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**AI-Based Recommendations of Stock Markets Investments**

MIDTERM REPORT

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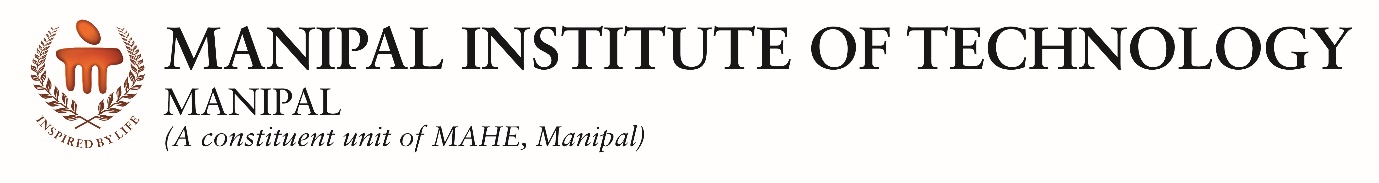
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**CERTIFICATE**

This is to certify that the project titled **AI-Based Recommendations of Stock Markets Investments** is carried out by **SURAMPALLI RAKESH** (Reg. No.160929044) during January-May, 2020 and the Midterm report is submitted to the Department of Mechatronics Engineering as part of requirement of B.Tech. (Mechatronics Engineering) project work evaluation.

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**ABSTRACT**

Artificial Intelligence in the financial industry has recently attracted a lot of interest among the investors. After the success of algorithmic trading in the business, artificial intelligence is believed to be the next generation of algorithmic trading where the algorithms are also done by computers instead of human. Compared to algorithmic trading, AI is presented in the market as a longer-term investment strategy with much larger holding time. Volatility of the stock market jumbles up a trader’s nervous system making it difficult to understand. Artificial Intelligence is supposed to be a predictive model that looks at more than technical patterns of trading.

Since stock market data are highly time-variant and are normally in a nonlinear pattern, predicting the future price of a stock is highly challenging. ARIMA is a statistical model which is known to be efficient for time series forecasting especially for short-term prediction. A model for forecasting the stock market trends based on the technical analysis using historical stock market data and ARIMA model.

The results from the model will be used for comparison with the real data to certain the accuracy of the model. This model will automate the process of direction of future stock price indices and provides assistance for financial specialists to choose the better timing for purchasing and/or selling of stocks. The results are shown in terms of visualizations using python programming language. The obtained results reveal that the ARIMA model has a strong potential for short-term prediction of stock market trends

Software tools/packages: NumPy, pandas, SciPy, matplot, statsmodels

*Keywords:* Algorithmic trading, ARIMA, time series

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**1. INTRODUCTION**

**1.1)Introduction to the area of work:**

In financial subjects, forecasting the stock exchange data involves an assumption that fundamental data publicly available in the past has some predictive relationship to the future stock returns. Stock market forecasting contains uncovering the market trends, planning investment tactics, identifying the best time to purchase the stocks and which stocks to purchase. It is the mix of speculators who need to purchase or offer or hold a share at a specific time. Prediction will continue to be making scientists in the analytics field always desiring to enhance the existing forecasting models. The companies and individuals are empowered to make investment decisions to develop viable system about their future endeavours.

Many of the investors in the stock market are finding a technique that could guarantee easy profiting by forecasting the stock trends and minimize the risk of investing. This motivates the researchers in the domain field to develop new forecasting models. Time series data analysis techniques use verifiable information as the premise for evaluating future results. Time series data can be defined as numerical data collected in a particular sequence over a period of time at regular intervals. The intention is to find if there is any link between the data collected so far and in what way does the data changes. In order to reduce the risk of investment, exchange of securities between the seller and buyer are facilitated by the stock exchanges. A stock exchange is an organization or a place where the stock traders or investors can deal with stocks. Some of the examples for stock market organizations include BSE, NSE.

**1.2)Brief present-day scenario works going with regard to the work area:**

Trading Technologies now has an AI platform that identifies complex trading patterns on a massive scale across multiple markets in real time. Combining machine learning technology with high-speed, big data processing power, the company provides clients with an ongoing assessment of compliance risk.

 Greenkey Technologies AI for trading uses speech recognition and natural language processing technology to save traders time searching through conversions, financial data and notes. With the company’s platform, financial professionals are using AI to sift through, and access, notes, market insights and trending companies in real-time.

[Kavout’s](https://www.kavout.com/) “K Score” is a product of its Kai intelligence platform that processes massive diverse sets of data and runs a variety of predictive models to come up with stock-ranking rating. With the help of AI, the company recommends daily top stocks using pattern recognition technology and a price forecasting engine. Its model portfolios are enhanced by AI algorithms.

[Auquan’s](https://auquan.com/) data science competition platform democratizes trading by allowing data scientists from all backgrounds to produce algorithmic trading strategies that help solve investment challenges. As a result, investment clients can reap the benefits of data science without the need for pricey in-house expertise.

[Epoque’s](http://www.epoque-plus.ch/) fully automated AI trading has three “engines”: a strategy enginethat observes and analyses potential trades; an order engine that creates orders and performs operational actions; and a logical engine that handles active orders and uses machine learning to improve its performance.

[Sigmoidal](https://sigmoidal.io/) is a consulting firm that offers end-to-end machine learning, data science, AI and software development for business — including the trading sector. In one case, its team of experts helped formulate an investment strategy by developing an intelligent asset allocation system that used deep learning to predict every asset in a particular portfolio

IBM-affiliated [EquBot’s](https://equbot.com/) proprietary investment technology combines AI with an active ETF. By gathering and processing data gleaned from various sources around the world, the company systematizes the investment process to “build a cause-and-effect understanding of markets, companies and management.”

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Fig1:a)time series b)normal returns

**1.3)Motivation to do the project work:**

AI is shaping the future of stock trading. Using AI millions of data points and execute trades at the optimal price, analysts forecast markets with greater accuracy and trading firms efficiently mitigate risk to provide for higher returns

The methodology that will be adopted by ARIMA model using time series and NLP to increase more accuracy in buying, selling and managing the portfolio.

The significance of the possible end result will be to increase the accuracy and risk in portfolio.

**1.4)Project Work schedule:**

24-01-2020---24-02-2020: selecting the desired methodology.

24-02-2020---24-03-2020: implementing linear models and arima model using time series and risk management in portfolio.

24-03-2020---01-05-2020: implementing deep learning algorithm and thesis writing.

1. **LITERATURE REVIEW**

While using **Time Series analysis** first step is to check whether historical stock market data is stationary using Plotting Rolling Statics Dickey Full Test. Second step is to eliminate TREND and SESSIONALITY from the series to make the data stationary series. For short term predictions ARIMA model has great potential. Finally the forecasted values are converted to original scale by applying TREND and SESSONALITY[1].

**Arima model** is one method for forecasting time series, it is assumed that past value of the series plus previous error terms contain information for the purpose of forecasting. The main advantage of Arima forecasting is that it requires data on time series in question only. However, Arima model are essentially backward looking, they are generally poor at predicting turning points, unless the turning point represents a return to a long-run equilibrium Exchange rate forecasting means estimating the rate which will be any of future time[2].

In [15] they focused on forecasting energy load forecasting using various techniques. They got data from “global energy forecasting competition 2012 load forecasting”. Most of the analysis they focused on short term forecasting. Models that have been specified in Deep neural networks are kernelized regression, linear regression, deep feedforward neural networks, deep recurrent neural networks. Greedy layer-wise unsupervised training had been done (i.e., stacked autoencoders Boltzmann machines). neural networks are complicated, with significant programming challenges and non-convex optimization. They applied state space transformation to our data. There is a scaling issues they had faced with large data most of them are using subset selection method. There are solved using K-mean clustering, naïve “nearest centroid” classification. The observation is clustering was more effective using feature standardization. The cluster size for the kernelized regression was 400.in feed forward Neural nets to explore the model parameters and then augmented these with recurrent structure to improve forecasting accuracy.

Model parameters through k-folds validations are: Sample set size, feature engineering, anomaly filtering, training algorithm, network tropology

Anomaly filtering is used to know the likelihood and outlier’s data for the dataset.

Then training algorithm are applied to modify the outliers by using Levenberg-Marquardt it is the combined with BFGS quasi-newton and gradient ascent algorithm and also by using RMS errors. They also specify about recurrent neural networks for feedback loops. Conclusions are SVM packages had produced superior results

In [16] they discussed about the sleep stage classification, unsupervised learning of features for time series analysis. Greedy layer-wise unsupervised learning solves the vanishing gradient problems. Techniques applied to perform tasks such as classification, segmentation, anomaly detection, Prediction

They assumed Time series as Vector X ={x(1),x(2),x(3),……..x(n)}; X(t) ∈ Rm pretraining to x in an array of m values such that every vector values have its own ={x1(t),x2(t),x3(t),……..xm(t)}

In Artificial neural networks the architecture has used are Restricted Boltzmann Machine, Hopfield Networks, Auto-encoders, Back propagation algorithm. Computation performed by a unit separated into 2 stages 1) aggregation function 2) activation function (i.e., 1.logistic sigmoid σ(x) = 2.hyperbolic tangent = – 1 3.ramp R(x) = max(0,x))

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In CNN, pooling, tiled CNN and fully convolution networks are used. In RNN, when the network has loops and unfolding using LSTM (Long short-term memory)

They designed neural networks forecast model using economic time series data the approach includes Elman RNN to predict chaotic time series. Multi variable adaptive regression splines performs time series forecast by using fuzzy model, they also specified about Deep belief network and Empirical model Decomposition and partial autocorrelation function. Anomaly detection is used to stacked denoising autoencoders.

Deep learning for time series classification are Gramian Angular Field and Markov Transition Field.

Gramian angular field are classified into two steps

Step1: rescaling the entire time series into value between [-1,1];

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Step 2: record the newly created time series into polar coordinates. The angle is encoded by the radius is encoded by time stamps i

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Markov transition field has Markov transition matrix where W composed by element wij

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In [17] they mainly focused on Anomaly Detection, missing value Imputation, clustering, forecasting with neural networks and error metrics. By performing Hidden Markov model, the limitations are conditions on the current state the future stat is independent of all the past states and Consider there are underlying hidden states that are responsible to generate the observation, which might not be correct for many time series forecasting .By using ARIMA it can’t model non-linear time series

Because of the limitations in hidden Markov model and ARIMA, they performed other models such as distance-based clustering method such as dynamic time wrapping and neural networks using LSTM

Algorithm and methods are 1) anomaly detection is an essential step before Appling any machine learning algorithms. 2) missing value imputation for time series by interpolation, LOCF, moving average, mean. SOFT IMPUTE algorithm to iteratively replace the missing elements with those obtained from a soft threshold SVD. 3) In Clustering, Dynamic time wrapping is one of the most popular distance metrics that is Euclidean distance beside DTW k-mean is also widely used.4) Forecasting with CNN,RNN and multi-layer perception.5)error metrics are of two types scale dependent and independent by using RMSE,MAE,MAPE we can calculate errors. They use 400 multivariant time series data.

In [18] Kalman filter algorithm for the sentiment analysis of the tweets. Stock market effect with respect to political news or some breaking news. Sentiment polarity of the twitter feeds is used to train Kalman filter

In Data processing and methodology, it primarily involved the raw data from internet to be bought in the form where the algorithm could be directly applied by advanced twitter search. Important step in inner joint between the sentiment scores and the closing price of the stocks

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Sentiment analysis the sentiment polarity is calculated by

St = Ø1Pt + Ø2 (Ø1Pt-1 + Ø2St-1). Kalman filter has state space model that act recursively on noisy input data and produces statistically optimal estimation of the system state.

Pt+1 = Pt \* ln (1 + St) + Pt. In this ln (1 + St) is bullish factor which is -1 to +1

1. **PROBLEM DEFINITION**

Although a lot of research has been done with respect to AI base stock investment. There is also a lack of research done on portfolio management and smart way to buy as sell. The aim is to suggest suitable investment to buy or sell for a customer using machine learning and help to manage the risk in portfolio.

1. **OBJECTIVES**

To model the ARIMA model of time series in machine learning for the investment traders.

Best advises are given for the investors whether to invest or to sell the stock with help of machine learning and risk management in portfolio.

The algorithm which was selected with the help of indicators gives the validation greater the 60% accuracy.

Quantitative Comparison of all the implemented methods to find the best fit.(Measures like accuracy, Precision and recall)

1. **THEORETICAL BACKGROUND**

**5.1) Time series:**

A time series is a sequence of numerical data points in successive order. In investing, a time series tracks the movement of the chosen data points, such as a security’s price, over a specified period of time with data points recorded at regular intervals. There is no minimum or maximum amount of time that must be included, allowing the data to be gathered in a way that provides the information being sought by the investor or analyst examining the activity.

There are several types of motivation and data analysis available for time series which are appropriate for different purposes

### Exploratory analysis

### Curve fitting

### Function approximation

Prediction and forecasting: One particular approach to such inference is known as [predictive inference](https://en.wikipedia.org/wiki/Predictive_inference), but the prediction can be undertaken within any of the several approaches to statistical inference. Indeed, one description of statistics is that it provides a means of transferring knowledge about a sample of a population to the whole population, and to other related populations, which is not necessarily the same as prediction over time. When information is transferred across time, often to specific points in time, the process is known as [forecasting](https://en.wikipedia.org/wiki/Forecasting).

* Fully formed statistical models for [stochastic simulation](https://en.wikipedia.org/wiki/Stochastic_simulation) purposes, so as to generate alternative versions of the time series, representing what might happen over non-specific time-periods in the future
* Simple or fully formed statistical models to describe the likely outcome of the time series in the immediate future, given knowledge of the most recent outcomes (forecasting).
* Forecasting on time series is usually done using automated statistical software packages and programming languages, such as [Apache Spark](https://en.wikipedia.org/wiki/Apache_Spark), [Julia](https://en.wikipedia.org/wiki/Julia_(programming_language)), [Python](https://en.wikipedia.org/wiki/Python_(programming_language)), [R](https://en.wikipedia.org/wiki/R_(programming_language)), [SAS](https://en.wikipedia.org/wiki/SAS_(software)), [SPSS](https://en.wikipedia.org/wiki/SPSS) and many others.

There are two sets of conditions under which much of the theory is built:

Stationary process

Ergodic process

**5.2) Correlation:**

Correlation is a statistical technique that can show whether and how strongly pairs of variables are related.

correlation: correlation always lies between -1 - 1

if correlation =1 ----->x and y features are same so we can consider only one between them

if correlation = -1 --->x and y features are opposite

if correlation = 0----->x and y don’t have any same features

if -1 < correlation < 0---> x and y have negative slope and have less opposite variation

if 0< correlation <1 -----> x and y have positive slope and have less variationA screenshot of a cell phone

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**5.3) q-q plotting:**

Q-Q Plots (Quantile-Quantile plots) are plots of two [quantiles](https://www.statisticshowto.com/quantile-definition-find-easy-steps/)against each other. A quantile is a fraction where certain values fall below that quantile. For example, the [median](https://www.statisticshowto.com/probability-and-statistics/statistics-definitions/mean-median-mode/#median)is a quantile where 50% of the data fall below that point and 50% lie above it. The purpose of Q-Q plots is to find out if two sets of data come from the same distribution.

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Fig. 3 Q-Q plot w.r.t to normal distribution

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**5.4) Moving average:**

A moving average (MA) is a widely used indicator in [technical analysis](https://www.investopedia.com/terms/t/technicalanalysis.asp) that helps smooth out price action by filtering out the “noise” from random short-term price fluctuations.

* Simple Moving Average (SMA) - calculates the arithmetic mean of a security over a number (n) of time periods, A

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A close up of a map

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Fig. 4 moving average

**5.5) Autoregressive:**

Autoregression is a time series model that uses observations from previous time steps as input to a regression equation to predict the value at the next time step

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Log returns

log return: log value of present value to previous data value

normal return: present value tp previous data value to minus 1

why log return??????????

1)log returns can be interpreted as continuously compound returns

2)log returns are time additive. the multi period log return is simply the sum of single period log terms

3)the use of log returns prevents security prices from become negative in modules of security returns

4)For many purpose, log returns of security can be reasonable modelled as distribution all to normal distribution

5)when returns and long returns are small their returns are approx. equal

6)logarithmic can help make an algorithm more numerically stable.

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Fig. 5 log return

1. **METHODOLOGY**

**6.1) Moving average:** Moving averages indicates the average value price over a pre-set period of time. The calculation involve the determination of the securities average value over the measurement period. As the most resent observation of the securities average value over the measurement period. Different methods of moving average calculation are available to be used for different purposes[10-11].it is common practice to examine the relationship between the moving average of a price and actual price itself. An indication that the price of the security is increasing occurs when the securities prices rise above its moving average, and a signal that the price is downward trend is when it moves below its moving average. This price indicator can be used as a simple trading system to tell you when to buy and when to sell [3].

Fig. 2 moving average with 20 day window

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**6.2) Bollinger bands:** It suggests 20 period in moving average, calculating the moving average using simple and using 2 standard deviations. They are displayed as three lines. The middle band is simple moving average. The upper band is same as the middle band, but it is transformed by a number of standard deviations [4-6].

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A picture containing bird

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**6.3)correlation:** In statistics, any statistical dependency whether [causal](https://en.wikipedia.org/wiki/Causality) or not, between two [random variables](https://en.wikipedia.org/wiki/Random_variable) or [bivariate data](https://en.wikipedia.org/wiki/Bivariate_data). In the broadest sense correlation is any statistical association, though it commonly refers to the degree to which a pair of variables are [linearly](https://en.wikipedia.org/wiki/Line_(geometry)) related.

**6.4) q-q plotting:** The Q-Q plot is a graphical tool for assessing the goodness-of-fit of observed data to a theoretical distribution in which every single observation in the data is represented by a symbol [8-9][14].

**6.5) T STATISTICS OR T TEST:**T test are implemented on continuous type values sample If the sample is greater than 30 t test is implemented else z test is implemented there are two types of t tests : 1)1 sample t-test 2)2 sample t-test

hypothesis 0(H0) :- It is not different ------> null hypothesis

hypothesis 1(H1) :- It is different ----------> alternative hypothesis

alpha(a) = 0.05 ------> means 5% of data p ------->significant value

1)1 sample t-test: comparing the total mean with the sub sample mean of the sample and calc the p value if p<a(i.e., p<0.05) ----->null hypothesis is violated if p>a -------->null hypothesis is accepted

1)2 sample t-test: comparing the total mean of one sample with the other sample mean and calc the p value if p<a(i.e., p<0.05) ----->null hypothesis is violated if p>a -------->null hypothesis is accepted

**6.6)Linear regression:**

It is a linear approach to modelling the relationship between a scalar response and one or more explanatory variables.

Here the data is reliance industries. I have taken only closing price from 15-04-2019 to 13-04-2020.this data’s had been divided into testing and training data. Training dates are from 15-04-2019 to 18-02-2020 and testing data if from 19-02-2020 to 13-04-2020.

For the training data scatter plot looks like

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And function generated for the scattered plot is y = -0.2391x + 11991 and R2 = 0.0232

And the MAD,MSE,MAPE for the testing data are:

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**6.7) ARIMA:**

ARIMA, short for ‘Auto Regressive Integrated Moving Average’ is actually a class of models that ‘explains’ a given time series based on its own past values, that is, its own lags and the lagged forecast errors, so that equation can be used to forecast future values.

Any ‘non-seasonal’ time series that exhibits patterns and is not a random white noise can be modelled with ARIMA models.

An ARIMA model is characterized by 3 terms: p, d, q

where,

p is the order of the AR term

q is the order of the MA term

d is the number of differencing required to make the time series stationary

If a time series, has seasonal patterns, then you need to add seasonal terms and it becomes SARIMA, short for ‘Seasonal ARIMA’. More on that once we finish ARIMA.

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## 6.2.1) What does the p, d and q in ARIMA model mean

The first step to build an ARIMA model is to [make the time series stationary](https://www.machinelearningplus.com/stationary-time-series).

In this reliance industries is taken as data

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So how to make a series stationary?

Stationary means its mean, variance and covariance should not change with respect to time

To check the normality of the density curve following tests are produced:

Shapirowilk test

D’Agostino pearson test

Kolmogoror smimov

To test the variance following tests are produced:

Breush pagan test

If normality and variance are normal and homoscedastic then we can conclude it is stationary

As the prices are not stationary, we are Appling integral (1) means taking difference of the two adjacent stocks to make it stationary.

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Once stationary is obtained now apply AR and MA to the stationary dataset

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Now we will apply ARIMA model using stats models’ package

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Sample dataset size is 34

(P,Q,D)= (7,2,1)

Mean square error for the prediction is 2258.52

1. **PLAN OF ACTION FOR THE NEXT TERM**

Implementing deep learning algorithm and genetic algorithm

Implementing risk management

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