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Predicting the Sporting Achievement in the Pole Vault for Men Using Artificial Neural Networks

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Abstract

The physical sports sector in Iraq suffers from the problem of achieving sports achievements in individual and team games in various Asian and international competitions, for many reasons, including the lack of exploitation of modern, accurate and flexible technologies and means, especially in the field of information technology, especially the technology of artificial neural networks. The main goal of this study is to build an intelligent mathematical model to predict sport achievement in pole vaulting for men, the methodology of the research included the use of five variables as inputs to the neural network, which are Avarage of Speed (m/sec in Before distance 05 meters latest and Distance 05 meters latest, The maximum speed achieved in the last 5 meters from the total approach distance of 30 meters, The ratio of the conversion coefficient of horizontal velocity to vertical velocity, The ratio of the conversion coefficient of horizontal velocity to vertical velocity, The height of the fist is over the full length of the pole's stick) and these are considered independent variables, while the dependent variable was the prediction of achievement (Final height achieved by the jumper) as an output. The neural network architecture was represented by three layers, the first layer is the input layer with the five variables, and one layer is hidden and contains one node, while the last layer is the output layer that represents the outcome of the sport achievement prediction of male weight jumping. The momentum term and learning rate were chosen by 0.95 and 0.4 respectively, and the transfer function in the hidden layer was the sigmoid function and in the last layer was the sigmoid function, the historical data used in this model represent the Olympic achievements of a number of world champions, the results of this study were that the artificial neural network has the ability to prediction of sport achievement for determine the height of the jump of the pole player with a degree of accuracy of 90.10%, correlation coefficient and 95.60%.

Keyword: Artificial Neural Network, Iraqi Sport Sector, Predicating, Man, Pole Vault

INTRODUCTION

Sport engineering has entered various athletics competitions through the development and redesign of some special devices and equipment, including motion simulation, using physical laws to find solutions and applications with accurate measurement methods of variables that directly affect performance. Sports engineering has become the main of information systems in the field of sports mechanical movement whether in education or training, especially in the field of athletics, due to the great support it provides in carrying out and implementing various operations and assisting the teacher, learner, trainer and all who are related to the educational and training process in all activities and decisions required for sports work. Therefore, it is important to take advantage of sport engineering to create a generation of champions athletes, and through it could achieve health, integrity, and speedy access to accurate information, improve the provided services and reduce material waste, plus developing the creative capabilities of the teacher as well the learner. Finally, sports engineering works to provide the teacher and the trainer with tools and devices that help in delivering information to the learner or the player fervermore; it seeks to link learning and training with the senses of the learner or player. Also, the largest number of those senses gives enjoyable and interesting to the learning ; and opens up to many of the favorite learning methods, as well as exciting variation in learning.

(Haake, 2009) briefly suggests that "There is noticeable and tangible evolution in the level of performance that reflected on the level of achievement by entering sport engineering and entering digital technology and technical devices in analyzing and evaluating the level of technology and its components with the schedule of information for each player whatever the number of attempts. “it has finded the development of the digital achievement of the pole vaulting, has increased by 86% during 94 years, as the level of achievement increased from 4.80 m in 1961 with the old pole to become 6.14 m with the modern fiberglass pole with the change of the end of the bar”.

Neural networks are a rather complex mathematical algorithm that is suitable for resolving all problems that are not subject to a fixed mathematical law. It simulates the way the human brain works to recognize sounds, speech, and images. The human brain owns billions of these neural networks and is interconnected in a way that even the human brain itself cannot perceive. Therefore, scientists have thought of a way in which they can simulate this process that occurs in the human mind. They have come to the science of Neural networks which falls under the science of artificial intelligence so that they produce the computers into smart devices that can acquire knowledge in the same way that a person acquires knowledge, which known as the control weights while learning(Alzwainy et al., 2015). In current study, smart artificial neural networks has used to find a mathematical model for calculating the height of player's jump.

RESEARCH AIMS

Training of athletes is of great importance in all areas of the sports sectors because training is an efficient tool for any development process if it provided with the appropriate practical climate and the optimal use of material resources. In pole vault, this importance arises more. After all, the athletes and their talent overwhelm the rest of the factors affecting the training process because many of the training sections in this game depend on the human element, and the role of equipment and supplies remains somewhat limited. So, the purpose of current study is to present and highlight the importance of using novel methods and techniques such as smart artificial neural networks in predicting the player's jump in (for Asian and Olympic) competitions alike, by:

1) Determine the factors affecting the player's jump.
2) Building a computer mathematical model to predict or forecasting the height of a player's jump in the pole vault.

RESEARCH IMPORTANCE

The significance of this study can be summarized as follows:

1) The application of artificial neural networks as modern technology in the sports sectors in the Republic of Iraq has become an quick necessity to ensure the unguis of the Iraqi sports player as well as the success of sports teams participating in international forums, fervermore it is keeping pace with the global technological development that most sports teams and teams in Iraq need.
2) This study is considered as contributor to the field of knowledge in the sports sectors, especially the academic and training side, due to the lack of regional and Arabian studies about predicting sports achievement using artificial neural networks.

RESEARCH HYPOTHESIS

Accordingly, Iraqi Athletes and Sports Teams, urgently need to use the modern technologies for achievement depending on high accurate mathematical equation to calculate the height of the player's jump.

RESEARCH METHODOLOGY

The research methodology included six sections as follows:

1. Explain the concept of neural network technology.
2. Explain the importance of the pole-vault game in the sports sector.
3. Collecting historical data and the technical (mechanical) performance of pole vault.
4. Developing a mathematical model for predicting the player's jump.
5. Checking and proving the perposal mathmatical model.
6. Conclusions and recommendations.

THE THEORETICAL BACKGROUND

The First Section: Artificial Neural Networks

They are computational techniques designed to simulate the way human brain performs a certain task, through massive utilizing treatment, and content of easy processing units. These units are mathematical elements called nodes or/and neurons that have a neurological property, In that it stores practical knowledge and experimental information to make it available to the user by weights adjusting (F. M. Al-Zwainy, 2009).

All artificial neural networks consist of several layers of artificial neurons. The first layer is called the insertion layer, and the last layer is called the excretory layer, and the hidden layers reside between the insertion and excretory layers. Also, there are many types of neuronal networks, the most important of which are perceptron, self-regulating Kohonen networks, and neuronal frontal networks.

Figure (1) shows each neuron in one of these layers related to all the neurons in the next layer and all the neurons in the layer that precedes it, where signals or values from the previous layer neurons return it for processing and give a particular output value that is transferred to all the neurons of the next layer. Each neuron receives multiple Input values and gives a single Output value. Neurons are sometimes associated with a fixed input that is involved in every treatment process and has nothing to do with network inputs, this is called bias (Fausett, 1994).

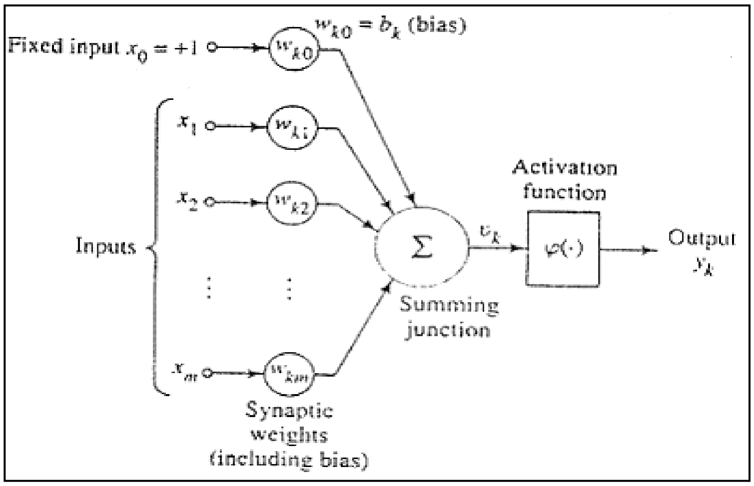

Figure 1. Neuron Model

Each connection between a neuron and another is characterized by its correlation with a value called weight, which forms how important the connection between these two neurons is. The neuron multiplies each input value received from the previous layer neurons by the weights of connections with these neurons, then collects the multiplication products all, then subject the result to transfer function or activation function, and it varies according to the type of neuron, including (Step function, Linear combination, Sigmoid and Rectifier. Accordingly, the transfer function results are considered a neuron output which it is tranfered to other layer (F. M. S. Al-Zwainy & Aidan, 2017).

The second section: Pole Vault

Pole vault is one of the athletics activities and it is derived from gymnastics. In this difficult type of jumping event, the players start with a very fast impulse and hold the pole in the hand. When the player reach the bar ,the pole should be stabed in the ground, and turns his speed into an ascension force, by stretching his muscles over the pole. So, the player float with two legs in the air and rises above the crossbar. The player leaves the pole as soon as passes the bar, as it must fall behind the player. It is considered a failed attempt if the jumper dropped the crossbar. Accordingly, the most commonly used pole stick is made of fiberglass with great flexibility (Frère et al., 2010).

1) **Pole vault phases**

a) Approach

Determining the optimum number of approaching steps, the pole is well held during running (approaching) hands are far apart by the shoulder width. The right hand is close to the pelvis and the tip of the pole is higher than the height of the vaulter's head. The stem is straight and actively approaching with a gradual increase in speed. The pole is carried diagonally and forward, then horizontally during approaching, preparing to plant (Schade et al., 2006).

b) Planting

The head of the pole is lowered gradually and smoothly during the last third of the approach. The planting starts when the left foot's descent in the second to the last step with the pole being pushed forward then the right arm is quickly raised from the hand near the head while the right foot is falling. Strongly prepared to rise (Angulo-Kinzler et al., 2016).

c) Take-off

The maximum energy of the pole is shifted by straightening the entire body with the entire right arm stretching up and in front of the take-off foot as the free leg swing actively up, therefore, performing the pendulum movement along the body around both the shoulders and the pelvis, pushing the left arm upward and the right arm along its length during departure (Angulo-Kinzler et al., 2016).

d) Swing up / Extension / Turn

The achievement could be reached by maximum bending of the pole with motionless position of the body can benefits from the stored energy. The legs fold and bond to the chest. The arms remain extended until the back becomes almost parallel to the ground thus moving toward the front and then up using the stored energy to push the vaulter by moving the body from the left of the pole to its right crosses the pelvis near the stick of the pole, as the spinning force starts pushing the arms together and then wraps the body to face the crossbar (Hubbard, 1980).

e) Crossing the bar/landing

Getting the maximum height after push off the pole, passing the crossbar by pushing the right hand with curving the body, then the body extends after passing the bar and landing on the back. Figure (2) stages of crossbar cross (Arampatzis et al., 1999).

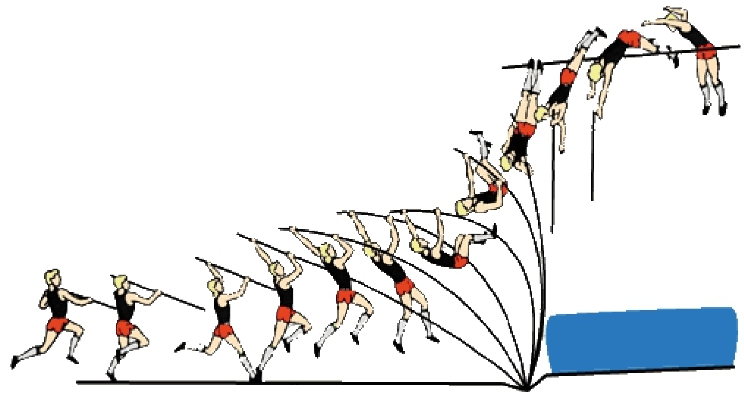

Figure 2. The stages of jumping Pole Vault

The pole used in jumping competitions must be light and flexible. At the end of the nineteenth century, the pole used in matches was made of a natural material such as wood or metal. At the beginning of the second half of the twentieth century, atheltes had used pole made from synthetic materials, but today they have used the pole which is made from artificial materials that differ from its predecessor, such as carbon fibers, glass fibers, and epoxy (which is a synthetic material used as a glue). Figure 3 shows the highest altitude the contestants reached by jumping the pole in the previous century (Arampatzis et al., 1999).

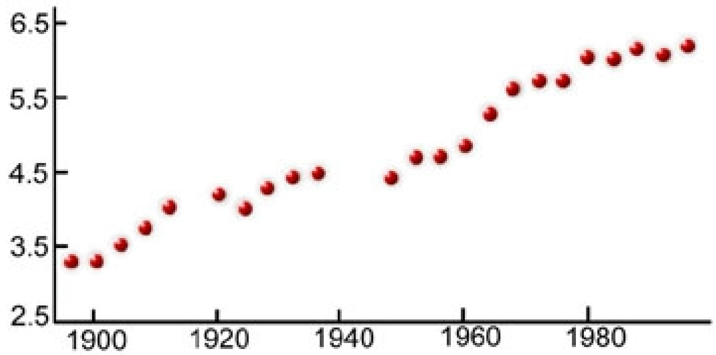

Figure 3. Heights of Pole Vault Jumping

PRACTICAL STUDY

The practical part of this research included important stages:

1. Determining the affecting factors to the height of the player's jump.
2. Building an artificial neural network model to estimate the height of the player's jump.

Determining the factors affecting the height of the player's jump.

The anthropometric specifications (height, arm length, shoulder width) of the pole vault player have an important role. fervermore, the requirements of training such as physical ,motion and correspond abilities such asspeed and agility which they are necessary for high achievement of pole vaulting (Gross et al., 2020).

The most important goal in the pole vault competition is to pass the maximum height of jumping without dropping the bar from its holders, so the jumping technique has evolved from a technique that relies on strength, compatibility, and agility using a solid pole, to a technique that relies on speed, agility, flexibility, and all motional capabilities (Gudelj et al., 2013).

The application of intelligent artificial neural network technology in estimating the height of a player's jump requires the diagnosis of the factors that affect the player's jump. This study demonstrates the development of the neural networks model to predict the height of the vaulter's jump for future matches based on historical data and information previously implemented in Iraq or internationally. The database included historical information from a previous competitive game held in various competitions in Iraq and the world. In this research, the factors (variables) affecting the pole-vault game were divided into two main categories: Independent Variables and Dependent Variables. The height of the jump has adopted as a non-independent variable, and its value is calculated based on other independent variables (player experience, player age, player length, player weight, weather conditions, type of pole, player approach speed, and length).

Accurate analyzes of balanced jumps were made for several events for athletes in pole vault game, especially for the Soviet elite pole vaulters and other athletes. The results of analysis and study indicated that there may be a new technical performance for the stage of implantation of the pole stick in the box that is much more rational as a technique or a new method for the stage of implantation that has not been used Previously.

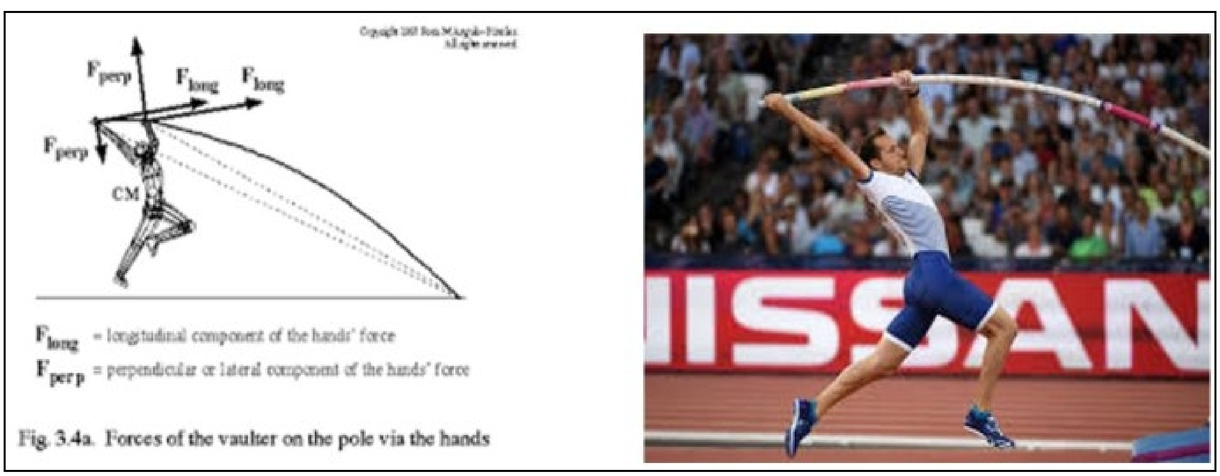

Figure 4. The image of the hero, Renault Lavigne, in ascending, and a mapping of the active forces of ascendancy

It is noticeable in the technique of the implantation stage in the box that the upper hand on the pole (that is, the right hand relative to the right jumper) has bends at the level of the joint arms, which are coupled with moving the wrist of the upper holding hand and are close to the shoulder joint of the upper holding hand (Here the right hand of the right-hand jumper (i.e. who uses his right hand for everything)), and as it imposes this type of kinetic performance on the pole by lowering its tip to the lowest level at the beginning of the box, these jumpers who use this effective technique in the implanting stage get the speed of converting energy gained speed of the horizontal approaching stage into kinetic energy stored in the pole with a high degree, where the upper grip (here the right hand) can be much higher on the pole and the level of the maximum speed limit. The realized parameter is the coefficient of converting the horizontal speed to a vertical speed that gathers and increases the speed of the vaulter (see Table 1).

Table 1. The effect of preparation and technical preparation on pole vaulting achievement

Athletes	Avarage of Speed (m/sec.)		The maximum speed achieved in the last 5 meters from the total approach distance of 30 meters	The ratio of the conversion coefficient of horizontal velocity to vertical velocity	The height of the fist is over the full length of the pole's stick	Final height achieved by the jumper
	Before distance 05 meters latest	Distance 05 meters latest				
BUPKA	9.78	9.8	10.73	0.913	5.13	6.01
FATALIN	9.25	9.43	10.50	0.898	5.05	5.90
BONDARENKO	9.17	9.23	10.40	0.888	5.00	5.65
ZHUKUROV	9.17	9.36	10.57	0.886	4.95	5.85
BOVATROVA	9.19	9.13	10.37	0.880	4.85	5.80
SBASOVA	9.20	9.06	10.35	0.875	4.80	5.70
TSHRBOJOV	9.14	9.04	10.46	0.864	4.75	5.70
AOBZUOV	9.12	8.96	10.44	0.858	4.75	5.65

The coefficient of converting the horizontal speed to the vertical speed depends on the following equation: (C) is the coefficient of converting the horizontal speed into a vertical speed, which in turn is the sum of the vertical-horizontal speed achieved by the jumpers and represented by (Vav), which is the average velocity for the last five meters of the approaching stage. (Vmax) is the maximum speed achieved by the jumpers for the last five meters of the total approaching distance, which is estimated at 30 meters from the start of approaching and running quickly with the pole.

$$C = Vav \div Vmax \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Whereas the first four-pole jumpers whose results are shown in the attached Table (1) (Bupka, Fatalin, Zhukurov, Bovatrova) use the new technique to carry and implant the pole in the last three steps and descend effectively, which represents the speed of their approaching in the last 5m distance as presented in Figure (5).

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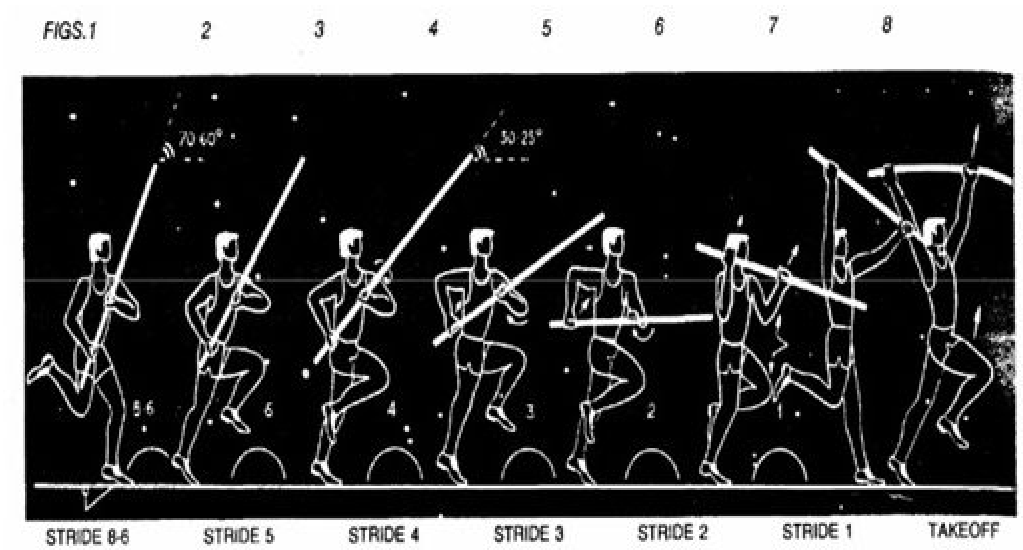

Figure 5. The last three approach steps and the implantation stage

Developing a mathmatical model for predicting the vaulter's jump.

The methodology of the current research of constructing the artificial neural network model has developed a set of sub-models, such as the (Input Model, Output Model, Data Division Model, and Network Model Architecture Selection Model, Weight Model, Learning Model, Momentum Model and Validity Model.

The Neuframe-v.5 software has applied. Neuframe is a commercial software built in C ++. This software is an artificial intelligence approch plus it is easy to use in developed various artificial neural networks. This program has been used to demonstrate how to build sub-models starting from the entry form and ending with the output model and as shown in Figure (6) below, except for the verification model, it has designed by utilization the SPSS (Statistical Package for Social Sciences).

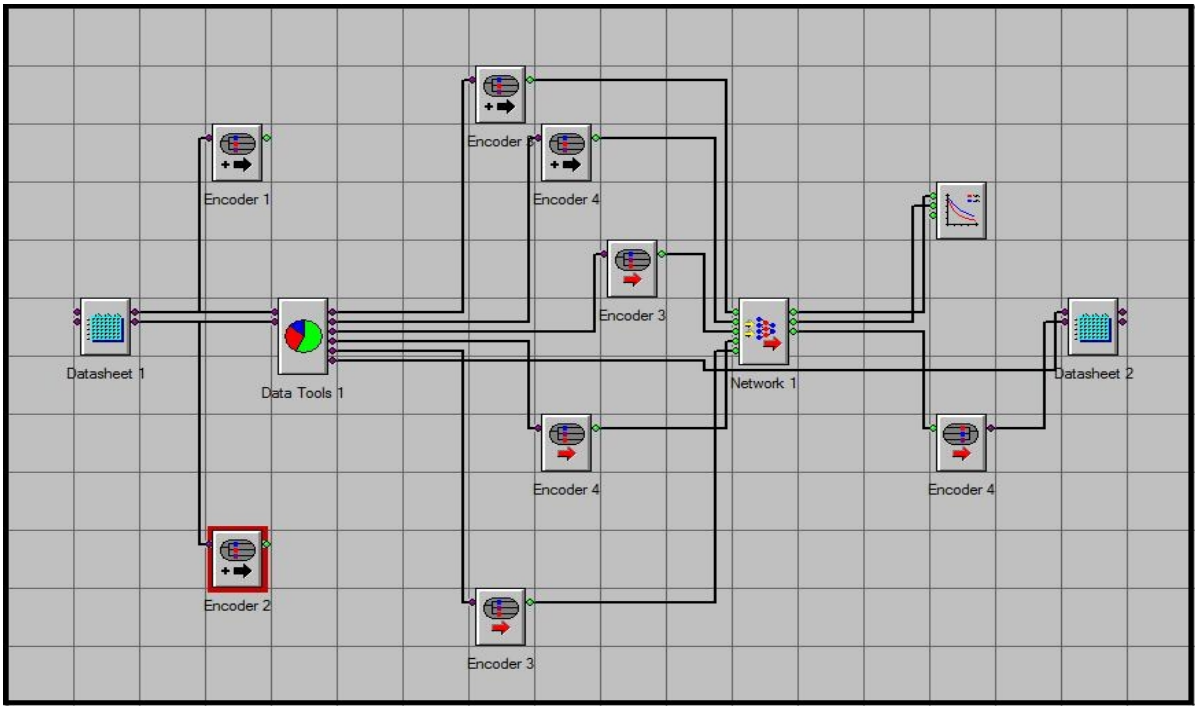

Figure 6. A model for the forward feeding back-feeding neural network, which was constructed using Neuframe-v.4 software.

1) Models of Inputs and Outputs

The process of selecting the variables in the input and output models acquires great importance that contributes to improving the performance of the neural network, as the increase in the number of input and output variables greatly affects the increase in the size of the neural network then consequently leads to a decrease in the speed of the learning process, thus affecting the efficiency of the neural network. There are several ways to choose the number of variables in the input and output models, and the method of “Priori Knowledge” was chosen in current research, as this way is widely used in the science and technology sector and is approved in many research and studies, as this method can be used when there is no Prior knowledge about the input variables and their effect on the output variables, and thus the input model included independent variables of both quantity and quality, which are (The average running speed, the maximum speed, the ratio of shifting the horizontal speed to the vertical speed and the height of the handgrip over the full length of the pole), while the output model included the non-independent variable (the final height achieved by the vaulter in pole vault). These two models are a means of storing and documenting data for previous games, and they can be updated continuously.

2) Model of Data Division

The input or output data in the neural network are either continuous variables or separate variables, and this data is divided into three main groups:

1) Training set for building a neural network model.
2) Testing set or testing of the neural network model.
3) An independent investigation group to assess model performance in the applicable environment (Validation Set).

A training set is used to control the weights connected to the neural network. The examination group is used to check the performance of the network in the various stages of education. The training is stopped when an error increases for the examination group. The examination group is used to evaluate the model's performance once the neural network training has been completed. Therefore, the division of data into the above three groups is a critical and important step in neural network modeling. In this research, a Statistically Consistent Method was used to divide data into the three groups (training group and examination group and the investigation group) by this method guarantees a statistical fit of the data for each group and for ensuring that there is no bias in the division of data in each group by using a T-test through the use of statistical criteria which are the mean, standard deviation, and range. One of the advantages of this method is that it adopts the trial and error method to reach the best division of data. In Table (2) has noted the percentage of data division for training, examination and investigation groups using the trial and error method, it has used different ratios of data for these groups in an attempt to get the best performance of the neural network represented by reaching the highest coefficient of correlation to show the strength of the relationship between neural network outputs (predicted height) and measured (actual) height, and in conjunction with the lowest test error, these two criteria are used in this research to choose the best division of data. Through table (2) it has shown that the best data division is 75% for the training group, 10% for the examination group and 15% of the investigation group, relying on the lowest error ratio for the examination (4.8%) and the highest correlation coefficient (92.5%) and the second division of data (80%, 5%, and 15%) is not chosen as the best division of data despite the correlation coefficient has the largest It is (92.8%), but now this difference between the value of the correlation coefficients is considered very little or imperceptible, while the error ratio for the first division of data is (6.66%) is greater compared to the chosen division as the best division of data. Thus, we find that the best performance of the neural network is when the data is divided into 75% for the training group, 10% for the examination group, and 15% for the investigation group.

Table 2. Effect of Behaviour on Data Division of ANN Model

Data partition %			Error of Training %	Error of Testing %	Coefficient Correlation (r)%
Training set	Testing set	Querying set			
75	10	15	4.8	6.51	92.5
80	5	15	8.09	6.66	92.80
85	5	10	7.99	6.79	91.54

For the purpose of distributing data for the variables to the three groups, which are the training group, the examination group and the investigation group, the program (Neuframe) is used to provid an efficient method for distributing data of three methods, that is:

1) Random Method: In this method, the program randomly distributes the data of the variables to the three groups according to the percentages which are obtained in Table (1).
2) Striped Method: In this method, the program has divided the total data into unspecified groups of packages, and each package includes data for both the training group and the examination group and the investigation group, then the data for each group of each package has collected to reach the percentages obtained In Table (1).
3) The Integrated Package (Blocked Method): In this method, the total data is dealt with as one package and divided respectively for the three groups, meaning that the first (75%) of the data is for the training group and (10%) the second is for the examination group and (15%) The third and final data are from the investigation group.

In order to study the effect of using the different options of randomization, blocked, random (verified as shown in Table 3), it has observed that the best performance of the neural network is when using the striped method, as it has the lower error concerning the examination (6.51%).

Table 3. Effect of Behaviour on Data Distribution of ANN Model

Data partition %			Distribution	Error of Testing %	Coefficient Correlation(r)%
Training set	Testing set	Querying set			
75	10	15	striped	6.51	92.5
75	10	15	blocked	6.99	92.20
75	10	15	random	6.99	91.00

3) Neural Network Architecture Model

Artificial neural network architecture is how neurons connect with each other to form the network. And determining the appropriate number of neuronal nodes in the intermediate layer of the neuronal network is an important factor for the success of the neural network, knowing that the number of nodes in the Input layer is equal to the number of factors affecting the productivity calculation, and the six factors are (age, experience, level of work, weather, and degree of location complexity), as for the output layer it contains one neuron node which is the measured height. Many methods could be used to find the optimal number of neuronal nodes in neural networks (F. M. Al-Zwainy, 2009), and the best method is to use equation (1) which involves starting with selecting one node in the intermediate layer and then starting with a gradual increase in the number of nodes until achieving the best network performance, and the maximum number of nodes is equal to (2I + 1), and this method is adopted by the researcher in this research.

Fervermore, by using the default settings of the program used in this research, which is the learning rate and its value is (0.2) and the step volume (Momentum Term) and its value is (0.8), and the Transfer Function for the output and hidden middle layer nodes is of type (Sigmoid).

From Figure (7) below, it has appeared that there is a slight variance in the error rate of the examination group also the best performance of the network is when the number of nodes is equal to one node. This is because it has the highest correlation coefficient (92.5%) and the error rate of the examination (6.51%). Thus the typical form of this network developed in this research is three neuronal layers (the input layer and a hidden layer and the output layer). The input layer has not made any treatment process but it is simply the place of feeding the network with the database and the input layer after this feeds (the transfer of information) to the hidden layer and then the hidden layer feeds the output layer. The actual processing of data is mainly in the hidden layer and the output layer.

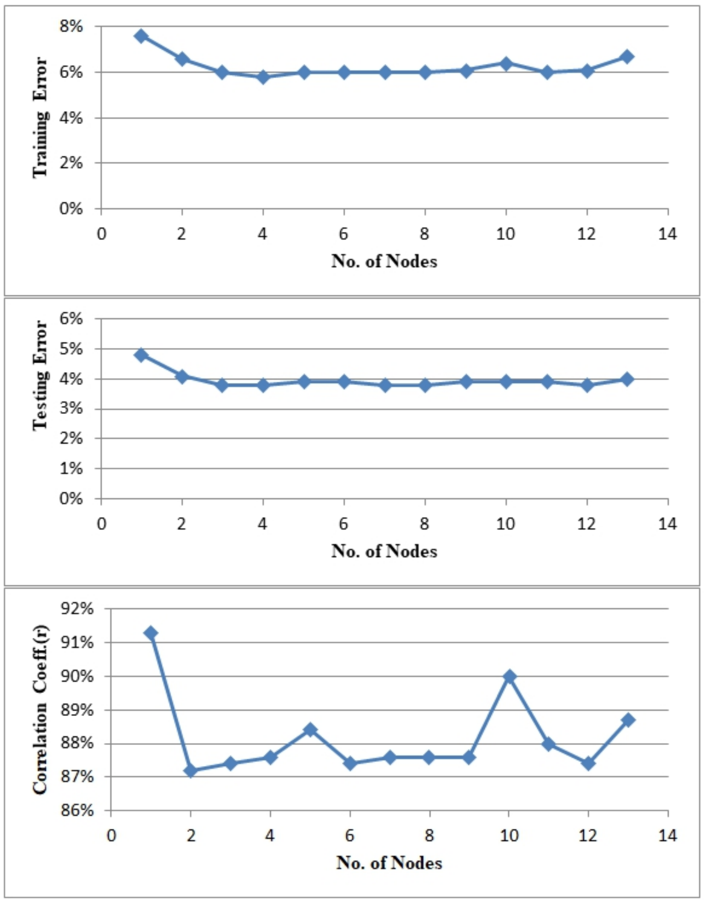

Figure (7): Performing the neural network model with the different number of nodes

4) Step size model and learning rate model

These two models are considered important models in improving the performance of the neuronal network, and they work together coherently through the neural network architecture, and they both affect each other. In order to demonstrate the effect of the step volume coefficient, or the so-called "Momentum Term", on network performance, The current research has performed a set of tests on the neural network via changing the momentum factor for values ranging from (0) and (1.0). From Figure (8) the network is not sensitive to the specific momentum diversity from the range (0.01) to (0.8), then it started decreasing gradually to check the error. The best performance of the network when the momentum factor is equal to (0.95) as it has the lowest error rate for the examination group (6.51%) and the largest correlation coefficient (r) (92.5%), note that there is an improvement in the network performance whenever the momentum factor approaches the maximum limit (1). In addition, we note that the effect of the "Learning Rate" on the performance of the model. The learning rate determines the speed of inclination and bias change, and the effect of the learning rate is achieved when fixing the optimum value of the Momentum Term (0.95), As it is shown in Figure (9), the optimum value for the learning rate is (0.4), as it has the lowest error of the examination group (6.51%), and the largest correlation coefficient (r) (92.5%), it is indicated that there is an improvement in network performance the closer the learning rate approaches its minimum (0.0).

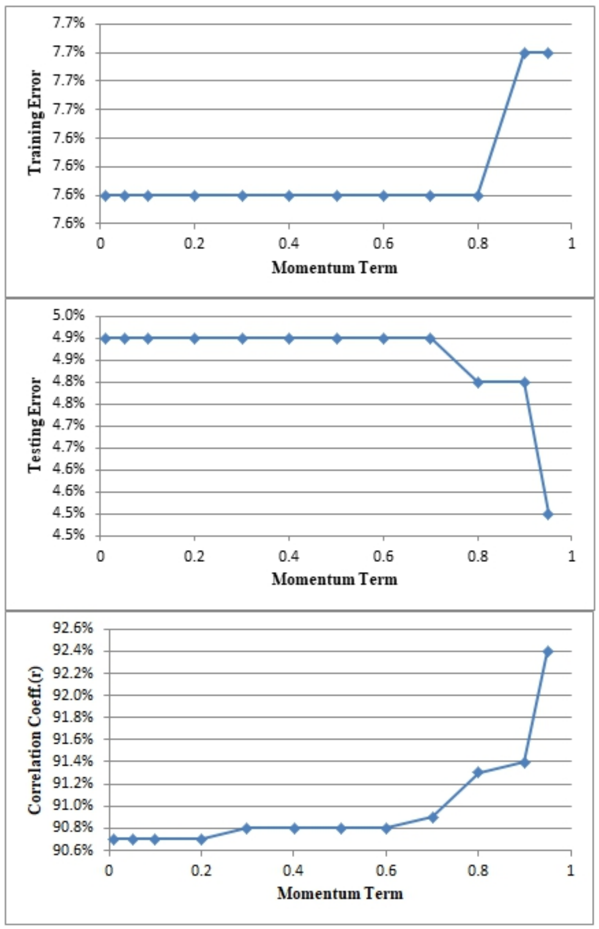

Figure (8): The effect of momentum determinant variation on the performance of the neural network model (learning rate = 0.2)

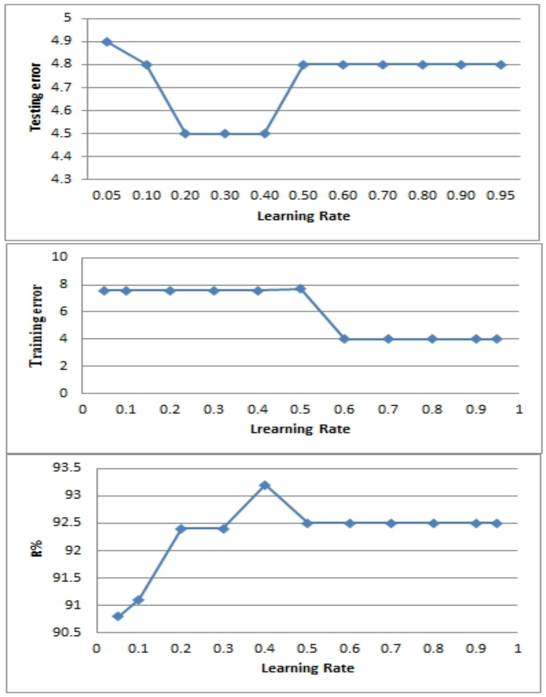

Figure (9): The effect of variation in the learning rate on the performance of the ANN model

To study the effect of the conversion function, four tests were performed, as it is shown in Table (4) below, also it can be noted that the performance of the neural network is almost insensitive to the type of function, as the correlation coefficient was within 92.5% and the error rate ranges between 4.8% and 6.51%, Through that, it has concluded that the best performance of the network model was obtained when using the sigmoid function for both the intermediate (hidden) and output layers, due to obtaining the highest correlation coefficient (92.5%) and the lowest error ratio for the examination (6.51%). Thus, the current research has found that the Sigmoid related is the most common as a transformation of neurons because it secures nonlinearity in the neuronal network calculations by converting the value of the activation of the neuron within the [0,1] field. Plus it provides an additional feature that is summarized in the simplicity of the derivative required in the back-propagation algorithm for errors, and it is one of the algorithms of controlled education used in front-feeding networks in this research.

Table 4. Impact Transfer Functions in ANN Model Performance.

Effect of Parameters	**Transfer Functions**		**Errors**		**Coefficient correlation (r)%**
	Hidden Layer	**Output Layer**	**Training %**	**Testing %**	
Model No.1 Choices of division (striped) Momentum Term (0.8)	sigmoid	sigmoid	4.8	6.51	92.5
	sigmoid	tanh	5.89	6.89	90.90
	tanh	sigmoid	5.99	6.98	90.95
	tanh	tanh	5.8	6.55	90.00

Learning Rate (0.2) No. of Nodes (1)					

5) Information of ANN Model

Each connection between a neuron and another is characterized by its association with a value called weight, which indicates how important the link between these two elements. The neuron multiplies each value of incoming value from the neurons of the previous layer by the weights of connections with these neurons, and then accumulates all multiplication products, then subjecting the result to a conversion factor that varies according to the type of neuron, the output of the transformation is the neuron's output that is transferred to the neurons of the subsequent layer. After training the network, weights were obtained for the nodes connecting the first layer (insertion) and the second layer (middle or hidden), as well as the weights between the second layer and the third layer (output) as it is shown in the Table (5) below and Figure (9).

Table 5. Weight and Threshold Levels for the ANN model

Parameter Estimates			
Predictor		Predicted	
		Hidden Layer 1	Output Layer
		H(1:1)	y
Input Layer	(Bias)	.539	
	x1	-1.919-	
	x2	-1.606-	
	x3	-.560-	
	x4	-.883-	
	x5	1.349	
Hidden Layer 1	(Bias)		.018
	H(1:1)		-1.733-

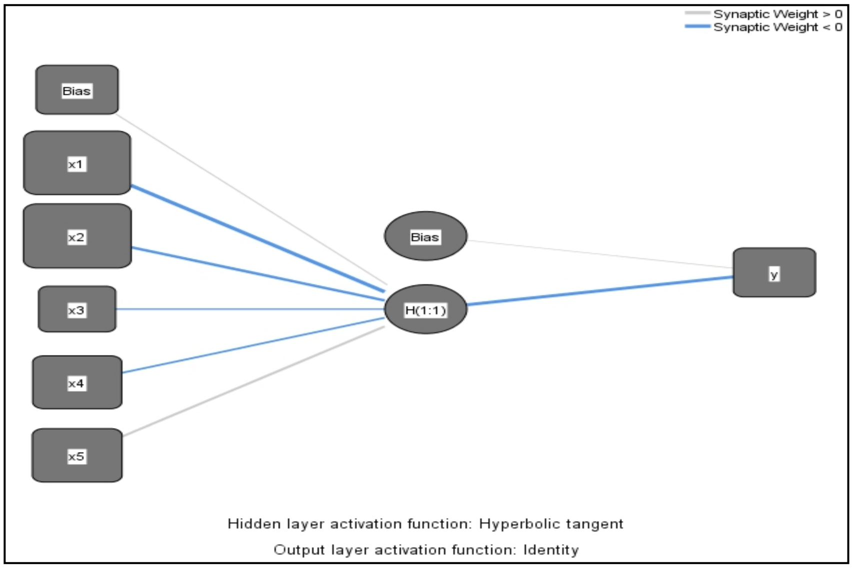

Figure 9: Architecture of ANN Model

Table 6. General Information of ANN Model

Input Layer	Covariates	1	x1
		2	x2
		3	x3
		4	x4
		5	x5
	No. of Units		five
	Rescaling Method for Covariates		Normalize
Layer of Hidden	No. of Hidden Layers		one
	No. of Units in Hidden Layer 1		one
	Transfer Function		Sigmoid
Layer of Output	Dependent Variables	one	y
	No. of Units		one
	Rescaling Method for Scale Dependents		Standardize
	Transfer Function		Sigmoid

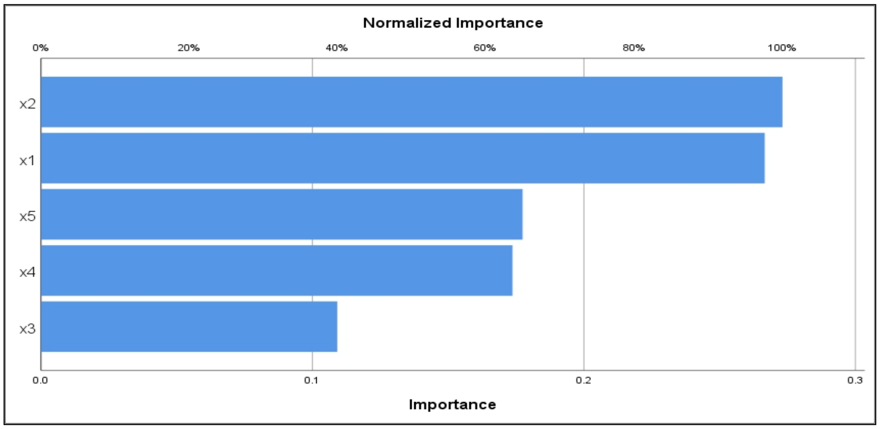

Figure (10): Normalized importance of independent varaibles

Table 14. Model Summaryb

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
No.1	.956a	.915	.801	.05825
MAPE		21.90%		
AA%		90.10%		
a. Predictors: (Constant), x5, x3, x1, x4				
b. Dependent Variable: y				

CONCLUSIONS AND RECOMMENDATIONS.

The main aim of current study is to utilization a new approch known as artificial neural networks(ANN) to forecasting the final height achieved in the pole vault. The application of artificial neural networks as a new technique in the sports sector in Republic of Iraq is very necessary to ensure the development and success of the Iraqi player. One model was built to predict the final height of the the player. In this work, multi-layer networks with error-back propagation techniques were used. It was found that these networks could predict the final height of the player with correlation coefficients (R) reached 95.6%.

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