

Human Operator Stress Assessment System

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Abstract

In the course of the work the phenomenon of occurrence and course of stress was investigated. Special attention was paid to professional stress. A study was conducted for 92 respondents aged 24 to 35. This paper proposed a contribution to the overall work on the automatic detection of people's stress levels to combat stress based on the use of technologies related to everyday life. A model of learning is proposed, which automatically draws conclusions about the level of stress - in the study it is an emotional overload. The conclusion is based on the obtained parameters of the state of the human operator. This includes data on physical performance and general information about human activities, such as coffee consumption, smoking, gender, height, weight. The paper presents: a list of the main technologies with which the system was created; a detailed description of the software implementation of the developed information system, a list of input data, a description of the proposed methods of supporting the automatic output of the proposed model.

Keywords 1

Indicators of the state of the organism, stress situation, stress, detection of stress, model

1. Introduction

In today's trends, Generation Z people suffer from psychological stress. Although the literature contains several definitions of stress, it is clear that different forms of stress affect our mental and physical health [1 - 3]. Stress is a natural feeling that in some cases helps the body protect itself. By their nature and origin, stressful situations can be related to the financial component, conflicts in relationships or at work. The relationship between negative emotional states has been the focus of both professional and health perspectives [4].

Considering occupational stress, it should also be noted the terrible consequences of its action in terms of burnout. The theoretical basis proposed by Smith received considerable support and was used as the basis for most modern research on burnout. Smith's model argues that personal and situational characteristics affect the perception of stress, and the perception of stress, in turn, affects the level of burnout [4]. To better illustrate the results of the study, attention should be paid to the results of a group of Mexican researchers. In their work, they concluded that university teachers' professional stress significantly correlated with the size of the burnout syndrome [4]. Among the surveyed 2108 respondents from Portuguese universities [5] from all over the country, the results of the study showed that 34.8% of respondents showed signs of emotional exhaustion, 84.2% had signs and symptoms of lack of professional success, and 6.3% showed impersonality. The study also found that between 6.3% and 34.8% of participants may have signs and symptoms characteristic of burnout, showing moderate to severe burnout. Hendrix, Acevedo and Hebert [4] recognized perceived stress as an important predictor of emotional exhaustion. Emotional exhaustion leads to burnout due to feelings of despair, isolation, exhaustion and fatigue. From this point of view, all indications are that the

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resulting stress is the biggest driver in the emergence of burnout and slowing down the mental activity of the employee.

Slow metabolism, digestive problems and the immune system are a clear result of the effects of stress on the human body. To date, special certified equipment or software that would allow the entrepreneur to explore the level of stress is virtually absent. This problem is most urgent to ensure the control over the occurrence and development of stress in operators of various activities in the process of performing their professional duties.

The purpose of this work is to create and develop an information system that automatically draws conclusions about the level of stress of the human operator during the work shift and possible further participation in the decision-making process.

Methods and object of research. In the course of the work, the following methods were implemented for the study: decision tree, k-nearest neighbors method, naive Bayesian classifier, and our own neural network was written using Keras. **The object of the study** was the human operator, his physical and mental performance in the event of occupational stress and after overcoming a stressful situation.

The subject of the study is the change of physical parameters of the human operator, such as pulse, pressure, etc. and speed of reaction - the time spent to solve the task set by the developed system under the influence of professional stress.

2. Review of literature sources

The issue of stress to workers was first raised in 1966 in a report prepared by the National Advisory Committee on Environmental Health for the Chief Physician of the United States. According to the document, every year the number of employees who suffer from stress in the workplace is constantly growing. However, it was not until the early 1990s that research into the harmful effects of stress on workers' health began (European Foundation for the Improvement of Living and Working Conditions (1992), in the Netherlands [6], USA [7], the insurance company St. Paul Fire and Marine Insurance "(1992) [8], National Institute of Occupational Health and Safety [9] and others).

According to the concept of G. Selye, one of the main functions of the psyche is to balance the body under constant influence of the aggressive environment. G. Selye identifies three main stages of stress: the first stage - the stage of anxiety; the second stage - the stage of resistance or resistance; the third stage is the stage of exhaustion. According to him, these three phases of the general adaptation syndrome resemble the stages of human life: childhood (with low resistance and excessive reactions to stimuli that occur quickly and end quickly), maturity (when there is adaptation to frequent environmental influences and increased resistance) and old age (irreversible loss of resistance and gradual aging, ending in death).

Selye distinguishes two types of stress - eustress and distress (see Figure 1). Distress is always unpleasant, it is associated with harmful stress. Eustress is combined with the desired effect - mental processes are activated, emotions are indicative. The same stressor can cause different effects in different people. Selye connects this with "conditioning factors" that selectively increase or inhibit a particular manifestation of stress. "Conditioning" can be internal (genetic predisposition, age, sex) and external (ingestion of hormones, drugs, diet). Plays the role and reactivity of the organism, which varies depending on internal and external conditions. The same situation can cause anxiety in one person, frustration in another and conflict in a third. In addition, if the protective reaction is prolonged and depletes the resources of physiological mechanisms, it passes into a state of painful adaptation [10]. Thus, G. Selye focused on the physiological side of the body's response and thus ignored the role of psychological processes, in turn, the psychological impact of stressors on the individual.

	DISTRESS	EUSTRESS
IMPACT ON PERCEPTION	Negative threat	Positive challenge
IMPACT ON EMOTIONS	Anxiety	Excitement
IMPACT ON PRODUCTIVITY	Procrastination	Motivation
IMPACT ON PERFORMANCE	Diminution	Enhancement

Figure 1: Distress versus eustress

3. Theoretical basis

There are several ways to classify the response to stress, but the study is more obvious to divide them into behavioral, intellectual, emotional and physiological manifestations of stress. The main signs of behavioral stress are psychomotor disorders (excess muscle tension, winter breathing rhythm), lifestyle changes (changes in daily routine, sleep disturbances), occupational disorders (decreased productivity, increased fatigue), impaired social role functions increasing conflict, increasing aggression, etc.). It should be noted a possible violation of the normal interaction of the cerebral hemispheres in the direction of dominance of the "emotional" hemisphere, and a decrease in the work of the "logical" half of the cortex of the large hemispheres. Physiological manifestations of stress affect almost all human organ systems - digestive, cardiovascular and respiratory. However, studies are most often performed on the cardiovascular system, which has a hypersensitivity that does not require long-term expectations. Under stress, the following changes are recorded in the physical condition of a person: increased heart rate, increased blood pressure, disorders of the gastrointestinal tract and sleep, increased emotional arousal, increased irritability, emotional burnout.

Thus, the main problems that may arise due to the constant long-term effects of stress on the body can be attributed:

1. Insomnia. Due to the high level of anxiety and nervousness, the quality of sleep and its duration deteriorates. Stress can also interrupt or delay sleep. No less important is the presence of a cup of coffee, because caffeine excites the body and drives away drowsiness.
2. Nutritional problems. Thousands of people respond to stress by overeating or malnutrition. To some extent, stress is a trigger that leads to an imbalance in diet. It should be noted that in the case of prolonged excessive consumption of sweets to reduce stress levels may increase blood sugar, which often causes worse health than before.
3. Depression. An unresolved situation can make a person feel insecure and angry, which can lead to depression and low self-esteem. In turn, this leads to a chronic "bad mood" syndrome, problems with clear thinking, loneliness and constant guilt. Illnesses caused by stress may seem unrelated, but when doctors, counselors, or patients themselves look more closely, there is often a causal link between stress and conditions such as depression.
4. Anxiety and panic attacks. Unfortunately, anxiety disorders and panic attacks are inextricably linked to stress. A person who suffers from such a problem is very anxious, constantly lives in fear, constantly experiences high levels of stress, which can't be overcome on their own.
5. Colds and viruses. Physical illness is also a popular type of illness caused by stress. People who are stressed often have an immune system that is not working properly. Prolonged emotional exhaustion negatively affects physical performance. Therefore, they can get sick faster and easier than they could otherwise.

6. Circulatory problems and heart problems. Stress causes narrowing of blood vessels, which leads to a decrease in blood flow in the body and creates problems such as blood clots, poor circulation or even strokes. Also, in the event of a stressful situation, heart rate and blood pressure increase. Over time, severe stress can damage the heart with increased wear. Elevated levels of stress can even raise blood cholesterol levels.
7. Cancer. More and more research is showing the link between stress and different types of cancer. Because it is known that stress suppresses the body's immune system. Therefore, modern treatments for cancer patients include relaxation therapy, music therapy, and even pet therapy, which can help relieve the stress associated with the disease.

Therefore, in the event of symptoms of these or other diseases, it is urgent to stop the effects of stress on the human body, especially if it is a worker and the environment of his workplace.

During the study of existing analogues, the CardioSport TP3 Heart Rate Transmitter was analyzed – the cheapest among the devices on the market. It is a simple chest belt and a source of heart rate data, as its main advantage is it can measure both heart rate and provide RR time interval data in milliseconds. A public experiment was conducted to test the operation of the device. A significant disadvantage is the lack of its own memory for data storage, so it requires additional equipment for data processing, such as a tablet or computer. According to the results of the tests, a significant error in the measured data in the case of temporary separation of the sensor from the human body. Also, a slight movement of the device can sometimes cause signal loss (especially during sleep). The public experiment involved 46 healthy volunteers, mostly university and high school students (27 men and 19 women; mean age: 24.6 years). The experiment was divided into two parts lasting 10 minutes each, so the whole procedure lasted 20 minutes. In the first part, participants were asked to try to relax in a vertical position while sitting, listening to relaxing music. The second part of the experiment was a mental task designed to serve as a source of mental stress. The results show a relatively good transfer property of the device and an accuracy of 97%. Among the disadvantages was also found a decrease in contact between the electrodes and the skin through the hair on the chest, so from the general table of results, the result of the experiment was excluded.

The next device under study was to use the fingerprint sensor of your own smartphone and view the analysis using the Welltory application. The main advantages are the availability of the application, as it is not tied to the operating system of the smartphone. The stated features of the work are:

1. Analysis of heart function - monitoring of heart function and diagnosis of heart rate, heart rate variability with 33 characteristics.
2. Blood pressure analysis - it is enough to enter the result of the connected device for measuring blood pressure and get conclusions from the measurement of blood pressure, taking into account 12 scientific indicators and heart rate variability.
3. More than 120 data sources for connection and monitoring, including a medical card, where there is information about the cardiogram of the heart by cardiograph and more.
4. Ability to sync with mobile devices and trackers such as FitBit, Garmin, MiFit, Polar, Oura, Withings, Samsung.

Among the disadvantages are possible failures in reading data from the sensor, which makes it impossible to continue working with the application. Also, this includes insufficiently developed stress analysis.

4. Statement of the problem

The problem of detecting stress was solved from different approaches. However, the former work can be divided into two different groups, depending on the use of physiological signals or other behavioral characteristics. The developed model aims to combine the work of these two groups.

The analysis of the behavior of the human operator in case of stress during the working day revealed the process of developing a certain coping behavior to adapt as quickly as possible to the requirements of the situation, weaken or mitigate its requirements. In the case of persistent stress, emotional burnout and exhaustion were recorded, which led to the impossibility of further participation in the decision-making process. Because the operator must be responsible for his work

during the working day, because in some situations, the wrong decisions lead to damage to the health of other employees, there is an urgent need to determine this condition. Therefore, to achieve this goal it is necessary to solve the following tasks:

1. Investigate the main stages of development of occupational stress and its impact on mental and physical activity of the human operator.
2. Based on the activities of the human operator to determine its possible depletion and inability to participate in the decision-making process.
3. Predict the further work of the human operator and the moment of critical overvoltage.

It should also be noted that the economic losses from the presence of stress in the workplace in the United States, for example, amount to \$ 300 billion annually. As for Ukraine, it is estimated that almost 70% of Ukrainians are constantly in a state of stress, and a third of the population is in a state of severe stress (2010 data). It should be noted that Ukraine does not have such accurate statistics as the United States and European countries. But, analyzing the statistics, we can say that the lack of statistics is an even bigger problem, because it does not show the dynamics of the situation.

5. Construction of model

Just as the object of study is the human operator, the subject of the study is the change in the physical parameters of the human operator and the speed of reaction - the time spent on solving the problem posed by the developed system under the influence of occupational stress. The visual representation of the data is shown in Figure 2.

The values of all data are generated on the basis of publicly available information on age, gender and physical characteristics of individuals. Stressful situations are created artificially to test and improve the performance of the developed model.

1. TEMP_mean – average temperature;
2. TEMP_std – nominal conditions - values of pressure and temperature for which values are resulted;
3. TEMP_min – the minimum value of temperature;
4. TEMP_max – the maximum value of temperature;
5. BVP_peak_freq – maximum heart rate;
6. TEMP_slope – deviation of the current pressure value and the value at the previous measurement stage;
7. Subject – the minimum value of the error;
8. Label – for the developed model is a known and predicted value depending on the type of data set (training or test);
9. Age – age of the respondent;
10. Height – growth of the respondent;
11. Weight – the weight of the respondent;
12. Gender_female – female;
13. Gender_male – male;
14. Smoker_NO – there was no smoking for an hour;
15. Smoker_YES – smoking for an hour;
16. Feel_ill_today_YES – a feeling of weakness is present;
17. Feel_ill_today_No – there is no feeling of weakness;
18. Coffee_today_YES – drinking coffee for an hour;
19. Coffee_today_No – there was no coffee for an hour;
20. Test 1 – the value of passing the respondent in milliseconds of the first test;
21. Test 2 – the value of the respondent in milliseconds of the second test.

TEMP_m	TEMP_m	BVP_pea	TEMP_slope	subject	label	age	height	weight	gender	gender	coffee_t	sport_toc	smoker_f	smoker_	feel_ill_t	test1	test2
35.79	35.84	0.13567	-0.000169	2	1	27	175	80	0	1	0	0	1	0	0	7629	7206
35.75	35.87	0.09502	-0.000789	2	1	27	175	80	0	1	0	0	1	0	0	8466	6720
35.66	35.75	0.07688	-0.000717	2	1	27	175	80	0	1	0	0	1	0	0	2669	6785
35.66	35.73	0.14027	7.53E-05	2	1	27	175	80	0	1	0	0	1	0	0	3310	5625
35.71	35.79	0.14932	0.0004417	2	1	27	175	80	0	1	0	0	1	0	0	5770	3944
35.75	35.84	0.08592	0.0005209	2	1	27	175	80	0	1	0	0	1	0	0	4217	6815
35.61	35.69	0.11765	0.0002377	2	1	27	175	80	0	1	0	0	1	0	0	8161	6231
35.77	35.84	0.14924	-0.000508	2	1	27	175	80	0	1	0	0	1	0	0	4571	3112
35.77	35.81	0.15385	-5.77E-06	2	1	27	175	80	0	1	0	0	1	0	0	5700	7857
35.79	35.84	0.15376	0.0004933	2	1	27	175	80	0	1	0	0	1	0	0	7962	8201
35.83	35.91	0.14932	0.0007123	2	1	27	175	80	0	1	0	0	1	0	0	4729	6386
35.87	35.91	0.09502	-0.000214	2	1	27	175	80	0	1	0	0	1	0	0	7361	6774
35.79	35.89	0.06331	-0.000606	2	1	27	175	80	0	1	0	0	1	0	0	6807	8417
35.77	35.83	0.06335	-0.00025	2	1	27	175	80	0	1	0	0	1	0	0	7693	4447

Figure 2: Visual presentation of the respondent's data

Before starting work on the data, we carry out their preliminary processing (Data Preparation) [11]. For this purpose, the values of the features in the input vector are reduced to a given range, for example, [0... 1] or [-1... 1]. The need to normalize data samples is due to the nature of the algorithms and models of machine learning used. The initial values of the features can vary in a very large range and differ from each other by several orders of magnitude. Since there are columns in the existing data set, we first find the columns whose values are duplicated (for example Feel_ill_today_YES and Feel_ill_today_No) and in the first step we combine them into a single column with a value of 0 or 1.

Being different in physical content, the data differ greatly in absolute value. The work of analytical models of machine learning (neural networks, Kohonen maps, etc.) with such indicators is incorrect: the imbalance between the values of the features can cause instability of working models, reduce learning outcomes and slow down the modeling process. For example, comparing the values of the Test 1, Test 2, and Temp_slope attributes will disable the model.

After normalization, all the numerical values of the input features will be reduced to a single area of their change - a narrow range. This will bring them together in one model of machine learning and ensure the correct operation of computational algorithms.

Therefore, after the normalization procedure, the type of data is shown in Figure 3. Also, at this stage, the tapes with NaN values were removed. The target attribute is a label column, where 1 is stress and 0 is stress free. The size of the processed data is 1180 tapes. Number of respondents - 92 people (see Figure 4).

	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC
1	TEMP_me	TEMP_std	TEMP_mir	TEMP_ma	BVP_peak	TEMP_slo	subject	label	age	height	weight	gender_n	coffee_to	sport_tod	smoker	feel_ill_t	Test 1	Test 2
2	0.998634	0.111481	0.996658	0.996386	0.454545	-0.05398	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.901134	0.856125
3	0.996339	0.263013	0.995544	0.997722	0.318362	-0.25182	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	1	0.798384
4	0.993983	0.242881	0.993038	0.993884	0.257576	-0.22893	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.327043	0.806107
5	0.993646	0.171562	0.993038	0.993328	0.469963	0.024039	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.405588	0.66829
6	0.994869	0.170524	0.994431	0.994996	0.500283	0.141035	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.707021	0.468576
7	0.99657	0.197735	0.995544	0.996386	0.287879	0.166312	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.516726	0.809671
8	0.997718	0.166617	0.997215	0.997776	0.394162	0.075887	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	1	0.740288
9	0.996811	0.17302	0.996101	0.996386	0.5	-0.16205	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.562239	0.369728
10	0.995967	0.092924	0.996101	0.995552	0.515443	-0.00184	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.701107	0.933468
11	0.996781	0.160808	0.996658	0.996386	0.515152	0.157514	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.979336	0.974338
12	0.998436	0.236424	0.997772	0.998332	0.500283	0.22743	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.581673	0.758703
13	0.998872	0.114988	0.998886	0.998332	0.318362	-0.06836	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.905412	0.8048
14	0.997638	0.213688	0.996658	0.997776	0.212121	-0.19349	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.837269	1
15	0.99626	0.125358	0.996101	0.996108	0.212241	-0.07969	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.946248	0.52865
16	0.995226	0.097518	0.995544	0.994996	0.5	0.003978	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.683518	0.778768
17	0.995592	0.144149	0.995544	0.994996	0.227401	0.13594	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.45449	0.760105
18	0.997177	0.211855	0.996101	0.997722	0.515152	0.191555	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.733087	0.339396
19	0.999059	0.227436	0.998051	0.998888	0.181921	0.192538	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.325461	1
20	0.999233	0.128365	0.998886	0.998888	0.394162	-0.08607	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.473432	0.271725
21	0.9992	0.129344	0.999443	0.999444	0.484848	0.074994	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.668758	0.518072
22	0.99989	0.111303	1	0.999444	0.485123	-0.04315	0.117647	1	0.771429	0.925926	0.888889	1	0	0	0	0	0.441943	0.290182

Figure 3: Normalized data

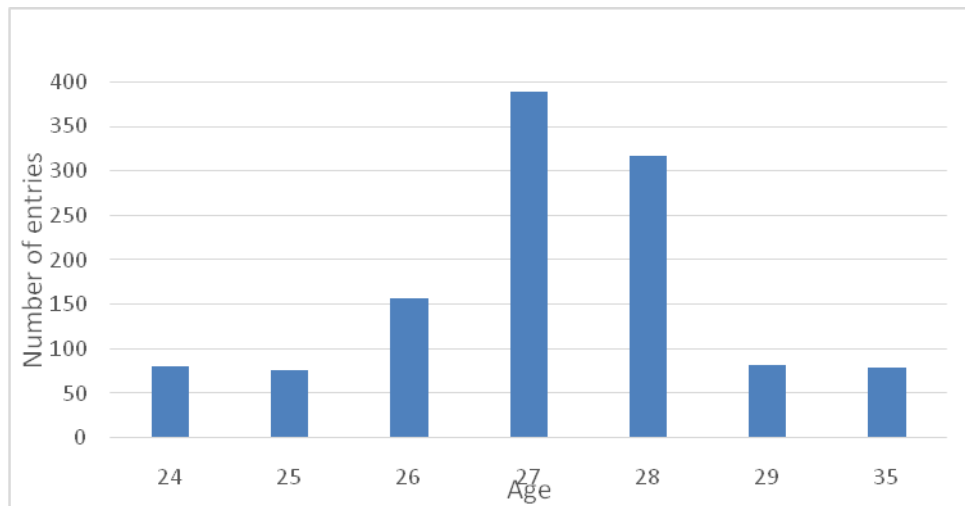


Figure 4: Diagram of the frequency of recordings before respondents

In addition to the state of the human cardiovascular, respiratory and muscular systems, the level of stress can be assessed by the speed of a person's reaction.

Subjective methods of stress assessment, including psychological testing and introspection, are now widely used. Currently, there are many variants of tests that detect anxiety, each of which differently reflects the components of anxiety in stress. Some tests take into account only the subjective components of anxiety, in others - its autonomic manifestations.

In addition to the traditional measurements of anxiety as a personality trait, there has recently been a tendency to identify the underlying or overt cause of this anxiety, which is realized in the form of specific fears (objects of anxiety). As it turned out, each person has an individual hierarchical structure of personal fears, which determines the effects on which a person develops psychological stress in the first place [14].

The most common methods are such as: the study of Spielberger-Khanin anxiety, "Self-assessment of anxiety Tsungge", a questionnaire to study the current fears of the individual - SLA, a test to study emotional states [12-14].

Test №1. Stroop color-word inference test. In psychology, the effect of the scab is called a reaction delay when reading words, when the color of the words does not match the written words (for example, the word "red" is written in blue). In the standard version of the test, the subject is asked to read the name of colored words (see Figure 5). This subtask is called "word reading". The second subtask is to write the color of the ink. The last subtask is to write the color of the word that appears on the screen.

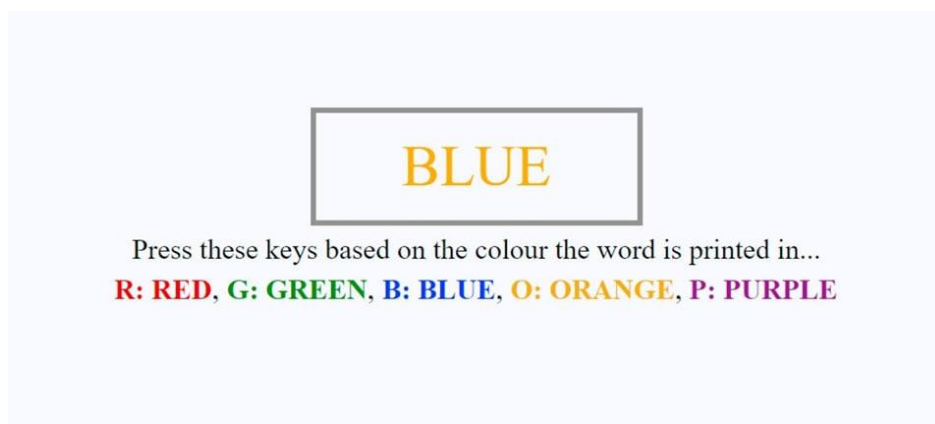


Figure 5: Stroop color-word inference test

In addition, the Strupa test will talk about the ability to focus and focus at a specific point in time. High levels of stress, the presence of any unresolved issues that do not come out of the head, obvious drowsiness, etc. interfere with the passage of the Strupa test. However, if a person seems to be all right, and the test is still given to him is clearly difficult because of the inability to concentrate, it may be worth paying attention to the ability to concentrate.

Test №2. Test to find a "hidden" object. The technique allows to assess the concentration and attentiveness of the person (see Figure 6). In the standard version of the test, it is suggested to find a "hidden" object drawn on the screen among other objects similar in shape or color.



Figure 6: Test to find a "hidden" object

6. Results

During the development of the proposed model the following methods were implemented:

1. Decision tree;
2. Naive Bayesian classifier;
3. The method of k-nearest neighbors;
4. Own neural network using Keras.

Decision tree. The aim is to create a model that assumes the value of the target variable by studying simple decision-making rules derived from the characteristics of the data. The elements of the tree structure are "leaves" and "branches". At the edges ("branches") of the decision tree are written the attributes on which the objective function depends, in the "letter" are written the values of the objective function, and in other nodes - the attributes by which the cases differ.

A naive Bayesian classifier is a probability classifier that uses the Bayesian theorem to determine the probability that an observation (sampling element) belongs to one of the classes under the assumption of (naive) independence of variables.

The method of k-nearest neighbors. A simple non-parametric classification method, where distances (usually Euclidean) calculated to all other objects are used to classify objects within the property space. Objects to which the distance is the smallest are selected, and they are allocated to a separate class [15].

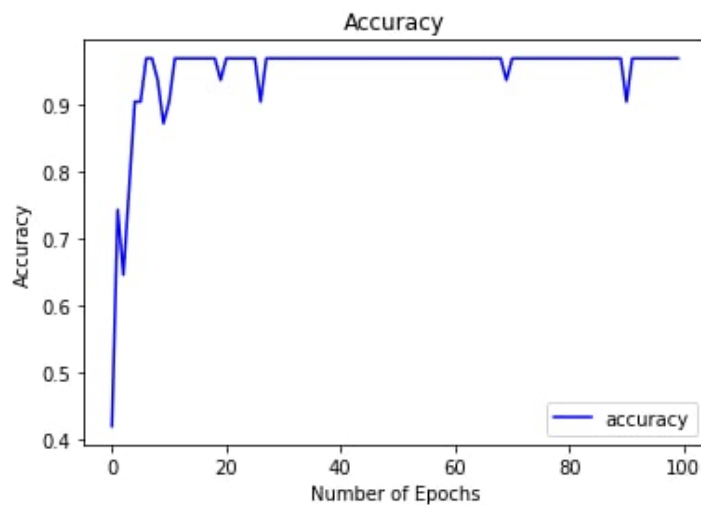
The main principle of the nearest neighbors method is that the object is assigned to the class that is most common among the neighbors of this element. Neighbors are taken based on the set of objects whose classes are already known, and based on the key value of k for this method, it is calculated which class is the most numerous among them [15].

Table 1

The results of the methods of the proposed model

No	Method	Accuracy
1	Artificial neural network	94%
2	K-nearest neighbor method	82%
3	Decision tree	79%
4	Naive Bayes classifier	77%

Own neural network using Keras. This interface-classifier allows you to implement your own model using the Keras neural network library. The results achieved during the development of the model are shown in Table 1. Also, in Figure 7 shows a graph of the accuracy of the model during training.

**Figure 7:** Graph of model accuracy during training

The result shows that the best accuracy is achieved in a method written using Keras. It was used for development:

1. Keras —an open neural network library written in Python.
2. Numpy —Python language extension that adds support for large multidimensional arrays and matrices, along with a large library of high-level mathematical functions for operations with these arrays.
3. Pandas —software library for data manipulation and analysis. In particular, it offers data structures and operations for manipulating numerical tables and time series.
4. Scikit-learn —is a free machine learning software library for the Python programming language that provides functionality for creating and training various classification, regression, and clustering algorithms.

7. Conclusions

In conditions of constant influence of stressors on the human mind, the decision can be ill-considered and made under the influence of emotions. In order to avoid such a situation in the workplace, the head of the enterprise should monitor the condition of the operator.

To predict the stress of the human operator, this system for assessing the stress of the human operator was developed. The main task of the model is to predict on the basis of the obtained parameters of the human condition (stress or not). To improve the performance of the model based on input data on physical parameters, sex, age, height, bad habits, additional testing was added. The purpose of testing is to increase the accuracy of model prediction.

Data on 92 respondents with 1180 records were selected for testing. Dataset division: test - 20%, training / validation - 80%. The best results were achieved with the help of our own developed neural network based on Keras. Also, in the course of the work the implementation of decision-making methods, naive Bayesian classifier, method to the nearest neighbors was presented.

During the work the following advantages of the model were realized:

1. Avoiding possible failures in reading data from the file by implementing continuous data acquisition from the sensor;
2. Introduction of employee tests for constant monitoring of his condition;
3. Conclusions about further participation in the decision-making process are based not only on physiological indicators, but also on general characteristics such as age, sex, weight, the presence of bad habits and more;
4. Normalization of input data to increase the accuracy of the prediction result of the developed model.

The main disadvantages include:

1. Working with sensors causes possible malfunctions, so the collected data may not be complete. Also, it is necessary to mention possible failures in the work of the Internet;
2. The model is very sensitive to "anomalies" in the data, so any of them can cause forecasting failures;
3. The model has been tested on a sample of up to 2,000 records, so its work with more data remains unexplored.

In general, the results of the developed model are good and need to be improved and tested on a large amount of data.

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