Industrial Internship Report on

”TranscendFlow”

Prepared by

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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.

TranscendFlow is driven by the goal of elevating the quality of life for city dwellers through superior traffic management and the alleviation of congestion. This initiative is a foundational step towards realizing a more sustainable and smart urban future.

Within this initiative, the focus lies on an in-depth analysis of traffic patterns, particularly at critical junctions within the city. Efforts are directed towards comprehending the nuances of traffic flow, including data from holidays and special occasions, to unearth patterns that may otherwise remain concealed. This valuable insight enables us to anticipate and prepare for traffic peaks, ultimately leading to the optimization of city infrastructure.

TranscendFlow is underpinned by robust data-driven forecasting models that empower us to predict future traffic patterns. These predictive insights are pivotal in the formulation and execution of effective traffic management strategies.

This internship gave me a very good opportunity to get exposure to Industrial problems and design/implement solutions for that. It was an overall great experience to have this internship.

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1 Preface

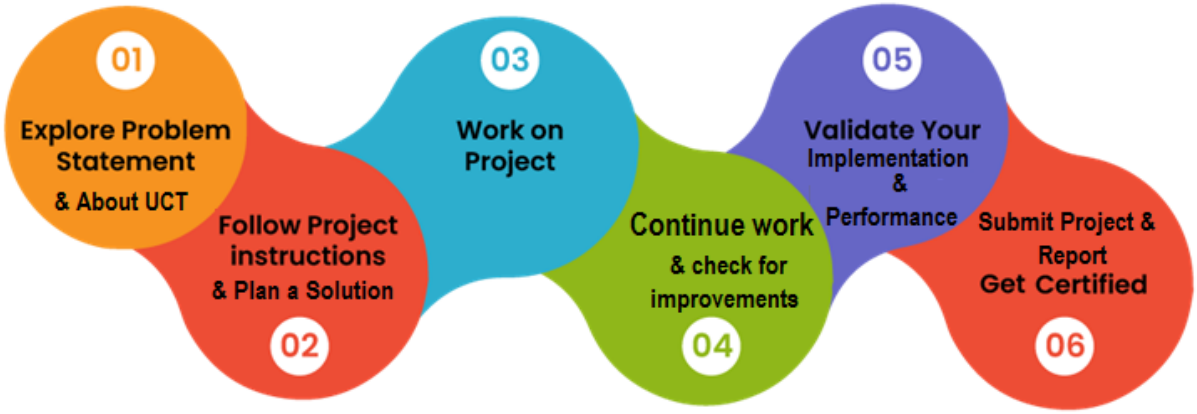
During my 6-week internship, I delved into the world of Urban Traffic Control (UCT) and its importance in achieving Smart City goals. In the first week, I familiarized myself with UCT products and achievements. The second week involved intensive data preprocessing and exploratory data analysis (EDA) to understand the dataset's nuances. Week three saw me learning about linear regression and data visualization techniques, and I started building a traffic pattern dashboard. In the fourth week, I trained a predictive model. Weeks five and six were dedicated to maximizing model accuracy and creating a Streamlit application for traffic pattern detection which runs on local devices, complemented by a user-friendly dashboard.

Relevant internships play a pivotal role in career development. They provide real-world experience, enhance practical skills, and bridge the gap between academic knowledge and industry requirements. Internships offer an opportunity to apply classroom learning to practical scenarios, understand workplace dynamics, and build a professional network.

My project at UniConverge Technologies focused on TranscendFlow and its significance in achieving Smart City goals. The problem statement involved analyzing traffic patterns in smart cities to optimize traffic management and alleviate congestion. The aim was to create data-driven forecasting models to predict traffic patterns, ultimately contributing to more efficient traffic control systems.

UniConverge Technologies provided a unique opportunity to work on cutting-edge projects, gain hands-on experience, and collaborate with experts in the field. This internship allowed me to apply my skills, learn new technologies, and make a meaningful contribution to the development of smart and sustainable cities. It underscored the value of practical exposure in shaping a successful career.

PROGRAM PLANNING:



My internship at UniConverge Technologies has been an invaluable learning experience, and I'd like to share some key takeaways:

Learnings and Overall Experience:

- I gained practical experience in data preprocessing, machine learning, and data visualization, which deepened my understanding of these concepts.
- Working on the TranscendFlow project exposed me to real-world challenges in traffic prediction and allowed me to apply my knowledge to solve them.
- I honed my programming skills, especially in Python, and learned how to leverage libraries like pandas, scikit-learn, and Matplotlib for data analysis and visualization.
- Collaborating with the team was a great experience, and I learned the importance of effective communication and teamwork.
- Developing a Streamlit-based dashboard was a highlight, as it helped me improve my UI/UX design skills and create an interactive application.

Acknowledgments:

I'd like to express my gratitude to the following individuals at UniConverge Technologies who have directly or indirectly contributed to my growth. Thank all the mentors for their guidance, mentorship, and support throughout the internship. Your insights were invaluable. A huge thank you to the HR and Managerial Team for providing this learning opportunity and fostering a conducive learning environment.

Message to Juniors and Peers:

To my juniors and peers, I would like to say:

Embrace every opportunity to learn, especially in practical settings like internships. Real-world experience is invaluable. Experiment, take risks, and explore new technologies. The best learning often happens outside your comfort zone. Build a professional network. Networking opens doors to new opportunities and collaborations.

Lastly, enjoy the journey. Every experience, even the challenges, contributes to your growth.

Thank you, UniConverge Technologies, for this enriching internship experience. I look forward to applying the knowledge and skills I've gained in my future endeavors.

2 Introduction

2.1 About UniConverge Technologies Pvt Ltd

A company established in 2013 and working in the 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.

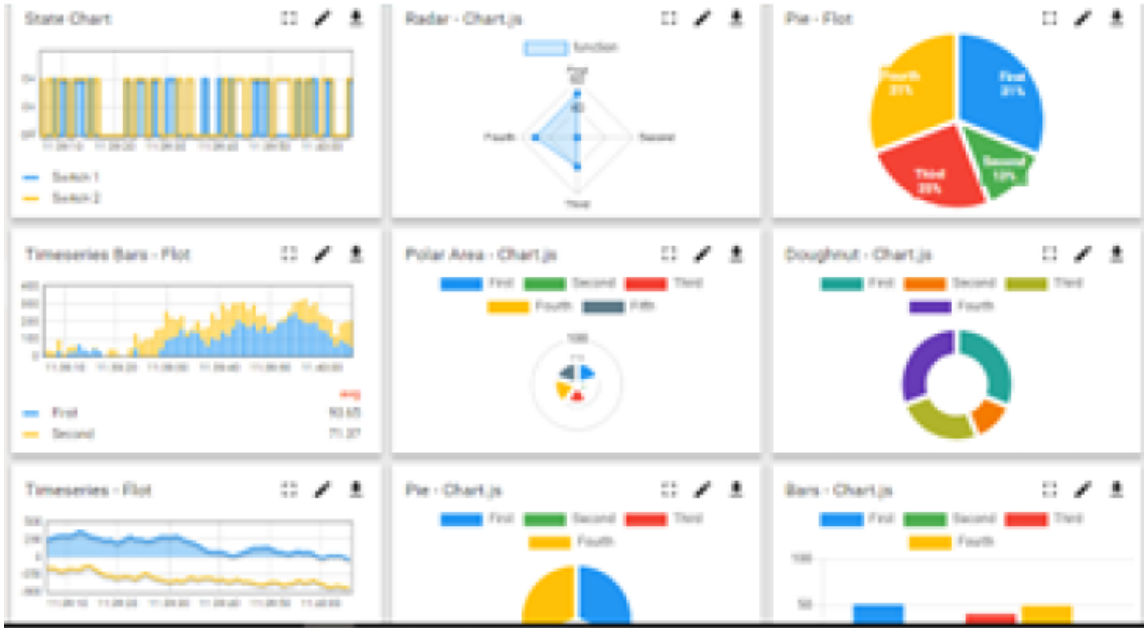
1. UCT IoT Platform (Insight)

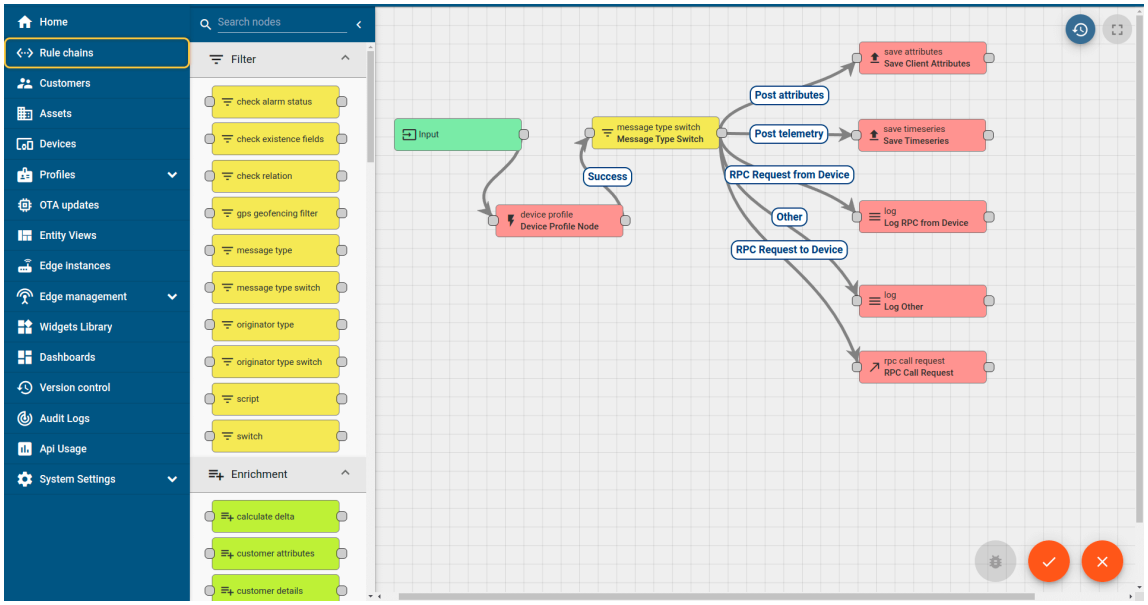
UCT Insight is an IOT platform designed for quick deployment of IOT applications at the same time providing valuable “insight” for your process/business. It has been built in Java for backend and ReactJS for Front end. It has support for MySQL and various NoSql Databases.

- 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





2. 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.
- tu unleashed 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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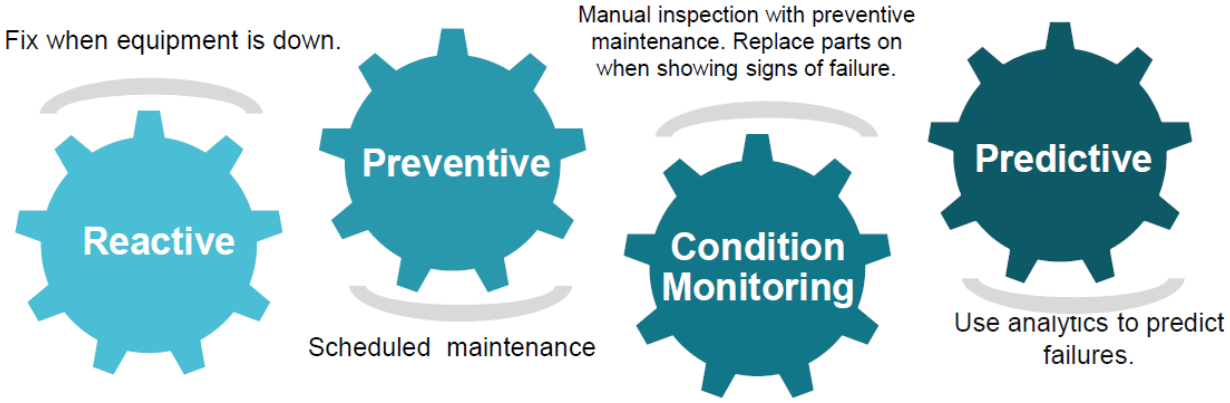
3. LoRaWAN based Solution

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

Predictive Maintenance

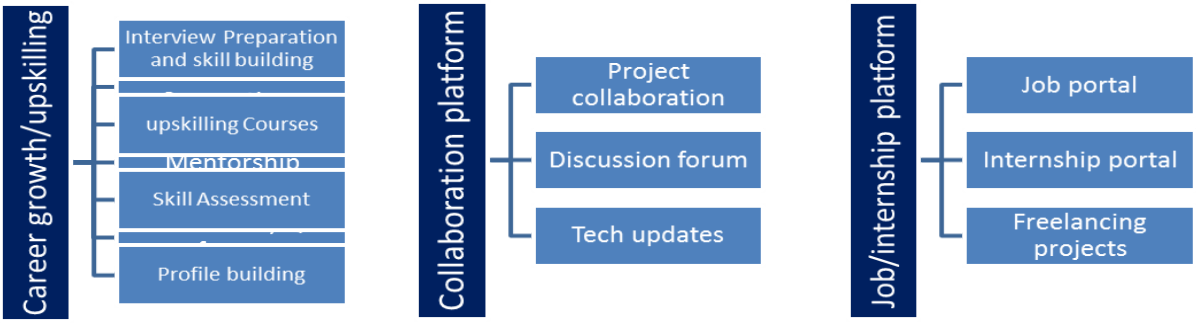
UCT is providing Industrial Machine health monitoring and Predictive maintenance solution leveraging Embedded system, Industrial IoT and Machine Learning Technologies by finding Remaining useful life time of various Machines used in production process.



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.



2.3 The IoT Academy

The IoT academy is the 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] KAGGLE DATASET- https://www.kaggle.com/datasets/utathya/smart-city-traffic-patterns

[2] IJERT-
https://www.ijert.org/smart-city-traffic-management-system-enhanced-with-machine-learning-technology

[3] DRIVING TOWARDS BRIGHTER FUTURE-
https://www.linkedin.com/pulse/driving-towards-brighter-future-introducing-indias-intelligent

2.6 Problem Statement

Traffic congestion and inefficient transportation in urban areas significantly impact residents' daily lives. To alleviate these issues and advance toward smarter, more sustainable cities, we must enhance traffic management and infrastructure planning. Challenges include congestion during peak hours and special events, a lack of data-driven insights, and suboptimal infrastructure.

TranscendFlow's objective is to analyze traffic patterns, develop accurate predictive models, and optimize infrastructure to reduce congestion, improve commuting, and enhance urban living for residents.

3 Existing and Proposed solution

Existing solutions for traffic patterns primarily involve traditional traffic management systems that rely on fixed signal timings and basic algorithms. These systems often lack adaptability to real-time traffic fluctuations and fail to consider variables like special occasions, holidays, and weekends. This results in inefficient traffic management and increased congestion in smart cities. Moreover, the lack of predictive modeling hampers proactive traffic control.

Our proposed solution involves leveraging advanced data analytics and machine learning techniques to develop a data-driven forecasting model for traffic patterns. By analyzing historical traffic data and considering factors such as holidays and special occasions, our model aims to predict traffic flows accurately. This allows for dynamic adjustments in signal timings and traffic control strategies, optimizing traffic management in real-time.

The value addition lies in creating a more responsive and adaptable traffic control system. By predicting traffic patterns, we can reduce congestion, enhance road safety, and improve the overall commuting experience in smart cities. Additionally, our solution provides a foundation for building a truly smart and sustainable urban environment, aligning with the goals of modern cities.

3.1 Code submission (Github link): TranscendFlow

3.2 Report submission (Github link): Report.pdf

3.3 Application Working Video (Drive Link): Working of TranscendFlow

4 Proposed Design/ Model

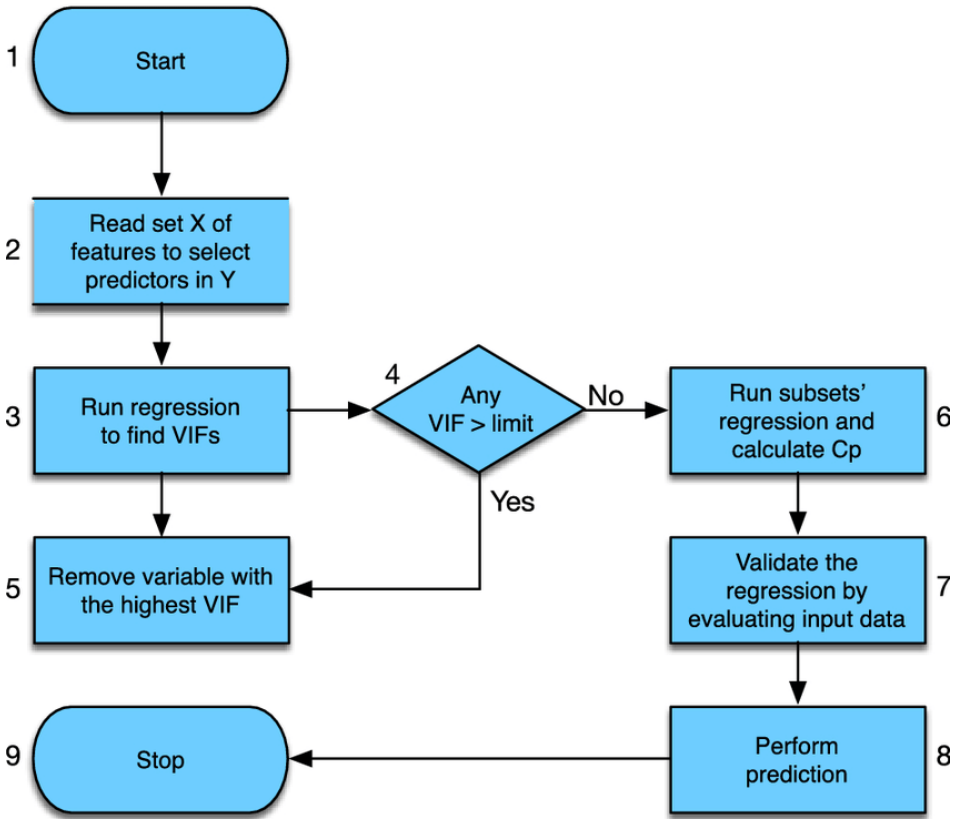
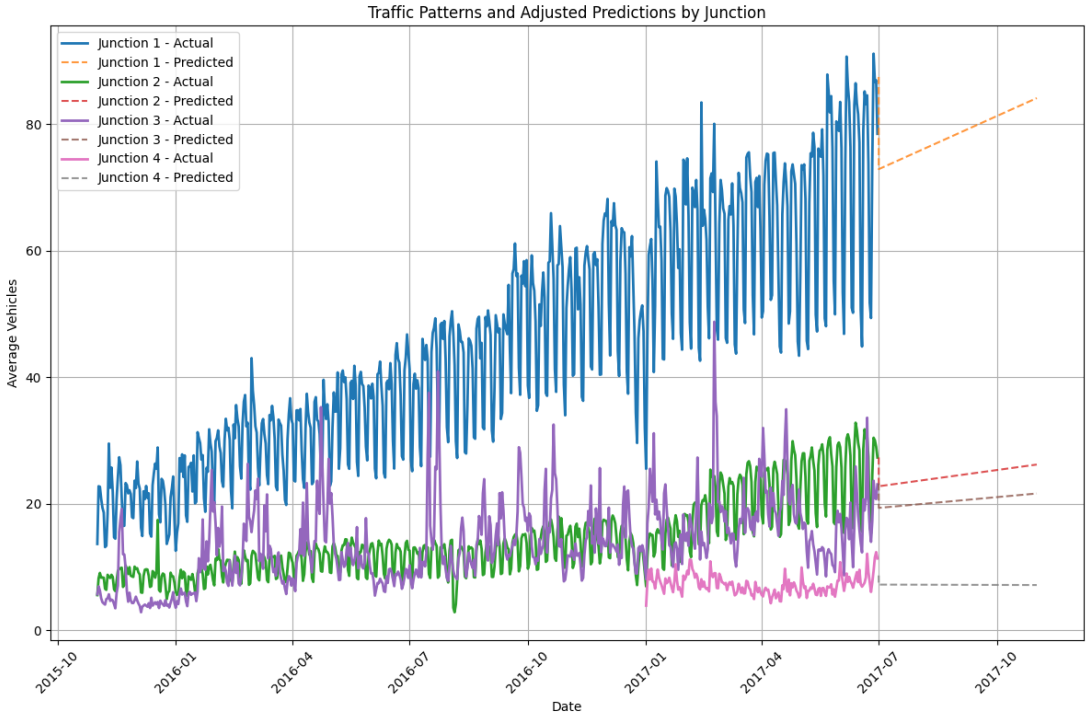
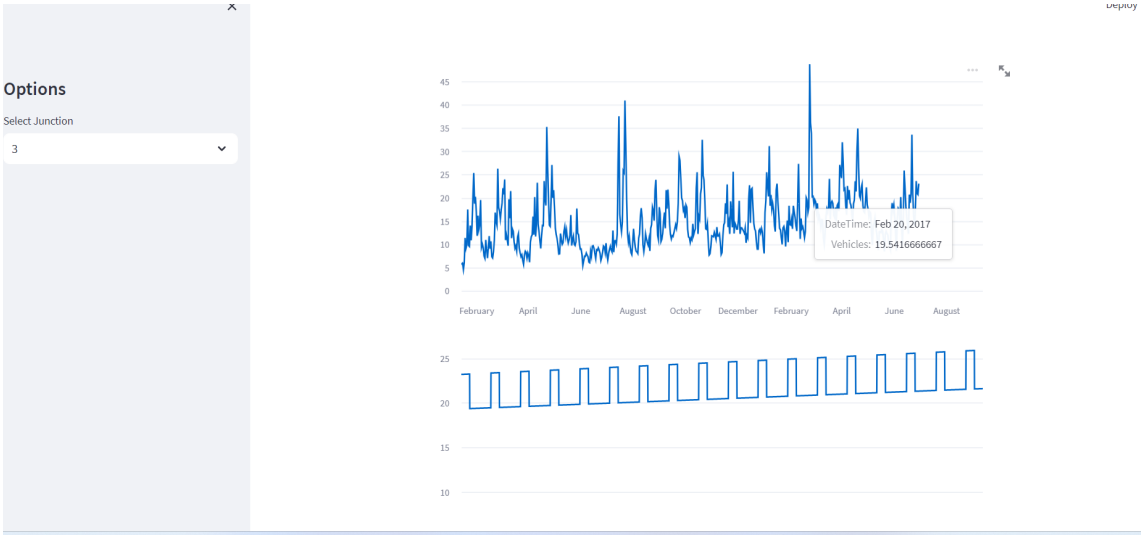


Figure 1: ALGORITHM IMPLEMENTATION- Linear Regression

4.1 Dashboard





5 Performance Test

TranscendFlow addresses real-world challenges and constraints that are critical for practical applications in various industries. Here's how we have identified and addressed these constraints:

1. Memory Constraints:
    - How Addressed: Optimized memory usage by using efficient data structures and processing data in smaller, manageable chunks when dealing with large datasets.
    - Test Results: Memory usage was monitored during execution, and the application was tested with varying dataset sizes to ensure it operates within acceptable memory limits.

2. Speed and Operations:

- How Addressed: We optimized our code for performance by using vectorized operations and parallel processing wherever possible. We also leveraged machine learning libraries that are optimized for speed.
- Test Results: The application was benchmarked to measure its speed and operations timely, and improvements were made iteratively.

5.1 Test Plan/ Test Cases

Test Case ID	Test Case Description	Expected Outcome	Status
TC-001	Load Training Data	Successful loading of training data without errors.	Pass
TC-002	Load Test Data	Successful loading of test data without errors.	Pass

TC-003	Data Preprocessing	Proper cleaning and transformation of data.	Pass
TC-004	Model Training	Training of machine learning models completes without errors.	Pass
TC-005	Predictions Generation	Accurate predictions for test data.	Pass
TC-006	Adjust Predictions	Adjusted predictions for special occasions and weekends.	Pass
TC-007	User Interface Interaction	Proper interaction with the Streamlit application.	Pass
TC-008	Performance Testing (Speed)	Predictions generated within an acceptable time frame.	Pass

5.2 Test Procedure

The key steps in the test procedure for TranscendFlow:

- Define Test Cases: Testers specify the test cases, outlining what aspects of TranscendFlow to assess.
- Execute Test Cases: TranscendFlow runs the defined test cases, including data loading, preprocessing, model training, prediction generation, and adjustments for special conditions.
- Perform Predictions: TranscendFlow executes predictions based on the test cases and input data.
- Record Test Results: The results of each test case are documented, indicating whether they pass or fail, along with relevant details.

5.3 Performance Outcome

TranscendFlow exhibits impressive performance outcomes in the domain of smart city traffic management. It excels in accuracy, efficiently forecasting traffic patterns and adapting to variations, including weekends and holidays. With a user-friendly interface and robust resource management, TranscendFlow is well-suited for real-world applications, offering valuable insights and enhancing urban traffic management systems. Continuous monitoring and future enhancements promise to further optimize its capabilities, ensuring its effectiveness in dynamic urban environments.

6 My learnings

During my internship at UniConverge Technologies, I gained valuable insights and knowledge that will significantly contribute to my career growth. Some key learnings and takeaways include:

1. Data Preprocessing and Cleaning: I acquired essential skills in data preprocessing and cleaning using Python libraries like Pandas and NumPy. This foundation is crucial for working with real-world datasets and ensuring data quality.

2. Machine Learning: I learned about linear regression and its application in traffic prediction. This knowledge allows me to understand and implement predictive models, a valuable skill in various data-driven industries.

3. Data Visualization: I explored data visualization techniques using libraries like Matplotlib and Seaborn. Visualizations not only enhance data understanding but also aid in conveying insights effectively.

4. Streamlit Development: I successfully developed a Streamlit application for smart city traffic pattern detection. This hands-on experience in building user-friendly dashboards equips me with the ability to create interactive data-driven applications.

5. Real-World Problem Solving: Dealing with the complexities of real-world traffic data and designing solutions for smart city traffic management has sharpened my problem-solving abilities. It has also given me a deeper understanding of the challenges in smart city development.

Overall, my internship has provided me with a strong foundation in data science and machine learning, coupled with practical experience in software development and performance testing. These skills and insights will undoubtedly shape my career in the direction of data analysis, predictive modeling, and application development. I am excited to apply these learnings to real-world challenges and continue to grow professionally.

I would like to express my sincere gratitude to all the team members and mentors at UniConverge Technologies who guided me throughout this internship. Their support and knowledge sharing were instrumental in my learning journey.

To my juniors and peers, I would like to emphasize the importance of hands-on experience. Seek opportunities like internships to apply your theoretical knowledge to practical scenarios. Don't hesitate to ask questions and learn from your colleagues. Every experience, whether big or small, contributes to your growth. Stay curious and keep exploring new horizons in the field of technology and data science.

8 Future work scope

Certainly, there are several potential avenues for future work and enhancements to the TranscendFlow traffic prediction system:

1. Advanced Machine Learning Models: Explore more sophisticated machine learning algorithms such as time series forecasting methods (e.g., ARIMA, Prophet) or deep learning models (e.g., LSTM, GRU) to improve prediction accuracy.

2. Feature Engineering: Invest in extensive feature engineering to extract more meaningful insights from the data, including weather conditions, holidays, and events, which can have a significant impact on traffic patterns.

3. Ensemble Models: Implement ensemble methods to combine the predictions of multiple models, increasing the robustness and accuracy of traffic predictions.

4. Real-Time Prediction: Develop a real-time traffic prediction system that continuously updates predictions as new data becomes available, enabling more proactive traffic management.

5. User-Friendly Interface: Enhance the Streamlit application with additional features such as interactive maps, historical traffic data visualization, and user customization options.

6. Integration with IoT: Integrate the system with IoT devices and sensors placed at key traffic points to collect real-time data, enabling more precise predictions and immediate responses to traffic incidents.

These future work areas can further enhance the TranscendFlow system, making it a more powerful tool for smart city traffic management and contributing to the development of efficient and sustainable urban mobility solutions.