Software Engineering Project

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Introduction

On-demand economy/business model has established itself as a serious competition to traditional business models. Airbnb, Uber and Zomato are examples of such on-demand business models that have revolutionized the way consumer thinks and behaves especially in tier-1 and tier-2 cities across the world [3]. The on-demand economy can be defined as a business, service, or product built on providing ways for users to request a physical object, a piece of data, or service and ways to fulfil that request. It is built on the concept of instant gratification, the psychological feeling consumers get when they can instantaneously make a transaction, and possibly follow the path of it all the way to fulfilment [2]. We have considered on-demand taxi-hailing service for the scope of our project.

Any disturbance to the status quo has direct impact on these on-demand business models. In case of natural calamities like flooding, hurricanes and earthquakes, these business have to quickly adapt to the changing environment to continue serving their customers. Also during violent situations like mob attacks, shooting or terrorist attack, quick response and adaptation is needed to provide secure environment for their users/ customers as well as partners/ vendors. Failing to evolve for these conditions may force these businesses to temporarily suspend their services along with losing customer base and customer goodwill. Currently, Uber had to shut down all its cab services amid the COVID-19 outbreak in many cities across India [4].

We believe that using external inputs such as google crisis alerts, location data information and twitter/news updates, on-demand business can handle disaster conditions in a better way. We have selected corona virus outbreak as an example of crisis situation to demonstrate use of location data to improve cab-aggregation services.

To summarize, we focus on cab-aggregation as a case study for our project and propose novel use of location data to enhance safety for users as well as aid cab-aggregators in maintaining the quality of the service.

Problem Premise

With rising cost of owning a vehicle, increasing fuel and maintenance costs, unavailability of convenient, affordable parking space, along with rising awareness about green energy and climate change, more and more people are opting out of buying a vehicle [6]. We live in a world where tax-hailing services have become an integral part of our daily life. These services have made transportation easier, affordable and efficient. There are many vendors providing on-demand cab services. Uber, Ola along with Meru, Lyft, Skycabs are some of the prominent service providers. With so much of competition, cab-aggregators have to constantly evolve and upgrade their service to provide better quality value-added-services to their users/riders as well as drivers. As a part of this project, we propose a novel value-added-service for on-demand businesses. Specifically, we demonstrate the utility with the focus on cab-aggregation service.

Currently ongoing Coronavirus disease (COVID-19) Pandemic has impacted all cab-aggregators business. The outbreak was first identified in Wuhan, China in December 2019 and was recognised as a pandemic in March 2020 by WHO. As of 25 March, more than 460,000 cases of COVID-19 have been reported in more than 190 countries and territories, resulting in more than 20,800 deaths and more than 113,000 recoveries [1]. As a response to containing the outbreak, many countries have been advising people to cut down on social contact and promoting social distancing. This has resulted in drastic reduction in number of rides forcing all cab-aggregators to suspend their services in most of the world [5, 7].

We believe that using location information for the places where positive cases of corona infection were found, the rides can be planned in such a way that no or minimal contact to the infected location is achieved. Machine learning models trained on virus infection data for locations can be used to assign threat severity for particular location. Forecasting techniques can be used to predict location based threat severity and accordingly provide notifications to the user for her future trips. These are few examples of using location and infection spread data to enable users as well as cab services take informed decisions in times of such an outbreak. This way, the riders, as well as drivers, are assured of the safe trip and cab-aggregators are not forced to shut down their services. We strongly believe that such applications can be beneficial in all disaster situations documented in previous section.

Formally we define the problem statement as follows:

In times of natural or man-made crises such as terror attacks, disease outbreak and earthquakes, ride-hailing services often face a total shut down due to lack of insight about the severity of the threat posed to passengers.

This leaves people in equally important and unavoidable situations such as sudden heart attack or pregnancy without any help and support. We propose to implement Machine Learning enabled cab-aggregation distrubuted system to provide informed decision support in times of crisis.

Solution Approach

We firmly believe that shutting down ride-hailing services is not the best approach. We propose an application which:

- Marks the locations according to the intensity of the crisis (in this case CoronaVirus) and dynamically update the threat level at all the locations.
- Suggests safer zones to travel through two points avoiding severely affected regions.
- Optimizes the pooling system where if a person is starting from a risky zone or location then the pooling partner can choose whether to travel with that person or not.
- Consists of dynamic pricing system for pooling services as well as cab services that factors in the risk factor for the passengers as well as the driver
- Helps users plan a future trip along the safest path according to the forecasted threat levels of the crisis.
- Uses microservice architecture instead of a monolithic architecture for different components for the distributed system.
- Processes requests in parallel along with uniform balancing by a load balancer.
- Uses NOSqL database for eventual consistency and Amazon DynamoDB for the database.
- Also maintains a relational database for each user which can be used to form clusters of users.

Novelty

Idea novelty lies deep in the roots of the problem that we are solving, the fundamental issue of not finding a cab (as a user) and not being able to operate(as an operator). Our solution plans to provide a data-driven, scalable decision chain for the system which eventually will track down the disaster/epidemic or some related inconvenience and re-route/ provide an alternative to the customer which eventually benefits both the stakeholders of the service. Though in the present context the ML supervised system would focus on finding alterables and changing matchmaking of various users classified in different zones of threat level but this could eventually be scaled(using the digital distribution infrastructure map) to bring in various other non-trivial factors into play.

It also uses Machine Learning to dynamically update the intensity of the outbreak according to the incoming data and clustering the points where cases of the disease are found. We are also adding the feature where a person can link his future travel plans and use data points forecasting to decide the intensity of the outbreak for the future and thus he can get the safest route to travel and plan accordingly. Fundamentally, the novelty of the project resides in the functionality that it provides to an industry that is worst stricken by natural/man-made calamities and helps pave ways for better supply chain management.

Constraints

Here is a comprehensive list of constraints that are required to be pro-quo in the functioning of the app/web app.

Functional Constraints:

- The app built in the project will not provide real-time access to disaster situations but uses a pre-trained model that alters the linear decision -making algorithm to make feasible changes to the rider's path.
- Network stability is not a factor considered during the project. Offline mode is not offered.
- The decision-making model runs on pre-existing data with an acceptable accuracy but does not ensure similar accuracy across all the locations.
- The design of the system is such that it can be horizontally scaled but will be tested under constrained conditions only which will be further discussed in the test plan sheet.
- Performance issues and constraints are not a part of this document and will be discussed later in the detailed review.

Resource Constraints:

- A primary resource constraint as discussed above in the functional part is the resource estimation/allocation for the nth user, which can be only discussed in the design document but has been listed here under resource constraint.
- An adequate amount of data for a standardized model accuracy is a challenge and some parts of data will be altered as per need of the hour.
- Stress testing could become a resource constraint.

Quality Constraints:

- In agile SDLC, the quality constraint is one of the most talked-about problems but our team will ensure a production-ready code with code quality reports in order to keep a check on any areas where quality standards are not met.
- Baseline comparison and standard quality testing measures will be applied to the decision-making model as well to ensure no compromises.

References

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