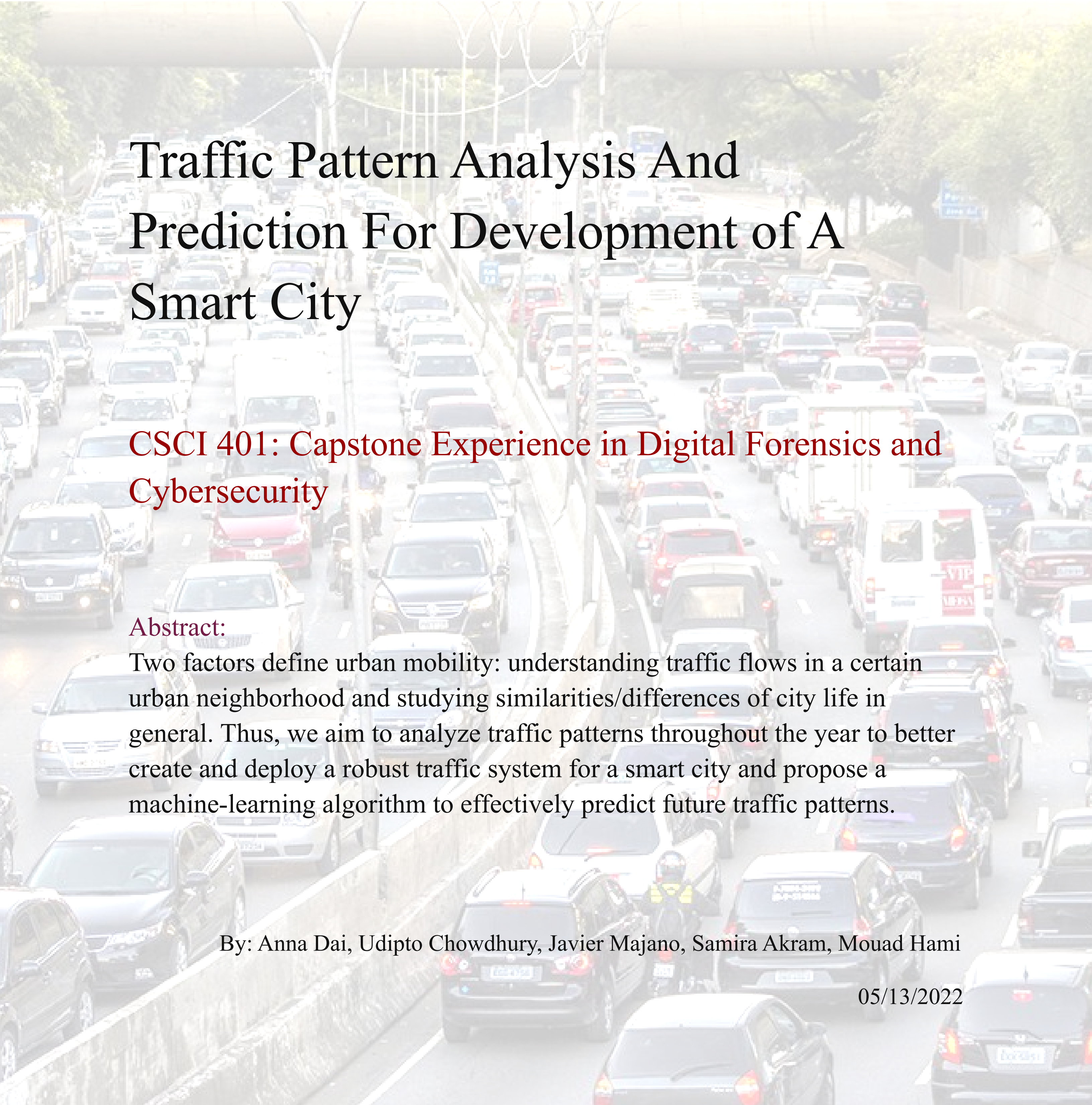


Traffic Pattern Analysis And Prediction For Development of A Smart City

CSCI 401: Capstone Experience in Digital Forensics and Cybersecurity

Abstract:

Two factors define urban mobility: understanding traffic flows in a certain urban neighborhood and studying similarities/differences of city life in general. Thus, we aim to analyze traffic patterns throughout the year to better create and deploy a robust traffic system for a smart city and propose a machine-learning algorithm to effectively predict future traffic patterns.

By: Anna Dai, Udipto Chowdhury, Javier Majano, Samira Akram, Mouad Hami

05/13/2022

Individual Contribution:

Anna Dai: Literature reviews and the development of Python (data manipulation & visualization), implementing the Machine Learning algorithms and creating evaluation metrics to compare performances.

Javier Majano: using literature reviews looked at the City of Seattle[2], finding what's a city[12] valuable resource & appropriate models[13]. Also helped with powerpoints

Mouad Hami: Conducted analysis of data received from data manipulation and visualization in order to understand feasible solutions that can be used in achieving status of smart city

Samira Akram: Literature Reviews on Paper [1] topic - "Smart City Applications: A Survey", Paper [6] on topic - Smart Traffic Analysis using Machine Learning, and Paper [7] on topic - Gap, techniques and evaluation: traffic flow prediction using machine learning and deep learning, identifying what new models and frameworks for forecasting traffic flow have been rapidly developing in recent years to improve traffic flow prediction performance. Many researchers have been generated to provide concepts and criteria by using different methodologies and algorithms.

Udipto Chowdhury: Literature Reviews, Conclusion, Cover Page, and Powerpoint Design (from *Traffic Analysis in a Smart City* to *Design and Implementation of a Smart Trac Signal Control System for Smart City Applications*)

Topic: Traffic Pattern Analysis And Prediction For Development of A Smart City

Abstract:

Since urbanization is showing a rapid growth in regards to city infrastructure as well as establishing better sustainability for economic, social, and environmental assets. It can be deduced that urban mobility is a concept that encourages workers, and architects to further develop a 'smart city' using efficiency. According to the World Bank, urban mobility is a simple concept of "going from one place to another" in any urban area. Two factors define urban mobility: understanding traffic flows in a certain urban neighborhood and studying similarities/differences of city life in general. Thus, we aim to analyze traffic patterns throughout the year to better create and deploy a robust traffic system for a smart city and propose a machine-learning algorithm to effectively predict future traffic patterns.

Objectives:

We aim to analyze traffic patterns throughout the year to better create and deploy a robust traffic system for a smart city and also propose a machine-learning algorithm to effectively predict future traffic patterns.

Literature Review:

Paper [1] discusses how in critical situations, the smart grid keeps the power infrastructure unused. This article gives a survey on the smart cities applications and the data gathered is utilized to track water suppliers, hospitals, transit systems, and other services. Also highlights traffic problems are another one of the most concerns in people's everyday life, especially the tourist places during peak hours. In the paper, researchers provided a computational intelligence approach for the smart city that pedestrian and bike traffic flows should be included in city management systems alongside cars. Many road experts are looking for new and innovative ways to deploy technology solutions to reduce traffic congestion. As a result, the focus is on changing traditional cities into smart cities through the use of electronic technology such as sensor networks and intelligent traffic systems.

Paper [2] discusses how cities that implemented a smart traffic system benefit them. The city of Seattle has built an adaptive transportation management system that allows traffic signals to respond to changes in weather and road conditions. This is an excellent feature because heavy rain or snow may obscure a driver's eyesight and having this technology can result in fewer motor vehicle crashes. Because it faces challenges with the weather, a tool called Rainwatch is used that tracks precipitation in real-time and provides flood alerts to assist keep residents and infrastructure safe. This paper will also discuss how the city-state of Singapore benefits from a smart traffic system. The smart Nation sensor platform (SNSP) gathers data from sensors located around Singapore to analyze pedestrian and traffic flows This also aids in the testing of crowd evacuation scenarios.

Paper [3] discusses how AI situation awareness can be used in smart cities and communities and gives an overview of AI-based technologies used in traffic to enable road vehicle automation and smart traffic control. The paper also discusses various locations that have enabled some form of AI situation awareness and how it has benefited certain cities as well as the challenges and standardization needed to help introduce advanced driver assistance systems and automated vehicle functionality in traffic.

Paper [4] discusses how smart cities are getting worse day by day and highlights the need to optimize control of traffic signals. The paper also proposed two machine learning approaches namely Edge-based Traffic Light Control (ETLC) and Global Traffic Light Control (GTLC) in efforts to enhance the efficiency of traffic in smart cities.

Paper [5] discusses how traffic data not only sends out reports on traffic congestion but ensures that there is efficiency in traffic flow as well as detecting motor accidents and obstacles. This way, not only traffic congestion will decrease but at the same time, people can travel from one place to another efficiently without having to honk a single horn. In addition, the traffic data regarding citywide traffic are essential for architects and construction workers to initiate a plan when it comes to reducing the number of motor-related fatalities but to ensure that a 'smart city' maintains zero tolerance in regard to air pollution and citywide cleanliness (e.g. waste pollution). Hence, that is how 'vision zero' comes to play when it comes to smart city development, and all in all, traffic not only plays an important role in citywide development but also in government funding and the general population.

Paper [6] illustrates how traffic can be both costly and inconvenient. India has the world's second-largest road network. National highways cover 97,991 kilometers of the 5.4 million kilometers of road network. The main source of traffic congestion is an increase in the number of automobiles due to population growth and economic development. Each week, the average city dweller travels for more than ten hours, with one to three hours spent in congested areas. Roads in smart cities will be built with sensors to study traffic flow, and there are a few traffic analysis / prediction systems that use neural networks and other prediction models that are inefficient and inappropriate for many real-world applications. So, in this study, a technique for traffic analysis based on the random forest algorithm is presented, which would examine only a subset of the data, say two-thirds of it, and predict traffic congestion on a certain road while also notifying automobiles planning to travel that way well in advance. As a consequence, dependable traffic flow information assists road users in moving swiftly and securely. The following modules will be included in the TAM Algorithm selected for this project:

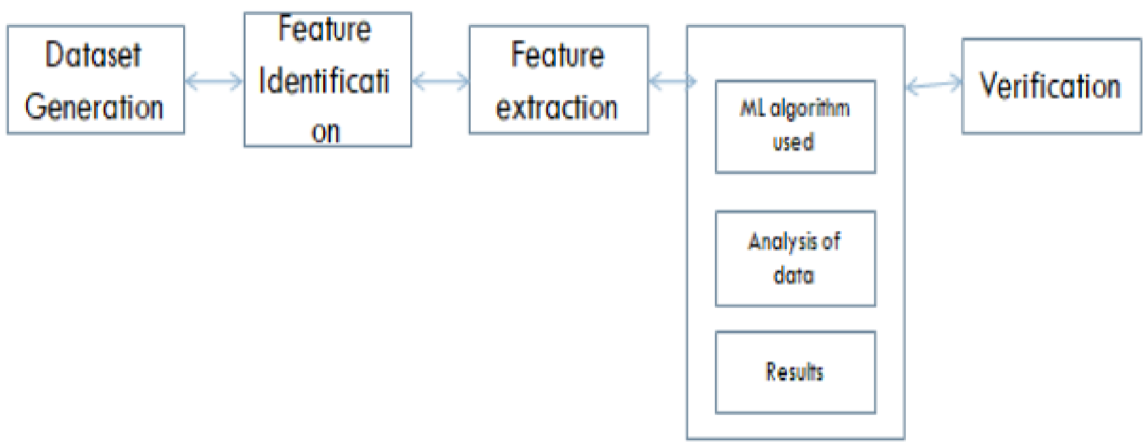


Fig 1: System Design Of TAM Algorithm

The random forest method is used to create a traffic analysis model. The main goal of this project is to evaluate traffic and develop a model that might help reduce traffic in a certain region to some level. In this context, a training model has been developed that can evaluate traffic. The major goal of this project was to not only assess traffic, but also to accurately offer a different route with less traffic to the user who had requested it. As a result, the training model will assist in traffic analysis by creating decision trees and predicting the result more accurately.

Paper [7] demonstrates how the Internet of Things (IoT) has risen to new intellectual solutions for smart cities, allowing people to live a more efficient, convenient, and better lifestyle. The Intelligent Transportation System (ITS) is a component applied to the variety of smart city applications aimed for improving transportation and commuting. The goal of ITS is to tackle traffic problems, especially congestion. With the development of Artificial Intelligence (AI) technologies such as machine learning, new models and frameworks for forecasting traffic flow have been rapidly developing in recent years to improve traffic flow prediction performance (ML). This paper is actually based on the traffic flow prediction model in connected vehicles that leverages machine learning techniques. Many research questions (RQ) have been generated to provide concepts and criteria by using this study. The research questions are as follows:

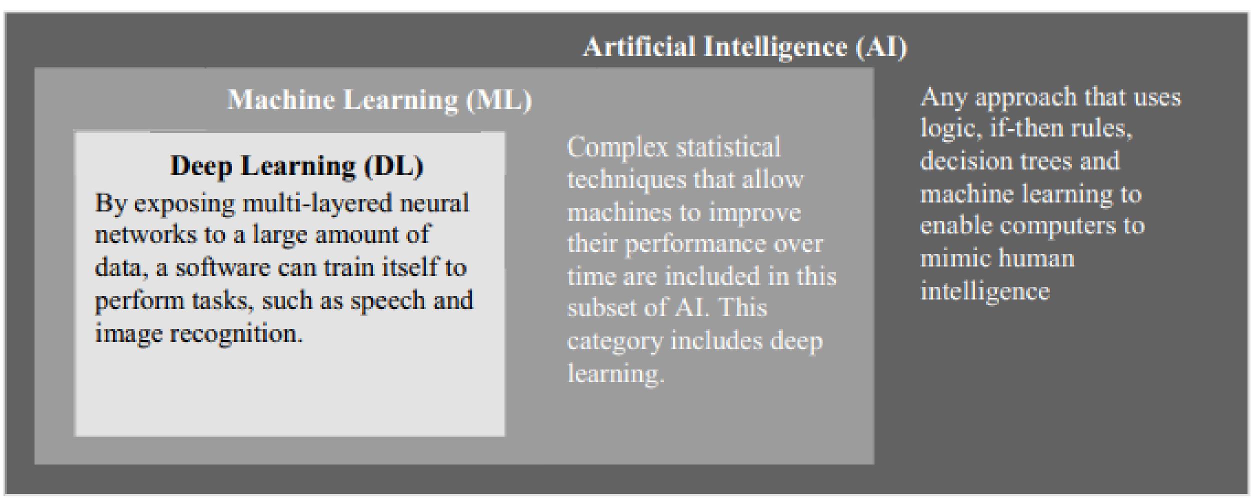


Fig. 2 The relationship between the concept of AI, ML and DL [14]

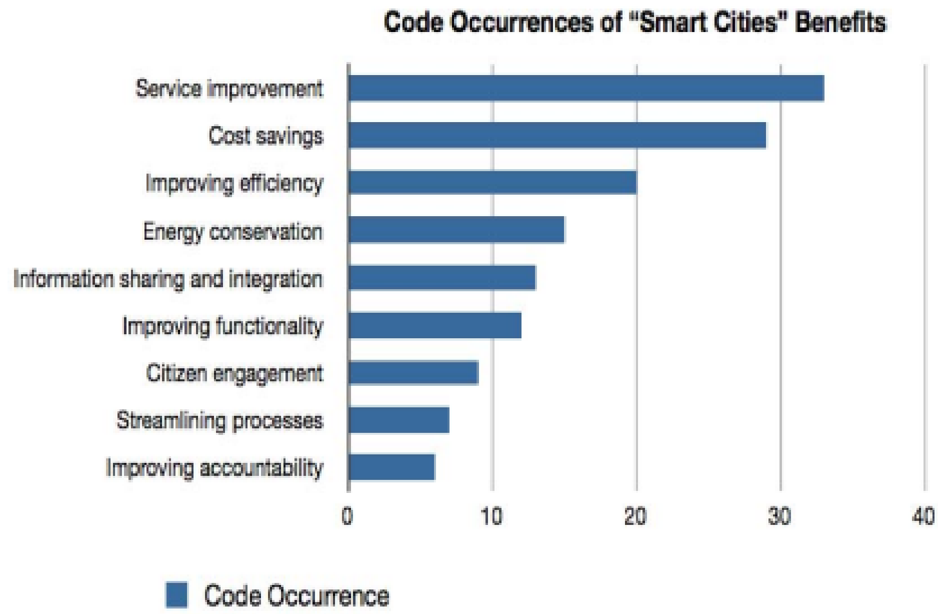
In Computer Vision (CV), ML strategies have been applied in a number of ways to develop congestion prediction models, yielding a variety of outputs and results. Moreover, systematic and coordinated research on the application of ML approaches in CV traffic flow prediction is still lacking in the available literature. The goal of this structured review is to give a thorough and reliable knowledge of traffic flow forecasts utilizing ML approaches for CV, as well as a description of pertinent existing material. Connected IoT environments created as a result of the process of configuring devices to gather traffic data for the ML and DL training may also be a great contribution to cybersecurity risks.

Furthermore, to solve cybersecurity issues for ITS in smart local urban centers, a framework must be built. This will open up a wide range of possibilities for future research, and want to expand on this work in the future to create the IoT Monitoring Framework for Smart City Cybersecurity. The emphasis will be on ITS implementation in small towns and cities. This will help to advance the use of ITS technology in local urban smart cities. The advancement of ITS will result in more organized and effective transportation management in smart cities.

This paper also pictured how it is essential to be aware of all current research to have a better grasp of understanding machine learning implementations which may enhance traffic flow prediction. The major motive of this study is to provide a comprehensive and systematic review of the literature containing 39 papers on four major databases: Scopus, ScienceDirect, SpringerLink, and Taylor & Francis. The extracted data includes the gaps, approaches, assessment procedures, variables, datasets, and conclusions of each content based on the methodology and algorithms used to estimate traffic flow. According to the report, the most often utilized machine learning algorithms for traffic flow prediction are Convolutional Neural Networks and Long-Short Term Memory. Their reliability was examined by comparing their proposed solutions to current baseline models. This study is confined to specific literature on common databases. As a result of this restriction, the conversation is more focused on (and restricted to) the strategies identified in the list of evaluated publications. The goal of this study is to get a complete knowledge of how to use machine learning and deep learning approaches to improve traffic flow prediction, hence advancing ITS in smart cities. In the future, experiments using the most often used algorithms in the publications evaluated in this study like CNN, LSTM, or a mix of both approaches might be done to improve traffic flow prediction.

This paper [8] will discuss how cities that implemented a smart traffic system benefit them. To highlight a few, smart cities have effectively handled difficulties such as crowding, crime, sprawl, traffic congestion, waste, energy overconsumption, pollution, divisions, government red tape, and bureaucratic sloth. Will also look at details in Seattle and see what implementation they have created. This paper will also discuss how the city-state of Singapore benefits from a smart traffic system. The smart Nation sensor platform (SNSP) gathers data from sensors located around Singapore in order to analyze pedestrian and traffic flows. This also aids in the testing of crowd evacuation scenarios. Overall we will go over how smart cities are affecting Seattle, how residents are a valuable resource and find a sustainable model.

We will first look at how the City of Seattle is being changed with its growth as a Smart city. According to S. AlAwadhi and H. J. Scholl, Smart City is defined by Seattle City's officials(IT and business managers) as “ manifests itself via proactive action and service to and interaction internally as well as with citizens, businesses, and other government entities' ' (AlAwadhi p.5). Smart City can offer high-quality ways of interaction with customers. Furthermore, a Smart city is also defined as a “smart grid” in terms of traffic, power, and communication, all of which lead to improved efficiency, mobility, and infrastructure integration. ”(AlAwadhi p. 5). This allows efficiency with infrastructure during power outages or traffic light issues. The Smart Grid initiative focuses primarily on energy conservation, cost savings, and service enhancement; it lays less emphasis on enhancing efficiency, functionality, and information exchange and integration. Going over Ebenezer Okai and Xiaohua's research focused on the benefits and the challenges of smart cities. The author states that the main objective of a smart city is to promote sustainable and inclusive development applications that will address the growing population and the demand for the resources of relatively large and populated cities (Obkai 1). As the population starts to increase cities are continuing to get bigger and are impacting transport, demand for housing water, and education. Smart cities give solutions to the difficulties that rising cities face today and in the future. The United Nations predicts that by 2050, there will be around 6 million people living in cities. This puts enormous pressure on communities to satisfy their inhabitants' present requirements. Overpopulation can occur and there won't be enough resources for everyone inside Seattle. Looking at in-depth details of Seattle, The city has built an adaptive transportation management system that allows traffic signals to respond to changes in weather and road conditions (Obkai 2). This is an excellent feature because heavy rain or snow may obscure a driver's eyesight, and having this technology can result in fewer motor vehicle crashes. Another feature that Seattle has implemented is RainWatch. Seattle is a city that faces a lot of challenges with the weather. A tool called Rainwatch is used that tracks precipitation in real-time and provides flood alerts. Having this tool can help keep residents and infrastructure safe and be alert for floods near them(Obkai 2). Looking below at the chart we see the occurrence of the benefits of smart cities.

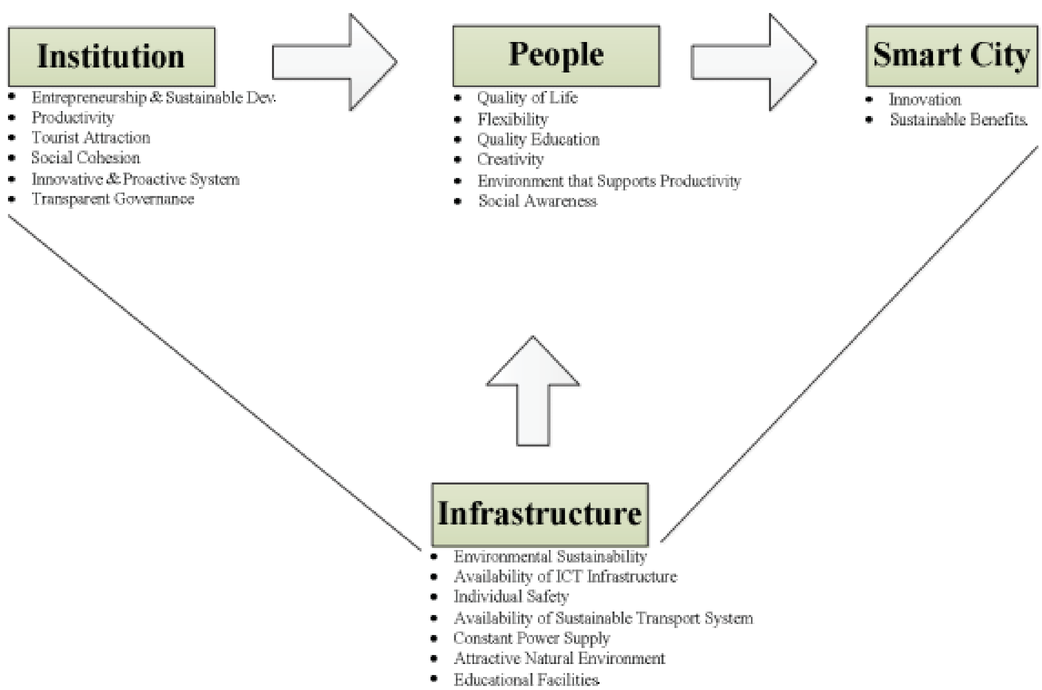


The graph shows the motives in Seattle for a Smart city. The top was Service & Cost Saving.

Looking at the Smart City in Spain, they installed sensors in the street lights and gathered environmental data using smart sensors. Smart garbage cans are only emptied when they are full, and smart parking systems direct vehicles to available spaces, lowering carbon emissions and traffic congestion.

Looking at G. R. Ceballos and V. M. Larios's article, we will take a look at what a city's most valuable resource is, which is its residents. A city must be aware of the requirements and issues that its residents face in the urban environment. Otherwise, communities will resort to unproductive methods of improving infrastructure and defining the best public policies. Quality of life is important and specifies that residents must be at the forefront of change, as the primary beneficiaries of the new urban paradigm. To achieve a good use of technology to better link the city to the citizen, a method to assess the user experience in municipal services as well as their expectations is required. A metric model is required to be constructed in order to improve inhabitants' quality of life. The author proposes a model in order to enhance citizen participation in order to support the SmartCity master plan development. To develop future cities by transforming the Kano model into a poll using the KPIs from Boyd Cohen's Smart Cities Wheel. This Wheel includes Economy, Environment, Living, Mobility, and people. And the Government. The research that was conducted developed a public consultation process that might aid in the development and evaluation of smart city initiatives centered on citizenship. This paper also talks about the complexity of smart cities and every city is different and dependent on its history, geography, economic, and social conditions. The importance of this is because development in smart cities is not the same compared in Seattle, or in Barcelona. Seattle builds towards the weather issue while Barcelona focuses on a different aspect. From looking at its valuable resources we will take a look at what is the appropriate model for a smart city.

Looking at the article "Towards a Refined Conceptual Framework Model for a Smart and Sustainable City Assessment", we will look at finding a model that is sustainable for a smart city. This paper reviews existing Smart City framework models, standards, and benchmarking methods. To reach this goal Existing Smart City framework models were thoroughly examined and analyzed. This was backed by focus-group interviews and a survey performed in Abuja to learn how stakeholders envisioned their Smart City efforts (Agbail pg.1). This also identified the primary metrics for assessing Smartness's impacts on cities and residents. This study fills this knowledge gap by offering a conceptual Smart City KPI framework model that can be easily implemented in Abuja and other cities in other developing nations with comparable histories and experiences. The report proposes a conceptual framework model to examine the impacts of Smart Cities from infrastructural, institutional, and human-centered aspects using FCT Abuja as a case study.



This model shows how institutions, infrastructure, and people are affected by creating a smart city. The innovation of a Smart City can come from. In the chart, people are the drivers of Smart initiatives, the focus of a Smart City. Institutional arrangements and governance are all-encompassing in the sense that they cover all municipal services, as stated in other components, by providing a dependable infrastructure to supply a clean environment, job generation, healthcare, and so on. Cities are constantly evolving into a “market ”destination for different innovations.

Traffic Analysis in a Smart City is another scholarly textbook that focuses on the concept of urbanization and how Urban Mobility is one of the toughest challenges when it comes to understanding the traffic flow. For Chiara Bachechi and Laura Po, traffic flow analysis is the study of interactions between travelers/commuters and general infrastructure. Their goal is to understand how people and transportation are travelling from one destination to another. These are the factors that are detrimental to their objective: detecting traffic congestion problems (what causes those traffic jams?) and optimizing the transport network with more efficient movement of people and vehicles (for citywide traffic to be more efficient). In the end, the two researchers have found the answers to their questions. How? They have used an application named SUMO (Simulation of Urban Mobility) in which the application takes the data from citywide sensors and real-time traffic data in which it gives you the graphs, maps, and traffic data along with video footage. Plus, the generated output includes information about vehicle count, lane density, and average speed for every road lane on the map and every minute of the simulation. Which will help them to answer their questions regarding their objective. All in all, their research was a success.

Speaking of Joseph N. Pelton and Indu B. Singh's scholarly article, *Smart Cities of Today and Tomorrow*. This scholarly textbook not only focuses on the general development of Smart City. But rather than creating a blueprint on how a smart city can be constructed with a thoughtful process based on 'Chapter 5: Using Intelligent Data Analytics for Urban Planning and Design'. Talk about this chapter, the two authors have used Arlington County as an example in which the officials have been measuring Carbon Dioxide (CO_2) in its atmosphere over time to assess energy efficiency. Beyond that, these are the pros when it comes to intelligent casual analysis when it comes to urban planning: It is good at spotting patterns, clusters, and associations which is very crucial when it comes to statistical analysis with line graphs, seismographs, and five-number summary. It also identifies and quantifies the strength of associations which is another advantage, statistics-wise. Because the greater the strength of correlation, the greater the chance that the data presented on a graph will be unbiased. The two authors then explained what predictive analytics is. And it is defined as, the practice of extracting information from past recorded performance datasets. What it means is that relevant historical big data that is available to a city can be used for analytic purposes and these datasets are processed using appropriate algorithms to determine patterns and to assist with more accurate predictions of future outcomes and trends based on past performance. In short, predictive analytics is a tool that can be used to predict future patterns in regard to traffic control and its' congestion based on the data gathered from the past.

And lastly, *Design and Implementation of a Smart Trac Signal Control System for Smart City Applications* is a scholarly article in which research students Wei-Hsun Lee and Chi-Yi Chiu are convincing people that infrastructure supporting vehicular network (V2X) capability is the key factor to the success of smart city because it enables many smart transportation services. In fact, a new track signal scheme is specially designed for the EVSP scenario, it can inform all the drivers near the intersection regarding which direction the emergency vehicle (EV) is approaching, smoothing the track flow, and enhancing the safety. To dig deeper, the two research students created a multi-modal smart traffic control system (STSC) for the infrastructure in the smart city is proposed, which can be widely applied for the intelligent transportation system in smart city applications. In fact, The STSC system designed follows the urban traffic control protocol V3.0 so that it is compatible with a traditional traffic signal controller and can be fast and cost-effectively deployed. All in all, their concept was a success and the two research students made history at the symposium.

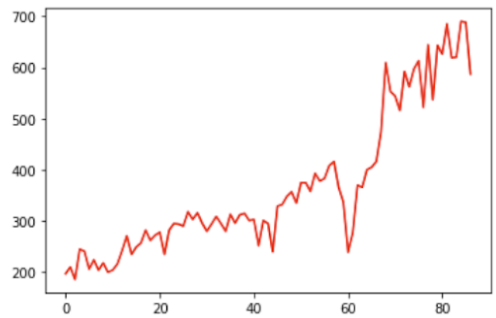
Proposed Technical Solution:

We will conduct in-depth data analysis, visualizations and machine learning algorithms using Python with built-in libraries and packages such as Pandas, Numpy, Matplotlib, Seaborn, Sklearn, etc in the Jupyter Notebook environment for project development.

Analysis:

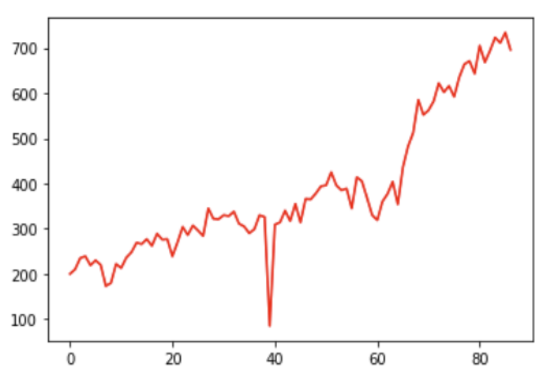
We decided to use a quantitative approach to analyze traffic on different days of the week first and foremost, we used a similar approach to analyze traffic to varying junctions to visualize where traffic can be improved which in turn will help modernize/optimize and improve the overall traffic system. This will be necessary for a smart city to increase urban mobility.

Using python we acquired data from Kaggle on smart cities focusing on urban neighborhoods in particular to visualize the traffic that is created in different junctions across the city. We also decided on looking at the day-by-day traffic data to understand when traffic is at its best and when traffic is at its worst. Looking at traffic in both instances allows us to further pinpoint days in which high rates of traffic occur and how junctions in the city affect the increased traffic. We can see this is the offhand traffic on Monday in our city with the x-axis representing the number of hours from the start of data collection and the y- axis representing the counts of traffic, as we can conclude from this data what is fairly clear is that as the day goes on traffic complaints slowly creep up and then has a fairly large dip around the 60th hour until it arises again in between the 60th and 75th hour.



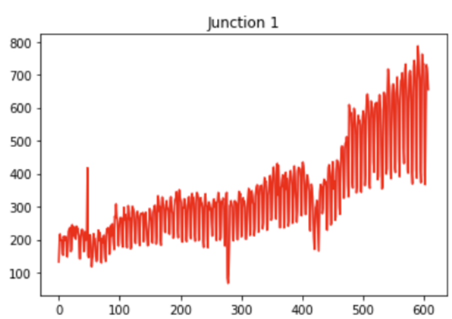
After this time the graph seems to steadily increase until data has stopped being collected. Using this graph helps to visualize when during the day there is a traffic dip on trains and how that correlates with the time of day. For example, one can observe that on any given Monday there will be a dip in traffic which will then be followed by a skyrocket in traffic which will continuously go up regardless of time.

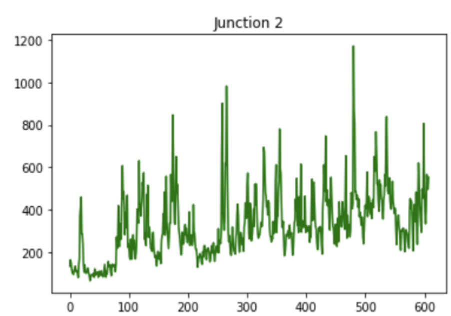
As an example of varying graphs, we have another example of traffic on a Tuesday using the same indications as above only this time there is a change in where the traffic count dips before the 40th hour and then rises back to its original standpoint as soon as the 40th-hour point is passed.



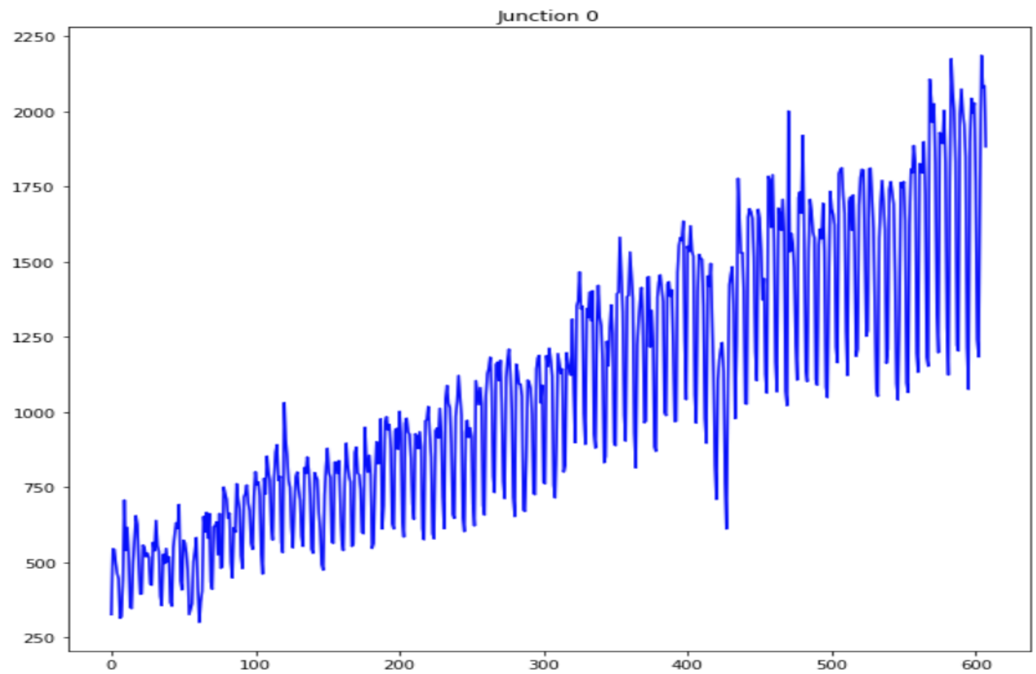
The exponential rise in traffic counts after the 40th is an indicator that on Tuesday an incident occurred that caused the traffic count to increase. Since there is no similar dip on the Monday graph we can assume that this is not something that occurs often and if spikes occur like this there is a limited movement that can be done by a city to relieve congestion that will be caused by such a huge spike like this.

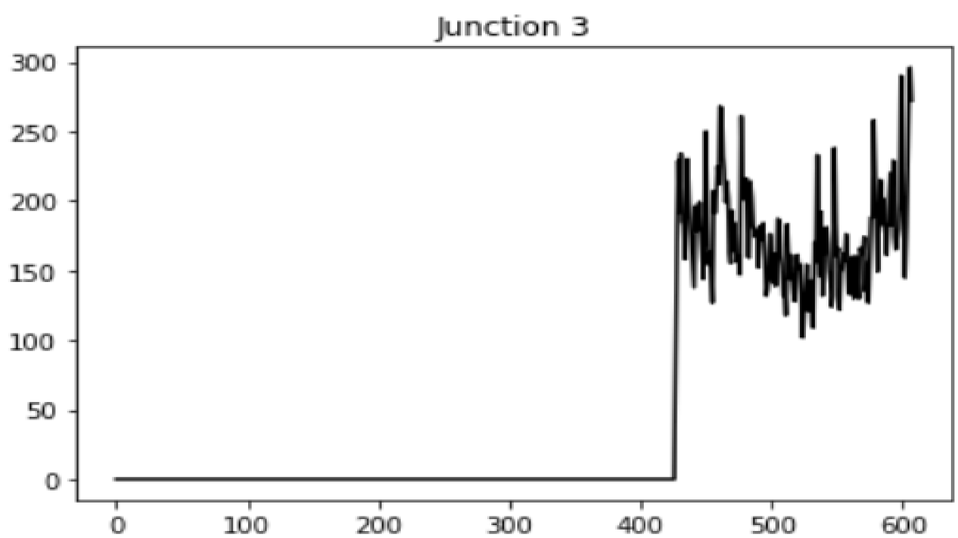
After comparing traffic daily we can deduce that there are days in the week where traffic is at its highest and other days where traffic is at its lowest comparatively. In order to further understand where traffic and where congestion occurs we need to focus on something more the best analysis is to compare based on junctions, using this method allows us to pinpoint which junction has an increased amount of congestion which would, in turn, lead to traffic. We compare 5 junctions in our smart city. Each junction ranges from 0 to 600 on the x-axis where the axis represents hours from start. This was done to set a basis for the data and to make the comparison fair, however, the amount of traffic will differentiate since each junction will not have similar traffic from the beginning 0 mark to the 600 mark.





As an example, we have junction 1 and junction 2, looking at junction 1 we see that at certain times the traffic spikes as well as dips exponentially and usually there is an increased state of oscillation. We do notice that around the 400th hour from start there is a dip that is not as exponential as the one that occurs near the 300th-hour indicator. We also notice that at junction 1 there are more reports of traffic which makes the graph appear more periodic than its counterpart at junction 2. Junction 2 seems to have more dips and more spikes in terms of traffic. Junction 2 also has higher traffic on the y axis compared to the other junctions. We can deduce that this is one of the busy junctions in the smart city and therefore this allows us to come up with certain changes that we can add to this junction to decrease traffic. In regards to the different maximum y-axis, this is quite normal because certain junctions will always have more traffic than the others because of city infrastructure and urban life as well. We have more examples of junctions in which there are varying time of availability but overall they all are similar in terms of max traffic and hour.



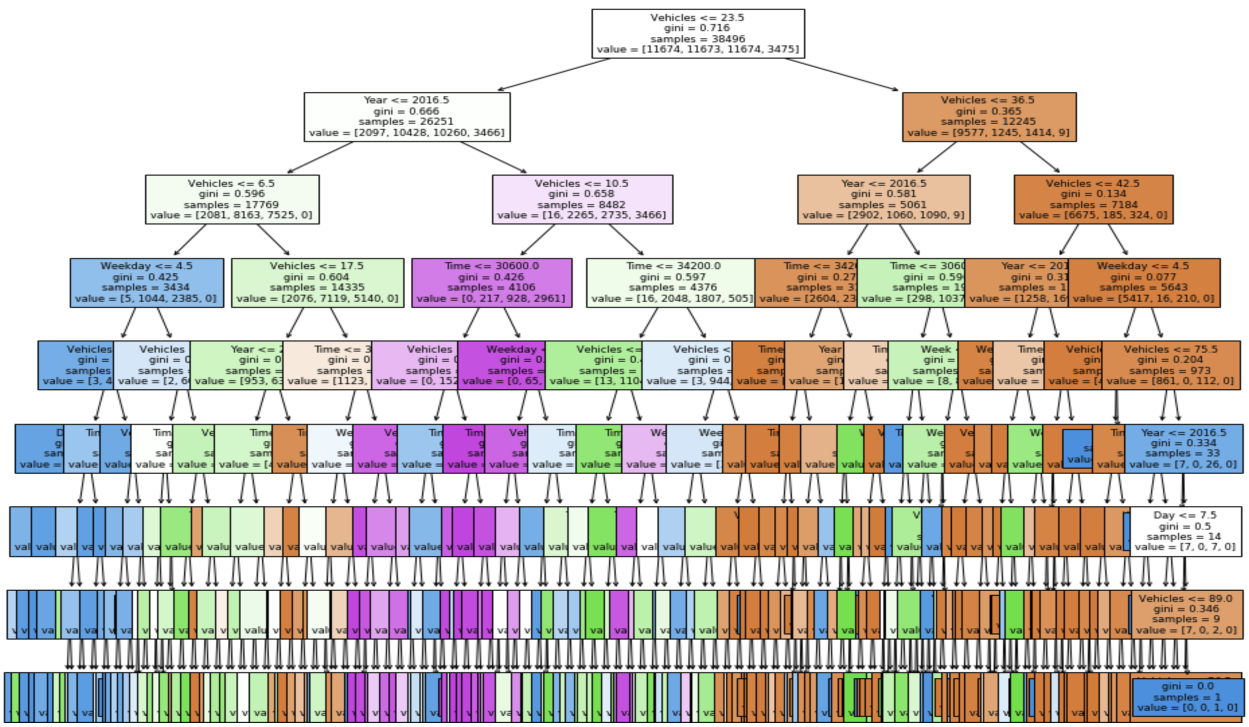


We have a graph of junction 0 and junction 3, in this comparison, we can see what may arise when we view two different junctions that have a different amount of traffic, in junction 0 we can see the max range of traffic on our y-axis is up to 2250 while our comparison in junction 3 the max range of traffic is only 300. We also notice that in our junction 3 traffic is not found at all until after the 400th hour from start. We can use this information and implement new times for junction 3. If we have junction 3 open from the initial start then we can offset some of the traffic that can be found in junction 0 and this will allow for even more urban mobility. We also can look at junction 4 which is after junction 3 and see that it is similar to junction 2. Junction 2 and junction 4 seem to be the busiest junctions in our city from the maximum number of traffic that is being reported and so opening junction 3 at earlier times will allow both junctions to have less congestion and less traffic.

With this in mind, we have begun to find patterns in certain junctions that can be used to help improve the traffic system for our smart city. Overall traffic at all junctions will go down which will, in turn, decrease the amount of congestion at certain locations in our city. A citywide decrease in traffic at all junctions will help promote a more smart city, using machine learning and AI awareness can offhand some of the requirements needed in terms of infrastructure costs that will be related to promoting a smart city.

Machine Learning Models (Performances):

Machine learning is one of the emerging technologies/techniques that has grabbed the attention of academicians and industrialists and is expected to evolve in the near future. Machine learning techniques are anticipated to provide predictive values in the smart city traffic context. In fact, machine learning paves the way for smart city development to support better infrastructures. Machine learning techniques are being utilized in several fields such as health care, finance, and so on. In this paper, we study different classification machine learning mechanisms that are used in the smart city traffic context. We have implemented three machine learning models namely Decision Trees, Random Forest, and Gradient Boosting to predict traffic in the given junctions. We observed that the baseline Decision Tree model achieved around 75% accuracy on the test set but suffers from overfitting issues on the training set. However, by using hyperparameter tuning we were able to reduce the overfitting issue and improve the test accuracy to 78%. We also plotted the tree to visualize each splitting node.



Similarly, we observed that the baseline Random Forest model also achieved approximately 75% test accuracy and around 78% test accuracy with grid search. Lastly, we observed that the Gradient Boosting model performs the best out of the three models with test accuracy being 81%.

Limitations:

We analyzed traffic data for smart cities to identify the underlying patterns and also implemented decision tree and random forest and gradient boosting machine learning algorithms to predict traffic within each junction at a given time, however, there are many other machine learning algorithms that could potentially be viable and effective in predicting traffic for smart cities such as Neural Networks. Also for future works, we aim to not only accurately predict the traffic but also explore different aspects of traffic in smart cities such as car accidents and security issues.

Conclusion:

In conclusion, urban mobility is a concept that encourages workers, and architects to further develop a 'smart city' using efficiency. With all the literature reviews that have been written and published for future generations to learn about smart cities, many architects and citywide workers will gain an understanding of how a smart city works not just on infrastructure but also citywide traffic. By conducting in-depth data analysis, visualizations, and machine learning algorithms using Python with built-in libraries and packages such as Pandas, Numpy, Matplotlib, Seaborn, Sklearn, etc in the Jupyter Notebook environment for project development. We have concluded that a citywide decrease in traffic at all junctions will help promote a more smart city, using machine learning and AI awareness can offhand some of the requirements needed. Additionally, three machine learning models were implemented to predict traffic in the given junctions in which, the Gradient Boosting model performs the best out of the three models with test accuracy being 81% along with Decision Trees and Random Forest both achieving 78% test accuracy. With that in mind, a smart city and specifically a more advanced traffic system will be a key to developing a sustainable city with efficiency and peace of mind.

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