RT&A, Special Issue № 4 (70)
Volume 17, November 2022

ALGORITHM FOR BUILDING A HYBRID MODEL OF THE EXISTING RISK MODEL

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Abstract

Putting risk theory and risk modeling into practice is high on the agenda. We introduce a forecasting algorithm that can be used to forecast "predictive events" - such as forecasting the risk of natural processes, as well as forecasting the risk of various processes of human activity. The article considers an algorithm for choosing the best pairs from event risk forecast models, which, using the precursors of these pairs, significantly reduces the risk of occurring of an event. For a given predictive event, the existing precursors of events are studied, on the basis of which a hybrid model is built.

Keywords: risk management, parallel data, prediction models, model improvement algorithm

I. Introduction

Risk, as an integral element of the economic, political and social life of society, necessarily accompanies all areas and spheres of public life. Basic scientific research in the field of safety theory and risks is very important in order to apply it in practice to reduce actual risks.

We have considered an algorithm for predicting events, which, by using parallel data, gave a sufficiently high forecast reliability, which makes it possible to reduce risks or avoid them altogether [1,2]. In this paper, we will review risk prediction models and the issues of building a new hybrid model based on them. A hybrid model is built based on the study of precursors for a given predicted event.

The conditions and factors of risk occurrence are of natural, man-made and social origin, if we consider them by genesis. Risks can be divided into predictable and unpredictable risks. Unpredictable risks for the evaluation of events may arise in force majeure situations. In this cases, timely identification of these hazards and threats is important to reduce the negative impacts they cause.

Recently, models have been used for non-force majeure risk situations in order to avoid or reduce negative consequences through timely and correct actions. Models should also be developed for force majeure situations (wars, emergency disasters, Tectogenic disasters). When considering the risks of economic tasks, models are developed for individual groups. There is a risk management model for service sector organizations, also decision-making models under conditions of uncertainty, as well as a model for taking into account risks in investment projects, and others are considered [3].

We need to identify risks before we consider risk prediction issues. For this one should:

- identify the possible consequences of the action of risk factors;
- identify existing hidden obstacles to achieving goals;
- in case of unsuccessful or undesirable development of events, new backup capabilities should be used, that is, if something unexpected happens, the model should be expanded.

The result of forecasting the risk of a certain event is to determine when, where the event will occur and what (what kind of) characteristics it will have. In risk forecasting, nonparametric methods are often used, such as, for example, the least squares method, which estimates the accuracy of the forecast. Adaptive methods, autoregressive methods and others are also used. It is also important to use expert forecasting methods, including those based on non-numerical data.

Particularly relevant is the development of forecasting methods under risk conditions, which are based on the use of combined economic-mathematical and econometric (both statistical and expert) methods in forecasting models.

Precursors in risk forecasting [4] - is what precedes the predictive event and on the basis of which the forecasting model of this event is developed.

If we consider the problem of forecasting an actual risk of any natural phenomenon, then the precursor is basically a certain geophysical phenomenon that precedes the occurrence of a natural event. Geophysical precursors (phenomena) include, for example, seismic, hydro-geodynamic, deformational, geochemical, thermal, gravitational, and electromagnetic events. As well as the results of observations obtained by remote monitoring using recently developed satellite technologies, etc.

Forecasting a specific natural phenomenon means determining a sequence of actions aimed at identifying the characteristic features of an event or anomalous variations in various geological and geophysical fields, their joint consideration and analysis in order to determine, for example, in the case of an earthquake forecast, its location, time and strength.

That is, the results of earthquake forecasting are the location of the earthquake, the time of the event and its strength [5].

II. Hybrid Approach to Risk Forecasting

To predict natural phenomena, a hybrid model is considered [5], according to which, out of the models developed on the basis on the necessary precursors, should be selected pairs, triplets, etc. of such models that have a minimum number of coincidences of forecasts. As a result, the forecast is significantly improved, which means that the indicator of forecast accuracy increases. [5] describes this forecasting model for earthquake problems.

Let us describe a forecasting model that is based on a hybrid approach specifically for risks. In this case, we have different models, developed for the same events, which calculate the risks of the event under consideration, using certain indicators of this event. Let's take the construction of high-rise buildings in Racha (a high mountainous region of Georgia) as an event, having calculated the values of the risks. Let the first model A1 be, for example, a model that calculates the risk if the building is built of brick (brick quality is a precursor), the model predicts that the risk of building collapse in Racha in case of an earthquake of a certain magnitude (for example, magnitude 5) is 28%. Let the second model A2 be based, for example, on the A1 cement brand. If, for example, the brand type is M500, then the risk of the building collapsing is 20%. It is necessary to consider the magnitude of the risk when using these two models together. That is, if you use these two risk models simultaneously for the construction works in the same region, then the risk of building collapse will certainly decrease. It is intuitively clear that the combination of two, three, four or more models reduces the risk, but increases the calculations of considering precursors.

Various models of building high-rise buildings in Racha, building houses in Kamchatka, which use the first, second, third, fourth methods. Models may consider variables such as what material to use for the foundation, etc. for the construction of a nuclear power plant, the construction of a conventional hydroelectric power plant. If we found those in which the requirements of each model match, then together, these requirements give much less result, but this should be measurable as well. The model that initially identified the 30% risk. Where did this percentage come from? How much is being built, and calculated, what is the probability of how much should be used - 70% depends on the thickness of the bricks, it would be 80% , if one put two blocks, how much for a hollow core slab, etc.

Second, on the contrary, depends on the concrete - what degree of adhesion the concrete should have, depending on concrete adhesion qualities, the risk percentage value will decrease if adhesion is high.

Thus, we use intersection of these various models, as we did before. We select pairs of models and calculate how much is risk (which is clearly reduced) when both of these conditions are met. The risk may even be reduced to zero. For example, if the brick is good, the concrete is good, the builders are good too, the site is well chosen, then the risk can be practically reduced to zero. This is the main idea.

Suppose we have the following models: $Mod_{1,}Mod_{2,}\ \ldots, Mod_n$. What each model represents and on the basis of what precursors it makes predictions is not essential in our case.
For each model, it is necessary to calculate the number of forecasts made, the number of correct and false forecasts, and also calculate the probability of correct prediction for each model. It is clear that the sum of correct and false predictions is the total number of predictions made. As for the probability of correct prediction [4], it is calculated for each model and determines how many times an earthquake was predicted and how many times an earthquake actually happened. Suppose that probabilities of correct prediction are calculated for 5 models in total (%), and accordingly these values are as follows: 6.00; 6.32; 7.06; 6.12; 7.59.

When forecasting earthquakes, the author of each model claims that their model is the best and explains this by the fact that his model predicted all earthquakes that occurred. Neither of them gives the number of false predictions and therefore does not calculate the probabilities of true predictions, which are fairly small numbers. The probability of the correct prediction of a model may be quite low, but it is possible to pair this model with another model and thus ensure the best correct prediction probability outcome. We will demonstrate the correctness of the above said with our example.

As the next step of the algorithm, we need to consider pairs of models. There will be 10 pairs in total: M1, M2,…,M10, where M1=$Mod_1 \cap Mod_2$; M2= $Mod_1 \cap Mod_3$; M3= $Mod_1 \cap Mod_4$; M4=$Mod_1 \cap Mod_5$; M5= $Mod_2 \cap Mod_3$; M6= $Mod_2 \cap Mod_4$; M7= $Mod_2 \cap Mod_5$; M8= $Mod_3 \cap Mod_4$; M9= $Mod_3 \cap Mod_5$; M10= $Mod_4 \cap Mod_5$. For each model, it is necessary to calculate the number of forecasts made, the number of correct and false forecasts, and also calculate the probabilities of correct predictions for each pair (see Table 1).

Table 1: *The "necessary models" for pairs*

Models	Number of prediction	Failed number of prediction	Successful number of prediction	Probability of success in %
$Mod_1 \cap Mod_2$	17	6	11	35.29
$Mod_1 \cap Mod_3$	20	6	14	30
$Mod_1 \cap Mod_4$	15	6	9	40
$Mod_1 \cap Mod_5$	13	6	7	46.15
$Mod_2 \cap Mod_3$	15	6	9	40

$Mod_2 \cap Mod_4$;	10	6	4	60
$Mod_2 \cap Mod_5$	16	6	10	37.5
$Mod_3 \cap Mod_4$	17	6	11	35.29
$Mod_3 \cap Mod_5$	8	6	2	75
$Mod_4 \cap Mod_5$	18	6	12	33.33

Let us analyze the constructed chart according to the corresponding diagram (see **Fig. 1**), which demonstrates that the best result gives M9 which is obtained by a combination of two models - Mod_3 and Mod_3 . The probability of their joint correct prediction has already increased to 75%. Although these models individually, compared to others, have much less correct prediction indices - 7.06% and 7.59%. In the example under discussion, two pairs of models can give the same result. At this stage, it is up to the expert to decide which ones to use.

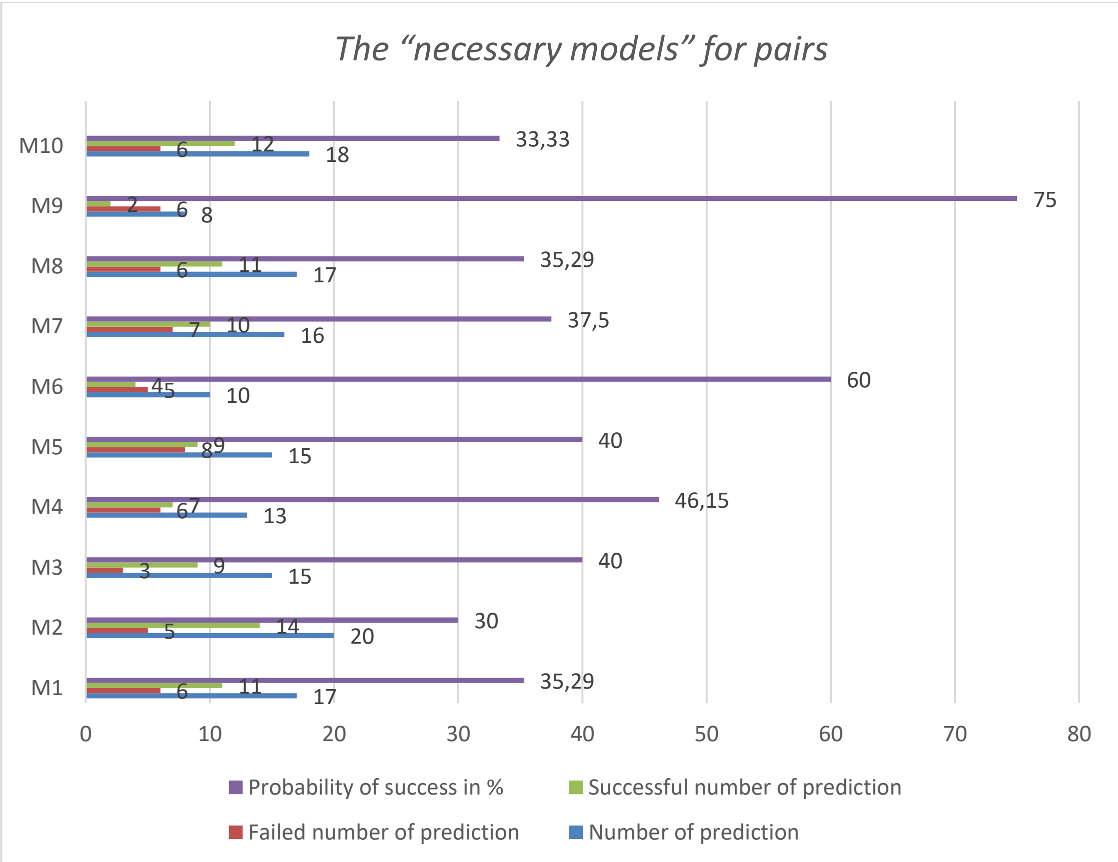

Figure 1: *The characteristics of the "necessary models" for pairs*

Obviously, this applies not only to risk forecasting, but also to forecasting any other event, both static (most often, these are the tasks of forecasting natural disasters) and dynamic forecasting, for example, economic fields.

III. Results

It is clear that the greater the number of the intersected predictive models from which we choose the best one, the better is the result, in contrast to choosing from a smaller number intersection.

However, it should be taken into account that more models require a large volume of data (precursors), the acquisition of which is also associated with high consumption of material resources. Collecting and analyzing large volume of data is an insurmountable problem for relatively small poor states. It is in such cases that it is advisable, theoretically, to choose two or three forecasting models, the intersection of the forecasts of which gives the best results. Information collection will be required only for these selected models, which will drastically reduce the cost of information processing.

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