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Information Technology, Automation and Robotics

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Oksana Sokolova – Senior Lecturer of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine) expects images of the barcodes and videos about each specific product, then it is decomposing and groups all videos using associated barcodes. As a result, we have folders in the file system for each of the upload barcodes. Each folder contains images decomposed from previously uploaded videos, so we can use these already associated images for training and testing AI models. Also, this chatbot can be useful for solving other AI problems.

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USE OF NEURAL NETWORKS TO MAXIMIZE THE EFFECTIVENESS OF SHOT PUTTERS TRAINING

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Abstract: *The main factors influencing the results of shot put are considered. The necessity of using modern methods for solving forecasting problems is substantiated. The method of artificial neural networks with different architecture is proposed to solve the following problems: finding the percentage of correction of the shot put technique, finding the subtype of the technique, the activation function of the sigmoid and the algorithm of reverse propagation of errors for learning networks. A software package has been developed that allows to find the approximate result of pushing the shot using the technique of "glide" and "from the ground". Examples of calculations in the environment Deductor Studio Lite are given.*

Keywords: *shot put, neural network, prediction, reverse search method, physical culture, athletics.*

I. INTRODUCTION

The current level of development of athletics, in particular shot put, sets the task of developing new, more rational means and methods of sports training that contribute to the rapid and reliable achievement of high sports results. But the force can not be increased indefinitely, and further growth of results is possible not so much by improving the technique of throwing, for which it is advisable to use information technology.

The aim of the work is to find the best indicators for the most effective use of force and speed of the athlete when performing an attempt, using a mathematical model of throwing (pushing technique without prior acceleration of the projectile) and software for calculating a number of elements (angle, initial force, initial speed). Also modeling of the push angle and the ejection angle of the nucleus for maximum results with the technique of pre-acceleration ("jumping" technique). Explore the possibilitythe use of artificial neural networks in calculating the performance of the athlete-thrower of the nucleus on the available data on age, height, body weight of the athlete, as well as the characteristics of the flight of the nucleus to determine the range of this flight, selection of subtypes of nuclear pushing techniques

II. LITERATURE ANALYSIS

The problem of finding the most effective shot put technique can be solved by artificial neural networks. As a neural network model, it is advisable to choose a two-layer parseptron. Estimation of the predominant number of neurons in the latent layer is performed using the known inequality [7-9].

In physical culture and sports, neural networks are used to analyze and predict the indicators of physical fitness of athletes, as well as the results of sports competitions [1].For example, for the available data from [2] the prediction problem was formulated: to determine the range of this flight based on the available data on the age, height, body weight of the athlete, as well as the characteristics of the nucleus flight. This problem was solved by the method of artificial neural networks in [3], but it did not take into account a number of important factors.

III. OBJECT, SUBJECT, AND METHODS OF RESEARCH

There are five tasks, each of which according to the available data on age, height, body weight of the athlete and other characteristics should determine the range of the nucleus, but the list of characteristics in each case will be different.

1. All men with the characteristics "Speed-angle-height" and without division into the used throwing technique (actually a model with [2]) are considered.
2. All men with the characteristics "Speed-angle-height" and without division into the used throwing technique, but with the addition of new parameters of the distance traveled by the core of the acceleration by the athlete.
3. All women are considered without division into the used throwing technique with the characteristics of the distance traveled by the nucleus.
4. Men with the technique of throwing "Glide" with the characteristics of "Speed-angle-height" and the parameters of the distance traveled by the nucleus are considered.
5. Men and women with the technique of throwing "Glide" with the characteristics of the distance traveled by the nucleus are considered.

We will prepare data for each task.

Table 1. Specified tasks

№	Sex	Technique	Speed-angle-height	Length of glide	Foot distance in power position	Length in flight phase	Length of spatial relocation in power position
1	People.	Any	+	-	-	-	-
2	People.	Any	+	+	+	+	+
3	Women.	Any	-	+	+	-	-
4	People.	Glide	+	+	+	-	-
5	Everyone	Glide	-	+	+	-	-

Name	Technique	Sex	Age [years]	Height [m]	Weight [kg]	Length of glide [m]	Foot distance in power position [m]	Distance [m]
Majewski	Glide	m	27	2,04	132	0,91	1,28	21,91
Bartels	Glide	m	31	1,87	135	0,87	1,29	21,37
Mikhnevich	Glide	m	33	2,02	127	0,92	1,17	20,74
Vili	Glide	w	24	1,96	120	0,89	1,19	20,44
Kleinert	Glide	w	33	1,9	90	1	1,03	20,2
Gong	Glide	w	20	1,8	85	0,85	1,23	19,89
Mikhnevich	Glide	w	27	1,8	85	0,88	1,08	19,66
Carter	Glide	w	23	1,75	95	0,99	1,14	18,96
Meiju	Glide	w	29	1,74	80	0,84	1,25	18,76
Gonzalez	Glide	w	31	1,79	75	1,02	1,08	18,74

Fig. 1. Given and prepared data (example of the fifth problem)

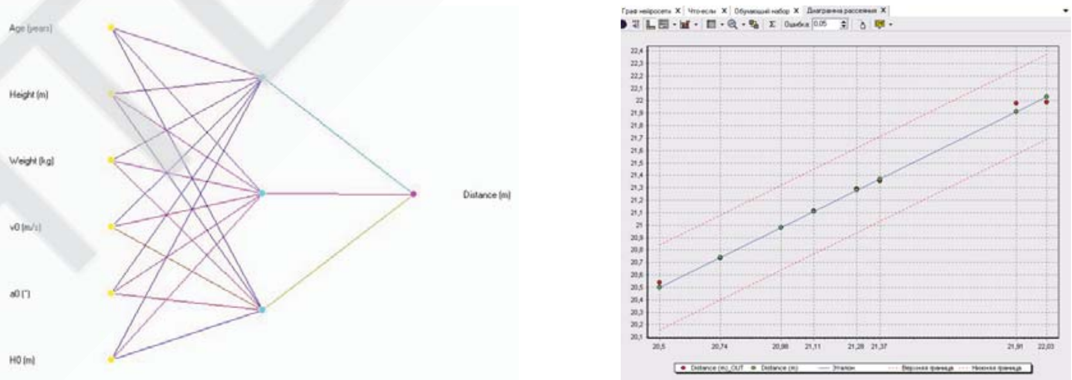

Fig. 2. Graph and scattering diagram of the neural network MLP-6-3-1 (task 1)

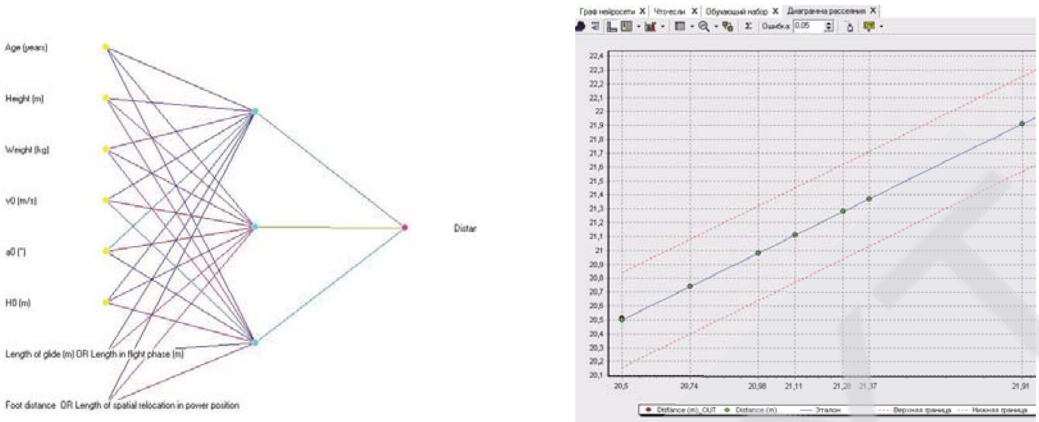

Fig. 3. Graph and scattering diagram of the neural network MLP-8-3-1 (task 2)

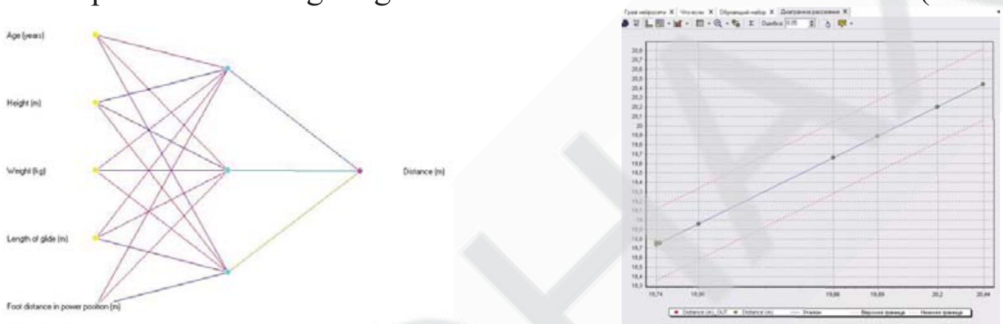

Fig. 4. Graph and scattering diagram of the neural network MLP-5-3-1 (task 3)

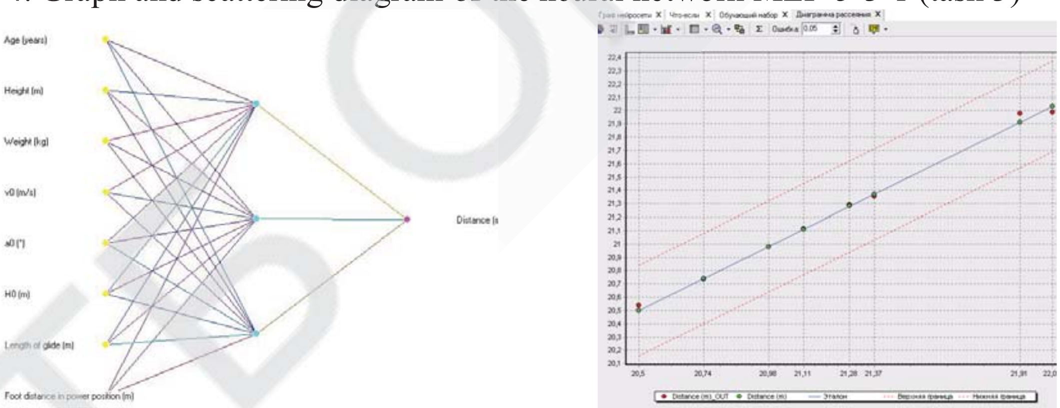

Fig. 5. Graph and scattering diagram of the neural network MLP-8-3-1-Glide (task 4)

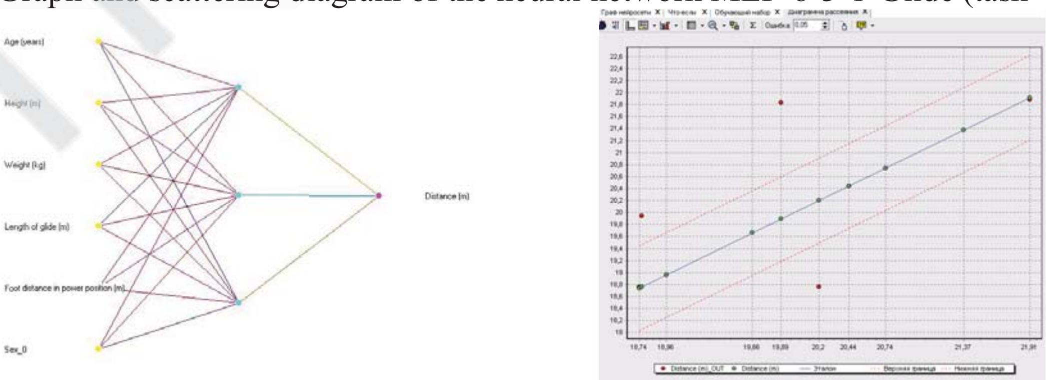

Fig. 6. Graph and scatter diagram of the neural network MLP-6-3-1-Glide (5)

The average accuracy (average errors - deviations) of all calculations are summarized in table 2.

It can be concluded that models that take into account all the characteristics of the thrust of the nucleus (№2 and №3) show slightly higher accuracy of calculations than the model based only on the characteristics "Speed-angle-height" (№1). At the same time, the patterns that determine the throwing distance in men and women are different, as evidenced by the model №5. The significant magnitude of the error in the model №4 is explained by the small number of examples for network learning.

Table 2. Accuracy of each calculation

Problem	Sex	Machinery	Average accuracy [m]	Average accuracy [%]
1	People.	Any	0.004632	0.0216%
2	People.	Any	0.003464	0.0163%
3	Women.	Any	0.003627	0.0192%
4	People.	Glide	0.375513	1.7144%
5	Everyone	Glide	0.6242436	3.3280%

However, this is only an assumption for modeling the shot put, it uses only 8 input data, 3 which can be neglected (article, technique and jump length), but they do not affect the assessment of the qualities of the athlete. The updated system helps to find the relationship between power, explosive, anthropogenic, speed and angular group of indicators of the athlete-thrower.

IV. RESULTS

In the table. 3. the list of the factors influencing result of pushing of a kernel is resulted.

Consider the example of two athletes using the developed software [2]: the first has high performance in strength training and blasting (barbell press 90 kg, squats 120 kg, push 50 kg, chest 60kg at a weight of 90 kg), the angle of departure of the projectile from height 1.8 m will be 30 degrees, the height of the release is 2 m, and the horizontal speed is 2 m / s, the final speed is 7 m / s. This athlete pushes the core to a result of 8.70 m.

Table 3. List of factors

№	Group	Factor	Unit of measurement
1	Height and height of issue	h_0 - height of the core release	m
2		Dr - arm length (scope)	m
3		ZT - the growth of the athlete	m
4	Subversive	LJ - the result of long jumps from a place	m
5		TJ is the result of a triple jump	m
6	Power	LT - result in bench press	kg
7		LS - the result of squats with a barbell on his shoulders	kg
8		VG - the result of taking on the chest	kg
9		TK - push rod	kg
10		WS - weight of the athlete	kg
11	Speed	$v_ф$ - the final rate of release of the projectile	m / s
12		$v_г$ - horizontal speed of projectile acceleration	m / s
13	Angular	ω_0 - push angle (from the upper arm)	degree
14		θ_0 - ejection angle (palm angle)	degree

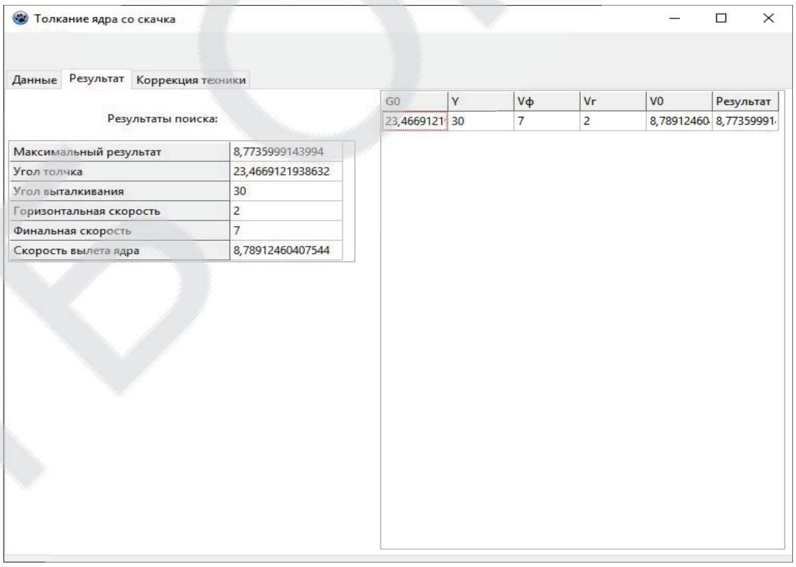

Fig. 7. The result of the first athlete

Consider the second case, let the athlete have average performance in power and explosive training (barbell press 70 kg, squat 100 kg, push 30 kg, chest 50kg at a weight of 70 kg), the angle of departure of the projectile with a height of 1.7 m will be 36 degrees , release height 2.1 m, and horizontal speed 1.5 m / s, final speed 8 m / s. This athlete pushes the core to a result of 10 m 20 cm.

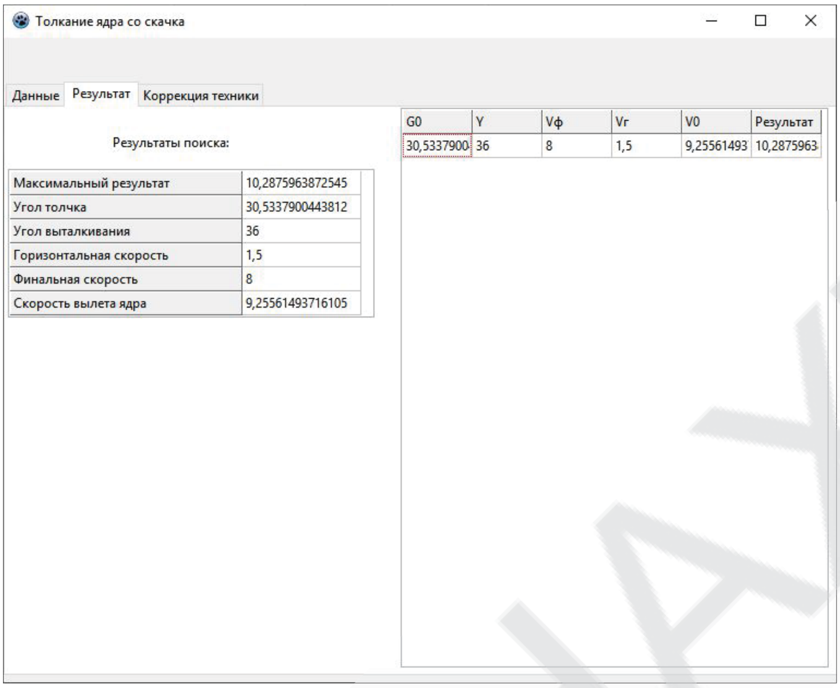

Fig. 8. The result of another athlete

The question arises: why an athlete with less strength training was able to push an athlete with a higher, and anthropogenic data which one is better? This is due to the effective maximum use of the technique of pushing the nucleus. In the example of the first athlete, he hoped for more strength, that his acceleration (horizontal speed) was faster than he was able to translate it into the final, so he pushed the core lower in angle and height. The second athlete had a slightly higher speed than the power, and worse anthropogenic data, but he was technically able to reduce the initial speed, translate it into the final and raise the angle of ejection, which was reflected in the result.

So, we have to answer the question:

1. How effectively the athlete's performance is used to achieve the best result;
2. What indicators for a particular athlete to consider important or less important;
3. To what extent the pushing technique is ahead of the power indicators, or the power technique;
4. How to improve the technique of pushing the nucleus.

Thus, we have 14 input values that belong to 5 classes - groups of dependence, which are divided into physical quantities and action class. The matrix of input values of the neural network will look like:

$$X_1 = \begin{bmatrix} h_0 & dr & ZT & 0 & 0 \\ LJ & TJ & 0 & 0 & 0 \\ LT & LS & VG & TK & WS \\ v_{\text{ф}} & v_{\text{г}} & 0 & 0 & 0 \\ \omega_0 & \theta_0 & 0 & 0 & 0 \end{bmatrix} \quad (1)$$

The initial factor will be the range of pushing the nucleus.

After the calculations, you can get answers to the following questions:

– how effectively the athlete's performance is used to achieve the best result;

– how to improve the technique of pushing the nucleus;

– what indicators for a particular athlete to consider more or less important;

– to what extent the pushing technique is ahead of the force indicators, or the force indicators are ahead of the technique.

These problems are solved by the first neural network, which finds the percentage of correction of the pushing technique [2].

After 14 factors were found [4] that affect the result of nucleus pushing, namely:core release height, arm length (scope), athlete's height, result in long jumps, result in triple jump, result in bench press, result in squat with barbell on shoulders, result in chest, barbell push, athlete's weight , final projectile release speed, horizontal projectile acceleration speed, push angle (from the upper arm), ejection angle (palm angle). These 14 input values belong to 5 classes - groups of dependencies, which are divided into physical quantities and by action class:height and height of release, subversive, power, speed, angular. The initial factor was the range of the nucleus. The results of calculations are given in [5].

But it is still necessary to determine which throwing technique is more suitable for the athlete according to his physical parameters. We have data on athletes, which can be considered input factors (Fig. 1):

1. The height of the release of the nucleus by different techniques.
2. Athlete's height.
3. Become an athlete.
4. Age of the athlete.
5. Arm length.
6. Leg length.
7. Type of muscle fibers.
8. Shoulder width.
9. Abalakov's test for motor quality - speed.
10. Acceleration length.

Висота випуску	Зріст	Стать	Вік	Довжина рук	Довжина ніг	Тип волокон м'язів	Широта плечей	Тест Абалакова	Довжина розгону	Тип техніки
220	190	2	16	90	70	2	50	27	120	1
184	160	1	18	78	67	2	65	21	134	2
150	150	2	23	87	67	1	56	15	100	2
178	165	1	23	67	56	1	57	23	123	1
196	170	2	21	65	65	2	67	25	130	3
221	166	2	21	58	48	2	47	34	130	1
223	205	1	19	92	70	2	76	22	148	2
152	217	2	25	74	82	2	24	26	142	4
208	186	2	32	92	56	2	51	25	127	4
208	150	2	23	55	85	1	24	35	125	4
197	225	1	26	69	54	2	75	35	139	3
221	225	1	25	108	64	2	40	20	123	2
150	188	1	28	66	80	2	53	27	114	2
192	185	2	25	82	60	1	69	27	143	1
209	187	2	23	54	58	1	21	19	121	1
198	178	1	35	72	78	1	41	23	135	3
171	227	2	15	100	94	2	64	24	134	4
167	160	1	32	100	87	1	65	26	128	4
170	165	2	30	63	63	1	59	15	119	2

Fig. 9. Input data

Each athlete can use a different throwing technique (one of 4 varieties): jump; circular swing (low legs); circular swing (high legs, low shoulders); circular swing (high legs, high shoulders). When using each technique, it gets different results. Thus, we add a new factor - "technique used for throwing" - as a result. We find the best results for each athlete for each of the factors and conduct a classification. Then we enter the data of the new athlete, and the model (Fig. 2) advises which technique is best to use this athlete to get the best results.

By conducting a series of numerical experiments, a was selectedneural network architecture with one hidden layer containing three neurons.The results of calculations in the Deductor environment are shown in Fig. 3.

The problem can be solved by the method of artificial neural networks with the architecture of a conventional perceptron with ten input factors, shown in Fig. 10, one hidden and one original ("selected technique"). The use of this model will help to reduce the time of the equipment almost twice, which in turn will help to rationally use the time to train the athlete in his age category.

V. CONCLUSIONS

The scientific novelty of the work lies in the system of modeling and finding the percentage of correction of equipment using a neural network device, with which it is possible to improve the training process of the athlete-thrower, which in turn will improve the result. Also psychologically the athlete will be ready for the best result.

The practical value is that a decision support system has been developed - an application that allows you to simulate the result of pushing the nucleus, and find the percentage of correction of technology.

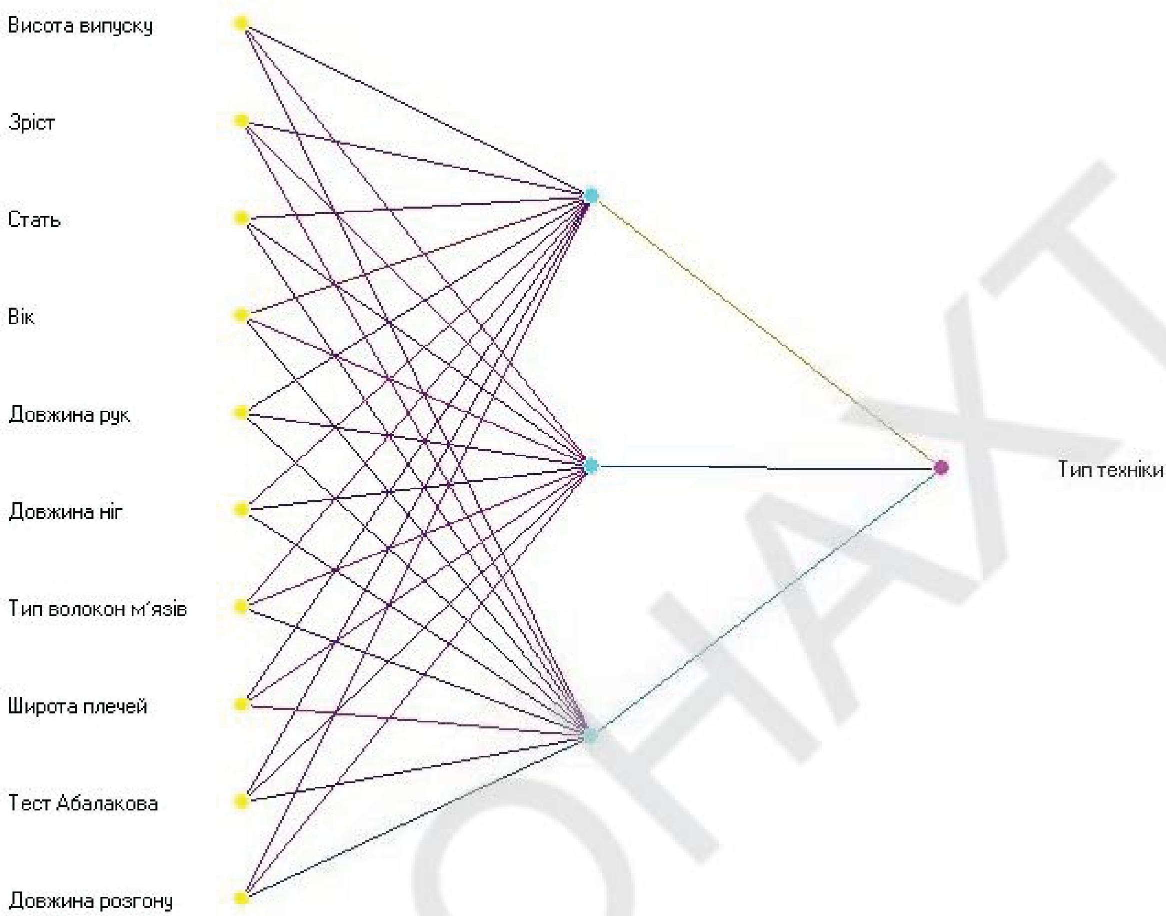

Fig. 10. Scheme of the neural network

Тип техніки	10x2x1	10x3x1
1	1,0265	1,0258
2	1,9963	2
2	1,9993	1,9998
1	1,0007	1,0069
3	2,9988	2,9997
1	1,0194	1,3062
2	1,9987	2
4	3,9783	3,998
4	3,9910	3,9818
4	3,9803	3,9825
3	2,4982	2,9999
2	1,9975	1,9995
2	2,5026	2,001
1	1,0259	1,0122
1	1,0152	1,0027
3	2,9991	3,0007
4	3,9872	3,99
4	3,9929	3,9882
2	1,9995	2,0002

Fig. 11. Comparison of the results of two calculations and available data

The use of artificial neural networks in the calculation of the performance of the athlete-thrower of the nucleus can allow the available data on age, height, body weight of the athlete, as well as the characteristics of the flight of the nucleus to determine the range of this flight. The comparative analysis of several models allowed to formulate certain conclusions about the accuracy of their calculations.

The problem of finding a technique can be solved by the method of artificial neural networks with the architecture of a conventional perceptron with ten input factors, shown in Fig. 10, one hidden and one original ("selected technique"). The use of this model will help to reduce the time of the equipment almost twice, which in turn will help to rationally use the time to train the athlete in his age category.

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