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AHP-Neural Network Based Player Price Estimation in IPL

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Abstract

The present study aims to design a methodical model based on Analytical hierarchy Process (AHP) and Artificial Neural Network (ANN) for estimation of player price in IPL. Based on expert view several key features are chosen for cricket player price calculation in IPL twenty-20 cricket tournament. Initial weights of attributes are calculated through AHP. Dataset is prepared using Open Source Information from the internet and offline experts. Back propagation neural network trains a pre normalized performance dataset of last three years IPL statistical dataset of 226 players. Finally, our proposed methodology gives a systematic way to select the important attributes and calculate the weights based on expert opinion to measure the optimal price for a player which will help the IPL team owner to select the player according their budget and strategies. A strict tradeoff between 'budget conscious bidding' and 'performance based bidding' is thus optimized using this model.

Keywords: *Expert System, Fuzzy System, MCDM, AHP, ANN, Feature Selection, IPL*

1. Introduction

Team selection is a very essential process in cricket as players are selected by their total contributions which depend on several attributes and it becomes more crucial when a huge amount of money is involved. In this regard appropriate player price estimation is the challenging task for the IPL franchisee owner to select the best winning team in low budget in IPL auction. Player price calculation does not depend only the past performance of the player's but it also depends on the recent form of the players and many more features of the players. In this paper we use real set of data from one of the most well-known cricket twenty-20 [21, 22] league known as Indian Premier League (IPL), initiated by Board for Control of Cricket in India (BCCI) in the year 2008 [23, 24] of India.

Cricket is the most popular game in India and it is the second most popular game worldwide after soccer. Cricket is a bat-and-ball game played between two teams of 11 players in which several role of players are there like Batsman who can bat and scored run, Bowlers who can bowl and try to out of the against player, Wicket-Keeper who can keep the ball behind the wicket and All-rounder who can bat and bowl both. Test, One-day (50 overs

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game) and Twenty-20 (20 over game) are the different forms of cricket play in present year. Among this three format of cricket twenty-20 is most populated after introduced IPL. The England and Wales Cricket Board (ECB) in England originally introduced Twenty20 in 2003. Initially, IPL started with 8 franchises or teams but now in IPL 9 teams took participated and the franchise owners formed their teams by bidding from a pool of Indian and Overseas international players and the best of Indian upcoming talents [25].

In this paper an intelligent model based on combination of AHP-ANN, is introduced to estimate player price depend on multiple attribute in IPL. At first AHP is used to measure the weights of the attributes which are responsible for player price measurement and then ANN is used to forecast the player price with the weights calculated by AHP. Finally, our proposed model predict accurate value of the player intelligently.

The paper is organized as follows: Section 2 focuses on the Literature survey. Section 3 discusses about the Features Contribution & Quantification of Linguistic variables for Player price Estimation. Proposed Methodology and discussion are carried out on section 4. Finally, section 5 concludes the paper.

2. Literature Survey

The Analytical Hierarchy Process (AHP), is a powerful tool of multi-criteria decision analysis for pair-wise comparison was first introduced by T.L.Saaty in 1980 [1, 2]. Application of Analytic Hierarchy Process (AHP) in materials and human resource management under group decision making environment was introduced by C. Muralidharan, in 2000 [3]. An advantage of the AHP is that it is designed to handle situations in which the subjective judgments of individuals constitute an important part of the decision process and its hierarchical structure is easy to understand.

A neural network [4] has one or more input nodes and one or more neurons. Some neuron's outputs are the output of the network. The network is defined by the neurons and their connections and weights. All neurons are organized into layers; the sequence of layers defines the order in which the activations are computed. ANN based algorithms are very helpful in real life dynamic situations. Artificial neural network (ANN), an evolutionary optimization based algorithm had been developed for supplier selection and vender selection in [5-7]. An automated web-based infrastructure management tool based on AHP-ANN was developed by Hassan Al-Barqawi in 2008 [8]. A hybrid model using analytic hierarchy process (AHP) and neural networks (NNs) theory to assess vendor performance was designed by Jitendra Kumar [9].

In cricket players are several jobs like batting, bowling (spin or fast), wicket-keeping, fielding, captaincy *etc*. H.H. Lemmer proposed several techniques for calculating the performance of bowlers, batsmen [10-12]. A graphical display for comparing the performances of bowlers, batsmen and all-rounders are presented by Paul J. van Staden [13]. Player valuations in the IPL by their previous performance, experience and other characteristics of individual players were done by David Parker [14]. An integer programming model for the efficient bidding strategy for the franchises has been implemented in real time and overcome winner’s curse which is typically associated with normal bidding processes described by Sanjeet Singh [15]. Selection of players in the annual Australian Football League (AFL) and recruitment of managers in the talent identification process with the help of Neural Network was done by John McCullagh [16]. A cricket team players selection from a set of six level players in complex situations using analytic hierarchy process proposed by A.G.Kamble [17]. S.K. Rastogi provided a unique approach to provide an objective valuation of cricketers based on the valuation of their cricketing and non-cricketing attributes as perceived by the business of cricket in [18]. A Hedonic price model for determination of Player Wage from the Indian Premier League Auction was developed by Liam J.A. Lenten [19]. The strategies of franchisee teams during the auction of the players in IPL and economical, behavioral factors with cricketing attributes that involve to make the decision was presented in Sonali Bhattacharya paper [20].

3. Features Contribution & Quantification of Linguistic Variables for Player Price Estimation

3.1. Features Contribution to Player Price Estimation

The player's price estimation depend on three basic features namely as-

- Player's Performance Appraisal
- Player's Experience Contribution
- Player's recent form.

Further classification of above features are shown below-

a) Player's Performance Appraisal **(C_1)**
   - **PA:** Performance appraisal of each players in last three IPL session.
   - **PER:** Past IPL performance analysis (whether player performance increase or decrease or same or alteration in last three IPL session).
   - **MW:** Match winning capability of any player.
   - **MOM:** No. of man of match won by a player.

b) Player's Experience Contribution **(C_2)**
   - **AGE:** Age of the players.
   - **CAP:** Captaincy capability of any player.
   - **ROLE:** Extra Role of a player in the team**.**
   - **FIELD:** Fielding Capability of a player.
   - **ICON:** Popularity or Fame of Player.

c) Player's Recent Form **(C_3)**
   - **INT:** Player plays or played international tournament.
   - **T20M:** Recent T20 International team member.
   - **ODM:** Recent One Day International team member.
   - **T20R:** Recent ICC T20I rating.
   - **ODR:** Recent ICC ODI rating.
   - **NAT:** Indian or Overseas Player.

Sample datasheet is shown in Table 1 according expert opinion.

Table 1: Sample Datasheet with Attributes in Linguistic Term

ID	Player	AGE	CAP	ROLE	FIELD	INT	ODR	T20R	T20M	ODM	MOM	ICON	MW	NAT	PA	PER	Base Price	Actual Price
1	Albie Morkel	33	NG	H	M	C	0	0.595	Y	Y	L	S	VH	F	0.739097	0.55	200	675
3	AB de Villiers	29	G	H	VH	C	1	0.607	Y	Y	H	S	VH	F	0.716215	0.55	400	1100
8	Adam Gilchrist	41	G	H	VH	C	0	0	N	N	M	B	VH	F	0.560940	0.35	400	900
12	Ajinkya Rahane	25	NG	L	H	C	0	0.36	Y	Y	H		H	I	0.640617	0.55	60	60
46	Brett Lee	36	NG	M	M	C	0	0	Y	Y	L	S	H	F	0.520720	0.8	300	900
49	Chris Gayle	33	M	M	L	C	0.645	0.919	Y	Y	VH	B	VH	F	1.000000	1	250	800
52	Dale Steyn	30	NG	L	M	C	0.746	0.772	Y	Y	H	S	VH	F	0.863194	1	200	1200
62	Dinesh Karthik	27	NG	H	VH	C	0	0	N	Y	M		H	I	0.575937	0.8	200	900
71	Gautam Gambhi	31	G	L	L	C	0.736	0.742	Y	Y	VH	B	VH	I	0.717120	0.8	200	2400
75	Harbhajan Singl	33	M	H	H	C	0	0.669	Y	N	M	S	H	I	0.759467	0.8	250	850
80	Irfan Pathan	28	NG	M	H	C	0.506	0.612	Y	Y	VL		M	I	0.636396	0.55	200	1900
83	Jacques Kallis	37	M	H	H	C	0.723	0.711	Y	Y	H	B	VH	F	0.780017	1	300	1100
84	Jaidev Unadkat	21	NG	L	L	C	0	0	N	N	L		M	I	0.667578	0.55	100	525
98	Kieron Pollard	26	NG	H	VH	C	0.671	0.58	Y	Y	H	B	VH	F	0.768536	1		900
102	Lasith Malinga	29	NG	M	M	C	0.74	0.786	Y	Y	M	S	H	F	0.953196	1	200	350
111	Manoj Tiwary	27	NG	L	VH	C	0	0	Y	Y	L		L	I	0.570752	0.1	100	675
126	MS Dhoni	33	G	H	H	C	0.889	0.633	Y	Y	H	B	VH	I	0.767566	1	400	1500
158	Rohit Sharma	26	M	M	VH	C	0.576	0.584	Y	Y	H	S	VH	I	0.731404	1	200	2000
164	Sachin Tendulk	40	G	M	M	C	0	0	N	Y	M	B	M	I	0.629722	0.35		1800
169	Shadab Jakati	32	G	L	M	UC	0	0	N	N	VL		L	I	0.686458	0.55	50	50
188	Suresh Raina	26	M	H	VH	C	0.759	0.888	Y	Y	H	S	VH	I	0.743090	1	125	650
200	Virat Kohli	24	M	H	H	C	0.921	0.902	Y	Y	H	B	VH	I	0.774771	1		1800
201	Virender Sehwa	34	G	M	H	C	0.689	0.415	Y	Y	VH	B	VH	I	0.681783	0.55		1800
204	Yo Mahesh	25	NG	L	L	UC	0	0	N	N	VL		L	I	0.633750	0.1	20	20

3.2. Quantify of some Non-numeric Attributes

$$\begin{cases} Age_N = 0.5, & If \quad Age < 20 \ or \ Age \geq 37 \\ Age_N = 0.8, & If \quad 20 \leq Age < 24 \ or \ 33 < Age \leq 37 \\ Age_N = 1.0, & If \quad 24 \leq Age \leq 33 \end{cases}$$

$$\begin{cases} Icon_N = 0.05, & If \quad Icon = Less \\ Icon_N = 0.50, & If \quad Icon = Average \\ Icon_N = 1.00, & If \quad Icon = Most \end{cases}$$

$$\begin{cases} Cap_N = 0.1, & If \quad Cap = Not \ Good \\ Cap_N = 0.6, & If \quad Cap = Medium \\ Cap_N = 1.0, & If \quad Cap = Good \end{cases}$$

$$\begin{cases} Role_N = 0.25, & If \quad Role = Low \\ Role_N = 0.65, & If \quad Role = Medium \\ Role_N = 1.00, & If \quad Role = High \end{cases}$$

$$\begin{cases} Field_N = 0.25, & If \quad Field = Below \ Average \\ Field_N = 0.50, & If \quad Field = Average \\ Field_N = 0.75, & If \quad Field = High \\ Field_N = 1.00, & If \quad Field = Very \ High \end{cases}$$

$$\begin{cases} MW_N = 0.25, & If \quad MW = Low \\ MW_N = 0.50, & If \quad MW = Medium \\ MW_N = 0.80, & If \quad MW = High \\ MW_N = 1.00, & If \quad MW = Very \ High \end{cases}$$

$$\begin{cases} MOM_N = 0.00, & If \quad MOM = Very \ Low \\ MOM_N = 0.20, & If \quad MOM = Low \\ MOM_N = 0.50, & If \quad MOM = Medium \\ MOM_N = 0.75, & If \quad MOM = High \\ MOM_N = 1.00, & If \quad MOM = Very \ High \end{cases}$$

$$\begin{cases} INT_N = 0.5, & If \quad INT = UC \\ INT_N = 1.0, & If \quad INT = C \end{cases}$$

$$\begin{cases} NAT_N = 0.8, & If \quad NAT = F \\ NAT_N = 1.0, & If \quad NAT = I \end{cases}$$

4. Proposed Methodology & Discussion

Our proposed model consist of two main part. In First Part Analytical Hierarchy Process is used to calculate the relative importance of the attributes and in the Last Part Artificial Neural Network (ANN-BP) is used to train the system and finally, generate the player price as an output. The details procedure describes are as follows:

4.1. AHP Model

AHP is an approach for decision making that involves structuring multiple choice criteria into a hierarchy, assessing the relative importance of these criteria, comparing alternatives for each criterion and determining an overall ranking of the alternatives. AHP helps to capture both subjective and objective evaluation measures, providing a useful mechanism for checking the consistency of the evaluation measures and alternatives suggested by the team thus reducing bias in decision making.

Step 1: Perform Pair-wise Comparison according Saaty nine-point preference scale.

Table 2. Saaty's Nine-Point Preference Scale

Scale	Compare factor of i and j
1	Equally Important
3	Weakly Important
5	Strongly Important
7	Very Strongly Important
9	Extremely Important
2,4,6,8	Intermediate value between adjacent scales

Let A represents $n \times n$ pair-wise comparison matrix:

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ a_{21} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & 1 \end{bmatrix} \qquad (1)$$

Step 2: Normalize the raw score by Arithmetic Mean as given below:

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \quad , \qquad j = 1, 2, \dots, n \qquad (2)$$

Step 3: Perform Consistency check.

Step 3a: Let C denotes a n-dimensional column vector describing the sum of the weighted values for the importance degrees of the attributes, then

$$C = [C_i]_{nx1} = AW^T, \qquad i = 1, 2, \dots, n \qquad (3)$$

Step 3b: To avoid inconsistency in the pair-wise comparison matrix, Saaty **[11]** suggested the use of the maximum Eigen value λ_{max} to calculate the effectiveness of judgment. The maximum Eigen value λ_{max} can be determined as follows:

$$\lambda_{\max} = \frac{\sum_{i=1}^{n} c.v_i}{n}, \qquad i = 1, 2, \dots, n \qquad (4)$$

Step 3c: With λ_{max} value, a consistency index (CI) can then be estimated by

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{5}$$

Step 3d: Consistency ratio (CR) can be used as a guide to check the consistency

$$CR = \frac{CI}{RI} \tag{6}$$

Where RI denotes the average random index with the value obtained by different orders of the pair-wise comparison matrices are shown in Table 2. The value of CR $\leq$ 0.10 is the consistent criteria.

The calculated weight of the criteria from AHP is shown in the Table 3.

Table 3. Weights of the Criteria by AHP

C1 0.626031	MOM	MW	PA	PER		
	0.06	0.346	0.189			
C2 0.30125	AGE	CAP	ER	FIELD	ICON	
	0.073	0.098	0.033	0.033	0.063	
C3 0.072439	INT	T20R	ODR	T20M	ODM	NAT
	0.009	0.018	0.009	0.024	0.009	0.003

4.2. ANN Topography

Step 1: Artificial Neural Network- Back Propagation (ANN-BP) is designed to train the network with 17- input neurons, one hidden layer with 10 neurons and 15-output neurons.
Step 1a: Input neurons created with 15 several features and two extra features name as previous base price and previous actual price of the players.
Step 1b: The calculated weights from AHP is the weights of the first fifteen input neurons to all hidden neurons.
Step 1c: The weights between hidden neuron to output neurons are initially set to 0.5 $\pm\delta$ ($0.21 < \delta < 0.51$).
Step 1d: The output neurons consist the 15 criterions.
Step 1e: Sigmoid function is used as an activation function in both input-to-hidden and hidden-to-output.
The neural network shows in the Figure 1.

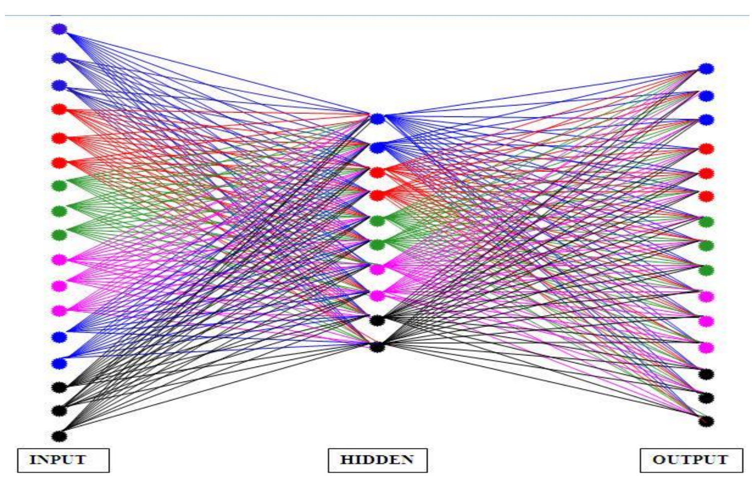


Figure 1. Neural Network with 17-input, 10-hidden, 15-output neurons

Step 2: Set the epoch count, learning rate and momentum of the learning.

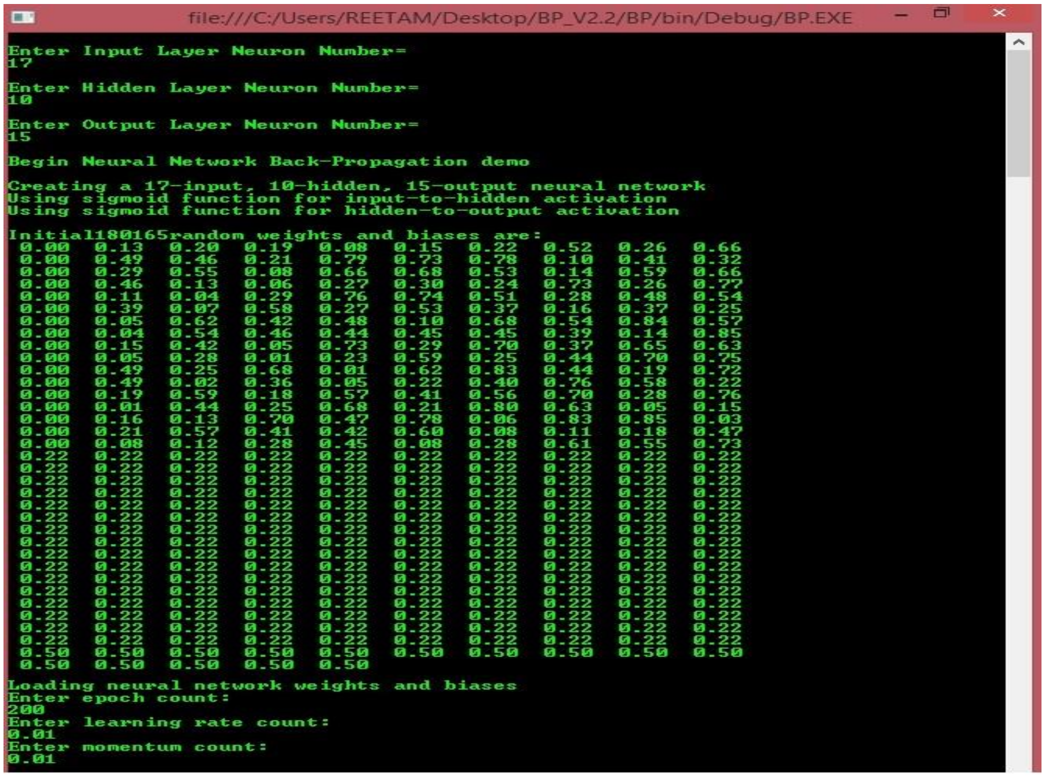


Figure 2. Initial Random Weights with Epoch Count, Learning Rate and Momentum

Step 3: This neural net check all 226 players' data one by one and modify the calculated weights of the attributes so that the pattern were matching accurately and minimize the errors.
Step 4: After complete the first time the resultant output again back propagated to hidden layer from output layer and also back propagated from hidden to input layer.
Step 5: Step-3 & Step-4 repeat until total no. of iteration (epoch count) completed.

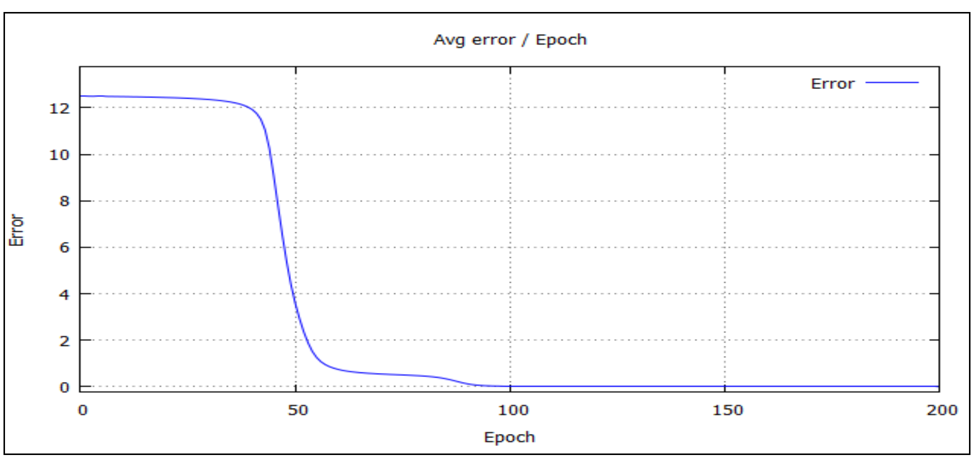


Figure 3. Average Error vs. Epoch Plotting Graph

Step 6: After completion of training the network Feed Forward is used to calculate the player price and store the result.

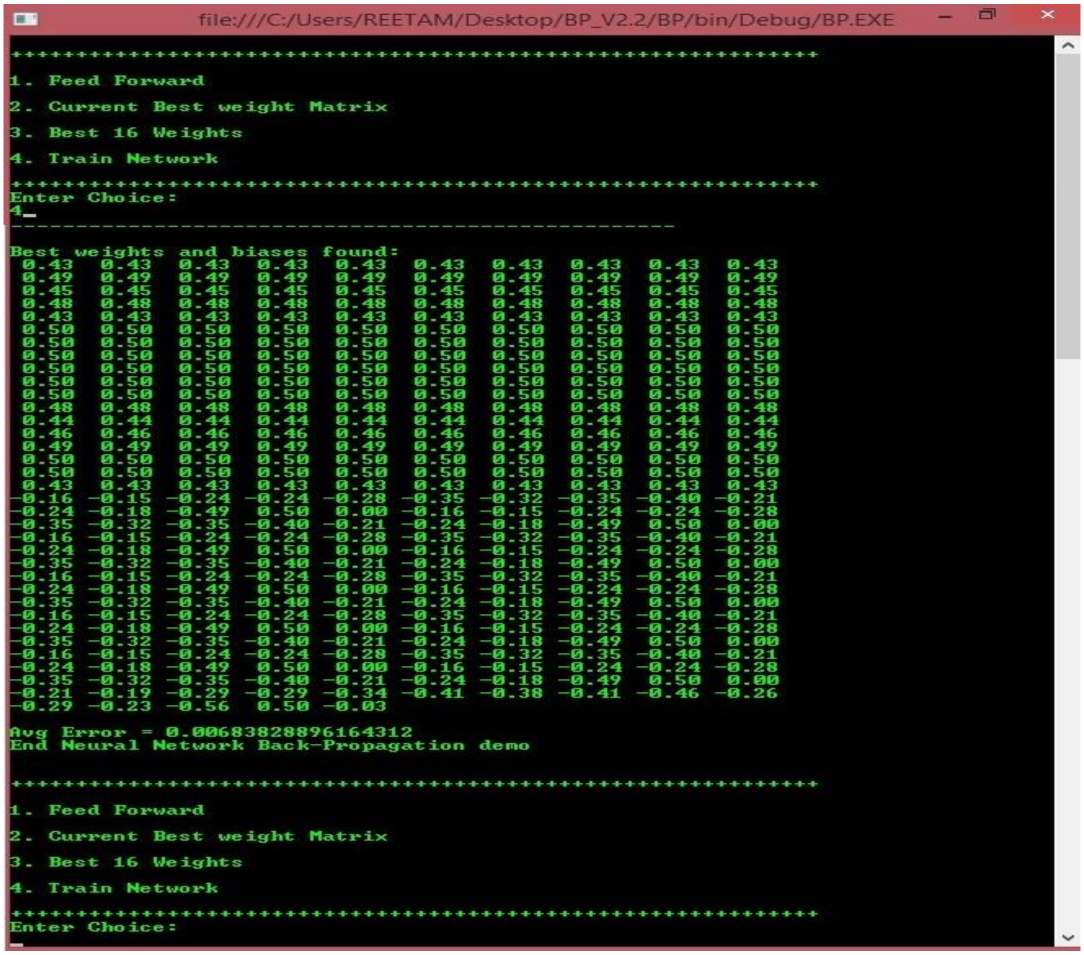
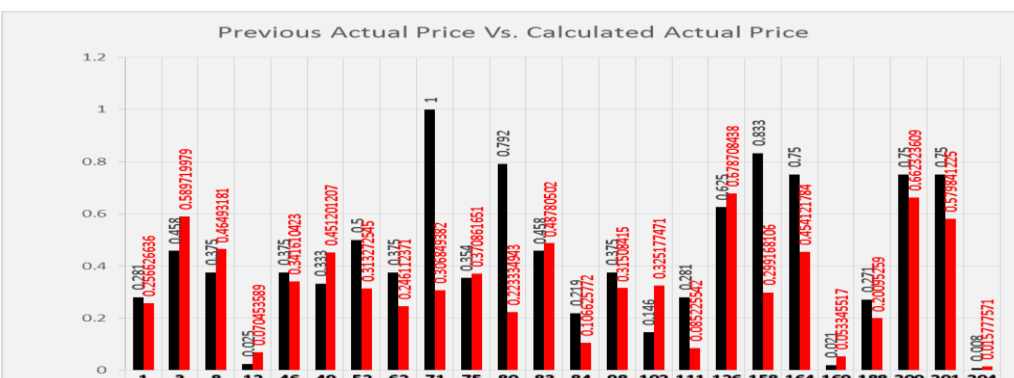


Figure 4. Final Average Error and Menu For Choice

Step 7: Validation the system with previous IPL player price auction.



	1	3	8	12	46	49	52	62	71	75	80	83	84	98	102	111	126	158	164	169	188	200	201	204
Series1	0.3	0.5	0.4	0	0.4	0.3	0.5	0.4	1	0.4	0.8	0.5	0.2	0.4	0.1	0.3	0.6	0.8	0.8	0	0.3	0.8	0.8	0
Series2	0.3	0.6	0.5	0.1	0.3	0.5	0.3	0.2	0.3	0.4	0.2	0.5	0.1	0.3	0.3	0.1	0.7	0.3	0.5	0.1	0.2	0.7	0.6	0

Figure 5. Previous Actual Price vs. Calculated Price

5. Conclusion

This paper has developed an intelligent model for player price estimation by using the combination of analytic hierarchy process (AHP) and artificial neural network (ANN). This model helps us to handle the complexity and selecting the attributes for player price calculation. The predictive value of the player is optimal and lies on the Pareto Frontier thus rendering it almost error free. Our results shows that some players got much more price than they deserved and some players did not get the right price in accordance to their optimal potential. This paper helps the bidder to bid the players with more efficiency and performance quotient investing the optimal amount suitable for the player. Inhibition of excess bidding is achieved through the method described. In addition, the methodical model of this research work opens a new way for prediction method for any type of real life dataset problem. A promising area of future research would be the selection of a winning cricket team with players selected from optimally found criteria values and minimum budget by applying this approach.

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