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. Our project is about Forecasting smart city traffic patterns which involves leveraging data and advanced technology to predict and manage urban traffic flows efficiently. It encompasses collecting data from diverse sources, such as traffic cameras, sensors, and mobile apps, to continuously monitor current traffic conditions. Analyzing historical data helps identify trends and congestion hotspots, forming the basis for predictive models. Machine learning and artificial intelligence techniques are then employed to process vast datasets and develop models that consider factors like time of day, weather, events, and historical trends. These models empower city planners and traffic management systems to anticipate traffic congestion, optimize transportation routes, and enhance overall urban mobility, ultimately contributing to more sustainable and efficient smart cities. 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.

TABLE OF CONTENTS

1 Preface

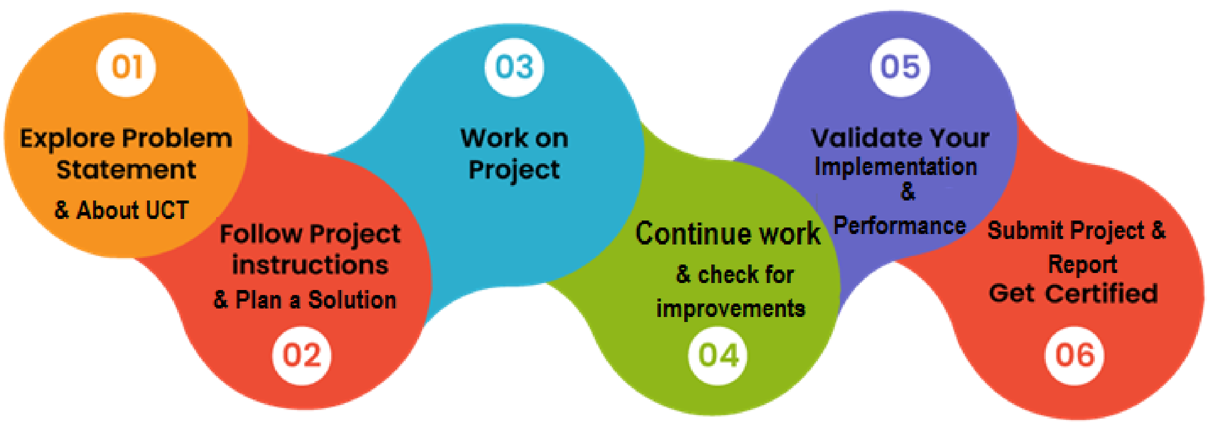
Summary of the whole 6 weeks' work.

About need of relevant Internship in career development.

Brief about Your project/problem statement.

Opportunity given by USC/UCT.

How Program was planned



Your Learnings and overall experience.

Thank to all (with names), who have helped you directly or indirectly.

Your message to your juniors and peers.

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.

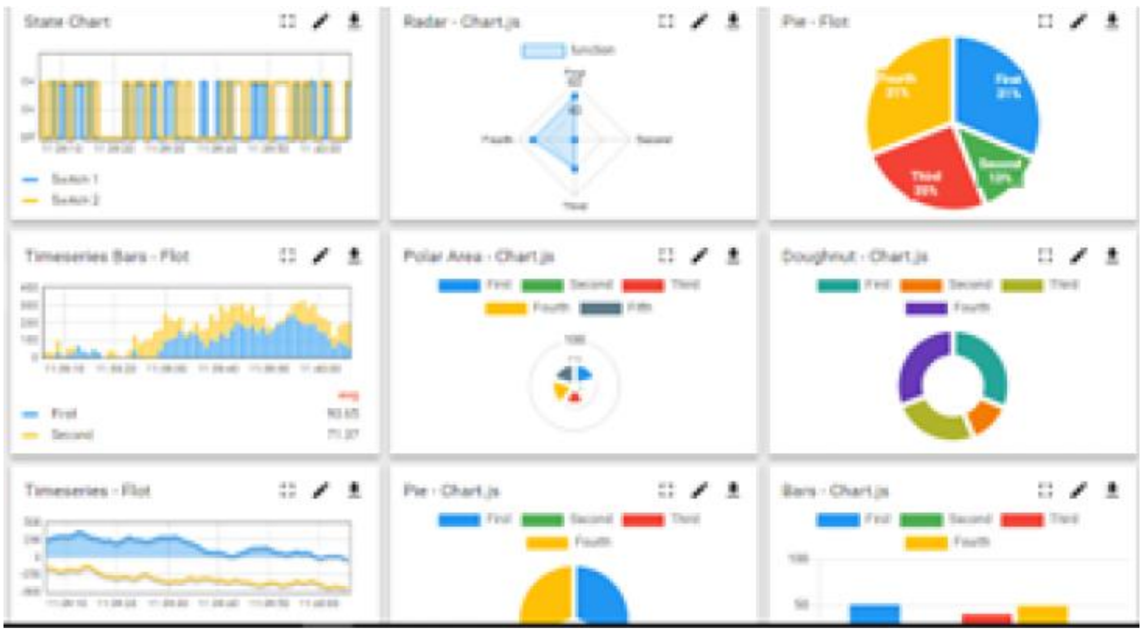
i. UCT IoT Platform (uct Insight)

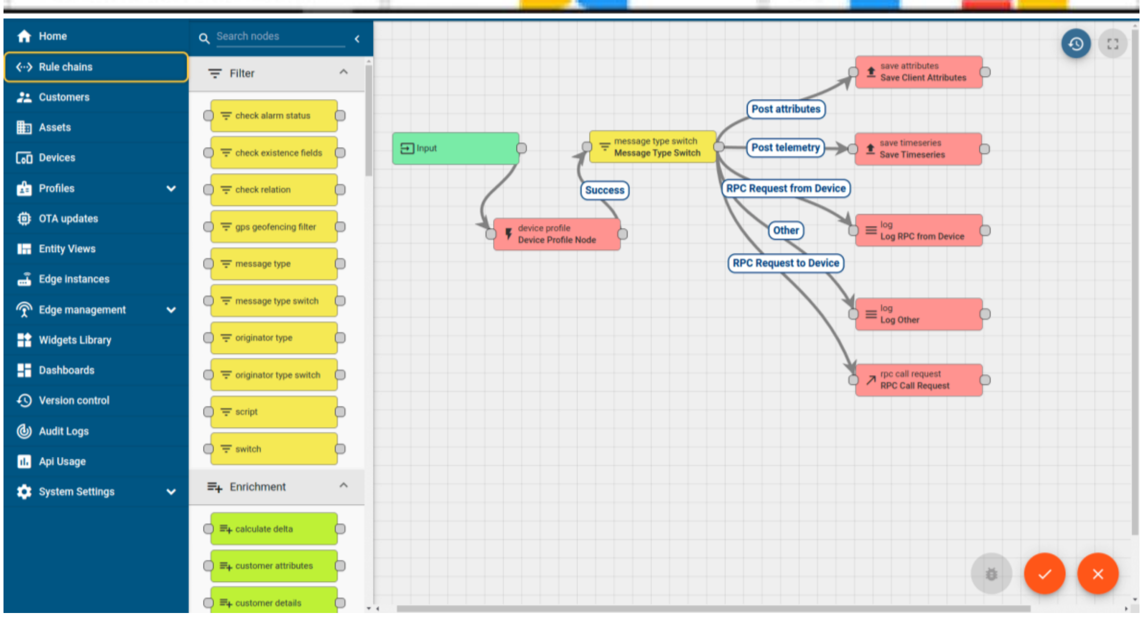
UCT Insight is an IOT platform designed for quick deployment of IOT applications on the same time providing valuable "insight" for your process/business. It has been built in Java for backend and ReactJS for Front end. It has support for MySQL and various NoSql Databases.

- 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.

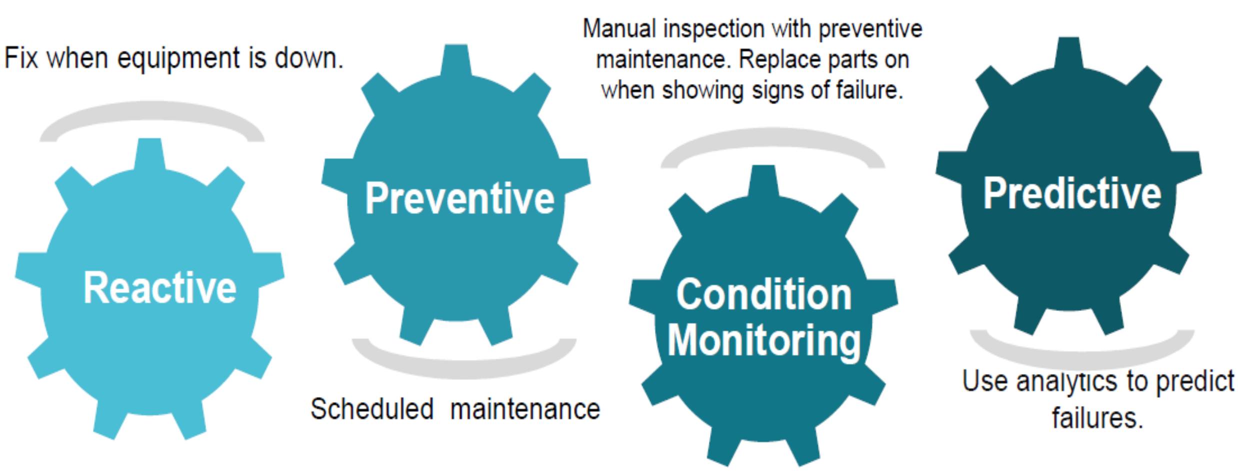
Its unique SaaS model helps users to save time, cost and money.

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

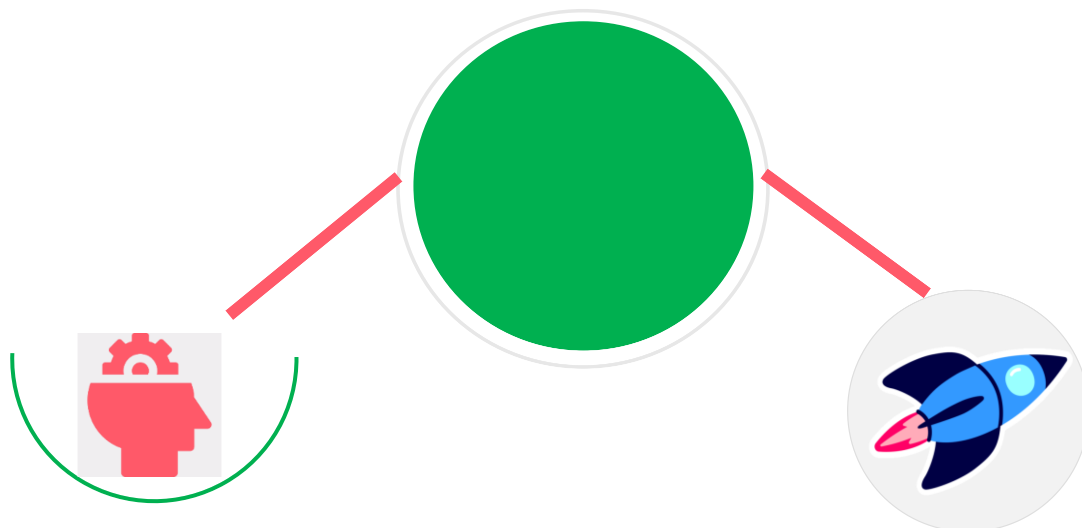
UCT is providing Industrial Machine health monitoring and Predictive maintenance solution leveraging Embedded system, Industrial IoT and Machine Learning Technologies by finding Remaining useful life time of various Machines used in production process.



2.2 About upskill Campus (USC)

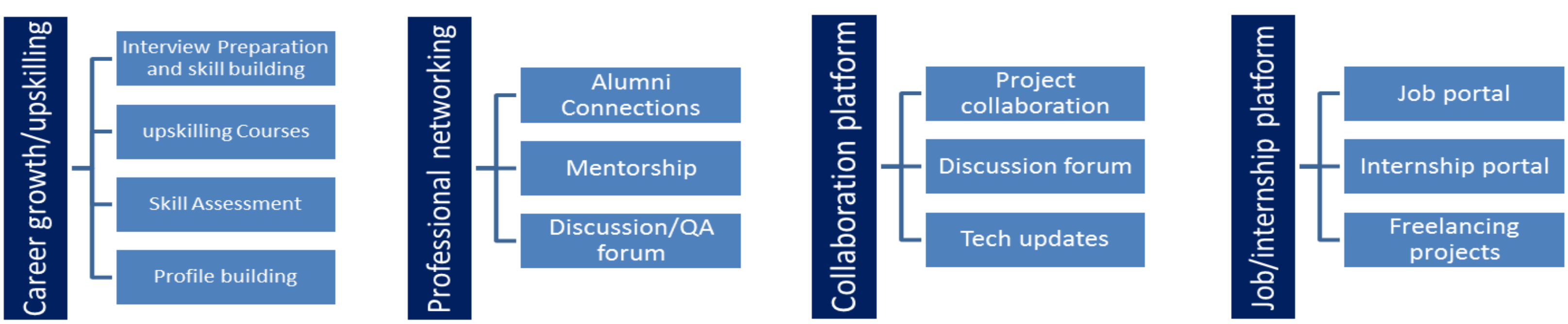
upskill Campus along with The IoT Academy and in association with Uniconverge technologies has facilitated the smooth execution of the complete internship process.

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



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://www.kaggle.com/ (for code reference)

[2] https://github.com/ (for project submission reference)

[3] Introduction To Machine Learning by: Alex Smola and S.V.N. Vishwanathan

2.6 Glossary

Big Data	**Extremely large and complex datasets that cannot be effectively managed with traditional data processing tools.**
Clustering	**A machine learning technique that groups similar data points together based on certain features or characteristics.**
Cross-validation	**A method to assess the performance of a machine learning model by dividing the dataset into subsets for training and testing.**
Hyperparameter	**Parameters in a machine learning algorithm that are not learned from the data but set prior to training.**
Deep Learning	**A subset of machine learning that focuses on artificial neural networks with multiple layers, used for complex tasks like image and speech recognition.**

3 Problem Statement

In the assigned problem statement which states;

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 your forecasting.

The problem of forecasting smart city traffic patterns represents a significant urban challenge in today's rapidly evolving urban landscape. With the continued growth of urban populations and the increasing complexity of transportation networks, efficiently managing and predicting traffic flows is essential. Traffic congestion, delays, and inefficient use of resources have become pervasive issues, leading to economic costs, environmental concerns, and a diminished quality of life for city dwellers. The problem statement revolves around developing accurate and real-time predictive models that can anticipate traffic patterns based on multiple variables, including historical data, weather conditions, special events, and real-time data feeds. Addressing this problem is crucial for optimizing traffic management, reducing congestion, improving urban mobility, and ultimately creating smarter, more sustainable cities for the future.

The forecasting of smart city traffic patterns presents a pressing urban challenge in today's increasingly interconnected world. As urban populations continue to surge, cities face mounting issues related to traffic congestion, inefficient transportation systems, and environmental concerns. The problem at hand centers on the development of advanced forecasting models capable of predicting traffic patterns in smart cities accurately. These models must incorporate an array of variables, including historical traffic data, real-time sensor information, weather conditions, special events, and emerging mobility technologies. Addressing this problem is essential for designing intelligent traffic management systems that can proactively adapt to changing conditions, alleviate congestion, reduce commuting times, and ultimately contribute to the development of more sustainable and livable urban environments.

4 Existing and Proposed solution

Experts propose several solutions to address the forecasting of smart city traffic patterns effectively:

1. Data Integration and Analytics: Experts recommend integrating data from various sources, including traffic cameras, GPS devices, sensors, and mobile apps. Advanced data analytics techniques, such as machine learning and artificial intelligence, can be employed to process and analyze this data, enabling accurate predictions.

2. Real-Time Monitoring: Implementing real-time monitoring systems allows cities to continuously track traffic conditions. This data can then be used to make immediate adjustments to traffic signal timings, road closures, and diversion routes to optimize traffic flow.

3. Predictive Modeling: Developing sophisticated predictive models is crucial. These models should consider a wide range of variables, such as historical traffic patterns, weather forecasts, special events, and even social factors like holidays or school schedules. Machine learning algorithms can adapt and improve these models over time as they receive more data.

4. Smart Traffic Management Systems: Implementing smart traffic management systems that are capable of dynamically adjusting traffic signals, lane configurations, and speed limits in real-time based on predictive models can significantly reduce congestion.

5. Public Transportation Integration: Encouraging the use of public transportation by integrating it with traffic forecasting can help reduce the number of private vehicles on the road, easing congestion.

6. Infrastructure Improvements: Experts often recommend investing in infrastructure improvements like expanding public transportation networks, creating dedicated bike lanes, and developing smart highways to accommodate increasing urban populations.

7. Behavioral Change Initiatives: Encouraging behavior change through public awareness campaigns can also be effective. This may include promoting carpooling, flexible work hours, or the use of ride-sharing services.

8. Policy and Regulation: Smart cities should consider implementing policies and regulations that incentivize sustainable transportation choices, such as offering tax incentives for electric vehicles or imposing congestion pricing during peak hours.

9. Public-Private Partnerships: Collaboration between governments and private sector companies can accelerate the deployment of innovative technologies and data-sharing agreements that enhance traffic forecasting and management.

These proposed solutions underscore the multidimensional nature of addressing traffic congestion in smart cities. Effective traffic forecasting requires a holistic approach that combines advanced technology, data-driven insights, policy measures, and community involvement to create more efficient and sustainable urban transportation systems.

In tackling the challenges of forecasting smart city traffic patterns, we propose a multifaceted approach that leverages cutting-edge technology and community engagement. First, we advocate for the development of user-friendly mobile applications that provide real-time traffic information to commuters. These apps can use crowdsourced data from commuters themselves, helping to supplement official traffic data sources and offer more accurate predictions. Moreover, we propose the creation of interactive maps that display not only current traffic conditions but also anticipated congestion patterns throughout the day. This visual representation can assist commuters in making informed decisions about their routes and travel times.

Additionally, we suggest the utilization of artificial intelligence and machine learning algorithms to analyze traffic data and generate predictive models. These models should be accessible to city planners and the public alike, fostering transparency and collaborative problem-solving. Furthermore, we recommend initiatives to encourage sustainable transportation options, such as promoting bike-sharing programs, electric scooters, and carpooling apps. By incentivizing these alternatives, cities can reduce the number of private vehicles on the road, consequently alleviating congestion.

Moreover, here we try to stress the importance of data privacy and cybersecurity, proposing the implementation of stringent measures to protect the personal information of commuters and the integrity of traffic data. Finally, we emphasize the significance of community involvement and awareness campaigns to encourage responsible and considerate commuting behavior. With these forward-looking solutions, we aim to contribute to the creation of more efficient and sustainable smart city traffic systems, enhancing urban mobility and improving the quality of life for all residents.

4.1 Code submission (Github link)

https://github.com/Tejasweni-Reddy/upskillcampus.git

4.2 Report submission (Github link)

https://github.com/Tejasweni-Reddy/upskillcampus.git

5 Proposed Design/ Model

Given more details about design flow of your solution. This is applicable for all domains. DS/ML Students can cover it after they have their algorithm implementation. There is always a start, intermediate stages and then final outcome.

5.1 High Level Diagram (if applicable)

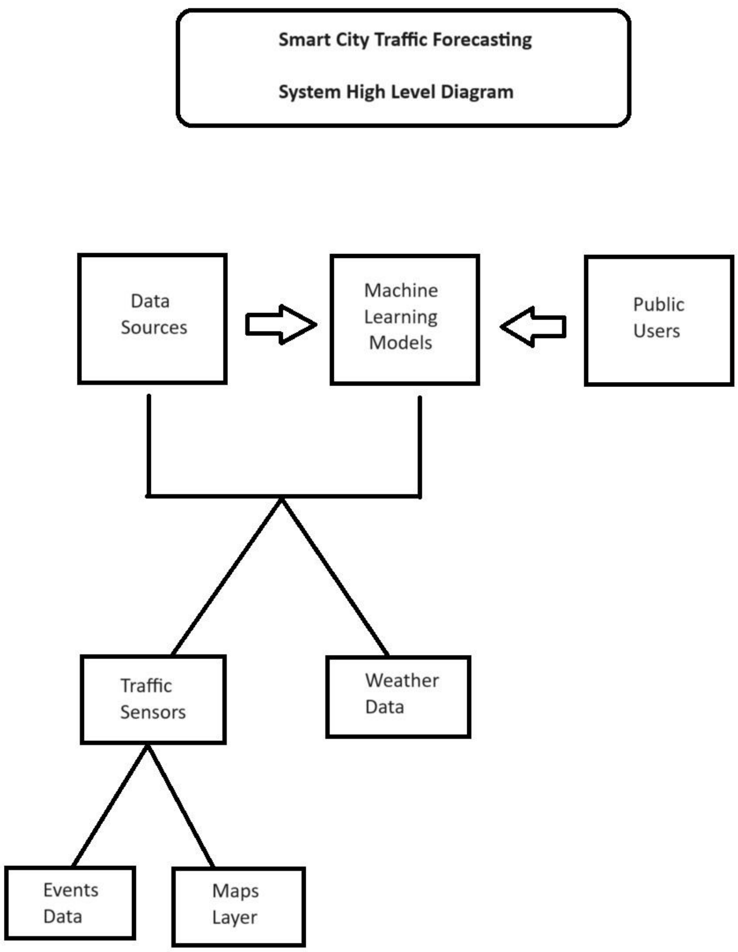


Figure 1: HIGH LEVEL DIAGRAM OF THE SYSTEM

5.2 Low Level Diagram (if applicable)

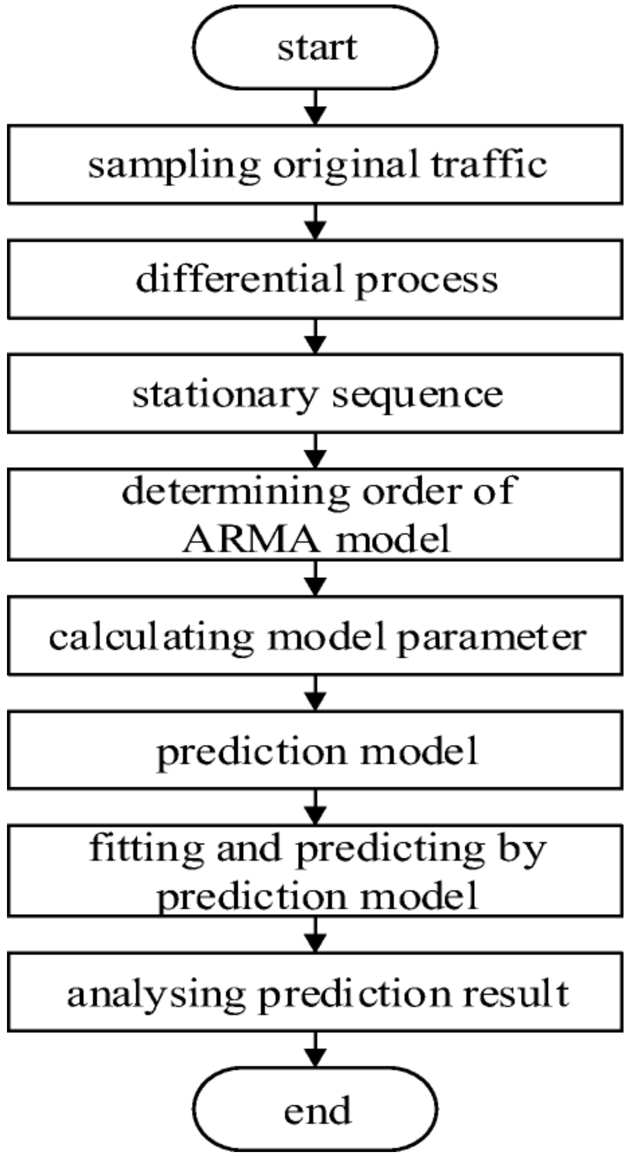


Figure 2. LOW LEVEL DIAGRAM OF THE SYSTEM

6 Performance Test

The command prompt is the local host in this paper to initialize the jupyter notebook.

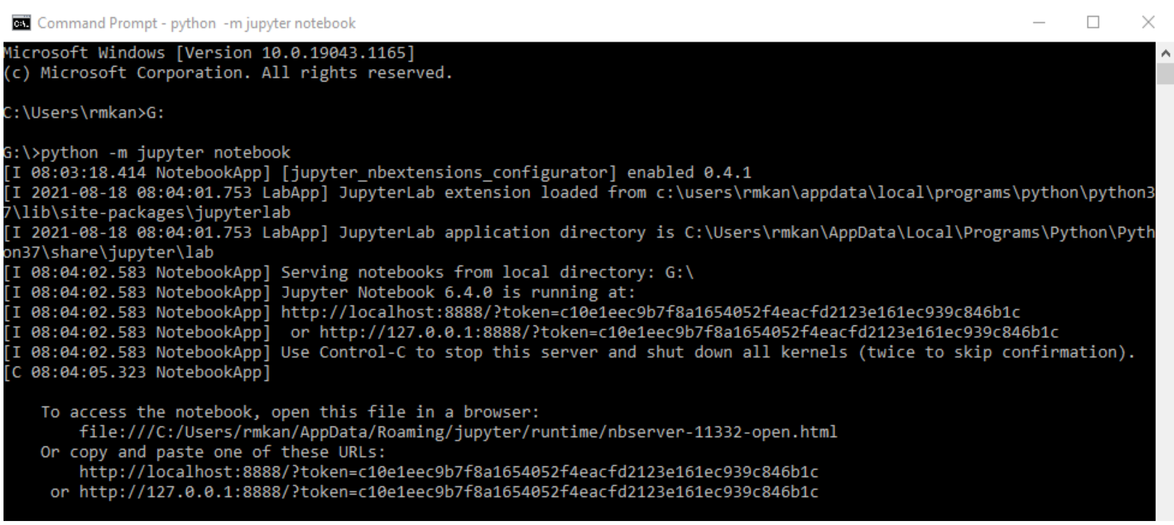


Figure 3. The figure signifies the initializing the jupyter notebook through command prompt

The local host contains the nbextenisons which we modify to our convenience

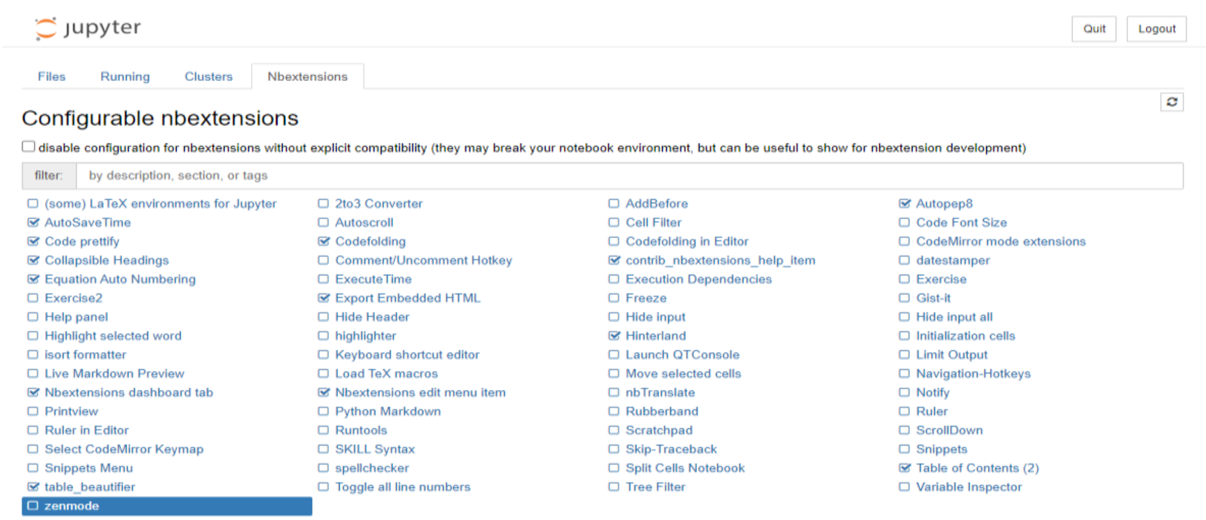


Figure 4. The figure denotes the necessary nbextenisons that is needed for the prediction to take place

6.1 Performance Outcome

The dataset is imported and displayed in the Jupyter Notepad

Out[10]:

	Junction	Vehicles	ID	Date	Time
0	1	15	20151101001	2015-11-01	00:00:00
1	1	13	20151101011	2015-11-01	01:00:00
2	1	10	20151101021	2015-11-01	02:00:00
3	1	7	20151101031	2015-11-01	03:00:00
4	1	9	20151101041	2015-11-01	04:00:00
...	...	...	...	...	...
48115	4	11	20170630194	2017-06-30	19:00:00
48116	4	30	20170630204	2017-06-30	20:00:00
48117	4	16	20170630214	2017-06-30	21:00:00
48118	4	22	20170630224	2017-06-30	22:00:00
48119	4	12	20170630234	2017-06-30	23:00:00

48120 rows × 5 columns

Out[12]:

	Junction	Vehicles	ID	Date	Time	DayOfWeek	Month	Year
0	1	15	20151101001	2015-11-01	00:00:00	6	11	2015
1	1	13	20151101011	2015-11-01	01:00:00	6	11	2015
2	1	10	20151101021	2015-11-01	02:00:00	6	11	2015
3	1	7	20151101031	2015-11-01	03:00:00	6	11	2015
4	1	9	20151101041	2015-11-01	04:00:00	6	11	2015

Figure 5. The above two figures display the dataset through Jupyter Notepad

As an illustration of the high-level nature of Pandas plots, we can split multiple series into subplots with single `plot`:

```
In [9]: variables.cumsum().plot(subplots=True)

Out[9]: array([<Axes: >, <Axes: >, <Axes: >], dtype=object)
```

Figure 6. The dataset is plot using the Pandas library which displays in the graph form.

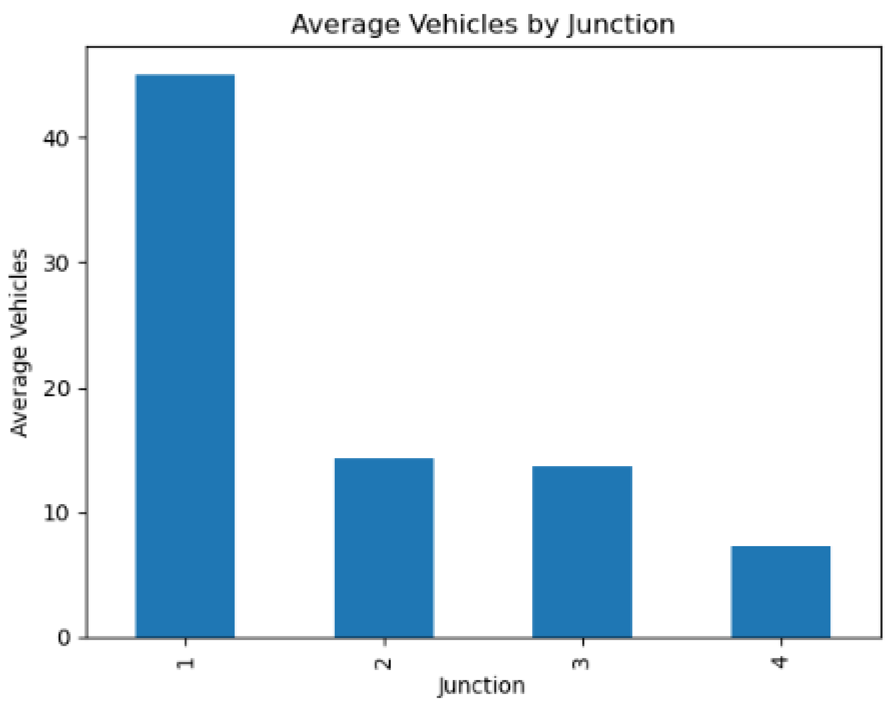


Figure 6. The data in the form of a Bar Graph

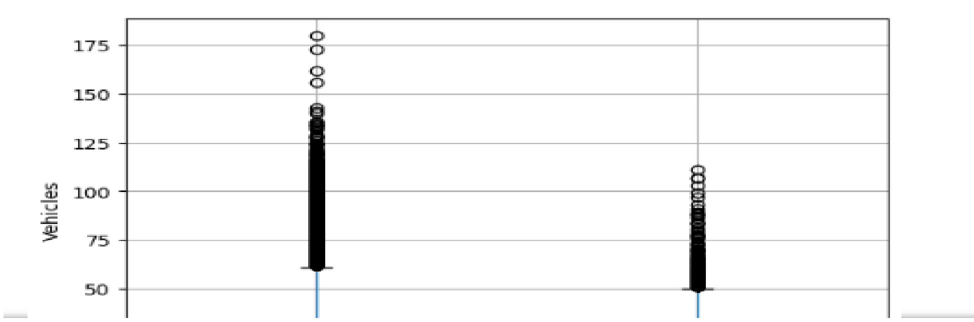


Figure 7. The Boxplot grouped by IsHoliday (Distribution of Vehicle by Holiday)

7 My learnings

My learning about forecasting smart city traffic patterns has equipped me with a valuable skill set that holds great potential for my career growth. Understanding the intricacies of traffic data analysis, predictive modeling, and the application of advanced technologies in smart city planning has not only broadened my knowledge base but also opened doors to various career opportunities. With this expertise, I can contribute significantly to urban planning and transportation management initiatives, aiding in the development of more efficient and sustainable smart cities. This knowledge is not only relevant to roles in urban planning and transportation management but also in data science, AI development, and consulting, where I can provide valuable insights and solutions for traffic-related challenges. Furthermore, it positions me as a valuable asset in the ever-evolving field of smart city development, offering the potential for career advancement and a meaningful impact on improving urban living conditions.

8 Future work scope

In the future, the system are often further improved using more factors that affect traffic management using other methods like deep learning, artificial neural network, and even big data. The users can then use this technique to seek out which route would be easiest to achieve on destination. The system can help in suggesting the users with their choice of search and also it can help to find the simplest choice where traffic isn't in any crowded environment. Many forecasting methods have already been applied in road traffic jam forecasting. While there's more scope to create the congestion prediction more precise, there are more methods that give precise and accurate results from the prediction. Also, during this period, the employment of the increased available traffic data by applying the newly developed forecasting models can improve the prediction accuracy. These days, traffic prediction is extremely necessary for pretty much every a part of the state and also worldwide. So, this method of prediction would be helpful in predicting the traffic before and beforehand. For better congestion prediction, the grade and accuracy are prominent in traffic prediction. within the future, the expectation are going to be the estimation of established order accuracy prediction with much easier and user-friendly methods so people would find the prediction model useful and that they won’t be wasting their time and energy to predict the information. There will be some more accessibility like weather outlook, GPS that's the road and accident-prone areas will be highlighted in order that people wouldn't prefer using the paths which aren't safe and simultaneously they'll predict the traffic. This will be done by deep learning, big data, and artificial neural networks.