Industrial Internship Report on

” Smart City Traffic Patterns ”

Prepared by

Vishwa Nayak

Executive Summary

This report provides details of the Industrial Internship provided by upskill Campus and The IoT Academy in collaboration with Industrial Partner UniConverge Technologies Pvt Ltd (UCT).

This internship was focused on a project/problem statement provided by UCT. We had to finish the project including the report in 6 weeks’ time.

My project was **Smart City Traffic Patterns** and I have to work on the project to convert my current city to Smart City. The vision is to into a digital and intelligence city to improve the efficiency of services for the citizens. One of the problems faced by the government is traffic. I have to work as a data scientist, working to manage the traffic of the city better and to provide input on infrastructure planning for the future.

This internship gave me a very good opportunity to get exposure to Industrial problems and design/implement solution for that. It was an overall great experience to have this internship. Also got to know about how to prepare myself for interview and what are things to learn and how to answer questions and what are the things to keep in mind most while answering the questions and also got the exposure to some sample questions what frequently asked in interview.

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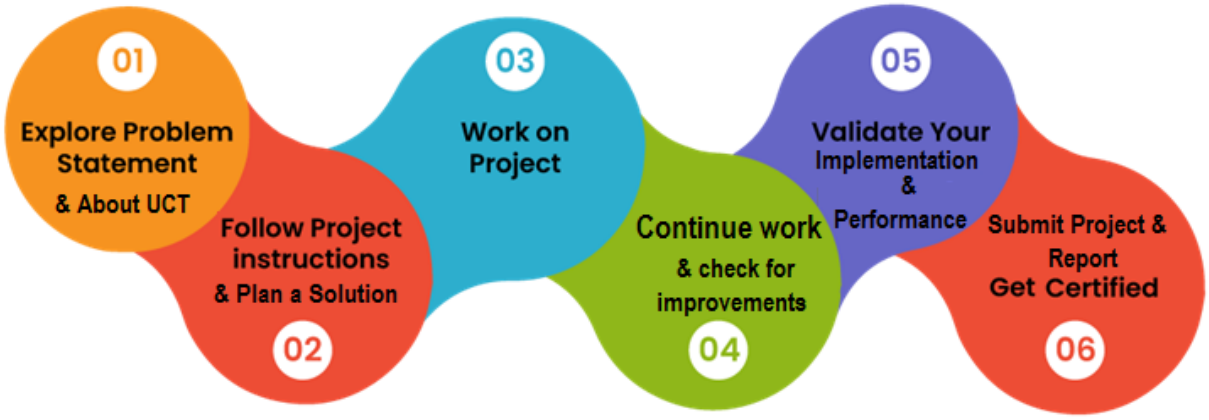
1 Preface

Over the course of Four weeks, I participated in an immersive learning journey that significantly enhanced my professional development. Through practical projects, interactive workshops, and collaborative discussions, I expanded my knowledge of essential data science and machine learning concepts. This experience not only sharpened my technical abilities but also strengthened my problem-solving, critical thinking, and communication skills, particularly in a team-based setting.

The core of my project centered on building an Intrusion Detection System leveraging machine learning techniques. This required analyzing intricate network data to detect potential security breaches or unusual patterns. The goal of the project was to strengthen cybersecurity by designing an automated system capable of identifying and responding to threats in real time, thereby improving network security and protecting sensitive data.

The opportunity offered by USC/UCT was truly transformative. The institution's dedication to delivering a well-rounded learning experience through hands-on exposure, mentorship, and industry-focused projects was exceptional. By aligning the curriculum with current industry needs and providing access to state-of-the-art tools and resources, USC/UCT empowered students like me to gain the skills and expertise essential for building a successful career in the technology field.



Throughout this journey, I have had the privilege of gaining invaluable knowledge and experiences that have profoundly shaped my professional growth. From refining my technical skills to enhancing my problem-solving abilities, each phase of this project has contributed to my development. Navigating complex datasets, collaborating with cross-functional teams, and devising effective solutions have been pivotal in building my expertise. Beyond the technical aspects, I have also gained critical insights into teamwork, adaptability, and project management—skills that are essential in real-world scenarios.

I am deeply grateful to all those who played a part in making this project a success. Upskill Campus, UCT, and the Edunet Foundation have been incredible pillars of support throughout this journey. Their mentorship, guidance, and resources were instrumental in shaping both my project and personal growth. I also want to acknowledge the indirect contributions from my peers, mentors, and even those who challenged me with tough questions, pushing me to think more creatively. The collective influence of everyone involved has had a significant impact on my learning.

To my juniors and peers, I want to offer a piece of advice: every project, challenge, and endeavor you take on is an opportunity for growth. Approach each moment with curiosity and enthusiasm, as it will lead you to new possibilities. Collaboration and seeking guidance are not signs of weakness but pathways to collective success. As you embark on your own journeys, remember that setbacks are stepping stones to progress, and learning from failures is a crucial part of the process. Stay resilient, stay curious, and never underestimate the power of your potential. Your journey is just as meaningful as your destination.

2 Introduction

2.1 About UniConverge Technologies Pvt Ltd

A company established in 2013 and working in Digital Transformation domain and providing Industrial solutions with prime focus on sustainability and RoI.

For developing its products and solutions it is leveraging various **Cutting Edge Technologies e.g. Internet of Things (IoT), Cyber Security, Cloud computing (AWS, Azure), Machine Learning, Communication Technologies (4G/5G/LoRaWAN), Java Full Stack, Python, Front end** etc.

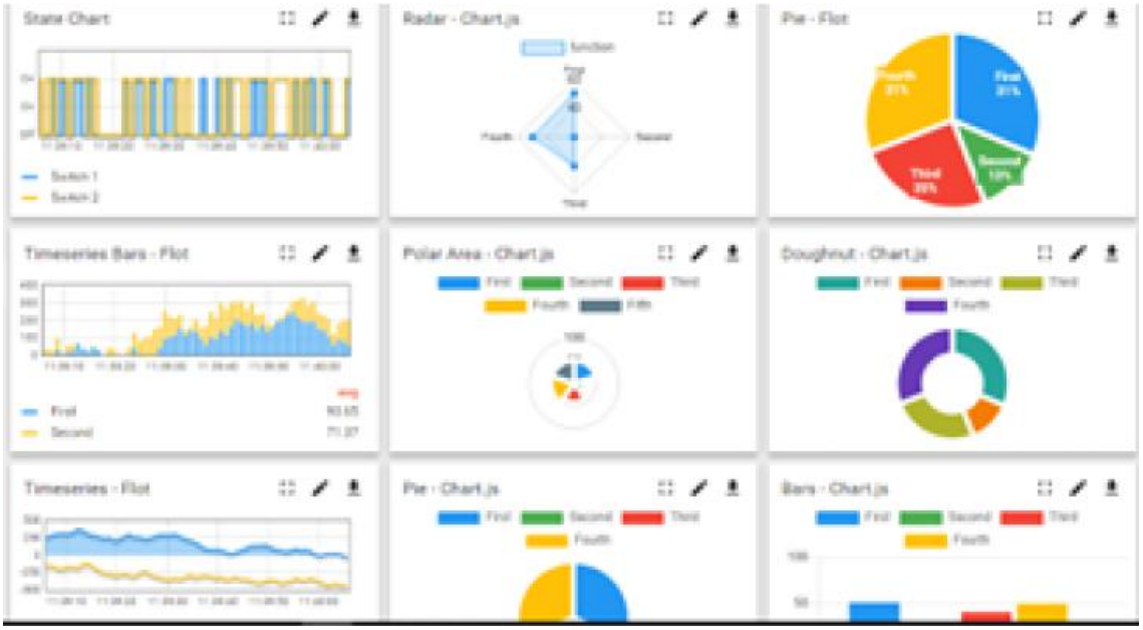
i. UCT IoT Platform (UCT Insight)

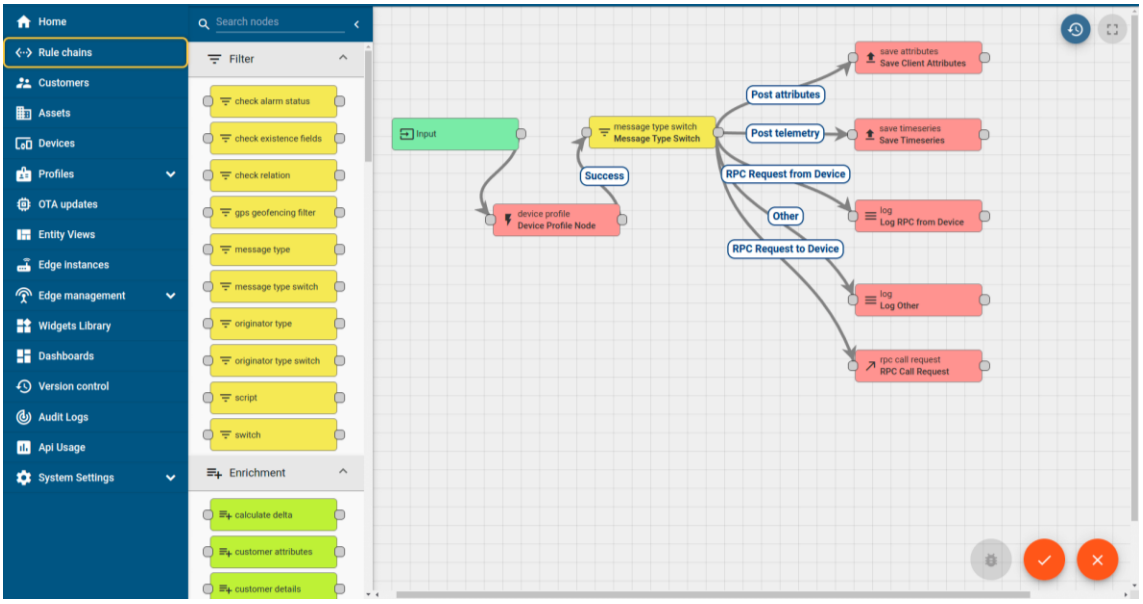
UCT Insight is an IOT platform designed for quick deployment of IOT applications on the same time providing valuable "insight" for your process/business. It has been built in Java for backend and ReactJS for Front end. It has support for MySQL and various NoSql Databases.

- It enables device connectivity via industry standard IoT protocols - MQTT, CoAP, HTTP, Modbus TCP, OPC UA
- It supports both cloud and on-premises deployments.

It has features to

- Build Your own dashboard
- Analytics and Reporting
- Alert and Notification
- Integration with third party application(Power BI, SAP, ERP)
- Rule Engine





ii. Smart Factory Platform (FACTORY WATCH)

Factory watch is a platform for smart factory needs.

It provides Users/ Factory

- with a scalable solution for their Production and asset monitoring
- OEE and predictive maintenance solution scaling up to digital twin for your assets.
- to unleased the true potential of the data that their machines are generating and helps to identify the KPIs and also improve them.
- A modular architecture that allows users to choose the service that they what to start and then can scale to more complex solutions as per their demands.

Its unique SaaS model helps users to save time, cost and money.

Machine	Operator	Work Order ID	Job ID	Job Performance	Job Progress		Output		Rejection	Time (mins)				Job Status	End Customer
					Start Time	End Time	Planned	Actual		Setup	Pred	Downtime	Idle		
CNC_S7_81	Operator 1	WO0405200001	4168	58%	10:30 AM		55	41	0	80	215	0	45	In Progress	i
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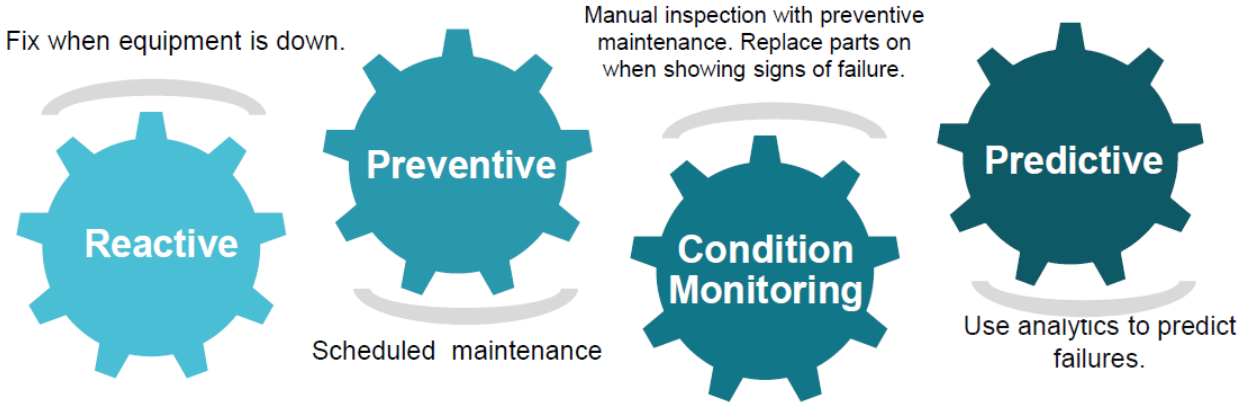
iii. LoRaWAN based Solution

UCT is one of the early adopters of LoRAWAN teschnology and providing solution in Agritech, Smart cities, Industrial Monitoring, Smart Street Light, Smart Water/ Gas/ Electricity metering solutions etc.

iv. Predictive Maintenance

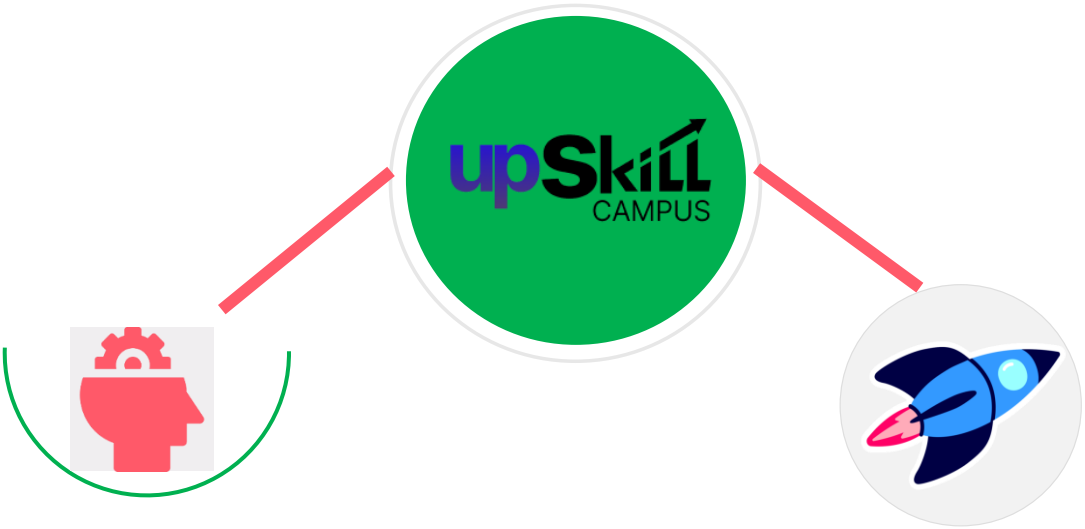
UCT is providing Industrial Machine health monitoring and Predictive maintenance solution leveraging Embedded system, Industrial IoT and Machine Learning Technologies by finding Remaining useful life time of various Machines used in production process.



2.2 About upskill Campus (USC)

upskill Campus along with The IoT Academy and in association with Uniconverge technologies has facilitated the smooth execution of the complete internship process.

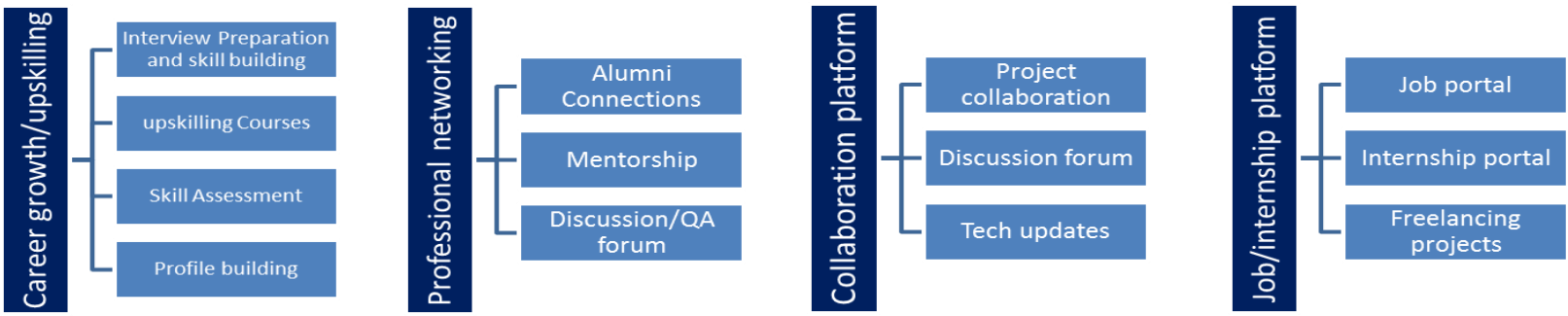
USC is a career development platform that delivers **personalized executive coaching** in a more affordable, scalable and measurable way.



Seeing need of upskilling in self paced manner along-with additional support services e.g. Internship, projects, interaction with Industry experts, Career growth Services

upSkill Campus aiming to upskill 1 million learners in next 5 year

https://www.upskillcampus.com/



2.3 The IoT Academy

The IoT academy is EdTech Division of UCT that is running long executive certification programs in collaboration with EICT Academy, IITK, IITR and IITG in multiple domains.

2.4 Objectives of this Internship program

The objective for this internship program was to

- ☛ get practical experience of working in the industry.
- ☛ to solve real world problems.
- ☛ to have improved job prospects.
- ☛ to have Improved understanding of our field and its applications.
- ☛ to have Personal growth like better communication and problem solving.

2.5 Reference

[1] https://learn.upskillcampus.com/s/mycourses

[2] Traffic Detection (kaggle.com)

[3] https://www.kaggle.com/code/tejwantsingh/smartcitytrafficdetection-tejwantsingh

[4] https://chat.openai.com/

2.6 Glossary

Terms	Acronym
AI & ML	Artificial Intelligence and Machine Learning
Data science	It is an interdisciplinary domain that applies scientific methods, algorithms, processes, and systems to extract valuable knowledge and insights from both structured and unstructured data. Data science integrates aspects of statistics, machine learning, data mining, and big data analytics to analyze and interpret complex data for decision-making and innovation across various industries.
Data Preprocessing	The process of cleaning, transforming, and preparing raw data before feeding it into a machine learning model for analysis.
USC/UCT	Upskill Campus / Uniconverge Technology
IOT	Intent of Things

3 Problem Statement

As a data scientist tasked with managing traffic and providing input for infrastructure planning in the context of transforming a city into a smart city, the project would involve the following steps:

1. **Data Collection**

   To begin, collecting comprehensive data is crucial for building an accurate traffic forecasting system. The types of data needed include:

   - Historical Traffic Data: Vehicle counts and traffic flow data for each of the four junctions over time.
   - Time-Based Data: Traffic patterns on normal weekdays, weekends, holidays, and special occasions (festivals, sports events, etc.).
   - Weather Data: Conditions like rain or extreme heat that may influence traffic.
   - Event Data: Information on major city events, parades, or road construction.
   - Public Transport Data: Interaction between traffic flow and public transport usage.
   - Demographic Data: Population density or commuter patterns.
   - Sensor Data: Real-time traffic data from cameras, IoT sensors, and GPS tracking.

2. **Exploratory Data Analysis (EDA)**

   Use the data to identify:

   - Peak Hours: When traffic tends to be highest during the day.
   - Seasonal Variations: How traffic changes during holidays and special events.
   - Junction-Specific Analysis: How traffic differs across the four junctions.
   - Anomalies: Any outliers, such as unexpected traffic surges.

3. **Traffic Forecasting Model**

   Given the complexity of traffic patterns, a machine learning-based approach or time-series forecasting models would be ideal. These models could include:

- Time Series Models (ARIMA, SARIMA): These models are effective for time-dependent data and can be tuned to account for seasonal changes such as holidays.
- Recurrent Neural Networks (RNN, LSTM): These deep learning models are well-suited for sequential data and can capture both long-term and short-term dependencies in traffic patterns.
- Hybrid Models: Combining statistical and machine learning models to improve forecasting accuracy.
- Spatio-Temporal Models: Capturing both spatial (junction-specific) and temporal (time-based) patterns in traffic flow.

4. Features for Prediction

- Day of the Week: Weekdays vs. weekends.
- Time of Day: Rush hours, off-peak hours.
- Weather Conditions: Rain, fog, snow, etc.
- Public Events: Sports, concerts, etc.
- Road Work/Construction: Known obstructions or diversions.
- Holiday Indicator: A variable indicating holiday or special event dates.

5. Infrastructure Planning Recommendations

Based on traffic predictions, the government can:

- Optimize Traffic Signal Timings: Use adaptive traffic control systems to adjust light timings based on real-time traffic data.
- Improve Public Transportation: Promote the use of public transport, particularly during peak hours and holidays, by ensuring efficiency and coverage.
- Plan for Smart Infrastructure: Use forecasts to plan future road expansions, flyovers, or bypasses at the busiest junctions.
- Dynamic Route Suggestions: Provide citizens with real-time traffic updates and alternate route suggestions via mobile apps or digital signs.
- Holiday/Event-Specific Management: Implement special traffic management strategies on high-traffic days such as holidays or during festivals.

6. **Continuous Monitoring and Real-Time Adjustments**

Implement real-time monitoring of traffic using IoT devices, cameras, and GPS data. By continuously feeding this real-time data into the model, the system can adjust traffic control dynamically, ensuring that sudden traffic peaks are handled smoothly.

7. **Reporting and Dashboards**

Develop a dashboard for city officials that provides:

- Real-time traffic updates.
- Short-term and long-term traffic predictions.
- Alerts for any abnormal traffic conditions.
- Reports on historical traffic data and trend analysis for better infrastructure planning.

8. **Simulation and Testing**

Before implementation, simulate the traffic system to test its effectiveness. Simulations can be based on historical peak traffic data, and different scenarios like holiday surges or road blockages can be modeled.

9. **Future Scalability**

Once a robust traffic system is in place for these four junctions, similar strategies can be rolled out across the city to manage overall traffic more effectively, while maintaining the flexibility to scale up as the city expands.

3.1 Code submission (Github link)

UpSkill-/Smart_City_Traffic_Patterns.ipynb at main · VishwaNayak1812/UpSkill- (github.com)

3.2 Report submission (Github link)

https://github.com/VishwaNayak1812/UpSkill-/blob/main/SmartCityTrafficPattern_Vishwa_USC_UCT.pdf

4 Proposed Design/ Model

The proposed LSTM-based model for traffic pattern forecasting offers a comprehensive and data-driven approach to address the challenges faced in urban traffic management within a smart city context. By leveraging the strengths of LSTM neural networks, the model is designed to capture complex temporal dependencies inherent in traffic data, enabling accurate predictions of future traffic patterns.

4.1 High Level Diagram (if applicable)

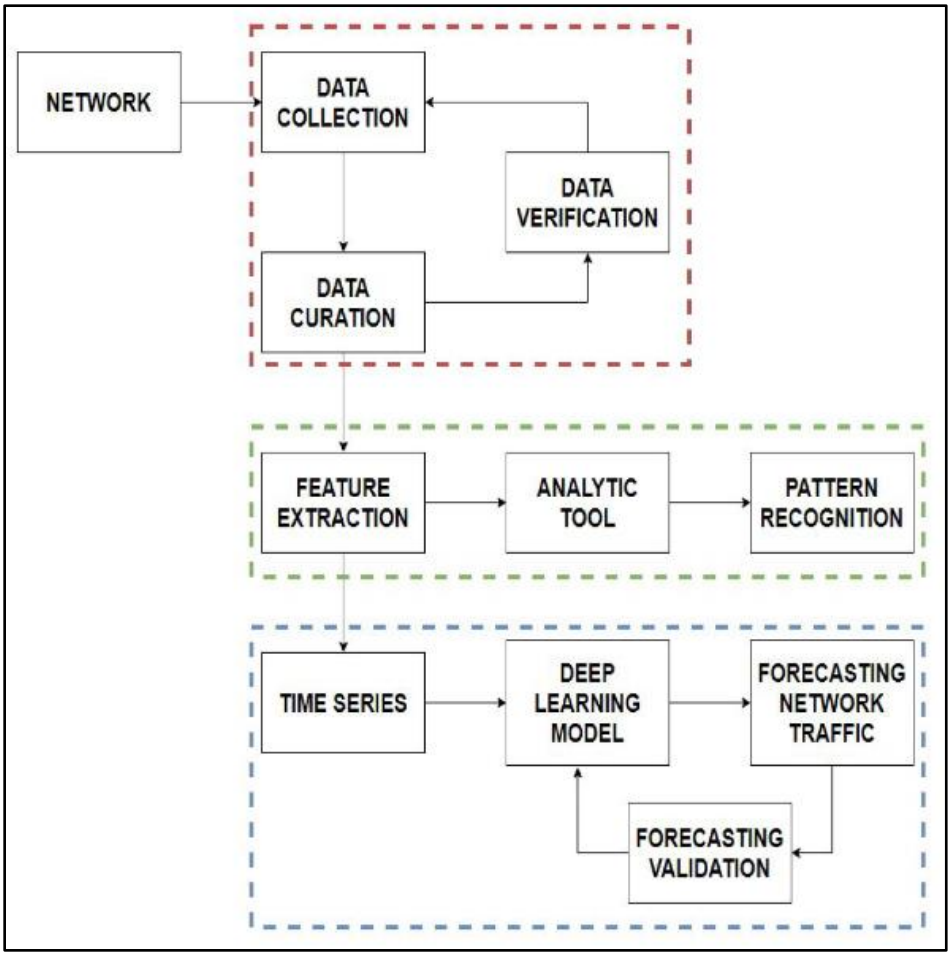
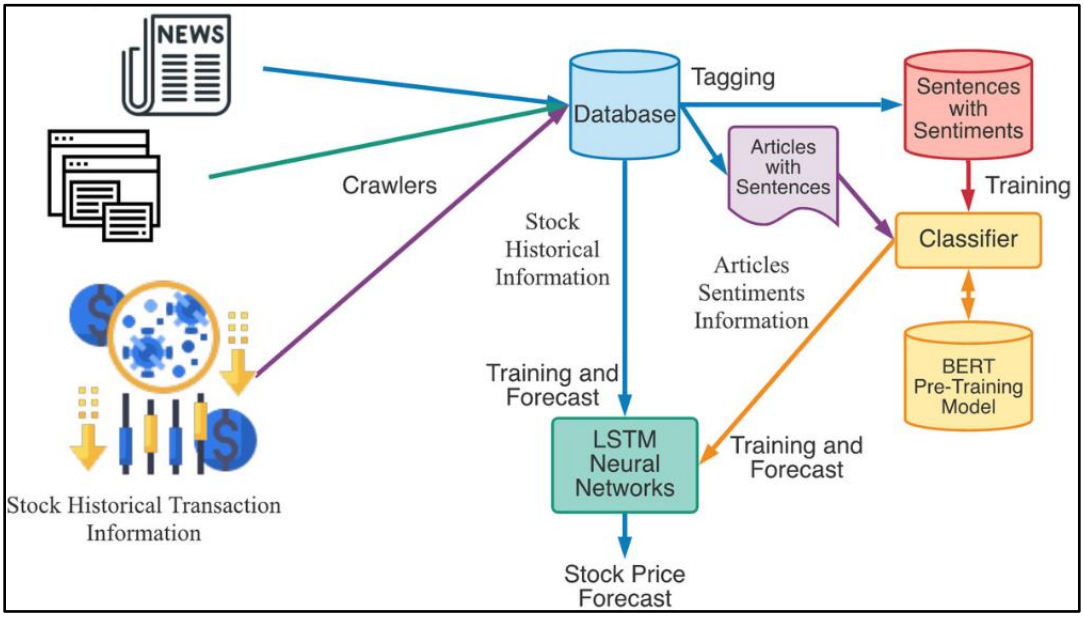
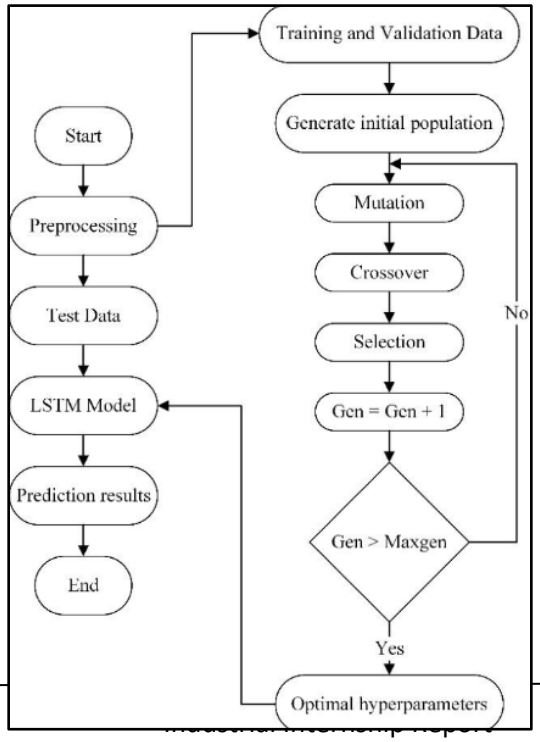


Figure 1: HIGH LEVEL DIAGRAM OF THE SYSTEM

4.2 Low Level Diagram (if applicable)



4.3 Interfaces (if applicable)



5 Performance Test

The performance evaluation of the LSTM model for traffic pattern forecasting involves a combination of quantitative metrics, visual assessments, and real-world testing. By carefully analyzing these aspects, you can determine the model's effectiveness and make informed decisions regarding its implementation in smart city traffic management systems.

5.1 Test Plan/ Test Cases

This test plan provides a comprehensive framework for validating the performance and functionality of the LSTM model for traffic pattern forecasting. By executing these test cases, you can ensure the system meets its objectives and performs reliably in a real-world environment.

5.2 Test Procedure

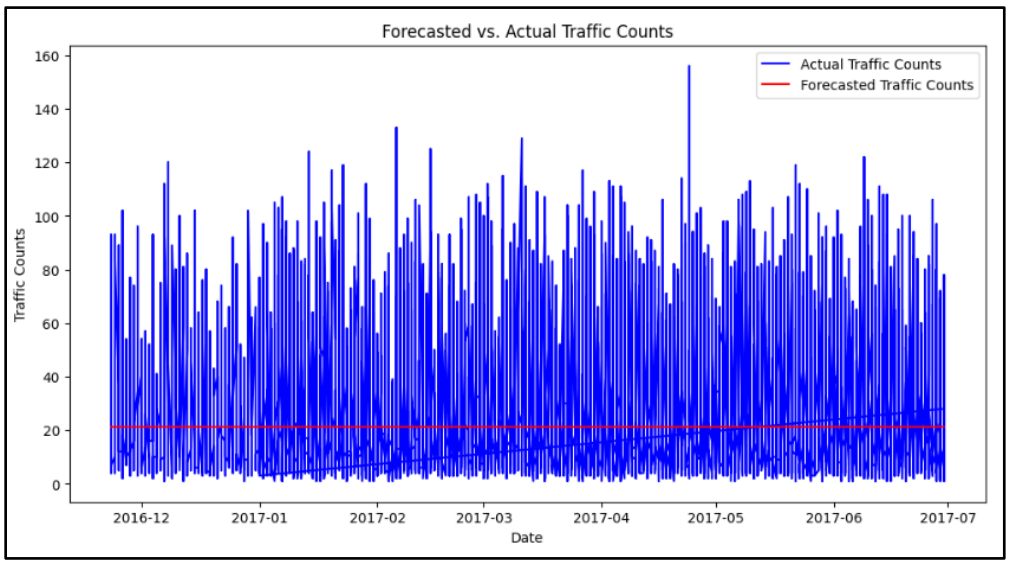
The test procedure outlines the step-by-step process to execute the test plan for the LSTM-based traffic pattern forecasting project. This procedure will ensure that all aspects of the system are thoroughly tested, and it will help maintain consistency across testing activities.

5.3 Performance Outcome

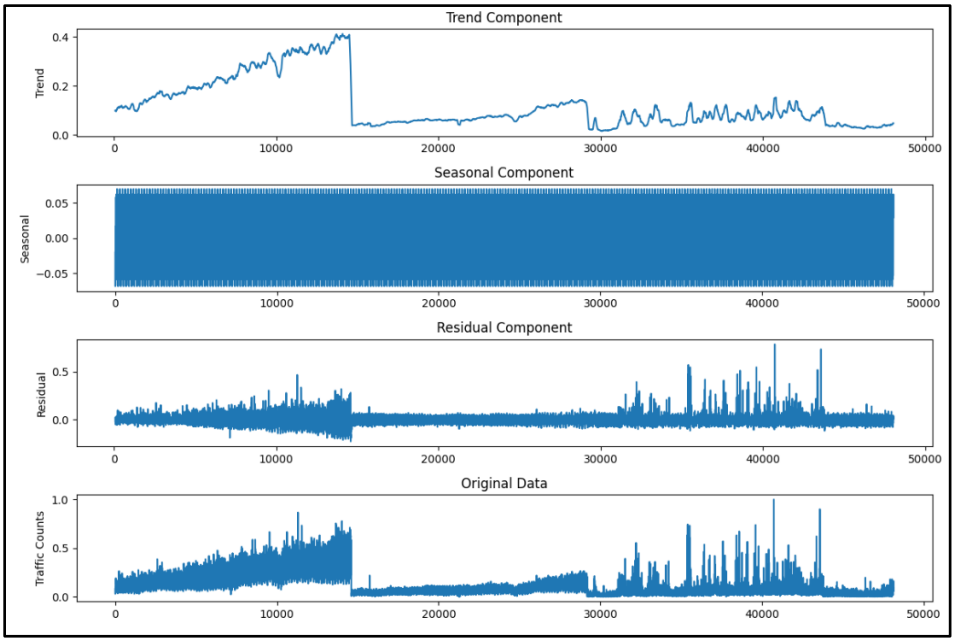
“Forecasted vs. Actual Traffic Counts” compares predicted traffic counts with actual recorded data from December 2016 to July 2017. The actual traffic counts (blue line) show significant fluctuations, while the forecasted counts (red line) follow a smoother trend, generally aligning with the actual data but not capturing all the peaks and troughs.

The forecasted traffic counts provide a good overall trend but may miss some of the more extreme variations seen in the actual data. This indicates that while the forecasting model is reasonably accurate, there is room for improvement in capturing short-term fluctuations.

There may be underlying seasonal patterns affecting traffic counts, such as holidays, weekends, or special events, which are not fully captured by the forecast. Identifying and incorporating these patterns could enhance the model’s predictive power.



The graph breaks down a time series dataset into its components: the trend component shows a gradual upward trend over time, indicating an overall increase in the data values. The seasonal component reveals minimal seasonal variation, suggesting that the data does not exhibit strong seasonal patterns. The residual component highlights irregularities or noise in the data after accounting for trend and seasonality. Finally, the original data graph displays the raw time series with pronounced fluctuations and spikes, representing the unprocessed data before any decomposition. This decomposition helps in understanding the underlying patterns for better analysis and forecasting.



6 My learnings

During this internship, I had the chance to delve into diverse areas of data science, machine learning, artificial intelligence, and data engineering. I acquired knowledge from various platforms, including Wikipedia, YouTube, e-books, webinars, and the resources provided by the internship. Below is a detailed overview of my learnings throughout this experience:

1. **Understanding Data Science:**

   I discovered the crucial role of data science in addressing complex issues by integrating mathematics, statistics, programming, and specialized knowledge. The importance of Exploratory Data Analysis (EDA) and data cleaning was emphasized as foundational steps in the data science workflow.

2. **Foundations of Machine Learning:**

   I was introduced to machine learning algorithms and their practical applications, covering both supervised and unsupervised learning methods. I gained insights into model evaluation, validation processes, and big data technologies, including Hadoop and Spark.

3. **E-book on Data Science:**

   This extensive guide encompassed a range of data science topics. Key takeaways included the definition of data science, methods for exploratory data analysis, data cleaning and preprocessing, along with machine learning algorithms and evaluation strategies.

4. **Impact of Big Data on Business:**

   I learned how big data drives businesses toward data-informed decision-making, predictive analytics, and enhanced customer insights across sectors such as retail, e-commerce, and manufacturing.

5. **Data Analyst vs. Data Scientist:**

Insights into the roles, responsibilities, and tools of data analysts and data scientists helped me compare these career paths, allowing me to weigh their advantages and disadvantages.

6. **Insights from Probability and Statistics:**

I explored the significance of probability theory, descriptive statistics, statistical inference, and regression analysis in data analysis, model building, and forecasting.

7. **AI and Data Science Career Pathways:**

This topic examined the interconnection between AI and data science, their applications, and potential career opportunities, including the sought-after job roles and salary prospects in both fields.

8. **Linear Algebra's Role in Data Science:**

I gained an understanding of how linear algebra and linear functions are fundamental to data representation, analysis, and prediction, particularly in machine learning and neural networks.

9. **Optimization in Machine Learning:**

I discovered the importance of optimization techniques in machine learning, including methods like gradient descent for fine-tuning model parameters.

10. **Preparing for Data Science Interviews:**

I familiarized myself with the skills required for data science interviews, the interview process itself, and common topics and questions that will assist me in my future job search.

11. **Practical Application of Data Science and ML:**

I engaged in hands-on experiences applying data science and machine learning concepts to real-world challenges. From data preprocessing to model execution, I learned to systematically address complex issues and extract valuable insights from data.

12. Data Analysis and Visualization:

I recognized the significance of data analysis and visualization in identifying patterns and trends. Visualizing actual and predicted traffic patterns at different junctions allowed me to effectively communicate insights and support informed decision-making.

13. Critical Thinking and Problem-Solving Skills:

The project presented several challenges that necessitated critical thinking and problem-solving. I learned to approach issues analytically, experiment with various solutions, and adjust my strategies as needed.

7 Future work scope

Detecting traffic patterns in smart cities is crucial for optimizing traffic management, resource allocation, environmental sustainability, safety, and urban planning. This project aimed to enhance urban living by developing a predictive model using Decision Trees.

While the project achieved its goals, there are several promising avenues for future exploration:

- **Ensemble Models:** Investigate ensemble methods like Gradient Boosting to improve prediction accuracy through the integration of multiple decision trees.
- **Time Series Forecasting:** Utilize time series models, such as ARIMA or Prophet, to better capture the temporal dynamics of traffic patterns and identify seasonal trends.
- **Data Augmentation:** Enhance the dataset by incorporating external factors, like social events and road construction, to gain a more comprehensive understanding of traffic influences.
- **Feature Selection:** Employ techniques like Recursive Feature Elimination or LASSO regression to pinpoint the most significant features for traffic prediction, streamlining the model and improving interpretability.
- **Hyperparameter Tuning:** Conduct thorough hyperparameter tuning to optimize the decision tree model and minimize the risk of overfitting.
- **Predictive Analytics Dashboard:** Create an interactive dashboard to visualize traffic predictions, enabling city officials to make informed decisions for effective traffic management.

In summary, the Smart City Traffic Patterns Prediction project successfully implemented a decision tree model to forecast traffic conditions. Future efforts will focus on exploring additional ensemble models and conducting comprehensive algorithm comparisons to enhance accuracy and insights, ultimately supporting effective traffic management and urban planning in smart cities.