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Game Within the Game: "Unveiling Hidden Patterns of the IPL using Machine Learning techniques"

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ABSTRACT

The Indian Premier League (IPL) is a premier cricket tournament in India, featuring ten teams representing various regions across the country. This study presents a detailed performance analysis of IPL players using key metrics such as total runs, wickets, batting averages, and economy rates. Utilizing IPL data from the 2020 to 2023 seasons, the research leverages data analytics to generate visual representations that uncover player trends and team dynamics. These insights serve as valuable tools for strategic decision-making, from player selection to match planning. The increasing reliance on analytics by team management and platforms like fantasy cricket and betting systems underscores its growing importance in the modern game. Furthermore, the study implements machine learning algorithms—including Decision Tree, Random Forest, K-Nearest Neighbors (KNN), Support Vector Machine (SVM), and XGBoost—to predict match outcomes based on player-specific features such as strike rates, economy, and wicket performance. Among the models tested, Decision Tree and XGBoost emerge as the most accurate and effective predictors of match results.

Keywords: IPL, cricket analytics, player performance, machine learning, match prediction, XGBoost, Decision Tree, Random Forest, SVM, KNN

1. Introduction

The Indian Premier League (IPL) is a national cricket match in which players are recruited from India's regional teams, the national squad, and the international team. Many variables, including live streaming, radio, and television broadcasts, contributed to the league's

popularity among cricket enthusiasts. Online traders and sponsors rely heavily on IPL match predictions. We can predict a match between two teams based on a variety of factors such as team composition, batting and bowling averages of each player in the team, and the team's previous match success, in addition to traditional factors such as toss, venue, and day-night, as well as the probability of winning by batting first at a specified match venue against a particular team.

There are numerous arenas in the Dream games, such as Dream11 and My cricket circle, in which millions of people spend to make a high return, require mathematical abilities and data. This project's primary goal is to extract various statistical measures from IPL historical data and forecast the best teams based on crucial aspects to provide consumers of betting sites and fantasy cricket leagues with scientific evidence to assist them make decisions. Emphasizing Sustainable Development Goal 17, the paper underscores the significance of collaborative partnerships among stakeholders, cricket experts, and data scientists in advancing the field of cricket analytics. Analytical methods in various aspects of cricket including results prediction is extremely important. Prediction of the outcome of a match using machine learning algorithms is a crucial aspect in cricket [28]. This model is often created using machine learning algorithms like Decision Tree, Naive Bayes and K-Nearest neighbor. The Evaluation Measures often compare and support their results as accuracy, precision, recall, sensitivity and error rate. Not only will this work aids team selectors such as coaches, scouts, and club owners, but it will also help players examine and improve their weaker skills. Cricket has always employed performance prediction, but there have been very few trials that use Explainable AI to generate such predictions. Decision-making may also be facilitated by the growing popularity of fantasy cricket and websites that allow fans to create their own teams based on match results. This research work aims to create a Cricket Prognosticator - IPL Edition, a predictive modeling system capable of accurately forecasting player performance in IPL matches. This method will anticipate forthcoming matches based on a variety of parameters such as player statistics, team makeup, pitch conditions, and historical data. Automated cricket prediction is used by various researchers which is used for cricket teams, coaches, and analysts who seek to improve their game strategies and player selection, as well as for sports betting and fantasy game platforms which will help them to obtain more accurate experiences for users [30]

The Cricket Prognosticator uses modern machine learning algorithms and data analytics approaches to deliver significant insights for cricket fans, sports commentators, and betting aficionados. This research will not only improve comprehension of cricket statistics but will also demonstrate the use of data science in the sphere of sports**.**

2. Literature Review

Numerous studies have been conducted on the topic of sports and machine learning. These days, most cricket decisions are based on statistical analysis. The requirements and efforts in team sports, including cricket, are explained in the research paper that follows.

Ayesha Choudhary[1] et. al., 2018, discussed on using the several variables such as home team, away team, toss winner, venue, umpires, home team score, away team score, power play score, playing 11 players, Number of wickets taken, Number of dot balls given, Number of fours, Number of sixes, Number of catches, Number of stampings. And the result of the paper is that, The Multilayer perception classifier outperformed other classifiers with correctly predicting 43 out of 60, 2018 Indian Premier League matches. The Twenty20 format of cricket carries a lot of randomness, because a single over can completely change the ongoing pace of the game. Indian Premier League is still at infantry stage, it is just a decade old league and has way a smaller number of matches compared to test and one-day international formats.

Kalpdrum Passi[2] et. al., 2018, suggested using the several variables such as No. of Innings,

Batting Average, Strike Rate, Highest Score, Overs, Bowling Average, Bowling Strike Rate, Four/Five Wicket Haul, Venue, Centuries, Fifties, Batting, Match Time, Hand, Match Type, Batting Position, Bowling Hand. And the result of the paper is that, Random Forest builds the most accurate prediction models for both batting and bowling in all the cases. Also, the accuracy of the models increases as increase the size of the training dataset for all algorithms except in case of Naïve Bayes for batting where the accuracy decreases as we increase the size of the training set. An accurate prediction of how many runs a batsman is likely to score and how many wickets a bowler is likely to take in a match will help the team management select best players for each match.

Ms. A. R. Deshpande [3] et. al., 2019 suggested several variables such as City, Venue, Toss Result, Home Team, Away Team. And the result of the paper is that, From the previous data, it is beneficial to the owner to get the details of the IPL match played and the users who predict the winning percentage of the team and get the statistics of the player. Pramila M. Chawan[4] discussed 2018 about using the several variables such as Pitch, Toss, Team strength, Home Ground Advantage and the result of the paper is that in a predictive model, a user makes a prediction on every game, and ends up watching that game to check if his prediction is going right Thus the project will not only improve the existing system of Fantasy Cricket, but will also augment the reach of Cricket in India.

Kalpdrum Passi et. al., 2018[5] explore how machine learning can be used to improve team and player performance in a variety of sports. For every sport, team, and player, the system outlined in the paper gathers raw data and transforms it into statistical data. The study demonstrated how to employ naive bayes, random forest, multiclass SVM, and decision trees to build prediction models that, by examining characteristics from One Day International cricket matches, could estimate the number of runs a player would score and the number of wickets a bowler would take.

C. Deep Prakash et. al., 2016[6]. The Deep Mayo Predictor model is presented in this research to forecast the results of the 2016 Indian Premier League matches that will take place in April and May. The three parts of the model are derived from several factors that were discovered through a more thorough examination of Twenty20 cricket. Machine learning techniques from Data Analytics are used to generate the models. The Mayo Predictor Model accurately predicted the results of 39 out of the 56 matches that were played in the league stage of the IPL IX tournament, demonstrating a high degree of prediction accuracy.

Debarghya Das, 'An Integer Optimization Framework for Fantasy Cricket League Selection and Substitution' [7] delves into applying binary integer programming to construct the best team sequences for cricket fantasy sports tournaments. Tim B. Swartz, 'Research Directions in Cricket' [8] The quantitative (statistical) research on cricket is the subject of this work. It examines the sport, the body of current literature, and offers recommendations for further research. The researchers used different machine learning algorithms for the study utilizes a comprehensive dataset comprising various attributes of cricket matches, including player statistics, match conditions, and historical performance. Additionally, player categorization is performed using a classification approach [29].

3. Methodology

In the context of CricPro: IPL Edition, machine learning algorithms, such as decision trees and random forests, play an important role in enhancing predictive analytics for cricket matches. These algorithms help to analyze vast amounts of historical data, including match results, player performances, and real-time variables, to generate insights and forecasts. Decision trees, with their intuitive tree-like structure, allow for easy interpretation of complex decision-making processes, helping analysts to understand which factors most significantly impact match outcomes. By using ensemble methods like random forests, the model can account for the variability and interdependencies of various predictor variables,

leading to more robust predictions. Additionally, these algorithms adapt to new data inputs over time, improving accuracy and reliability. With the integration of such machine learning techniques, CricPro can provide users with valuable projections on player performances, match scores, and winning probabilities, ultimately enriching the experience of fans, players, and teams in the IPL. The entity-relationship (ER) diagram for the Prediction Modelling Project on Cricket Prognosticator IPL Edition is shown in Figure 1 below. In this ER diagram: its components are as: User: Represents users of the system, who make predictions. Attributes: UserID (Primary Key), Username, Email, Profile Picture. Match: Stores information about IPL matches. Attributes: MatchID (Primary Key), Date, Playing XIs, Venue, Team: Represents IPL teams to be predicted, Attributes: TeamID (Primary Key), Captain, Vice-Captain, Player: Represents IPL players, Attributes: PlayerID (Primary Key), Name, Batting Stastics, Bowling Statistics

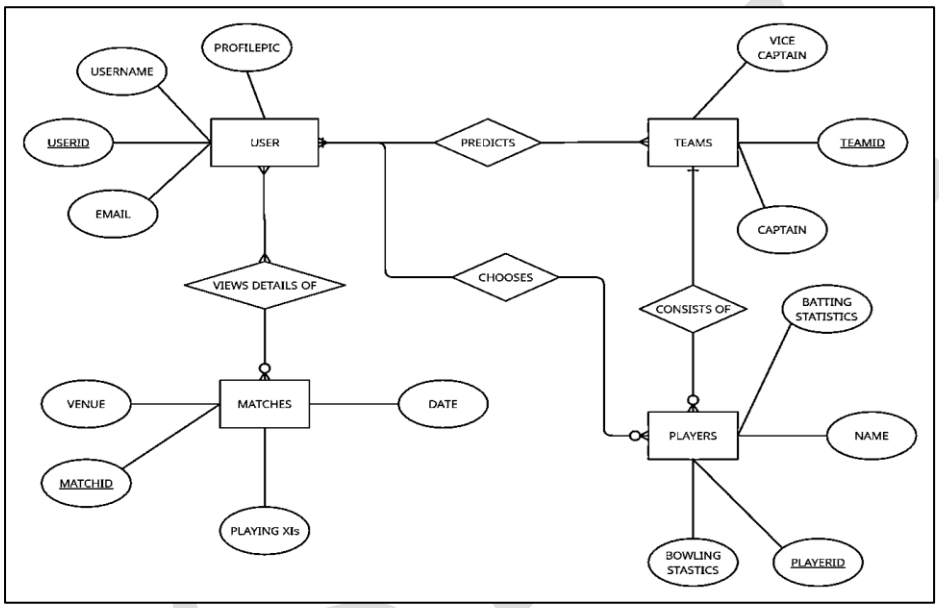

Fig. 1: ER diagram of the system

The methodological component of this work into the following six sub-sections: Machine Learning, Data Engineering, Dream Team Recommending Module, Feature Engineering, Data Visualization, and Getting Data as shown in Figure 2 below:

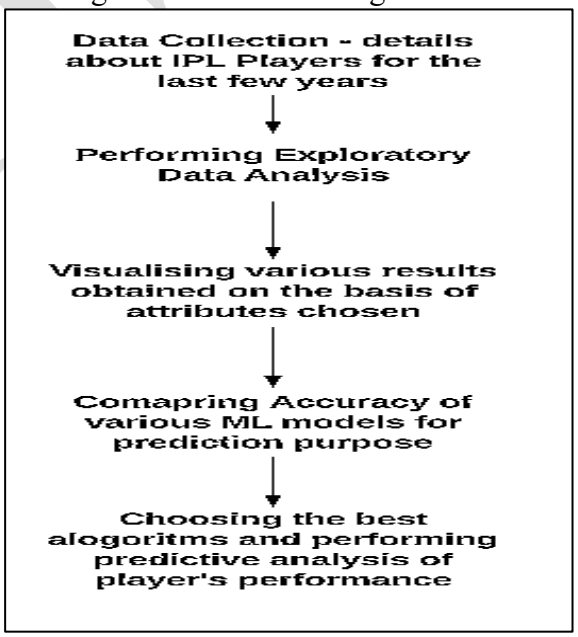

Fig. 2: Systematic view of the system

3.1 Data Selection: In this step the data relevant to the research work is extracted. Multiple data sets are selected for the research step from Kaggle.

3.2 Pre-Processing Following data extraction and selection, the data is processed, and initial information is extracted from it. To provide a consistent picture of a player's batting and bowling performance, data from previous performances is combined into a single score system. Missing values were imported and variables were standardized.

3.3 Data Mining Once the data is processed and transformed it is used for data mining. The data is modeled to perform predictive analysis. The following models, mentioned in Table 1 are used to train 80 percent of data and is tested on 20 percent of data: -

Table1: Model used in the system

Models used	**Explanation of the model**
Decision Tree Model	A decision tree is a graphical depiction of a result and the choice that produced it. It is given in a way that makes visualizing easier: sequentially. Because it makes the underlying relationships between the features clear, it has a higher predictive value.
Model of Random Forest	Random forest performs a good job of estimating the important variables and has no trouble with large input parameters. Consequently, this model is selected to act as a comparative strategy for the tree-based method that was previously discussed.
Support Vector Machine (SVM)	SVM is a supervised modeling technique that employs the kernel trick to transform the data and then uses the resultant transformation to identify the best class boundary. One benefit of SVM is its ability to capture complex relationships between variables in a dataset.
XGBoost	By employing different regularization techniques to reduce overfitting, Extreme Gradient Boosting improves model performance in a much faster and more advanced manner. It might be helpful in improving accuracy.
K-Nearest Neighbor(KNN)	KNN is a versatile and widely used machine learning algorithm that is primarily used for its simplicity and ease of implementation. It does not require any assumptions about the underlying data distribution. It can also handle both numerical and categorical data, making it a flexible choice for various types of datasets in classification and regression tasks. It is a non-parametric method that makes predictions based on the similarity of data points in each dataset. K-NN is less sensitive to outliers compared to other algorithms.

3.5 Evaluation
After the model has been trained, it is assessed by calculating the accuracy scores of the different models. Which model is best is determined by the values of these criteria.

4. Findings and Discussion

4.1 Assessment of models for machine learning:

In data mining, performance evaluation is based on the type of problem solved and the results. For this reason, the validation strategy employed in this study was chosen to complement the examined related work as well as the goal of the investigation. The results and assessments in this study were based on the literature review and the commonly used performance indicators for the regression model in this project. Accuracy scores for the different algorithms were calculated and the best algorithm was chosen based on the same parameter for both datasets, as mentioned in Figure 3 and Figure 4.

ALGORITHMS	MODEL ACCURACY SCORE
KNN	15.1515
DECISION TREE	78.7871
RANDOM FORESTS	12.1212
SVM	3.0303
XGBOOST	6.0606

Fig. 3: Batting algorithms

ALGORITHMS	MODEL ACCURACY SCORE
KNN	38.0952
DECISION TREE	14.2857
RANDOM FORESTS	14.2857
SVM	19.0476
XGBOOST	42.8571

Fig 4: Bowling algorithms

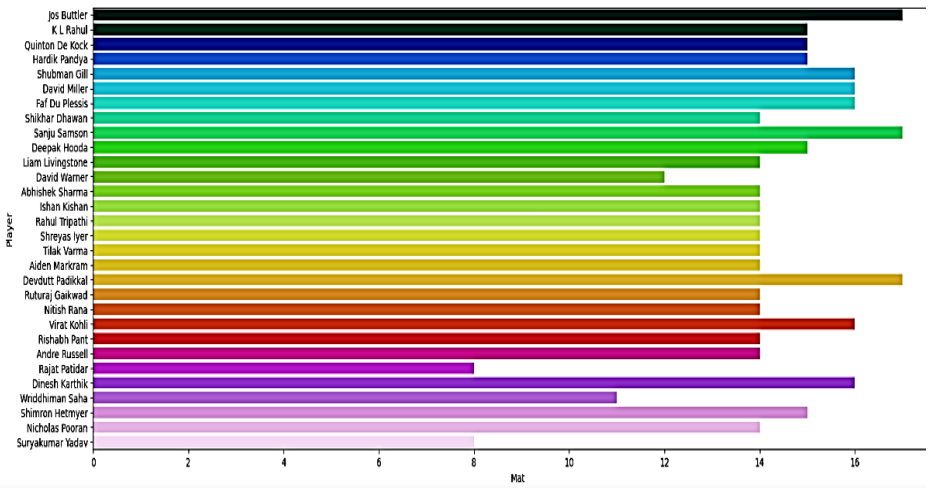

Fig. 5: Top 30 players as batsmen

Above result, in Figure 5 was obtained graphically, x-axis is representing the matches played by the players as batsmen for their teams and y- axis represents the players' names (top 30)

in the order taken in the dataset. The graph helped to visualise most matches played by a batsmen with Jos Buttler, Devdutt Padikkal and Sanju Samson proving to be the players who have played maximum matches for their teams i.e. 17. Also, it was found that Rajat Patidar has played the least matches for his team i.e. 8.

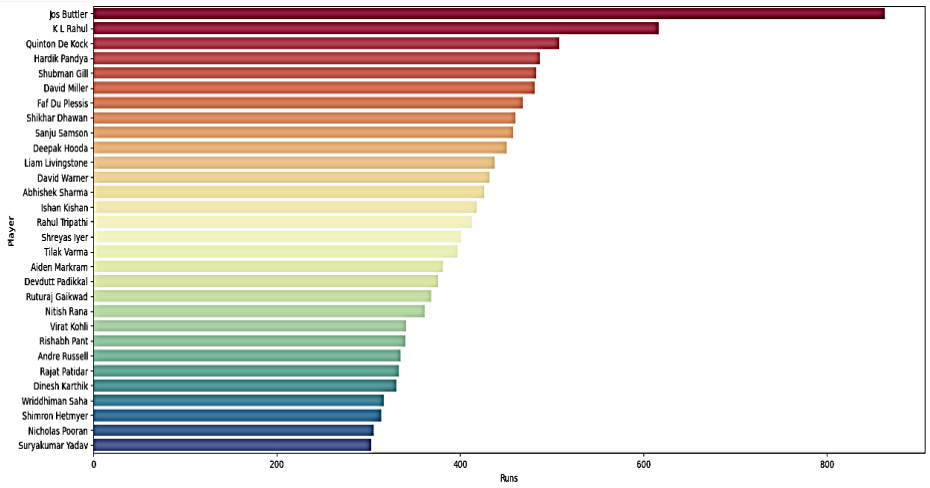

Fig. 6: Maximum runs scored by batsmen

With x-axis representing the runs scored and y-axis representing the players' names, the graph in Figure 6 showcases that the maximum runs scored by a batsmen is above 800 (by Jos Buttler), KL Rahul has scored the second most runs (above 600 <800) and Suryakumar Yadav has scored the least (less than 400) runs among the top 30 batsmen of the season.

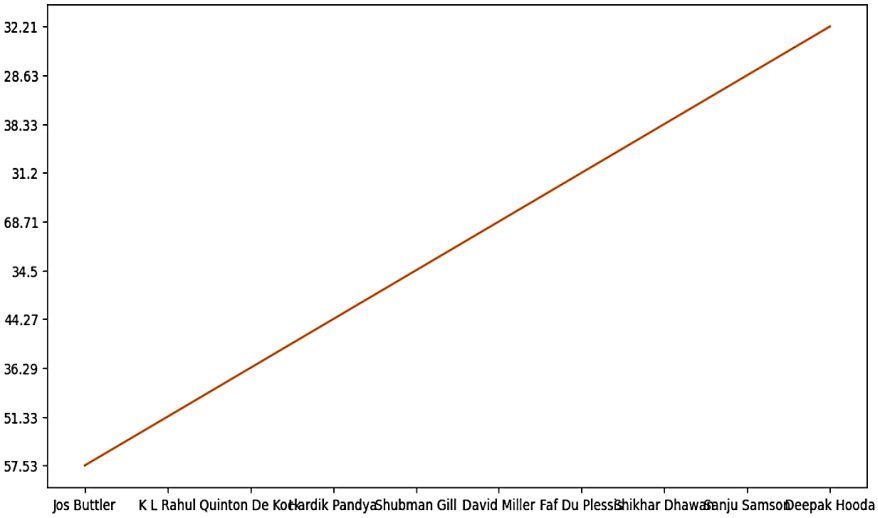

Fig. 7: Average runs scored by the top 10 batsmen in every match

This line graph in Figure 7 shows the average runs scored by the top 10 batsmen in every match with Jos Butler having the highest average of 57.53 and Deepak Hooda having the lowest average of 32.21 amongst the top 10.

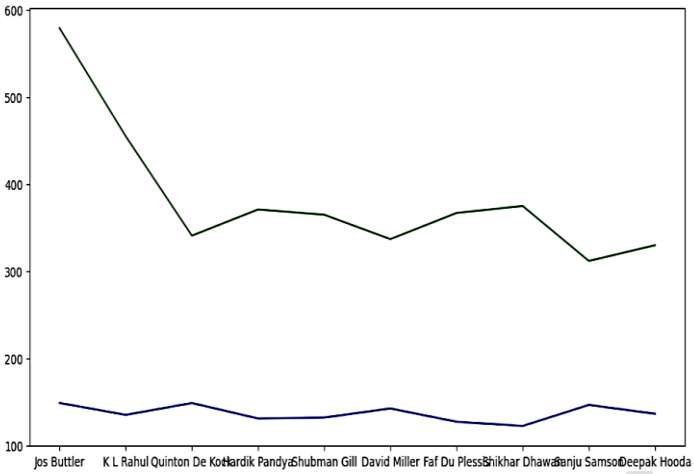

Fig. 8: Strike rate

In the above line graph, in Figure 8, blue line shows the strike rate (no. of runs scored by a batsmen per 100 balls faced) of the top 10 batsmen with Jos Buttler, Quinten De Kock and Sanju Samson having the highest strike rate of almost 150. The green line shows the number of balls faced by the batsman in the entire season with Jos Buttler facing the maxing number of balls (almost 600). Following batsmen, mentioned in Table 2 were found to have the best performance over the last couple of years in IPL.

Table 2: Performance of players

	POS	Player	Mat	Inns	NO	Runs	HS	Avg	BF	SR	100
0	54	Jos Buttler	17	17	2	863	116	57.53	579	149.05	4
1	56	K L Rahul	15	15	3	616	103	51.33	455	135.38	2
3	41	Hardik Pandya	15	15	4	487	87	44.27	371	131.26	0
5	25	David Miller	16	16	9	481	94	68.71	337	142.72	0
11	26	David Warner	12	12	3	432	92	48.00	287	150.52	0
17	6	Aiden Markram	14	12	4	381	68	47.63	274	139.05	0
24	104	Rajat Patidar	8	7	1	333	112	55.50	218	152.75	1
25	32	Dinesh Karthik	16	16	10	330	66	55.00	180	183.33	0
27	133	Shimron Hetmyer	15	15	8	314	59	44.86	204	153.92	0
29	143	Suryakumar Yadav	8	8	1	303	68	43.29	208	145.67	0
37	30	Devon Conway	7	7	1	252	87	42.00	173	145.66	0
53	17	Axar Patel	13	10	6	182	42	45.50	120	151.66	0

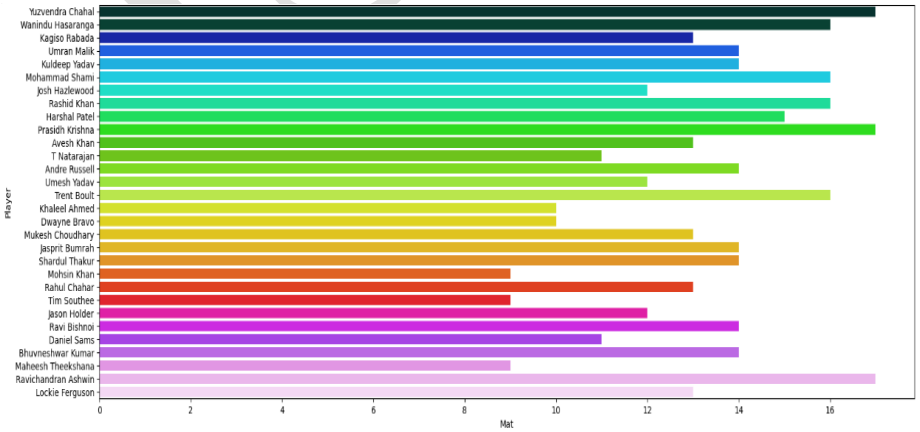

Fig. 9: Players matches

Above result in Figure 9 was obtained graphically, x-axis is representing the matches played by the players as bowlers for their teams and y- axis represents the players' names (top 30) in the order taken in the dataset. The graph helped to visualise most matches played by a bowler with Yuzvendra Chahal, Prasidh Krishna and Ravichandran Ashwin proving to be the players who have played maximum matches for their teams i.e. 17. Also, it was found

that Mahesh Theekshana, Mohsin Khan and Jason Holder have played the least matches for their team i.e. 9.

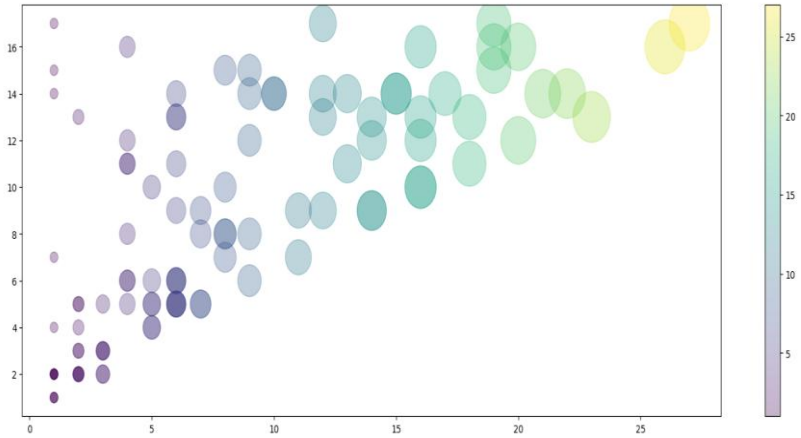

Fig. 10: Wickets taken against number of matches played

The above graph in Figure 10, is plotted for showcasing wickets taken against the number of matches played. The colour scheme shows the distribution of number of wickets in 17 matches with 27 being the highest number of wickets taken by a bowler shown by the colour yellow and the least being 1 shown by the colour purple.

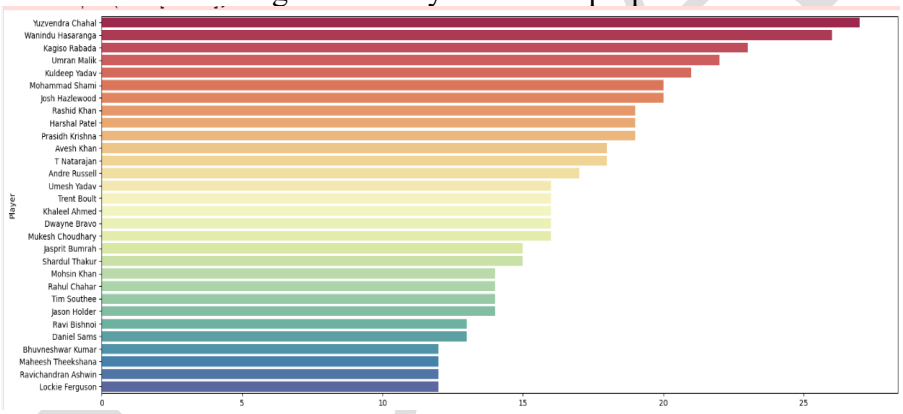

Fig. 11: Wickets taken by bowler

With x-axis representing the wickets taken and y-axis representing the players' names, the above graph in Figure 11 showcases that the maximum wickets taken by a bowler is more than 25 by Yuzvendra Chahal, Wanindu Hasaranga has taken the second most wickets and Lockie Ferguson has taken the least (less than 15) wickets among the top 30 bowlers of the season.

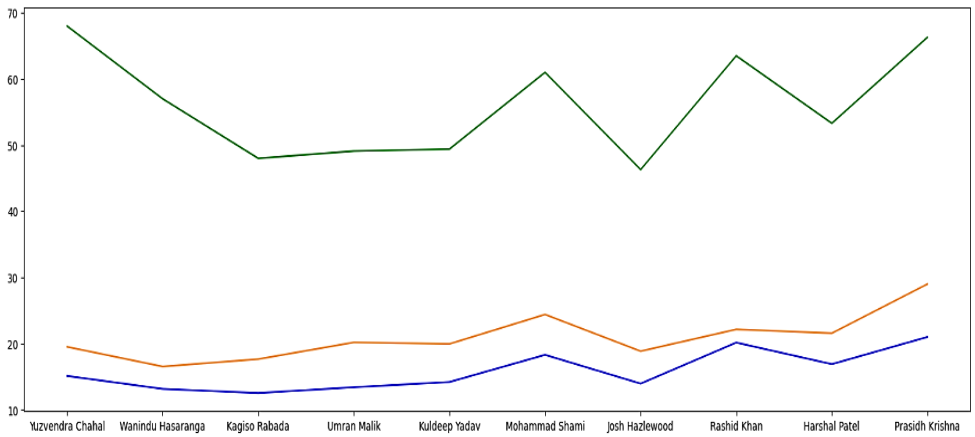

Fig. 12: Strike Rates by Batsmen

In the above linear graph in Figure 12, blue line shows the strike rate (no. of balls the bowler has bowled before picking up a wicket) of the top 10 bowler with Kagiso Rabada having the best strike rate i.e. less than 15. The orange line shows the average of the bowlers i.e. the runs a bowler concedes before picking up a wicket. Wanindu Hasaranga has the best average amongst all bowlers i.e. less than 20. The green line shows the overs bowled by the bowlers to pick up the wickets in the entire season with Yuzvendra Chahal having bowled the most overs i.e. more than 65 and Josh Hazlewood bowling the least number of overs i.e. less than 50. Following results, mentioned in Table 3 were obtained for the best bowlers over the last few years.

Table 3: Performance of best bowlers

	POS	Player	Mat	Inns	Ov	Runs	Wkts	Avg	Econ	SR	\
0	1	Yuzvendra Chahal	17	17	68.0	527	27	19.51	7.75	15.11	
1	2	Wanindu Hasaranga	16	16	57.0	430	26	16.53	7.54	13.15	
7	8	Rashid Khan	16	16	63.5	421	19	22.15	6.59	20.15	
8	9	Harshal Patel	15	15	53.3	410	19	21.57	7.66	16.89	
13	14	Umesh Yadav	12	12	48.0	339	16	21.18	7.06	18.00	
14	15	Trent Boult	16	16	62.0	492	16	30.75	7.93	23.25	

5.Conclusion and Future Scope

From the research work it is found that following hyperparameter adjustment, Decision Tree and XGBoost performed the best out of the five models Decision tree, Random Forest, XGBoost, KNN, and Support Vector Machine (SVM). Future research could incorporate additional variables into the model, such as the type of pitch, the player's popularity, etc. This study can also be used for team selection. Scouts and team owners can utilize this to their advantage by using their experience and the features as a guide when choosing a player. Various researchers [24-27] focused on data security in various types of environments such as distributed, cloud computing etc. Cricket data can also be secured in the similar way such as implemented using various homomorphic, symmetric, and asymmetric algorithms discussed Other latest technologies like cloud computing, genetic programming, linear programming, and other advanced artificial intelligence approaches can be implemented on the given dataset. Deep learning techniques such as CNN etc. can be used to give better accuracy and to handle large amount of data of IPL teams in future.

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