A project report submitted in partial fulfilment of the requirement

For the award of the degree of

MASTER OF SCIENCE IN STATISTICS

BY

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Under the esteemed guidance of

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DEPARTMENT OF STATISTICS

ANDHRA UNIVERSITY

VISAKHAPATNAM

2021-2023

CERTIFICATE

This is to certify that the project entitled "
" submitted in partial fulfilment of course work for the award of Master of Science in Statistics in Andhra University, a Bonafede record work jointly during the year 2021-2023 done by

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Project Guide

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DECLARATION

We hereby declare that this project entitled “ ” is authentic work done by us under the esteemed guidance of Prof. K. Nirupama Devi mam, for the partial fulfilment of the award of MASTER OF SCIENCE IN STATISTICS (M.Sc.) degree and we further admit that this has not been submitted by us anywhere else for award of any other degree.

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INTRODUCTION:

Before liberalization, Indian economy was tightly controlled and protected by number of measures sectors like licensing system, high tariffs and rates, limited investment in core only. During 1980's Growth of economy was highly unsustainable because of its dependence on borrowing to correct the current account deficit.

To reduce this, the government of India introduced economic policy in 1991 to implement structural reforms. The financial sector at that time was much unstructured and its scope was limited only to bonds, equity, Insurance, commodity markets, mutual and pension funds. To Structure the security market, a regulatory authority named as SEBI (security Exchange Board of India) was introduced and first electronic exchange National Stock Exchange also set up. The purpose behind this was to regularize investments, mobilization of resources and to give credit.

Mark Twain once has divided the people into types; one who has seen die great Indian monument, The Taj Mahal and the second, who have not. The same can be said about investors. There are two types of investors: those who are aware of the investment opportunities available in India and those who are not.

A stock market is a place where buyers and sellers of stocks come together, physically, or virtually. Participants in the market can be small individuals or large fund managers who can be situated anywhere. Investor's place their orders to the professionals of a stock exchange who executes these buying and selling orders. The stocks are listed and traded on stock exchanges. Some exchanges are physically located, based on open Outcry system where transactions are carried out on trading floor. The other exchanges are virtual exchanges whereas a network of computers is composed to do the transactions electronically. The whole system is order- driven; the order placed by an investor is automatically matched with the best limit order. This system provides more transparency as it shows all buy and sell orders.

OUTLOOK OF INDIAN STOCK MARKET:

Indian Stock Markets is one of the oldest in Asia. Its history dates to nearly 200 years ago. The earliest records of security dealings in India are merger and obscure. The East Indian Company was the dominant institution in those days and business in its loan securities used to be transacted towards the close of the 18th century.

By 1830's business on corporate stocks and shares in Bank and Cotton presses took place in Bombay. Though the trading list was broader in 1839, there were only half a dozen brokers recognized by banks and merchants during 1840 and 1850. The 1850's witnessed a rapid development of commercial enterprise and brokerage business attracted many men into the field and by 1860 the number of brokers increased into 60. In 1860-61 the American Civil War broke out and cotton supply from United States to Europe was stopped; thus, the SHARE MANIA' in India began. The number of brokers increased to about 200 to 250.

At the end of the America Civil War, the brokers who thrived out of Civil War in 1874, found a place in a street (now appropriately called as Dalal Street) where they would conveniently assemble and transact business. In 1887, they formally established in Bombay, the "Native share and Stockbroker’s Association", which is alternatively known as ''The Stock Exchange''. In 1895, the stock Exchange at Bombay was consolidated.

The Indian Stock market has been assigned an important place in financing the Indian corporate sector. The principal functions of the stock markets are:

1. Enabling mobilizing resources for investment directly from the investors.
2. Providing liquidity for the investors and monitoring.
3. Discipline company management.

The two major Stock exchanges in India are:

- NATIONAL STOCK EXCHANGE (NSE)
- BOMBAY STOCK EXCHANGE (BSE)

National stock Exchange:

National Stock Exchange of India Limited (NSE) is one of the leading stock exchanges in India, based in Mumbai. NSE is under the ownership of various financial institutions such as banks and insurance companies. It is the world's largest derivatives exchange by number of contracts traded and the third largest in cash equities by number of trades[b] for the calendar year 2022. It is one of the largest stock exchanges in the world by market capitalization. NSE's flagship index, the NIFTY 50, a 50 stock index is used extensively by investors in India and around the world as a barometer of the Indian capital market. The NIFTY 50 index was launched in 1996 by NSE.

The Economic Times estimates that as of April 2018, 6 crore (60 million) retail investors had invested their savings in stocks in India, either through direct purchases of equities or through mutual funds. Earlier, the Bimal Jalan Committee report estimated that barely 3% of India's population invested in the stock market, as compared to 27% in the United States and 10% in China.

National Stock Exchange was incorporated in the year 1992 to bring about transparency in the Indian equity markets. NSE was set up at the behest of the Government of India, based on the recommendations laid out by the Pherwani committee in 1991 and the blueprint was prepared by a team of five members (Ravi Narain, Raghavan Puthran, K Kumar, Chitra Sankaran and Ashishkumar Chauhan) along with Dr. R H Patil and SS Nadkarni who were deputed by IDBI in 1992. Instead of trading memberships being confined to a group of brokers, NSE ensured that anyone who was qualified, experienced, and met the minimum financial requirements was allowed to trade.

NSE commenced operations in 30 June 1994 starting with the wholesale debt market (WDM) segment and equities segment in 03 November 1994. It was the first exchange in India to introduce an electronic trading facility. Within one year of the start of its operations, the daily turnover on NSE exceeded that of the BSE.

Bombay Stock exchange:

BSE Limited, also known as the Bombay Stock Exchange (BSE), is an Indian stock exchange which is located on Dalal Street in Mumbai. Established in 1875 by cotton merchant Premchand Roychand, a kumauni businessman, it is the oldest stock exchange in Asia, and also the tenth oldest in the world. The BSE is one of the world's largest stock exchanges by market capitalization.

The Economic Times estimates that as of April 2018, 6 crore (60 million) retail investors had invested their savings in stocks in India, either through direct purchases of equities or through mutual funds. Earlier, the Bimal Jalan Committee report estimated that barely 3% of India's population invested in the stock market, as compared to 27% in the United States and 10% in China.

Bombay Stock Exchange was started by Premchand Roychand in 1875. While BSE Limited is now synonymous with Dalal Street, it was not always so. In the 1850s, five stock brokers gathered together under a Banyan tree in front of Mumbai Town Hall, where Horniman Circle is now situated. A decade later, the brokers moved their location to under the banyan trees at the junction of Meadows Street and what was then called Esplanade Road, now Mahatma Gandhi Road. With a rapid increase in the number of brokers, they had to shift places repeatedly. At last, in 1874, the brokers found a permanent location, the one that they could call their own. The brokers group became an official organization known as "The Native Share & Stockbrokers Association" in 1875.

On 12 March 1993, a car bomb exploded in the basement of the building during the 1993 Bombay bombings. The BSE is also a Partner Exchange of the United Nations Sustainable Stock Exchange initiative, joining in September 2012. BSE established India INX on 30 December 2016. India INX is the first international exchange of India. BSE became the first stock exchange in the country to launch commodity derivatives contract in gold and silver in October 2018.

About Oil and Natural Gas Corporation Company:

The Oil and Natural Gas Corporation (ONGC) is an Indian central public sector undertaking under the ownership of Ministry of Petroleum and Natural Gas, Government of India. It is headquartered in Dehradun. ONGC was founded on 14 August 1956 by the Government of India. It is the largest government-owned-oil and gas explorer and producer in the country, and produces around 70% of India's crude oil (equivalent to around 57% of the country's total demand) and around 84% of its natural gas. In November 2010, the Government of India conferred the *Maharatna* status to ONGC. In a survey by the Government of India for fiscal year 2019–20, it was ranked as the largest profit making Central Public Sector Undertaking (PSU) in India. It is ranked 25th among the Top 250 Global Energy Companies by Platts.

The equity shares of ONGC are listed on the Bombay Stock Exchange, where it is a constituent of the BSE SENSEX index, and the National Stock Exchange of India, where it is a constituent of the S&P CNX Nifty.

As on 31 March 2013, Government of India held around 69% equity shares in ONGC. Over 480,000 individual shareholders hold approx. 1.65% of its shares. Life Insurance Corporation of India is the largest non-promoter shareholder in the company with 7.75% shareholding.

REVIEW OF LITERATURE:

Forecasting of stock returns in the stock market is a prominent issue for the past several decades. The existing econometric models has been improved depending on applications. The efficient and robust econometric models are Auto Regressive Integrated Moving Average (ARIMA) models, which are used to forecast the financial time series data for short term than the other techniques such as Artificial Neural Networks, etc. Many researchers worked in ARIMA forecasting models to predict the future returns.

Gerra (1959) studied a time series analysis based on least square method to forecast the storage movement and stock price for egg industry. Suits (1962) establish an econometric model for the purpose of forecasting policy analysis and instrument of U.S. economy. Such mitz and watts (1970) were analysed the time series data for identifying the moving average and auto regressive process estimations. They used parametric model of exponential smoothing method in United States, Canada, Australia, and Argentina to forecast wheat yields. Reid (1971), New bold and Granger (1974) were concluded and finalized that the Jenkins approach of ARIMA model produces most appropriate and accurate results than regression and exponential smoothing (Naylor et al,1972). N. Rangan and N.Titida, (2006) analysed ARIMA forecasting on oil palm price time series data, he found that estimated ARIMA term is most efficient for the future returns. In ARIMA model, stationarity, invertibility and parsimony are the three important parameters are used to identification, estimation, and diagnostic checking respectively.

Forecasting techniques can be categorized into two broad categories: quantitative and qualitative. The techniques in the quantitative category include mathematical models such as moving average, straight-line projection, exponential smoothing, regression, trend-line analysis, simulation, life-cycle analysis, decomposition, Box-Jenkins, expert systems, and neural network. The techniques in the qualitative category include subjective or intuitive models such as jury or executive opinion, sales force composite, and customer expectations.

Typically, the two forms of forecasting error measures used to judge forecasting performance are mean absolute deviation (MAD) and mean absolute percentage error (MAPE). For both MAD and MAPE, a lower absolute value is preferred to a higher absolute value. MAD is the difference. between the actual sales and the forecast sales. Absolute values are calculated over a period, and the mean is derived from these absolute differences. MAPE is used with large amounts of data, and forecasters may prefer to measure error in percentage (Wilson & Keating, 1994)

In many papers ARIMA model has been used as a benchmark model in order to compare the forecasting accuracy of the ANN. Jung-Hua Wang; Jia-Yann Leu developed a prediction system of recurrent neural network trained by using features extracted from ARIMA analysis. The results showed that the performance of the ARIMA was better than that of the basic forecasting techniques and at the same time ARIMA is also considered as better forecasting technique compared to Machine Learning Techniques. It was also asserted that useful prediction can be made even without the use of extensive data or knowledge.

There are many notable and commendable works in this field. The author D. Banerjee had developed a predictive model for forecasting Indian stock market. He used the monthly stock indices data for prediction using ARIMA. The authors Ayodele A. Adebiyi, Aderemi O. Adewumi, Charles K. Ayo used ARIMA model for designing predictive models for forecasting stock prices of Nokia and Zenith Bank. They used NYSE and NSE data. The authors Aloysius Edward and Jyothi Manoj had built a forecast model using ARIMA for predicting stock prices of various Automobile sector stocks like Bajaj, Tata Motors, Hero and Mahindra. The authors Mohamed Ashik A, Senthamarai Kannan K had used ARIMA model for forecasting stock prices of the National Stock Exchange NIFTY 50 stocks. The authors Mahantesh C. Angadi, Amogh P. Kulkarni performed time series analysis using ARIMA model for stock market forecasting. The authors Prapanna Mondal, Labani Shit and Saptarsi Goswami studied the effectiveness of time series modelling using /arima for forecasting stock prices of various sectors - IT, infrastructure, banking, automobiles, power, FMCG, steel. The authors J. Kamalakannan, I. Sengupta and S. Chaudhury performed stock market prediction using ARIMA model for stock prices of APPLE Inc. The authors J.V.N. Lakshmi, Ananthi Sheshasaayee performed a data analysis of temperature dataset using Hadoop techniques. The authors Himanshi, Komal Kumar Bhatia used KNN classifier to analyse undergraduate students' salary.

Banerjee. D, (2014) in her paper "Forecasting of Indian Stock Market using Time- series ARIMA Model" has applied ARIMA model based on which she predict the future stock indices which have a strong influence on the performance of the Indian economy. In her paper she first determined the ARIMA model then she forecasted the Sensex through model validation and at the end the recurrence validation was done.

Abdullah Lazim (2012) in his paper has addressed the forecasting of gold bullion coin prices through ARIMA model and had concluded by suggesting that the gold bullion coin selling prices are in upward trends and could be considered as a worthy investment. Wouter Theloosen in his research paper "A review on the determinants of the price of gold" has cited the different factors associated with the gold price fluctuation.

Baber. P... Baber. R. Thomas. G in their study "Factors affecting Gold prices: a case study of India" list different factors affecting the gold price in India and gives special emphasis on rise in gold price in the decade from 2002 to 2012.

Mohamad As'ad (2012) has modeled the peak daily electricity demand using half hourly demand date. He coined for ARIMA Models based past three, six, nine and twelve months of data and suggested that the ARIMA model build based on past three months data is the best model in terms of forecasting two to seven days ahead and ARIMA model based on the past six months data is the best model to forecast one day ahead.

Aidan Meyler, Geo Kenny, and Terry Quinn (1998) had forecasted Irish inflation though ARIMA model. This research paper gives an insight of ARIMA Modelling by step-by-step approach for forecasting using ARIMA Model.

Deepika M. G, Gautam Nambiar & Rajkumar M (2012) has tried to study the forecasting of gold price through ARIMA model & Regression, but their finding suggests that suitable model was not identified to forecast Gold price through ARIMA Model hence Regression analysis was carried out in the later part of their study.

From the last two decades, enormous research has been conducted in the field of volatility in context to predicting and forecasting. Many researchers app HJ autoregressive ARIMA model for forecasting volatility' ARIMA models have been used for forecasting the oil and natural gas prices in commodities market' but not much has been done in context of volatility estimation or forecasting for the Indian stock market' The volatility models for estimation and forecasting in content to stocks and derivative market have been improved over the decades' Some of the research studies in volatility estimation include contributions from Parkinson in 1980, Garman and Klas' 1980 Satchell in 1991' and Yangand Zhangin 2000 (Bennett & Gil). In the various experiments' it was that Parkinson volatility estimator was five times more efficient than the classical close-to-close estimator' While Garman - Klass volatility estimator and Roger - Satchell estimator showed 7'4. times more accuracy in comparison to close-to-close method' Yang Zhang estimator was 14 times more accurate estimator.

Among many research studies related to volatility prediction in context to tire National Stock Exchange' few have used the volatility estimators to check their suitability for forecasting Tripathy and Gil- Alana (2010") studied data of three years and concluded that Parkinson's performance was to all the volatility estimators on the basis of low adjusted R" Rajan (2011) described in his study various time series models for modelling volatility for SENSEX' This study suggested that among various GARCH models' TGARCH had the capability of capturing the irregular behaviour of stock market and estimating volatility for SENSEX' As 'ad (2012)studied four ARIMA - outs for forecasting daily peat electricity demand’.

The study revealed that forecasting for two to seven the ARIMA months past data is the best model' Using error parameters, RMSE and MAPE' it u' also shown in the Study that 6 months of past data could best predict one day ahead using the ARIMA 'Devi' Sundar' and A[i12013) studied time series analysis in context to five stocks from Nifty forecasted the stock prices' Rotela Jr. Salomon, and Pamplona (2014) evaluated the performance of ARIMA model in comparison to other smoothing models for forecasting the Bovespa Stock Index. A study was conducted in estimation and forecasting of volatility using ARIMA technique with time-series data from the S&P 500 Index. Ariyo, Adewumi, and Ayo (2014) demonstrated different ARIMA models' building process for price prediction of stocks for a short-term duration.

Researchers found that the ARIMA model had robust prospective for stock prediction in short term as compared to other prevailing prediction techniques. Mondal, Shit, and Gosrvami (2014) examined the effectiveness of ARIMA model while studying the 56 Indian stocks of different sectors of the economy. Among all the various sectors, the study analysed the predicting accuracy of the stock prices, and it was found to be g50%, which gave a view that ARIMA forecasts with good accuracy. Kumar and Patil (2015) examined the different volatility estimators and based on different error measuring parameters; the study found that the Garman Klass estimator with ARIMA technique forecasted volatility with high accuracy. Kumar and Anand (20 1 5) used Box - Jenkin's ARIMA model to forecast the sugarcane production in India up to 5 years. The study revealed the growth in production for the year 2013and then a sharp dip in2014 followed by growth of approximately, from 20 1 5 to 2017. Mattack and Saha (2016) studied the effect of volatility due to the introduction of derivatives on the underlying asset with the help of ARMA - GARCH models.

The study further found that the volatility decreased over the period due to the listing of derivatives in the incision stock market. Singh, Devi, and Roy (2016) analysed the timeseries data for index of industrial production of India and found that trend and seasonal effects in the IIP. Forecasting of IIP of India using ARIMA model depicted a decline in rainy season and then showed fuller considerable increase after Auglist2016. Guha and Bandyopadhyay CAK) forecasted the gold prices for Multi Commodity Exchange of India Ltd. (MCX) using the ARIMA model. One out of six differ parameters was chosen as the best model (ARIMA (1, 1, 1)) because it satisfied all the benchmarks of fit statistics. Murthy. Anupama, and Deeppa (2012) addresses the applicability of ARIMA (0, 1, 0) as a forecasting tool and studied the performance of short lens forecasted values and long ten forecasted values of gold price.

ARIMA (0, 1, 0) with log transformation found out to be valid and a comparatively better model than other ARIMA models Kumar and Khanna (2018) examined the volatility behaviour with ARCH, GARCH, and GARCH_tsEKK model and analysed volatility spill over in stock markets among India, Japan, China, and Hong Kong. The study resulted in claiming the Indian financial market as a stable market among other stock markets studied and that the previous shocks and news impacted the current volatility. The present study examines the various literatures on volatility estimation, volatility forecasting, and ARIMA models. This study, while addressing the issue of accuracy of the ARIN{A model in forecasting volatility, and the efficiency of various volatility estimators with respect to the Indian stock market, made an effort to estimate and predict the best estimator based on accuracy from ARIMA technique for forecasting in context to CNX Nifty index. This study contributes to the literature firstly by bringing forth the accuracy results of various volatility estimation techniques, which have not been analysed, for the In Jian stock market. Secondly, ARIMA and GARCH models were studied for volatility clustering, calendar effect, volatility shocks, casualties, etc., but not the accuracy of the forecasted values. This research studied the accuracy of forecasted values with different volatility estimators, which makes it unique in context to the Indian stock market.

STATISTICAL PROGRAMMING LANGUAGE

Introduction to R:

R is a programming language for statistical computing and graphics supported by the R Core Team and the R Foundation for Statistical Computing. Created by statisticians Ross Ihaka and Robert Gentleman, R is used among data miners, bioinformaticians and statisticians for data analysis and developing statistical software.[7] Users have created packages to augment the functions of the R language.

The official R software environment is an open-source free software environment within the GNU package, available under the GNU General Public License. It is written primarily in C, Fortran, and R itself (partially self-hosting). Precompiled executables are provided for various operating systems. R has a command line interface.[11] Multiple third-party graphical user interfaces are also available, such as RStudio, an integrated development environment, and Jupyter, a notebook interface. R is available as Free Software under the terms of the Free Software Foundation's GNU General Public License in source code form. It compiles and runs on a wide variety of UNIX platforms and similar systems (including FreeBSD and Linux), Windows and MacOS.

The R environment:

R is an integrated suite of software facilities for data manipulation, calculation, and graphical display. It includes:

- an effective data handling and storage facility.
- a suite of operators for calculations on arrays, in particular matrices,
- a large, coherent, integrated collection of intermediate tools for data analysis,
- graphical facilities for data analysis and display either on-screen or on hardcopy, and

- a well-developed, simple and effective programming language which includes conditionals, loops, user-defined recursive functions and input and output facilities.

The term "environment" is intended to characterize it as a fully planned and coherent system, rather than an incremental accretion of extremely specific and inflexible tools, as is frequently the case with other data analysis software.

R and Statistics:

Our introduction to the R environment did not mention statistics, yet many people use R as a Statistics system. We prefer to think of it of an environment within which many classical and modern statistical techniques have been implemented. A few of these are built into the base R environment, but many are supplied as packages. There are about 25 packages supplied with R (called "standard" and "recommended" packages) and many more are available through the CRAN family of Internet sites (via https://CRAN.Rproject.org) and elsewhere. Most classical statistics and much of the latest methodology is available for use with R, but users may need to be prepared to do a little work to find it.

Here we use the following R packages:

- **quandmod:** The `quantmod` package is a popular open-source package in the R programming language that provides a set of functions for quantitative financial modelling and trading. Some of the key features of the `quantmod` package include:
    1. Data retrieval: The package provides a range of functions for downloading financial data from various sources, including Yahoo Finance, Google Finance, and the Federal Reserve Economic Data (FRED) database.
    2. Technical analysis: The package includes a suite of functions for performing technical analysis on financial data, such as calculating moving averages, calculating various oscillators, and identifying chart patterns.

3. Charting: The package provides a range of functions for creating and customizing financial charts, including candlestick charts, line charts, and bar charts.
4. Portfolio optimization: The package includes functions for optimizing portfolios based on various criteria, such as minimizing risk or maximizing returns.
5. Back testing: The package includes functions for back testing trading strategies, allowing users to evaluate the performance of their strategies using historical data.

Overall, the `quantmod` package is a versatile and powerful tool for financial modelling and trading in R.

- **tsereis:** In R programming language, the `tseries` package provides a set of tools for time series analysis and financial econometrics. It includes functions for time series data pre-processing, visualization, forecasting, and statistical tests for time series analysis.

  Some of the key functions of the `tseries` package include:

  1. adf.test: Performs the Augmented Dickey-Fuller (ADF) test for unit roots in time series.
  2. acf: Computes the autocorrelation function (ACF) for a time series.
  3. pacf: Computes the partial autocorrelation function (PACF) for a time series.
  4. ar: Fits an autoregressive (AR) model to a time series.
  5. arma: Fits an ARMA model to a time series.
  6. arima: Fits an ARIMA model to a time series.
  7. ets: Fits an exponential smoothing state space model to a time series.

To use the `tseries` package in R, you can install it from the Comprehensive R Archive Network (CRAN) using the `install.packages` function.

- **timeSeries:** The `timeSeries` package is another R package for time series analysis, but it is a bit different from the `tseries` package.

The `timeSeries` package is designed to handle irregularly-spaced time series data, while the `tseries` package is designed for regularly-spaced time series data. The `timeSeries` package provides a set of classes and methods for handling and manipulating time series data, including functions for time series visualization, time series transformation, and time series modelling.

Some of the key features of the `timeSeries` package include:

1. Support for multiple time series classes, including "timeSeries", "zooreg", "fts", "xts", "zoo", "irts", and "ftsad".
2. Functions for time series visualization, including `plot()` and `chartSeries()`.
3. Functions for time series transformation, including `diff()` and `log()`.
4. Functions for time series modeling, including `arima()` and `forecast()`.
5. Support for time series data with missing values.

- **forecast:** The `forecast` package in R is a popular package for time series forecasting. It provides a wide range of functions for time series modeling and forecasting, including both traditional statistical models and more modern machine learning approaches.

Some of the key features of the `forecast` package include:

1. Support for a wide range of time series classes, including "ts", "zoo", "xts", "timeSeries", and others.
2. Functions for time series visualization, including `autoplot()` and `ggseasonplot()`.
3. Functions for time series transformation, including `diff()` and `log()`.
4. A wide range of time series modelling functions, including `arima()`, `ets()`, `tbats()`, and others.
5. Functions for evaluating and comparing forecast accuracy, including `accuracy()` and `forecast::tsCV()`.

Following are the statistical functions used in R programming:

1. **Acf():** In R language, `acf()` is a function used to compute and plot the autocorrelation function (ACF) of a time series. The ACF is a measure of the linear relationship between observations in a time series at different lags.

   The `acf()` function takes a time series object as input and produces a plot of the ACF along with confidence intervals to help identify significant correlations. The function also returns a list containing the computed ACF values, confidence intervals, and other relevant information.

   The general syntax of acf() is:

```
acf(x, lag.max = NULL, type = c("correlation", "covariance", "partial"), plot = TRUE,
na.action = na.fail, demean = TRUE, ...)
```

arguments:

- **x** is a univariate or multivariate (not ccf) numeric time series object or a numeric vector or matrix, or an "acf" object.
- **lag.max** is maximum lag at which to calculate the acf. Default is 10\log$_{10}$(N/m)10log10(N/m) where NN is the number of observations and mm the number of series. Will be automatically limited to one less than the number of observations in the series.
- **type** is character string giving the type of acf to be computed. Allowed values are "correlation" (the default), "covariance" or "partial". Will be partially matched.
- **plot** is logical. If TRUE (the default) the acf is plotted.
- **na.action** is function to be called to handle missing values. na.pass can be used.
- **demean** is logical. Should the covariances be about the sample means?
- **…** is further arguments to be passed to plot.acf.

2. **Pacf():** In R language, `pacf()` is a function used to compute and plot the partial autocorrelation function (PACF) of a time series. The PACF is a measure of the linear relationship between observations in a time series at different lags, after removing the effects of the intervening observations.

The `pacf()` function takes a time series object as input and produces a plot of the PACF along with confidence intervals to help identify significant correlations. The function also returns a list containing the computed PACF values, confidence intervals, and other relevant information.

The general syntax of pacf() is:

```
pacf(x, lag.max = NULL, plot = TRUE, na.action = na.fail,, ...)
```

arguments:

- **x** is a univariate or multivariate (not ccf) numeric time series object or a numeric vector or matrix, or an "acf" object.
- **lag.max** is maximum lag at which to calculate the acf. Default is 10\log$_{10}$(N/m)10log10(N/m) where NN is the number of observations and mm the number of series. Will be automatically limited to one less than the number of observations in the series.
- **plot** is logical. If TRUE (the default) the acf is plotted.
- **na.action** is function to be called to handle missing values. na.pass can be used.
- **…** is further arguments to be passed to plot.acf.

3. In R language, adf.test() is a function used to perform an Augmented Dickey-Fuller (ADF) test on a time series. The ADF test is a commonly used statistical test for checking whether a time series is stationary or not.

   The adf.test() function takes a time series object as input and performs the ADF test. It returns a list containing the test statistic, p-value, and critical values for a range of significance levels.

The general syntax of adf.test() is:

```
adf.test(x, nlag = NULL, output = TRUE)
```

Arguments:

- **x** is a numeric vector or univariate time series.

- **nlag** is the lag order with default to calculate the test statistic. See details for the default.
- **output** is a logical value indicating to print the test results in R console. The default is TRUE.

4. **auto.arima():** In R language, `auto.arima()` is a function from the `forecast` package used to automatically select the best ARIMA model for a given time series. The function uses a stepwise search algorithm to explore the possible combinations of ARIMA parameters (p, d, q) and selects the model with the lowest Akaike Information Criterion (AIC) value.
   The `auto.arima()` function takes a time series object as input and returns an ARIMA model object that can be used for forecasting. The function also provides diagnostic information about the selected model, including the AIC value, the estimated parameters, and the residual diagnostics.

   The general syntax of auto.arima() is:

auto.arima(x, seasonal = TRUE)

arguments:

- **x** is a univariate time series
- **seasonal** is a specification of the seasonal part of the ARIMA model, plus the period (which defaults to frequency(x)). This may be a list with components order and period, or just a numeric vector of length 3 which specifies the seasonal order. In the latter case the default period is used.

5. **arima():** In R language, `arima()` is a function used to fit an ARIMA model to a given time series. The ARIMA model is a popular time series model that can capture different types of trends, seasonality, and autocorrelation in the data.
   The `arima()` function takes a time series object as input, along with the order of the ARIMA model (p, d, q) and optionally the order of the seasonal ARIMA model

(P, D, Q, s) if the time series has a seasonal component. The function fits the ARIMA model to the time series using maximum likelihood estimation.

The general syntax of arima() is:

```
arima(x, order = c(0L, 0L, 0L), seasonal = list(order = c(0L, 0L, 0L), period = NA), xreg = 
NULL, include.mean = TRUE, transform.pars = TRUE, fixed = NULL, init = NULL, 
method = c("CSS-ML", "ML", "CSS"), n.cond, SSinit = c("Gardner1980", 
"Rossignol2011"), optim.method = "BFGS", optim.control = list(), kappa = 1e6)
```

arguments:

- **x** is a univariate time series
- **order** is A specification of the non-seasonal part of the ARIMA model: the three integer components (p, d, q)(p,d,q) are the AR order, the degree of differencing, and the MA order.
- **seasonal** is a specification of the seasonal part of the ARIMA model, plus the period (which defaults to frequency(x)). This may be a list with components order and period, or just a numeric vector of length 3 which specifies the seasonal order. In the latter case the default period is used.
- **Xreg** is Optionally, a vector or matrix of external regressors, which must have the same number of rows as x.
- **include.mean** is should the ARMA model include a mean/intercept term? The default is TRUE for undifferenced series, and it is ignored for ARIMA models with differencing.
- **transform.pars islogical;** if true, the AR parameters are transformed to ensure that they remain in the region of stationarity. Not used for method = "CSS". For method = "ML", it has been advantageous to set transform.pars = FALSE in some cases, see also fixed.
- **Fixed** is optional numeric vector of the same length as the total number of coefficients to be estimated.
- **Init** is optional numeric vector of initial parameter values. Missing values will be filled in, by zeroes except for regression coefficients. Values already specified in fixed will be ignored.

- **Method** is fitting method: maximum likelihood or minimize conditional sum-of-squares. The default (unless there are missing values) is to use conditional-sum-of-squares to find starting values, then maximum likelihood. Can be abbreviated.
- **n.cond** is only used if fitting by conditional-sum-of-squares: the number of initial observations to ignore. It will be ignored if less than the maximum lag of an AR term.
- **SSinit** is a string specifying the algorithm to compute the state-space initialization of the likelihood; see KalmanLike for details. Can be abbreviated.
- **optim.method** is The value passed as the method argument to optim.
- **optim.control** is List of control parameters for optim.
- **Kappa** is the prior variance (as a multiple of the innovations variance) for the past observations in a differenced model. Do not reduce this.

6. forecast(): The R package forecast provides methods and tools for displaying and analysing univariate time series forecasts including exponential smoothing via state space models and automatic ARIMA modelling.

The general syntax of forecast() is:

forecast(object, ...)

arguments:

- **object** is A model for which forecasts are required.
- **…** is Other arguments passed to methods.

METHODOLOGY:

Statistical analysis:

Time series analysis is a statistical method used to analyse data that is collected over time. This data can be anything that changes over time, such as stock prices, temperature readings, or sales data.

The goal of time series analysis is to identify patterns and trends in the data, as well as to make predictions about future values. This is achieved by examining the statistical properties of the data, such as the mean, variance, and autocorrelation.

One common approach to time series analysis is to use a mathematical model to describe the underlying structure of the data. This model can then be used to make predictions about future values or to identify anomalies in the data.

There are several techniques used in time series analysis, including:

1. Smoothing: This involves removing random fluctuations in the data to reveal underlying trends and patterns.

2. Decomposition: This involves separating a time series into its component parts, such as trend, seasonal variation, and random fluctuations.

3. Autoregression: This involves modelling a time series as a function of its past values, with the assumption that the future values of the series will be related to its past values.

4. Moving averages: This involves calculating the average value of a time series over a rolling window of time, which can help to smooth out random fluctuations and reveal underlying trends.

Time series analysis is used in a wide variety of applications, including finance, economics, engineering, and environmental science. It can be used to make predictions about future values, to detect anomalies in the data, and to identify underlying trends and patterns that might not be immediately apparent.

Autocorrelation function:

Autocorrelation is a measure of the correlation between a time series and a lagged version of itself. In other words, it is a measure of how closely related a time series is to its past values.

Autocorrelation can be measured using the autocorrelation function (ACF), which calculates the correlation between a time series and its lagged values at different time lags. The ACF can be plotted as a function of the lag to visualize the autocorrelation pattern.

If a time series exhibits strong positive autocorrelation at lag 1, for example, this means that the current value of the series is strongly correlated with the value of the series one time step in the past. This can indicate that the time series has a trend or a cyclic pattern.

On the other hand, if a time series exhibits strong negative autocorrelation at lag 1, this means that the current value of the series is strongly negatively correlated with the value of the series one time step in the past. This can indicate that the time series is oscillating or fluctuating randomly around a mean.

Autocorrelation can be useful for identifying underlying patterns and trends in a time series, and for selecting appropriate models for forecasting and prediction. For example, if a time series exhibits a seasonal pattern, this can be detected through the autocorrelation function, and a seasonal model such as the seasonal ARIMA model can be used for forecasting.

It is important to note that autocorrelation does not imply causation, and other factors such as external events or changes in the underlying system can also affect the behaviour of a time series. Therefore, it is important to carefully interpret the results of autocorrelation analysis in the context of the specific application.

The general regression equation of autocorrelation is known as the autoregressive (AR) model, and it is given by:

$$Y_t = c + \varphi_1 Y_{t-1} + \varphi_2 Y_{t-2} + ... + \varphi_p Y_{t-p} + e_t$$

where Y_t is the value of the time series at time t,

c is a constant,

$\varphi_1, \varphi_2, ..., \varphi_p$ are the autoregressive coefficients at lags 1, 2, ..., p,

$Y_{t-1}, Y_{t-2}, ..., Y_{t-p}$ are the lagged values of the time series,

and e_t is the error term at time t.

This equation expresses the current value of the time series as a function of its past values, with the autoregressive coefficients determining the strength and direction of the relationship at different lags. The error term represents the part of the time series that is not explained by the autoregressive model.

The AR model is a type of linear regression model that can be used to capture and model the autocorrelation in a time series. It assumes that the time series is stationary, and that the autocorrelation can be explained by a linear relationship with its past values.

The AR model can be extended to include other explanatory variables, such as external factors or other time series, using the autoregressive integrated moving average (ARIMA) or the vector autoregression (VAR) models. These models can be used for forecasting and prediction of the time series values.

Partial autocorrelation function:

Partial autocorrelation is a statistical measure that assesses the direct association between two time points in a time series, while controlling for the correlation at intermediate time points. In other words, partial autocorrelation measures the correlation between a time series and a lagged version of itself, after removing the effects of the other lagged values.

Partial autocorrelation can be computed using the partial autocorrelation function (PACF), which measures the direct correlation between two time points in a time series, while adjusting for the correlation at intermediate lags. The PACF is a useful tool for identifying the appropriate order of an autoregressive (AR) model, which is a model that regresses the current value of a time series on its past values.

For example, if the PACF of a time series exhibits a significant spike at lag 1 and no significant spikes at other lags, this indicates that an AR(1) model may be appropriate for modelling the time series. The AR(1) model includes only the first lag of the time series in the regression equation and assumes that the other lags have no direct effect on the current value of the time series.

Partial autocorrelation can help to identify the underlying structure and dependencies in a time series and can be used to select appropriate models for forecasting and prediction. It is important to note that partial autocorrelation analysis assumes that the time series is stationary, and that the autocorrelation can be explained by a linear relationship with its past values. If the time series is non-stationary, additional steps such as differencing or detrending may be required to obtain meaningful results from partial autocorrelation analysis.

ARIMA(Autoregressive Integrated Moving Average):

ARIMA stands for Autoregressive Integrated Moving Average. It is a popular time series model used for analysing and forecasting time series data. The model combines the concepts of autoregression (AR), differencing (I), and moving average (MA) into a single framework.

The ARIMA(p, d, q) model is a generalization of the autoregressive (AR) model, the moving average (MA) model, and the ARMA (autoregressive moving average) model. The model is defined by three parameters:

1. p: the number of autoregressive terms (lags) to include in the model. This parameter represents the degree of dependence between the current value and the past values of the time series.
2. d: the order of differencing required to make the time series stationary. This parameter represents the number of times the time series needs to be differenced to remove the trend or the non-stationarity from the data.
3. q: the number of moving average terms (lags) to include in the model. This parameter represents the degree of dependence between the errors of the model and the past errors of the time series.

The ARIMA model assumes that the time series is stationary after differencing. The stationarity condition is required to satisfy the assumptions of the model, including the constant mean and variance, and the independence of the residuals. The order of differencing, d, is determined by examining the pattern of the autocorrelation function (ACF) and the partial autocorrelation function (PACF) of the time series.

The ARIMA(p, d, q) model is estimated using maximum likelihood estimation (MLE) or least squares estimation (LSE) methods. The model parameters are estimated by minimizing the sum of squared errors between the observed values and the predicted values of the time series.

The ARIMA model can be used to forecast future values of the time series based on its past values and the estimated parameters of the model. The selection of the appropriate order (p, d, q) for the ARIMA model is typically based on the ACF and PACF of the time series, as well as other model selection criteria such as the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC).

Augmented Dickey-Fuller (ADF) test:

The Augmented Dickey-Fuller (ADF) test is a statistical test used to determine whether a time series is stationary or not. It is an extension of the Dickey-Fuller (DF) test, which is a simpler version of the ADF test.

The ADF test is used to test the null hypothesis that a unit root is present in a time series, indicating that the series is non-stationary. The alternative hypothesis is that the series is stationary. If the null hypothesis is rejected, then the time series is considered stationary.

The ADF test is performed by estimating a regression model of the form:

$$\Delta y_t = \alpha + \beta_t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + ... + \delta_p \Delta y_{t-p} + e_t$$

where y_t is the time series,

Δy_t is the first difference of the time series, t is a time trend,

and e_t is a white noise error term.

The parameter β represents the degree of non-stationarity in the time series, while the parameter γ represents the degree of dependence between adjacent observations in the time series.

The ADF test compares the value of the test statistic, which measures the strength of the evidence against the null hypothesis, to critical values from a table of values based on the sample size and the level of significance. If the test statistic is less than the critical value, the null hypothesis is rejected, and the time series is considered stationary. If the test statistic is greater than the critical value, the null hypothesis is not rejected, and the time series is considered non-stationary.

The ADF test is commonly used in econometrics and finance to test for stationarity in financial time series data, such as stock prices, exchange rates, and interest rates. It is a useful tool for identifying trends and patterns in time series data and for developing statistical models to forecast future values of the series.

DATA COLLECTION AND DATA SOURCE:

The present study is based on secondary data.
The secondary data is collected form books, journals, and company websites. The entire secondary data were collected form official websites of Yahoo Finance. The data from 2019 to 2022 of ONGC.NS(Oil and Natural Gas Corporation equity NS) is used to forecasting the future stock values of ONGC.

Data for our objective was collected through website i.e.., secondary data.
https://finance.yahoo.com/quote/ONGC.NS/history?period1=1546300800&period2=1672444800&interval=1d&filter=history&frequency=1d&includeAdjustedClose=true

The data we collected consists of five components namely

- OPEN: The first price at which the stock opens in the morning when the market opens at 9:15 AM.
- HIGH: The stock price reached at the highest level throughout the trading day.
- LOW: The stock price reached the lowest level throughout the trading day.
- CLOSE: The final price of the stock when the market closes for a day or The stock price at which it remains at the time of closing the market at 3:30 PM.
- VOLUME: Volume is nothing but quantity of shares.

Our main objective is to analyse the historical data. We have collected past 3 years data to analyse by calculating trend, seasonal indices, and later finding the best model to data for forecasting the future values by using the R programming language.
The data is as follows:

Date	Open	High	Low	Close	Adj Close	Volume
########	150	150.1	148	148.5	110.21732	4496586
########	148	148.35	145.75	147.05	109.14109	17436694
########	145	145.65	141.6	142.4	105.68984	26599483
########	142.05	146.2	142.05	145.7	108.13912	7395898
########	147.55	148.4	145.75	147.85	109.73486	12700566
########	149.1	149.1	146.3	147.45	109.43797	6163846
########	147.9	148.2	144.85	145.3	107.84226	4951441
########	145.9	147	143	143.25	106.32071	7131028
########	144	145.5	143.65	144.65	107.35982	7665486
########	145	145.2	142.5	143.45	106.46915	6028078
########	144.7	145.5	144.05	145.15	107.7309	3680774
########	145.2	147.25	145.2	146.35	108.62156	3667241
########	146.5	147.45	144.45	145	107.61958	5142302
########	145.1	147.7	145.1	146.75	108.91842	4904282
########	147	147.2	144.1	144.7	107.39691	4087312
########	145.5	146	144.05	144.35	107.13715	4113351
########	144.7	145.55	143	143.3	106.35783	4946218
########	143.4	143.95	141.05	141.7	105.17029	3820645
########	142.1	144.45	141.65	142	105.39296	3871762
########	142.5	142.95	139.65	141.65	105.13319	2910523
########	142.3	143.7	140.1	141.05	104.68787	7282910
########	141.45	141.5	138.5	139.7	103.68591	8511453
########	140.2	142.8	139.25	141.25	104.83633	28107358
########	141	143.3	139.8	141.8	105.24451	5260578
########	142.5	147.45	142.45	146.25	108.54732	9532350
########	146	148.2	142.3	142.95	106.09806	5413425
########	143.4	147.75	142.5	146.7	108.88131	5075180
########	146.9	148.3	145.5	147.9	109.77196	6080631
########	146.3	148.3	143.15	144.15	106.98869	4510762
########	143.25	143.65	137.1	138.2	102.57258	6424512
########	138.5	140.95	136.55	137.45	102.01593	6816203
########	133.5	134.2	127.6	132.15	98.082253	25346334
########	138	140.9	133.4	135	100.19754	37975666
########	136.8	138.9	135.8	137.1	101.75617	10614715
########	137.2	140.35	137.2	139.15	103.2777	9077045
########	141.6	145.35	140	144.05	106.91449	14236359
########	145	148.6	144.2	146.95	109.06686	13876243
########	148.6	150.5	147.1	148.6	110.29152	18273813
########	149	149.35	145.7	147.75	109.66063	20216077
########	147.5	149.2	146	147.5	109.47507	12458860
########	148.75	149.75	146.5	148	109.84618	11868751
########	144.4	150.75	143.1	148.65	114.38624	48854712

########	149.9	150.2	147.85	149.1	114.73252	9764801
########	148.75	155.65	147.85	155	119.27255	11194669
########	155.1	157	152.8	154.8	119.11868	15648948
########	154.8	155.5	151.5	152.05	117.00254	30210637
########	152.1	152.6	147	150.4	115.73286	17986042
########	151.55	154.3	151.1	153	117.73358	15880368
########	154	155.6	151.1	151.85	116.84865	10818012
########	151.25	151.25	145.7	149.75	115.23269	21001041
########	150	152.5	149.5	151.05	116.23303	6328309
########	151.9	157.45	151.2	156	120.04207	15483879
########	155	157.3	153.6	154.65	119.00325	7575127
########	155.95	163.2	154.8	157	120.81156	18289779
########	156.65	157.05	150.6	151.85	116.84865	28675956
########	152.95	153.45	148.45	152.35	117.23339	26751005
########	152	160.55	150.7	158.65	122.08123	22638399
########	159	163.05	158.7	160.05	123.93976	16694599
########	160.15	161.4	157.5	160.1	123.97851	10063152
########	160	160.25	155.2	155.9	120.72605	25492224
########	160.5	160.95	155.8	157.25	121.77148	20605152
########	159.2	159.7	156.4	157.5	121.96511	10435568
########	158.55	159.1	154.6	155.45	120.3776	8283863
########	155.25	156.35	153.3	155.25	120.22271	10752094
########	156	157.15	153.95	156.55	121.22941	6797106
########	157.8	160.25	156.55	158.1	122.42974	13120469
########	158.6	158.9	157.05	157.55	122.0038	8487177
########	156.95	159.95	156.8	158	122.35228	9363447
########	158	159.4	155.9	158.6	122.81693	5279154
########	159	159.65	157.25	157.6	122.04253	5631030
########	158.3	158.3	156.1	156.45	121.15197	3902646
########	156.5	161	155.85	160.45	124.24951	8394765
########	160.85	162.2	159.05	160.6	124.36567	9606055
########	160.7	161.5	156.9	157.9	122.27484	5543020
########	158	165	157.6	163.75	126.80499	10137024
########	165.7	170.45	165.7	168.65	130.59944	33596281
########	168.35	170	166.55	168.85	130.75433	1.34E+08
########	169.5	169.95	167.9	168.4	130.40582	8708111
########	168	171.15	166.15	169.2	131.02535	9844317
########	169.3	172	168.4	168.9	130.79303	22056708
########	168.85	171.9	168.7	170.25	131.83846	12720120
########	170	171.7	168.15	170.15	131.76102	18962836
########	170.4	172.5	168.6	171.7	132.96129	9042790
########	171.4	171.4	167.75	168.9	130.79303	8603091
########	167.4	170.1	167.4	169.4	131.18022	6869953

########	168.4	169.4	165.7	166.3	128.77965	6195094
########	167.2	167.9	163	164.1	127.07603	7792358
########	162	165.4	160.85	164.15	127.11472	7268915
########	164.6	165.2	161.8	162.75	126.03062	5412275
########	163.4	166.9	162	165.95	128.50861	5197438
########	166.5	168	162.1	167.35	129.59276	5532072
########	170	176.6	169.1	176	136.29115	7103649
########	175.1	176.5	173.8	174.75	135.32317	7135887
########	174.85	178	174.15	177	137.06554	10347293
########	178.5	178.9	173	174.15	134.85855	9247879
########	174	175.9	168.8	174.4	135.05212	9263195
########	174	175.2	172.55	173.65	134.47133	7461458
########	173.15	176.4	171.6	175.3	135.74907	16628505
########	173.9	174.65	170.35	171.55	132.84517	7205487
########	172	172	167.55	169.45	131.21893	21945960
########	168	173.95	166.55	171.95	133.15491	17113729
########	173	173.2	167.5	172.15	133.3098	17756361
########	172.9	173.5	170.05	170.6	132.1095	8578302
########	170.5	172.1	168.85	169.4	131.18022	14152285
########	169.6	170.1	166.55	167.5	129.70889	5052519
########	168.1	169	163.2	164.65	127.50191	10866149
########	164.85	170.35	164.85	169.25	131.06407	11282418
########	168.05	171.45	166	170.85	132.3031	9478876
########	168.8	170.2	167	168.95	130.83177	6678516
########	168.95	171	168.45	169.3	131.10278	7153585
########	169.5	169.95	162.95	164.4	127.3083	4603627
########	164	166.95	163.25	166.15	128.66347	5808715
########	166.8	169.1	164.6	167.35	129.59276	4625698
########	166.3	172.75	166.3	172	133.19362	5793816
########	171.75	173.45	169.8	170.95	132.38054	11402911
########	171.15	171.85	164.85	165.2	127.92783	6585159
########	165.5	168.45	165.5	166.2	128.70221	6697367
########	166.1	169.15	166.1	167.55	129.74764	5978575
########	167.55	171.8	167.25	170.6	132.1095	36738164
########	170.3	171.3	166.65	167.75	129.90251	5325984
########	168.2	170.4	159.25	161	124.67542	15160240
########	163	166.25	161.5	165.65	128.27629	10975678
########	165.8	167.95	163.5	166.3	128.77965	8253849
########	166.4	168.9	166.1	167.1	129.39916	8827834
########	167.1	168.05	160	161.5	125.06259	14509056
########	161.45	161.5	151.05	152.4	118.01572	10273814
########	152.4	155.45	150.65	153.4	118.79012	15033604
########	153.05	154.4	149.65	151.65	117.43494	5310646

########	153	154.1	152	153.1	118.55782	6576542
########	153	153.35	148	149.7	115.92492	13015538
########	150	151.7	148.8	150.7	116.6993	8465078
########	151	154.4	150.7	152.25	117.89957	12865346
########	152.4	153.65	149	149.9	116.0798	8046201
########	149.95	150.8	143.05	143.4	111.04631	15971004
########	144.5	145.8	140.4	143.9	111.4335	25660025
########	144	147.4	140.65	146.65	113.56304	12077069
########	146.5	147.75	144.15	144.6	111.97558	5519598
########	145.4	145.85	142.9	143.6	111.2012	9202665
########	144.3	144.8	141.4	143.85	111.39479	28004780
########	144.4	144.4	141.4	141.9	109.88474	10055490
########	142	142.4	138.35	140.35	108.68446	19155260
########	141.4	141.8	138.1	138.75	107.44543	11943745
########	137.7	139.7	136.25	138.85	107.52288	9857785
########	138.5	139.75	135.1	136.9	106.01283	9105690
########	136	136.35	132.75	134.35	104.03816	9912972
########	132.8	132.9	130.1	131.3	101.6763	9551686
########	130.85	132.5	129.35	131.45	101.79245	11765339
########	131.45	131.85	128.4	130.5	101.05679	13083927
########	130.5	132.7	127.9	130.85	101.32782	10164125
########	131.65	132.4	129.65	130.95	101.40527	8847432
########	130.95	133.5	125.5	127.75	98.927246	12944927
########	129	129.8	125.75	126.85	98.230301	14449993
########	127.7	129.1	126.4	127.9	99.043404	12017531
########	128	128.5	126.05	126.3	97.804382	5695238
########	126.6	126.85	124.35	125.05	96.836418	6214250
########	125	125.55	119.65	121.2	93.855042	9765538
########	121.2	121.5	116.2	116.95	91.127823	8867462
########	116.35	123.45	115.75	122.25	95.257614	10008179
########	124	125.05	119.6	123.75	96.426407	11056410
########	124.1	126.4	123.15	125.6	97.867935	18829260
########	125.05	125.95	120.4	121.2	94.439453	11763326
########	120	124.25	119.5	123.25	96.036797	30777971
########	123.5	125.75	119.5	121.2	94.439453	9910931
########	120.5	120.5	116.5	117.15	91.283661	8243808
########	117.5	119.4	115.55	119	92.725182	8873226
########	119.45	129.9	119.45	125.15	97.517296	32226347
########	126.4	128.55	124.5	127.95	99.699051	15759526
########	127.3	129.95	126	129.4	100.82891	9454697
########	129.2	130.9	125.15	125.75	97.984818	11398745
########	126.25	128.35	125.25	125.9	98.1017	8659474
########	126.25	129.3	125.35	128.85	100.40035	13251256

########	130.95	133.25	128.5	130.7	101.84187	18224041
########	130.75	132	129.05	129.7	101.06266	11879210
########	129.7	129.95	125.95	127	98.958817	12238136
########	127	127.25	123.65	124.3	96.854973	8680319
########	124.4	134.95	121.6	133.6	104.10157	30270009
########	137.45	140.85	134.95	136.3	106.20541	17685955
########	136.25	139.8	132.8	133.5	104.02365	16012272
########	132	133.65	130.7	131.45	102.42628	5824582
########	131.8	138.05	131.2	137.05	106.78982	19764328
########	135.9	136.1	130.45	131.5	102.46524	11359611
########	131.1	132.9	128.55	131.8	102.69901	11625597
########	131.5	133.35	126.75	128.2	99.893852	10259184
########	128.2	129.85	125.4	128.1	99.815941	7082143
########	129.95	132.75	127.3	129.55	100.9458	20137433
########	129.55	129.75	125.4	126.55	98.608177	9194007
########	126.45	127.15	123.95	125.85	98.062737	15309757
########	125.85	127.1	125.1	125.5	97.790009	6169256
########	126.3	129.9	126.1	129	100.51724	11840486
########	129.45	136.45	129	135.25	105.38724	19460416
########	137	139.15	135.35	138.65	108.03654	17145941
########	140	143.2	138.3	141.65	110.37415	15149481
########	141.1	141.9	139.15	141.4	110.17934	9372042
########	140.1	144.5	139.9	143.5	111.81569	17597233
########	143.5	146.15	142.2	144.25	112.40007	11582273
########	144.25	144.95	141.25	141.9	110.56895	7500868
########	141.9	142.2	139.05	140.7	109.63391	6919238
########	141.6	141.6	138.1	139.55	108.73782	6636201
########	140.35	140.85	139	139.85	108.97158	698557
########	140.55	143.85	138.2	142.15	110.76374	8236221
########	144	144	139.8	140.55	109.51703	7064774
########	140.6	142.2	139.65	141.7	110.4131	22281969
########	140.55	144.75	140.1	144.15	112.32215	8049866
########	144.15	149.65	144.15	147.4	114.85457	11733406
########	148.2	148.75	145	146.35	114.03641	7883507
########	146.35	148	143.85	144.65	112.71177	6207456
########	144.95	145.05	140.4	142.05	110.68582	7332352
########	141.95	143.5	137.6	138.3	107.76382	8252930
########	138.4	139.75	136.65	139.1	108.38719	7032172
########	139.1	140.4	137.5	138.2	107.6859	7969923
########	138.2	139.25	135.65	136.2	106.12749	8178628
########	137.3	138.8	135.15	135.55	105.621	8390855
########	135.45	136.1	133.2	133.9	104.33533	6851414
########	135	135.1	132.8	133.25	103.82884	5821375

########	132.85	135.25	132.25	133.7	104.17947	7657346
########	133.7	134.5	130.6	131.15	102.19251	7946555
########	131	134.65	130.8	133.85	104.29637	6323556
########	133.85	134.55	130.5	130.95	102.03667	11930938
########	131.85	133.4	129.25	130.25	101.49123	16115025
########	130.4	133.05	129.55	132.65	103.36131	5343104
########	132.4	133.55	131.1	133.15	103.75091	6663638
########	133.05	133.45	130.5	131.75	102.66003	9434148
########	131.05	131.45	127.55	128.1	99.815941	15010167
########	128.1	128.4	126	127.65	99.465294	7809967
########	126.9	130.65	126.85	130.05	101.33539	5821599
########	129.3	130.4	128.45	128.9	100.43931	4185400
########	129.5	129.5	126.3	126.55	98.608177	5097809
########	126.9	127.8	125.6	126.3	98.413376	3841176
########	126.4	128.3	124.9	125.2	97.556252	6125011
########	126.1	128.5	125	128	99.738014	6878932
########	128.1	128.3	125.35	125.9	98.1017	9804404
########	126.45	127.45	126	126.5	98.569221	6663052
########	126.5	126.95	125	125.6	97.867935	6241723
########	125.15	126	124.3	125.3	97.634178	8062616
########	125.6	125.65	124.15	125.1	97.478333	6687482
########	125.1	126.85	124.2	125.7	97.945854	6223102
########	126	126.8	124.85	125.15	97.517296	8515990
########	124.9	126.3	124.05	124.65	97.127693	10466423
########	124.9	126.6	124.7	126	98.179611	9979742
########	126	129.55	124.5	128	99.738014	23164167
########	129.5	129.9	127.2	128.4	100.0497	8435235
########	128.4	129.25	127.1	127.95	99.699051	4023932
########	127.2	129.25	127.2	128.8	100.36139	5102473
########	128.75	128.9	126.85	127.45	99.309464	2574894
########	127.65	128.65	127.1	128.05	99.776985	4759843
########	131	133.4	128.05	128.45	100.08866	31381588
########	129.7	129.8	125.1	126.25	98.37442	14611204
########	125.6	127.7	125.4	125.75	97.984818	7193304
########	125	125.45	123.2	123.45	96.19265	6236192
########	124.95	125.1	122.8	123.7	96.387444	10135017
########	124.45	125.2	123.7	124.15	96.738091	6550218
########	124.25	125.7	124.25	125.45	97.751045	5737187
########	125.45	125.65	123.8	125.05	97.439377	12432511
########	125.05	125.5	124.25	124.65	97.127693	5714614
########	125	125.2	124.05	124.5	97.010818	7322878
########	124.55	125.55	124	125.4	97.71209	8561603
########	126	126.75	120	122.9	95.764091	16106541

########	123.05	124.5	122.4	122.75	95.647209	6497799
########	122	122	116	116.4	90.699265	23639592
########	117.25	118.95	116.4	117.8	91.790154	21105999
########	118	119.8	117.3	118.35	92.218712	11172364
########	118.35	118.5	116.8	117.25	91.361588	12078165
########	117.55	117.7	115.6	116.6	90.855103	11611352
########	117.35	118.15	116.45	117.65	91.673271	15562740
########	117.55	117.55	115	115.6	90.075912	21142714
########	115.8	116	106.75	108.95	84.894196	83360147
########	104.35	104.95	101.55	103.45	80.608589	18445537
########	104.1	106.9	103.8	106.15	82.712433	16896688
########	106.4	107.4	105.1	106.8	83.218925	11348275
########	106.8	107.8	106.3	107.25	83.56955	10750236
########	107.3	109.75	106.55	109.25	85.127953	21415595
########	109.15	109.15	105.75	106.2	82.751396	32081049
########	107.15	107.65	106.3	106.8	83.218925	20946852
########	107	107.8	106.5	106.7	83.140984	13053367
########	107	108.2	104.25	105.35	82.089066	17702073
########	105.55	106.3	103	103.3	80.491707	26644685
########	101.5	102.9	98.8	99.95	77.881371	36666416
########	99.95	100.25	96.55	99.3	77.374901	35575369
########	100.3	102.2	98.8	101.7	79.244965	21806183
########	102	104.1	101.7	102.8	80.102097	28378025
########	102.5	102.5	97.2	98.05	76.400887	20167769
########	98.7	100.25	97.25	97.55	76.011284	18255196
########	97.4	98.5	95.5	95.8	74.647682	16192058
########	95.7	96.2	92.05	93.35	72.738632	29616674
########	90.3	92.7	89.5	91.95	71.647736	30416954
########	94	95	88.25	89.1	69.42701	24442896
########	90.9	94	89.65	93.35	72.738632	24098468
########	94.2	94.9	90.7	92.8	72.310066	22998427
########	93.35	94.4	92	92.6	72.154236	16357817
########	89.5	91.5	87.65	88.5	68.959488	17823038
########	82.15	82.5	74	74.55	58.089615	86655504
########	76.75	77.4	71.05	71.7	55.868874	63562895
########	66.6	68.4	62	62.5	48.700211	76137223
########	59.4	67	50	65.9	51.349503	73051747
########	63.5	65.2	60	60.15	46.86908	49829392
########	61.1	63	59.65	60	46.752201	46722476
########	61.6	86.8	57.5	68.15	53.102707	1.78E+08
########	62.15	64	58.1	61.05	47.570362	61258526
########	63.05	74.4	62.75	72.35	56.375362	1.29E+08
########	60.65	65.5	60	60.4	50.557858	36058875

########	63.5	64.7	60.1	62.5	52.315659	38808651
########	61.2	63	60	61.55	51.520462	28639475
########	61.85	65.6	59.65	64.75	54.199024	46474588
########	66	66	62.8	64.45	53.94791	33298637
########	61.05	65.65	60.1	63.35	53.027153	32929981
########	65	69.65	63.55	68.3	57.170555	45891607
########	67	67.25	65.1	65.75	55.036076	21883386
########	69	71	66.5	69.85	58.467983	39757833
########	71.2	74.4	70.2	72.9	61.020988	30982061
########	72.4	76.35	71	74.45	62.318405	30555738
########	76	77.65	76	77.3	64.704018	19209747
########	78.8	78.8	72.65	75.05	62.820652	22311833
########	75.1	76.45	73.5	74.35	62.234707	22311032
########	74	76.5	73.4	75.45	63.155476	24473640
########	77.8	77.8	75.15	76.3	63.866962	14561017
########	75.35	75.65	73.8	74	61.941753	15698459
########	69.7	70.75	67.2	69.35	58.049458	27607022
########	65.9	66.35	60.8	65.35	54.70126	73840707
########	67.5	69.05	66.55	67.35	56.375362	38207377
########	67.15	69.5	66.6	67.6	56.584618	31588097
########	68	69.5	67.65	68.45	57.296108	16723889
########	67.8	69.7	67.1	69.2	57.923904	20422626
########	69.4	70.95	68.7	70.5	59.012066	18023637
########	72.6	81.05	71.5	79.9	66.880348	54290691
########	76	77.85	74.05	76.55	64.076233	28640967
########	78.9	81.9	78.15	78.45	65.666618	61865481
########	81.35	81.35	77.45	79.25	66.33625	38948167
########	78.3	78.3	75.1	75.6	63.281025	20794229
########	76.4	77.2	74.75	76	63.615845	18523649
########	76	78.15	74.5	77.05	64.494759	15701754
########	76.95	77.35	74.5	76.3	63.866962	14186736
########	79	79.05	76.25	78.2	65.457367	20493531
########	77	77.35	75.2	76.15	63.741405	13344652
########	77.25	78.5	75.9	76.15	63.741405	16835999
########	76.95	76.95	72.4	72.9	61.020988	13014456
########	74.4	78.7	74.1	77.15	64.578453	42315983
########	77.2	78.5	76.3	78	65.289955	12969847
########	78.75	79	76.4	77	64.452896	17999828
########	76.95	76.95	75.4	76.15	63.741405	12443419
########	77	78.2	76.6	77	64.452896	11837966
########	77.2	78.2	75.9	77.95	65.248093	11655865
########	77.5	80.95	77.4	78.85	66.001442	18645811
########	78.05	83.75	77.4	83.2	69.642593	40559441

########	85	86.5	83.65	83.95	70.270401	25047349
########	84.45	84.9	82.6	84.3	70.56337	15367928
########	86.05	87.45	85.3	86.3	72.237465	23936651
########	85	86.05	84	84.9	71.065605	15120972
########	85.1	88.8	85	86.95	72.781555	18202925
########	90	93.1	89.2	90.95	76.129745	32511374
########	91.95	92.4	89.35	90	75.334557	16702413
########	90.6	91.5	87.7	88.25	73.869713	17382514
########	88.3	89.55	86.5	86.9	72.739693	14275999
########	81.55	84.2	81.55	83.9	70.228546	20601082
########	84	85.9	83	84.1	70.395958	17274210
########	85.5	85.75	82.35	83.9	70.228546	13467530
########	83.6	84.75	83.2	84.2	70.47966	15440371
########	83	83.95	81.8	83.6	69.977425	18460298
########	85.5	86.3	84.3	85.75	71.777092	21920473
########	86.1	86.2	84.1	84.85	71.023735	19227535
########	85.5	86.5	84.4	85.65	71.693382	23440997
########	86.25	86.65	82.55	83.1	69.558899	33080229
########	82.25	84	80	81.6	68.303322	1.21E+08
########	83.1	84.8	82.5	84.15	70.43782	23684852
########	83.95	84.1	81.6	82.4	68.972977	14299071
########	83.5	83.55	80.65	81.35	68.09407	25762293
########	79	80.95	78.3	80.45	67.340729	35344784
########	81.35	84.15	81.1	81.85	68.512596	35154027
########	82.45	83.35	81.6	82.4	68.972977	16786174
########	83.05	84.9	82.8	83.75	70.102982	17510294
########	83.75	83.8	81.8	81.95	68.596283	20123433
########	82	82.9	81	81.3	68.052216	18626174
########	81.6	82.25	79.9	80.2	67.131462	17348038
########	80	80.15	77.7	78.55	65.750336	17773167
########	79.2	79.55	78.4	78.9	66.043297	9360631
########	78.5	78.95	77.15	77.35	64.745872	9303879
########	78	78.2	75.85	76.25	63.825115	14377090
########	76.4	76.7	75	76.15	63.741405	10604062
########	76.3	80.65	76.3	80.35	67.257011	24934060
########	81	81.25	79.2	80.3	67.215172	15570346
########	80.6	82.9	80.35	82.45	69.014824	20976092
########	82.75	83.5	81.7	82.6	69.140381	17882873
########	82.5	83.85	82.05	82.65	69.182228	14673501
########	82.1	82.4	80.25	81	67.801102	10000280
########	81.4	82	80.1	80.8	67.63369	8510736
########	81	81.25	79.3	79.9	66.880348	10616766
########	79.8	80.7	79.3	79.5	66.545517	9905015

########	80	80.4	77.5	77.7	65.038834	9668266
########	77.95	78.85	77.15	78.3	65.541061	10963756
########	78.35	78.5	75.55	75.9	63.532143	11874183
########	76.3	77.7	75.9	76.1	63.699551	13360346
########	76.5	77.5	76.3	76.95	64.411041	9077292
########	77.85	79.95	77.05	78.05	65.331802	26386380
########	78.15	79.4	78.1	78.65	65.834038	11786462
########	79.5	79.75	78.9	79.05	66.168846	7067852
########	79.55	80	78.2	78.45	65.666618	10835360
########	78.45	79.1	77.7	78.1	65.373642	10481019
########	78.55	79.45	78.4	78.6	65.792168	7316635
########	78.7	78.95	76.95	77.1	64.536606	11635634
########	77.5	79.8	77.4	79.3	66.378128	13610411
########	79.75	81.9	79.15	80.65	67.508133	28329507
########	80.85	81.7	79.1	79.55	66.587372	12081197
########	79	83.25	77.9	82.15	68.763702	37457277
########	82.95	83.45	80.65	81.05	67.842957	17027574
########	81.3	81.85	80.6	81.25	68.010361	9797861
########	81.4	82.5	80.2	80.5	67.382568	22479622
########	81.2	82.1	80.75	81.4	68.135918	15967425
########	81.8	81.95	80	80.15	67.089607	16308382
########	80.35	81.8	80	80.35	67.257011	14666431
########	81	85.5	80.9	81.95	68.596283	93192019
########	82.75	82.8	78	79.35	66.41996	38005204
########	81.15	81.75	79.5	80.3	67.215172	31151170
########	80.5	81.3	78.8	79.05	66.168846	19975929
########	78.55	79.1	77.35	77.9	65.206238	12855650
########	78.2	78.35	75.95	76.45	63.992504	16573385
########	76.55	76.65	74	74.45	62.318405	17905003
########	73.95	73.95	70.9	72.7	60.853577	28166106
########	73.5	74.4	72.65	73.65	61.648777	18646363
########	73.45	73.7	72.6	73.3	61.355808	11510019
########	73.85	74.75	73.25	73.65	61.648777	11989916
########	73.75	74.35	73.25	73.8	61.774334	8883202
########	74.25	74.45	72.55	73.05	61.146545	10284798
########	73.05	74.3	72.85	73.15	61.230259	16070680
########	73.8	74.8	72.95	74.3	62.192871	25690567
########	74	74.1	70.9	71.15	59.556149	13686080
########	71	71.3	68.75	69.5	58.175022	18042069
########	69.7	70.15	67.4	67.65	56.62648	17014238
########	66.05	67.35	65.5	66.65	55.789425	32950752
########	68	69.25	66.15	68.9	57.672787	20235576
########	69.45	73.7	69.25	71.85	60.142082	28336496

########	72.5	72.7	68.9	69.15	57.88205	20797874
########	69.4	70.45	67.6	69.25	57.965748	20069170
########	67.5	69.4	66.65	69.15	57.88205	20869186
########	69	69.7	68.4	69.2	57.923904	12608039
########	70	70.2	69	69.35	58.049458	10028285
########	69.3	73.35	69.1	70.5	59.012066	50074263
########	70.9	71	68.25	68.45	57.296108	21348017
########	69	70.6	68.25	70.3	58.844662	25747313
########	70.3	70.6	68.8	69.15	57.88205	10564850
########	69.1	69.75	68.8	69.1	57.840202	9070661
########	68.5	68.8	66.65	67	56.082386	24825690
########	67	68.5	65.7	66.05	55.287189	17333956
########	66.65	67.55	66	67.25	56.291653	18590744
########	67.35	70.45	67.35	69.3	58.007614	25987617
########	69.5	69.75	67.25	67.4	56.41721	18530340
########	68	68.6	67	67.8	56.752033	19589424
########	67.4	69.1	67.3	68.85	57.630932	26354156
########	69.2	69.6	68.6	69	57.756496	13177360
########	69.5	69.5	67.65	68.2	57.086857	14224945
########	68.1	68.45	66.5	66.85	55.956833	17088331
########	67.25	67.4	66.1	66.35	55.538303	15025477
########	66.05	66.35	64.1	64.4	53.906063	29901005
########	65	65.9	64.2	64.9	54.324585	25849220
########	65.4	66.05	64.2	65.7	54.994225	12847852
########	66	66.75	65.7	66.3	55.49646	10809489
########	66.3	66.9	65.6	66.45	55.622009	12479581
########	66.9	68.1	66.2	67.6	56.584618	17947631
########	67.7	68.2	67.2	68	56.919437	10496588
########	68.65	68.65	67.8	68.45	57.296108	8473527
########	69.05	71	68.5	70.75	59.221336	33795453
########	71.45	72.7	70.55	72.35	60.560608	23531793
########	72.5	72.9	70.75	71.55	59.890968	16446681
########	71.2	72.5	70.05	72.15	60.3932	16264536
########	74	74	72.5	72.65	60.811726	5387569
########	72.7	73.3	71	71.3	59.681713	18852045
########	71.65	72.1	70.9	71.95	60.225784	14032869
########	71.5	74.2	71.45	72.15	60.3932	27903903
########	72.45	72.7	70.7	71.65	59.974682	14790440
########	72	77.8	71.8	76.5	64.03437	44111534
########	76.75	78.05	75.4	76.1	63.699551	31379070
########	77.2	81.8	77.15	80.8	67.63369	87040163
########	81.15	81.5	79.45	80.2	67.131462	30469713
########	80.8	81.15	78	78.5	65.708473	44245938

########	78.5	82	77.05	81.55	68.26149	42923229
########	81.5	85.05	80.95	84.85	71.023735	52652362
########	85.4	89	85	88.7	74.246376	53618786
########	89.75	91	87.25	89.85	75.208992	44126894
########	91.15	94	90.75	91.55	76.631996	46638129
########	93	93.45	90.05	90.75	75.962341	34326971
########	91.5	92.85	90.9	91.2	76.33902	25763702
########	91	92.2	88.7	91.65	76.715691	25329334
########	92.6	104.4	92.6	96.8	81.026497	1.47E+08
########	98.25	102.55	97.45	101.5	84.96064	75021883
########	102.5	102.5	99.2	100.45	84.081726	33553433
########	101.9	103.6	100.65	102.9	86.132515	34618175
########	105.1	105.6	100.7	101.5	84.96064	41881430
########	101.5	102.3	98.15	99	82.868004	36480527
########	98.9	98.95	88.95	89.85	75.208992	58724337
########	89.05	92.3	86.6	90.55	75.794937	58602960
########	90.5	91.3	88.3	90.8	76.004196	29216106
########	92.5	95.5	92.15	93.15	77.971275	46351620
########	94	95.15	93.3	93.8	78.515366	17759262
########	94.2	94.65	92	93.15	77.971275	17678810
########	93.5	94.5	92.75	93.25	78.05497	15960705
########	93.3	95.55	92.55	93.05	77.88755	43701316
########	93.75	94.45	93	93.2	78.013107	15130377
########	94.05	97.3	93.7	96.95	81.152061	39545073
########	96.5	96.5	94.35	94.95	79.477959	26998014
########	98.9	99.3	96.25	96.95	81.152061	50306161
########	98	99.05	97.1	97.9	81.94725	25285200
########	98.95	101.3	98.55	100.65	84.249153	36022114
########	101.5	102.9	98.05	102.55	85.839546	36301647
########	102	104.5	100.75	103.45	86.592888	28353142
########	104.95	107.9	104.1	105.25	88.099586	42401579
########	107	107.45	104.2	105.05	87.932182	24455634
########	105.25	106.1	100.65	101.4	84.87693	28185982
########	101.4	101.85	96.05	96.65	80.900948	33623461
########	97.75	99	97.5	98.1	82.114662	26085121
########	99	99.8	97.85	98.85	82.742447	18486566
########	99.05	100.2	93.9	94.7	79.2687	26939349
########	94.6	95.45	92.5	92.75	77.636436	27311961
########	93.05	93.75	90	91.35	76.464577	28522112
########	91.4	91.75	88.9	89.7	75.083427	34022621
########	89	91.4	88.8	90.65	75.878639	26810222
########	90.75	92.95	87.75	88.3	73.911575	33858273
########	89	91.2	88.45	90.85	76.046043	24228098

########	92.5	93.95	91.2	92.85	77.720139	22141489
########	94.6	95.3	93	93.35	78.138664	25912911
########	94.25	98.6	94	97.65	81.737999	49670027
########	98.95	99.95	96.8	97.65	81.737999	30514219
########	99.5	100.8	99.1	99.65	83.412102	29096831
########	99.8	103.35	99.8	101	84.542114	39638657
########	102	102.5	98.6	100	83.70507	21467230
########	100	100.35	98.9	99.45	83.24469	11287104
########	98.9	99.4	96.55	97	81.193909	18187705
########	97	99.25	95.6	98.45	82.407623	26118576
########	99.25	104.85	99.25	103.75	86.843994	76236798
########	102	103.5	100.8	102.25	87.056854	21014091
########	103.7	115.5	103.35	110.7	94.251282	1.1E+08
########	110.7	112.2	103.85	105.1	89.483376	48225988
########	105.9	108.55	105.3	106.3	90.505074	36592043
########	109.75	114.4	109.45	112.2	95.528389	90860972
########	114	115.35	111	113.6	96.720375	26071364
########	116	120.5	115.35	119.05	101.36057	62038881
########	115.5	118.4	110.05	111	94.506706	55154985
########	114.3	117.65	113.5	117.05	99.657753	41672980
########	115.9	116.65	112.75	113.5	96.635231	36303917
########	114.05	115.8	113.2	114	97.060936	19434630
########	113.95	117	112.3	112.7	95.954109	38272786
########	116.25	118.25	113.5	114.95	97.869781	57756103
########	118.95	122.35	117.2	118.25	100.67944	63866178
########	119.4	119.55	114.2	116.75	99.402328	26817643
########	116.9	117	113.6	114.4	97.401512	23841269
########	116.75	117.4	114	115.05	97.954933	20691698
########	116	116.85	112.8	114.35	97.35894	19679802
########	113.8	116.3	113.45	115.1	97.997498	20680669
########	114.8	114.85	108.75	109.35	93.101875	31017863
########	110	112.2	107.5	110.2	93.825584	26710696
########	106.25	113.25	104.45	110.5	94.081001	50386785
########	110.5	111.25	108.55	109.6	93.314735	15825065
########	109.6	110.3	106.6	107.15	91.228767	15815643
########	105	106	102.85	104.8	89.227959	31083656
########	106	107.7	101.3	102	86.844009	37295495
########	103	104	100.25	102.4	87.184555	26637085
########	104.05	106.3	102.6	103.5	88.121117	31843017
########	102.8	104.2	101.9	102.15	86.971718	19587582
########	103	105.25	101.15	104.35	88.844826	22299747
########	102.15	104.5	99.4	103.45	88.078545	24878516
########	102.65	104.4	101.3	103.95	88.50425	15156974

########	103.9	105.35	103.45	104.65	89.100235	10330347
########	103.8	105.7	103.3	103.6	88.206261	26105970
########	103	104.9	103	103.8	88.376549	17645822
########	100.85	102.25	97.45	98.05	83.480919	27005598
########	98.05	102.5	98.05	102.05	86.886566	25505623
########	104.25	106.75	103.8	105.1	89.483376	28659714
########	104.6	107.85	104.2	107.3	91.356491	21627285
########	103.95	105.95	101.9	103.05	87.737976	19166492
########	103.3	105	102.2	102.85	87.567688	23082015
########	102.4	104.45	101.65	103.1	87.780548	14844968
########	102	103.65	101.6	102.4	87.184555	12790334
########	105.25	105.7	102.5	102.8	87.525131	11797791
########	102.8	104	102.8	103.2	87.865685	8886250
########	103.75	104.4	103.3	103.9	88.461693	6887787
########	104.9	105.9	103.55	104.05	88.589401	14990087
########	104.15	112.7	103.3	108.15	92.080185	81358264
########	108.15	110.7	106	107.7	91.697029	33975507
########	108	110.3	107.7	109.65	93.357307	30811922
########	112.4	114	110.5	111.1	94.59185	47588366
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########	110.85	112.35	109.65	111.45	94.889847	28016564
########	113.85	114.95	112.5	113.9	96.9758	33477142
########	112.55	118.7	110.75	118.1	100.55173	48355326
########	118.7	121.15	113.7	115.1	97.997498	49718697
########	116	116	111.55	112.95	96.166954	23626454
########	113.95	115.4	112.25	114.25	97.273796	19960145
########	115	117.5	114.3	116.1	98.8489	29395737
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########	113.45	114.7	111.2	111.8	95.187843	21131045
########	111.05	114.05	111.05	112.75	95.996674	20562816
########	113.25	113.95	110.85	113.05	96.252106	24785960
########	114.4	117.1	113.7	114.6	97.571793	25820379
########	115.4	115.4	113	113.35	96.507523	12045621
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########	113.2	115.55	111.85	112.35	95.656105	19331994
########	112.5	114.35	111.4	113.65	96.762939	16430926
########	114.35	118.45	114.2	117.6	100.12602	51620011
########	118	119.4	116	117.75	100.25373	27162991
########	118.8	123.8	118.45	122.5	104.29794	64241347
########	124.6	126.7	123.35	125.45	106.8096	72354379
########	126.95	127.5	124.9	125.15	106.55419	28709907
########	125.75	125.9	122.65	124.8	106.25619	15261479
########	127	128	123.05	124.05	105.61763	29718157

########	123.75	124.8	122.45	123.95	105.53249	12245640
########	123.95	126.6	122.5	123.55	105.19192	18360366
########	124.4	125.8	121.25	124.8	106.25619	19547491
########	125.6	128.5	124.85	125.35	106.72446	32779493
########	127	128.25	126.1	126.7	107.87386	31654780
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########	124.55	124.55	118.9	120.25	102.38226	87912730
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########	122.7	124.2	121.5	122.05	103.91481	23629008
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########	124.45	124.45	121.35	122	103.87224	24358397
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########	122.55	124.5	121.8	122.35	104.17024	23728169
########	121.8	122.45	119.1	119.4	101.65856	20857415
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########	117.75	119.75	117.3	118.85	101.19029	16012542
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########	123	125	121.05	121.5	103.44653	30193164
########	119.9	120.4	117.8	119.9	102.08427	18479814
########	119.4	119.4	116.85	117.05	99.657753	17151883
########	117.1	118.65	116.6	117.9	100.38145	11240925
########	119	119.35	118	118.55	100.93487	8420962
########	119	120.8	118.6	120.4	102.50998	8580799
########	120.3	121.75	120.1	120.8	102.85055	12709481
########	119.2	119.4	116.2	116.9	99.530037	28589465
########	117.2	117.4	115.75	116.8	99.444893	19691248
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########	114.85	115.6	114.1	114.55	97.529221	8149770
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########	116.15	118.2	115.15	117.9	100.38145	15163353
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########	116	117	114.3	115	97.912354	8294214
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########	116.1	117.9	115.3	116.25	98.976616	13519139
########	116.8	116.95	115.35	116.1	98.8489	10342014
########	116.9	118.35	114.7	115.5	98.338066	14771886
########	116	116	112.7	113.85	96.933228	16025745
########	113.9	115.25	112.9	113.2	96.379799	10074307
########	110.65	111.75	108.5	110.2	93.825584	23878081
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########	116.75	120.4	116.75	120.15	102.29713	15933414
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########	118.9	120.15	118	118.65	101.02	13031666
########	119.95	123.5	118.8	123.1	104.80878	21326802
########	123.8	124.35	121.15	121.65	103.57424	12505630
########	122.5	122.75	119.55	119.95	102.12684	8530847
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########	128.7	129.7	124.75	127.75	110.47167	25968166
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########	144.75	146.05	141.35	144.5	124.95622	26714630
########	145.2	149.65	144.1	146.25	126.46952	42893182
########	147.8	148.5	147	147.6	127.63696	16099471
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########	170.15	170.15	159.5	160.4	138.70572	59769140
########	163.9	166.6	160.5	160.95	139.18135	30561341
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########	165.1	165.85	162.75	163.55	141.42967	11619888

########	163.65	163.8	159.7	160	138.35983	16690451
########	161	161.75	158.65	159.05	137.53832	14821875
########	163.75	165.5	161.2	162.1	140.17581	22899876
########	163.5	163.5	158	158.6	137.14919	10331930
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########	159	162.95	158.9	161.4	139.57048	34568006
########	163.55	163.95	160.3	163.1	141.04054	33022684
########	163.1	163.6	157	157.9	136.54385	21652522
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########	153.95	154.8	151.35	152.95	132.26335	20609479
########	151.2	154.2	149.8	152	131.44182	11591857
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########	140.5	144.65	140.4	144	129.12653	8561767
########	144	146.85	143.15	145.9	130.83028	10690334
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########	149.5	149.9	146.35	147.35	132.13052	7989291
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########	145.3	146.25	144.55	145.35	130.3371	12156709
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########	137.4	137.95	135.3	136.8	122.67022	4968143
########	138.5	141	137.15	140.5	125.98806	6324169
########	141.55	141.6	137.2	138.5	124.19461	5657495
########	136.55	138.05	136	137.35	123.16339	4404298
########	139.15	140.5	138.5	139.5	125.09133	8738089
########	140.2	140.85	137.45	138.9	124.5533	6571286
########	138.75	141.2	138.5	140.5	125.98806	11556524
########	140.45	142.95	139.45	142.4	127.6918	6393760
########	142.35	143.45	141.2	143.05	128.27466	3765911
########	143.1	148.6	143.1	147.8	132.53404	16351836
########	148.5	151.1	147.4	150.35	134.82068	12977680
########	150.6	151.4	148.35	150.8	135.22417	9012777
########	151.5	157.5	151.35	157.05	140.82863	30889365
########	158.25	159.4	156.4	158.35	141.99435	16418985
########	158.8	161.65	157.6	160.95	144.32581	14457548
########	162.7	165.7	161.4	164.95	147.91264	21220614
########	164.95	165.5	163.05	163.95	147.01593	7445346
########	162.95	163.3	160.2	161.05	144.41547	11646259
########	162.5	168.2	162.3	165.85	148.7197	32577835
########	168.3	168.4	163.4	163.85	146.92629	11175409
########	165.3	171	164.9	170.25	152.66522	36648534
########	170.9	170.9	166.5	166.85	149.61639	14474454
########	165.3	166.4	162.3	163.65	146.74692	8625926
########	165.2	168.3	163.75	165.7	148.58519	28783449
########	163	166.7	163	165.15	148.092	14249846
########	165.1	168.75	164.5	165.7	148.58519	25936832
########	167.55	174.7	166.25	168.8	151.36499	32790065
########	171.6	174.85	169.55	172.6	154.77251	24031034
########	174	174.9	168.5	170.95	153.29292	14220953
########	170.55	174.05	170.5	171.3	153.60678	12478192
########	170	171.25	166	167.5	150.19928	12529302
########	170	172.7	169.05	169.6	152.08238	17434362
########	170.7	173.3	169.2	172.1	154.32416	11723574
########	172	173	166.5	166.95	149.70609	13231599
########	167.9	169.6	163.1	163.95	147.01593	17938632
########	165.85	170.4	165.15	169.1	151.634	26763203
########	167.95	170.5	167.1	168.15	150.78212	12884995
########	168.9	176.35	165.2	166.2	149.03352	44604164
########	170	170	156.4	164.15	147.19528	31146458

########	164.5	168.9	164.5	168.55	151.14081	15960268
########	168.55	172.4	168.5	171.75	154.01028	24640791
########	171.2	171.75	166.7	167.9	150.55795	11829998
########	167.4	167.55	163.05	163.4	148.06601	14222260
########	166.5	166.5	163.25	164.95	149.47057	29399172
########	166.25	166.4	159.65	160.75	145.66472	21301826
########	160.75	162.4	156	156.65	141.94946	28766189
########	159.4	160.4	156.8	159.5	144.53201	20225258
########	160.5	161.85	155.8	160.65	145.57408	20210070
########	165.65	168.35	161.9	162.95	147.65825	41103406
########	168.3	171.8	162.9	170.3	154.3185	42345653
########	170.1	171	163.85	165.25	149.7424	32658756
########	167.1	189.8	167.1	186.95	169.40601	1.33E+08
########	190	194.95	177.8	179.1	162.29269	73127816
########	183	183.8	173.85	175.4	158.93991	51977091
########	168.25	176.9	165	174.35	157.98845	62112814
########	172.5	176.4	171.7	175.7	159.21175	26187452
########	174	175.5	170.6	171.8	155.67773	20214021
########	168.3	169.5	161.65	163.75	148.38318	42333127
########	166	167.85	161.85	167.3	151.60004	25545119
########	166.6	171.5	164.6	170.3	154.3185	66314748
########	171.7	175	170.3	172.55	156.35736	20614652
########	176.2	181.25	173.8	175.45	158.98521	39742745
########	176.5	177.7	174.85	175.6	159.12114	10994784
########	178.9	180.4	176.5	177.45	160.79753	20332589
########	178.5	179.25	175.1	175.8	159.30237	13608989
########	175.5	177.9	174.65	176.35	159.80077	15253027
########	174.95	175.2	170.55	171	154.95282	14210783
########	163	164.85	161.15	162	146.79739	95239532
########	161.85	165.25	161.15	163.9	148.51909	33523683
########	163.9	168.25	163.55	167.95	152.18903	28335224
########	166.95	169.05	165.35	168.05	152.27965	17745513
########	170.25	172.75	169.3	171.85	155.72305	20054934
########	170.6	173.5	170.3	172.8	156.58389	12969222
########	170.6	173.8	168.2	168.85	153.00459	24550313
########	169	171.3	168.7	170.9	154.8622	9529874
########	171	172.75	169.55	171.2	155.13405	9724979
########	171	172.2	168.2	168.9	153.04988	13184429
########	171.4	174.85	170.7	174.25	157.89783	23458303
########	176	179	175.1	175.8	159.30237	23916912
########	177.3	179.8	176	177.15	160.52568	17880666
########	176.9	177.35	174.8	175.5	159.03052	10076403
########	175.7	176.7	173.9	174.15	157.80719	12246720

########	174.15	176.3	173.7	174	157.67128	10267952
########	171	173	168.3	169.65	153.72949	12583497
########	171.1	171.7	165.7	166.95	151.28288	20086229
########	167.95	168.9	163.35	164.85	149.37994	13981957
########	166	166	162.45	164.8	149.33464	13030499
########	166.5	167.45	159.5	160.45	145.39285	15964743
########	158.15	159.25	155.9	156.35	141.67763	23405519
########	159	162.8	157.95	162.25	147.02394	23661920
########	164.2	168.4	163.4	164.85	149.37994	26878516
########	163.9	167.4	161.1	166.95	151.28288	16768573
########	165.25	167.3	162.75	164.75	149.28934	9952775
########	160.45	161.65	152.9	154.45	139.95592	22602956
########	154	160	153.75	158.6	143.71648	15084514
########	159	161	154	156.5	141.81354	21459069
########	160	160.3	152.95	153.55	139.14038	12934346
########	154.2	156.25	151.8	153.5	139.09506	13205775
########	156	163.7	155.55	163.15	147.83948	17843200
########	162	164.5	160.2	163.2	147.88478	12616832
########	158.55	162.05	157.8	160	144.98509	8932407
########	161.65	163.8	160.1	161.9	146.70679	7235654
########	161.75	164.2	154.65	155.1	140.54492	18029557
########	157.4	157.75	150.15	150.65	136.51251	19141394
########	152.9	153.25	147.6	152.6	138.27954	19366472
########	152.8	153.3	148.1	151.9	137.64522	12824105
########	155	155.5	141.1	143.8	130.30534	52469252
########	145.65	147.3	141.15	144.05	130.53189	40261336
########	145.4	153	145.4	151.25	137.05621	57675204
########	151.2	152.9	148.75	149.75	135.69698	22780094
########	147.8	152.9	146	152.45	138.1436	25429955
########	153.95	154.2	151.15	151.6	137.37338	16747177
########	153.1	156	152.8	153.95	139.50284	30327268
########	154.8	162.95	154.2	161.85	146.66148	61411715
########	163.5	166.4	162.1	163.4	148.06601	45994327
########	166	167.35	164.5	165.55	150.01427	31122996
########	164	166.65	163.35	164.65	149.19873	17812698
########	162	163.95	158.45	159.55	144.57732	12237777
########	159.55	160.55	155.3	155.95	141.31517	12844437
########	156.95	157.25	150.8	151.4	137.19214	16223385
########	149.15	151.55	142.6	143.55	130.07881	25130676
########	142.45	145.15	140.65	141.45	128.17587	22922034
########	138.6	138.9	130	134.4	121.78747	28656582
########	136.1	140.2	135	139.1	126.04642	20581784
########	136.95	136.95	131	134.85	122.19524	31824106

########	134	136.4	132.2	134.8	122.14993	26829020
########	137	141	135.2	137.35	124.46064	25461812
########	140	142.6	137.25	141.5	128.22119	24188349
########	142.8	151.75	142.15	149.35	135.33453	54387675
########	149.35	157.4	146.2	154.15	139.68407	1.66E+08
########	153	154.45	149.25	151.55	137.32805	38725546
########	148.95	151.15	130	131.05	118.75185	1.26E+08
########	129.95	129.95	124.1	126	114.17576	85993413
########	127	128.6	126	127.4	115.44438	44595740
########	123	123.5	119.85	120.95	109.59966	59092334
########	121.25	124.15	121.25	123.5	111.91037	36229792
########	126.35	126.35	121	121.5	110.09805	42778692
########	121.5	125.9	121.05	125.5	113.72268	31521678
########	124.9	126.75	123.5	124.1	112.45406	25216226
########	122.45	124.9	121.4	124.45	112.77122	27166975
########	124.4	132.6	123.8	127.15	115.21783	38464081
########	127.6	128.4	124.6	126.55	114.67415	18088858
########	127.05	130.7	126.95	129.9	117.70976	21010247
########	130.5	133.2	124.45	127.9	115.89745	33778758
########	135	136.6	132.2	132.55	120.11109	60317150
########	133	133.5	131.8	133.1	120.60947	20853780
########	133.8	133.8	131.55	132.45	120.02046	11630255
########	132	132.45	128.4	129.8	117.61916	21705935
########	130.85	131.6	127.75	128.2	116.1693	22172845
########	129.1	130.2	127.8	128.6	116.53177	20187969
########	130.4	130.5	128.25	130.25	118.02693	25736737
########	130.45	134.5	129.9	134.15	121.56094	19738642
########	134.1	139	133.2	138.4	125.4121	20592826
########	136.7	137.05	134.6	136.7	123.87162	15037928
########	136	138.45	133.8	135.65	122.92017	15853543
########	134.35	137.15	134	136.25	123.46386	14311959
########	135.1	138.5	133.6	136.5	123.69041	66480753
########	136.3	137.5	135.05	136.5	123.69041	12451233
########	136.4	136.75	133.45	133.8	121.24378	15829467
########	134.5	136	132.05	132.8	120.33763	19479706
########	133.9	139.7	133.5	139.2	126.13702	40876891
########	139.5	141.9	136.1	139.95	126.81665	31230003
########	139.95	140.8	138.7	139.65	126.54479	15694770
########	138.25	138.3	134.7	135.55	125.75621	42597708
########	137.5	138.5	134.05	134.6	124.87485	35382493
########	134.5	134.5	129.8	131.9	122.36993	31231393
########	131.9	134.2	130.1	133.75	124.08626	24268146
########	134.7	137.4	134.5	136	126.17369	22730039

########	137	138.15	136.15	136.55	126.68396	14620592
########	136.5	138.25	136.1	136.65	126.77673	12105053
########	134.2	136.6	133.75	135.9	126.08092	9198908
########	137.9	139.85	137.55	138.6	128.58585	21720398
########	135	136.25	134.15	134.7	124.96762	20349294
########	134.7	135.75	132.3	132.75	123.15851	17495310
########	132.9	133.9	132.65	133.4	123.76155	14865879
########	134.1	134.15	131.7	132.1	122.55548	10870488
########	131	132.95	130.05	132.5	122.92658	12042788
########	131.65	134.15	131.5	131.85	122.32355	14629497
########	132.5	134.2	131.95	134	124.31821	12327341
########	135	135.4	133.6	134	124.31821	13500202
########	134.2	135.15	133.5	133.9	124.22542	10846178
########	132.45	134.1	132	133.2	123.576	8597956
########	133.6	134.4	132	132.6	123.01936	10810473
########	131.1	132	130	131.25	121.7669	20909579
########	132.1	134.35	129.7	130.55	121.11748	19411428
########	131.4	133.6	131.3	133.2	123.576	13080582
########	132.2	133.2	130.05	130.9	121.44218	11156865
########	130.4	130.85	128.1	128.65	119.35474	11366882
########	128.25	129.1	127.5	128.6	119.30837	10407849
########	127.3	128.8	122.65	123.45	114.53046	12848954
########	124.35	127.9	123.85	124.45	115.45821	14465123
########	123.95	123.95	121.5	122.55	113.69549	15267018
########	123.5	128.2	123.5	126.65	117.49926	20597761
########	125.5	132.4	125.5	126.8	117.63842	33530494
########	131.7	135	130.6	132.4	122.8338	50966493
########	134.9	135	131.8	133.9	124.22542	14137567
########	136.5	136.55	132.4	132.65	123.06574	14570735
########	132.05	134.25	131.2	134.05	124.36459	13532236
########	133	134	132.2	133.25	123.62239	10183057
########	133.25	133.5	130.25	131.1	121.62774	13176461
########	131.1	132	129.1	131.35	121.85967	9401804
########	131.2	131.85	127.65	129.85	120.46806	13320136
########	132	132.8	127.05	127.6	118.38062	13205955
########	127	128.2	126	127.8	118.56617	9320940
########	128.45	129.1	127.6	128.7	119.40114	6490293
########	128.7	128.7	127.4	127.8	118.56617	7381712
########	127	131	125.8	129.6	120.23612	18748363
########	129.35	133.4	128.75	131.55	122.04522	11945173
########	133	134	132.4	132.8	123.20491	2154912
########	132.45	132.9	129.85	130.75	121.30302	10232002
########	130.75	132.2	130.3	131.8	122.27716	13865026

########	132.1	135.6	131.8	133.7	124.03987	22918037
########	134.4	135.2	132.8	134.05	124.36459	8753855
########	134.1	135.7	134.1	135.15	125.3851	11630848
########	135.85	139.2	135.35	136.45	126.59119	21117499
########	136.4	136.7	135.25	136.4	126.54479	7561534
########	136.4	138.4	136.05	137.85	127.89003	7498344
########	138.55	139	136.75	138.55	128.53946	9987481
########	138.95	139	137	138.65	128.63222	12033732
########	137.5	140.85	137.4	139.85	129.74553	15908521
########	140.6	141.3	139.2	140.45	130.30217	18492513
########	140.6	141	138.6	139.25	129.18887	12743505
########	140	143.35	140	142.35	132.06491	24636519
########	142.8	143.3	141.2	142.9	132.57515	11460200
########	141.95	143.8	141.7	143.2	132.85349	13368536
########	143.15	143.25	140.2	141.75	131.50826	19958908
########	136	136.35	134.4	135.45	131.94661	16348881
########	134.95	135.9	132.9	135.2	131.70306	11198874
########	135.55	136.65	134.55	136.5	132.96945	9010911
########	136.5	140	135.5	139.45	135.84314	11803087
########	139	141.3	137.75	140.55	136.9147	9789098
########	139.5	141.2	139.05	139.6	135.98927	8925344
########	140.05	141.1	139.5	140.25	136.62245	13558920
########	139.6	141.8	139.6	141.1	137.45047	17720938
########	141.45	142	139.8	140.05	136.42763	27727625
########	141.85	144.8	140.55	140.9	137.25565	24518337
########	141.5	143.95	140.6	143.75	140.03194	18440387
########	142.85	143.15	141.15	142.45	138.76555	10977472
########	140.8	141.75	140.1	140.65	137.0121	9731670
########	141.25	143	140.35	142.65	138.96037	10150945
########	142.5	142.95	140.3	140.7	137.06082	9438307
########	140	142.5	139.2	142.35	138.66815	8946335
########	143.05	144.65	142.55	144.35	140.61641	12593054
########	144.35	148.6	144.1	147.6	143.78235	17692988
########	147.65	148.85	146.65	147.45	143.63623	11426194
########	148.35	150.5	147	147.2	143.3927	20540447
########	147.05	147.55	145	145.8	142.02892	10635055
########	145.5	146.2	143.1	145.85	142.07762	6714207
########	146.5	146.8	142.7	143.5	139.78839	10011408
########	145	145.15	141.55	142.25	138.57072	9123323
########	140.6	143.5	139.3	139.8	136.1841	8007752
########	140.5	142.85	139.5	141.3	137.64529	7150680
########	142.1	145.4	142.1	144.8	141.05478	8765357
########	143.45	144.65	142.7	143.9	140.17804	9534858

########	142.75	146	142.5	144.65	140.90865	36752195
########	145.45	148.75	144.55	146.75	142.95433	9644998

RESULTS AND CALCULATIONS:

```
> ################# Stock Market Price Prediction using R #################
>
> ##Importing Required Packages
> library(quantmod)
> library(tseries)
> library(timeSeries)
> library(forecast)
>
> ##Importing Dataset from Finance Websites...(Default yahoo)
> getSymbols('ONGC.NS', from = '2019-01-01', to = '2022-12-31')
[1] "ONGC.NS"
> View(ONGC.NS)
> #class(ONGC.NS)
>
> chartSeries(ONGC.NS, subset = 'last 6 months', type = 'auto')
```

ONGC.NS
[2022-07-01/2022-12-30]
Last 146.75
150
145
140
135
130
125
120
Volume (millions):
9,644,998
120
80
40
0
Jul 01 2022
Jul 25 2022
Aug 16 2022
Sep 12 2022
Oct 03 2022
Oct 24 2022
Nov 14 2022
Dec 05 2022
Dec 26 2022


```
> addBBands()
```

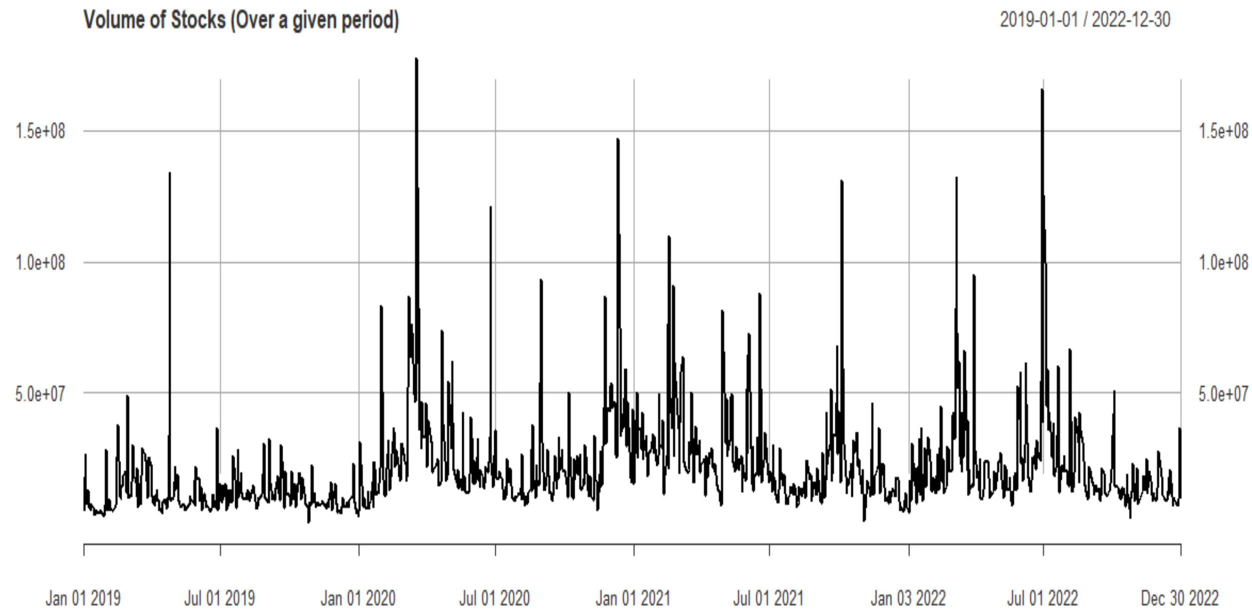

```
> ##Assigning columns of dataset
> Open_prices = ONGC.NS[,1]
> High_prices = ONGC.NS[,2]
> Low_prices = ONGC.NS[,3]
> Close_prices = ONGC.NS[, 4]
> Volume_prices = ONGC.NS[,5]
> Adjusted_prices = ONGC.NS[,6]
>
> plot(Open_prices, main = 'Opening Price of Stocks (Over a given period)')
```

> plot(High_prices, main = 'Highest Price of Stocks (Over a given period)')

> plot(Low_prices, main = 'Lowest Price of Stocks (Over a given period)')

> plot(Close_prices, main = 'Closing Price of Stocks (Over a given period)')

> plot(Volume_prices, main = 'Volume of Stocks (Over a given period)')



> plot(Adjusted_prices, main = 'Adjusted Price of Stocks (Over a given period)')

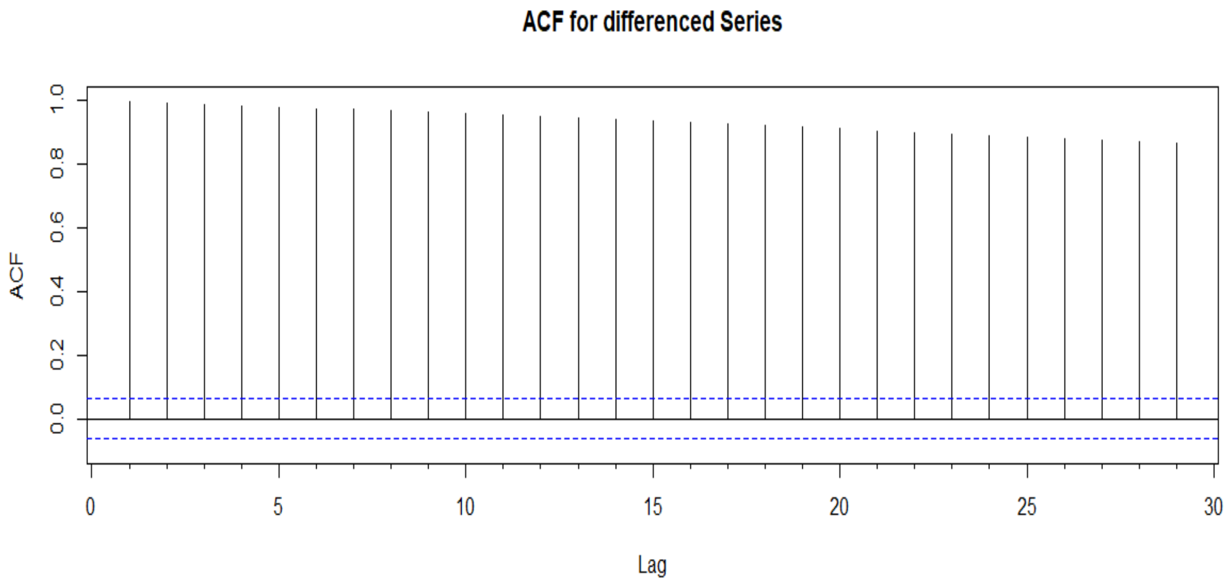
> Predic_Price = Adjusted_prices

> #class(Predic_Price)

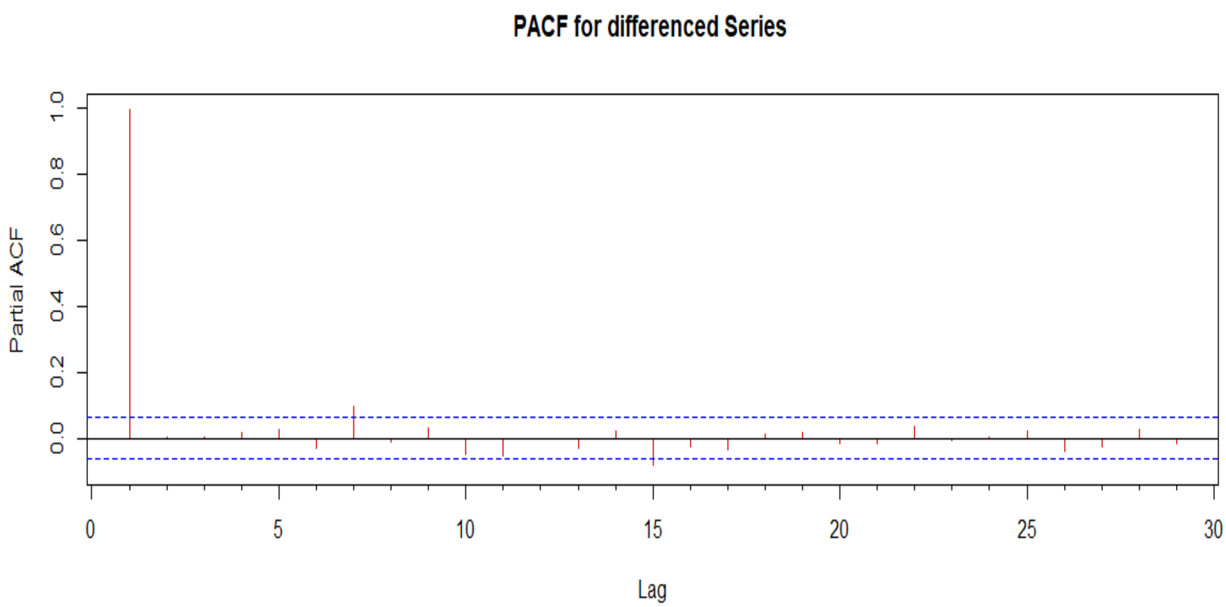
>

> ######## Finding the Linear Relation between observations ########

> Acf(Predic_Price, main = 'ACF for differenced Series')



> Pacf(Predic_Price, main = 'PACF for differenced Series ', col = '#cc0000')



> Auto_cf = Acf(Predic_Price, plot = FALSE)

> Auto_cf

Autocorrelations of series ‘Predic_Price’, by lag

```
0        1      2       3       4       5       6       7       8       9       10      11      12    13
1.000 0.995 0.990 0.985 0.981 0.976 0.972 0.968 0.965 0.961 0.957 0.953 0.948 0.944
14      15      16      17      18      19      20      21      22      23      24      25      26      27
0.939 0.934  0.929 0.923 0.918 0.913 0.908 0.902 0.898 0.893 0.888 0.883 0.878 0.872
28      29
0.867 0.862
> PAuto_cf = Pacf(Predic_Price, plot = FALSE)
> PAuto_cf
Partial autocorrelations of series ‘Predic_Price’, by lag

 1         2         3         4         5         6         7          8         9        10       11        12
 0.995  0.005  0.005  0.019  0.025 -0.027  0.094 -0.010  0.031 -0.048 -0.051  0.000
13       14        15        16       17         18       19        20       21       22        23       24
0.027  0.020  -0.080 -0.023  -0.033  0.013  0.017 -0.014 -0.014 0.036 -0.007  0.002
25       26        27       28       29
0.036 -0.007  0.002  0.020 -0.037
>
> print(adf.test(Predic_Price))

        Augmented Dickey-Fuller Test

data:  Predic_Price
Dickey-Fuller = -1.4277, Lag order = 9, p-value = 0.8206
alternative hypothesis: stationary
>
> ################### Prediction of Return ##########################
>
> return_ONGC <- 100*diff(log(Predic_Price))
> ONGC_return_train <- return_ONGC[1:(0.9*length(return_ONGC))]
> ONGC_return_test <-
return_ONGC[(0.9*length(return_ONGC)+1):length(return_ONGC)]
```

```
>
> auto.arima(ONGC_return_train, seasonal = FALSE)
Series: ONGC_return_train
ARIMA(3,0,2) with zero mean

Coefficients:
          ar1      ar2     ar3     ma1     ma2
      -1.4631  -0.5674  0.1268  1.4379  0.6391
s.e.   0.0856   0.1042  0.0384  0.0818  0.0749

sigma^2 = 6.657:  log likelihood = -2104.07
AIC=4220.14   AICc=4220.23   BIC=4248.88
> fit <- Arima(ONGC_return_train, order = c(0,0,0))
> fit
Series: ONGC_return_train
ARIMA(0,0,0) with non-zero mean
Coefficients:
        mean
        0.0130
s.e.  0.0887
sigma^2 = 7.008:  log likelihood = -2128.78
AIC=4261.57   AICc=4261.58   BIC=4271.15
>
> preds <- predict(fit, n.ahead = (length(return_ONGC) -
(0.9*length(return_ONGC))))$pred
> preds
Time Series:
Start = 892
End = 990
Frequency = 1
```

```
 [1] 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819
 [9] 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819
[17] 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819
[25] 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819
[33] 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819
[41] 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819
[49] 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819
[57] 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819
[65] 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819
[73] 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819
[81] 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819
[89] 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819 0.01295819
[97] 0.01295819 0.01295819 0.01295819
```

> ################## Forecasting Predicted Result ##################

>

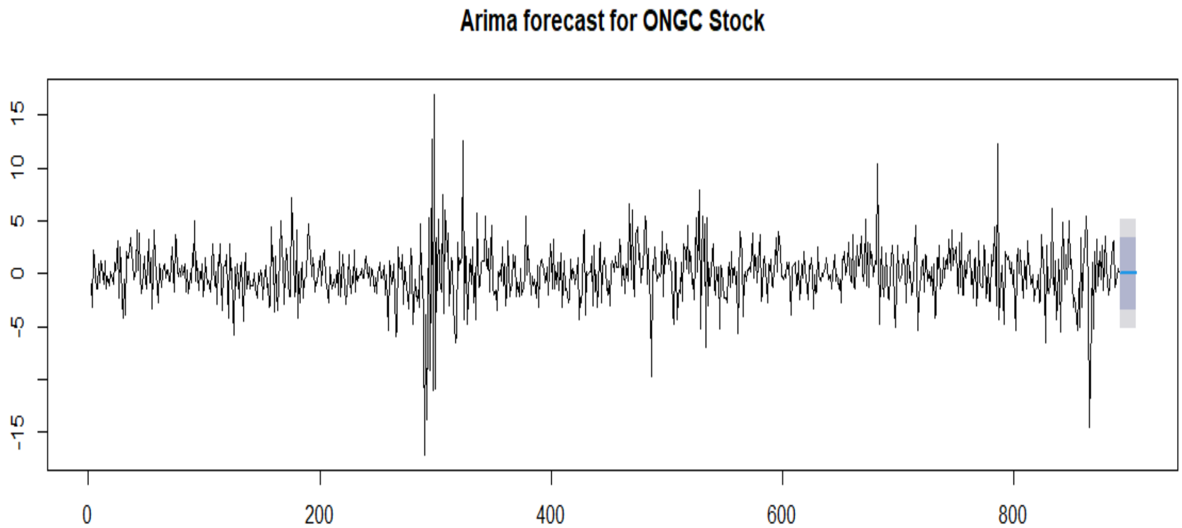
> test_forecast <- forecast(fit,h = 15)

> test_forecast

Point	Forecast	Lo 80	Hi 80	Lo 95	Hi 95
892	0.01295819	-3.379609	3.405526	-5.175526	5.201442
893	0.01295819	-3.379609	3.405526	-5.175526	5.201442
894	0.01295819	-3.379609	3.405526	-5.175526	5.201442
895	0.01295819	-3.379609	3.405526	-5.175526	5.201442
896	0.01295819	-3.379609	3.405526	-5.175526	5.201442
897	0.01295819	-3.379609	3.405526	-5.175526	5.201442
898	0.01295819	-3.379609	3.405526	-5.175526	5.201442
899	0.01295819	-3.379609	3.405526	-5.175526	5.201442
900	0.01295819	-3.379609	3.405526	-5.175526	5.201442
901	0.01295819	-3.379609	3.405526	-5.175526	5.201442
902	0.01295819	-3.379609	3.405526	-5.175526	5.201442
903	0.01295819	-3.379609	3.405526	-5.175526	5.201442
904	0.01295819	-3.379609	3.405526	-5.175526	5.201442
905	0.01295819	-3.379609	3.405526	-5.175526	5.201442
906	0.01295819	-3.379609	3.405526	-5.175526	5.201442

>

> plot(test_forecast, main = "Arima forecast for ONGC Stock")




```
> accuracy(preds, ONGC_return_test)
                 ME      RMSE      MAE  MPE MAPE
Test set  0.1332474 1.39622 1.072215 -Inf  Inf
>
```