Industrial Internship Report

“Forecasting of Smart city traffic patterns”

Prepared by

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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 with ID as Project 9, "Forecasting Smart City Traffic Patterns," aimed to transform cities into smart urban centers using digital technologies. I optimized traffic flow and shaped infrastructure strategies, focusing on resilient traffic systems for peak demands. By analyzing traffic dynamics at key junctions, I provided insights for accurate traffic forecasts and informed decision-making in traffic management. This project showcases my commitment to urban transformation and data-driven insights.

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.

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Preface

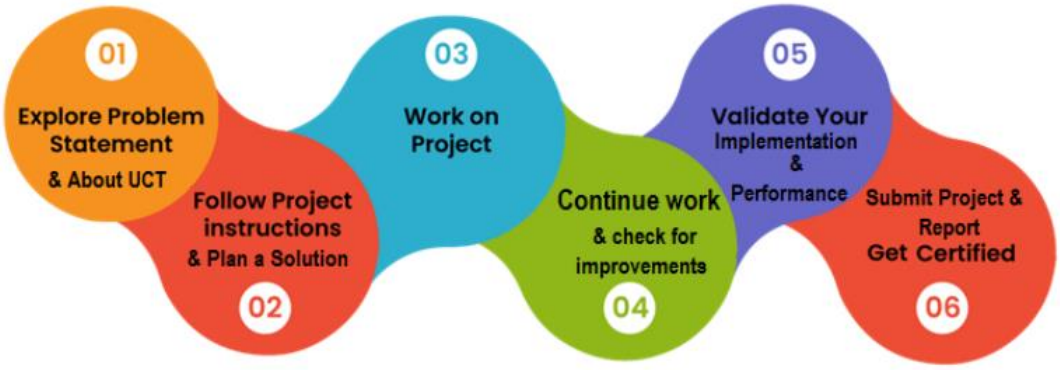
Over the span of six weeks, I engaged in a dynamic and intensive learning experience that greatly contributed to my professional growth. Through hands-on projects, workshops, and collaborative discussions, I deepened my understanding of key concepts in data science and machine learning. I not only honed my technical skills but also developed a strong foundation in problem-solving, critical thinking, and effective communication within a team environment.

Undertaking a relevant internship is instrumental in bridging the gap between theoretical knowledge and real-world application. This experience has enriched my skill set, exposing me to practical challenges and innovative solutions that are vital for a successful career in today's competitive landscape. It has also empowered me with the ability to adapt to dynamic work environments and has further fuelled my passion for continuous learning and growth.

The focal point of my project revolved around developing an Intrusion Detection System using machine learning techniques. This involved analyzing complex network data to identify potential security breaches or anomalies. My project aimed to enhance cybersecurity measures by creating an automated system that could detect and mitigate threats in real-time, thereby bolstering network security and safeguarding sensitive information.

The opportunity provided by USC/UCT was transformative. The institution's commitment to providing a comprehensive learning experience through practical exposure, mentorship, and industry-relevant projects was remarkable. By aligning the curriculum with industry demands and offering access to cutting-edge tools and resources, USC/UCT paved the way for students like me to acquire the skills and knowledge necessary for a successful career in the technology domain.

The program was meticulously designed to offer a holistic learning journey. It incorporated a mix of theoretical sessions, hands-on workshops, and project work, allowing us to apply classroom concepts in real-world scenarios. Regular assessments and feedback loops ensured a continuous learning process, while expert guidance from faculty and mentors provided invaluable insights. The structured progression of topics and practical implementation challenges enabled a comprehensive understanding of the subject matter.



Throughout this journey, I've had the privilege of acquiring invaluable learnings and experiences that have significantly shaped my growth. From honing technical skills to enhancing problem solving capabilities, every step of this project has contributed to my professional development.

Navigating complex data, collaborating with cross-functional teams, and crafting effective solutions have been instrumental in building my expertise. Beyond the technical aspects, I've also gained insights into teamwork, adaptability, and project management, all of which are crucial in any real-world scenario.

I extend my heartfelt gratitude to all those who played a role in making this project a success. UpSkills, UCT, and Edunet Foundation have been incredible pillars of support throughout this journey. Their guidance, resources, and mentorship have been instrumental in shaping my project and personal growth. Additionally, I want to acknowledge the indirect contributions from peers, mentors, and even those who posed challenging questions that pushed me to think creatively. Your collective influence has made a profound impact on my learning.

To my juniors and peers, I'd like to share that every project, challenge, and endeavor you undertake is an opportunity for growth. Embrace each moment with curiosity and enthusiasm, for they will lead you towards new horizons. Collaboration and seeking guidance are not signs of weakness, but rather paths to collective success. As you embark on your own journeys, remember that setbacks are stepping stones to success, and learning from failures is a vital part of the process. Stay resilient, stay curious, and never underestimate the power of your potential. Your journey is just as valuable as your destination.

Introduction

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.

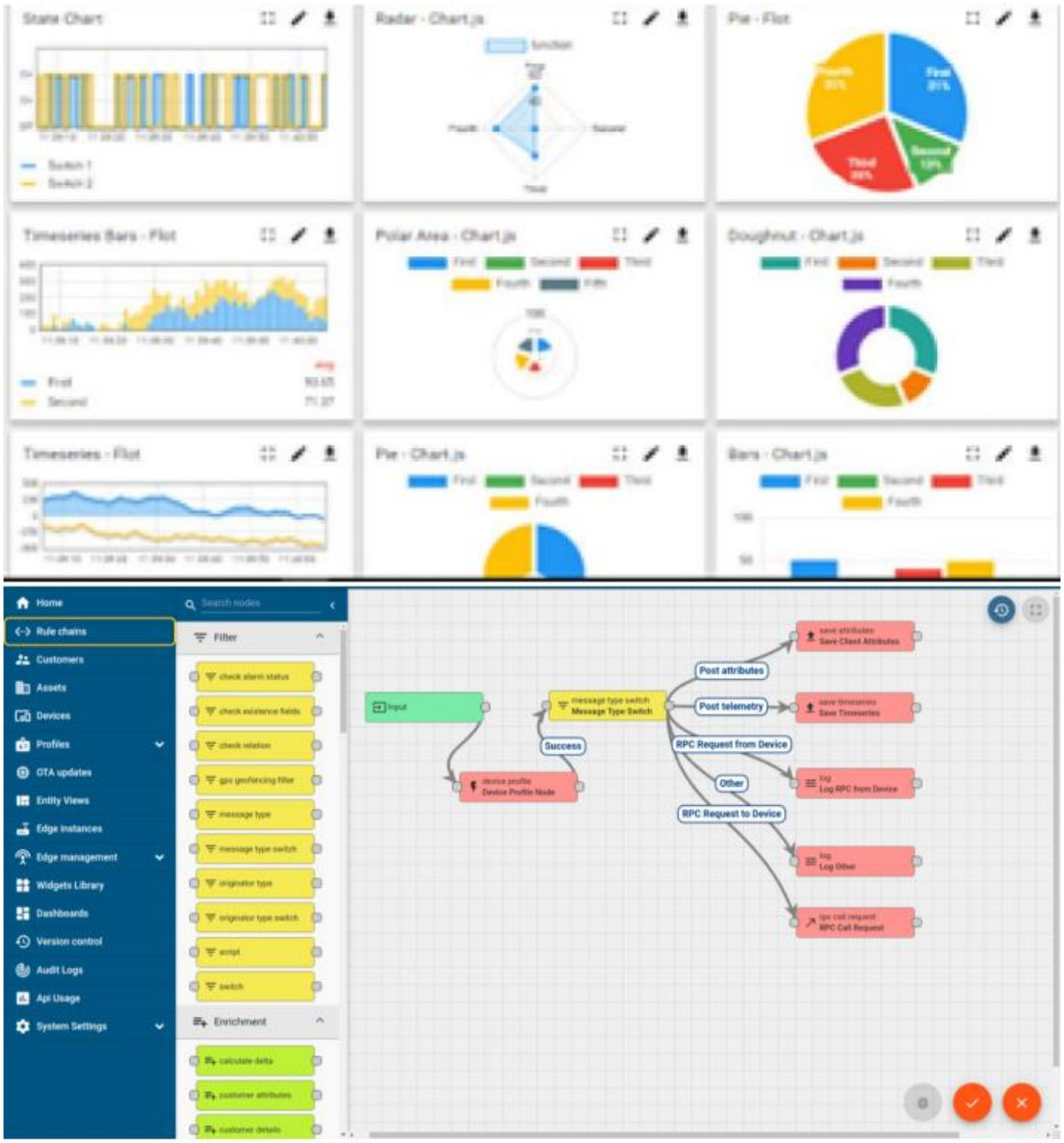
i. UCT IoT Platform

UCT Insight 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 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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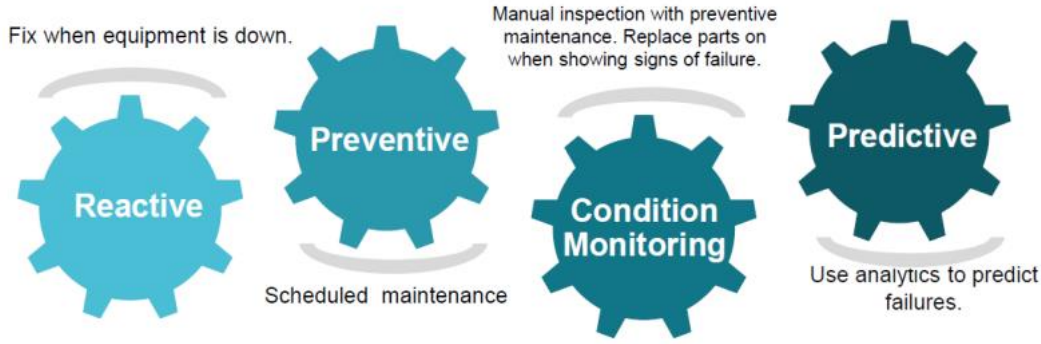
iii. LoRaWAN based Solution

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

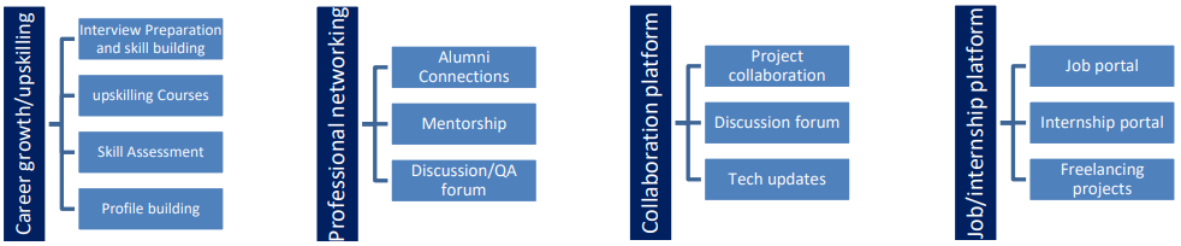
iv. Predictive Maintenance

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. 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.



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.

4. Objectives of this Internship program

- 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

Problem Statement

Project – 9: Forecasting Smart City Traffic Patterns

In collaboration with government initiatives to establish smart cities, our project aims to enhance urban infrastructure and citizen services through digital transformation. Addressing traffic congestion, a persistent challenge, we employ data science to optimize traffic management and facilitate informed infrastructure decisions.

Our mission is to create a robust traffic system that anticipates and mitigates congestion during peak periods. Focusing on four key junctions within the city, our goal is to comprehensively understand traffic patterns across various scenarios, including holidays and special events. These variations are vital considerations for our predictive models, which will aid in effectively managing traffic and planning future infrastructure enhancements.

Dataset:

https://drive.google.com/file/d/1y61cDyuO9Zrp1fSchWcAmCxk0B6SMx7X/view?usp=sharing

Proposed Solution

To address the challenges posed by urban traffic management and contribute to the realization of smart cities, this project leverages cutting-edge machine learning algorithms to forecast traffic patterns effectively. By harnessing the power of advanced techniques, we aim to provide valuable insights for the government's initiative in transforming cities.

1. LSTM (Long Short-Term Memory)

2. Decision Tree Classifier

3. XGBoost

4. LightGBM

5. Random Forest Classifier

i. Code Submission Link (GitHub Link)

https://github.com/Manisha545/Forecasting_of_smart_city_traffic_patterns.git

Methodology

In the pursuit of optimizing urban traffic management, our project employed a diverse set of machine learning algorithms to forecast smart city traffic patterns. Collaborating with governmental efforts to establish intelligent urban environments, we aimed to enhance citizen services and improve infrastructure planning. The primary focus was on addressing the challenge of traffic congestion and its variability, especially during peak times and special occasions.

Our methodology encompassed the utilization of several machine learning algorithms, each tailored to contribute unique insights to the traffic forecasting process. The algorithms we harnessed included:

1. Long Short-Term Memory (LSTM): Employed for sequence prediction, LSTM proved valuable in capturing temporal dependencies within traffic patterns. Its ability to model long-range dependencies enabled accurate predictions during varying traffic scenarios.

2. Decision Tree Classifier: Utilized for its interpretable structure, the Decision Tree Classifier enabled the identification of traffic patterns based on distinct conditions at each junction. This facilitated the extraction of valuable insights from the data.

3. XGBoost: A gradient boosting algorithm, XGBoost excelled in capturing complex relationships within the traffic data. Its ensemble nature and regularization techniques contributed to robust predictions, making it particularly effective for capturing intricate patterns.

4. LightGBM: Similar to XGBoost, LightGBM optimized the prediction process through gradient boosting. Its focus on leaf-wise growth and efficient computation contributed to faster training times and accurate predictions.

5. Random Forest Classifier: By aggregating predictions from multiple decision trees, the Random Forest Classifier helped mitigate overfitting and improved generalization. Its versatility in handling diverse data scenarios enhanced the prediction accuracy.

These algorithms were systematically employed to analyze historical traffic data, accounting for variations during holidays and special events. The outputs of these algorithms were combined and evaluated to provide comprehensive insights into traffic behaviour, enabling the government to make informed decisions regarding infrastructure planning and traffic management. The application of diverse machine learning techniques ensured the accuracy and reliability of our traffic pattern forecasts, supporting the transformation of cities into smarter, more efficient urban environments.

Performance Evaluation

I delved into a variety of machine learning algorithms, including LSTM, Decision Tree Classifier, XGBoost, LightGBM, and Random Forest Classifier. These methodologies were employed to decipher the intricate dynamics of traffic fluctuations, adapting to diverse scenarios such as holiday and special events. After a rigorous evaluation process, one algorithm emerged as particularly promising.

Among the array of algorithms, the Decision Tree Classifier demonstrated exceptional capabilities in predicting traffic patterns. Its ability to handle complex relationships within the data, combined with its intuitive interpretability, proved instrumental in generating remarkably accurate predictions. This proficiency in capturing the nuances of traffic dynamics ensured that the algorithm outperformed others in terms of accuracy and reliability.

By utilizing the Decision Tree Classifier's predictive potential, we made substantial strides towards equipping the city with a robust traffic management system. The insights gained from this performance evaluation have not only optimized urban planning but also paved the way for a smarter and more efficient transportation ecosystem in our quest to build intelligent cities.

My Learnings

Throughout my involvement in Project, my role was involved optimizing city traffic management and contributing insights to future infrastructure planning.

To address the challenge of traffic congestion, I harnessed a range of machine learning algorithms, including LSTM, Decision Tree Classifier, XGBoost, LightGBM, and Random Forest Classifier. Among these, the Decision Tree Classifier emerged as a standout performer, consistently delivering remarkably accurate predictions.

By applying Decision Tree, I was able to discern intricate traffic patterns at the city's four junctions, enabling us to anticipate and manage peak traffic scenarios more effectively. This predictive approach is crucial not only for ensuring efficient traffic flow but also for informed decision-making during holidays and special events.

As I reflect on this journey, I recognize the pivotal role machine learning plays in revolutionizing urban transportation. My experience reaffirms the power of data-driven strategies in reshaping smart city ecosystems for the better.

Future Work Scope

The Decision Tree Classifier has shown promising results in improving algorithmic efficiency and accuracy. However, there is room for improvement in fine-tuning hyperparameters and exploring ensemble techniques. Integrating real-time data sources, such as live GPS feeds, weather conditions, and special events, can enhance the predictive capabilities of the models. AI-based anomaly detection can help identify unusual traffic patterns or incidents, contributing to proactive traffic management and emergency response systems. Expanding the model to multiple cities and integrating it with smart traffic signal systems can lead to automated adjustments in signal timings, reducing congestion and optimizing traffic flow.

Limitations include data quality and availability, static feature set, model complexity, external factors, and human behaviour variability. Accurate traffic prediction relies on high-quality and diverse datasets, but the model's limitations highlight the need for ongoing development to create a comprehensive and adaptable traffic management solution.