Risk Management and Soft Computing

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Anotace

Článek pojednává o řízení a vyhodnocování rizik prostředky Soft Computingu, jako je fuzzy logika, umělé neuronové sítě a genetické algoritmy. Je uvedena případová studie rizika platby klienta.

1 Řízení rizik

Risk management is a sphere that covers wide scale of techniques that are used in many branches. This branch has started to develop since the 21 century namely for the purpose to improve the risk management. It led to spread in many branches such as banking, insurance, industry, direct mailing and so on. The risk management represents the activity connected with the increase of probability of success in achievement the best economic results with minimization of danger of failure. The aim of risk management represents the search of possible risk, the determination of their significance, design of analyses of risk, appropriate build up of model and decision making of acceptance of correction restriction to decrease the risk. It is possible to reach this aim except classical methods by means of Soft Computing such as fuzzy logic, artificial neural networks and genetic algorithms.

The risk generally means the danger of rise of damage, harm, losses or destruction in some case failure at business that can break the stability of the firm, invoke the bankruptcy of the firm or company. This branch has become inevitable to keep up the competitiveness. From the point of risk management the risk is apprehended in the connection with ambiguity of running of certain real processes that include political, territorial, economic, financial, security, juridical, legislative, supply, production, customer, technical, technological, informative, environmental, human factor, inevitable accident and so on. The risk can be classified according to the type as a systematic and unsystematic, inner and outer, influenceable and non influenceable, primary and secondary.

The risk is connected with the term of uncertain results, it means that the result must be uncertain and at least one of possible results must be undesirable. The risk is closely connected with the term of change of variable in time that could be against expected values of positive or negative deviations. It is necessary to evaluate the entrepreneurial risk from the positive side (hope of higher profit or success) and negative side (danger of strong economic losses).

The risk rises from the lack of information and insufficient understanding, the use of unsuitable, unverified and unreliable data, the application of unsuitable methods and by the influence of stochastic processes. The decision making is generally done under the certainty or uncertainty of risk (we know or not the probability of phenomena).

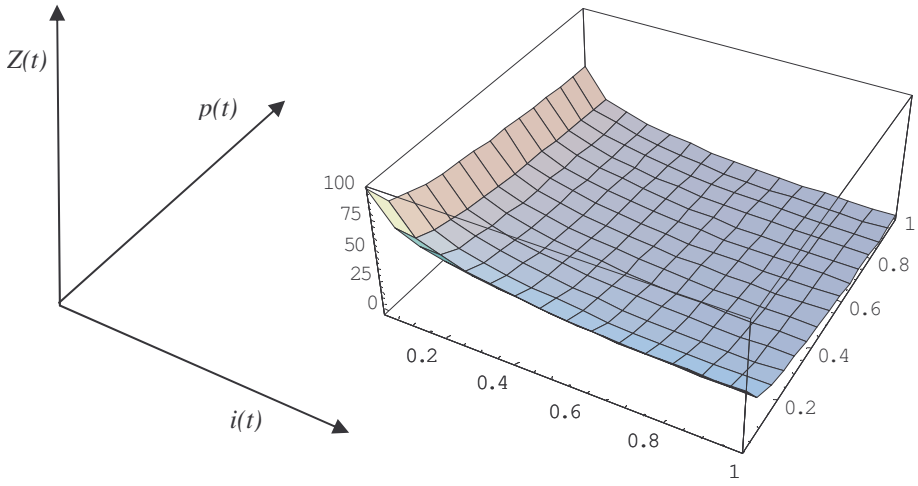
The risk $r(p,i)$, or perhaps the size of supposed losses $Z(p,i)$, depends on the probability of occurrence of risk p and on the intensity of negative effect i. It is possible to express the size of risk, eventually the losses by formulas

$$r(p,i) = \int_S r(p,i)dS, \quad Z(p,i) = \int_S Z(p,i)dS, \text{ where } dS = dpdi.$$

When we take in consideration the time aspect we can define the size of supposed losses $Z(t)$ in time interval $<0,T_0>$ by formula

$$Z(t) = \int_0^{To} \mathrm{p(t).i(t).dt.}$$

where $p(t)$ is the probability of occurrence of risk in time t and $i(t)$ is the intensity of negative effect in time t. The picture presents the fact that the probability of occurrence of risk $p(t)$ and the size of negative effect $i(t)$ declines in time t. The aim is to decrease the volume under the surface $Z(t)$ to be minimum.



2 Risk management – classical methods

The expert evaluation of risk is done on basis of matrix risk at classical methods. The dependence of intensity of negative effect and the probability of occurrence of risk is searched. The following table presents the level of risk that is expressed by the scale - high, medium, low, very low risk (H, M, L, VL), eventually by numerical values.

	1	2	3	4	5
16	M 16	M 32	H 48	H 64	H 80
8	L 8	M 16	M 24	H 32	H 40
4	L 4	L 8	M 12	M 16	M 20
2	VL 2	L 4	L 6	M 8	M 10
1	VL 1	VL 2	L 3	L 4	L 4

The risk depends on the probability of occurrence of risk determined by numbers 1, 2, 3, 4, 5 (from the smallest probability up to highest) and intensity

of negative effect determined by numbers 1, 2, 4, 8, 16 (from the smallest intensity up to highest). It is evident that it is necessary to take in consideration not only the intensity of negative effect but the probability of occurrence of risk during the risk analysis. Even if the probability of occurrence of risk is lower but the intensity of negative effect is high it is necessary to take the fact in consideration during the solution of correction measures to reduce the losses.

3 Risk management – Soft Computing – theory

The classical methods do not have to be sufficient at the risk management analysis. It is suitable to use the advanced methods in this case. The fuzzy logic, artificial neural networks and genetic algorithms belong to among them. These methods open new possibilities of application at the sphere of risk management. The methods enable to solve not only non linear dependencies, but the multi-criteria and hard algorithm development tasks.

The **fuzzy logic** enables to work with vague and inaccurate terms. The build up of the model with fuzzy logic includes three basic steps - fuzzification, fuzzy inference and defuzzification.

The first step goes from linguistic variables e.g. the variable risk has for example the following attributes - low, medium and high risk. The membership functions of attributes are expressed by mathematical functions.

The second step defines the behavior by means of the rules of the type <If>, <Then>, <With>. The conditional clauses creates these algorithms which evaluate the state of relevant input variables with set up of weight *x* of rules in the form

<If> $Input_a$ <And> $Input_b$ …<And> $Input_x$ <Or> $Input_y$ …<Or> $Input_z$ <Then> $Output_1$ <With> *x.*

The third step transfers results from previous process of fuzzy inference on linguistic variables. The real action may be assessment of the height of total risk.

The **artificial neural networks** represent the thinking of human brain. The activity of artificial neural network consists of three stages - learning, testing and implementation.

The weights of nodes are set up during the process of learning, the process of testing search how is the network learnt. The network has become an "expert" when it is learned and it produces outputs on the basis of knowledge obtained during the process of learning.

The **genetic algorithms** simulate the evolution of human population. At operation with genetic algorithms the most often used operators are selection, crossover and mutation. The selection means the choice of best population. The crossover means the exchange of so called chromosomes among single individuals of population. The mutation means the modification of part of chromosome when a random change happened. These operations are presented at following table.

Selection			Crossover		Mutation	
01111010	>	00100010	Parents	Offspring	Before	After
122	>	34	011**0010**	011*1001*	0110010	0010110
			011*1001*	011**0010**		

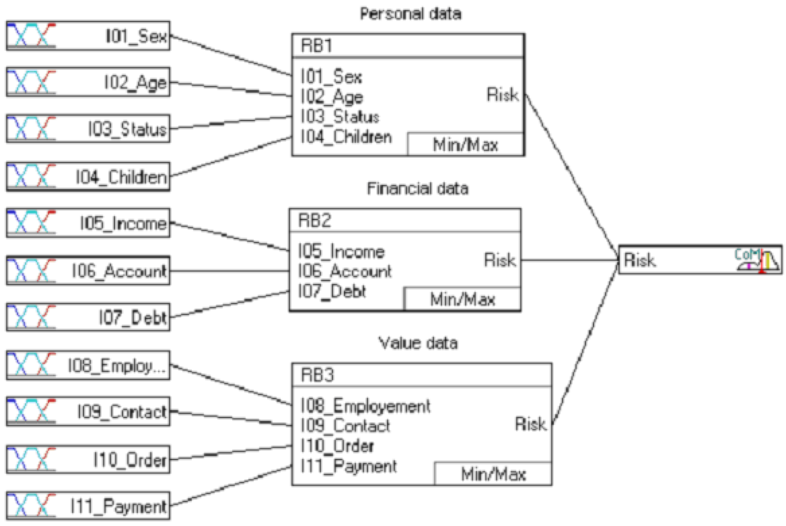
The genetic algorithms operate in such a way that the initial population of chromosomes is crated first; this population is changed by means of genetic operators so long until the process has no been finished. The reproduction process that is repeated is called the epoch of evaluation of population (one generation) and it is presented by three mentioned steps.

4 Risk management – Soft Computing – Case study

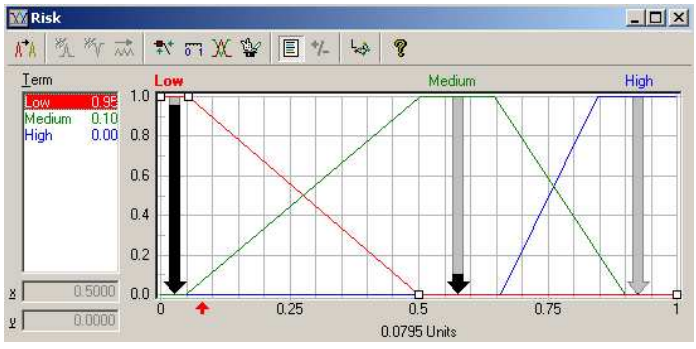
The case study includes the evaluation of risk of payment of debt by customer. Here is a part of the table.

Order	Gender	Age	Status	Child	Income	Account	Debt	Duration	Time	Purchase	Number
1	0	65	1	0	11000	50000	0	45	5	15	0
2	0	25	0	1	10300	0	0	5	2	8	1
3	1	78	0	0	8300	0	0	60	2	20	0
…	…	…	…	…	…	…	…	…	…	…	…

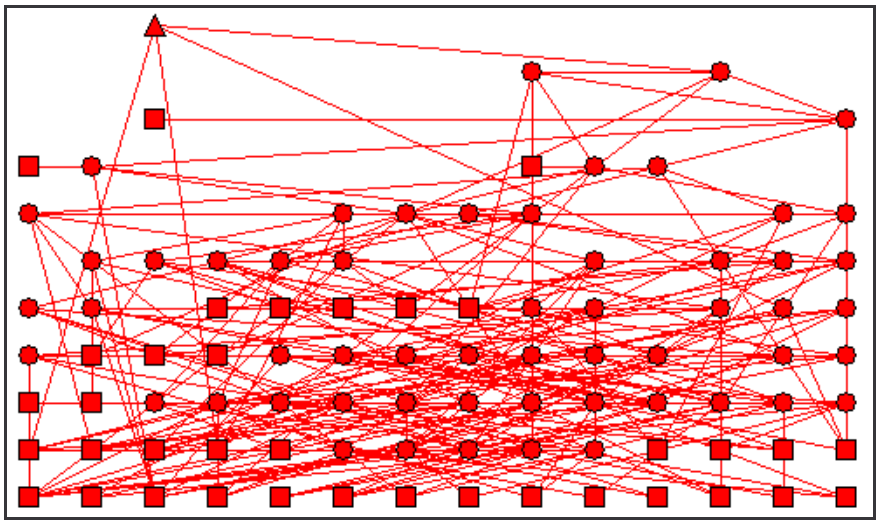
The **fuzzy logic** model was build up



that performed evaluation of risk of client with the result of low risk.



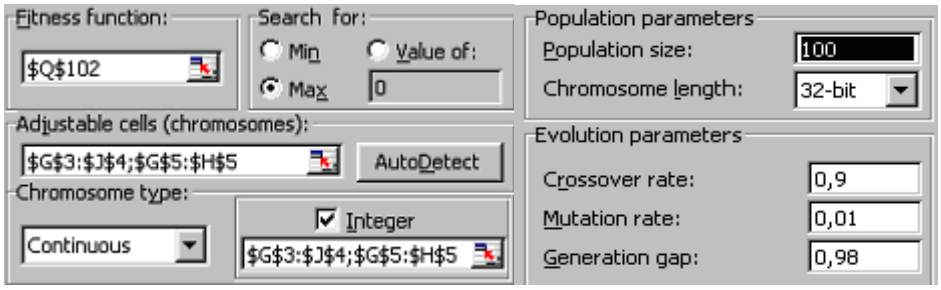
The **artificial neural network** model was build up



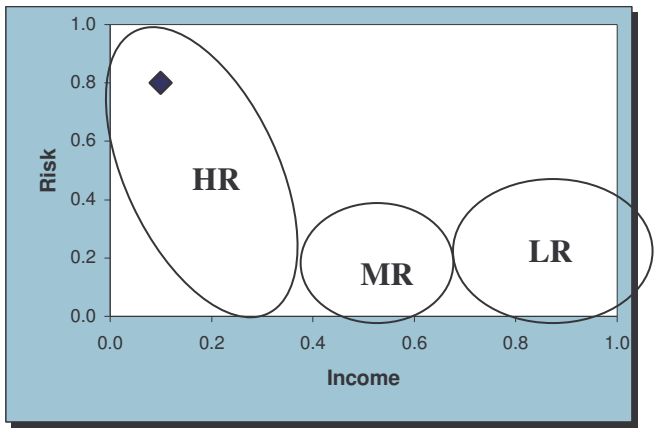
that performed evaluation of the risk of client with the result of medium risk (35%).

Risk	Sex	Age	Status	Children	Inncome	Account	Debt	Duration	Time	Purchase	Number
35	0	65	1	0	11000	50000	0	45	5	15	0

The **genetic algorithm** model was build up



that performed evaluation of the risk of client with the result of high risk (HR).



5 Conclusion

The means of Soft Computing have distinct contributions to analyses and evaluation of risk because the problems of risk belong to the multi-criteria and hard algorithm development tasks. The results of analyses and calculations serve us as a support of decision making processes. The correct decision making is an important step for the firm or organization to be successful and competitive. These problems are solved in greater detail in [6, 9, 18].

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