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NEURAL CLASSIFIER OF THE COMMUNICATION DAMAGE SIZE BEING A RESULT OF COLLISION OF VEHICLES IN ROAD TRAFFIC

Summary. In the article the results of the attempts of MLP neural network application to define the size of a communication damage being the result of a road collision were presented. The size of the damage was used as a research parameter defined by the coefficient dependent on the cost of repair of the damaged vehicle and its market value. The elements of the damage mechanism determining the way of damage qualification were the inner factors of the system, that is; the technical features of the vehicles, the character features of the drivers, the influence of the weather conditions and the location of the event in time and space. The research was conducted on one thousand cases reported for liquidation in Silesian branch of one of the insurance companies. In the conducted research the working of the neural networks with the limited input data was checked.

KLASYFIKATOR NEURONOWY ROZMIARU SZKODY KOMUNIKACYJNEJ JAKO SKUTKU ZDERZENIA POJAZDÓW W RUCHU DROGOWYM

Streszczenie. W artykule przedstawiono wyniki prób zastosowania sieci neuronowej typu MLP do określenia rozmiaru szkody komunikacyjnej będącej skutkiem kolizji drogowej. Jako parametr badawczy przyjęto rozmiar szkody określony współczynnikiem zależnym od kosztu naprawy uszkodzonego pojazdu oraz jego wartości rynkowej. Elementy mechanizmu szkodowego, determinujące sposób kwalifikacji szkody stanowiły czynniki wewnętrzne układu, tj. cechy techniczne pojazdów, cechy osobnicze kierujących, wpływ czynników atmosferycznych oraz lokalizacji czasowo-przestrzennej zdarzenia. Badaniem objęto tysiąc przypadków zgłoszonych celem likwidacji w śląskim oddziale jednego z zakładów ubezpieczeń. W przeprowadzonych badaniach sprawdzono działanie sieci neuronowych przy ograniczonej liczbie danych wejściowych.

1. INTRODUCTION

High number of the damage events in road traffic in Poland causes, that the issues concerning the liquidation of personal damages and the restitution of the damaged belongings are an important factor of social and economical life of the country [2].

According to the methodology of the damage liquidation used by insurance companies the division into partial and total communication damages is applied [7].

In case of the damage events under the protection of the civil responsibility of the perpetrator (in Poland OC – civil responsibility insurance) – the damage is qualified as partial when the cost of vehicle repair is not higher than its market value. The cost of vehicle repair is defined according to a technology set by the vehicle producer. A vehicle which meets that condition is let to be repaired.

In a situation where the cost of repair exceeds the market value of a car, the so-called total damage occurs. For total damages the amount of due indemnity is set on the basis of the difference between the vehicle value before the damage and after the damage – the so-call remainder. In such case the repair of the car is qualified as economically unjustified and the preferred form of liquidation is the selling of the damaged car by the owner and purchase of a car with parameters corresponding the vehicle before the damage. In this case the insurance company does not agree to pay the repair costs.

The analogical methodology applies to voluntary insurance policies (in Poland Auto-casco).

The difference lies only in the fact, depending on the general conditions of given insurance company, that the damage is calculated here as total in the case when the repair cost exceeds 70÷80% of the market value of the vehicle before the damage.

The size of the communication damage according to the expert methodology of damage liquidation used by the insurance companies is defined depending on a rule:

$$R = \frac{KN}{WR} \tag{1}$$

where: KN – cost of vehicle repair [zloty], WR – market value of the vehicle [zloty].

If the size of the damage marked by the rule (1) equals, than the damage is considered partial and is calculated according to the cost of car repair. The cost is calculated on the basis of repair technology and the price list of the spare parts of the car producer.

If the damage size equals, then the damage is described as total and the vehicle repair is economically unjustified. In such case the amount of the due indemnity is the difference in value of a car before the damage and the value of the car after the damage (so-called remainder).

The way the communication damage is classified, due to its size which is the ratio of the technological repair costs of a car to its market value, determines the way of damage calculation and at the same time the value of the amount of due indemnity. Therefore the right decision made by the liquidator of the damage concerning the liquidation process is crucial in financial assessment. Currently in insurance companies in Poland there are two expert systems used to calculate the damage sizes in vehicles – INFO-EKSPERT and EUROTAX. It happens that the financial assessment of the same damage done by the expert in both systems differs considerably. According to a calculation in one of the systems it would be advisable to calculate a given damage as total, according to the other system data only as partial.

Due to this fact in hereby paper an attempt was made to apply the artificial neural networks as an additional tool helpful in the communication damage liquidation process [8, 9]. Such tool should be helpful in recognition and classification of damage when it comes to their size – the division between the partial and total damage.

In figure 1 an example result of a collision of two cars in road traffic was shown. The demonstrative photo documentation created by the insurance company does not enable to classify the damage explicitly as partial or total. The appearing difficulties are caused by a significant deformation of the left side of the sheathing and the lack of the external damages of the remaining areas.

Fig. 1. The example photo documentation of the vehicle damage
Rys. 1. Przykładowa dokumentacja zdjęciowa uszkodzeń pojazdu

2. RESEARCH EXPERIMENT

In the planned research experiment it was decided to check the usefulness of the artificial neural networks in the task of classification of the communication damage size as a result of car collision in road traffic. In most recent literature one can find the whole range of possible uses of artificial intelligence application [1,3÷6,10]. In conducted experiments it was decided to use the artificial neural networks of multi-layer perceptron type [6, 10]. The characteristic feature of artificial neural networks is their possibility to model the nonlinearity with the simultaneous preservation of resistance to interruptions. Additionally, the neural networks have the ability to generalise the knowledge gained in the learning process to the analysis of new cases of a given phenomenon [6, 10].

The data used in the research was gained from the damage documentations prepared by the insurance company performing on the Polish market. The data consists of one thousand damage events.

In the MLP network research the influence of the architecture and the teaching algorithm was checked on the value of the classification error. The variants with one and two hidden layers were checked. For each hidden layer it was assumed that 5, 10, 15, 20, 25 and 30 neurons may appear.

The usefulness of 12 other network teaching methods was also checked, that is:

- Gradient descent backpropagation (No 1),
- Gradient descent with momentum backpropagation (No 2),
- Gradient descent with momentum and adaptive learning rate backpropagation (No 3),
- Resilient backpropagation RPROP (No 4),
- Conjugate gradient backpropagation with Fletcher-Reeves updates (No 5),
- Conjugate gradient backpropagation with Polak-Ribiere updates (No 6),
- Conjugate gradient backpropagation with Powell-Beale restarts (No 7),
- Scaled conjugate gradient backpropagation (No 8),
- One step secant backpropagation (No 9),
- BFGS quasi-Newton backpropagation (No 10),
- Levenberg-Marquardt backpropagation (No 11),
- Bayesian regularization backpropagation (No 12).

The best variant of network architecture was marked for each of the mentioned algorithms of teaching. In the hidden layers the tangent curve neurons were used.

For inputs of neural networks the following data was given:

- the month when the damage event occurred,
- the hour when damage event occurred,
- the area where the damage event occurred,
- the type of motor-car body of the sufferer and the perpetrator,
- the age of the vehicles of the sufferer and the perpetrator,
- the colour of the vehicle of the sufferer and the perpetrator,
- the weight of the vehicle of the sufferer and the perpetrator,
- the speed of the vehicles of the sufferer and the perpetrator,
- the gender of the sufferer and the perpetrator,
- the age of the sufferer and the perpetrator,
- the driving experience of the sufferer and the perpetrator,
- the type of the damage event,
- the type of collision,
- the mean breadth of the deformation measured in the direction of the tangent of the collision,
- the mean height of the deformation,
- the value of the permanent deformation in the direction of the normal of the collision.

The places where the damage events occurred were divided into two types: built-up area and outside built-up area.

The motor-car bodies of the vehicles were classified as: mono-box, two-box or three-box.

The motor-car bodies of the vehicles taking part in the collision were in the following colours: white, black, grey, pale green, dark green, pale blue, dark blue, red, crimson, silver, yellow, orange, graphite and other.

The type of collision is meant by the collision of cars in movement and the crash into a stopping car.

A type of a damaging event is either a crash into the back of other car, crash into the side of a car, crash into the front of a car or crash into the corner of a car.

The outputs of the neural networks defined the classification of the communication damage to the group of partial or total damage. Because the neural networks which were used were taught by the method with the teacher, it was necessary to initially mark the correct answers. It was performed by marking, due to the expert methodology of damage liquidation, the size of the damage R from the equation (1).

3. THE RESULTS OF THE EXPERIMENT

On the basis of the achieved results it was impossible to define unambigiously the best network architecture, not dependent on the applied teaching method. That fact was confirmed by the well-known from literature conclusion that there is a necessity to treat each experiment individually. In this case the experiments were differentiated by the applied algorithms of teaching.

By the observation of network architecture the conditions were observed, in which together with the expansion of the structure the correctness of the results is better, which is a result of the bigger memory capacity of such networks (it applies to the bigger number of connections) It should be noticed, however, that in some moment the further expansion of the structure causes the increase in error. Such condition is a result of the network loss of the generalisation feature.

The influence of the complexity of the network on the value of testing error is shown in figure 2.

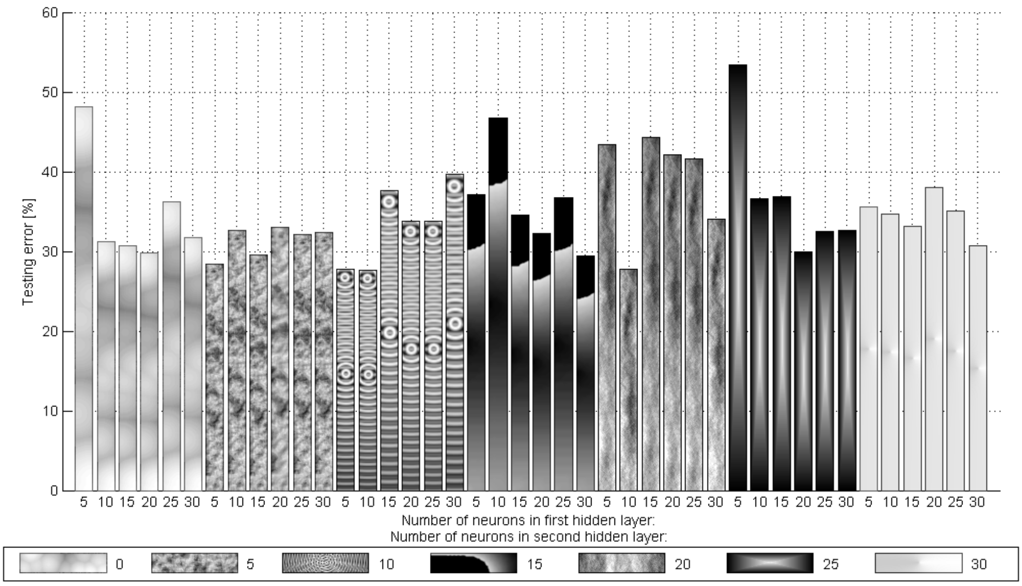

Fig. 2. The example influence of the network architecture on the value of testing error
Rys. 2. Przykładowy wpływ architektury sieci na wartość błędu testowania

The best achieved results for the subsequent algorithms of neural network teaching were shown in table 1.

As a result of the conducted experiments it was not possible to build the classifier of the communication damage size characterised by the error on satisfactory level. For most checked methods of teaching it was possible to build a neural network with the error value in the range of 25÷35%. The built classifiers are characterised by a small difference depending on the applied method of teaching.

In the research the neural networks were taught on the basis of data received from the damage documentation. In experiments all the available data was used. The closer look at the applied data caused the formulation of a hypothesis concerning the purposefulness of the application of some of them. That is why in the next part of the experiment, an attempt was made to teach the classifiers with the limited number of input parameters. In the experiments only the data was used which was directly connected with the mechanics of the occurrence of the cars collision, that is, the type of motor-car body of the sufferer and the perpetrator, the age of the vehicle of the sufferer and the perpetrator, type of the damage event, type of collision, the mean breadth of the deformation measured in the direction of the tangent of the collision, the mean height of the deformation. The whole experiment was repeated for a new set of input data. The best results achieved in the experiments were shown in table 2.

Table 1
The best results for subsequent algorithms of neural network teaching

No of algorithm	**Testing error [%]**
1	28,87
2	31,39
3	30,29
4	28,40
5	26,54
6	25,88
7	26,05
8	28,66
9	29,37
10	26,56
11	27,15
12	26,65

Table 2
The best results for subsequent algorithms of neural network teaching
(limited amount of data)

No of algorithm	**Testing error [%]**
1	26,79
2	30,23
3	31,38
4	26,18
5	24,69
6	24,87
7	29,03
8	28,23
9	27,82
10	24,25
11	28,97
12	26,44

During the comparison of the achieved results it can be noticed that only a small change occurs in the achieved correspondence with the model for classifiers taught with the limited set of input data. The best result was little below 25% of the error.

4. SUMMARY

The conducted experiments did not confirm the possibility of the successful use of the MLP artificial neural networks in the task of classification of the damage size being a result of road collision of cars. Despite the checking of various variants of architecture and the methods of teaching of MLP networks, as well as limiting the input data it was impossible to build a classifier characterised by an error on expected level. The best neural network achieved the error of about 25%. Such value seems to be insufficient for the use of neural classifiers in practice of decision making if the damage is partial or total.

Despite the achieved unsatisfactory results it does not seem right to confirm the thesis about the non-effectiveness of neural networks application for such a task. It should not be forgotten that in the experiment not all the possibilities were depleted concerning the use of the neural networks.

In order to examine them more thoroughly the experiments with other types of neural networks with/and the choice of optimum input data should be conducted. Simultaneously the one hundred percent correctness of the expert method in order to mark the correct answers which should be given by a neural network should be questioned.

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