Stochastic Modeling in Stock Market Trend Prediction

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Abstract:-

In Modern centuries a lot of predicting techniques take been proposed and applied for the stock market movement prediction. In this paper, the pattern examinations of the financial exchange forecast are introduced by utilizing Hidden Markov Model with the one day distinction in close incentive for a particular period. The likelihood esteems π gives the pattern level of the stock costs which is determined for all the notice arrangement and stowed away successions. It supports for decision makers to make decisions in case of indecision on the basis of the proportion of probability values found from the steady state probability distribution.

Keywords: Markov chain, Transition Probability Matrix, Hidden Markov Model and Stock Market

1. Introduction

The most two popular trending in Indian stock market classified named as the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE). The BSE has been started since 1875. The NSE has been founded in 1992 and started trading in 1994. Even though both exchanges following the same trading mechanism, trading hours, settlement process, etc. The two prominent Indian market indexes are Sensex and S&P CNX Nifty.

Financial market (Stock Market) is a platform for shareholders to particular some bonds of a company. Investors will become a part of the company members and share in both gain and losses of that particular company. This is the better way for the investors to get extra income apart from their permanent jobs. Variations of share prices on every day make it more volatile and difficult to forecast the upcoming price. When purchasing a stock, it does not any guarantees are anything in return. Thus, it makes stocks risky in investment, but investors can get high profit return. When investors are taking wrong decision in choosing the counters, it may end up in capital loss. The behavior of financial market revenues has been deeply discoursed over some years.

Hassan and Nath (2005) utilized HMM to anticipate following day closing price for a portion of the airplanes. Gupta and Dhingra (2012), have carried out HMM by utilizing different perception information (open, close, low, exorbitant costs) of stock to forecast its closing prices. Jyoti Badge (2012) used

methodological pointers as an input variable instead of stock prices used for investigation. Kavitha (2013), had applied HMMs for one day close value of a particular period for stock market trend analysis using Baum-Welch algorithm. They used MATLAB to get hidden states sequence. Therefore, the investors can observe easily the behavioral pattern of the stock market. Sasikumar and Sheikh Abdullah (2015), an attempt to various stochastic modeling using BSE Oil gas Stock data set. Sasikumar and Sheikh Abdullah (2016), an attempt to prediction of financial market (Stock Market) using hidden markov model and also making one day changes in close value of stock market value has been used for some period and the parallel transition probability matrix and emission probability matrix are obtained.

Mohamed Ashik and Senthamarai Kannan (2017), applied to ARIMA model to forecast in NSE closing stock price. Nguyet Nguyen (2018), have established the hidden Markov model to forecast once-a-month closing prices of the S&P 500 and formerly used these estimates to trade the stock using the four measures: AIC, BIC, HQC, and CAIC to inspect the concerts of HMM with numbers of states from two to six. Ali Sasani and Stephanie Tibado (2020), have used to machine learning techniques on stock market prediction. Deneshkumar et al., (2020), have used to hidden Markov model in trend analyses of the stock market prediction are presented.

The trend analysis of the stock market is discovered utilizing Hidden Markov Model by considering the one day distinction in close incentive for a specific period. For an offered perspective succession, the hidden sequence of states and their relating likelihood esteems are found. The probability values of π gives the trend level of the stock costs. Leaders present choices in defense of helplessness. The proposed approach gives a stage for leaders to settle on choices based on the level of likelihood esteems acquired from the consistent state likelihood dissemination. The hidden states and grouping are created for financial exchange information utilizing Hidden Markov model through MATLAB programming.

This paper is prepared into five sections as follows, Section II Basic concepts and definition of Markov chain and Transition Probability matrix. Section III Explaining and Construction of Hidden Markov Model, Section IV Deals the numerical results and discussion of proposed method. Finally, Conclusions in Section V.

2. Markov Chain

A Markov chain is a discrete random process with the property that the next state depends only on the current state; the past states have no influence on the future. The Stochastic process $X = \{X_n, n = 0, 1, 2, 3, \dots\}$ is called a Markov Chain (MC) provided that

$$P_r = P_r \{X_{n+1} = j | X_n = i, X_{n-1} = i_{n-1}, \dots, X_1 = i_1, X_0 = i_0\}$$

$$P_r = P_r \{X_{n+1} = j | X_n = i\}, \text{ for all } j \in S \quad \dots (1)$$

where, n is independent and S is the countable state space. The probabilities P_{ij} are then called the transition probabilities for the Markov chain X .

2.1 Transition Probability Matrix

The transition probability P_{jk} satisfy $P_{jk} \geq 0$, $\sum_k P_{jk} = 1$ for all j . These probabilities might be written in the framework structure.

$$P = \begin{bmatrix} p_{11} & p_{12} & p_{13} & \dots \\ p_{21} & p_{22} & p_{23} & \dots \\ \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \end{bmatrix}$$

This is called the transition probability matrix (TPM). P is a stochastic matrix ie., a square matrix with non-negative elements and row total is equal to one.

3. Construction of Hidden Markov Model

Hidden Markov model is very effective and intuitive approach to many sequential pattern such as thermodynamics, statistical mechanics, protein sequence analysis, multiple sequence alignments, physics, chemistry, economics, finance, signal processing, information theory, gene annotation, classification, similarity search.

Hidden Markov model (HMM) is a stochastic model which isn't straightforwardly recognizable, it depicts the discernible events that are depend on upon inside factors. Deneshkumar et al., (2020), the observable events are represented as symbols, where the invisible factor involved in the observation is represented as a state. Kavitha et al., (2013), HMM is a stochastic model where the system is assumed to be a Markov Process with hidden states. HMM gives better accuracy than other models. Utilizing the given information esteems, the boundaries of the HMM (λ) meant by A , B and π are discovered.

HMM consists of

A set of hidden or latent states (S); A set of possible output symbols (O); A state transition probability matrix (A) Probability of making transition from one state to each of the other states observation emission probability matrix (B). Probability of emitting/observing a symbol at a particular state. Prior probability matrix (π).

Probability of starting at a particular state: An HMM is defined as $\lambda = (S, O, A, B, \pi)$. where $S = \{S1, S2, \dots, SN\}$ is a set of N possible states and $O = \{O1, O2, \dots, OM\}$ is a set of M possible observation symbols, A is an $N \times N$ state Transition Probability Matrix (TPM), B is an $N \times M$ observation or Emission Probability Matrix (EPM) and π is an N dimensional initial state probability distribution vector and A, B and π should satisfy the following conditions.

$$\sum_{j=1}^N a_{ij} = 1 \quad \text{where } 1 \leq i \leq N; \quad \dots (2)$$

$$\sum_{j=1}^M b_{ij} = 1 \quad \text{where } 1 \leq i \leq M; \quad \dots (3)$$

$$\sum_{i=1}^N \pi_i = 1 \quad \text{where } \pi_i \geq 0 \quad \dots (4)$$

Figure 1: General structure of a hidden Markov model

The main problems of hidden Markov model are: Evaluation, Decoding and Learning.

Evaluation problem - Given the HMM $\lambda = \{A, B, \pi\}$ and the observation sequence $O = O1, O2, \dots, OM$, the probability that model λ has generated sequence O is calculated. Regularly this issue is established by the Forward Backward Algorithm (Rabiner, 1989 & 1993).

Decoding problem - Given the HMM $\lambda = \{A, B, \pi\}$ and the observation sequence $O = O1, O2, \dots, OM$, calculate the most likely sequence of hidden states that produced this observation sequence O . Generally this issue is dealt with by Viterbi Algorithm (Rabiner, 1989 & 1993)

Learning problem - Given some training observation sequences $O = O1, O2, \dots, OM$ and general structure of HMM (numbers of hidden and visible states), determine HMM parameters $\lambda = \{A, B, \pi\}$ that best fit

training data. The most common solution for this problem is Baum - Welch algorithm (Rabiner 1989 & 1993) which is considered as the traditional method for training HMM.

4. Results and discussions

In this study is based on secondary data has been taken from Yahoofinance.com and BPCL.NS, HINDPETRO.NS and IOC.NS and the daily close value data from the month of January 1, 2021 to September 20, 2021 period was considered. The table 1. Shows that the descriptive measures of stock price closing values for ranges between 87.00 Currency in INR to 498.100 Currency in INR. The mean and standard deviation of BPCL.NS closing stock price is 444.225 and 27.7173 which is high among the other two stock values and lowest closing stock price value is IOC.NS. The value of skewness indicates that the closing stock price could be positively/negatively skewed distribution depending upon on the respective stocks.

Table 1: Descriptive Statistics for BPCL.NS, HINDPETRO.NS and IOC.NS Stock Price

Sl. No	Descriptive	BPCL.NS	HINDPETRO.NS	IOC.NS
1	Sum	78627.910	45280.650	18124.360
2	Mean	444.225	255.822	102.397
3	Median	449.250	252.450	103.200
4	Mode	387.300	224.900	104.650
5	Standard Deviation	27.7173	25.5036	8.01682
6	Variance	768.254	650.435	64.270
7	Maximum	498.100	309.000	118.350
8	Minimum	380.600	216.650	87.00
9	Coeff. of Skewness	-.303	.392	-.052
10	Coeff. of Kurtosis	-.752	-1.029	-.960

Table 2: The closing value of stock Price for BPCL.NS, HINDPETRO.NS and IOC.NS

Sl. No	BPCL.NS				HINDPETRO.NS			IOC.NS		
	Date	Close Value	Difference	symbol	Close Value	Difference	symbol	Close Value	Difference	symbol
1	01-01-21	381.95	-	-	221.25	-	-	91.50	-	-
2	04-01-21	395.35	13.40	I	222.75	1.50	I	93.85	2.35	I
3	05-01-21	392.00	-3.35	D	223.1	0.35	I	93.00	-0.85	D
4	06-01-21	387.30	-4.70	D	220.95	-2.15	D	94.10	1.10	I
5	07-01-21	392.20	4.90	I	222.8	1.85	I	94.50	0.40	I
6	08-01-21	400.15	7.95	I	225.5	2.70	I	96.15	1.65	I
7	11-01-21	401.75	1.60	I	224.35	-1.15	D	96.00	-0.15	D

8	12-01-21	402.55	0.80	I	224.9	0.55	I	97.95	1.95	I
9	13-01-21	411.90	9.35	I	227.15	2.25	I	100.95	3.00	I
10	14-01-21	426.70	14.80	I	233.6	6.45	I	103.20	2.25	I
11	15-01-21	414.60	-12.10	D	228.6	-5.00	D	101.30	-1.90	D
12	18-01-21	409.55	-5.05	D	231.25	2.65	I	98.30	-3.00	D
13	19-01-21	413.45	3.90	I	231.9	0.65	I	98.55	0.25	I
14	20-01-21	413.85	0.40	I	231.05	-0.85	D	98.30	-0.25	D
15	21-01-21	408.30	-5.55	D	228.8	-2.25	D	96.70	-1.60	D
16	22-01-21	396.05	-12.25	D	225.4	-3.40	D	95.70	-1.00	D
17	25-01-21	387.30	-8.75	D	220.2	-5.20	D	93.45	-2.25	D
18	27-01-21	380.60	-6.70	D	216.65	-3.55	D	91.40	-2.05	D
19	28-01-21	384.30	3.70	I	221.5	4.85	I	92.60	1.20	I
20	29-01-21	383.60	-0.70	D	218.6	-2.90	D	93.25	0.65	I
21	01-02-21	393.00	9.40	I	217.95	-0.65	D	95.80	2.55	I
22	02-02-21	408.00	15.00	I	222.3	4.35	I	98.80	3.00	I
23	03-02-21	414.90	6.90	I	225.25	2.95	I	101.85	3.05	I
24	04-02-21	418.55	3.65	I	229.6	4.35	I	103.60	1.75	I
25	05-02-21	415.00	-3.55	D	225.05	-4.55	D	102.40	-1.20	D
26	08-02-21	420.05	5.05	I	229.55	4.50	I	104.10	1.70	I
27	09-02-21	419.35	-0.70	D	226.55	-3.00	D	97.70	-6.40	D
28	10-02-21	415.80	-3.55	D	224.9	-1.65	D	96.75	-0.95	D
29	11-02-21	421.95	6.15	I	227.4	2.50	I	96.50	-0.25	D
30	12-02-21	418.10	-3.85	D	223.85	-3.55	D	95.10	-1.40	D
31	15-02-21	419.00	0.90	I	222.6	-1.25	D	94.15	-0.95	D
32	16-02-21	417.95	-1.05	D	225.65	3.05	I	95.60	1.45	I
33	17-02-21	411.70	-6.25	D	234.45	8.80	I	95.00	-0.60	D
34	18-02-21	432.20	20.50	I	245.7	11.25	I	99.00	4.00	I
35	19-02-21	430.00	-2.20	D	244	-1.70	D	97.55	-1.45	D
36	22-02-21	422.55	-7.45	D	241.5	-2.50	D	95.65	-1.90	D
37	23-02-21	435.25	12.70	I	244.9	3.40	I	97.65	2.00	I
38	24-02-21	438.70	3.45	I	244.75	-0.15	D	97.95	0.30	I
39	25-02-21	461.55	22.85	I	252.45	7.70	I	100.90	2.95	I
40	26-02-21	449.85	-11.70	D	242.45	-10.00	D	98.05	-2.85	D
41	01-03-21	455.25	5.40	I	247.5	5.05	I	100.70	2.65	I
42	02-03-21	469.00	13.75	I	250.1	2.60	I	102.20	1.50	I
43	03-03-21	466.35	-2.65	D	248.9	-1.20	D	102.60	0.40	I
44	04-03-21	463.90	-2.45	D	245.85	-3.05	D	101.45	-1.15	D
45	05-03-21	461.80	-2.10	D	243.2	-2.65	D	101.46	0.01	I
46	08-03-21	466.70	4.90	I	243.15	-0.05	D	103.60	2.14	I
47	09-03-21	445.90	-20.80	D	238.2	-4.95	D	100.55	-3.05	D
48	10-03-21	445.50	-0.40	D	241	2.80	I	98.85	-1.70	D

49	12-03-21	457.55	12.05	I	241.35	0.35	I	101.30	2.45	I
50	15-03-21	460.55	3.00	I	241.9	0.55	I	101.05	-0.25	D
51	16-03-21	453.85	-6.70	D	241.65	-0.25	D	100.40	-0.65	D
52	17-03-21	432.05	-21.80	D	235.9	-5.75	D	98.20	-2.20	D
53	18-03-21	426.90	-5.15	D	233.65	-2.25	D	97.25	-0.95	D
54	19-03-21	432.95	6.05	I	234.75	1.10	I	98.75	1.50	I
55	22-03-21	439.35	6.40	I	236.55	1.80	I	99.15	0.40	I
56	23-03-21	436.50	-2.85	D	239	2.45	I	96.75	-2.40	D
57	24-03-21	429.95	-6.55	D	232.5	-6.50	D	94.55	-2.20	D
58	25-03-21	418.95	-11.00	D	227.25	-5.25	D	90.90	-3.65	D
59	26-03-21	424.20	5.25	I	229.8	2.55	I	90.10	-0.80	D
60	30-03-21	430.80	6.60	I	230	0.20	I	91.55	1.45	I
61	31-03-21	427.95	-2.85	D	234.5	4.50	I	91.85	0.30	I
62	01-04-21	437.40	9.45	I	237.6	3.10	I	93.15	1.30	I
63	05-04-21	428.05	-9.35	D	235.25	-2.35	D	90.75	-2.40	D
64	06-04-21	428.10	0.05	I	235.4	0.15	I	91.15	0.40	I
65	07-04-21	428.20	0.10	I	236.05	0.65	I	92.70	1.55	I
66	08-04-21	430.55	2.35	I	238.75	2.70	I	92.95	0.25	I
67	09-04-21	425.60	-4.95	D	234.05	-4.70	D	91.70	-1.25	D
68	12-04-21	403.95	-21.65	D	226.4	-7.65	D	87.00	-4.70	D
69	13-04-21	409.40	5.45	I	231.55	5.15	I	88.80	1.80	I
70	15-04-21	404.85	-4.55	D	237.15	5.60	I	90.10	1.30	I
71	16-04-21	413.80	8.95	I	236.55	-0.60	D	90.15	0.05	I
72	19-04-21	408.75	-5.05	D	231.4	-5.15	D	88.10	-2.05	D
73	20-04-21	408.10	-0.65	D	232.7	1.30	I	87.80	-0.30	D
74	22-04-21	418.35	10.25	I	233.5	0.80	I	87.85	0.05	I
75	23-04-21	423.05	4.70	I	233.7	0.20	I	88.05	0.20	I
76	26-04-21	418.90	-4.15	D	232.5	-1.20	D	88.20	0.15	I
77	27-04-21	420.35	1.45	I	232.95	0.45	I	88.85	0.65	I
78	28-04-21	417.50	-2.85	D	231.35	-1.60	D	89.40	0.55	I
79	29-04-21	419.55	2.05	I	229.7	-1.65	D	88.90	-0.50	D
80	30-04-21	421.80	2.25	I	234.65	4.95	I	90.85	1.95	I
81	03-05-21	416.00	-5.80	D	235.85	1.20	I	91.45	0.60	I
82	04-05-21	421.45	5.45	I	241.5	5.65	I	91.40	-0.05	D
83	05-05-21	424.80	3.35	I	244.8	3.30	I	92.20	0.80	I
84	06-05-21	434.00	9.20	I	245.4	0.60	I	92.60	0.40	I
85	07-05-21	443.15	9.15	I	251.45	6.05	I	94.70	2.10	I
86	10-05-21	453.70	10.55	I	255	3.55	I	99.15	4.45	I
87	11-05-21	462.25	8.55	I	265.6	10.60	I	103.70	4.55	I
88	12-05-21	449.25	-13.00	D	262.25	-3.35	D	102.80	-0.90	D
89	14-05-21	442.25	-7.00	D	254.4	-7.85	D	101.05	-1.75	D

90	17-05-21	443.65	1.40	I	251.85	-2.55	D	102.00	0.95	I
91	18-05-21	448.45	4.80	I	265	13.15	I	105.55	3.55	I
92	19-05-21	446.45	-2.00	D	272.75	7.75	I	107.20	1.65	I
93	20-05-21	454.80	8.35	I	266.4	-6.35	D	104.70	-2.50	D
94	21-05-21	461.05	6.25	I	276.3	9.90	I	104.30	-0.40	D
95	24-05-21	472.85	11.80	I	284.55	8.25	I	109.45	5.15	I
96	25-05-21	474.40	1.55	I	288.15	3.60	I	110.30	0.85	I
97	26-05-21	472.20	-2.20	D	284.25	-3.90	D	112.00	1.70	I
98	27-05-21	467.85	-4.35	D	280.4	-3.85	D	110.25	-1.75	D
99	28-05-21	471.50	3.65	I	280.65	0.25	I	109.85	-0.40	D
100	31-05-21	472.00	0.50	I	279.7	-0.95	D	109.25	-0.60	D
101	01-06-21	470.85	-1.15	D	281.55	1.85	I	109.90	0.65	I
102	02-06-21	474.65	3.80	I	288.4	6.85	I	110.85	0.95	I
103	03-06-21	473.90	-0.75	D	287.65	-0.75	D	112.45	1.60	I
104	04-06-21	478.25	4.35	I	298.8	11.15	I	114.60	2.15	I
105	07-06-21	481.40	3.15	I	301.1	2.30	I	114.70	0.10	I
106	08-06-21	487.45	6.05	I	302.25	1.15	I	116.70	2.00	I
107	09-06-21	485.05	-2.40	D	300.35	-1.90	D	114.95	-1.75	D
108	10-06-21	483.55	-1.50	D	298.45	-1.90	D	115.95	1.00	I
109	11-06-21	483.60	0.05	I	295.05	-3.40	D	115.10	-0.85	D
110	14-06-21	483.70	0.10	I	298.4	3.35	I	114.75	-0.35	D
111	15-06-21	481.90	-1.80	D	298.35	-0.05	D	115.75	1.00	I
112	16-06-21	481.25	-0.65	D	304.35	6.00	I	115.90	0.15	I
113	17-06-21	476.90	-4.35	D	309	4.65	I	114.60	-1.30	D
114	18-06-21	472.35	-4.55	D	295.75	-13.25	D	112.30	-2.30	D
115	21-06-21	475.05	2.70	I	302.4	6.65	I	112.65	0.35	I
116	22-06-21	473.65	-1.40	D	304.55	2.15	I	113.85	1.20	I
117	23-06-21	469.60	-4.05	D	300.25	-4.30	D	112.90	-0.95	D
118	24-06-21	466.10	-3.50	D	295.4	-4.85	D	111.45	-1.45	D
119	25-06-21	470.05	3.95	I	298	2.60	I	111.40	-0.05	D
120	28-06-21	467.15	-2.90	D	297.25	-0.75	D	110.85	-0.55	D
121	29-06-21	466.25	-0.90	D	292.55	-4.70	D	108.15	-2.70	D
122	30-06-21	468.10	1.85	I	293.2	0.65	I	107.90	-0.25	D
123	01-07-21	462.75	-5.35	D	296.2	3.00	I	107.55	-0.35	D
124	02-07-21	462.76	0.01	I	297.95	1.75	I	108.45	0.90	I
125	05-07-21	459.70	-3.06	D	304.45	6.50	I	108.80	0.35	I
126	06-07-21	458.05	-1.65	D	304.55	0.10	I	108.40	-0.40	D
127	07-07-21	460.50	2.45	I	306.35	1.80	I	107.95	-0.45	D
128	08-07-21	458.20	-2.30	D	283.85	-22.50	D	107.55	-0.40	D
129	09-07-21	456.90	-1.30	D	278.95	-4.90	D	107.30	-0.25	D
130	12-07-21	451.00	-5.90	D	271.9	-7.05	D	107.20	-0.10	D

131	13-07-21	450.25	-0.75	D	272.2	0.30	I	107.80	0.60	I
132	14-07-21	448.70	-1.55	D	270.1	-2.10	D	107.10	-0.70	D
133	15-07-21	447.05	-1.65	D	267.1	-3.00	D	106.30	-0.80	D
134	16-07-21	448.00	0.95	I	268.1	1.00	I	106.10	-0.20	D
135	19-07-21	453.90	5.90	I	272.05	3.95	I	105.95	-0.15	D
136	20-07-21	453.80	-0.10	D	276.15	4.10	I	105.60	-0.35	D
137	22-07-21	460.90	7.10	I	276.4	0.25	I	106.70	1.10	I
138	23-07-21	461.35	0.45	I	277.4	1.00	I	106.00	-0.70	D
139	26-07-21	456.00	-5.35	D	273.55	-3.85	D	104.65	-1.35	D
140	27-07-21	453.30	-2.70	D	269.2	-4.35	D	103.95	-0.70	D
141	28-07-21	453.45	0.15	I	264.95	-4.25	D	104.00	0.05	I
142	29-07-21	449.10	-4.35	D	263.6	-1.35	D	103.90	-0.10	D
143	30-07-21	445.50	-3.60	D	261.15	-2.45	D	103.15	-0.75	D
144	02-08-21	457.80	12.30	I	272.8	11.65	I	105.50	2.35	I
145	03-08-21	463.40	5.60	I	274.65	1.85	I	106.15	0.65	I
146	04-08-21	457.15	-6.25	D	272.25	-2.40	D	105.30	-0.85	D
147	05-08-21	453.50	-3.65	D	265	-7.25	D	103.95	-1.35	D
148	06-08-21	455.60	2.10	I	264.95	-0.05	D	105.90	1.95	I
149	09-08-21	452.50	-3.10	D	262	-2.95	D	104.40	-1.50	D
150	10-08-21	444.70	-7.80	D	257.95	-4.05	D	102.25	-2.15	D
151	11-08-21	450.00	5.30	I	258.9	0.95	I	104.65	2.40	I
152	12-08-21	448.15	-1.85	D	255.2	-3.70	D	104.10	-0.55	D
153	13-08-21	454.90	6.75	I	255.05	-0.15	D	104.65	0.55	I
154	16-08-21	464.00	9.10	I	257.7	2.65	I	107.20	2.55	I
155	17-08-21	465.00	1.00	I	253.6	-4.10	D	105.70	-1.50	D
156	18-08-21	463.50	-1.50	D	253.8	0.20	I	106.20	0.50	I
157	20-08-21	455.20	-8.30	D	247.2	-6.60	D	103.50	-2.70	D
158	23-08-21	451.70	-3.50	D	245.65	-1.55	D	103.00	-0.50	D
159	24-08-21	456.40	4.70	I	249.75	4.10	I	105.90	2.90	I
160	25-08-21	460.70	4.30	I	257.85	8.10	I	106.10	0.20	I
161	26-08-21	466.75	6.05	I	255.5	-2.35	D	105.60	-0.50	D
162	27-08-21	471.30	4.55	I	256.6	1.10	I	105.95	0.35	I
163	30-08-21	472.55	1.25	I	259.6	3.00	I	107.35	1.40	I
164	31-08-21	471.65	-0.90	D	266.6	7.00	I	110.85	3.50	I
165	01-09-21	477.00	5.35	I	266.65	0.05	I	110.75	-0.10	D
166	02-09-21	479.80	2.80	I	266.7	0.05	I	110.15	-0.60	D
167	03-09-21	491.30	11.50	I	275.95	9.25	I	113.10	2.95	I
168	06-09-21	490.80	-0.50	D	269.95	-6.00	D	111.60	-1.50	D
169	07-09-21	481.95	-8.85	D	267.35	-2.60	D	111.85	0.25	I
170	08-09-21	489.55	7.60	I	269.85	2.50	I	112.60	0.75	I
171	09-09-21	491.15	1.60	I	268.65	-1.20	D	112.80	0.20	I

172	13-09-21	498.10	6.95	I	270.65	2.00	I	114.00	1.20	I
173	14-09-21	493.10	-5.00	D	274.15	3.50	I	115.25	1.25	I
174	15-09-21	489.95	-3.15	D	275.7	1.55	I	116.40	1.15	I
175	16-09-21	439.05	-50.90	D	282.5	6.80	I	118.35	1.95	I
176	17-09-21	436.25	-2.80	D	282.95	0.45	I	118.25	-0.10	D
177	20-09-21	420.40	-15.85	D	272.50	-10.45	D	114.60	-3.65	D

BPCL.NS

Transition Frequency Matrix of BPCL.NS

$$F = \begin{bmatrix} 45 & 43 \\ 43 & 44 \end{bmatrix}, \text{ and}$$

Transition probability matrix is

$$P = \begin{bmatrix} 45/88 & 43/88 \\ 43/87 & 44/87 \end{bmatrix}$$

$$P = \begin{bmatrix} 0.51136 & 0.48863 \\ 0.49425 & 0.50574 \end{bmatrix},$$

$$P^2 = \begin{bmatrix} 0.503003 & 0.496997 \\ 0.50271 & 0.49729 \end{bmatrix},$$

$$P^3 = \begin{bmatrix} 0.50286 & 0.49714 \\ 0.502855 & 0.497145 \end{bmatrix},$$

$$P^4 = \begin{bmatrix} 0.502857 & 0.497143 \\ 0.502857 & 0.497143 \end{bmatrix},$$

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$$P^n = \begin{bmatrix} 0.502857 & 0.497143 \\ 0.502857 & 0.497143 \end{bmatrix}.$$

HINDPETRO.NS

Transition Frequency Matrix of HINDPETRO.NS

$$F = \begin{bmatrix} 57 & 40 \\ 39 & 39 \end{bmatrix}, \text{ and}$$

Transition probability matrix is

$$P = \begin{bmatrix} 57/97 & 40/97 \\ 39/78 & 39/78 \end{bmatrix}$$

$$P = \begin{bmatrix} 0.587629 & 0.412371 \\ 0.5 & 0.5 \end{bmatrix},$$

$$P^2 = \begin{bmatrix} 0.551493 & 0.448507 \\ 0.543814 & 0.456186 \end{bmatrix},$$

$$P^3 = \begin{bmatrix} 0.548327 & 0.451673 \\ 0.547654 & 0.452346 \end{bmatrix},$$

$$P^4 = \begin{bmatrix} 0.548049 & 0.451951 \\ 0.54799 & 0.45201 \end{bmatrix},$$

$$P^5 = \begin{bmatrix} 0.548025 & 0.451975 \\ 0.54802 & 0.45198 \end{bmatrix},$$

$$P^6 = \begin{bmatrix} 0.548023 & 0.451977 \\ 0.548022 & 0.451978 \end{bmatrix},$$

$$P^7 = \begin{bmatrix} 0.548023 & 0.451977 \\ 0.54802 & 0.451977 \end{bmatrix},$$

.

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$$P^n = \begin{bmatrix} 0.548023 & 0.451977 \\ 0.54802 & 0.451977 \end{bmatrix}.$$

IOC.NS

Transition Frequency Matrix of IOC.NS is

$$F = \begin{bmatrix} 54 & 36 \\ 37 & 48 \end{bmatrix}, \text{ and}$$

Transition probability matrix is

$$P = \begin{bmatrix} 54/90 & 36/90 \\ 37/85 & 48/85 \end{bmatrix}$$

$$P = \begin{bmatrix} 0.6 & 0.4 \\ 0.435294 & 0.564706 \end{bmatrix},$$

$$P^2 = \begin{bmatrix} 0.534118 & 0.465882 \\ 0.50699 & 0.49301 \end{bmatrix},$$

$$P^3 = \begin{bmatrix} 0.523266 & 0.476734 \\ 0.518798 & 0.481202 \end{bmatrix},$$

$$P^4 = \begin{bmatrix} 0.521479 & 0.478521 \\ 0.520743 & 0.479257 \end{bmatrix},$$

$$P^5 = \begin{bmatrix} 0.521185 & 0.478815 \\ 0.521064 & 0.478936 \end{bmatrix},$$

$$P^6 = \begin{bmatrix} 0.521136 & 0.478864 \\ 0.521116 & 0.478884 \end{bmatrix},$$

$$P^7 = \begin{bmatrix} 0.521128 & 0.478872 \\ 0.521126 & 0.478874 \end{bmatrix},$$

$$P^8 = \begin{bmatrix} 0.521127 & 0.478873 \\ 0.521126 & 0.478874 \end{bmatrix},$$

$$P^9 = \begin{bmatrix} 0.521127 & 0.478873 \\ 0.521127 & 0.478873 \end{bmatrix},$$

.

.

.

$$P^n = \begin{bmatrix} 0.521127 & 0.478873 \\ 0.521127 & 0.478873 \end{bmatrix}$$

From the P^2 to P^n values, we observed that the probability of decrease to decrease, decrease to increase, increase to decrease and increase to increase values having same probability in 4th subsequence days in BPCL.NS, the next stock close value such as same probability in 7th subsequence days in HINDPETRO.NS and another one stock close value same probability in 9th subsequence days in IOC.NS. From this empirical evidence, Markov chain is more useful and powerful to predict next day values; it is not reliable for subsequent days.

In my observation all the above mentioned three types of Stochastic models were partially supported to prediction of the stock market, even some of the authors were strongly agree with the stock market prediction is not reliable to the investors. Some of the authors said that, their prediction method was more reliable for short term investors only. The above empirical result also shows that the Markov chain analysis is powerful tool for predict next day value only, which is not useful for lateral days.

In this paper, BPCL.NS, HINDPETRO.NS and IOC.NS daily close value data for a month period is considered. Two observing symbols “ I ” and “ D ” have been used.

where, “I indicates Increasing” , “ D indicates Decreasing ”

If Today’s close value – Yesterday’s close value > 0 , then observing symbol is I

If Today’s close value – Yesterday’s close value < 0 then observing symbol is D

Minimum value is: -63.40, Maximum values is: 145.48, D_1 : 3 and D_2 : 4.55

$$U = [D_{\min} - D_1, D_{\max} + D_2] \quad \dots (5)$$

where, $D_{\min}$ is Minimum value, $D_{\max}$ is Maximum value, D_1 and D_2 is two positive real number.

U: [-160 to -150], U_1 : [-160 to -15], U_2 : [-15 to 0], U_3 : [0 to 20] and U_4 : [20 to 150].

There are four hidden states assumed and are denoted by the symbol as S1, S2, S3, S4.

where, S1 - very low, S2 - low, S3 - high and S4 - very high

BPCL.NS

Table 3: Transition table with probability values for difference in one day close value.

	S1		S2		S3		S4	
	I	D	I	D	I	D	I	D
S1	0	0	0	0.7500	0.2500	0	0	0
S2	0	0.0366	0	0.4512	0.5000	0	0.0122	0
S3	0	0.01	0	0.4713	0.5057	0	0.0115	0
S4	0	0	0	1.00	0	0	0	0

Probability values of TPM, EPM, and π for difference in day one close value (Figure 2 and Table 3):

$$\begin{bmatrix} & S1 & S2 & S3 & S4 \\ S1 & 0 & 0.75 & 0.25 & 0 \\ S2 & 0.04 & 0.45 & 0.50 & 0.01 \\ S3 & 0.01 & 0.47 & 0.51 & 0.01 \\ S4 & 0 & 1 & 0 & 0 \end{bmatrix} \quad \text{and} \quad \begin{bmatrix} & I & D \\ S1 & 0 & 1 \\ S2 & 0.53846 & 0.46154 \\ S3 & 0.375 & 0.625 \\ S4 & 0 & 1 \end{bmatrix}$$

Steady state probability distribution difference in day one close value.

$$\pi = [0.0229 \quad 0.4742 \quad 0.4913 \quad 0.0114]$$

Figure 2. TPM of day one in BPCL.NS.

Table 4: Transition table with probability values for difference in day two close value.

	S1		S2		S3		S4	
	I	D	I	D	I	D	I	D
S1	0	0	0	0.181818	0.545455	0	0.272727	0
S2	0	0.05	0	0.35	0.57333	0	0.03	0
S3	0	0.060241	0	0.542169	0.39759	0	0	0
S4	0	0.20	0	0.60	0.2	0	0	0

Probability values of TPM, EPM, and π for difference in day two close value (Figure 3 and Table 4):

$$\begin{bmatrix}
 & S1 & S2 & S3 & S4 \\
 S1 & 0 & 0.181818 & 0.545455 & 0.272727 \\
 S2 & 0.05 & 0.35 & 0.57333 & 0.03 \\
 S3 & 0.060241 & 0.542169 & 0.39759 & 0 \\
 S4 & 0.20 & 0.60 & 0.2 & 0
 \end{bmatrix}
 \text{ and }
 \begin{bmatrix}
 & I & D \\
 S1 & 0.818182 & 0.181818 \\
 S2 & 0.60 & 0.40 \\
 S3 & 0.39759 & 0.60241 \\
 S4 & 0.20 & 0.8
 \end{bmatrix}$$

Steady state probability distribution difference in day two close value.

$$\pi = [0.0575 \quad 0.4374 \quad 0.4775 \quad 0.0273]$$

Figure 3. TPM of day two in BPCL.NS.

Table 5: Transition table with probability values for difference in day three close value.

	S1		S2		S3		S4	
	I	D	I	D	I	D	I	D
S1	0	0	0	0.15	0.45	0	0.4	0
S2	0	0.06	0	0.238095	0.619048	0	0.079365	0
S3	0	0.12	0	0.533333	0.32	0	0.026667	0
S4	0	0.53	0	0.333333	0.133333	0	0	0

Probability values of TPM, EPM, and π for difference in day three close value (Figure 4 and Table 5):

	S1	S2	S3	S4
S1	0	0.15	0.45	0.4
S2	0.06	0.238095	0.619048	0.079365
S3	0.12	0.533333	0.32	0.026667
S4	0.53	0.333333	0.133333	0

and

	I	D
S1	0.85	0.15
S2	0.698413	0.30
S3	0.346667	0.653333
S4	0.133333	0.866667

Steady state probability distribution difference in day Three close value.

$$\pi = [0.1216 \quad 0.3620 \quad 0.4275 \quad 0.0887]$$

Figure 4. TPM of day three in BPCL.NS.**Table 6: Transition table with probability values for difference in day four close value.**

	S1		S2		S3		S4	
	I	D	I	D	I	D	I	D
S1	0	0.000000	0	0.15	0.45	0	0.4	0
S2	0	0.063492	0	0.238095	0.619048	0	0.079365	0
S3	0	0.12	0	0.533333	0.32	0	0.026667	0
S4	0	0.533333	0	0.333333	0.133333	0	0	0

Probability values of TPM, EPM, and π for difference in day four close value (Figure 5 and Table 6):

$$\begin{bmatrix} & S1 & S2 & S3 & S4 \\ S1 & 0 & 0.15 & 0.45 & 0.4 \\ S2 & 0.063492 & 0.238095 & 0.619048 & 0.079365 \\ S3 & 0.12 & 0.533333 & 0.32 & 0.026667 \\ S4 & 0.533333 & 0.333333 & 0.133333 & 0 \end{bmatrix} \text{ and } \begin{bmatrix} & I & D \\ S1 & 0.85 & 0.15 \\ S2 & 0.698413 & 0.30 \\ S3 & 0.346667 & 0.653333 \\ S4 & 0.133333 & 0.866667 \end{bmatrix}$$

Steady state probability distribution difference in day Four close value.

$$\pi = [0.1216 \quad 0.3620 \quad 0.4275 \quad 0.0887]$$

Figure 5. TPM of day four in BPCL.NS.

HINDPETRO.NS

Table 7: Transition table with probability values for difference in day one close value.

	S1		S2		S3		S4	
	I	D	I	D	I	D	I	D
S1	0	0	0	1	0	0	0	0
S2	0	0	0	0.506329	0.481013	0	0.012658	0
S3	0	0.01087	0	0.413044	0.576087	0	0	0
S4	0	0	0	0	1	0	0	0

Probability values of TPM, EPM, and π for difference in day one close value (Figure 6 and Table 7):

$$\begin{bmatrix} & S1 & S2 & S3 & S4 \\ S1 & 0 & 1 & 0 & 0 \\ S2 & 0 & 0.5063 & 0.481013 & 0.012658 \\ S3 & 0.01087 & 0.41304 & 0.576087 & 0 \\ S4 & 0 & 0 & 1 & 0 \end{bmatrix} \text{ and } \begin{bmatrix} & I & D \\ S1 & 0 & 1 \\ S2 & 0.493671 & 0.5063 \\ S3 & 0.576087 & 0.4239 \\ S4 & 1 & 0 \end{bmatrix}$$

Steady state probability distribution difference in day one close value.

$$\pi = [0.0057 \quad 0.4566 \quad 0.5317 \quad 0.0057]$$

Figure 6. TPM of day one in HINDPETRO.NS

Table 8: Transition table with probability values for difference in day two close value.

	S1		S2		S3		S4	
	I	D	I	D	I	D	I	D
S1	0	0	0	0.2	0.8	0	0	0
S2	0	0.0120	0	0.373494	0.614458	0	0	0
S3	0	0.035294	0	0.60	0.352941	0	0.011765	0
S4	0	1	0	0	0	0	0	0

Probability values of TPM, EPM, and π for difference in day two close value (Figure 7 and Table 8):

$$\begin{bmatrix}
 & S1 & S2 & S3 & S4 \\
 S1 & 0 & 0.2 & 0.8 & 0 \\
 S2 & 0.0120 & 0.373494 & 0.614458 & 0 \\
 S3 & 0.03529 & 0.60 & 0.352941 & 0.011765 \\
 S4 & 1 & 0 & 0 & 0
 \end{bmatrix}
 \quad \text{and} \quad
 \begin{bmatrix}
 & I & D \\
 S1 & 0.80 & 0.20 \\
 S2 & 0.614458 & 0.3855 \\
 S3 & 0.364706 & 0.64 \\
 S4 & 0 & 1
 \end{bmatrix}$$

Steady state probability distribution difference in day two close value.

$$\pi = [0.0287 \quad 0.4770 \quad 0.4885 \quad 0.0057]$$

Figure 7. TPM of day two in HINDPETRO.NS

Table 9: Transition table with probability values for difference in day three close value.

	S1		S2		S3		S4	
	I	D	I	D	I	D	I	D
S1	0	0	0	0.25	0.5	0	0.25	0
S2	0	0.0290	0	0.289855	0.681159	0	0	0
S3	0	0.109756	0	0.548781	0.329268	0	0.012195	0
S4	0	0.83333	0	0	0	0	0.166667	0

Probability values of TPM, EPM, and π for difference in day three close value (Figure 8 and Table 9):

$$\begin{bmatrix}
 & S1 & S2 & S3 & S4 \\
 S1 & 0 & 0.25 & 0.5 & 0.25 \\
 S2 & 0.0290 & 0.289855 & 0.681159 & 0 \\
 S3 & 0.109756 & 0.548781 & 0.329268 & 0.012195 \\
 S4 & 0.83333 & 0 & 0 & 0.166667
 \end{bmatrix}
 \text{ and }
 \begin{bmatrix}
 & I & D \\
 S1 & 0.75 & 0.25 \\
 S2 & 0.681159 & 0.3188 \\
 S3 & 0.341463 & 0.658537 \\
 S4 & 0.166667 & 0.833333
 \end{bmatrix}$$

Steady state probability distribution difference in day three close value.

$$\pi = [0.0924 \quad 0.3988 \quad 0.4739 \quad 0.0346]$$

Figure 8. TPM of day three in HINDPETRO.NS

Table 10: Transition table with probability values for difference in day four close value.

	S1		S2		S3		S4	
	I	D	I	D	I	D	I	D
S1	0	0.00	0	0.085714	0.514286	0	0.40	0
S2	0	0.06	0	0.351852	0.462963	0	0.12963	0
S3	0	0.322581	0	0.403226	0.274194	0	0	0
S4	0	0.571429	0	0.333333	0.095238	0	0	0

Probability values of TPM, EPM, and π for difference in day four close value (Figure 9 and Table 10):

$$\begin{bmatrix}
 & S1 & S2 & S3 & S4 \\
 S1 & 0 & 0.085714 & 0.514286 & 0.4 \\
 S2 & 0.06 & 0.351852 & 0.462963 & 0.12963 \\
 S3 & 0.322581 & 0.403226 & 0.274194 & 0 \\
 S4 & 0.571429 & 0.333333 & 0.095238 & 0
 \end{bmatrix}
 \text{ and }
 \begin{bmatrix}
 & I & D \\
 S1 & 0.914286 & 0.085714 \\
 S2 & 0.592593 & 0.41 \\
 S3 & 0.274194 & 0.725806 \\
 S4 & 0.095238 & 0.904762
 \end{bmatrix}$$

Steady state probability distribution difference in day four close value.

$$\pi = [0.2034 \quad 0.3139 \quad 0.3604 \quad 0.1220]$$

Figure 9. TPM of day four in HINDPETRO.NS

IOC.NS**Table 11: Transition table with probability values for difference in day one close value.**

	S1		S2		S3		S4	
	I	D	I	D	I	D	I	D
S1	0	0	0	0	0	0	1	0
S2	0	0	0	0.54878	0.45122	0	0	0
S3	0	0.01099	0	0.395604	0.593407	0	0	0
S4	0	0	0	1	0	0	0	0

Probability values of TPM, EPM, and π for difference in day one close value (Figure 10 and Table 11):

$$\begin{bmatrix} & S1 & S2 & S3 & S4 \\ S1 & 0 & 0 & 0 & 1 \\ S2 & 0 & 0.54878 & 0.45122 & 0 \\ S3 & 0.01099 & 0.395604 & 0.593407 & 0 \\ S4 & 0 & 1 & 0 & 0 \end{bmatrix} \text{ and } \begin{bmatrix} & I & D \\ S1 & 1 & 0 \\ S2 & 0.456122 & 0.54878 \\ S3 & 0.593407 & 0.40659 \\ S4 & 0 & 1 \end{bmatrix}$$

Steady state probability distribution difference in day one close value.

$$\pi = [0.0057 \quad 0.4685 \quad 0.5200 \quad 0.0057]$$

Figure 10. TPM of day one in IOC.NS**Table 12: Transition table with probability values for difference in day two close value.**

	S1		S2		S3		S4	
	I	D	I	D	I	D	I	D
S1	0	0	0	0	0.5	0	0.5	0
S2	0	0	0	0.395349	0.604651	0	0	0
S3	0	0.011765	0	0.611765	0.376471	0	0	0
S4	0	1	0	0	0	0	0	0

Probability values of TPM, EPM, and π for difference in day four close value (Figure 11 and Table 12):

$$\begin{bmatrix} & S1 & S2 & S3 & S4 \\ S1 & 0 & 0 & 0.5 & 0.5 \\ S2 & 0 & 0.395349 & 0.604651 & 0 \\ S3 & 0.011765 & 0.611765 & 0.376471 & 0 \\ S4 & 1 & 0 & 0 & 0 \end{bmatrix} \quad \text{and} \quad \begin{bmatrix} & I & D \\ S1 & 1 & 0 \\ S2 & 0.604651 & 0.395349 \\ S3 & 0.376471 & 0.623529 \\ S4 & 0 & 1 \end{bmatrix}$$

Steady state probability distribution difference in day two close value.

$$\pi = [0.0114 \quad 0.4942 \quad 0.4885 \quad 0.0057]$$

Figure 11. TPM of day two in IOC.NS

Table 13: Transition table with probability values for difference in day three close value.

	S1		S2		S3		S4	
	I	D	I	D	I	D	I	D
S1	0	0	0	0	0	0	1	0
S2	0	0	0	0.325301	0.674699	0	0	0
S3	0	0.011628	0	0.651163	0.337209	0	0	0
S4	0	0.5	0	0.5	0	0	0	0

Probability values of TPM, EPM, and π for difference in day four close value (Figure 12 and Table 13):

$$\begin{bmatrix} & S1 & S2 & S3 & S4 \\ S1 & 0 & 0 & 0 & 1 \\ S2 & 0 & 0.325301 & 0.674699 & 0 \\ S3 & 0.011628 & 0.651163 & 0.337209 & 0 \\ S4 & 0.5 & 0.5 & 0 & 0 \end{bmatrix} \quad \text{and} \quad \begin{bmatrix} & I & D \\ S1 & 1 & 0 \\ S2 & 0.674699 & 0.325301 \\ S3 & 0.329412 & 0.662791 \\ S4 & 0 & 1 \end{bmatrix}$$

Steady state probability distribution difference in day three close value.

$$\pi = [0.0114 \quad 0.4841 \quad 0.4928 \quad 0.0114]$$

Figure 12. TPM of day three in IOC.NS

Table 14: Transition table with probability values for difference in day four close value

	S1		S2		S3		S4	
	I	D	I	D	I	D	I	D
S1	0	0	0	0	0.625	0	0.375	0
S2	0	0	0	0.333333	0.666667	0	0	0
S3	0	0.0625	0	0.675	0.2625	0	0	0
S4	0	1	0	0	0	0	0	0

Probability values of TPM, EPM, and π for difference in day four close value (Figure 13 and Table 14):

$$\begin{bmatrix}
 & S1 & S2 & S3 & S4 \\
 S1 & 0 & 0 & 0.625 & 0.375 \\
 S2 & 0 & 0.333333 & 0.666667 & 0 \\
 S3 & 0.0625 & 0.675 & 0.2625 & 0 \\
 S4 & 1 & 0 & 0 & 0
 \end{bmatrix}
 \quad \text{and} \quad
 \begin{bmatrix}
 & I & D \\
 S1 & 1 & 0 \\
 S2 & 0.666667 & 0.333333 \\
 S3 & 0.2625 & 0.7375 \\
 S4 & 0 & 1
 \end{bmatrix}$$

Steady state probability distribution difference in day four close value.

$$\pi = [0.0465 \quad 0.4709 \quad 0.4651 \quad 0.0174]$$

Figure 13. TPM of day four in IOC.NS

To generate a random sequence of emission symbols and states are calculated by using the function “Hmmgenerate”. Murphy(1998) has using the HMM Matlab toolbox syntax is: [Sequence, States] = Hmmgenerate (L, PM, EPM). The length of both sequence and state to be generated is denoted by L. Using the iterative procedure, for each TPM and EPM framed we get an optimum sequence of states generated. The length of the sequence taken as $L = 4$ and the optimum sequence of states obtained from the all four day’s differences with TPM and EPM is given in the below and here ‘ π ’ is the start symbol.

BPCL.NS

1.	ϵ	$\rightarrow$	I S3	$\rightarrow$	D S3	$\rightarrow$	D S2	$\rightarrow$	I S3
2.	ϵ	$\rightarrow$	I S4	$\rightarrow$	I S3	$\rightarrow$	I S2	$\rightarrow$	D S4
3.	ϵ	$\rightarrow$	I S4	$\rightarrow$	D S2	$\rightarrow$	I S3	$\rightarrow$	D S2
4.	ϵ	$\rightarrow$	I S3	$\rightarrow$	D S1	$\rightarrow$	I S2	$\rightarrow$	D S3

HINDPETRO.NS

1.	ϵ	$\rightarrow$	D S2	$\rightarrow$	D S2	$\rightarrow$	D S3	$\rightarrow$	I S3
2.	ϵ	$\rightarrow$	I S3	$\rightarrow$	D S3	$\rightarrow$	D S2	$\rightarrow$	I S3
3.	ϵ	$\rightarrow$	I S4	$\rightarrow$	D S1	$\rightarrow$	I S3	$\rightarrow$	I S2
4.	ϵ	$\rightarrow$	I S4	$\rightarrow$	D S3	$\rightarrow$	I S2	$\rightarrow$	D S2

IOC.NS

1.	ϵ	$\rightarrow$	I S4	$\rightarrow$	D S2	$\rightarrow$	I S3	$\rightarrow$	I S2
2.	ϵ	$\rightarrow$	I S3	$\rightarrow$	I S2	$\rightarrow$	I S2	$\rightarrow$	D S2
3.	ϵ	$\rightarrow$	I S4	$\rightarrow$	D S1	$\rightarrow$	I S4	$\rightarrow$	D S1
4.	ϵ	$\rightarrow$	I S3	$\rightarrow$	I S2	$\rightarrow$	D S2	$\rightarrow$	D S3

5. Conclusion

Stock market prediction is challenging and interesting due to its randomness. Hidden Markov Model can be used for Stock market assumption by finding stowed away models. Here the Hidden Markov model easily identified such as four states of the stock market and also it was used to predict the future values. The most elevated worth in the Optimum State Sequences is the better exhibition of the specific Sequence.

Hidden states and successions have been produced to effectively distinguish the level of the arrangement whether the following day values is increasing. And furthermore distinguished whether the increasing level is moderate high or high or very high and furthermore diminishing level whether moderate low or low or very low. This model will be particularly helpful for present moment just as long haul financial backers.

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