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Stabilization and recovery assistant of people with disabilities based on artificial intelligence methods

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Abstract. Chronic non-communicable diseases account for more than 70% of global mortality statistics. The main share is made up of diseases of the cardiovascular system. Adequate preventive measures—impact on controllable and conditionally controllable risk factors—can reduce the contribution of these diseases to the structure of mortality. A significant effect can be achieved with an adequately selected level of physical activity, but doctors do not always recommend specific actions to patients. This article describes a prototype of a cognitive assistant for constructing personalized plans for therapeutic physical exercises for relatively healthy people and people suffering from cardiovascular diseases. The developed system consists of two main components: a cardiovascular risk assessment module and an exercise planning module. The risk assessment module consists of a knowledge base and an argumentative reasoning algorithm. Its task is to identify risk factors and levels, which is dual in nature: in the case of monitoring a relatively healthy user, the risk of developing cardiovascular disease is assessed, while in the case of interaction of the system with a user with cardiovascular disease, the risk of complications of a chronic form is assessed—development of a cardiovascular event. The exercise planning module includes an exercise database and a scheduler algorithm. The planning algorithm selects optimal therapeutic physical exercises according to optimal criteria, in order to form a plan that will not harm the patient and will increase his physical performance. The developed mechanism allows you to create training scenarios for users with any level of initial training, taking into account the available sports equipment, the preferred location for training (home, street, gym) and at any level of the cardiovascular continuum.

Key words and phrases: cognitive assistant, prevention, planning, risk analysis, semiotic network, knowledge base

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1. Introduction

According to the World Health Organization (WHO), there were 55.4 million deaths worldwide in 2019. The WHO Fact Sheet notes that cardiovascular diseases have been the leading cause of death worldwide for more than 20 years. The most common cause of death is coronary heart disease, accounting for 16% of total deaths worldwide. The greatest increase in mortality since 2000 was due to this disease: by 2019, mortality from it increased by more than 2 million cases and reached 8.9 million cases. Cerebral stroke is the second leading cause of death, accounting for approximately 11% of total deaths [1].

Together, coronary heart disease, stroke, diabetes, lung cancer, and chronic obstructive pulmonary disease accounted for nearly 100 million additional healthy life years lost in 2019 compared to 2000 [2].

In the Russian Federation, chronic non-communicable diseases (CNCDs) are found in a large number of the adult working population and are the leading causes of mortality. For example, arterial hypertension is found in 45.7% of the adult population of the Russian Federation [3]. As a result of mortality from CVDs in Russia in 2016, economic losses amounted to 2.7 trillion rubles (3.2% of gross domestic product) [4]. More than 90% of these losses are due to the mortality of people of working age.

The Russian Federation is implementing a comprehensive strategy for the prevention of non-communicable diseases, in which two directions can be distinguished—identifying people at high risk of chronic diseases or with an unidentified diagnosis [5]. Preventative measures include influencing lifestyle factors and other preventive measures in an identified group of people with increased risk factors [6]. Early identification of risk factors and prevention of the development of chronic non-diseases with personalization for a specific patient and his involvement in the process (4P medicine), according to some estimates, can increase the quality of life by 9.8%, reduce the number of years of life potentially lost due to disability by 27.3% [7]. The main goal of timely identification of risk factors and early prevention is to orient the patient towards a healthy lifestyle, and this is the main difference between preventive medicine and the traditional approach of palliative medicine [8].

Risk factors for the development of CNCDs (as well as other diseases) are usually divided into 2 groups: uncontrollable and controllable (unchangeable and modifiable or non-modifiable and modifiable) [9]. Uncontrollable factors include those factors that the patient and the doctor cannot influence—heredity, family history, trauma, past illnesses, etc. Controllable (changeable/modifiable) factors are those the degree of influence of which can be reduced, and ideally eliminated, due to medical and non-medical influence [9]. Among the controllable ones, we can distinguish a group of conditionally controllable risk factors, which include chronic diseases, which, with proper drug control, remain in the compensation phase (remission) and do not have a direct or indirect negative impact on the human body. Thus, the main task is the timely identification of controllable and conditionally controllable risk factors in the patient and adequate influence on them.

The modern approach to preventing exposure to risk factors is not only about changing behavioral habits and lifestyles and medicinal control of conditions. WHO currently gives a major role to the adequate prescription of physical exercise as a component of an integrated approach to the prevention and treatment of cardiovascular diseases [10]. In addition, it was noted that 5 million deaths per year can be prevented by increasing the level of physical activity of the population, thus reducing the risk of mortality from chronic NCDs by 20%–30%. However, in modern prevention, recommendations for optimizing physical/motor activity are too superficial. Although, when recommending certain types of physical activity to patients, even such as regular physical activity (walking), it is possible to reduce systolic blood pressure in people suffering from arterial hypertension to the target level of 140 mm Hg. Art. and below [11]. Doctors need to explain in detail to patients which exercises they can use and which they cannot. It is also advisable to help patients create individual training plans. A number of multicenter large studies have demonstrated that regular dosed aerobic dynamic exercise lasting 150–300 minutes can significantly reduce the development of cardiovascular diseases in healthy individuals and reduce the risk of developing cardiovascular events in individuals who already have a number of cardiac nosologies [12]. Dosed anaerobic with static loads did not have a significant effect on these points, but they improved the quality of life and overall tolerance to physical activity.

In this regard, the purpose of this study is to develop an approach to developing personalized recommendations to the patient for certain physical exercises that he should perform independently. To achieve this goal, the patient is provided with an assistant who creates a personalized physical activity plan, approved by the doctor, with tips for implementation and gradually increasing intensity.

2. Materials and methods

The assessment of risk factors is based on a combined approach based on domestic and foreign clinical models and recommendations [4, 13, 14]. The assessment of risk levels is based on the cardiovascular continuum model [13], from which patients were divided into two main groups: patients without cardiovascular diseases and patients already having one or more cardiovascular diseases. Thus, for patients, the identification of risk factors and levels is of a different nature: in the first case, we are talking about assessing the risk of developing cardiovascular disease, while in the second case, the risk of complications of chronic non-diseases is assessed—the development of a cardiovascular event [15].

A formalized representation of knowledge about assessing the risks of developing a cardiovascular disease or a cardiovascular event in a person is carried out on the basis of a knowledge base implemented in the form of a heterogeneous semantic network (HSN) [16].

The construction of a set of hypotheses and the final solution is carried out on the basis of an argumentative algorithm proposed by G. S. Osipov [17]. Based on the information about the patient available in the system, a primary set of nodes is activated, then the algorithm sequentially performs the operations of expanding and narrowing the set of arguments, activating and eliminating hypotheses until the sets of hypotheses and arguments are stabilized. Stabilized sets are the result of the algorithm—risk levels (hypotheses) are explained by risk factors (arguments).

3. Results

A prototype of an assistant for the stabilization and improvement of people with disabilities c.Live using therapeutic physical education methods has been developed. The created intelligent recommendation system is focused on preventing the development of CNCDs in healthy patients and preventing the deterioration of development in people suffering from CNCDs, with the help of recommendations for lifestyle correction and a personalized plan for physical therapy exercises [18]. The developed prototype, in the first version, is focused on personifying risk assessment and issuing recommendations for the prevention of coronary heart disease using exercise therapy methods [19]. For this purpose, expert knowledge was collected not only from cardiologists, but also from rehabilitation doctors [20]. It is possible to assess risk factors based on the characteristics (parameters) of a person. In implementing the system, two main sources of obtaining information about the patient were identified: questionnaires in the application and electronic medical records (EMR). These sources are complementary, but a situation is envisaged when there is no access to the patient's EMR.

Knowledge about the names of risk factors, risk levels, physical exercise and general preventive recommendations was obtained from international and domestic literature, including clinical guidelines and individual scientific publications. The knowledge was adapted to the characteristics of the Russian population, for which expert work was carried out by cardiologists together with rehabilitation doctors. Thus, a structured representation of knowledge was formed.

Before determining and prescribing treatment or prevention tactics for CNCDs, the doctor needs to comprehensively assess the patient's health status in order to prescribe adequate (in a particular case) recommendations. To do this, the first stage of the assistant's work is to assess the risk levels of CNCDs.

After the risk levels are assessed, the physical exercises acceptable for the patient to perform are selected. For this purpose, a database was created in which attributes were added to all types of physical activity: indications and contraindications for use. The risk levels calculated by the system are indications and contraindications depending on their nature. If the patient does not have a disease of the cardiovascular system, and the maximum calculated risk level is not higher than high, then this situation is considered a partial limiter—the variety of possible exercises is not reduced, but the duration of training and the number of approaches for one exercise are reduced. For situations of patients with cardiovascular diseases with a calculated level of risk of a cardiovascular event that is very high or extreme, then in such situations all strength exercises are excluded and restrictions are placed on high-intensity exercises that such exercises should be performed by the patient no more than twice per week at approximately equal intervals.

To personalize the exercises, the following parameters were included in the exercise database:

- Exercise ID. The parameter is necessary for linking with video files demonstrating the correct execution of exercises;
- Brief description of the exercise;
- The number of MET units (universal endurance units) expended during the exercise. This parameter allows you to create a training plan that is optimal for the user;
- Locations where the exercise can be performed. The parameter allows the user to choose one of three locations where he will perform exercises: at home, on the street, in the gym. Each of the locations includes a list of exercise machines and other aids available for use, for example, a fitness expander, which expands the selection of available exercises;
- A list of diseases that this exercise has a positive effect on. This parameter plays an important role in planning exercises that help the user improve their condition. Moreover, for each disease from the list, a numerical representation of the strength of influence is stored, where 1 means weak influence and 5 means strong. This view is used to plan exercises that will bring maximum benefit to the user;
- List of diseases that this exercise negatively affects. This parameter is necessary when planning exercises that will not bring negative consequences to the user. For each disease from this list, a numerical representation of the strength of influence is also stored, where 1 means weak influence and 5 means strong. This representation is used when planning exercises to minimize the possible negative impact of the exercise on the user.

The developed algorithm is presented in Figure 1.

To create a personalized training plan, a planner algorithm has been developed, which is based on the following statements:

- In sports and general physical training, a training plan is drawn up for three months.
- When drawing up a plan, the user's current illnesses are taken into account. Based on knowledge about the user's diseases, the set of exercises acceptable for the user is narrowed.

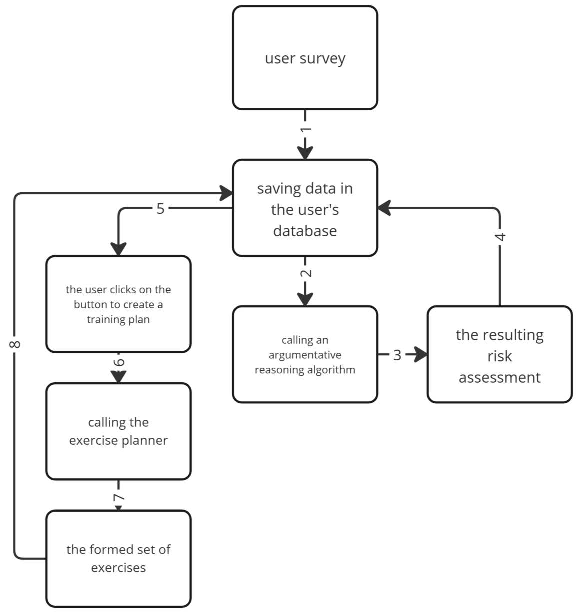

Figure 1. Scheme of synthesis of a personalized exercise plan

- When drawing up a plan, the current health status of the user is taken into account. Before drawing up a plan, potential risks are assessed based on existing health data.
- As the user's training level increases, the load on the user's muscles increases.
- As the user becomes more trained, the intensity of the exercises increases.
- The user can choose a location for training: home/street/gym.

Generating a personalized training plan consists of the following steps:

1. The user takes a survey.
2. The survey results are sent to the risk assessment module. The results of the module's operation are added to the database, which stores information about the user's health status.
3. In the user interface, the "Create a training plan" button becomes available for clicking. When you click on the button, the scheduler algorithm is launched, to which all available information about the user is transmitted as input.
   - 3.1. The scheduling algorithm receives user data.
   - 3.2. The planner algorithm receives a set of exercises, each exercise is described by attributes (number of METs per 1 repetition, indications, contraindications, muscle groups involved, location).
   - 3.3. The planner algorithm excludes from the set of exercises those that have a negative impact on the user's concomitant diseases and those that have a negative impact on diseases whose risk level for the user is quite high.
   - 3.4. The scheduler algorithm divides the remaining exercises into three sets, each set corresponding to one of the possible locations: home, street, gym.
   - 3.5. For each concomitant disease of the user, the planner algorithm ranks sets of exercises in descending order of positive effect on this concomitant disease.

   3.6. For each muscle group (a set of muscles involved during a workout; a total of 4 muscle groups are considered based on the statement of 4 workouts per week), the planner algorithm filters the resulting sets by the attribute "muscle groups involved" and from the remaining exercises based on the principle of maximum benefit for the user compiles sets of exercises for each location. The limit is the amount of METs allowed per workout.
   3.7. The planner algorithm repeats the previous steps for each week, taking into account that over time the allowable amount of METs per workout increases.
   3.8. The result of the scheduler algorithm is stored in the user database.
4. The interface prompts the user to select the location where he plans to conduct the next training session. Data is loaded from the database and displayed to the user.

The scheduling algorithm itself works as follows:

Let given:
$E = \{e_1, \dots .e_n\}$—set of all exercises,
$D = \{d_1, \dots , d_m\}$—the set of all diseases that are taken into account when drawing up a training plan,
$L = \{l_1, \dots , l_k\}$—the set of all locations in which the user can perform exercises.
$M = \{m_1, \dots , m_r\}$—set of muscle groups.
Each exercise e from the set E is characterized by:
l_e—location where exercise should be performed $l_e \in L$,
m_e—the amount of MET, given by some natural number,
t_e—time that will be spent on performing the exercise,
M_e—muscle groups that are affected by the exercise,
P_e—a list of diseases in which this exercise has a positive effect on health,
N_e—a list of diseases in which this exercise has a negative effect on health,
$fp_e : P_e \to \{1, 2, 3, 4, 5\}$—a function that evaluates the positive effect of performing an exercise on human health for a disease selected from P_e, the higher the value, the more positive the effect,
$fn_e : N_e \to \{1, 2, 3, 4, 5\}$—a function that evaluates the negative effect of performing an exercise on human health for a disease selected from N_e; the higher the value, the more dangerous the exercise is for health.
Each user is described by the parameter:
UD—diseases that the user has or the likelihood of having them is high.

The goal of the algorithm is to create sets of exercises for 12 weeks, with four workouts planned each week. The duration of training in the first four weeks is t_1 minutes, in the next four weeks t_2 and in the final four weeks t_3 minutes.

Step 1. We remove all exercises from the list that can cause harm to the user, i.e. exercises that can have a negative effect on his health; we use AE to denote the set of exercises available to the user.

$$AE = \{e \in E : N_e \cap UD = \varnothing\}.$$

Step 2. Organize the many exercises available to the user by location. Let us denote such sets by AE_l, where l indicates the location.

$$AE_l = \{e \in AE : l_e = l\}.$$

Step 3. Let's create sets of exercises for each workout in each location for each muscle group, sets of exercises will be stored in $w_{month,week,muscle\_group}$.

A library of video materials has been created for users, in which an experienced trainer clearly shows how to perform certain exercises. A total of 118 explanatory videos were recorded on the correct execution of exercises in three locations: 41 videos for practicing at home, 36 for practicing outdoors, 41 for practicing in the gym.

Algorithm 1: Create a set of exercises for training

```
months = {1, 2, 3}
weeks = {1, 2, 3, 4}
for l ∈ L
do
    for muscle_group ∈ M
    do
        exercise_list = create_exercise_list(l, m, UD, user_met_limit)
        n=0
        for month ∈ months
        do
            for week ∈ weeks
            do
                total_time := 0
                while total_time < t_month
                do
                    w_{month,week,muscle_group}.add(exercise_list[n])
                    total_time := total_time + t_{exercise_list[n]}
                    n=n+1
                    if n >= len(exercise_list) then
                        n=0
```

Algorithm 2: Create exercise list

```
Function create_exercise_list(location, muscle_group, user_diseases, user_met_limit):
    n := 0
    answer_list := []
    current_size := −1
    exercises_after_filtration =
      filter_exercise_list(location, muscle_group, user_diseases, user_met_lmit)
    while current_size! = len(answer_list)
    do
        current_size := len(answer_list)
        for e ∈ exercises_after_filtration
        do
            if max_{a∈user_diseases} fp_e(a) > n then
                answer_list.add(e)
                n := n + 1
    return answer_list
```

Algorithm 3: Filter exercise list

```
Function filter_exercise_list(location, muscle_group,user_diseases, user_met_lmit):
    answer_list := []
    for e ∈ AE_l
     do
        if muscle_group ∈ M_e & user_met_limit <= m_e then
            answer_list.add(e)
    sort(answer_list) #Sorting exercise in descending order of total utility
    return answer_list
```

4. Conclusions

A feature of the developed architecture of the c.Live cognitive assistant is its easy scalability and extensibility. A formalized representation of knowledge in the form of a heterogeneous semantic network allows you to both reuse existing feature nodes and logical operation nodes, and create new nodes of various types. The argumentative reasoning algorithm is capable of working with a large number of hypotheses and their arguments, while the computation time will increase slightly.

Expanding the list of exercises available to users will allow for more fine-tuning of individual training plans. To expand functionality, close cooperation with practicing doctors of various specialties, including rehabilitation doctors, is necessary.

Due to the fact that a relational structure was chosen to store the knowledge base in a form suitable for machine processing, the current version of the knowledge base can be quite easily expanded by adding new diseases with their risk factors and recommendations. This makes it possible to add treatment scenarios for new diseases based on unified system mechanisms.

As a consistent development of this development, it is advisable at the following stages to pay attention to other diseases: the cardiovascular system (risks of developing arrhythmias, arterial hypertension, heart failure, etc.), the endocrine system (diabetes mellitus, primarily type 2), the digestive system (gastritis, stomach ulcer), pulmonary system (chronic bronchitis, chronic obstructive pulmonary disease, bronchial asthma), etc. Expanding the list of diseases in the application will allow us to cover as many segments of the population as possible from various professions and social status.

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References

1. *Top 10 leading causes of death in the world* https://www.who.int/ru/news-room/fact-sheets/detail/the-top-10-causes-of-death/. 2020.
2. *WHO publishes statistics on the leading causes of death and disability worldwide for the period 2000–2019* https://www.who.int/ru/news/item/09-12-2020-who-reveals-leading-causes-of-death-and-disability-worldwide-2000-2019/. 2019.
3. Balanova, Y. *Arterial hypertension in the Russian population: prevalence, contribution to survival and mortality, possibilities for reducing socio-economic damage* (Abstract for the scientific degree of Doctor of Medical Sciences, 2021).
4. Kontsevaya, A., Drapkina, O. & Balanova, Y. Economic damage from cardiovascular diseases in the Russian Federation in 2016. *Rational pharmacotherapy in cardiology* **14,** 156–166 (2018).
5. Boytsov, S., Chuchalin, A. & Arutyunov, G. Prevention of chronic non-infectious diseases: Recommendations. *Profmedforum* (2013).
6. *Cardiovascular prevention 2017. Russian national recommendations* 122 pp. (2018).
7. *P4-medicine - a new direction in the development of healthcare* https://www.dirklinik.ru/article/500-4p-meditsina-novoe-napravlenie-razvitiya-zdravoohraneniya/. 2023.
8. Suchkov, S., H., A. & Antonova, E. Personalized medicine as an updated model of the national healthcare system.Part 1. Strategic aspects of infrastructure. *Russian Bulletin of Perinatology and Pediatrics* **62,** 7–14 (2017).
9. Savilov, E. & Shugaeva, S. Risk factor: theory and practice of application in epidemiological studies. *Epidemiology and infectious diseases* **22,** 306–310 (2017).
10. *World Health Organization. News bulletin. Physical activity.* https://www.who.int/ru/news-room/fact-sheets/detail/physical-activity/. 2023.
11. Shebeko, L., Vlasova, S., Germanovich, L. & Belyakovskaya, N. Physical rehabilitation of patients with arterial hypertension. *Bulletin of the Transbaikal State University* **93,** 80–87 (2013).
12. Bubnova, M. & Aronov, D. Methodic recommendations. Maintaining physical activity of those with limitations in health. In Russ. *CardioSomatics* **7** (ed Boytsov, S.) 5–50 (2016).
13. Trenkwalder, P. Preventing thecardiovascular complications of hypertension. *European Heart Journal Supplements* **6,** H37–H42 (2004).
14. ESC recommendations for the prevention of cardiovascular diseases in clinical practice. *Russian Journal of Cardiology. Clinical recommendations. Arterial hypertension in adults* **27,** 191–288 (2022).
15. Tolpygina, S. & Martsevich, S. Cardiac risk stratification in stable coronary artery disease. In Russ. *The Clinician* **14,** 24–33. doi:10.17650/1818-8338-2020-14-1-2-24-33 (2020).
16. Kobrinsky, B., Kadykov, A., Poltavskaya, M., Blagoslonov, N. & Kovelkova, M. Principles of functioning of an intelligent system for dynamic control of risk factors and the formation of recommendations for health care. *Preventive Medicine* **22,** 78–84 (2019).
17. Osipov, G. *Acquisition of knowledge by intelligent systems: Fundamentals of theory and technology* Russian (Fizmatlit, 1998).
18. Drapkina, O., Novikova, N. & Dzhioyeva, O. Methodological recommendations: "Current opportunities and prospects of complex physical activity of patients with cardiovascular pathology". In Russ. *Russian Journal of Preventive Medicine* **23,** 61–119. doi:10 . 17116 / profmed20202303261 (2020).
19. Dibben, G., Faulkner, J., Oldridge, N., Rees, K., Thompson, D., Zwisler, A.-D. & Taylor, R. Exercise-based cardiac rehabilitation for coronary heart disease. *Cochrane Database of Systematic Reviews* **11.** doi:10.1002/14651858.CD001800.pub4 (2021).
20. Lyamina, N., Karpova, E., Kotelnikova, E. & Bizyaeva, E. Physical training in the rehabilitation and prevention in patients with ischemic heart disease after percutaneous coronary

interventions: the borders of efficiency and safety. In Russ. *Russian Journal of Cardiology,* 93–98. doi:10.15829/1560-4071-2014-6-93-98 (2014).

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Ассистент стабилизации и восстановления людей с ограниченными возможностями на основе методов искусственного интеллекта

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Аннотация. Хронические неинфекционные заболевания составляют более 70% в статистике общемировой смертности. Основную долю составляют заболевания сердечно-сосудистой системы. Снизить вклад данных заболеваний в структуру смертности могут адекватные меры профилактики — воздействие на управляемые и условно управляемые факторы риска. Значительного эффекта можно добиться с помощью адекватно подобранного уровня физической активности, однако врачи не всегда рекомендуют пациентам конкретные действия. В настоящей статье описан прототип когнитивного ассистента построения персонифицированных планов лечебных физических упражнений для условно здоровых людей и лиц, страдающих сердечно-сосудистыми заболеваниями. Разработанная система состоит из двух основных компонентов: модуль оценки рисков сердечно-сосудистых заболеваний и модуль планирования упражнений. Модуль оценки рисков состоит из базы знаний и алгоритма аргументационных рассуждений. Его задача — выявление факторов и уровней риска, которое носит двойственный характер: в случае мониторинга условно здорового пользователя происходит оценка риска развития сердечно-сосудистого заболевания, в то время как в случае взаимодействия системы с пользователем с сердечно-сосудистым заболеванием, оценивается риск осложнения хронической формы — развитие сердечно-сосудистого события. Модуль планирования упражнений включает базу данных упражнений и алгоритм-планировщик. Алгоритм планирования осуществляет подбор оптимальных лечебных физических упражнений по оптимальным критериям, с целью формирования такого плана, который не навредит пациенту и увеличит его физические показатели. Разработанный механизм позволяет составлять сценарии тренировок для пользователей с любым уровнем исходной подготовки, с учётом имеющегося спортивного инвентаря, предпочитаемой локации для выполнения тренировок (дом, улица, зал) и на любом уровне сердечно-сосудистого континуума.

Ключевые слова: когнитивный ассистент, профилактика, планирование, анализ рисков, семиотическая сеть, база знаний