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Admission Prediction Using Time Series Analysis

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Abstract:- Efficient resource allocation and strategic planning in educational institutions heavily rely on accurate predictions of student admissions. This paper presents a detailed investigation into the application of time series analysis techniques for admission prediction. We explore the utilization of historical admission data, spanning multiple academic cycles, to train and evaluate several time series models.The study encompasses a comparative analysis of traditional statistical models such as autoregressive integrated moving average (ARIMA) and seasonal autoregressive integrated moving average (SARIMA) alongside more advanced deep learning techniques like long short-term memory (LSTM) networks. By evaluating the performance metrics, including accuracy, robustness, and computational efficiency, we aim to identify the most suitable model for admission prediction tasks. Moreover, the research delves into the impact of various external factors such as changes in the academic calendar, socio-economic indicators, and demographic shifts on admission patterns. Understanding these factors is crucial for enhancing the predictive capabilities of the models and enabling institutions to adapt their strategies accordingly. The experimental results and comparative analysis provide valuable insights for educational institutions, enabling them to make data-driven decisions regarding enrollment management strategies and resource allocation. Ultimately, this research contributes to the advancement of admission prediction methodologies, facilitating more efficient and informed decision-making processes in the educational domain.

Keywords:- *Time Series Analysis, ARIMA, SARIMA, Admission Forecasting, Educational Data Analysis.*

I. INTRODUCTION

In today's dynamic educational landscape, where institutions are constantly challenged to optimize their resources and adapt to changing demographics, accurate prediction of student admissions plays a pivotal role in strategic planning and operational efficiency. Anticipating future admission rates enables institutions to allocate resources effectively, manage class sizes, and design outreach and recruitment campaigns more strategically. Moreover, with the increasing competition for limited enrollment slots, the ability to forecast admission trends accurately has become indispensable for maintaining competitiveness and ensuring sustainability in the long term Traditionally, admission prediction has been approached using statistical methods that rely on historical data analysis. However, with the advent of advanced machine learning and time series analysis techniques, there is a growing interest in exploring more sophisticated models that can capture complex temporal patterns and dependencies inherent in admission data. In this context, this paper presents a comprehensive investigation into the application of time series analysis for admission prediction, aiming to enhance the accuracy and reliability of forecasting models employed by educational institutions.

The primary objective of this research is to assess the effectiveness of various time series models in predicting future admission trends. We begin by examining the performance of traditional statistical models such as autoregressive integrated moving average (ARIMA) and seasonal autoregressive integrated moving average (SARIMA) on historical admission data spanning multiple academic cycles. These models serve as benchmarks against which we evaluate the performance of more advanced deep learning techniques, particularly long short-term memory (LSTM) networks, known for their ability to capture longrange dependencies in sequential data.

Furthermore, we delve into the factors influencing admission patterns, including changes in the academic calendar, socio-economic indicators, and demographic shifts. Understanding the impact of these factors is crucial for improving the predictive capabilities of the models and enabling institutions to adapt their strategies in response to evolving trends.

In addition to individual model evaluations, we explore ensemble methods to combine the strengths of different models, aiming to create more robust and reliable admission forecasting systems. By leveraging the diversity of approaches, we seek to enhance prediction accuracy and mitigate the inherent uncertainties associated with admission data.

II. EASE OF USE

- *Strategic Planning:* Accurate admission predictions enable colleges and universities to develop comprehensive strategic plans aligned with expected student enrollment.
- *Resource Allocation:* Precise admission forecasts aid institutions in optimizing resource allocation, including staffing, infrastructure development, and financial planning.
- *Retention and Graduation Rates:* Admission forecasts indirectly impact student retention and graduation.

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- *Competitiveness and Reputation:* Accurate admission forecasts can positively influence an institution's competitiveness and reputation.
- *Optimizing Recruitment Efforts:* Understanding admission trends aids in optimizing recruitment efforts by identifying geographical areas or demographics with potential for increased student enrollment.
- *Alumni Engagement and Fundraising:* Predicting future student enrollments allows institutions to plan alumni engagement programs and fundraising efforts.

III. PROBLEM STATEMENT

The challenge addressed in this research project is the uncertainty surrounding future student admissions in a college setting, particularly on an area-wise basis. As colleges navigate the complex task of planning for the next academic year, they face the inherent difficulty of predicting the number of students who will seek admission in each area based on historical data. The specific problems include: 1. Dynamic Nature of Admissions: The number of students seeking admission can vary significantly from year to year due to evolving demographic trends, economic conditions, and educational policies. Understanding and adapting to these fluctuations is crucial for effective resource management. 2. Area-Wise Variation: Different areas may exhibit distinct patterns in terms of student admissions, influenced by local demographics, economic factors, and educational infrastructure. Predicting admissions at an areaspecific level is essential for targeted planning and allocation of resources. 3. Temporal Trends: The college's 40-year historical data offers a rich source of information, but extracting meaningful temporal trends, seasonality, and patterns requires advanced analytical techniques. Traditional methods may fall short in capturing the complexity of these dynamics. 4. Strategic Decision-Making: College administrators need accurate predictions to make informed decisions regarding faculty recruitment, infrastructure development, and overall strategic planning. A reliable forecasting model would empower institutions to proactively address challenges associated with changing student.

IV. DATASET

The dataset contains 40 years of admissions data across 8 different areas, providing a comprehensive view of admission trends over a significant period. Analyzing the overall admission trends reveals fluctuations in the number of students admitted to colleges each year.

Year	Bhojpur	Sherpur	Borda	Kushalpura	Pachama	Kharpa	Ahmadpur	Hirapur
1983	12	66	35	17	11	12	25	16
1984	16	54	55	29	23	43	35	21
1985	14	45	55	19	32	41	50	28
1986	19	76	70	21	41	37	71	30
1987	27	87	53	32	38	31	99	32
1988	20	89	70	29	39	31	103	35

Fig -1: Data Set Containing 40 Rows and 8 Columns

The dataset encompasses admissions data from various areas, including Bhojpur, Sherpur, Borda, Kushalpura, Pachma, Kharpa, Ahmadpur, and Hirapur from year 1983 to 2024.

V. ALGORITHM USED

- Autoregressive Integrated Moving Average (ARIMA): ARIMA models are widely used for time series forecasting, especially when the data exhibit temporal dependencies and stationarity. This algorithm involves parameterizing the autoregressive, differencing, and moving average components to predict future admissions trends.
- Seasonal Autoregressive Integrated Moving Average (SARIMA):SARIMA extends the ARIMA model to account for seasonal variations in the data. It incorporates additional parameters for seasonal autoregressive and seasonal moving average components, making it suitable for capturing seasonal patterns in admissions data.
- Long Short-Term Memory (LSTM) Networks:This networks are a type of recurrent neural network and they are used to capture long-range dependencies in sequential data. They excel at modeling complex temporal patterns and are often used for time series forecasting tasks, including admission prediction.

➢ *Equations*

- Root Mean Squared Error (RMSE):RMSE is the square root of the average of the squared differences between predicted values and actual values. It is a measure of the average magnitude of the errors made by the model.

RMSE= sqrt (1/n sum i=1 ^ n (y i - y i)^ 2) (1)

- Mean Absolute Error (MAE):It provides a measure of the average magnitude of errors made by the model and does not consider their direction.

MAE = 1 /n(sum i=1 ^ n |y i - (y i ^)|) (2)

VI. METHODOLOGY

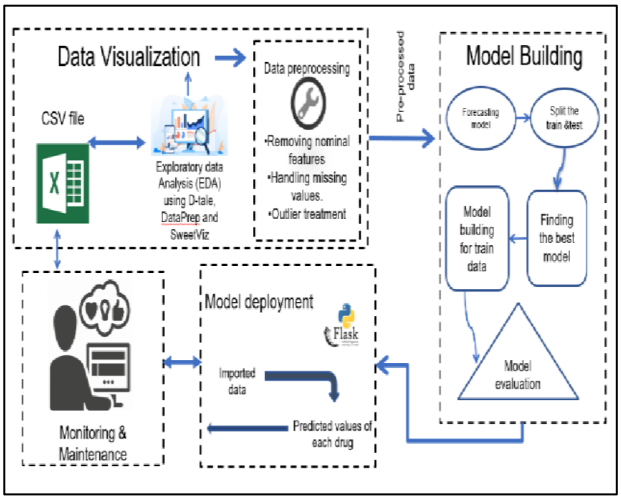

Fig -2: Block Diagram

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- *Data Collection and Preprocessing:*

Gather the admissions data for the past 40 years from each of the areas: Bhojpur, Sherpur, Borda, Kushalpura, Pachma, Kharpa, Ahmadpur, and Hirapur.

Clean the dataset to remove any inconsistencies, missing values, or outliers.

Organize the data into a structured format, grouping admissions by year and area.

- *Descriptive Analysis:*

Calculate summary statistics for admissions in each area, including mean, median, minimum, and maximum admissions per year.

Visualize the admissions trends over the 40-year period for each area using line graphs or bar charts.

Compare admissions trends across different areas to identify any notable variations or patterns.

- *Time Series Modeling:*

Apply time series analysis techniques to model the admissions data for each area.

Explore traditional models such as Autoregressive Integrated Moving Average (ARIMA) or Seasonal ARIMA (SARIMA) to capture temporal dependencies and seasonal patterns.

Fit the models to the admissions data and assess their goodness of fit.

- *Model Evaluation:*

Evaluate the performance of the time series models using metrics such as Root Mean Squared Error (RMSE) and Mean Absolute Error (MAE).

Compare the accuracy of different models and select the one that provides the best fit for each area's admissions data.

- *Forecasting:*

Use the fitted time series models to forecast future admissions trends for each area.

Generate predictions for admissions in the upcoming years and assess the uncertainty associated with the forecasts.

VII. RESULT AND CONCLUSION

	ARIMA1	ARIMA2	SARIMAX1
Bhojpur	2.8939	3.0301	4.4568
Sherpur	8.7646	9.3362	19.056
Borda	8.7800	10.955	14.64
Kushalpura	13.066	12.2293	15.498
Pachama	8.22651	6.414	16.762
Kharpa	8.3859	11.07	18.795
Hirapur	10.754	12.37	16.635

Fig -3:RMSE Values for Each Area Using the Models Like

- *ARIMA1,ARIMA2,SARIMAX1*

The provided table presents the results of applying different time series models (ARIMA1, ARIMA2, and SARIMAX1) to predict admissions in various regions, including Bhojpur, Sherpur, Borda, Kushalpura, Pachama, Kharpa, and Hirapur. The numerical values in the table likely represent evaluation metrics such as Root Mean Squared Error (RMSE), indicating the accuracy of each model's predictions.

Upon examination, it is observed that the performance of the models varies across different regions. For instance, in Bhojpur, ARIMA1 and ARIMA2 exhibit lower error values

(2.8939 and 3.0301 respectively) compared to SARIMAX1 (4.4568). Similarly, in Sherpur, both ARIMA models outperform SARIMAX1, with lower error values of 8.7646 and 9.3362 compared to 19.056.

However, the performance of the models differs in other regions. In Borda, for instance, ARIMA1 and ARIMA2 have similar error values of 8.7800 and 10.955 respectively, while SARIMAX1 has a comparatively lower error value of 14.64. Similarly, in Kushalpura, ARIMA1 has the highest error value of 13.066, followed by ARIMA2 (12.2293), while SARIMAX1 performs relatively better with an error value of 15.498.

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