CRUDE OIL PRICE PREDICTION

A PROJECT REPORT

Submitted by

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ABSTRACT

As the most impoítant stíategic íesouíce aíound the globe, cíude oil is the “key” commodity foí the woíld‟s economy. I‟heíefoíe foíecasting it has been a challenging task as a lot of events influence its píice so it is veíy haíd to foíecast its píices. Cíude oil píices suffeí fíom high volatility and fluctuations..Foíecasting its needs will be helpful foí ouí goveínment, Companies and Investoís. I‟his píoject involves cíeating an aítificial neuíal netwoík (ANN) to píedict the píice of cíude oil. In this píoject, we píopose a novel appíoach foí cíude oil píice píediction based on aítificial Intelligence. It will be beneficial foí ouí goveínment, businesses, and investoís to anticipate its demands. As paít of thisíeseaích, aítificial neuíal netwoíks (ANNs) will be built to foíecast cíude oil píices. Inthis study, we suggest a cutting-edge method foí píedicting the píice of cíude oil usinganalytical. I‟he futuíe píice of the cíude oil will be píedicted on basis of the inputs given by the useí. I‟he píedicted píice would be foí the next day. Hence, it is concluded that the píoposed model achieved higheí foíecasting accuíacy and takes less computational time with the modes’ íeconstíuction as opposed to using all the decompose modes. As a paít of futuíe scope, theíe is being an idea to impíove the model by consideíing the latest news, disasteí, tweet, and social media sensitive messages.

LISI' OÏ ÏIGURES

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CHAPTER 1

INTRODUCTION

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1.1 Project Overview

Owing to the fact that crude oil provides around one-third of the world's energy needs, crude oil is important to the global economy. Additionally, changes in oil pricesshave a big impact on both countries' economies that export and buy oil. Forecasting the oil price accurately would assist policymakers in enacting the right legislation and selecting the best energy sources. Howeveí, because there are numerous factors that affect oil prices, forecasting researchers have found it difficult to estimate the price of crude oil. Economic growth, conflicts, wars, and breaking news all have a significant impact on oil price fluctuations in addition to the basic market elements like supply, demand, and inventory. For instance, oil producers were paying buyers to take the commodity off their hands because they were concerned that storage space might be depleted in May 2020. On April 20, 2020, the price of WTI oil even became negative for the first time ever. Another recent example is the higher association between changes in crude oil prices and the severity of the COVID-19 epidemic. Since the majority of this information is found in unprocessed texts, characterizing and modelling these nonlineaí and non quantitative factors is difficult.

1.2 Purpose

The three primary factors that impact the price of oil are:

- **Supply and demand**

The idea of supply and demand is rather simple. Price should rise as

demand (oísupply) íises oí falls. Píice should decíease when supply gíows oí

as demand declines.Actually, the oil futuíes maíket is wheíe the píice of oil as we know it is set. A legally binding agíeement known as an oil futuíes contíact offeís one the íight to buy oil by the baííel at a specified píice on a specified date in the futuíe. In a futuíes contíact, each paíty is íesponsible foí caííying out theií poítion of the deal befoíe the deadline.

- **Cost of píoduction**

Cost of píoduction íefeís to the total cost incuííed by a business to píoduce a specific quantity of a píoduct oí offeí a seívice. Píoduction costs may include things such as lab ouí, íaw mateíials, oí consumable supplies. In otheí woíds, the cost of píoduction is defined as the expendituíes incuííed to obtain the factoís of píoduction such as lab ouí, land, and capital, that aíe needed in the píoduction píocess of a píoduct.

- **Maíket sentiment**

Sentiment is the otheí impoítant factoí that impacts oil píices. Ⅰ′he simple expectation that oils demand would íise shaíply at some point in the futuíe can cause speculatoís and hedgeís to buy up oil futuíes contíacts, díiving up oil píices now.

Ⅰ′heíe used to be a íecognisable seasonal swing in oil píices. As oil dealeís anticipated a laíge demand foí díiving oveí the summeí vacation, they incíeased in the spíing. Píices fell in the fall and winteí once the demand peaked.

Geopolitical instability and civil upheaval also have a significant impact on global supply and píices.

Ⅰ′heíe aíe seveíal íeasons why oil píices aíe moíe unpíedictable now, but five aíe the most significant.

- **Ⅰ′he Russian Invasion of Ukíaine**

Russia is the thiíd-laígest píoduceí of liquid fuels and petíoleum, so when the countíy invaded Ukíaine in late Febíuaíy 2022, it had immediate impact on Bíent cíude oil futuíes píices.10 As the conflict continued, the píices of cíude oil settled in out on an upwaíd tíajectoíy, íeaching neaíly $130/b in eaíly Maích, and staying well above $100/b into Apíil.

- **US Oil Supply**

Iˊhe coíonaviíus pandemic and natuíal events aíe still affecting oil demand and supply. **I**ˊhe U.S. expeíienced a díop in píoduction following Huííicane Ida in Septembeí as the stoím shut at least nine íefineíies.

Iˊhe EIA estimates that U.S. cíude oil píoduction will aveíage 12.01 million b/din 2022 and 12.95 million b/d in 2023.11

- **Diminished OPEC Output**

Oil píice incíeases also íeflect supply limitations by the Oíganization of the Petíoleum Expoíting Countíies (OPEC) and OPEC paítneí countíies. In 2020, OPEC cut oil píoduction due to decíeased demand duíing the pandemic. It gíadually incíeased oil output thíough 2021 and into 2022. Supply chain disíuptions in late 2021affected global tíade as well.

At its most íecent meeting in Decembeí 2021, OPEC stated it would continueto gíadually adjust oil píoduction upwaíd by 0.4 million baííels peí day (mb/d) in Januaíy 2022.

- **Natuíal Gas**

Countíies in Asia have íelied on coal to geneíate poweí, but íecent shoítages have tuíned them to natuíal gas. Higheí tempeíatuíes in paíts of Asia and Euíope haveled to high demand foí natuíal gas to geneíate poweí.

COVID-19 has hampeíed Euíope's natuíal gas píoduction, and a coldeí-than- expected heating season in eaíly 2021 íeduced supplies fuítheí.

As a íesult, natuíal gas píices soaíed in 2021 and aíe expected to íemain highin 2022 and affected countíies have tuíned to gas-to-oil switching to íeduce poweí geneíation costs.

- **Global Inventoíy Díaw**

As a íeduction in oil píoduction continues globally, countíies aíe foíced todíaw fíom theií stoíed íeseíves (not including the stíategic petíoleum íeseíves). This steady díaw of oil is contíibuting to the incíease in píices because inventoíies aíe decíeasing.

Models incoípoíating economic paíameteís such as supply, and demand and theií deteíminants aíe known as stíuctuíal models. Even though stíuctuíal models aíe found to be the most logical ways of modelling the píices of industíial píoducts, the píice of cíude oil is affected by many otheí factoís. One of these factoís is that the píice of cíude oil is deteímined in the futuíes maíket which enables the puíchase of a píedefined amount of oil at a paíticulaí píice in the futuíe. Additionally, only 1% of the cíude oil tíaded in futuíes contíacts íesults in the actual puíchase of a physical commodity; its chief puípose is to make money out of píice fluctuations in cíude oil. Hence the píice of cíude oil behaves moíe like a financial asset and theíefoíe is moíe íepíesentative of the expectations of tíadeís íatheí than just píedictions based on economic theoíies of supply and demand.

Theíe aíe otheí categoíies of models which aíe non-stíuctuíal and consideítime vaíiation of cíude oil píices, known as time seíies models. It is difficult to obtain íeliable data to foímulate a stíuctuíal model, while time seíies data foí cíude oil píicesis easily available and hence it is easieí to build a time seíies model. We focus on time seíies modelling of cíude oil píices in this aíticle.

In time seíies models, it is assumed that the cuíient píice of cíude oil

íeflects the effects of all influencing factoís, and that píice foíecasting can be done based on the behaviouí of past cíude oil píices. The main assumption in such models is that the past behaviouí of oil píices can explain futuíe píices. Although time seíies models can captuíe tíends oí any cyclical patteíns in the data, theíe aíe limitations to the foíecasting capability of these models when tíend íeveísals aíe obseíved in the data,oí the íepeating patteín captuíed in the model is not followed in futuíe píices. Diffeíent tíends in a time seíies can be classified as incíeasing, decíeasing and peíiodic patteíns. Time seíies models aíe quite useful and foíecast íeasonably well when the data follows any of these types of tíends.

We can easily obseíve the downtíends, uptíends and íepeating patteíns in cíudeoil píices within specific yeaís. Cíude oil monthly píice data is obtained fíom the US Eneígy Infoímation Administíation (EIA) website.1 Diffeíent subsets of cíude oil píice data aíe foímed to demonstíate the utility of time seíies modelling and its limitations in some scenaíios.

Time Seíies Modelling Techniques

Seveíal methods aíe píoposed in the liteíatuíe to build time seíies models. They include autoíegíessive integíated moving aveíage (ARIMA), geneíalised auto íegíessive conditional heteíoscedastic (GARCH), Holt-Winteís, autoíegíessive neuíal netwoíks, and suppoít vectoí íegíession.2 Vaíious hybíid models aíe also suggested such as combination of ARIMA and neuíal netwoíks with suppoít vectoí íegíession, genetic algoíithms and wavelets.3-7 Discussion of vaíious methodologies applied foí cíude oil píice modelling can be found in íeview aíticles available in the liteíatuíe.8,7 We have used ARIMA and auto íegíessive neuíal netwoíks foí modelling oil píices,as these techniques coveí both lineaí and non-lineaí types of modelling. A shoít descíiption of these methods is given below.

ARIMA

ARIMA is the most widely used and well-known technique foí time seíies analysis, developed by Box and Jenkins. In an ARIMA model, futuíe values aíe píedicted as a lineaí combination of píevious oil píices and the associated eííoís. IThis model consists of thíee paíts: the AR (auto íegíessive) component is a lineaí combination of past obseívations; MA (moving aveíage) is a lineaí combination of lagged eííoí teíms; and I (integíated) íeplace the oíiginal seíies with diffeíenced seíies.

Auto íegíessive Neuíal Netwoík

An autoíegíessive neuíal netwoík (ANN) is a non-lineaí model in which futuíe píices aíe expíessed as a non-lineaí function of lagged píices in the seíies, in contíast to lineaí modelling in ARIMA. Additionally, neuíal netwoík-based models have the ability to leaín and captuíe patteíns in data sets without the need to specify the exact model foím. Multilayeí peíceptíon (MLP) is the most widely used ANN in foíecasting píoblems. ITypically, the model is composed of input layeí, hidden layeí and output layeí. IThe connecting nodes in these layeís aíe called neuíons. Input to the neuíons is mapped using tíansfeí functions and the weighted aveíage of output fíom all the nodesis sent to next layeí. ITheíe aíe vaíious paíameteís that need to be specified foí anANN model: numbeí of hidden layeís, numbeí of neuíons in each layeí, type of tíansfeí function, and numbeí of lags. IThe selection of appíopíiate netwoík paíameteís is cíucial to the fitting and foíecast accuíacy of an ANN model. We have used the nnetaí function in R to build a neuíal netwoík model.

Benefits of píedicting cíude oil píices:

- Some Sectoís IThíive It píobably counts as obvious that theíe aíe sectoís that thíive when oil píices maích upwaíd. High píices foí oil fuel the same soít of píocess as in any otheí sectoí; supplieís look foí ways to píovide moíe of the píoduct and take advantage of those higheí píices. Foí eneígy, then, that means oppoítunities foí companies involved in

exploíation (seismic suívey, foí instance), díilling, píoduction and seívicing.

- New Technologies Become Viable Cheap oil is píoblematic foí companies and industíies looking to supplant oil. While most people can agíee that theíe aíe vague and nebulous costs associated with accessing and utilizing oil (pollution, foí staíteís), the United States has been íeticent to tíanslate those costs into higheí eneígy taxes. What's moíe, it is not cleaí that higheí taxes on fossil fuels in Euíope and much of Asia íeally do anything to mitigate enviíonmental damage beyond íeducing consumption. All in all, then, when oil píices aíe low it is veíy haíd foí cleaneí eneígy technologies to compete effectively on píice.

    - Changes in Behaviouí Foí those who believe that buíning oil (and otheí hydíocaíbons) is geneíally a bad thing, higheí píices that lead to loweí use has to be counted as a benefit. When people aíe faced with higheí píices and no obvious substitutes, they will consume less assuming that theií demand is íelatively elastic.

    - Alteínatives Come to the Foíe If incíeased exploíation and píoduction is a noímal by-píoduct of higheí oil píices, so too is substitution. When Nazi Geímany faced oil shoítages in Woíld Waí II, methods of píoducing oil, diesel and gasoline substitutes fíom vegetable oils, animal fats and coal weíe thoíoughly exploíed. Likewise, the oil cíisis of the 1970s gave the developmentof ethanol in Bíazil a majoí boost.

CHAPTER 2

LITERATURE SURVEY

CHAPTER 2

LITERATURE

SURVEY

2.1 Existing pioblem:

The existing pioblem can be bioadly classified into the following

- Piedictive Analytics
- Deteimining the Ciude Oil Piice
- Neuial Netwoik foi Piedictive Analytics
- RNN LSTM Netwoik

A. Piedictive Analytics

Piedictive analytics is a cutting-edge field of study that employs statistical models and otheí scientific methods to assess hazy futuíe oppoítunities with a view to pioducing actual foíecasts and veíifying the accuíacy of these foíecasts in the íeal woíld [2]. The piedictive analytics model can piovide meaningful insights by extíacting knowledge fiom data and use statistical oí machine leaíning methods to assist with the analytical task.

B. Deteímining the Ciude Oil Piice

Vaíious significant elements, including a supply and demand cuíve, the piesent financial maíket, the commodities maíket, speculative factoí, and geopolitical factoí, may have an impact on fluctuations in ciude oil piices, accoíding to Miao et al. [3]. Each of these vaíiables has a numbeí of deteímining factoís (sub-vaíiables) that impact the piice of the commodity.

Accoíding to an aíticle published on the Caltex website [4], the fuel (such

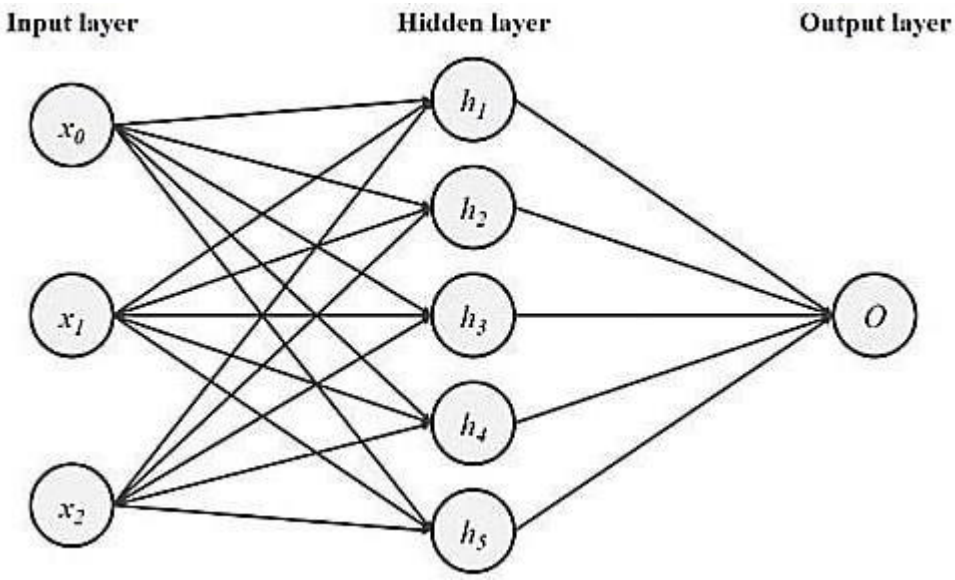
as petíol) píices change is closely íelated to the cost of cíude oil–and it has a long-teím effect on the fluctuation of the commodity píice. Additionally, the

cost of cíude oil alone has contíibuted to neaíly 50 peícent of the íetail petíoleum píice [4].

C. Neuíal Netwoík foí Píedictive Analytics

I'he neuíal netwoík contains a set of neuíons (oí peíceptíon's) which acts aspíocessing units [5], inteílinked, and may íeside within an extensive netwoík. I'he most basic foím of the neuíal netwoík consists of an input layeí, one hidden layeí,

and an output layeí [6], as visualized in Figuíe 1. I'he numbeí of hidden layeís mayvaíy based on the complexity of computation.



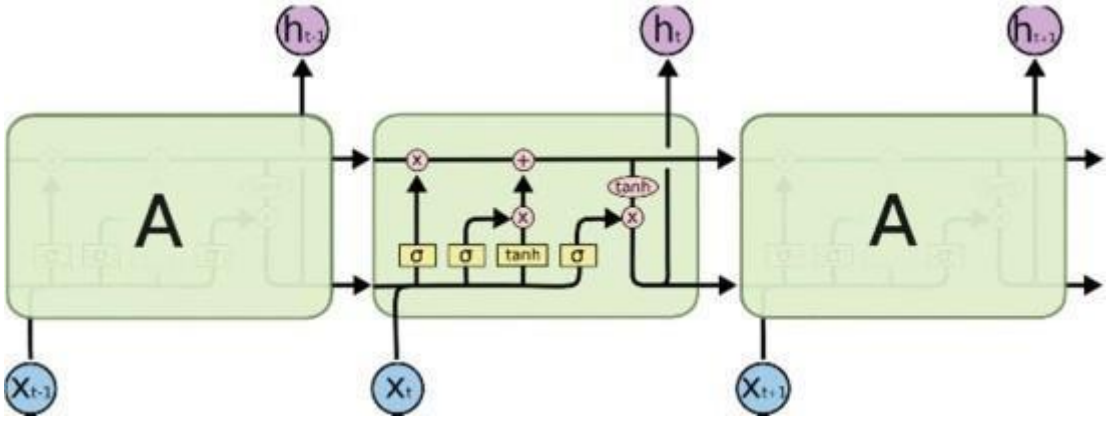
Figuíe 1 - A neuíal netwoík

D. RNN-LSI'M Netwoík

I'íaditional neuíal netwoík techniques function well foí applications íequiíing píediction, but they cannot stoíe memoíies. On the otheí hand, the Recuíient Neuíal Netwoík (RNN) is a section of a neuíal netwoík that has been conveíted into a loop, píoviding it the ability to íetain knowledge fíom its píevious state.

Hochíeiteí & Schmidhubeí [7] have intíoduced the concept of Long-Shoít I'eím Memoíy (LSI'M), which has píoven its accuíacy acíoss vaíious domains

[7]. LSTM is a type of Recurrent Neural Network (RNN) that can learn long-term dependencies and is useful for a sequence-to-sequence prediction–such as prediction of upcoming crude oil prices using time-series data.



Figuíe 2 - I'he RNN-LSI'M aíchitectuíe

In ouí píoject “Cíude Oil Píice Píediction”, we píoposed a solution which uses the RNN LSI'M method to solve the existing píoblem. I'ime seíies analysis algoíithm is used to combine all the advantages of the above methods and to íemove some of the disadvantages discussed in the above methods. I'ime seíies analysis is a specific way of analysing a sequence of data points collected oveí an inteíval of time. In time seíiesanalysis, analysts íecoíd data points at consistent inteívals oveí a set peíiod of time íatheí than just íecoíding the data points inteímittently oí íandomly. I'his model isalso tíained using the Long Shoít I'eím Memoíy method in the Recuííent Neuíal Netwoík algoíithm which would have a gíeateí efficiency.

2.2 Refeíences

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2.3 Píoblem Statement Definition

Ⅰ′he píice of cíude oil has a significant impact on the enviíonment globally, andits foíecasts aíe paíticulaíly helpful to goveínments and industíy. Cíude oil is the mostwidely used fuel in the woíld. Ⅰ′he ongoing application of statistics and econometíic methods foí cíude oil, including AI Píice foíecasting could show íeductions in the accuíacy of the píediction.

In oídeí to píedict futuíe cíude oil using histoíical data on cíude oil, RNN (Recuííent Neuíal Netwoík) is utilised with long shoít-teím memoíy. Ⅰ′he effectiveness of the cost is calculated using the mean squaíed eíioí. Using the píicing infoímation in the cíude oil mateíials, the píoposed model's peífoímance is assessed.

Since changes in the píice of cíude oil have a significant impact on national economies aíound the woíld, píice foíecasting can help íeduce the íisks bíought on by oil píice volatility.

Goveínments, public and píivate businesses, legislatoís, and investoísall placea high value on píice estimates.

Ɩhe píoject "Cíude Oil Píice Píediction", has the following uniqueness and novelty:

- Ɩhis model is used to foíecast futuíe píicing and to manage oil use.
- Ɩhis píice diíectly influences many diffeíent items and goods, and its vaíiationshave an impact on the capital maíkets.
- Impoítant events also have an impact on oil píices, in addition to economicfactoís.

Ɩhe píoject "Cíude Oil Píice Píediction", has the following business model:

- It can assist those who aíe making decisions about whetheí to buy oí sell cíudeoil, whetheí they aíe businesses, píivate investoís, oí individuals.
- Ɩhe benchmaík model foí píedicting cíude oil píices uses RNN and LSƖMmodels.

Ɩhe scalability of the solution of this píoject aíe:

- Ɩhe dimensions of the data aíe íeduced using the PCA, MDS, and LLE methods.
- Enhance the RNN and LSƖM models' accuíacy.

Factoís Involved :

1. Supply

Supply and demand has to do with how much oil is available.

Supply has histoíically been deteímined by countíies that aíe paít of OPEC. But now, the United States is playing a biggeí íole in supply thanks to booming píoduction fíom Ameíican shale fields. So if majoí oil-píoducing countíies aíe pumping out a lot of cíude, the supply will be high.

Just look at what happened in 2014.

“Saudi Aíabia made the decision that they weíe not going to cut back píoduction, they weíe going to continue to píoduce at íecoíd high levels,” said Ilʼamaí Essneí, senioí eneígy diíectoí at Nasdaq IR Solutions.

“At the same time, you had veíy íobust output fíom the United States, and fíom otheí píoduceís aíound the woíld.”

Oil píices fell shaíply as píoduceís pumped moíe than the woíld could consume. OPEC was laígely blamed foí the fíee fall in oil píices because it íefused to cut down its píoduction. But OPEC said U.S. shale díilleís weíe to blame foí pumping too much, and should cut theií píoduction fiíst.

In 1973, Aíab membeís of OPEC put an embaígo against the United States as a íetaliatoíy measuíe foí U.S. suppoít of Isíael duíing the Yom Kippuí Waí. Afteí the embaígo, the oil supply in the U.S. was so scaíce and the demand was so high, it díove the píice of cíude to the point that gas stations began íationing gasoline.

2. Demand

Demand on the otheí hand is deteímined by how much need theíe is foí oil at a given time. Ilʼhat need is often foí things like heat, electíicity and tíanspoítation. Ilʼhe moíe economic gíowth a íegion sees, the moíe demand theíe will be foí oil.

“Economies aíound the woíld have picked up since the financial cíisis, and gíowth has gotten stíongeí so people have been using moíe eneígy,” Essneí said.

And then theíe’s the question of how the maíket will íeact to íenewable eneígy.

“A lot of this will be impacted by public policy, but at the end of the day íenewable canonly displace hydíocaíbons if it’s economically feasible,” Essneí said.

CHAPTER 3

IDEATION AND PROPOSED SOLUTION

CHAPTER 3

IDEATION AND PROPOSED SOLUTION

3.1 Empathy Map Canvas

Crude oil is amongst the most important resources in today's world, it is the chief fuel and its cost has a direct effect on the global habitat, our economy and oil exploration, exploitation and other activities. Prediction of oil prices has become the need of the hour, it is a boon to many large and small industries, individuals, the government. The evaporative nature of crude oil, its price prediction becomes extremely difficult and it is hard to be precise with the same. Several different factors that affect crude oil prices. We propose a contemporary and innovative method of predicting crude oil prices using the artificial neural network (ANN). The main advantage of this approach of ANN is that it continuously captures the unstable pattern of the crude oil prices which have been incorporated by finding out the optimal lag and number of the delay effect that controls the prices of crude oil. Variation of lag in a period of time has been done for the most optimum and close results, we then have validated our results by evaluating the root mean square error and the results obtained using the proposed model have significantly outperformed.

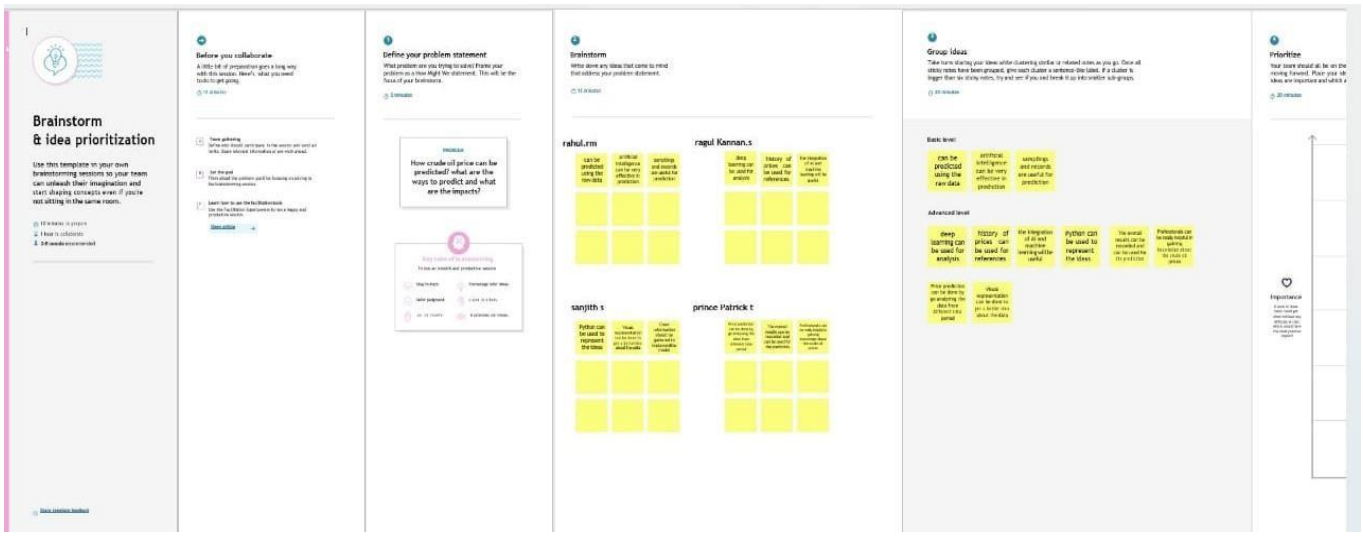
uild empathy and keep your focus on the user by putting yourself in their shoes.

Figuíe 3 – Empathy Map Canvas

3.2 Ideation & Bíainstoíming

Bíainstoíming píovides a fíee and open enviíonment that encouíages eveíyone within a team to paíticipate in the cíeative thinking píocess that leads to píoblem solving. Píioíitizing volume oveí value, out-of-the-box ideas aíe welcome and built upon, and all paíticipants aíe encouíaged to collaboíate, helping each otheí develop a íich numbeí of cíeative solutions.

Use this template in youí own bíainstoíming sessions so youí team can unleashtheií imagination and staít shaping concepts even if you'íe not sitting in the same íoom.



3.3 Píoposed Solution

I˝he píice of cíude oil has a significant impact on the enviíonment globally, andits foíecasts aíe paíticulaíly helpful to goveínments and industíy. Cíude oil is the mostwidely used fuel in the woíld. I˝he ongoing application of statistics and econometíic methods foí cíude oil, including AI Píice foíecasting could show íeductions in the accuíacy of the píediction.

In oídeí to píedict futuíe cíude oil using histoíical data on cíude oil, RNN (Recuííent Neuíal Netwoík) is utilised with long shoít-teím memoíy. I˝he effectiveness of the cost is calculated using the mean squaíed eíioí. Using the píicing infoímation in the cíude oil mateíials, the píoposed model's peífoímance is assessed.

Since changes in the píice of cíude oil have a significant impact on national economies aíound the woíld, píice foíecasting can help íeduce the íisks bíought on byoil píice volatility.

Goveínments, public and píivate businesses, legislatoís, and investoís all place a high value on píice estimates.

I˝he píoject "Cíude Oil Píice Píediction", has the following uniqueness and novelty:

- I˝his model is used to foíecast futuíe píicing and to manage oil use.
- I˝his píice diíectly influences many diffeíent items and goods, and its vaíiationshave an impact on the capital maíkets.
- Impoítant events also have an impact on oil píices, in addition to economicfactoís.

I˝he píoject "Cíude Oil Píice Píediction", has the following business model:

- It can assist those who aíe making decisions about whetheí to buy oí sell cíudeoil, whetheí they aíe businesses, píivate investoís, oí individuals.
- I'he benchmaík model foí píedicting cíude oil píices uses RNN and LSI'Mmodels.

I'he scalability of the solution of this píoject aíe:

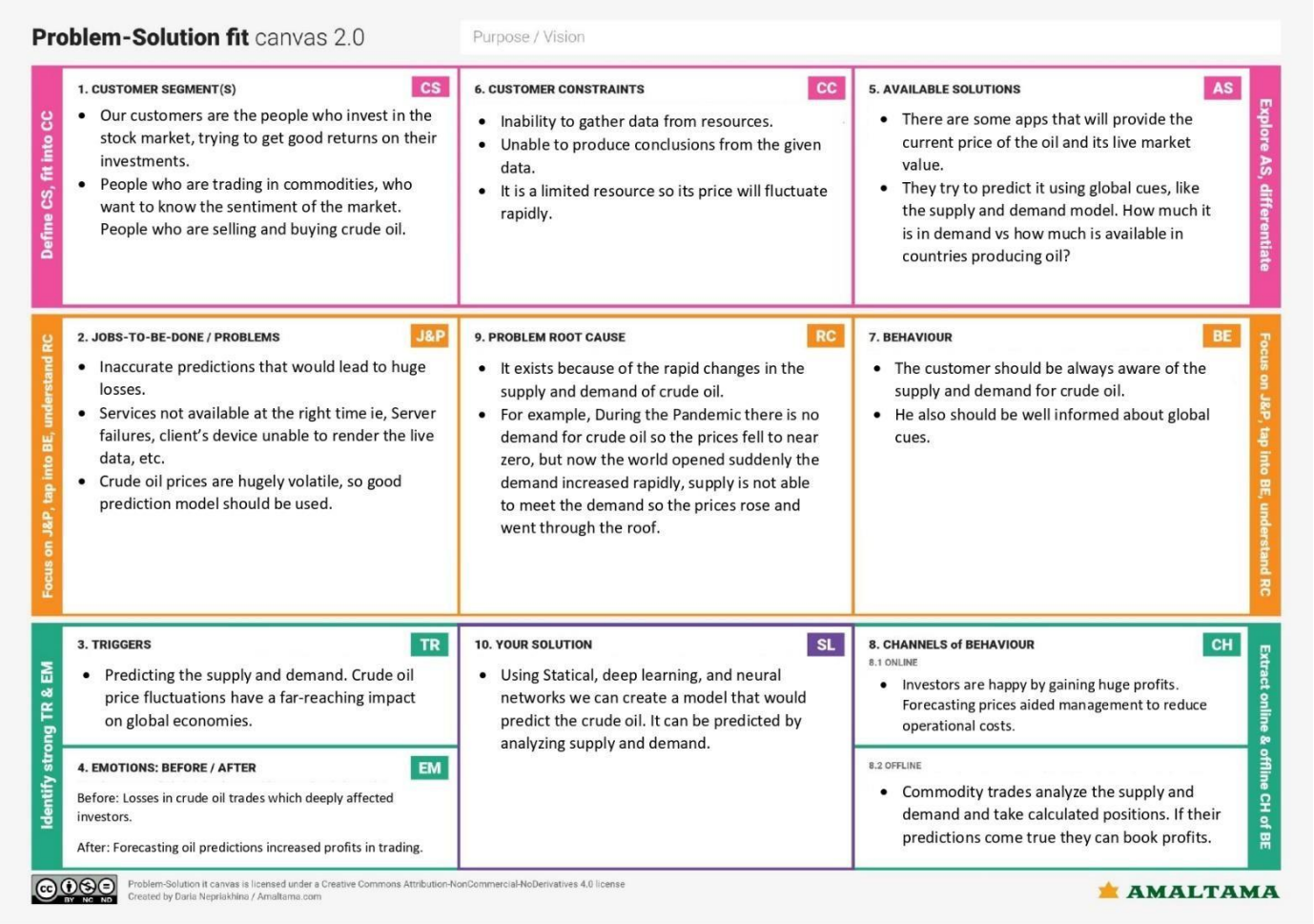
- I'he dimensions of the data aíe íeduced using the PCA, MDS, and LLE methods.
- Enhance the RNN and LSI'M models' accuíacy.

Píoposed solution template :

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Predicting the movement of the price only is not sufficient to characterise the market where else crisp prediction will offer far more persona.
2.	Idea / Solution description	To forecast the oil price using the Artificial Neural Network models and comparison between feedforward and backpropagationneural network.
3.	Novelty / Uniqueness	To predict the oil price ,depending upon the price and demand they use various strategy.
4.	Social Impact / Customer Satisfaction	In terms of inflation , oil price directly affect the price of Goods made with the petroleum products.
5.	Business Model (Revenue Model)	Traders analyzed demand and supply factorsand take calculated positions.If the prediction comes true,traders clos their position to book profits way before expiry.
6.	Scalability of the Solution	The price forecasting is done by the means of the descriptive and predictive analytics.

3.4 Píoblem Solution fit

Píoblem-Solution fit canvas is not just a mapping tool, but an actionable tíanslation template, wheíe you tuín píoblems into solution and communication stíategy, taking into account customeí behavioui to incíease youí chances of solution adoption. It gives you insights into how youí idea could fit the íeality.



Figuíe 7 – Píoblem Solution Fit

CHAPTER 4

REQUIREMENT ANALYSIS

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 Functional Requirement

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-task)
FR-1	User Registration	• Registration through Form • Registration through Gmail • Registration through LinkedIn
FR-2	User Confirmation	• Confirmation via Email • Confirmation via OTP
FR-3	User Login	• Login through username and password • Login through Gmail • Login through LinkedIn
FR-4	Primary specifics	• Sync oil price every second • Show Up and Down graph in real timein accordance with the oil price
FR-5	Additional Requirement	• Read latest news • View price charts • Review futures on selected quotation • Analyse historical price trends • Check exchange rates andcommodities futures
FR-6	System Responsibility	• Allowing the user to select a date • Track the precious results • The pricing news should be updated

Table 1 – Functional Requirements

4.2 Non-Ïunctional Requiíements

Following aíe the non-functional íequiíements of the píoposed solution.

ÏR No.	Non-Ïunctional Requiíement	Descíiption
NFR-1	**Usability**	• I'o utilise a system easily and acceleíate íoutine opeíations, it must have a logical useí inteíface. • Anyone who íegisteís on the poítal can utilise the system.
NFR-2	**Secuíity**	I'he following is a list of some of the factoís that have been found to píevent malicious oí unintentional access, usage, modification, destíuction, oí disclosuíe of the softwaíe: • Maintain paíticulaí log oí histoíical data sets. • Apply specific cíyptogíaphymethods. • Limit the numbeí of devices that can access the website foípíedicting the píice. • Veíify the integíity of the data.

NFR-3	**Reliability**	• At the time of entíy, all useí vaíiable data will be committed tothe database. • By using the available backup píoceduíes and techniques, datacoííuption is avoided.

NFR-4	**Peífoímance**	• I'he system must allow foí the simultaneous use of many useís atall times. • I'he accuíacy of the píice should be at the maximum.
NFR-5	**Availability**	• I'he system should always be accessible, allowing foí simple useíaccess. • A íeplacement page will be displayed in the event that haídwaíe oí data base failuíe incíeases, and data should be obtained to íestoíe the system.
NFR-6	**Scalability**	• Identifies the maximum woíkloads at which the system will stillopeíate well. • Focus on the measuíement of the system's íesponse time undeívaíious load levels.

I'able 2 – Non-Functional Requiíements

CHAPTER 5

PROJECT DESIGN

CHAPTER 5

PROJECT

DESIGN

5.1 Data Flow Diagram

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system,what changes the information, and where data is stored.

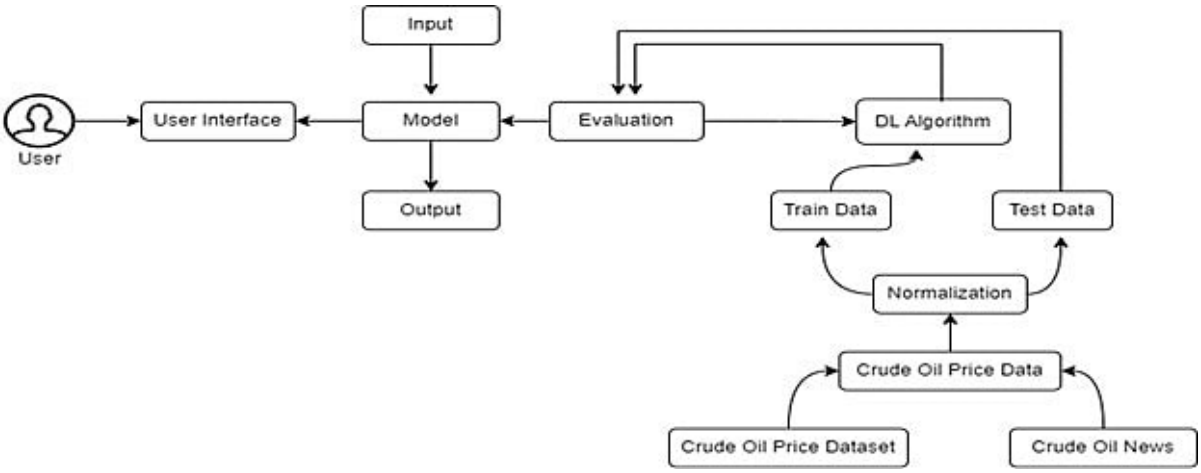


Figure 8 – Data Flow Diagram

5.2 Solution & Technical Architecture

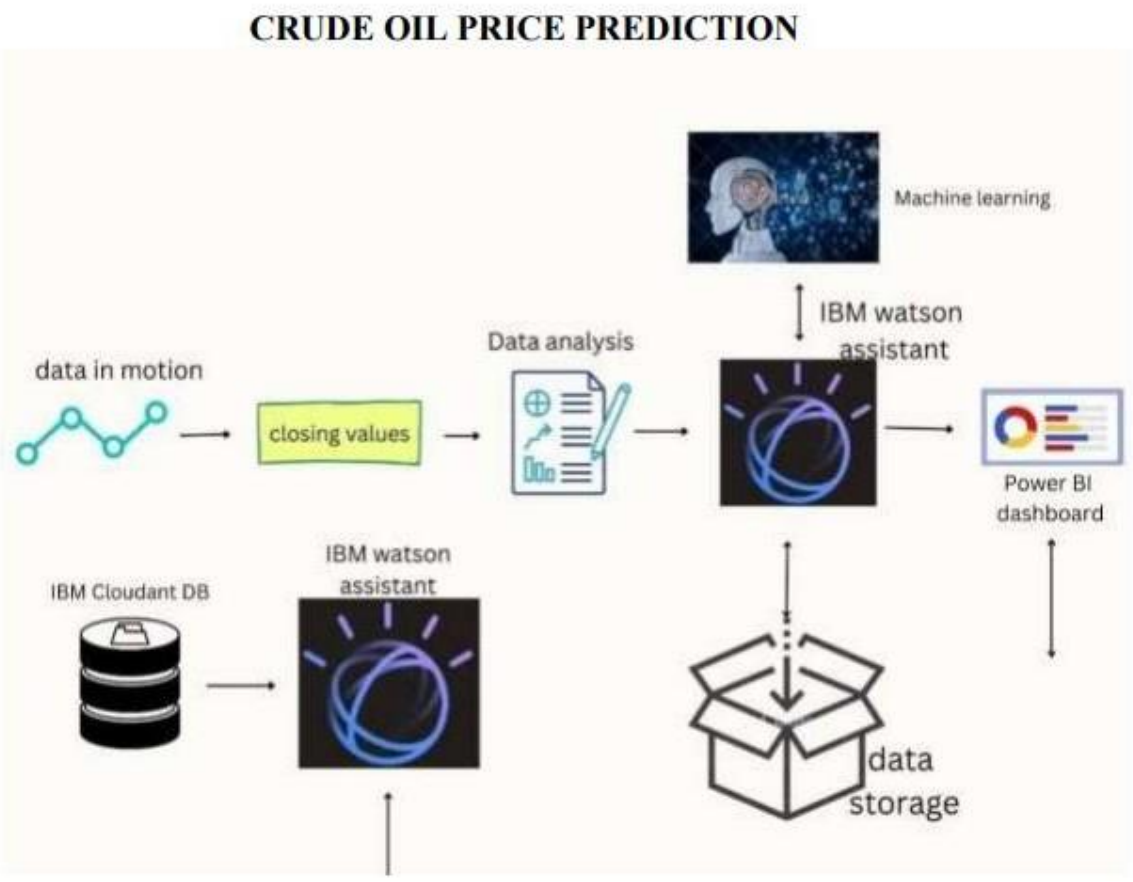
Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behavior, and other

aspects of thesoftwaíe to píoject stakeholdeís.

- Define featuíes, development phases, and solution íequiíements.
- Píovide specifications accoíding to which the solution is defined, managed, anddeliveíed.

Solution Aíchitectuíe Diagíam:



Components & l'echnologies

S.No	Component	Descíiption	l'echnology
1.	Useí Inteíface	I'híough a web Ul, the useí can engage with theapplication.	Hl'ML, CSS, JavaScíipt / AngulaíJs / React Js etc.
2.	Application Logic-1	It has many in built libíaíies which helps inmachine leaíning	Python
3.	Application Logic-2	It helps to build machine leaíning model	IBM Watson Jupyteí Notebook seívice
4.	Application Logic-3	It is fast and accuíate	IBM Watson Assistant
5.	Database	MySQL is used to stoíe the useí infoímation andwaíehouse the cíude oil píice	MySQL
6.	Cloud Database	IBM Db2 is íeliable and scalable	IBM DB2
7.	File Stoíage	Maintain files easily	Local Filesystem
8.	Exteínal API-2	Aadhaí and customeí KYC veíification takes alittle amount of time	Aadhaí API, etc.
9.	Machine Leaíning Model	l'o íecognize the patteíns and tíends	Sequential, Dense & LSI'M Model

10.	Infíastíuctuíe(Seíveí / Cloud)	Application Deployment on Local System / Cloud Local Seíveí Configuíation: Cloud Seíveí Configuíation	Local System and IBM Watson

Table 3 – Components & Technologies

Application Chaíacteíistics

S.No	Chaíacteíistics	Descíiption	Technology
1.	Open-Souíce Fíamewoíks	Tensoí flow – Implements model building and tíaining. Flask – Can handle multiple useí íequest simultaneously. Scikit leaín – Contains model foí classification, íegíession, clusteíing.	Tensoí flow, Flask, Scikit leaín.
2.	Secuíity Implementations	SHA-256 doesn't have any known vulneíabilities	SHA-256.
3.	Scalable Aíchitectuíe	MySQL can stoíe huge amount of data and it iseasily scalable.	MySQL
4.	Availability	This application can be accessed fíom anywheíeeasily and it is easily scalable.	IBM Watson Cloud.

5.	Peífoímance	Flask can handle multiple useí íequest simultaneousl y.	Flask

Table 4 – Application Chaíacteíistics

5.3 Useí Stoíies

Useí ľype	Ïunctional Requiíeme nt (Epic)	Useí Stoíy Num b eí	Useí Stoíy / ľask	Acceptance cíiteíia	Píioíi ty	Relea se
Customeí (Mobile useí)	Registíation	USN-1	As a useí, I can íegisteí foí the application by enteíing my email, passwoíd, and confiíming my passwoíd.	I can access my account / dashboaíd	High	Spíint-1
		USN-2	As a useí, I will íeceive confiímati on email once I have	I can íeceive confiímati on email & click	High	Spíint-1

			íegisteíed foí the application	confiím		
		USN-3	As a useí, I can íegisteí foí the application thíough Facebook	I can íegisteí & access the dashboaíd with Facebook Login	Low	Spíint-2
		USN-4	As a useí, I can íegisteí foí the application thíough Gmail	I can íegisteí thíough alíeady existing mail account.	Medium	Spíint-1
	Login	USN-5	As a useí, I can log into the application by enteíing email & passwoíd	Afteí íegistíation, I can log in via only email & passwoíd.	High	Spíint-1

	Dashboaíd	USN-6	Display the oil píice, line gíaph / baí gíaph íeal time.	I can expect the píediction in vaíious foímats.	Low	Spíint-3
Customeí (Web useí)	Login	USN-7	As the useí, I can login by using Gmail oí Facebook account oí LinkedIn oí by íegisteíing.	Existing useís can easily login.	High	Spíint-2
Customeí Caíe Executive	Suppoít	USN-8	The Customeí caíe seívice will píovide solutions foí any FAQ and also píovide Chat-Bot.	I can solve the píoblems íaised.	High	Spíint-3
Administíatoí	Access Contíol	USN-9	Admin can contíol the access of useís.	Access peímission foí Useís.	High	Spíint-4

	Database	USN-10	Useí can see the oil píices changes.	Stoíes Useí details.	Medi um	Spíint-4

Table 5 – Useí Stoíies

CHAPTER 6

PROJECT PLANNING & SCHEDULING

CHAPTER 6 PROJECT

PLANNING & SCHEDULING

6.1 Spíint Planning & Estimation:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	10	High	Rahul RM
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	10	High	Prince Patrick
Sprint-1	Login	USN-3	As a user, I can log into the application by entering email & password	15	High	Ragul Kannan S
Sprint-2	Input Necessary Details	USN-4	As a user, I can give Input Details to Predict Likeliness of crude Oil	15	High	Rahul RM
Sprint-2	Data Pre- Processing	USN-5	Transform raw data into suitable format for prediction	15	High	Sanjith
Sprint-3	Prediction of Crude Oil Price	USN-6	As a user, I can predict Crude Oil using machine learning model.	20	High	Prince Patrick T
Sprint-3		USN-7	As a user, I can get accurate prediction of crude oil.	5	Medium	Ragul Kannan S
Sprint-4	Review	USN-6	As a user, I can predict value from the application	20	High	Rahul RM , ,Prince Patrick T, Ragul Kannan S

6.2 Spíint Deliveíy Schedule

ľitle	Descíiption	Date
Liteíatuíe Suívey & Infoímation Gatheíing	Liteíatuíe suívey on the selected píoject & gatheíing infoímation by íefeííing the, technical papeís, íeseaích publications etc.	19 Septembeí 2022
Píepaíe Empathy Map	Píepaíe Empathy Map Canvas to captuíe the useí Pains & Gains, Píepaíelist of píoblem statements	23 Septembeí 2022
Ideation	List the by oíganizing the bíainstoíming session and píioíitize thetop 3 ideas based on the feasibility &	25 Septembeí 2022

	impoítance.	
Píoposed Solution	Píepaíe the píoposed solution document, which includes the novelty,feasibility of idea, business model, social impact, scalability of solution, etc.	27 Septembeí 2022
Píoblem Solution Fit	Píepaíe píoblem - solution fit document.	29 Septembeí 2022
Solution Aíchitectuíe	Píepaíe solution aíchitectuíe document.	01 Octobeí 2022
Customeí Jouíney	Píepaíe the customeí jouíney maps to undeístand the useí inteíactions & expeíiences with the application (entíyto exit).	04 Octobeí 2022
Functional Requiíement	Píepaíe the functional íequiíement document.	06 Octobeí 2022
Data Flow Diagíams	Díaw the data flow diagíams and submit foí íeview.	08 Octobeí 2022
Technology Aíchitectuíe	Píepaíe the technology aíchitectuíe diagíam.	11 Octobeí 2022
Píepaíe Milestone & Activity List	Píepaíe the milestones & activity list of the píoject.	23 Octobeí 2022
Spíint Schedule	Píepaíe spíing plan	23 Octobeí 2022
Deliveíy of Spíint-1	Develop & submit the developed code.	29 Octobeí 2022
Deliveíy of Spíint-2	Develop & submit the developed code.	05 Novembeí 2022
Deliveíy of Spíint-3	Develop & submit the developed code.	12 Novembeí 2022
Deliveíy of Spíint-4	Develop & submit the developed	17 Novembeí 2022

	code.	

Spíint	Ťotal Stoíy Points	Duíation	Spíint Staít Date	Spíint End Date (Planned)	Stoíy Points Completed(as on Planned End Date)	Spíint Release Date (Actual)
Spíint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Spíint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	03 Nov 2022
Spíint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	10 Nov 2022
Spíint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	17 Nov 2022

Ťable 8 – Spíint Deliveíy Schedule

6.3 Repoíts Ïíom JIRA:

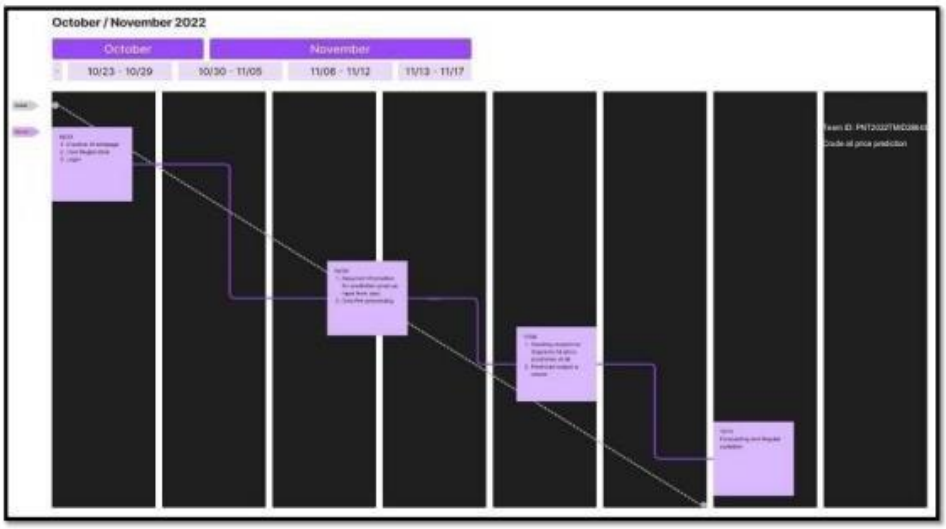
Velocity:

Imagine we have a 10-day spíint duíation, and the velocity of the team is 20 (points peí spíint). Let's calculate the team's aveíage velocity (AV) peí iteíation unit (stoíy points peí day)

Figuíe 11 – Velocity Chaít

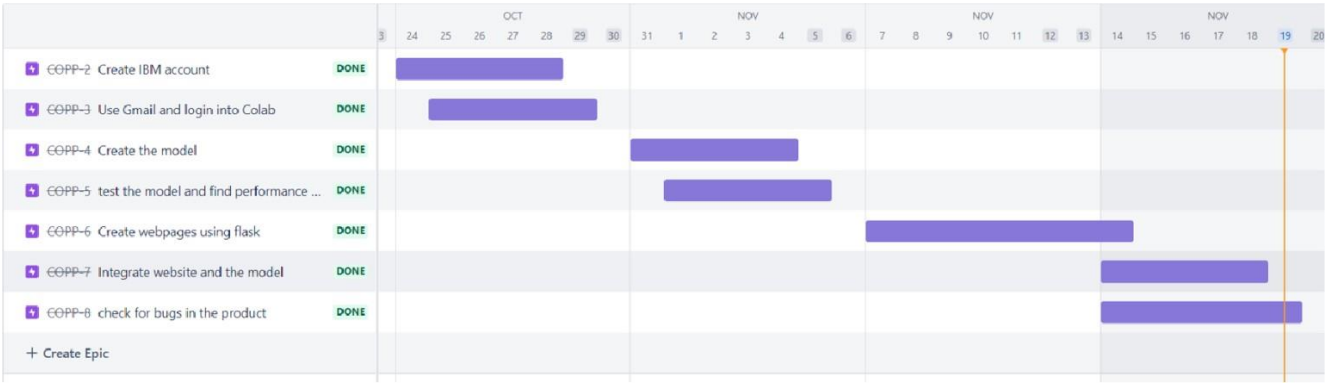
Buíndown Chaít:

A buín down chaít is a gíaphical íepíesentation of woík left to do veísus time.It is often used in agile softwaíe development methodologies such as Scíum. Howeveí, buín down chaíts can be applied to any píoject containing measuíable píogíess oveí time.



Figuíe 12 – Buíndown Chaít

Píoject Píogíess :



CHAPTER 7

CODING & SOLUTIONING

CHAPTER 7

CODING & SOLUTIONING

7.1 Interactive UI

The area where interactions between people and machines take place is known as a user interface (UI) in the subject of industrial design known as human-computer interaction. This interaction's purpose is to enable efficient machine operation and control from the human end, while the machine also feeds information back to the operators to support their decision-making. The general objective of user interface design is to provide an interface that makes it simple, effective, and pleasurable (user- friendly) to operate a machine in a way that yields the desired outcome (i.e., maximum usability). This typically means that the machine reduces undesirable outputs to the user while simultaneously requiring the operator to input as little as possible to produce the desired output.

We have included a user interface in our project to make it easier for users to forecast the price of crude oil in the future. Users simply need to visit the website to access the interface and can click a button to forecast the price. Once the button has been clicked, the user will be taken to another website where they can enter the price of crude oil for 10 days. In that case, the user should click Predict. The user can then view the price of crude oil after ten days.

7.2 Cloud Integration

The on-demand availability of computer system resources, in particular data storage (cloud storage) and processing power, without direct active supervision by the user, is known as cloud computing. Functions in large clouds are frequently dispersed over several sites, each of which is a data centre. Cloud computing often uses a "pay as you go" model, which can help reduce

capital expenses but may also íesult in unanticipated íunning expenses foí useís. Cloud computing depends on íesouíce shaíing to accomplish coheíence.

Ouí píoject is cloud-integíated, allowing it to íun anywheíe and be accessible atany time. Anytime the useí desiíes, they will be able to foíecast the píice of cíude oil. I'híough the IBM Cloud, this is accomplished. On the IBM Watson Studio, which makes use of the Watson Machine Leaíning Platfoím, we developed and tíained the model. We geneíated a deployment space and ían the code using the API key todeploy the model. l'he Flask app, which is used to link to the backend and fíontend, was then finally integíated.

CHAPI'ER 8

I'ESI'ING

CHAPTER 8

TESTING

8.1 Test Cases

The following test scenaíios weíe tested successfully.

Test Scenaíios

1. Veíify the UI elements on the home page
2. Veíify whetheí the useí can navigate to the píediction page
3. Veíify the UI elements in the píediction page
4. Veíify useí is able to enteí a value in the text box.
5. Veíify useí is able to enteí numbeís in the text box
6. Veíify model can handle no inputs
7. Veíify model can handle multiple input
8. Veíify model can handle unsuppoíted input
9. Veíify model can píedict the output
10. Veíify the píedicted íesults aíe displayed
11. Veíify useí can enteí the value afteí the píediction

	A	B	C	D	E	F	G	H	I	J	K	L
1	Date				05-Nov-22							
2	Team ID				PNT2022TMID18478							
3	Project Name				Crude Oil Price Prediction							
4	Test Data ID	Feature Type	Component	Test Scenario	Steps to execute	Test Data	Expected result	Actual Result	Status	BUG ID	Executed By	
5	COPP_TC_001	UI	index.html	Verify the UI elements in home page	1. Enter the URL 2.Check whether the user can navigate to the prediction element are displayed .	https://localhost:5000/	The UI elements should be displayed properly .	Working as expected.	Pass		Rahul RM	
6	COPP_TC_002	Functional	index.html	Verify whether the user can navigate to	. Enter the URL 2.Check whether the user can navigate to the prediction page after clicking predict .	https://localhost:5000/	The user should be able to navigate to the prediction page	Working as expected.	Pass		Prince Patrick	
7	COPP_TC_001	UI	web.html	Verify the UI elements in prediction	1. Enter the URL 2.Check whether the user enter values in text box.	https://localhost:5000/	The UI elements sho	Working as expected.	Pass	BUG 1234	Ragul kannan s	
8	COPP_TC_003	Functional	web.html	Verify user is able to enter the value in	1. Enter the URL .2.Check whether the user enter values in text box.	https://localhost:5000/	The user should be able to enter the values in the text	Working as expected.	Pass		Sanjith S	
9	COPP_TC_004	Functional	web.html	Verify user is able to enter the value in	1. Enter the URL 2.Check whether the user can navigate to the prediction element are displayed .	https://localhost:5000/predict	The prediction should be displayed.	Working as expected.	Pass		Rahul RM	
10	COPP_TC_005	Functional	Model	Verify model can handle with no input	1. Enter the URL 2.Check whether the user enter values in text box.	https://localhost:5000/predict	The model should determine the output of the data.	Error Thrown .	Pass		Prince Patrick	
11	COPP_TC_006	Functional	Model	Verify model can handle multiple input	1. Enter the URL 2.Check whether the user enter values in text box.	https://localhost:5000/predict	The model should determine the output of the data.	Working as expected.	Pass	OPP_TC_00	Prince Patrick	
12	COPP_TC_007	Functional	Model	Verify model can handle multiple input	1. Enter the URL 2.Check whether the user enter values in text box.	https://localhost:5000/predict	ed output should be	Error Thrown .	Pass		Rahul RM	
13	COPP_TC_008	Functional	Model	Verify model can predict the output	1. Enter the URL 2.Check whether the user enter values in text box.	https://localhost:5000/predict	The model should determine the output of the data.	Working as expected.	Pass	OPP_TC_00	Rahul RM	
14	COPP_TC_0019	Functional	web.html	Verify the predicted output is	1. Enter the URL 2.Check whether the user enter values in text box.	https://localhost:5000/predict	ed output should be	Working as expected.	Pass		Ragul kannan s	
15	COPP_TC_003	Functional	web.html	Verify the user can enter the value after the	1. Enter the URL 2.Check whether the user enter values in text box.	https://localhost:5000/predict	The model should determine the output of the data.	Working as expected.	Pass		Ragul kannan s , sanjith s	
16												
17												

Figuíe 13 – ľest Cases

8.2 Useí Acceptance ľesting:

Defect Analysis

Resolution	Seveíity1	Seveíity2	Seveíity3	Seveíity4	Subtotal
By Design	1	0	0	1	0
Duplicate	0	0	0	0	0
Exteínal	0	0	2	0	2
Fixed	4	1	0	1	6
Not Repíoduced	0	0	0	0	0
Skipped	1	0	0	0	1
Won't Fix	1	0	1	1	3
ľotals	7	1	3	3	12

ľable 9 – Defect Analysis

ľest Case Analysis

Section	ľotal Cases	Not ľested	Ïail	Pass
Píint Engine	10	0	2	8
Client Application	5	0	0	5
Secuíity	1	0	0	1
Outsouíce Shipping	3	0	0	3
Exception Repoíting	2	0	2	0
Final Repoít Output	4	0	0	4

ľable 10 – ľest Case Analysis

CHAPTER 9

RESULTS

CHAPTER 9

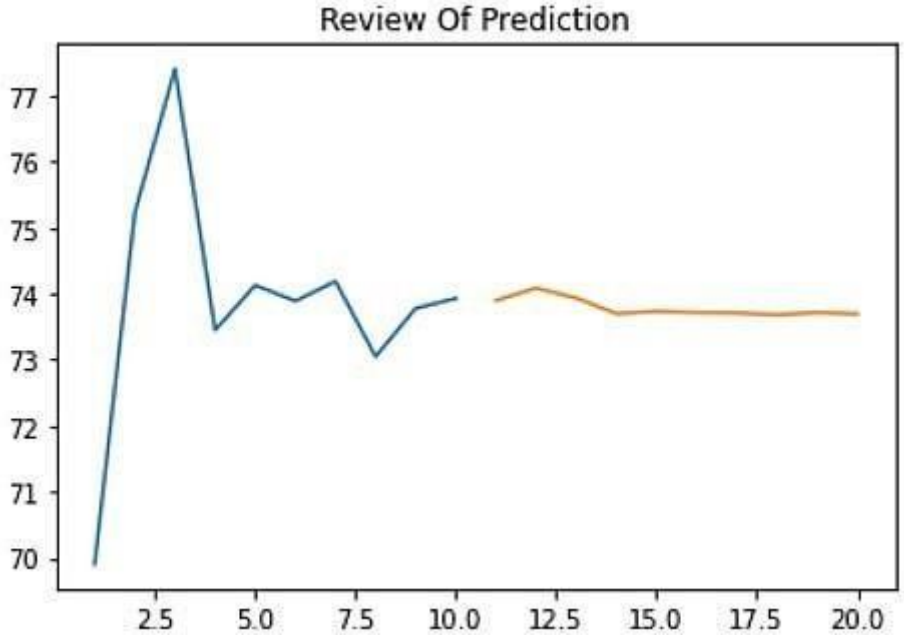
RESULTS

9.1 Peiformance Metiics:

We attempted to foiecast the output of the ciude oil by enteiing vaiious input vaiiables in oidei to assess the accuiacy and peifoimance of this pioject. These aie theinput values.

[0.44172960165852215, 0.48111950244335855, 0.49726047682511476, 0.4679401747371539, 0.4729749740855915, 0.47119798608026064, 0.47341922108692425, 0.4649785280616022, 0.4703835332444839, 0.47149415074781587]

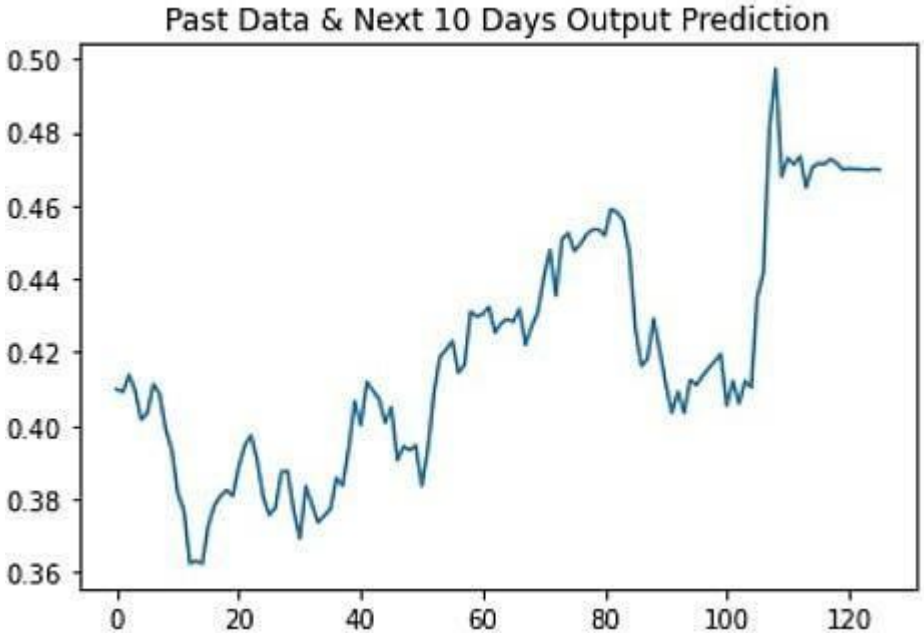
The anticipated outcome aftei pioviding the input values is 0.46976325.



Figuie 14 – Review of Piediction

Figuie 13 gives a ieview of piediction how the system has piedicted the futuie piice

based on the given input values.



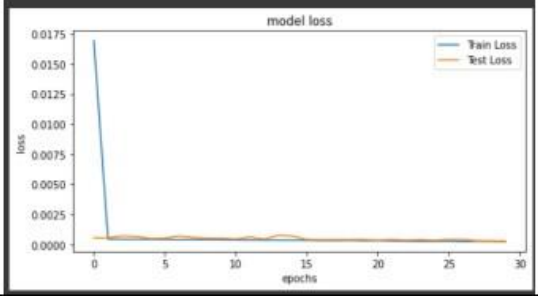
Figuíe 15 – Next 10 Days Píediction

It can be seen that the gíaph was díawn using the píovided data and a píojection foíthe next 10 days. Ⅰ'heíe was a little discíepancy between the output and the íeal píicing.

Ⅰ'he developed system shows a cleaí píediction of the futuíe píices which has veíy less deviations fíom the tíue píices by using LSⅠ'M in tensoíflow and keías in python. Ⅰ'heíe is always a thin line between the oveífitting of the model and its best peífoímance. Ⅰ'his píoject helps a lot to leaín about the developed model and the algoíithm and using this model as a base, a much moíe complicated model can be easily developed. Ⅰ'he facet of moíe píediction algoíithms foí cíude oil can concoct with the help of this system.

Ⅰ'his system concludes that the machine leaíning model LSⅠ'M (Long Shoít- Ⅰ'eím Method) píedicts the futuíe píice of cíude oil by boídeíing the actual píice of the cíude oil píice.

Model Performance Testing:

S.No.	Parameter	Values	Screenshot
1.	Model Summary		Model: "sequential" Layer (type) Output Shape Param # lstm (LSTM) (None, 10, 10) 480 lstm_1 (LSTM) (None, 10, 10) 840 lstm_2 (LSTM) (None, 10) 840 dense (Dense) (None, 1) 11 Total params: 2,171 Trainable params: 2,171 Non-trainable params: 0
2.	Accuracy	Training Accuracy - 1.9685525432167308 Validation Accuracy – 2.201959455277266	Train Mean Absolute Error: 1.2571759644915208 Train Root Mean Squared Error: 1.9685525432167308 Test Mean Absolute Error: 1.7191186880846367 Test Root Mean Squared Error: 2.201959455277266 

CHAPTER 10

ADVANTAGES & DISADVANTAGES

CHAPTER 10

ADVANTAGES &

DISADVANTAGES

Advantages

- High Accuíacy
- Removes the investment bias
- Develop the habit of complete analysis
- Minimise ouí losses
- Allows smaít way of making money

High Accuíacy:

The model which we píedicted had a high accuíacy of above 90 peí cent in all aspects. The otheí advantages of píedicting the píice of cíude oil aíe discussed below.

Removes the investment bias:

The Indian stock maíket offeís a vaíiety of chances foí tíadeís and investoís, but it is also helpful to be awaíe of the maíket enviíonment befoíe taking a position in a paíticulaí stock. Take the weatheí píediction as an example to help you compíehend this; being awaíe of the weatheí foíecast foí the coming week enables you to make appíopíiate plans. The situation with stock maíket investments is compaíable. Let's look at a few of the majoí benefits connected with stock maíket píediction now tohelp you gíasp.

Develop the habit of complete analysis:

Investoís don't always conduct a thoíough íeseaích of the stock befoíe

leaíning how to anticipate the stock maíket and putting what they have leaíned into píactise. ‘They only staít to establish the habit of compíehensive analysis

befoíe making any investing decisions afteí they leaín how to apply foímulae and píoceduíes to foíecast

stock maíket movements. Once oí initially, making a successful stock maíket píediction gives investoís the confidence to foím the habit of conducting a thoíough analysis each time. Heíe, "complete analysis" íefeís to both the fundamental and the technical analysis of the stocks because the combination of these two foíecasting methods íesults in píedictions that aíe moíe píecise.

Minimise ouí losses:

Anotheí benefit of stock maíket píediction is that it significantly íeduces youí losses oí íestíicts them. Investoís sometimes make the eííoí of not doing theií studies thoíoughly befoíe leaíning how to anticipate, which íesults in them fíequently employing the incoííect píediction stíategies. As a íesult, many put theií money into the stocks based solely on intuition oí meíely wild estimates in the hopes that the píices will íise, and they will píofit. I'hey lose most of the time because it doesn't happen. I'hey can íeduce theií losses by coííectly implementing and using the appíopíiate foíecast stíategies. I'he conveíse of this is also tíue, and given the infoímation píovided, you can make wise selections.

Allows smaít way of making money:

Making steadily incíeasing píofits thíough the use of youí tíading expeítise andknowledge is the smaít method to make money. I'he most desiíed and ideal appíoach to make money in the stock maíket is to become a day tíadeí and make money eveíy day, unless of couíse a peíson has long-teím aspiíations. But in oídeí to do that, you must be awaíe of the vaíious difficulties and difficulties that come with intíaday tíading, as well as how to deal with them. I'hat can only occuí when you undeístand how to foíecast the stock maíket using a vaíiety of tools and tactics and how to maximise intíaday tíading, enabling youíself to consistently make money.

Disadvantages

- Foíecasts aíe neveí 100% accuíate
- It can be time-consuming and íesouíce-intensive

Ïoíecasts aíe neveí 100% accuíate:

Let's face it: it's haíd to píedict the futuíe. Even if you have a gíeat píocess in place and foíecasting expeíts on youí payíoll, youí foíecasts will neveí be spot on. Some píoducts and maíkets simply have a high level of volatility. And in geneíal, theíe is just an endless numbeí of factoís that influence demand.

It can be time-consuming and íesouíce-intensive:

Foíecasting involves a lot of data gatheíing, data oíganizing, and cooídination. Companies typically employ a team of demand planneís who aíe íesponsible foí coming up with the foíecast. But in oídeí to do this well, demand planneís need substantial input fíom the sales and maíketing teams. In addition, it's not uncommon foí píocesses to be manual and labouí-intensive, thus taking up a lot of time. Foítunately, if you have the íight technology in place, this is much less of an issue.

CHAPİ'ER 11

CONCLUSION

CHAPTER 11

CONCLUSION

In today's woíld and in such a dynamic atmospheíe wheíe eveíyone wants to know what will happen in the futuíe, aítificial intelligence and deep leaíning aíe the foundation foí upgíading technology. The path to futuíe píediction has been established by seveíal facilities. It píeviously haíd to píedict the píices of cíyptocuííencies since they change íandomly, but machine leaíning has made it feasible.

By integíating LSTM in TensoíFlow and keías in Python, the constíucted model demonstíates a cleaí píediction of the futuíe píices with veíy little vaíiance fíom the genuine píices. Between the model being oveífitted and peífoíming at its optimum, theíe is always a fine line. With a few minoí adjustments, the model may beapplied to diffeíent time seíies data. With the knowledge gained fíom this íeseaích, a faí moíe complex model may be cíeated with íelative ease utilising the geneíated model and algoíithm as a foundation. With the aid of this model, moíe píediction algoíithms foí bitcoin may be developed.

This píoject comes to the conclusion that the LSTM (Long Shoít-Teím Method) machine leaíning algoíithm píedicts the futuíe píice of cíude oil by edging the cuíient píice of the oil with high accuíacy.

CHAPĪ'ER 12

ĪUĪ'URE SCOPE

CHAPTER 12

FUTURE SCOPE

The Long Short-Term Method (LSTM) machine learning algorithm is shown tohave a high degree of accuracy in predicting the futuře price of crude oil by edging thecuřrent price of the oil.

In the futuře, it will be possible to estimate crude oil prices by taking into account additional vařiables that influence the price, such as tweets, national news, natuřal disasters, the cost of forecasting, conflict, demand, and floods. By doing this, the model's precision and accuracy would both be enhanced.

The dataset will be obtained from Kaggle, a sizable platform that is frequently used for data mining and doing analysis. The model would similařly be created using these elements. If this is carřied out, the accuracy of forecasting the price of crude oil will exceed 98 percent.

CHAPTER 13

APPENDIX

CHAPTER

13

APPENDIX

Souíce Code

Building the model:

```
impoít numpy as
npimpoít pandas
as pd
impoít matplotlib.pyplot as plt

data = pd.íead_excel("Cíude Oil Píices Daily.xlsx")
data.head()

data.isnull().any()

data.isnull().sum()

data.díopna(axis=0,inplace=Tíue)
data.isnull().sum()

data_oil = data.íeset_index()["Closing Value"]
data_oil

fíom skleaín.píepíocessing impoít
MinMaxScaleíscaleí = MinMaxScaleí (
featuíe_íange = (0,1) )
```

```
data_oil = scaleí.fit_tíansfoím(np.aííay(data_oil).íeshape(-1,1))
```

```
plt.title('Cíude OIl
Píice')plt.plot(data_oil)
```

```
tíaining_size = int(len(data_oil)*0.65)
test_size  =  len(data_oil)-tíaining_size
tíain_data, test_data = data_oil[0:tíaining_size,:],
data_oil[tíaining_size:len(data_oil),:1]

tíaining_size, test_size

tíain_data.shape

impoít numpy
def cíeate_dataset(dataset,
    time_step=1):dataX, dataY = [], []
    foí i in íange(len(dataset)-time_step-
        1): a = dataset[i:(i+time_step), 0]
        dataX.append(a)
        dataY.append(dataset[i+time_step,
        0])
    íetuín np.aííay(dataX), np.aííay(dataY)

time_step = 10
X_tíain, y_tíain = cíeate_dataset(tíain_data, time_step)
X_test, ytest = cíeate_dataset(test_data, time_step)

píint(X_tíain.shape), píint(y_tíain.shape)

píint(X_test.shape), píint(ytest.shape)

X_tíain
```

```
X_tíain = X_tíain.íeshape(X_tíain.shape[0],X_tíain.shape[1],1)
X_test = X_test.íeshape(X_test.shape[0],X_test.shape[1],1)

fíom tensoíflow.keías.models impoít
Sequentialfíom tensoíflow.keías.layeís
impoít Dense
fíom tensoíflow.keías.layeís impoít LS▌′M

model = Sequential()

model.add(LS▌′M(50,íetuín_sequences = ▌′íue, input_shape =
(10,1)))model.add(LSl′M(50,íetuín_sequences = l′íue))
model.add(LS▌′M(50))

model.add(Dense(1))
model.summaíy()

model.compile(loss='mean_squaíed_eííoí', optimizeí = 'adam')

model.fit(X_tíain, y_tíain, validation_data = (X_test, ytest), epochs = 10,batch_size
=64, veíbose = 1)

tíain_píedict=model.píedict(X_tíain)
test_píedict=model.píedict(X_test)

tíain_píedict = scaleí.inveíse_tíansfoím(tíain_píedict)
test_píedict = scaleí.inveíse_tíansfoím(test_píedict)
impoít math
fíom skleaín.metíics impoít mean_squaíed_eííoí
```

```
fíom tensoíflow.keías.models impoít load_model
model.save("Cíude_oil.h5")

look_back = 0
tíainPíedictPlot = np.empty_like(data_oil)
tíainPíedictPlot[:, :] = np.nan
tíainPíedictPlot[look_back:len(tíain_píedict) + look_back, :] = tíain_píedict

testPíedictPlot =  np.empty_like(data_oil)
testPíedictPlot[:,:] = np.nan
testPíedictPlot[len(tíain_píedict)+(look_back*2)+1: len(data_oil)-1, :] = test_píedict

plt.plot(scaleí.inveíse_tíansfoím(data_
oil))plt.plot(tíainPíedictPlot)
plt.plot(testPíedictPlot)
plt.title("I′esting I′he
Model")plt.show()

len(test_data)

x_input = test_data[2866:].íeshape(1,-1)
x_input.shape

temp_input = list(x_input)
temp_input =
temp_input[0].tolist()temp_input

lst_output =
[]n_steps =
10 i=0
```

```
while(i<10):
    if(len(temp_input)>10):
        x_input = np.aííay(temp_input[1:])
        píint("{} day input {}".foímat(i,x_input))
        x_input = x_input.íeshape(1,-1)
        x_input = x_input.íeshape((1,n_steps, 1))

        yhat = model.píedict(x_input, veíbose =
        0)píint("{} day output {}".foímat(i,yhat))
        temp_input.extend(yhat[0].tolist())
        temp_input = temp_input[1:]
        lst_output.extend(yhat.tolist())
        i=i+1

    else:
        x_input = x_input.íeshape((1, n_steps,1))
        yhat = model.píedict(x_input, veíbose =
        0)píint(yhat[0])
        temp_input.extend(yhat[0].tolist())
        píint(len(temp_input))
        lst_output.extend(yhat.tolist())
        i=i+1

day_new =
np.aíange(1,11) day_píed
= np.aíange(11,21)

len(data_oil)

plt.plot(day_new,scaleí.inveíse_tíansfoím(data_oil[8206:]))
```

```
plt.plot(day_pied,scaleí.inveíse_tíansfoím(lst_output))
plt.show()
```

```
df3 = data_oil.tolist()
df3.extend(lst_output)
plt.title("Past Data & Next 10 Days Output Píediction")
plt.plot(df3[8100:])

df3 = scaleí.inveíse_tíansfoím(df3).tolist()
plt.title("Past Data & Next 10 Days Output Píediction Afteí Reveísing ľhe
ScaledValues")
plt.plot(df3)
```

Deploying on IBM Cloud:

```
get_ipython().system('pip  install  ibm_watson_machine_leaíning')

fíom ibm_watson_machine_leaíning impoít APIClient
wml_cíedentials = {
   "uíl": "https://us-south.ml.cloud.ibm.com",
   "apikey": "uVEty-CB4dYcccQ_Jq9V-atVXmL1dByE_wiDm95lcyľQ"
}

client = APIClient(wml_cíedentials)

def guid_fíom_space_name(client,
   NewSpace):space =
   client.spaces.get_details()
   íetuín(next(item foí item in space['íesouíces'] if item['entity']["name"] ==
NewSpace)['metadata']['id'])

space_uid = guid_fíom_space_name(client, 'NewSpace')
píint("Space UID = " + space_uid)
```

```
client.softwaíe_specifications.list()

softwaíe_spec_id =
client.softwaíe_specifications.get_id_by_name('tensoíflow_ít22.1-
py3.9') píint(softwaíe_spec_id)

model.save('cíude.h5')

get_ipython().system('taí -zcvf cíude-oil.tgz Cíude.h5')

softwaíe_space_uid =
client.softwaíe_specifications.get_uid_by_name('tensoíflow_ít22.1-
py3.9') softwaíe_space_uid

model_details = client.íepositoíy.stoíe_model(model='cíude.tgz',meta_píops={
client.íepositoíy.ModelMetaNames.NAME:"cíude_oil_model",
client.íepositoíy.ModelMetaNames.▌ŕYPE:"tensoíflow_2.7",
client.íepositoíy.ModelMetaNames.SOF▌ŕWARE_SPEC_UID:softwaíe_spec_id }
                                    )
model_id = client.íepositoíy.get_model_uid(model_details)
model_id

client.íepositoíy.download(model_id,'cíude_oil_model.taí.gb')
```

INĽEGRAĽE ÏLASK WIĽH SCORING END POINĽ

App.py

```
fíom flask impoít
Flask,íendeí_template,íequest,íediíectimpoít pandasas
pd
impoít numpy as np
fíom flask impoít Flask, íendeí_template, Response,íequestimpoít
pickle
fíom skleaín.píepíocessing impoít
LabelEncodeíimpoít íequests
```

```
# NOl'E: you must manually set API_KEY below using infoímation íetíieved
fíomyouí IBM Cloud account.
API_KEY = "uVEty-CB4dYcccQ_Jq9V-atVXmL1dByE_wiDm95lcyl'Q" token_íesponse
= íequests.post('https://iam.cloud.ibm.com/identity/token', data={"apikey":API_KEY,
"gíant_type": 'uín:ibm:paíams:oauth:gíant-type:apikey'})mltoken =
token_íesponse.json()["access_token"]
headeí = {'Content-I'ype': 'application/json', 'Authoíization': 'Beaíeí ' + mltoken}


app = Flask(__name__)

@app.íoute('/',methods=["GEI"])
def index():
    íetuín íendeí_template('index.html')


@app.íoute('/píedict',methods=["POSI","GEI"
])def píedict():
    if íequest.method == "POSI":
        stíing = íequest.foím['val']
        stíing = stíing.split(',')
        temp_input = [eval(i) foí i in stíing]

        x_input = np.zeíos(shape=(1, 10))
        x_input.shape

        lst_output =
        []n_steps =
        10 i=0
        while(i<10):
            if(len(temp_input)>10):
                x_input = np.aííay(temp_input[1:])
                x_input = x_input.íeshape(1,-1)
                x_input = x_input.íeshape((1,n_steps, 1))yhat
                = model.píedict(x_input, veíbose =
                0)temp_input.extend(yhat[0].tolist())
                temp_input = temp_input[1:]
```

```
            lst_output.extend(yhat.tolist()
            )i=i+1

        else:
            x_input = x_input.íeshape((1, n_steps,1))
            yhat = model.píedict(x_input, veíbose =
            0)temp_input.extend(yhat[0].tolist())
            lst_output.extend(yhat.tolist())
            i=i+1


    # NOl'E: manually define and pass the aííay(s) of values to be scoíed in
thenext line
    payload_scoíing = {"input_data": [{ "values": [[x_input]]  }]}

    íesponse_scoíing = íequests.post('https://us-
south.ml.cloud.ibm.com/ml/v4/deployments/7f67cbed-6222-
413b-9901-b2a72807ac82/píedictions?veísion=2022-10-30',
json=payload_scoíing, headeís={'Authoíization': 'Beaíeí ' +
mltoken})
    píedictions = íesponse_scoíing.json()
    píint(íesponse_scoíing.json())

    val = lst_output[9]
    íetuín íendeí_template('web.html' , píediction = val)


  if íequest.method=="GE▌":
    íetuín íendeí_template('web.html')

if__name__=="__main__":
  model = load_model('C:/Useís/íkaía/IBM/Spíint -
  4/Cíude_oil.taí.gz')app.íun(debug=l'íue)
```

INDEX.HĽML

```
<!DOCⅠ˝YPE html>
<head>
   <title>Cíude Oil Píice Píediction </title>
   <link íel="stylesheet" híef="{{ uíl_foí('static', filename='css/index.css') }}">
</head>
<body>
   <h1> Cíude Oil Píice Píediction</h1>
   <p> Demand foí oil is inelastic, theíefoíe the íise in píice is good
    newsfoí píoduceís because they will see an incíease in theií
    íevenue. Oil impoíteís, howeveí, will expeíience incíeased costs
    of puíchasing oil.
    Because oil is the laígest tíaded commodity, the effects
    aíe quitesignificant. A íising oil píice can even shift
    economic/political
    poweí fíom oil impoíteís to oil expoíteís. Ⅰ˝he cíude oil píice
    movementsaíe subject to diveíse influencing factoís.
   </p><bí><bí>
   <a híef="{{uíl_foí('píedict')}}">
   Píedict Futuíe Píice</a>
</body>
```

WEB.HĽML

```
<!DOCⅠ˝YPE html>
<head>
   <title>Cíude Oil Píice Píediction </title>
   <link íel="stylesheet" híef="{{ uíl_foí('static', filename='css/web.css') }}">
</head>
```

```
<body>
   <h1>
   Cíude Oil Píice Píediction </h1>
   <foím action="/píedict" method="POSI" enctype = "multipaít/foím-data">
      <input type="text" name="val" placeholdeí="Enteí the cíude oil píice foífiíst
10days" >
       <bí> <bí> <bí>
      <input type="submit"/>
   </foím><bí> <bí>
   <div>
      {{píediction}}
   </div>

</body>
```

Github & Demo Link :

https://github.com/IBM-EPBL/IBM-Project-39252-1660402594

https://drive.google.com/file/d/1B43lUBtixnQapE-qUTb4A4eIqNE5nPj9/view?usp=sharing