Industrial Internship Report on

” Forecasting of Smart city traffic patterns”

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. My project was Forecasting of Smart city traffic patterns. 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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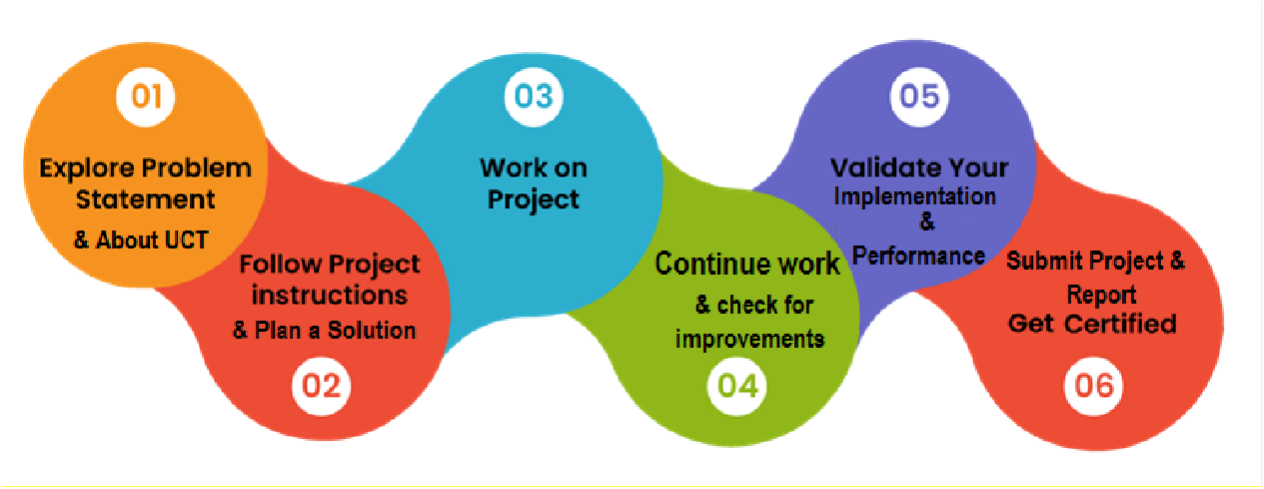
1 Preface

The first week was spent deciding the project from a list of topics, the next week exploring and researching about the project. In the third week we performed EDA on the train dataset to gain insights about the data. 4th week marked the beginning of model choosing for forecasting. After evaluating various ML techniques decision tree classifier was selected and implemented in the fifth week. In the last week the model was improved through continuous testing and enhancements to increase its accuracy.

Such internships provide practical knowledge most of all. In colleges students are able to work in labs and do practical, but they do not get the hands-on experience with the technology and problems of the real world. This is where, such organizations come into play with their internship programs, that help students get to know the outside world and build a good understanding of how work is actually done, which prepares them better for their future endeavors.

My project was Forecasting of Smart city traffic patterns. It included data about traffic at 4 junctions in a city. Based on that data we were supposed to predict how the traffic would behave in the upcoming years.

The opportunity provided by USC & UCT has been a significant milestone in my academic and professional journey. It has allowed me to access world-class resources I am grateful for the opportunity to be a part of the USC & UCT community.



During this project, I had the opportunity to work on a real-world problem, learn deeply into the world of exploratory data analysis and time series analysis. This involved designing, training, and most importantly testing the project with respect to real world constraints. Contrasting this experience with academic projects, I discovered that working on industry-level projects is a significantly different experience. It entailed identifying and addressing various factors that govern the entities of our world, which was a unique experience. Overall, this project provided an excellent learning opportunity, allowing me to gain

practical experience in handling big real-world projects and go through the unique challenges they present.

I extend my heartfelt thanks to Mr. Kaushlendra Singh Sisodia, Mr. Nitin Tyagi, and Mr. Apurv and all the members of UpSkill Campus, The IoT Academy and UniConverge Technologies Pvt Ltd for their significant contributions, both direct and indirect, to my knowledge and skill development during the smooth conduct of my internship for six weeks. Also, thanks to the Edunet Foundation team for linking me to this wonderful company and enabling me to get this opportunity.

To my juniors and peers, I want to emphasize the significance of industrial training, as it introduces you to a new world. Maintain a commitment to ongoing learning and exploration, without fear of asking questions or engaging in collaboration. These steps are the paths to your learning, innovation, and the creation of something of great worth.

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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.

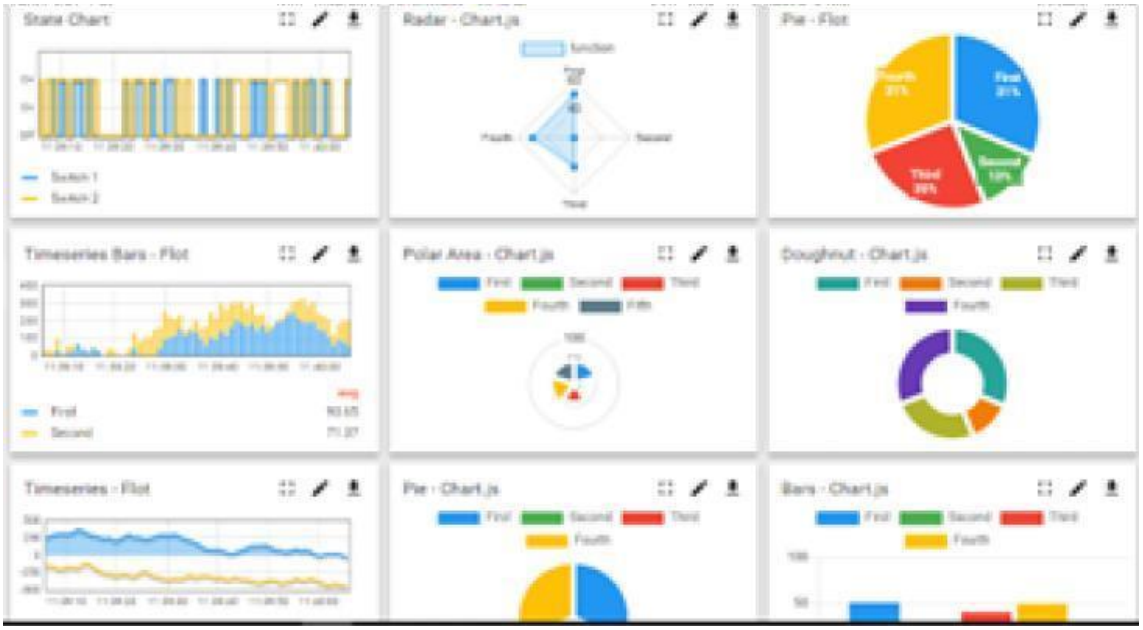
i. UCT IoT Platform (UCT Insight)

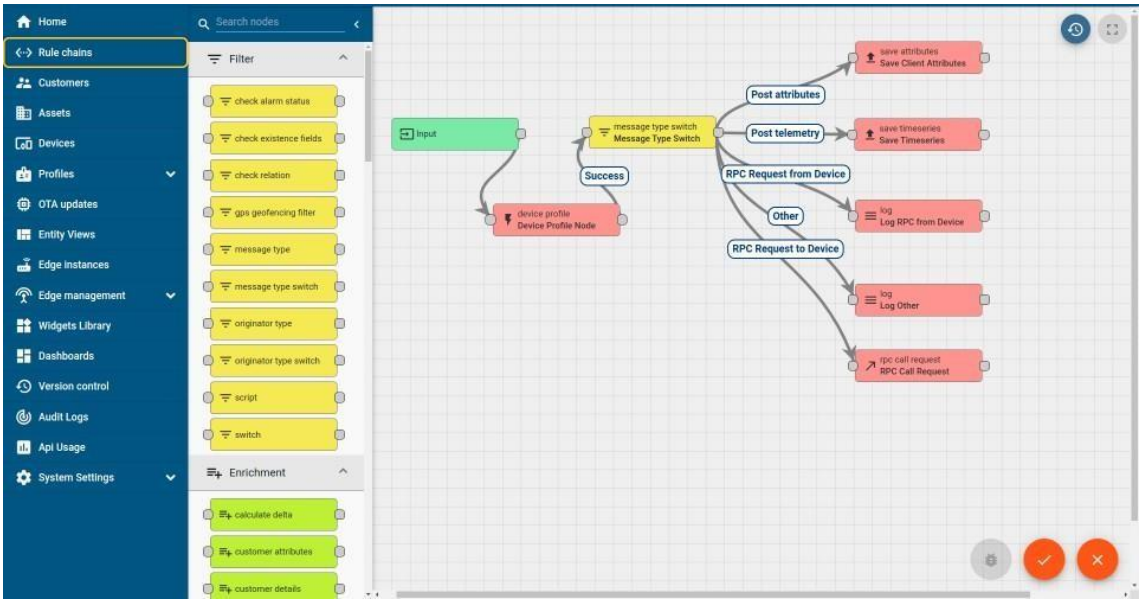
UCT Insight is an IOT platform designed for quick deployment of IOT applications on the same time providing valuable "insight" for your process/business. It has been built in Java for backend and ReactJS for Front end. It has support for MySQL and various NoSql Databases.

- 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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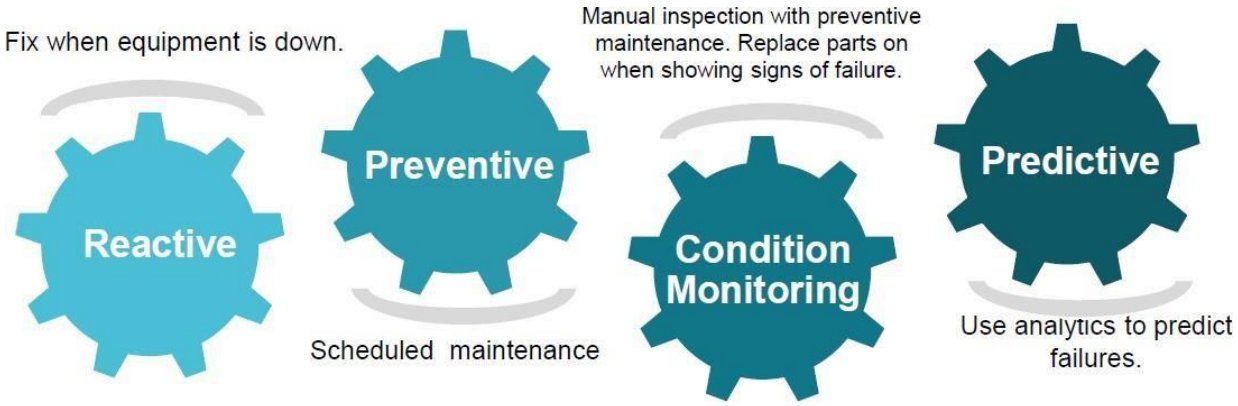
iii. LoRaWAN based Solution

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

iv. Predictive Maintenance

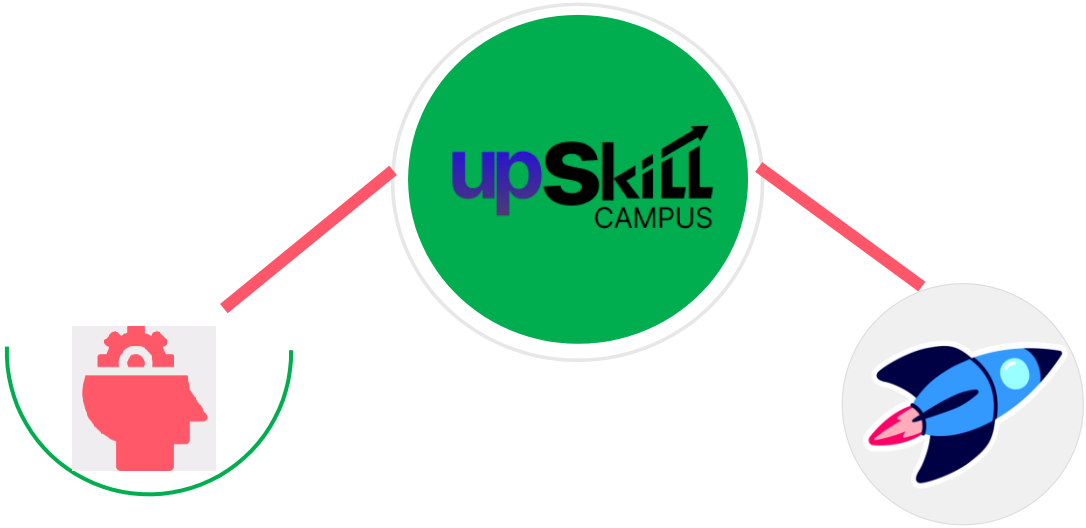
UCT is providing Industrial Machine health monitoring and Predictive maintenance solution leveraging Embedded system, Industrial IoT and Machine Learning Technologies by finding Remaining useful life time of various Machines used in production process.



2.2 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.

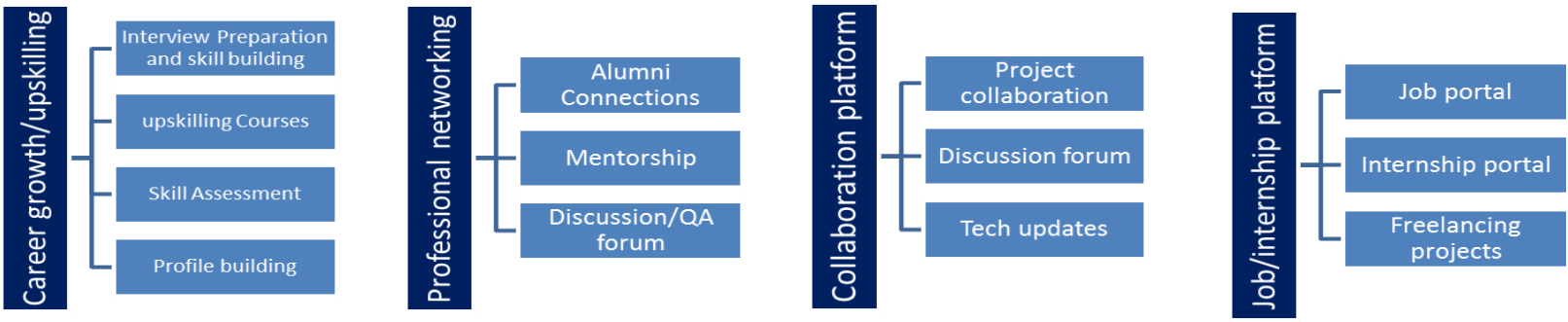
USC is a career development platform that delivers **personalized executive coaching** in a more affordable, scalable and measurable way.



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] Smart City Traffic Patterns Prediction Using Machine Learning by David Opeoluwa Oyewola, Emmanuel Gbenga Dada, and Muhammed Besiru Jibrin

2.6 Glossary

Terms	Acronym
AI	Artificial Intelligence
ML	Machine Learning
RMSE	Root Mean Square Error
API	Application Programming Interface (a set of rules for software interaction)
MIPS	Millions of Instructions Per Second (a measure of processing speed)

3 Problem Statement

We are working with the government to transform various cities into a smart city. The vision is to convert it into a digital and intelligent city to improve the efficiency of services for the citizens. One of the problems faced by the government is traffic. You are a data scientist working to manage the traffic of the city better and to provide input on infrastructure planning for the future.

The government wants to implement a robust traffic system for the city by being prepared for traffic peaks. They want to understand the traffic patterns of the four junctions of the city. Traffic patterns on holidays, as well as on various other occasions during the year, differ from normal working days. This is important to take into account for forecasting future traffic patterns.

4 Existing and Proposed solution

Existing solutions provided by others and their limitations

To address this problem, some scholars have proposed different approaches such as machine learning, computer vision, deep learning, and neural networks techniques. After carefully reviewing some relevant publications, it
was discovered that the existing literature does not provide any work that uses BAG, GLM, BGLM, MARS, and KNN techniques to solve the problem of traffic congestion prediction in smart city. Furthermore, the prediction accuracy of some of the existing work is relatively low while in some cases the authors did not use performance metrics to evaluate the performance of their proposed system. Also, some authors did not compare their work with high performing machine learning or deep learning models.

The proposed solution

Considering these shortcomings, the novelty of this work centres on the use of machine learning for traffic pattern prediction. First of all, an in-depth analysis was conducted on the data presented, which revealed valuable insights into the relation of variables governing the flow of traffic. Based on this, the most important factors were taken into account to build a predictive model to forecast future traffic patterns at the given instances.

Value addition planned

One of the paramount benefits of these solutions is their ability to properly evaluate how traffic changes with changes in time. It is most highlighted in the relation of vehicles and date. This helps in properly forecasting what the trend will be in similar situations over the next few years, which could further lead in reducing traffic and devising new routes to manage traffic more systematically.

4.1 Code submission (GitHub link)

https://github.com/dhruvi-sukhadiya/upskill-campus

4.2 Report submission (GitHub link):

https://github.com/dhruvi-sukhadiya/upskill-campus/blob/main/ForecastingOfSmartCityTrafficPatterns_Dhruvi_USC_UCT.pdf

5 Proposed Design/ Model

Problem Definition: Clearly define the problem and gather requirements.

Data preprocessing: Collect, clean, exploring the data and apply data augmentation to increase the dataset.

Data splitting: Splitting the dataset into columns that bear better analysis & modelling potential than others.

Model Selection: Choose an appropriate model or algorithm, we have used decision tree classifier as it is got the lowest Root Mean Square Error.

Model Training: Train and optimize the model.

Model Evaluation: Evaluate and fine-tune the model.

Predict: Finally predicting the output

6 Performance Test

During analysis and visualization phase, it was identified that the DateTime column was restricting the possibility to perform operations. Hence, it was divided in to date, month, year, hour, weekday and weekend column. These greatly enhanced the ability to draw relations between the mentioned parameters and number of vehicles, which lead to better understand the patterns of traffic.

They even helped boost the testing and predicting accuracy by almost 25% and exceeded the expectations of the model.

6.1 Test Plan/ Test Cases

Testing was conducted on a bunch of machine learning techniques namely: Bagging (BAG), K-Nearest Neighbours (KNN), Multivariate Adaptive Regression Spline (MARS), Bayesian Generalized Linear Model (BGLM), and Generalized Linear Model (GLM) and Decision trees.

An array of values were input for each of their parameters and their prediction accuracy was compared to each other using Root Mean Square Error (RMSE). And the algorithm with the lowest value for RMSE was chosen as the final model for the project.

6.2 Test Procedure

Test Objective: To verify that the system correctly predicts the number of vehicles at any given time.

Test Data: Input the train dataset containing past 2 years of vehicle records.

Procedure: Submit the dataset to the system for analysis and training. Record the system's prediction results.

Expected Outcome: The system should accurately forecast the number of vehicles as per past data.

6.3 Performance Outcome

The machine learning model shows remarkable proficiency when tasked with analyzing the train dataset. In these scenarios, it demonstrates a high level of accuracy and reliability, effectively predicting the value of vehicles in future.

7 My learnings

During this project, I had the opportunity to work on a real-world problem, learn deeply into the world of exploratory data analysis and time series analysis. This involved designing, training, and most importantly testing the project with respect to real world constraints. Contrasting this experience with academic projects, I discovered that working on industry-level projects is a significantly different experience. It entailed identifying and addressing various factors that govern the entities of our world, which was a unique experience. Overall, this project provided an excellent learning opportunity, allowing me to gain practical experience in handling big real-world projects and go through the unique challenges they present.

8 Future work scope

Due to the lack of information given by the dataset, solutions could not be devised to solve the problem of increasing traffic. Problems like routing traffic across junctions were not able to be solved as the mapping of junctions was not present. However, I plan to explore this aspect in the future.

Additionally, I want to highlight that we conducted model accuracy testing through only one or two methods, while there are multiple testing methods that should be explored for a comprehensive evaluation.