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Identification of causal relationships of risk assessment

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Identification of causal relationships of risk assessment

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Abstract. The paper deals with the identification of the cause-and-effect relationship of risk assessment with an indistinctly specified initial information. An example of a risk assessment task is the operation of a storage facility for the transport or storage of industrial products. A fire with different parameters must be considered as an anomalous external influence. The storage response , measured by the assessment of the safety of the content and its non-penetration into the external environment , can vary depending on the current state of the system, for example, the degree of possible damage in emergency conditions.

1. Introduction

It is known that any preventive measures to prevent and eliminate emergencies and to ensure fire safety are based on the analysis of certain statistical data. These statistics are compiled using special systems designed to account for fires and their consequences. In order to take into account fires and their consequences, to analyze the causes and conditions of fires, to assess the fire safety of residential areas and facilities, to develop measures to prevent fires, as well as to create conditions for firefighting.

The current fire registration information system has the following shortcomings:

1. Only statistical data in the form and content that responds to strictly regulated queries are available in the system. For example, strict statistical reports can be obtained on the basis of available data on regions, objects, causes, consequences and other factors. It is not possible to obtain information (reports) on unregulated requests.

2. Based on the data in the system, the relationship between the causes and consequences of fires is not assessed or analyzed.

3. Based on the data obtained, it is not possible to assess and forecast the fire safety situation in the regions due to various factors.

4. It is not possible to enter primary fire data from the regions online and use the central database remotely.

5. Modern technologies for input, processing and reporting of primary data are not used.

These include the lack of an effective system for monitoring and forecasting emergencies, despite the existence of a number of specialized agencies responsible for forecasting, assessing, monitoring and controlling the safety of the population and territories from natural, man-made and environmental emergencies. and as a result, a comprehensive analysis of the threat of earthquakes, dangerous hydrometeorological events, exogenous geological processes, man-made accidents and disasters, and the risk of their occurrence is not fully implemented. Fires are emergencies that cause damage to the lives and health of citizens, property of legal entities and individuals, as well as the environment, causing man-made accidents and disasters.

Analysis of the literature has shown that today in modern domestic and foreign science, not enough attention is paid to the use of the modeling method in the investigation of the cause-and-effect relationships of fires. At the same time, the capabilities of this particular method in the study of the cause-and-effect relationships of fires make it possible to fully restore the true picture of what happened.

Modern methods of risk assessment are a set of all possible methods for assessing, analyzing and ensuring the safety of a certain object. At the moment, the number of known methods is counted in dozens, however, not all of them have found practical application, and have remained only a hypothetical model in relation to security. In addition, it should be noted that the problem is that not all existing modern knowledge is applied in the investigation of the cause-and-effect relationships of fires. For example, the emergence of risk assessment based on the theory of probability has become a major impetus for the development of a security system. Therefore, we can conclude that any promising direction from an adjacent or even parallel area can give impetus to the further development of the theory of security. This is confirmed by the wide integration of the most advanced ideas into security: modern integrated security systems based on a software and hardware complex; application of mathematical analysis in the field of reliability [1-3].

Despite the large number of methods, the quality of assessing the risk of fires is still not at a sufficient level, therefore, it is necessary to consider methods that are fundamentally new for this area. These include the adaptation of artificial neural networks and fuzzy sets [2-4].

Fire is one of the emergencies that cause damage to the lives and health of citizens, property of legal entities and individuals, as well as the environment, causing man-made accidents and disasters.

Therefore, the creation of the most necessary software for the construction of an automated information-analytical system based on modern artificial intelligence and information-analytical technologies for the registration of fires and the analysis of their causes is an urgent scientific and practical problem.

2. The main part

To identify the cause-and-effect relationships of risk assessment during the operation of a storage facility for transportation or storage of industrial products, it is necessary:

1. Formalize the task:

– to create classification and descriptive scales;

– to collect the initial factual information and enter the training sample into the system.

2. Carry out the synthesis and verification of the model.

3. Estimate the value of features for forecasting. Highlight the features that are most essential for solving the problem.

4. Analyze the model by answering the following questions:

– What will be the maximum temperature inside the storage with the known parameters of the fire?

– Does the internal temperature exceed the set critical value or not? If so, how long will the system be in critical conditions?

– Which corresponds to the greater risk of damage to the contents of the storage facility: a short but high temperature fire, or a prolonged moderate heat load?

5. Display the results of the analysis in graphical form of non-local neurons and semantic networks of features.

A fire with different parameters must be considered as an anomalous external influence. The storage response (as measured by the assessment of the safety of the content and its non-penetration into the external environment) can vary depending on the current state of the system, for example, the degree of possible damage in emergency conditions.

An object of the form

$$y = f(x_1, x_2, ..., x_n), \tag{1}$$

for which the connection < inputs (x_i) -output (y) > can be represented as an expert knowledge matrix.

A method of representing linguistic information about an object (1) in the form of a special *neuro-fuzzy* network isomorphic to the knowledge base is proposed.

The essence of training consists in the selection of such weights of the arcs that minimize the difference between the results of neuro- fuzzy approximation and the real behavior of the object. The system of recurrent relations is used for training [1-2]:

$$w_{jp}(t+1) = w_{jp}(t) - \mu \frac{\partial E_t}{\partial w_{jp}(t)}, \tag{2}$$

$$c_i^{jp}(t+1) = c_i^{jp}(t) - \eta \frac{\partial E_t}{\partial c_i^{jp}(t)}, \tag{3}$$

$$b_i^{jp}(t+1) = b_i^{jp}(t) - \eta \frac{\partial E_t}{\partial b_i^{jp}(t)}, \quad j = \overline{1,m}, i = \overline{1,n}, p = k_j. \tag{4}$$

minimizing criterion

$$E_t = \frac{1}{2}(\hat{y}_t - y_t)^2, \tag{5}$$

applied in the theory of neural networks, where:

$\hat{y}_t$ and y_t –– Theoretical and experimental outputs of the object (1) on the t-m step of training;

$w_j^p; c_i^{jp}, b_i^{jp}$ – Weight rules(w)and accessories (b,c)parameters on the t-m step of training;

η – a learning option that can be selected in accordance with work recommendations.

Private derivatives included in the ratios (2)-(4) characterize the sensitivity of the error (E_t) to the change in the parameters of the neuro-fuzzy network, and are calculated as follows:

$$\frac{\partial E_t}{\partial w_{jp}} = \varepsilon_1 \varepsilon_2 \varepsilon_3 \frac{\partial \mu^{dj}(y)}{\partial w_{jp}}, \tag{6}$$

$$\frac{\partial E_t}{\partial c_i^{jp}} = \varepsilon_1 \varepsilon_2 \varepsilon_3 \varepsilon_4 \frac{\partial \mu^{jp}(x_i)}{\partial c_i^{jp}}, \tag{7}$$

$$\frac{\partial E_t}{\partial b_i^{jp}} = \varepsilon_1 \varepsilon_2 \varepsilon_3 \varepsilon_4 \frac{\partial \mu^{jp}(x_i)}{\partial b_i^{jp}}, \tag{8}$$

where

$$\varepsilon_1 = \frac{\partial E_t}{\partial y} = y_t - \hat{y}_t, \tag{9}$$

$$\varepsilon_2 = \frac{\partial y}{\partial \mu^{d_j}(y)} = \frac{\overline{d}_j \sum_{j=1}^{m} \mu^{d_j}(y) - \sum_{j=1}^{m} \overline{d}_j \mu^{d_j}(y)}{\left(\sum_{j=1}^{m} \mu^{d_j}(y) \right)^2}, \tag{10}$$

$$\varepsilon_3 = \frac{\partial \mu^{d_j}(y)}{\partial \left(\prod_{i=1}^{n} \mu^{jp}(x_i) \right)} = w_{jp}, \tag{11}$$

$$\varepsilon_4 = \frac{\partial\left(\prod_{i=1}^{n} \mu^{jp}(x_i)\right)}{\partial \nu^{jp}(x_i)} = \frac{1}{\mu^{jp}(x_i)} \prod_{i=1}^{n} \mu^{jp}(x_i), \tag{12}$$

$$\frac{\partial \mu^{d_j}(y)}{\partial w_{jp}} = \prod_{i=1}^{n} \mu^{jp}(x_i), \tag{13}$$

$$\frac{\partial \mu^{jp}(x_i)}{\partial c_i^{jp}} = \frac{2c_i^{jp}(x_i - b_i^{jp})^2}{((c_i^{jp})^2 + (x_i - b_i^{jp})^2)^2}, \tag{14}$$

$$\frac{\partial \mu^{jp}(x_i)}{\partial b_i^{jp}} = \frac{2(c_i^{jp})^2(x_i - b_i^{jp})}{\left((c_i^{jp})^2 + (x_i - b_i^{jp})^2\right)^2}. \tag{15}$$

Similarly, the neuro-fuzzy network learning algorithm consists of two phases. In the first phase, the model value of the object output is calculated, corresponding to the set network architecture. In the second phase, the value of the non-binding is calculated (6) and (15) the weights of the interneural bonds are recalculated.

3. Conclusion

Based on the information obtained, it will be possible to assess and forecast the state of fire safety in the region on various factors using modern artificial intelligence and information-analytical technologies. Primary data will be transmitted online from the regional and district departments of the Ministry of Emergency Situations to the Central Database in Tashkent via a VPN network.

The developed report generator allows to generate and receive data (reports) on arbitrary queries and forms. With the help of the developed mobile application, the state fire service officers involved in the investigation will be able to use the necessary instructions and legal documents.

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