenblatt in 1957 and implemented as the Mark-1 electronic machine. The main mathematical problem it can cope with the linear partitioning of arbitrary non-linear sets [11].

A perceptron consists of three types of elements, namely signals from sensors are fed into associative elements, and then into reactive elements. In this way, perceptron allows the creation of a set of "associations" between input and the desired output response. In biological terms, this corresponds to transforming, for example, visual information into a physiological response of motor neurons

Fig. 2.4 shows a model of an elementary perceptron.

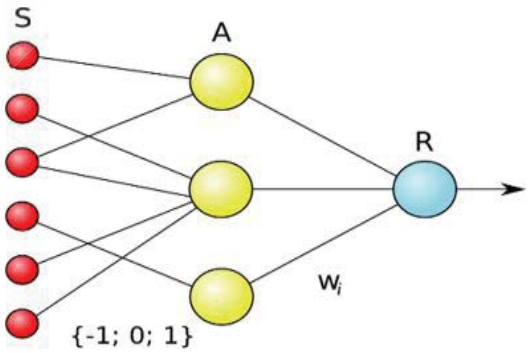

Fig. 2.4. Logic diagram of an elementary perceptron

III. OBJECT, SUBJECT AND METHODS OF RESEARCH

The aim of the work is to study the possibility of using different algorithms in the development of software for filtering spam in the textual content of social network messengers and speed response to unnecessary messages.

The aim is to do the following tasks: a) the analysis of the special possibilities of the recognition of spam messages; b) the analysis of the existing methods of spam recognition c) the realization of the methods of combating spam based on the naive Bayesian Classifier, the method of reference vectors and multilayers perceptron neural network; d) the analysis of the used algorithms.

The object of the research is the process of identifying spam in the text context of SOCIAL networks messengers.

Subject of study – the process of filtering spam messengers in SOCIAL networks using the base of methods for recognizing spam.

Research methods: classification theories, probabilistic classifiers, the theory of neural quantities, statistical methods of analysis of linguistic methods.

Scientific novelty – improved methods for the recognition of spam in the messenger using text messages of a particular text stream.

IV. RESULTS

As a training dataset was chosen the dataset of spam messages from the kaggle SMS Spam Collection Dataset, but the dataset of messages from a particular company can also be used to train the algorithm [12]. To implement the spam filtering algorithms we used the Python 3.6 programming language, the PyCharm. programming environment and the Keras, NumPy, Sklearn and Pandas libraries [13].

The simulation was performed on a LifeBook E744 notebook with 8Gb RAM, an Intel Core i7 CPU (up to 3.2 GHz) and an Intel HD Graphics 4600 video processor.

The spam messages dataset contains two columns, the first one contains the message class (ham – normal message, spam – spam messages). Let's first convert the first class column to an array of integers. A 1 will indicate that the given message is spam, a 0 – normal message.

To turn the whole text of the messages into numbers (vectorization), we need to make a dictionary of words, an array of words [11, 13]. Each word in the dataset is converted to lower case. Since our set could get punctuation marks, the next step is to clear the dictionary of unnecessary words.

After that, each word is brought to the infinitive (permanently -> permanent).

Having analyzed the resulting set of data, we can see some words are repeated very often, and others, on the contrary, very rarely. We will remove from the resulting set of words that are repeated more than 1000 and less than 5 times.

Then, on the basis of the obtained set of words we will create a dictionary, deleting all repetitions (i.e. every word in the dictionary is unique). The vectorizer from sklearn library was used for this purpose.

The created vocabulary included 1191 words. The sentences of the dataset are vectorized using the dictionary. After transformation, the data can be fed to the input classifiers. Also, some part of the dataset (about 600 messages), which is not part of the training data, was rejected for further testing of algorithms.

By testing each of the algorithms, we will count the number of mistakes and percentage of the mistakes.

The general scheme of execution of the developed software application is given in fig 4.1 [14].

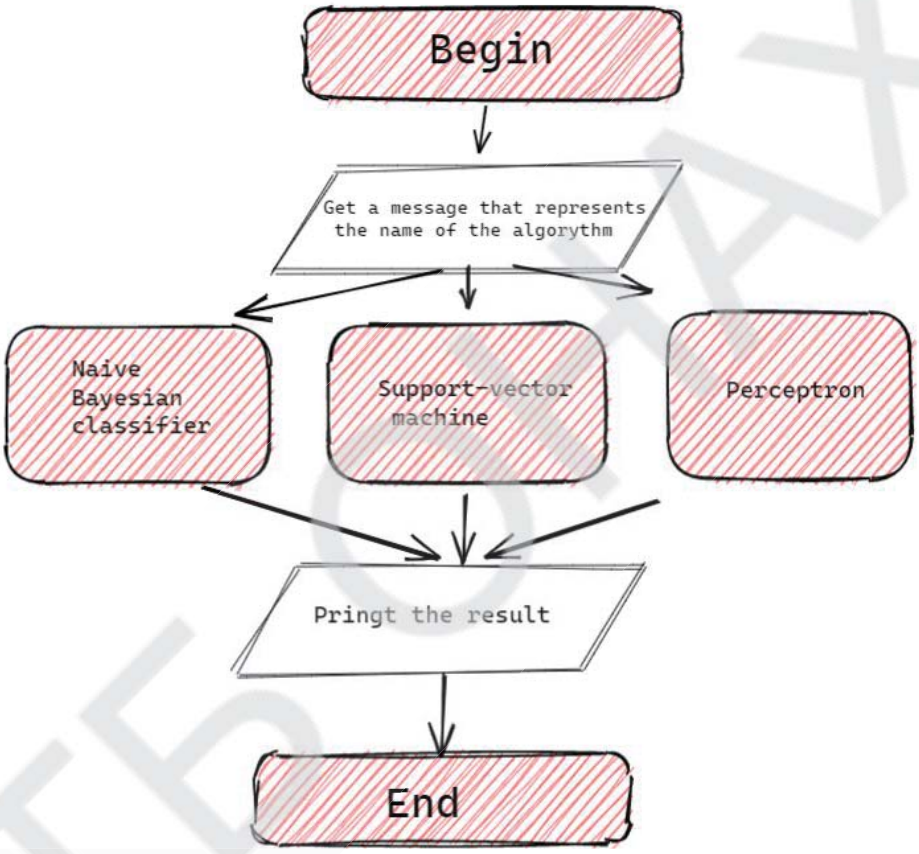

Fig. 4.1. The general scheme of execution of the developed software application

Algorithm of analyzing spam messages contains the following steps:

1) the user enters into the software application the initial text that should be analyzed;

2) software application parses the initial text into array of words, then each word is converted to the infinitive, then the resulting set of words is vectorized and transmitted to the input to the selected algorithm;

3) the algorithm analyzes the received data and returns the result as the probability of belonging the received data to the class (our algorithm has two classes: spam and non-spam);

4) the received data is analyzed and converted to a human readable representation;

5) the software application displays the result of the analysis and the probability of belonging the message to the spam-class;

6) the results of the analysis can be saved to the selected file if it is needed.

Firstly we have tested a perceptron multilayer neural network, which consists of 4 layers: 1 input, 2 hidden, and 1 output (Fig. 4.2).

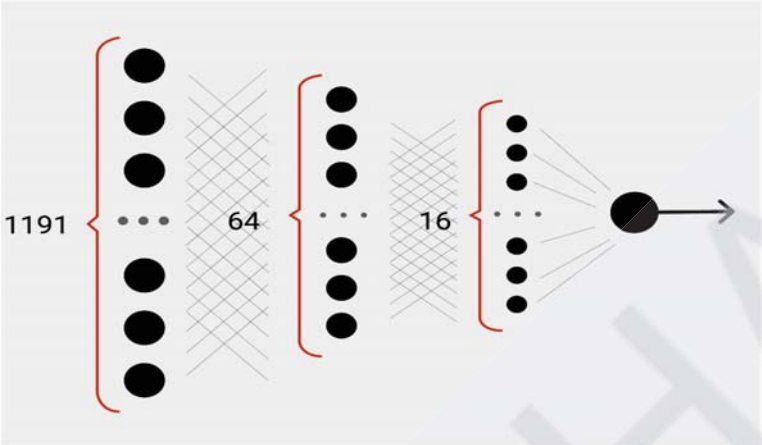

Fig. 4.2. Schematic model of the perceptron neural network

Having tested the created model we get:

```
Count mistake: 12
Mistake: 2.086957 %
```

Fig. 4.3. Results of the perceptron neural network

As can be seen on Fig. 4.3 the average number of perceptron mistakes is 12 out of about 600 messages, and the average mistakes probability is 2%.

Using the same input data, let us test an algorithm based on the naive Bayesian classifier (Fig. 4.4) and the Support Vector Method (SVM) (Fig. 4.5).

```
Count mistakes: 10
Mistake: 1.739130
```

Fig. 4.4. Results of the naive Bayesian classifier

```
Count mistakes: 6
Mistake: 1.043478
```

Fig. 4.5. The results of the method of support vectors

From the obtained data let's draw a graph in Fig. 4.6.

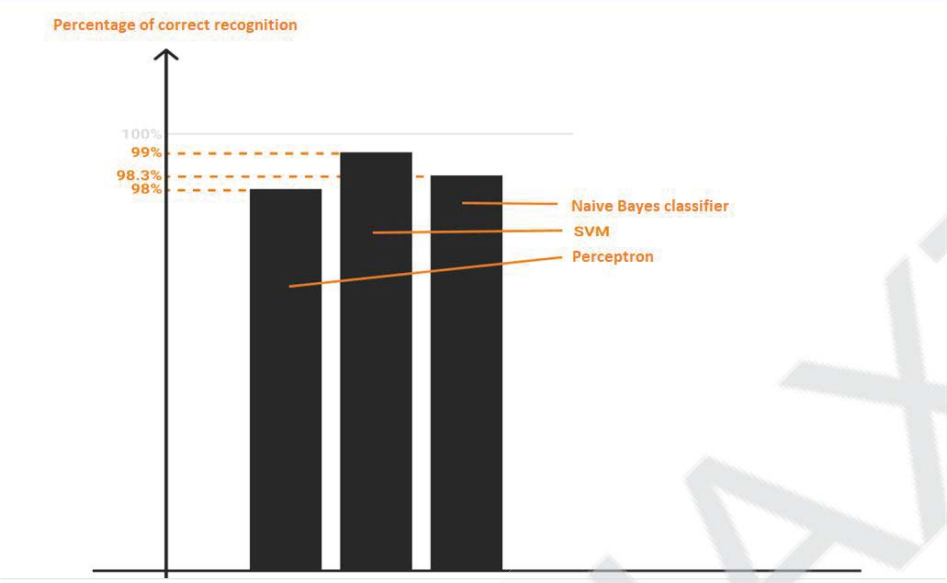

Fig. 4.6. Comparative graph

The analysis shows that the most accurate for the given dataset of spam messages is the application of the support vector method.

The work of the algorithms was also tested in the popular messenger Telegram [15].

V. CONCLUSIONS

As part of this research, the scientific and applied problem of determining spam in the textual context of social networking messengers was solved by the example of Kaggle SMS Spam Collection Dataset using chatbots in the popular messenger Telegram.

1. Considered the relevance of spam detection and possible problems due to spam intervention.

2. Considered the basic methods of spam recognition, namely naive Bayesian classifier, the method of support vectors and multilayer perceptron neural network.

3.It was developed the program to filter spam in the messenger Telegram, that uses three implemented algorithms for spam recognition.

4. A comparative analysis of the three most popular methods for recognizing spam messages was performed and it was shown that the most effective method is the support vectors algorithm with a mistake of only 1.044%. In second place was the algorithm based on the naive Bayes classifier with a mistake of 1.739%. The third place for our case was taken by the multilayer perceptron neural network with a mistake of 2.087%.

VI. REFERENCES

1. Vergelis, M., Shcherbakova, T., Sidorina, T., & Kulikova, T. (2020, April 8). Spam and phishing in 2019. https://securelist.ru/spam-report-2019/95727.

2. Chaudhry, S., Dhawan, S., & Tanwar, R. (2020). Spam Detection in Social Network Using Machine Learning Approach. In: U. Batra, N. Roy, & B. Panda (Eds.), *Data Science and Analytics. REDSET 2019. Communications in Computer and Information Science* (pp. 236-245). https://doi.org/10.1007/978-981-15-5830-6_20.

3. (2008, July 29). Ways to combat spam. *Ostriv znan*. http://korysne.ostriv.in.ua/publication/code-24F002FC35B8C/list-1420E79CF27.

4. Zhang, W., & Gao, F. (2013). Performance analysis and improvement of naïve Bayes in text classification application, *Proceedings of the IEEE Conference Anthology*, China, pp. 1-4. https://doi.org/10.1109/ANTHOLOGY.2013.6784818.

5. Liu, B., Blasch, E., Chen, Y., Shen, D., & Chen, G. (2013). Scalable sentiment classification for Big Data analysis using Naïve Bayes Classifier. *Proceedings of the IEEE International Conference on Big Data*, USA, pp. 99-104. https://doi.org/10.1109/BigData.2013.6691740.

6. McCallum, A., & Nigam, K. (1998). A Comparison of Event Models for Naive Bayes Text Classification. *AAAI 1998: Learning for Text Categorization* (pp. 41-48). http://courses.washington.edu/ling572/papers/mccallum1998_AAAI.pdf

7. Sarkar, S.D., Goswami, S., Agarwal, A., & Aktar, J. (2014). A Novel Feature Selection Technique for Text Classification Using Naive Bayes, International Scholarly Research Notices, 2014, Article 717092. https://doi.org/10.1155/2014/717092.

8. Tychynska, L.M., & Cherepashchuk, A.A. (2016). Bayesian formula. https://web.posibnyky.vntu.edu.ua/fitki/ 4tichinska_teoriya_jmovirnostej/17.htm

9. Nguyen, L. (2017). Tutorial on Support Vector Machine. Applied and Computational Mathematics, 6(4), 1–15. https://doi.org/10.11648/j.acm.s.2017060401.11

10. Sharma, N. (2020, January 31). Understanding the Mathematics behind Support Vector Machines. *Heartbeat*. https://heartbeat.fritz.ai/understanding-the-mathematics-behind-support-vector-machines-5e20243d64d5

11. Chollet, F. (2018). *Deep learning with python.* Manning Publications. https://www.manning.com/books/deep-learning-with-python

12. SMS Spam Collection Dataset [Data set]. https://www.kaggle.com/uciml/sms-spam-collection-dataset.

13. Applications for Python. *Python Software Foundation*. https://www.python.org/about/apps/

14. Oliinyk, V., Podorozhniak, A., & Liubchenko, N. (2020). Method of comprehensive spam recognition in social networks. *Proceedings of the 8th international scientific and technical conference Problems of informatization*, Ukraine, *Vol. 2,* p. 39. http://repository.kpi.kharkov.ua/bitstream/KhPI-Press/50565/1/Conference_NTU_ KhPI_2020_Problemy_informatyzatsii_Ch_2.pdf

15. Oliinyk, V., Liubchenko, N., & Podorozhniak, A. (2020). Research of the method of complex spam recognition in social networks. *Proceedings of the XIV International scientific-practical conference of undergraduates and graduate students "Theoretical and practical research of young scientists"*, Kharkiv, Ukraine, p. 8. http://web.kpi.kharkov.ua/masters/wp-content/uploads/sites/135/2020/12/TPRYS-2020.pdf.

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2021

Information Technology, Automation and Robotics

Proceedings

Odessa National Academy of Food Technologies

The collection includes student works of the participants of the competition, which were not included in the number of prize-winners. The texts of the competitive works are published in the form in which they were submitted by the authors. The authors of the articles are responsible for the content and form of submission of the material.

Responsible for the issue: Sergii Kotlyk

Computer typesetting and layout: Oksana Sokolova

Odessa 2021