

Cluster Analysis of Indian Stock Market during the 90 Day Period after 4 June 2024 Crash

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Abstract— 4, June 2024 can be considered as a unique market event in the history of Indian stock markets. Prior to this event, Indian share markets were upbeat and steadily growing due to a prevailing market sentiment that a third term election win for the BJP/NDA alliance is certain. This sentiment was supported by multiple opinion polls and odds data released by illegal betting markets. However, as vote counting started on June 4, 2024 and live results started percolating, markets realized that BJP will not be in a position to cross the midway mark and obtain a simple majority to form the government. Stock markets crashed by the end of the day at 3.30 pm on Tuesday, BSE Sensex lost 4389.73 points (-5.74%) to close at 72,079.05, and Nifty 50 ended at 21,884.50, lower by 1,379.40 (-5.93%). Both NIFTY and SENSEX indices recovered very fast and within a few days regained their last traded levels of 3, June, 2024. Recovery of all the stocks is not uniform and the market event resulted in triggering a correction phase. This paper is a detailed analysis of the stock market from 4, June 2024 to 4 September 2024. Detailed cluster analysis is done and results are reported. Clustered Heat maps (Double Dendograms) are presented along with traditional quantitative analysis. Heat Maps and Dendograms can be considered as visual statistics/analytical tools. The objective of this research is to study clusters of shares and industry segments and the pattern of their recovery. Historically, Indian stock markets went through many such crashes. However, only high-level details are available in the literature. It is very difficult for individual retail investors to obtain stock market historical data which is older than three years. This research paper attempts to document granular details which can be used in the future. The study of outliers in the data will give insights into specific stocks/ industry sectors and their resilience. The results of the analysis presented in this paper can be used by investors and financial institutions to handle future crashes, reduce panic selling and limit their losses.

Index Terms—4th June-2024 India Stock market crash, Cluster Analysis, Dendograms, Heat Maps, Hierarchical Clustering, Panic Selling, Post-crash recovery, Quantitative Analysis, Stock Market Crashes, Visual analytics, Visual statistics.

I. INTRODUCTION

Stock Market crashes and booms are regular features of stock markets across the globe. Indian stock markets experience many booms and crashes. Important major crashes of the Indian stock market are summarized below.

- Stock Market Crash of 1865 is prior to the formation of Bombay stock exchange in the year 1875 (BSE, 2024).

Parsee and Gujarati traders manually traded in global stock prior to the formation of Bombay stock exchange. Speculation regarding prolonged American civil war resulted in irrational increase of share prices of new Indian companies. End of the American civil war led to a major crash of these shares in the year 1865 (Mampatta & Bhayani, 2015).

- Crash of 1982 was a result of aggressive short selling by the Bengal cartel of Reliance Industries shares (Groww, 2024).
- In April 1992 Indian stock markets crashed by 12.77% triggered by the Harshad Mehta scam (Jaiswal, 2024) (Kumar, 2024).
- Crash of 2004, on 17, May, 2004 stock markets fell by 15.52 % triggered by the shock defeat of Vajpai led BJP government by Sonia Gandhi led congress (CNN, 2004).
- Crashes of 2008 was triggered by the fear of US economy entering into a long recession period (Wikipedia, 2024)
- Crash of 2020-COVID 19 Pandemic triggered stock market crashes across the globe in the year 2020. Indian stock markets experienced a major crash on 28th, February , 2020 based on WHO warning of a global Pandemic situation. Free fall of the markets continued for several months. On March 9th, 2020 NIFTY fell by 538 points, March 12th and 16th recorded close to 8% fall and on 23 March 2020 SENSEX lost 3,934 points (13.15%) and NIFT lost 1,135 points (12.98%) as coronavirus related lockdowns were clamped across the globe.
- Crash of Indian stock markets on 4, June, 2024 is the topic of this research work

4, June 2024 can be considered as a unique market event in the history of Indian stock markets. Prior to this event, Indian share markets were upbeat and steadily growing due to a prevailing market sentiment that a third term election win for the BJP/NDA alliance is certain.

This sentiment was supported by multiple opinion polls and odds data released by illegal betting markets. However, as vote counting started on June 4, 2024 and live results started percolating, markets realized that BJP will not be in a position to cross the midway mark and obtain a simple majority to form the government. Stock markets crashed by the end of the day at 3.30 pm on Tuesday (June 4, 2024), BSE Sensex lost 4389.73 points (-5.74%) to close at 72,079.05, and Nifty 50 ended at 21,884.50, lower by 1,379.40 (-5.93%).

II. LITERATURE SURVEY

Why Stock Markets Crash: Critical Events in Complex Financial Systems written by Didier Sornette (Sornette, 2017) is a fascinating book on global stock Markets and it offers deep technical insights into reasons and events before the market crash. Bulls, Bears and Other Beasts (5th Anniversary Edition): A Story of the Indian Stock Market, a book written by Santosh Nair (Nair, 2022) chronicles the major events of the Indian stock market in the last 40 years.

The following articles are reviewed for the purpose of this research work:

- How Abraham Lincoln triggered India's first stock market crash (Mampatta & Bhayani, 2015).
- History of Stock market crashes in India- Known and Unknown (Groww, 2024).
- Scam 1992- Harshad Mehta Scam (Jaiswal, 2024).
- Indian Stock Market Scam-The Complete Case Study of Harshad Mehta (Kumar, 2024).
- Investors flee Gandhi's India (CNN, 2004).
- Stock Market Crashes in India (Wikipedia, 2024).

III. OBJECTIVES OF THE RESEARCH STUDY

As of July 24, retail investors own 10% of the Indian stock market and they contribute to about 35% of cash segment trade. This group of investors is steadily growing and may reach 25% market share in the next few years (Vyas, 2024).

Bulk of the retail investors depend on publicly available information to take their investment decisions. Mutual fund houses and other asset management companies have teams of research associates and their research is meant for their paid customers. It is very difficult to obtain historical stock price data which is more than three years old.

Retail investors have to depend on scanty data and anecdotal blogs to understand major stock exchange events which have occurred in the past. Deep understanding of past events will make them prepared to handle future stock market crashes and also be alert to irrational market bubble growths and anticipate imminent crashes. Furthermore, in any crash few companies get adversely affected, few survive and few recover soon and few never recover from the crash. These inputs can significantly alter the retail investor behavior by moderating panic selling and frenzy buying eventually safeguarding their investments.

The objective of this research is to gather, analyze and report granular level details of the stock market crash that happened on 4th June 2024 document the results for future use.

IV. SIGNIFICANCE OF THE RESEARCH

Deep dive research and reports generated will go a long way to assist investors in the future to plan their exit/hold/buy on dips strategy during future market crashes. The granular and detailed analysis will mitigate the risk of lack of historical data beyond three years from the public domain.

V. CLUSTER ANALYSIS OF INDIAN STOCK MARKET CRASH ON 4 JUNE 2024

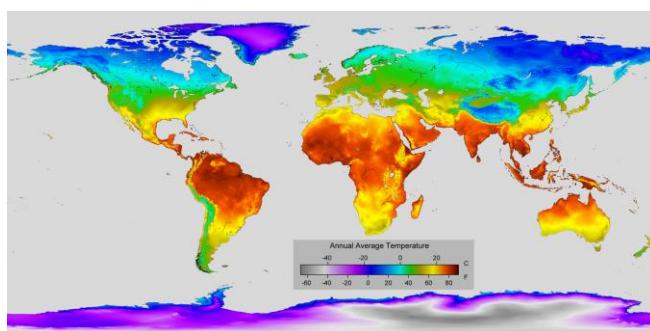
A. *Cluster Analysis*

Visual Analytics is a multidisciplinary science and technology field evolved from theory of information visualization and scientific visualization. It facilitates analytical reasoning by using interactive visual software tools. Currently, many such commercial software tools are available (Wikipedia, 2024). Visual Statistics is an emerging field. It can be considered as a visual analytics method. Book titled: Visual Statistics: Seeing Data with Dynamic Interactive Graphics (Young et al., 2011), gives us an excellent insight into the topic.

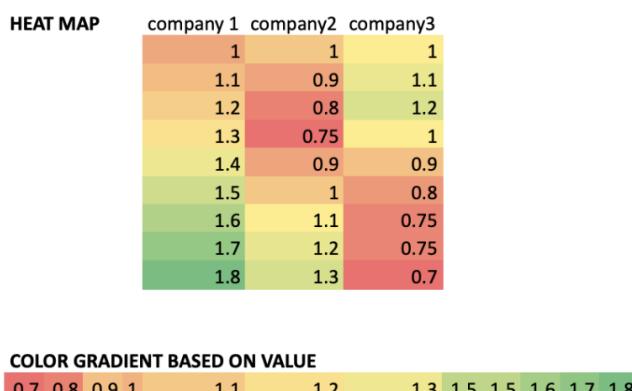
Stock market investors who use technical trading as opposed to fundamental trading extensively use charts and candlestick charts. Candlestick charts were developed in the 18th century by Munehisa Homma, a Japanese rice trader and later entered into stock markets across the globe as analytical tools (Canvass, 2023). Below is *Figure 1: An example of the Candlestick chart (Wikipedia, 2024)*.



Heat Maps are a regular feature of weather reporting tools. Occasionally, stock markets use heat maps (Intraday Screener, 2024). HEAT MAPS are extensively used in weather reporting. Visually they are very easy to interpret.



The following example explains how heat maps can be generated. Each cell is colored according to the value and the color gradient is given as a legend. When data is colored as per the gradient, it becomes an effective visual analytics tool.



This paper proposes to use heat maps extensively to cluster the data related to stock market crashes.

For analysis and reporting Clustered heat map (also called double dendrogram) is extensively used in this research paper. Data is organized as variables (columns) and variable values are presented as rows.

A cell in the table represents one of the data points of the variable. Based on the values of the cell, a color gradient is created. Individual cells are displayed as colored rectangles. The color of the cell is proportional to its value on the graded color gradient. The order of the rows is determined by performing hierarchical cluster analyses of the rows. This tends to position similar rows together on the plot. The order of the columns is determined similarly.

The following table has scores of 5 student's scores in five subjects:

STUD ENT	SUBJE CT 1	SUBJE CT 2	SUBJE CT 3	SUBJE CT 4	SUBJE CT 5
1	40	40	50	60	60
2	50	60	60	70	70
3	60	70	60	50	50
4	40	50	45	60	70
5	40	70	60	40	40

Heat map analysis is performed using statistical tool NCCS (NCSS, 2024)

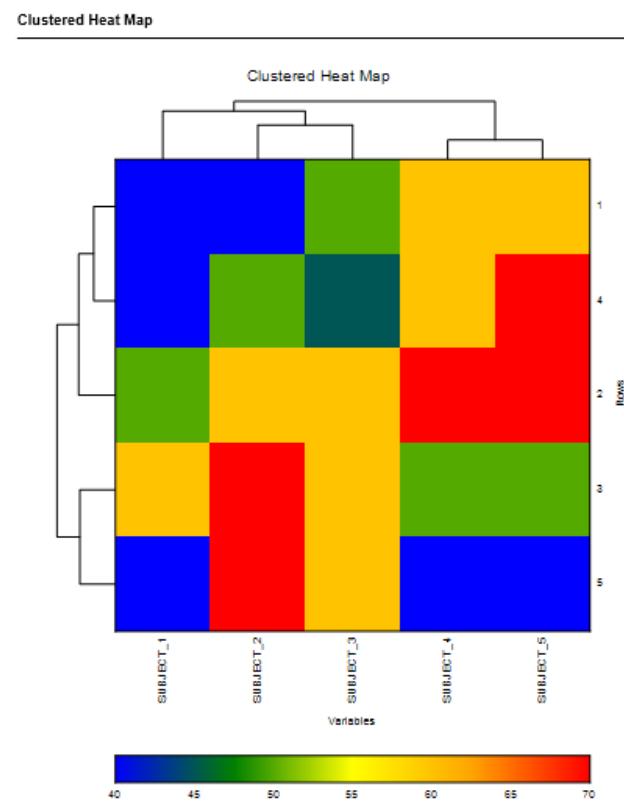


Figure 2: Heat map derived from NCSS software (NCSS, 2024)

Color gradient is given at the bottom of the image for the scores range from 40-70. Students are represented in rows and subjects as variable columns.

Algorithm classifies variables as the following clusters

Cluster Variables in this Cluster

1	SUBJECT_4, SUBJECT_5
2	SUBJECT_2, SUBJECT_3
None	SUBJECT_1

Students with similar marks are as indicated in the rows are clubbed together. The following references give us more details about dendrogram :

- What is Dendrogram (Bock, 2024)
- Hierarchical clustering explained by Prasad Pai (Pai, 2021).

B. Data Preparation for the analysis

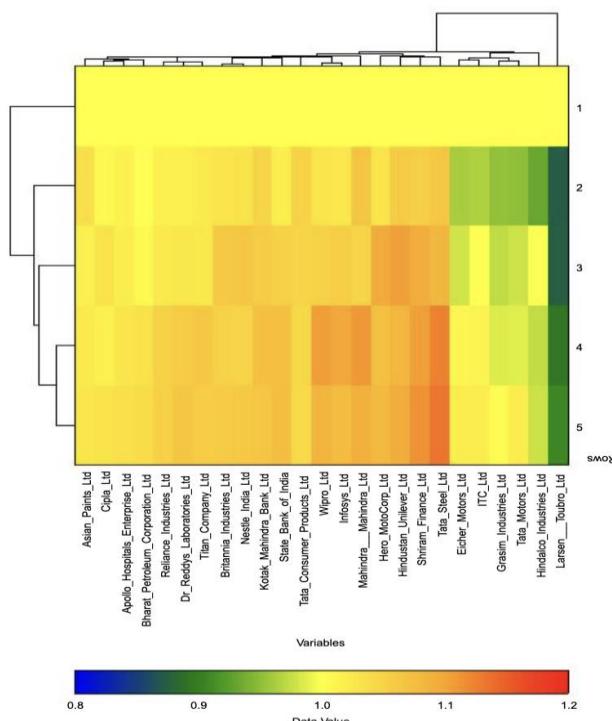
The following steps were followed to :

- Categorize the companies first into small manageable groups like NIFTY 50, NIFTY Next 50, NIFTY BANK etc.
- Obtain historic closing price date from 3, June, 2024 (day before the crash) till 3, September 2024 the target period chosen for this research
- Divide the closing stock of each day's closing stock price with the closing stock price of the respective stock on 3, June, 2024. This will lead to a base value of 1 for every stock on 3, June, 2024. On subsequent days, a value of 0.9 will indicate a 10% fall and a value of 1.1 will indicate 10% increase in the stock value.
- This approach will give us a quick technique on whether stocks have fallen/rose from the pre-crash day.

VI. NIFTY COMPANIES ANALYSIS

A. NIFTY 50 company analysis from 3/June/2024 to 3/September/2024

NIFTY50- First Set of 25 companies first few days after the crash



Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)

Distance Type: Euclidean

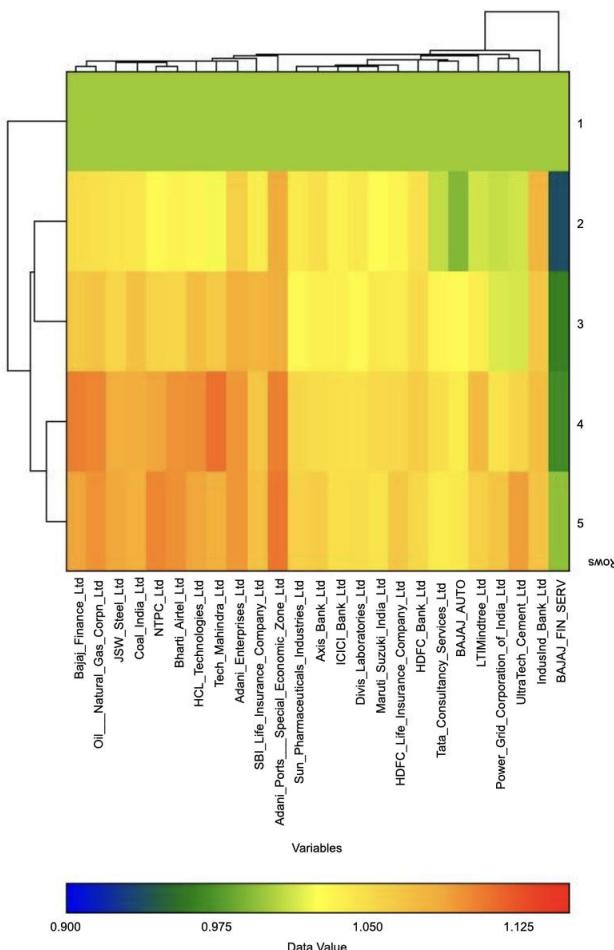
Scale Type: None

Cluster Variables in this Cluster

1 Asian_Paints_Ltd, Britannia_Industries_Ltd, Cipla_Ltd, Nestle_India_Ltd, Hero_MotoCorp_Ltd
 Hindustan_Unilever_Ltd, Mahindra___Mahindra_Ltd, Reliance_Industries_Ltd, Tata_Consumer_Products_Ltd
 Tata_Steel_Ltd, Wipro_Ltd, Apollo_Hospitals_Enterprise_Ltd, Dr_Reddys_Laboratories_Ltd
 Titan_Company_Ltd, State_Bank_of_India, Shriram_Finance_Ltd, Bharat_Petroleum_Corporation_Ltd
 Kotak_Mahindra_Bank_Ltd, Infosys_Ltd

2 Eicher_Motors_Ltd, Grasim_Industries_Ltd, Hindalco_Industries_Ltd, ITC_Ltd, Tata_Motors_Ltd

None Larsen___Toubro_Ltd

NIFTY50- Second Set of 25 companies**Cluster Detail Report when Clustering Variables**

Clustering Method: Single Linkage (Nearest Neighbor)

Distance Type: Euclidean

Scale Type: None

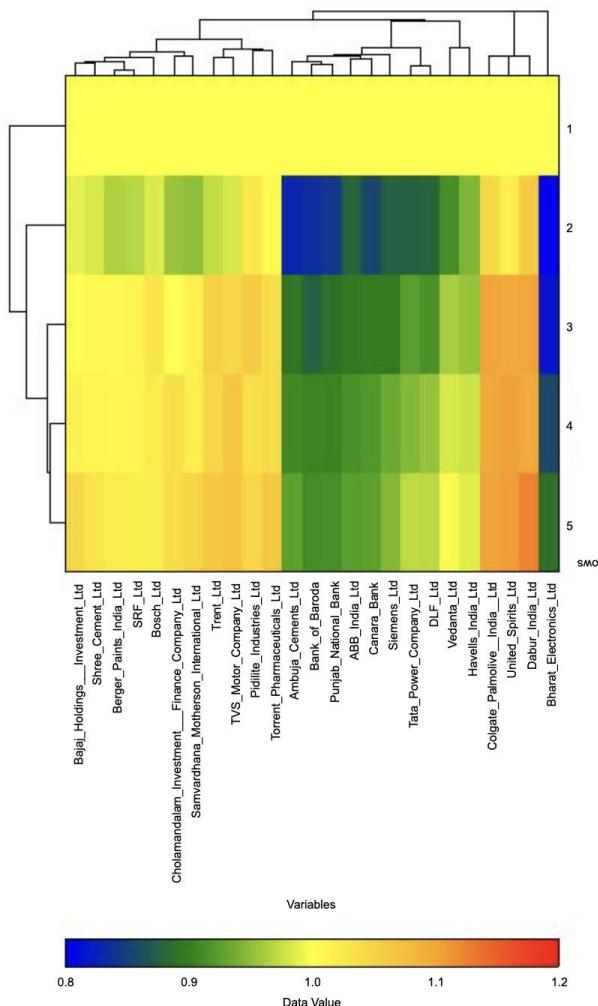
Cluster Variables in this Cluster

1 Bajaj_Finance_Ltd, Adani_Enterprises_Ltd, Sun_Pharmaceuticals_Industries_Ltd, JSW_Steel_Ltd
 HDFC_Bank_Ltd, Tata_Consultancy_Services_Ltd, ICICI_Bank_Ltd, Power_Grid_Corporation_of_India_Ltd
 Maruti_Suzuki_India_Ltd, Axis_Bank_Ltd, HCL_Technologies_Ltd, Oil_Natural_Gas_Corp_Ltd

NTPC_Ltd, Coal_India_Ltd, Bharti_Airtel_Ltd, Tech_Mahindra_Ltd, LTIMindtree_Ltd,
 Divis_Laboratories_Ltd
 Adani_Ports__Special_Economic_Zone_Ltd, HDFC_Life_Insurance_Company_Ltd,
 SBI_Life_Insurance_Company_Ltd
 UltraTech_Cement_Ltd, BAJAJ_AUTO
 None IndusInd_Bank_Ltd, BAJAJ_FIN_SERV

B. NIFTY NEXT 50 company analysis from 3/June/2024 to 3/September/2024

NIFTY NEXT 50 company analysis from 3/June/2024 to 3/September/2024



Cluster Detail Report when Clustering Variables

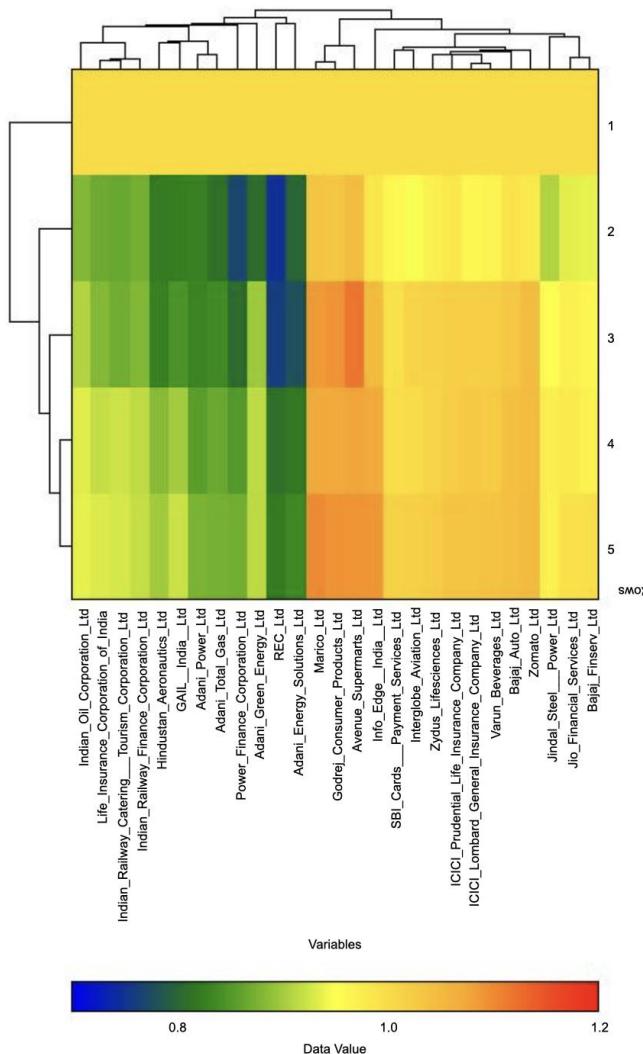
Clustering Method: Single Linkage (Nearest Neighbor)
 Distance Type: Euclidean
 Scale Type: None

Cluster Variables in this Cluster

1 Bajaj_Holdings__Investment_Ltd, Berger_Paints_India_Ltd, Ambuja_Cements_Ltd, ABB_India_Ltd, Trent_Ltd, Bosch_Ltd, Vedanta_Ltd, Shree_Cement_Ltd, SRF_Ltd, Siemens_Ltd, Tata_Power_Company_Ltd, Cholamandalam_Investment__Finance_Company_Ltd, Samvardhana_Motherson_International_Ltd, Pidilite_Industries_Ltd, Havells_India_Ltd, Torrent_Pharmaceuticals_Ltd, Bank_of_Baroda

2	Canara_Bank, DLF_Ltd, Punjab_National_Bank, TVS_Motor_Company_Ltd
None	Colgate_Palmolive__India__Ltd, Dabur_India_Ltd, United_Spirits_Ltd
	Bharat_Electronics_Ltd

NIFTY Next 50- Second Set of 25 companies first few days after the crash



Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)

Distance Type: Euclidean

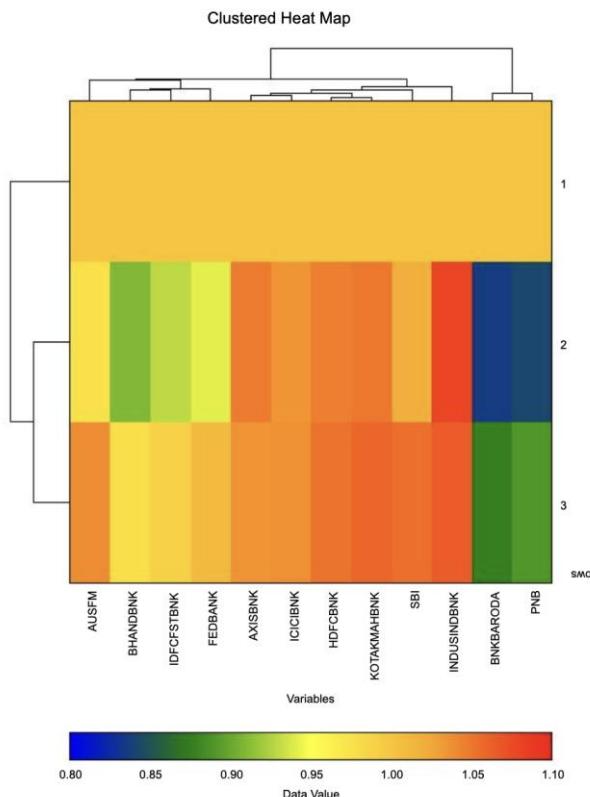
Scale Type: None

Cluster Variables in this Cluster

- 1 Indian_Oil_Corporation_Ltd, Life_Insurance_Corporation_of_India, Hindustan_Aeronautics_Ltd, Power_Finance_Corporation_Ltd, GAIL_India_Ltd, Indian_Railway_Finance_Corporation_Ltd, Adani_Power_Ltd, Indian_Railway_Catering__Tourism_Corporation_Ltd, Adani_Total_Gas_Ltd, Adani_Green_Energy_Ltd
- 2 Marico_Ltd, Info_Edge_India_Ltd, SBI_Cards__Payment_Services_Ltd, Jindal_Steel__Power_Ltd, Jio_Financial_Services_Ltd, Zydus_Lifesciences_Ltd, Godrej_Consumer_Products_Ltd, ICICI_Prudential_Life_Insurance_Company_Ltd

ICICI_Lombard_General_Insurance_Company_Ltd, Varun_Beverages_Ltd, Bajaj_Auto_Ltd,
Bajaj_Finserv_Ltd
Interglobe_Aviation_Ltd, Avenue_Supermarts_Ltd, Zomato_Ltd
3 REC_Ltd, Adani_Energy_Solutions_Ltd

C. NIFTY BANK company analysis few days from 3/June/2024



Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)
Distance Type: Euclidean
Scale Type: None

Cluster Variables in this Cluster

1 AUSFM, BHANDBNK, FEDBANK, IDFCFSTBNK
2 AXISBNK, HDFCBNK, ICICIBNK, INDUSINDBNK, KOTAKMAHBNK, SBI
3 BNKBARODA, PNB

D. NIFTY FMCG company analysis few days from 3/June/2024

Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)
Distance Type: Euclidean
Scale Type: None

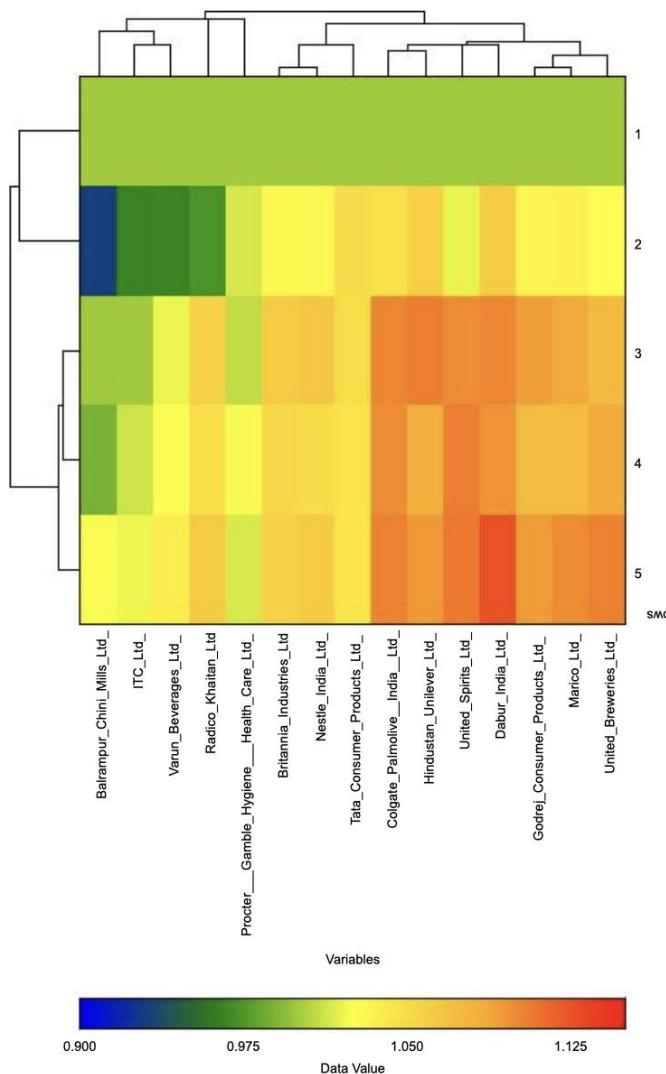
Cluster Variables in this Cluster

1 Balrampur_Chini_Mills_Ltd_, ITC_Ltd_, Procter__Gamble_Hygiene__Health_Care_Ltd_
 Radico_Khaitan_Ltd, Varun_Beverages_Ltd_

2 Britannia_Industries_Ltd, Colgate_Palmolive__India__Ltd_, Dabur_India_Ltd_,
 Godrej_Consumer_Products_Ltd_

Hindustan_Unilever_Ltd_, Marico_Ltd_, Nestle_India_Ltd_, Tata_Consumer_Products_Ltd_

United_Breweries_Ltd_, United_Spirits_Ltd_



E. NIFTY AUTO company analysis few days from 3/June/2024

Cluster Detail Report when Clustering Variables

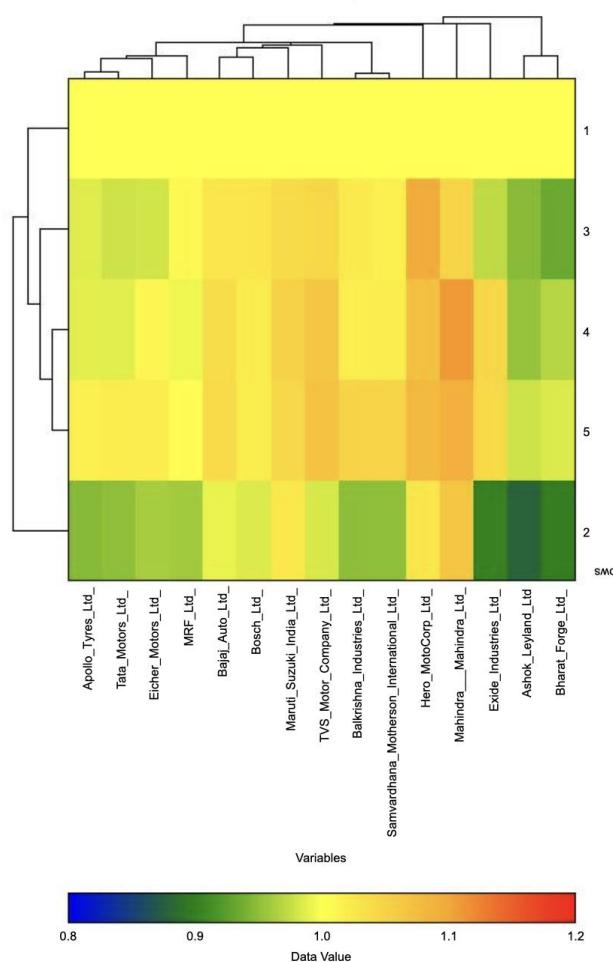
Clustering Method: Single Linkage (Nearest Neighbor)
 Distance Type: Euclidean
 Scale Type: None

Cluster Variables in this Cluster

1 Apollo_Tyres_Ltd_, Bajaj_Auto_Ltd_, Balkrishna_Industries_Ltd_, Bosch_Ltd_, Eicher_Motors_Ltd_,
 Exide_Industries_Ltd_, Hero_MotoCorp_Ltd_, MRF_Ltd_, Mahindra__Mahindra_Ltd_,
 Maruti_Suzuki_India_Ltd_

Samvardhana_Motherson_International_Ltd_, TVS_Motor_Company_Ltd_, Tata_Motors_Ltd_

2 Ashok_Leyland_Ltd, Bharat_Forge_Ltd_



F. NIFTY ENERGY company analysis first few days from 3/June/2024 and detailed cluster till 3/September/2024

Cluster Detail Report when Clustering Variables

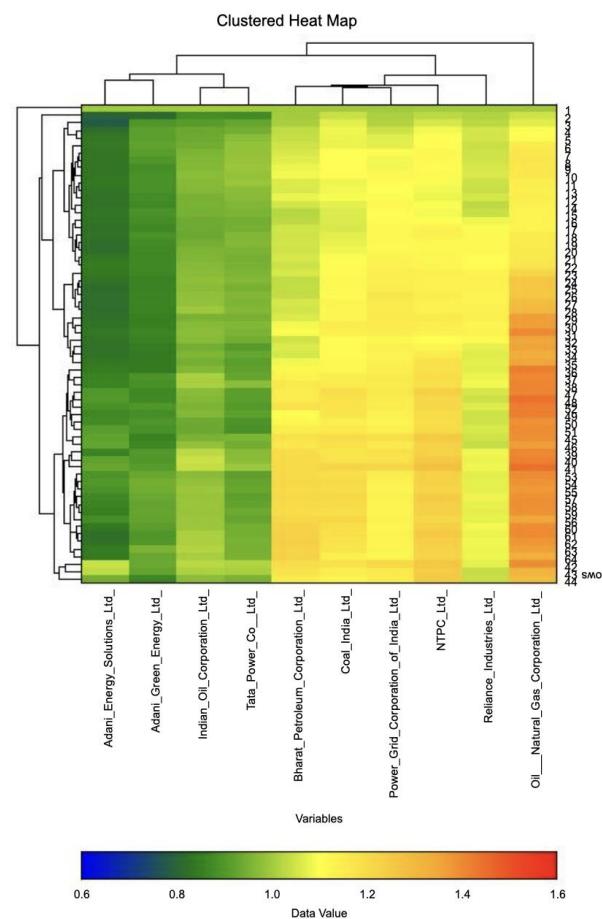
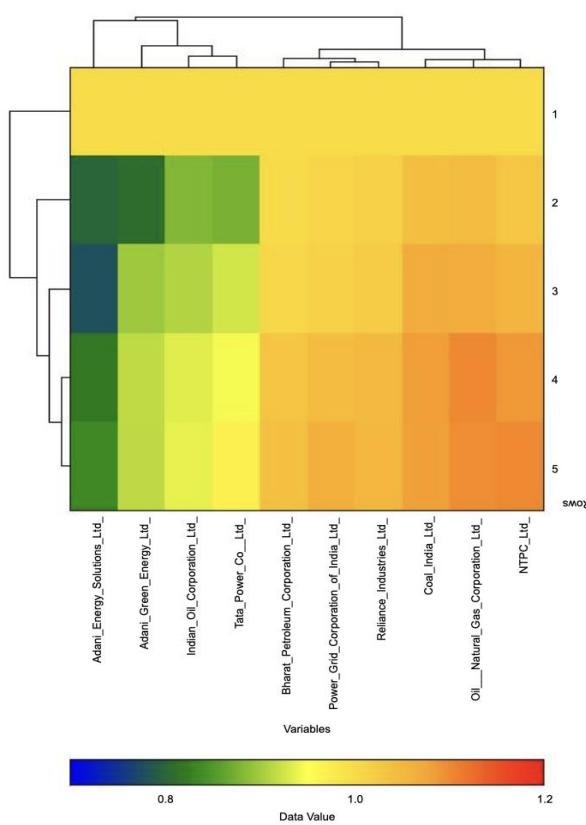
Clustering Method: Single Linkage (Nearest Neighbor)

Distance Type: Euclidean

Scale Type: None

Cluster Variables in this Cluster

1	Bharat_Petroleum_Corporation_Ltd_, Coal_India_Ltd_, NTPC_Ltd_, Oil_Natural_Gas_Corporation_Ltd_, Power_Grid_Corporation_of_India_Ltd_, Reliance_Industries_Ltd_
2	Adani_Green_Energy_Ltd_, Indian_Oil_Corporation_Ltd_, Tata_Power_Co_Ltd_
None	Adani_Energy_Solutions_Ltd_



Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)

Distance Type: Euclidean

Scale Type: None

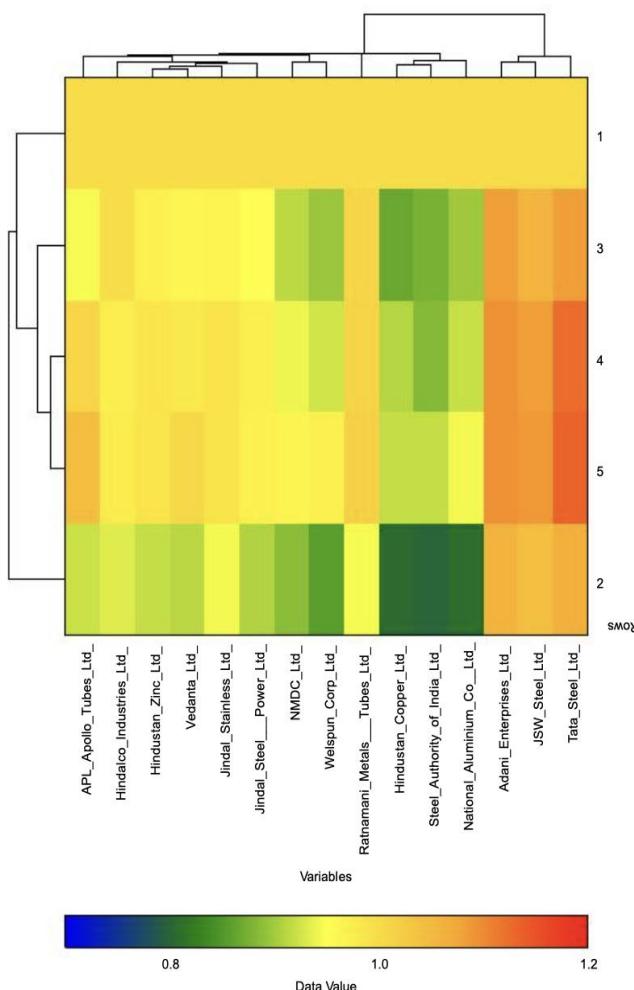
Cluster Variables in this Cluster

1 Adani_Energy_Solutions_Ltd_, Adani_Green_Energy_Ltd_, Indian_Oil_Corporation_Ltd_
Tata_Power_Co_Ltd_

2 Bharat_Petroleum_Corporation_Ltd_, Coal_India_Ltd_, NTPC_Ltd_, Power_Grid_Corporation_of_India_Ltd_
Reliance_Industries_Ltd_

None Oil_Natural_Gas_Corporation_Ltd_

G. NIFTY METAL company analysis few days from 3/June/2024 and detailed cluster till 3, September 24



Cluster Detail Report when Clustering Variables

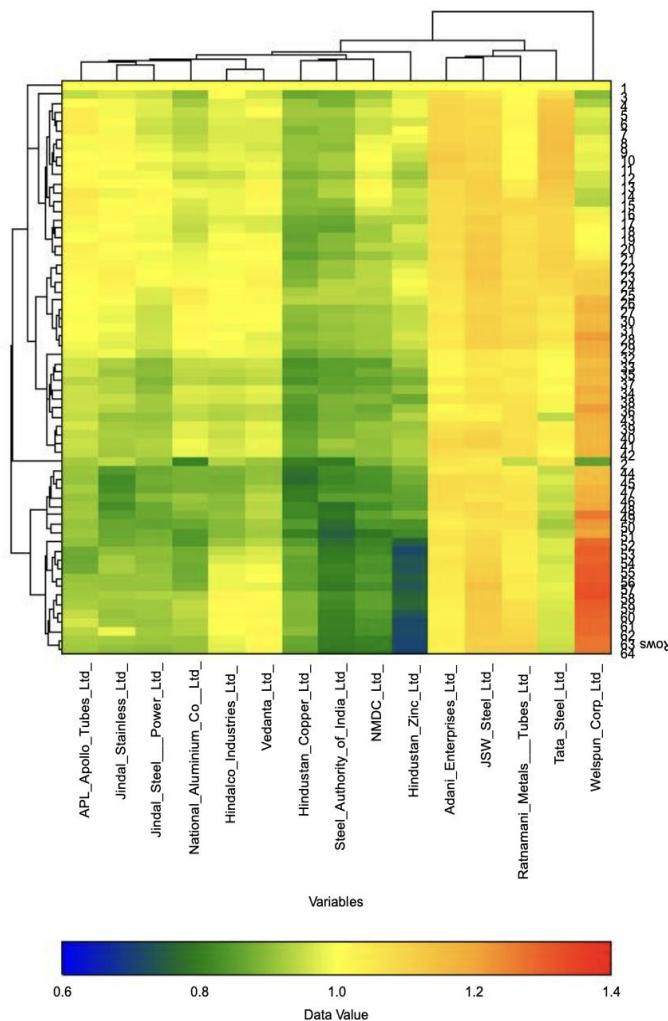
Clustering Method: Single Linkage (Nearest Neighbor)

Distance Type: Euclidean

Scale Type: None

Cluster Variables in this Cluster

1 APL_Apollo_Tubes_Ltd_, Hindalco_Industries_Ltd_, Hindustan_Copper_Ltd_, Hindustan_Zinc_Ltd_
 Jindal_Stainless_Ltd_, Jindal_Steel___Power_Ltd_, NMDC_Ltd_, National_Aluminium_Co__Ltd_
 Ratnamani_Metals___Tubes_Ltd_, Steel_Authority_of_India_Ltd_, Vedanta_Ltd_, Welspun_Corp_Ltd_
 2 Adani_Enterprises_Ltd_, JSW_Steel_Ltd_, Tata_Steel_Ltd_



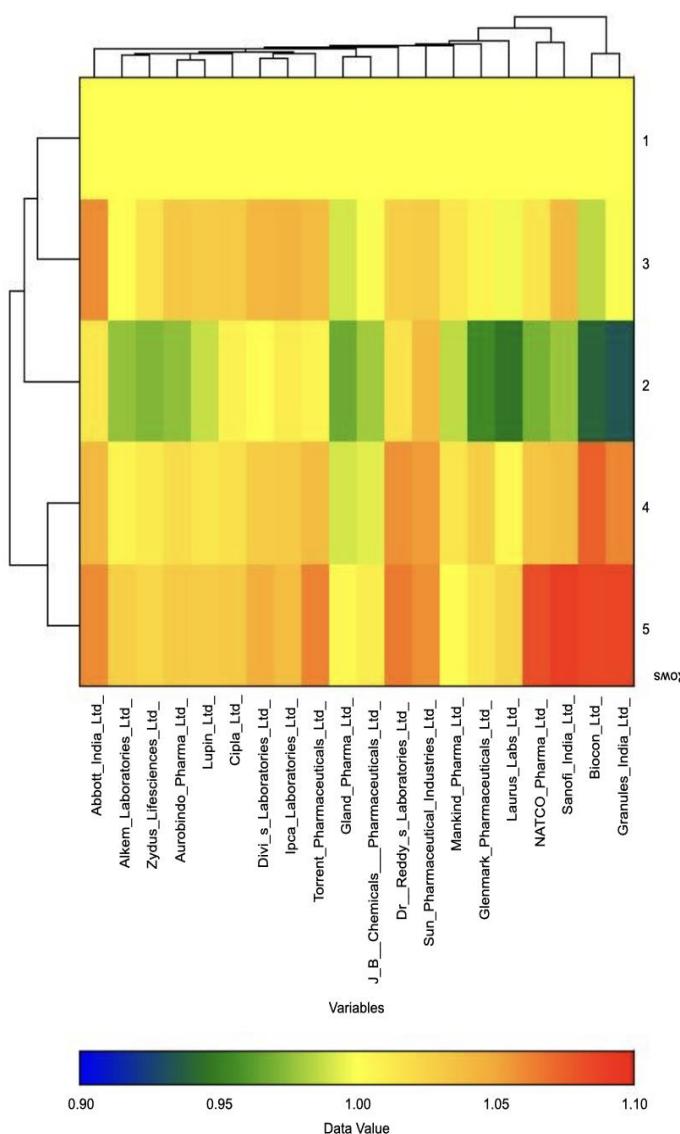
Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)
 Distance Type: Euclidean
 Scale Type: None

Cluster Variables in this Cluster

1 APL_Apollo_Tubes_Ltd_, Hindalco_Industries_Ltd_, Hindustan_Copper_Ltd_, Hindustan_Zinc_Ltd_
 Jindal_Stainless_Ltd_, Jindal_Steel___Power_Ltd_, NMDC_Ltd_, National_Aluminium_Co__Ltd_
 Steel_Authority_of_India_Ltd_, Vedanta_Ltd_
 2 Adani_Enterprises_Ltd_, JSW_Steel_Ltd_, Ratnamani_Metals___Tubes_Ltd_, Tata_Steel_Ltd_
 None Welspun_Corp_Ltd_

H. NIFTY PHARMA company analysis few days from 3/June/2024 and detailed clusters till 3, September 24

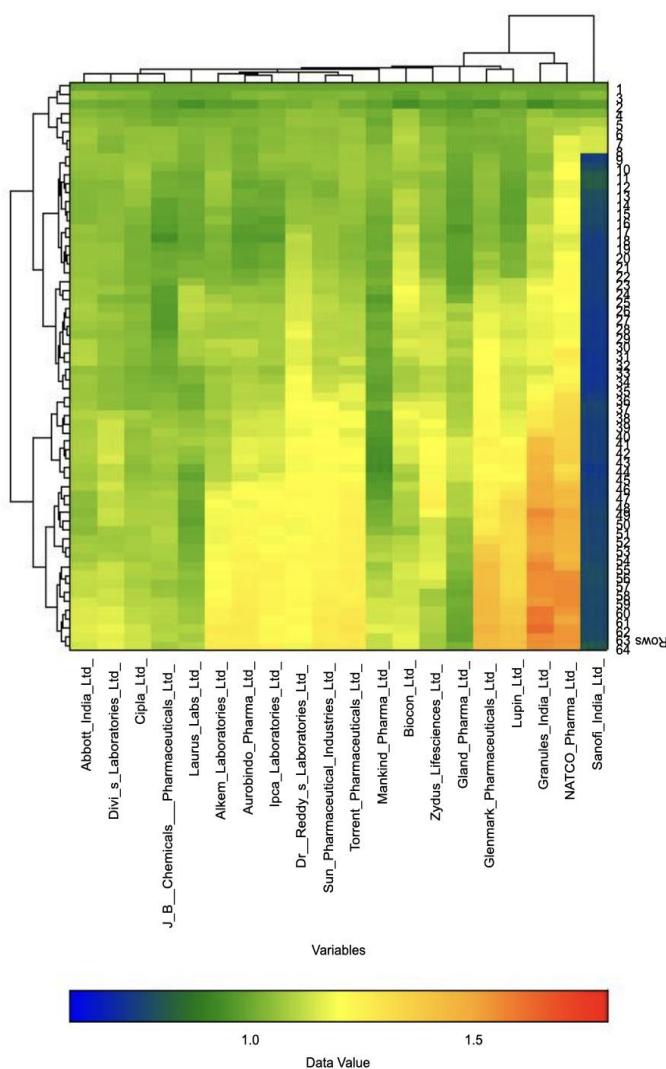


Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)
 Distance Type: Euclidean
 Scale Type: None

Cluster Variables in this Cluster

1	Abbott_India_Ltd_,	Alkem_Laboratories_Ltd_,	Aurobindo_Pharma_Ltd_,	Cipla_Ltd_,
	Divi_s_Laboratories_Ltd_,	Dr_Reddy_s_Laboratories_Ltd_,	Gland_Pharma_Ltd_,	Glenmark_Pharmaceuticals_Ltd_,
	Ipca_Laboratories_Ltd_,	Sun_Pharmaceutical_Industries_Ltd_,	Mankind_Pharma_Ltd_,	
	Torrent_Pharmaceuticals_Ltd_,	Dr_Reddy_s_Laboratories_Ltd_,	NATCO_Pharma_Ltd_,	
	Zydus_Lifesciences_Ltd_,	Sun_Pharmaceutical_Industries_Ltd_,	Sanofi_India_Ltd_,	
	Aurobindo_Pharma_Ltd_,	Lupin_Ltd_,	Biocon_Ltd_,	
	Lupin_Ltd_,	Mankind_Pharma_Ltd_,	Granules_India_Ltd_,	
	Cipla_Ltd_,	NATCO_Pharma_Ltd_,		
		Sanofi_India_Ltd_,		
2		Biocon_Ltd_,	Granules_India_Ltd_,	
3		NATCO_Pharma_Ltd_,	Sanofi_India_Ltd_,	



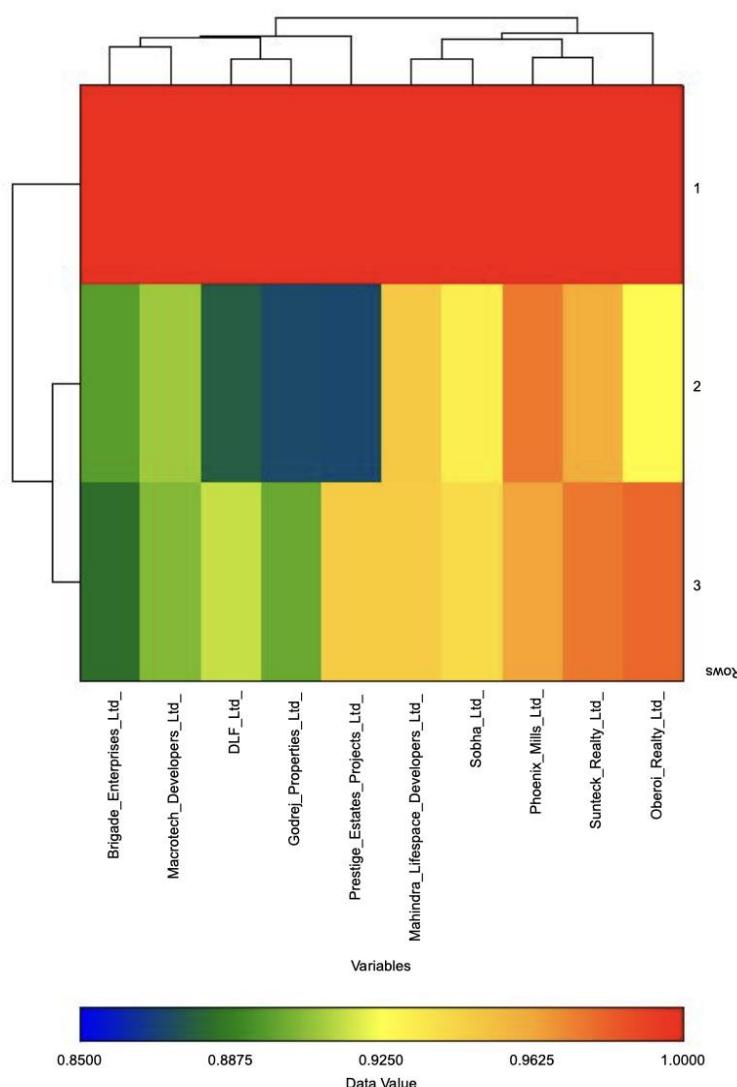
Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)
 Distance Type: Euclidean
 Scale Type: None

Cluster Variables in this Cluster

1	Abbott_India_Ltd_, Alkem_Laboratories_Ltd_, Aurobindo_Pharma_Ltd_, Biocon_Ltd_, Cipla_Ltd_, Divi_s_Laboratories_Ltd_, Dr__Reddy_s_Laboratories_Ltd_, Gland_Pharma_Ltd_, Glenmark_Pharmaceuticals_Ltd_, Ipcा_Laboratories_Ltd_, J_B__Chemicals__Pharmaceuticals_Ltd_, Laurus_Labs_Ltd_, Lupin_Ltd_, Mankind_Pharma_Ltd_, Sun_Pharmaceutical_Industries_Ltd_, Torrent_Pharmaceuticals_Ltd_, Zydus_Lifesciences_Ltd_
2	Granules_India_Ltd_, NATCO_Pharma_Ltd_
None	Sanofi_India_Ltd_

I. NIFTY REALTY company analysis few days from 3/June/2024 and detailed cluster till 3, September 24



Cluster Detail Report when Clustering Variables

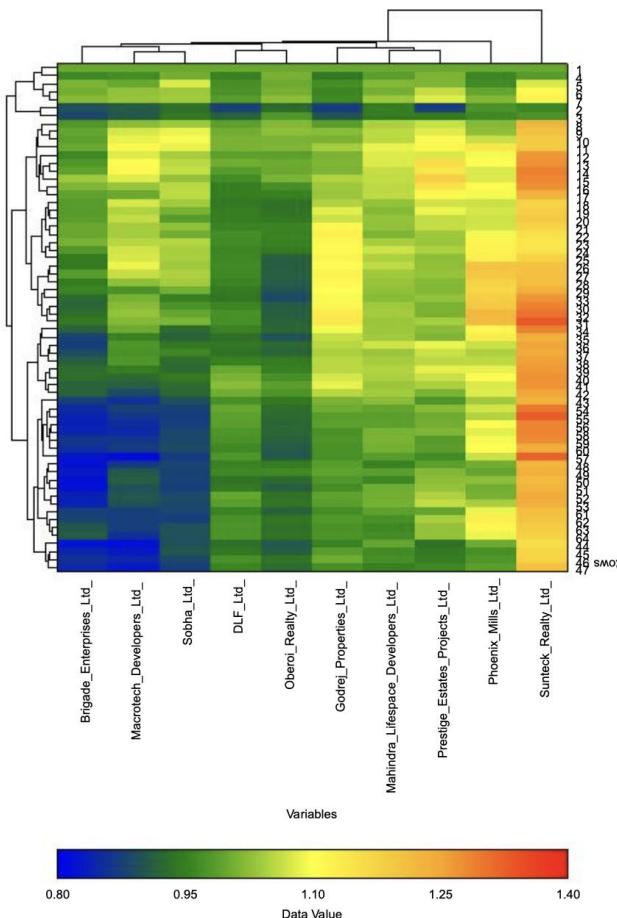
Clustering Method: Single Linkage (Nearest Neighbor)

Distance Type: Euclidean

Scale Type: None

Cluster Variables in this Cluster

1	Brigade_Enterprises_Ltd_, DLF_Ltd_, Godrej_Properties_Ltd_, Macrotech_Developers_Ltd_, Prestige_Estates_Projects_Ltd_
2	Mahindra_Lifespace_Developers_Ltd_, Phoenix_Mills_Ltd_, Sobha_Ltd_, Sunteck_Realty_Ltd_
None	Oberoi_Realty_Ltd_



Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)
 Distance Type: Euclidean
 Scale Type: None

Cluster Variables in this Cluster

1	Brigade_Engines_Ltd, DLF_Ltd, Godrej_Properties_Ltd, Macrotech_Developers_Ltd, Mahindra_Lifespace_Developers_Ltd, Oberoi_Realty_Ltd, Prestige_Estates_Projects_Ltd, Sobha_Ltd
None	Phoenix_Mills_Ltd, Sunteck_Realty_Ltd

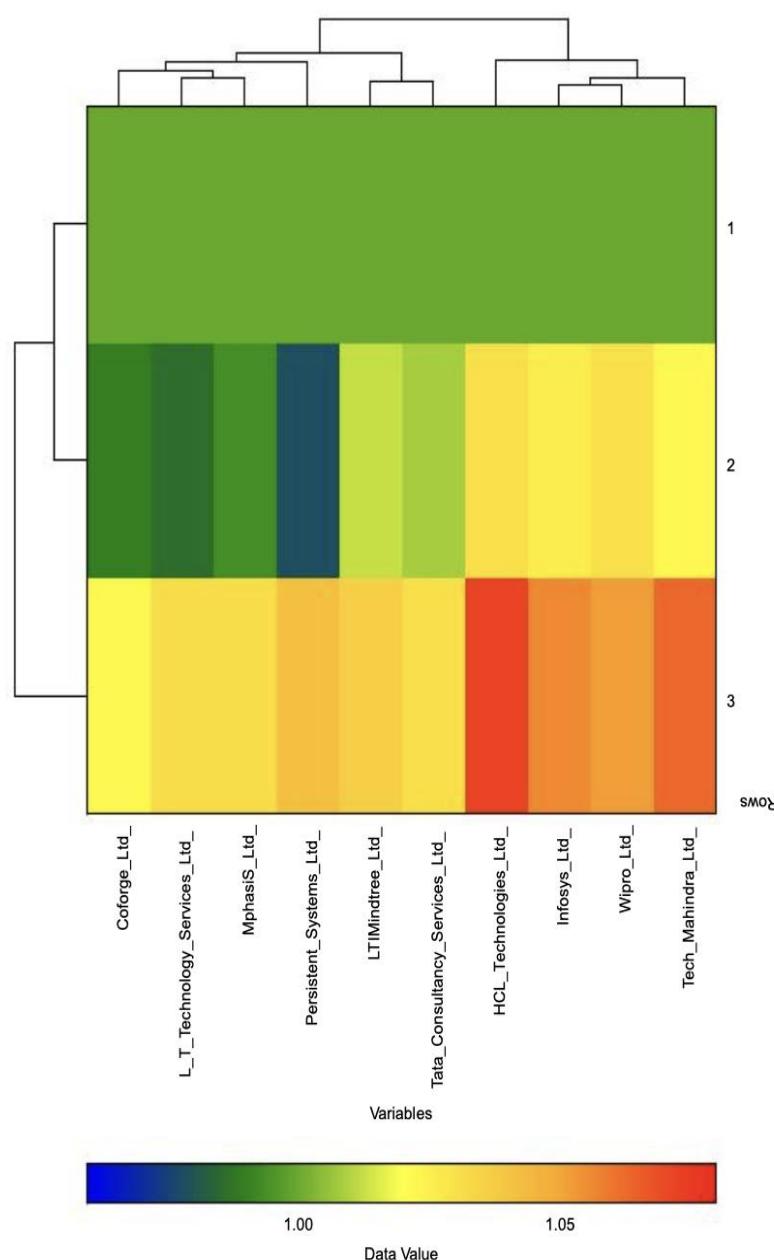
J. NIFTY IT company analysis few days from 3/June/2024 and detailed cluster till 3, September 24

Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)
 Distance Type: Euclidean
 Scale Type: None

Cluster Variables in this Cluster

1	Coforge_Ltd, L_T_Technology_Services_Ltd, MphasiS_Ltd, Persistent_Systems_Ltd
2	HCL_Technologies_Ltd, Infosys_Ltd, Tech_Mahindra_Ltd, Wipro_Ltd
3	LТИMindtree_Ltd, Tata_Consultancy_Services_Ltd

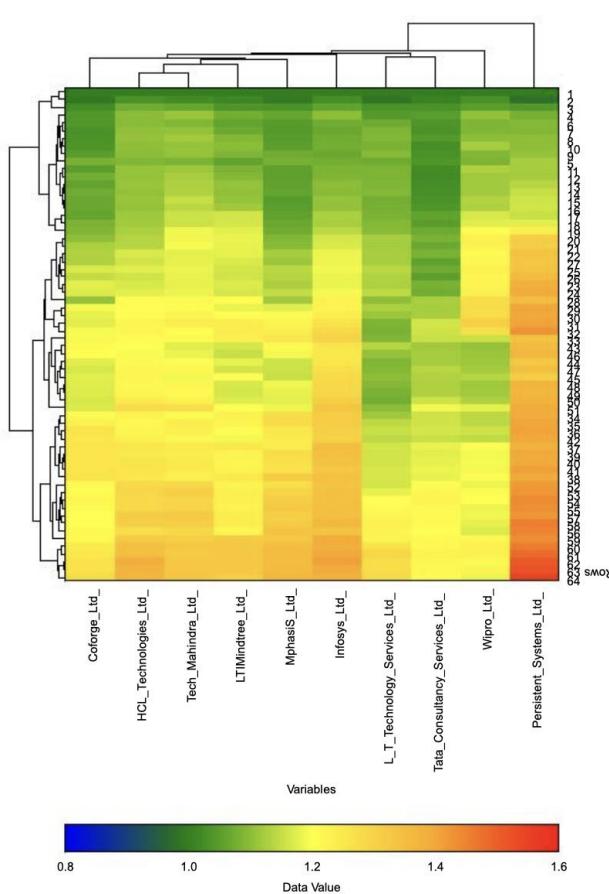


Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)
 Distance Type: Euclidean
 Scale Type: None

Cluster Variables in this Cluster

1	Coforge_Ltd_, HCL_Technologies_Ltd_, Infosys_Ltd_, L_T_Technology_Services_Ltd_, LTIMindtree_Ltd_, MphasiS_Ltd_, Tata_Consultancy_Services_Ltd_, Tech_Mahindra_Ltd_
None	Persistent_Systems_Ltd_, Wipro_Ltd_



K. NIFTY MID CAP 100 company analysis few days from 3/June/2024

The heat map for NIFTY MID CAP 100 has been divided into four sectors, each constituting 25 companies.

- NIFTY MIDCAP F25
- NIFTY MIDCAP S25
- NIFTY MIDCAP T25
- NIFTY MIDCAP Four25

L. NIFTY MID CAP 100: First set of 25 Companies (NIFTY MIDCAP F25)

Cluster Detail Report when Clustering Variables

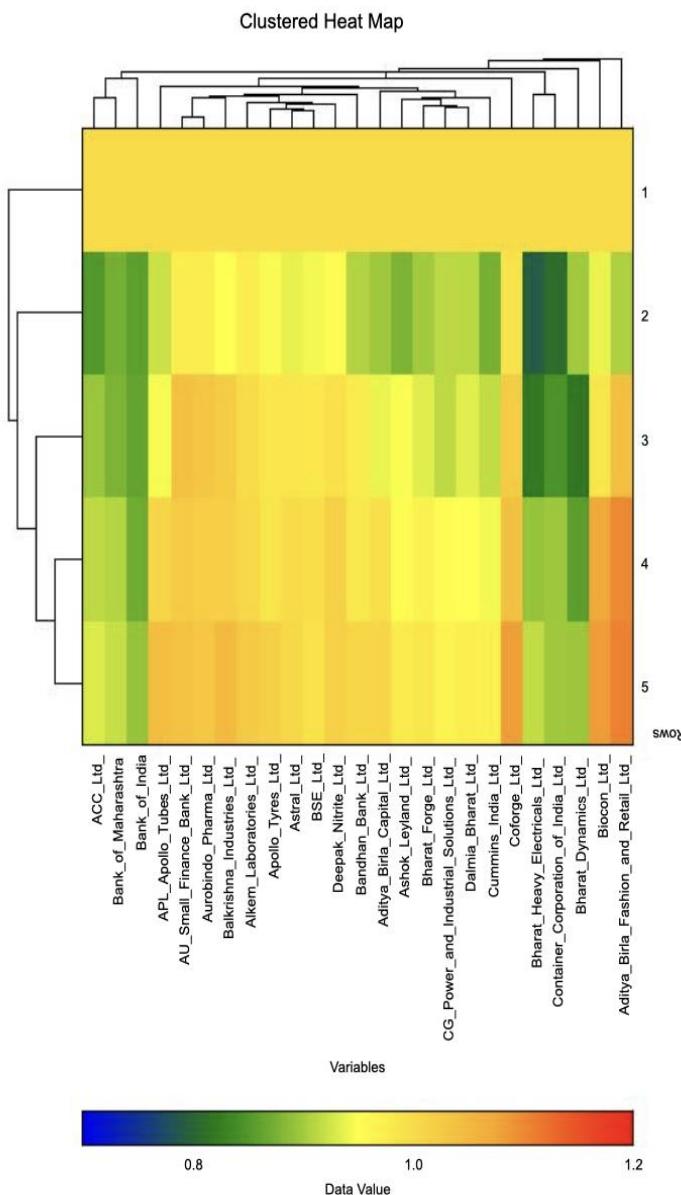
Clustering Method: Single Linkage (Nearest Neighbor)

Distance Type: Euclidean

Scale Type: None

Cluster Variables in this Cluster

1	ACC_Ltd_, APL_Apollo_Tubes_Ltd_, AU_Small_Finance_Bank_Ltd_, Aditya_Birla_Capital_Ltd_, Alkem_Laboratories_Ltd_, Apollo_Tyres_Ltd_, Ashok_Leyland_Ltd_, Astral_Ltd_, Aurobindo_Pharma_Ltd_, BSE_Ltd_, Balkrishna_Industries_Ltd_, Bandhan_Bank_Ltd_, Bank_of_India, Bank_of_Maharashtra, Bharat_Dynamics_Ltd_, Bharat_Forge_Ltd_, Bharat_Heavy_Electricals_Ltd_, CG_Power_and_Industrial_Solutions_Ltd_, Coforge_Ltd_, Container_Corporation_of_India_Ltd_, Cummins_India_Ltd_, Dalmia_Bharat_Ltd_, Deepak_Nitrite_Ltd_
None	Aditya_Birla_Fashion_and_Retail_Ltd_, Biocon_Ltd_



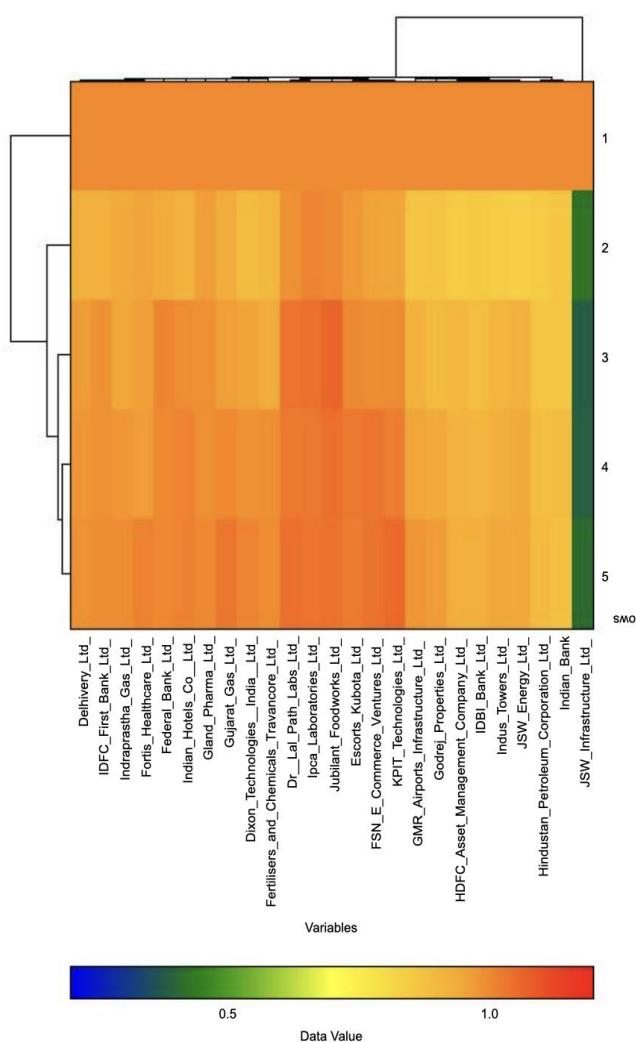
M. NIFTY MID CAP 100: Second set of 25 Companies (NIFTY MIDCAP S25)

Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)
 Distance Type: Euclidean
 Scale Type: None

Cluster Variables in this Cluster

1	Delhivery_Ltd_, Dixon_Technologies_India_Ltd_, Dr_Lal_Path_Labs_Ltd_, Escorts_Kubota_Ltd_FSN_E_Commerce_Ventures_Ltd_, Federal_Bank_Ltd_, Fertilisers_and_Chemicals_Travancore_Ltd_Fortis_Healthcare_Ltd_, Gland_Pharma_Ltd_, Gujarat_Gas_Ltd_, IDFC_First_Bank_Ltd_Indian_Hotels_Co_Ltd_, Indraprastha_Gas_Ltd_, Ipcu_Laboratories_Ltd_, Jubilant_Foodworks_Ltd_KPIT_Technologies_Ltd_
2	GMR_Airports_Infrastructure_Ltd_, Godrej_Properties_Ltd_, HDFC_Asset_Management_Company_Ltd_Hindustan_Petroleum_Corporation_Ltd_, IDBI_Bank_Ltd_, Indian_Bank, Indus_Towers_Ltd_JSW_Energy_Ltd_
None	JSW_Infrastructure_Ltd_



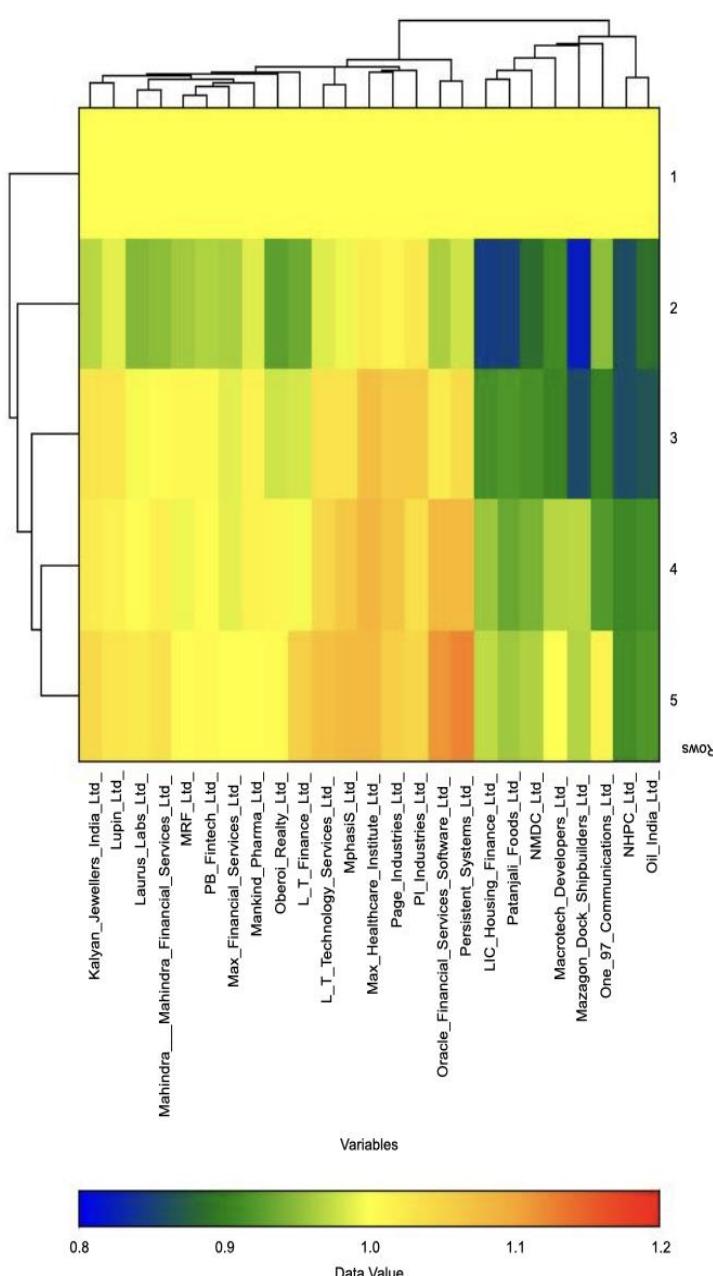
N. NIFTY MID CAP 100: Third set of 25 Companies (NIFTY MIDCAP T25)

Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)
 Distance Type: Euclidean
 Scale Type: None

Cluster Variables in this Cluster

1	Kalyan_Jewellers_India_Ltd_, L_T_Finance_Ltd_, L_T_Technology_Services_Ltd_, Laurus_Labs_Ltd_, Lupin_Ltd_, MRF_Ltd_, Mahindra_Mahindra_Financial_Services_Ltd_, Mankind_Pharma_Ltd_, Max_Financial_Services_Ltd_, Max_Healthcare_Institute_Ltd_, MphasiS_Ltd_, Oberoi_Realty_Ltd_, Oracle_Financial_Services_Software_Ltd_, PB_Fintech_Ltd_, PI_Industries_Ltd_, Page_Industries_Ltd_, Persistent_Systems_Ltd_
2	LIC_Housing_Finance_Ltd_, Macrotech_Developers_Ltd_, Mazagon_Dock_Shipbuilders_Ltd_, NMDC_Ltd_, One_97_Communications_Ltd_, Patanjali_Foods_Ltd_
3	NHPC_Ltd_, Oil_India_Ltd_



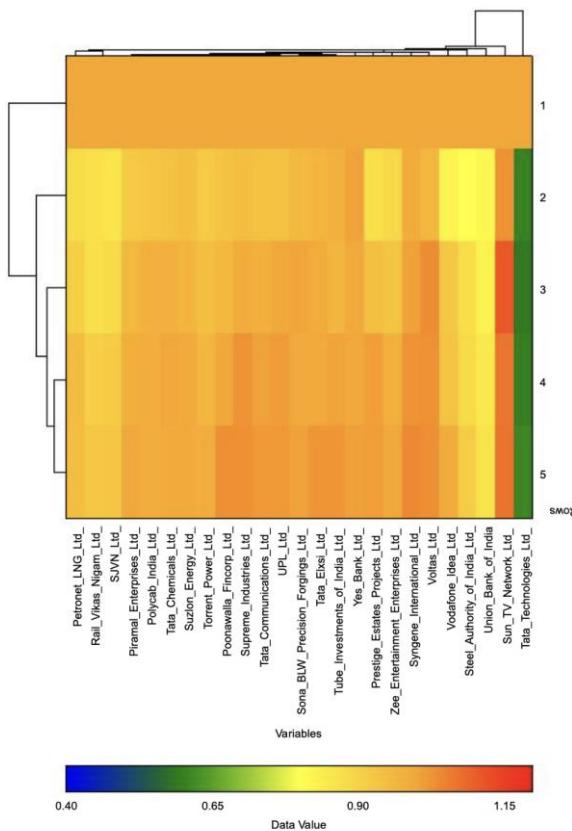
O. NIFTY MID CAP 100: Fourth set of 25 Companies (NIFTY MIDCAP Four25)

Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)
 Distance Type: Euclidean
 Scale Type: None

Cluster Variables in this Cluster

1	Petronet_LNG_Ltd_, Piramal_Enterprises_Ltd_, Polycab_India_Ltd_, Poonawalla_Fincorp_Ltd_, Prestige_Estates_Projects_Ltd_, Rail_Vikas_Nigam_Ltd_, SJVN_Ltd_, Sona_BLW_Precision_Forgings_Ltd_, Steel_Authority_of_India_Ltd_, Supreme_Industries_Ltd_, Suzlon_Energy_Ltd_, Syngene_International_Ltd_, Tata_Chemicals_Ltd_, Tata_Communications_Ltd_, Tata_Elxsi_Ltd_, Torrent_Power_Ltd_, Tube_Investments_of_India_Ltd_, UPL_Ltd_, Union_Bank_of_India, Vodafone_Idea_Ltd_, Voltas_Ltd_, Yes_Bank_Ltd_, Zee_Entertainment_Enterprises_Ltd_
None	Sun_TV_Network_Ltd_, Tata_Technologies_Ltd_



P. NIFTY SMALLCAP 100 company analysis few days from 3/June/ 2024

The heat map for NIFTY SMALLCAP 100 has been divided into four sectors, each constituting 25 companies.

- NIFTY SMALLCAP F25
- NIFTY SMALLCAP S25
- NIFTY SMALLCAP T25
- NIFTY SMALLCAP Four25

Q. NIFTY SMALLCAP 100: First set of 25 Companies (NIFTY SMALLCAP F25)

Cluster Detail Report when Clustering Variables

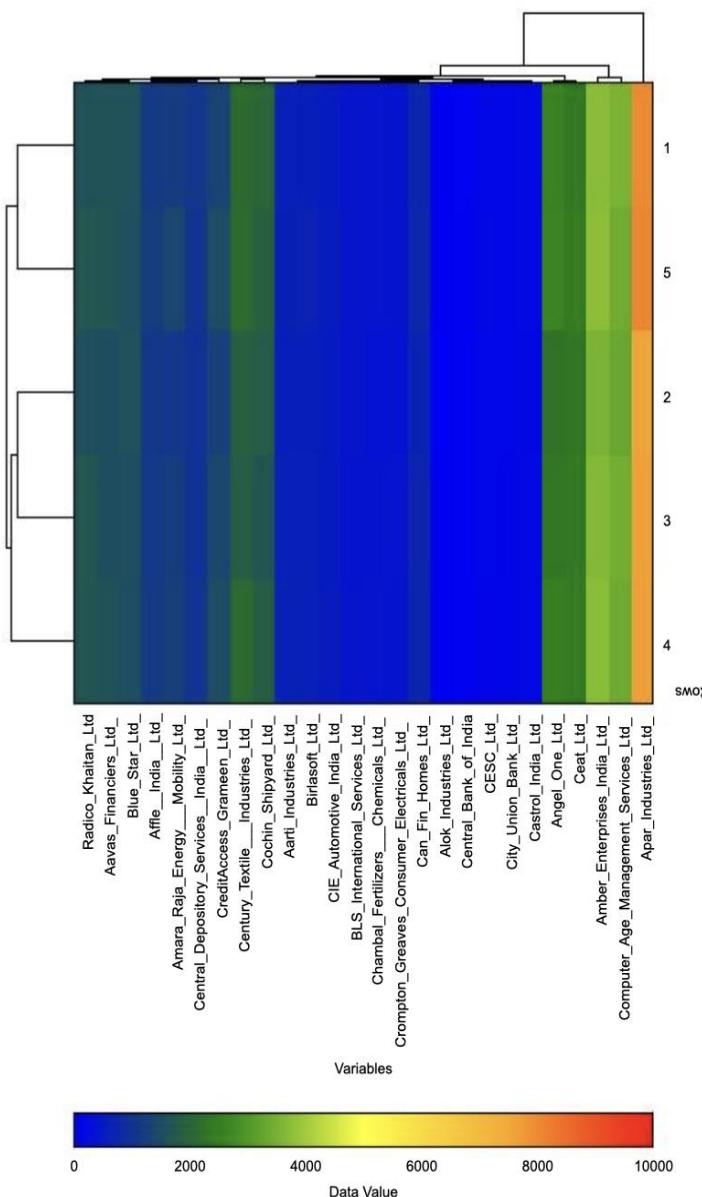
Clustering Method: Single Linkage (Nearest Neighbor)

Distance Type: Euclidean

Scale Type: None

Cluster Variables in this Cluster

1	Radico_Khaitan_Ltd, Aarti_Industries_Ltd, Aavas_Financiers_Ltd, Affle_India_Ltd, Alok_Industries_Ltd, Amara_Raja_Energy_Mobility_Ltd, Angel_One_Ltd, BLS_International_Services_Ltd, Birlasoft_Ltd, Blue_Star_Ltd, CESC_Ltd, CIE_Automotive_India_Ltd, Can_Fin_Homes_Ltd, Castrol_India_Ltd, Ceat_Ltd, Central_Bank_of_India, Central_Depository_Services_India_Ltd, Century_Textile_Industries_Ltd, Chambal_Fertilizers_Chemicals_Ltd, City_Union_Bank_Ltd, Cochin_Shipyard_Ltd, CreditAccess_Grameen_Ltd, Crompton_Greaves_Consumer_Electricals_Ltd
2	Amber_Enterprises_India_Ltd, Computer_Age_Management_Services_Ltd
None	Apar_Industries_Ltd



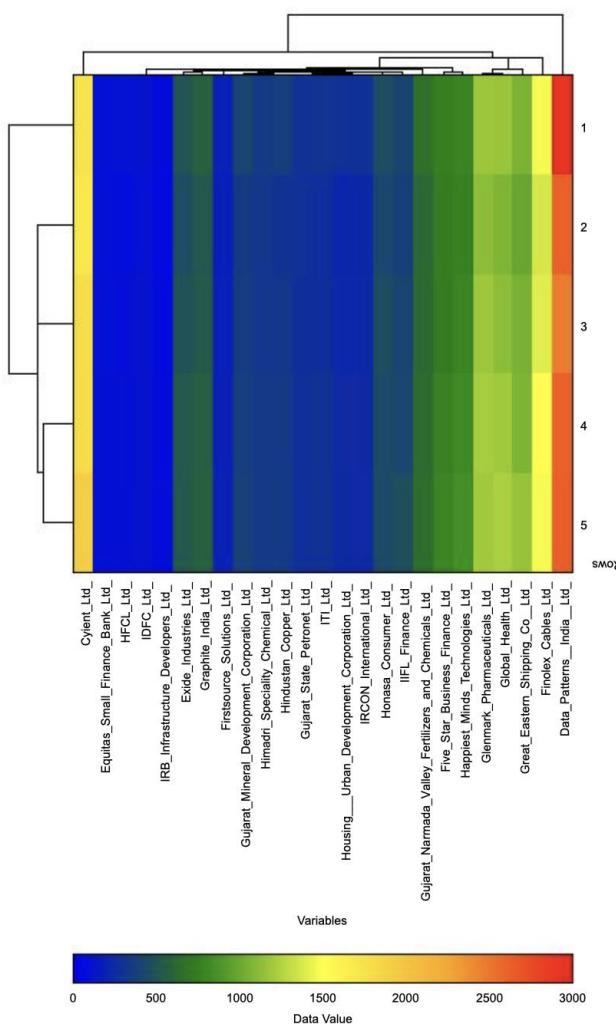
R. NIFTY SMALLCAP 100: Second set of 25 Companies (NIFTY SMALLCAP S25)

Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)
 Distance Type: Euclidean
 Scale Type: None

Cluster Variables in this Cluster

1	Equitas_Small_Finance_Bank_Ltd_, Exide_Industries_Ltd_, Finolex_Cables_Ltd_, Firstsource_Solutions_Ltd_, Five_Star_Business_Finance_Ltd_, Glenmark_Pharmaceuticals_Ltd_, Global_Health_Ltd_, Graphite_India_Ltd_, Great_Eastern_Shipping_Co_Ltd_, Gujarat_Mineral_Development_Corporation_Ltd_, Gujarat_Narmada_Valley_Fertilizers_and_Chemicals_Ltd_, Gujarat_State_Petronet_Ltd_, HFCL_Ltd_, Happiest_Minds_Technologies_Ltd_, Himadri_Speciality_Chemical_Ltd_, Hindustan_Copper_Ltd_, Honasa_Consumer_Ltd_, Housing_Urban_Development_Corporation_Ltd_, IDFC_Ltd_, IIFL_Finance_Ltd_, IRB_Infrastructure_Developers_Ltd_, IRCON_International_Ltd_, ITI_Ltd_
None	Cyient_Ltd_, Data_Patterns_India_Ltd_



S. NIFTY SMALLCAP 100: Third set of 25 Companies (NIFTY SMALLCAP T25)

Cluster Detail Report when Clustering Variables

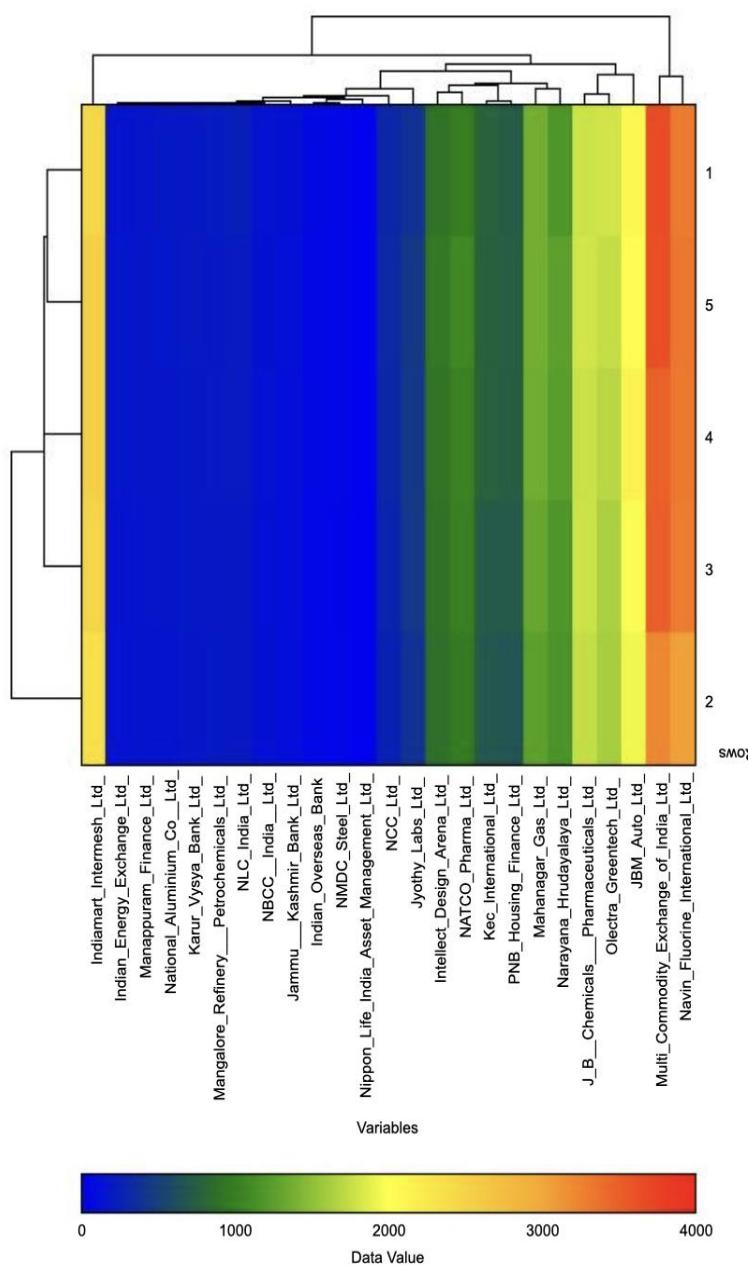
Clustering Method: Single Linkage (Nearest Neighbor)

Distance Type: Euclidean

Scale Type: None

Cluster Variables in this Cluster

1	Multi_Commodity_Exchange_of_India_Ltd_, Navin_Fluorine_International_Ltd_
2	Indian_Energy_Exchange_Ltd_, Indian_Overseas_Bank, Intellect_Design_Arena_Ltd_,
J_B_Chemicals_Pharmaceuticals_Ltd_	
JBM_Auto_Ltd_, Jammu_Kashmir_Bank_Ltd_, Jyothy_Labs_Ltd_, Karur_Vysya_Bank_Ltd_	
Kec_International_Ltd_, Mahanagar_Gas_Ltd_, Manappuram_Finance_Ltd_,	
Mangalore_Refinery_Petrochemicals_Ltd_	
NATCO_Pharma_Ltd_, NBCC_India_Ltd_, NCC_Ltd_, NLC_India_Ltd_, NMDC_Steel_Ltd_,	
Narayana_Hrudayalaya_Ltd_	
National_Aluminium_Co_Ltd_, Nippon_Life_India_Asset_Management_Ltd_, Olectra_Greentech_Ltd_	
PNB_Housing_Finance_Ltd_	
None	Indiamart_Intermesh_Ltd_



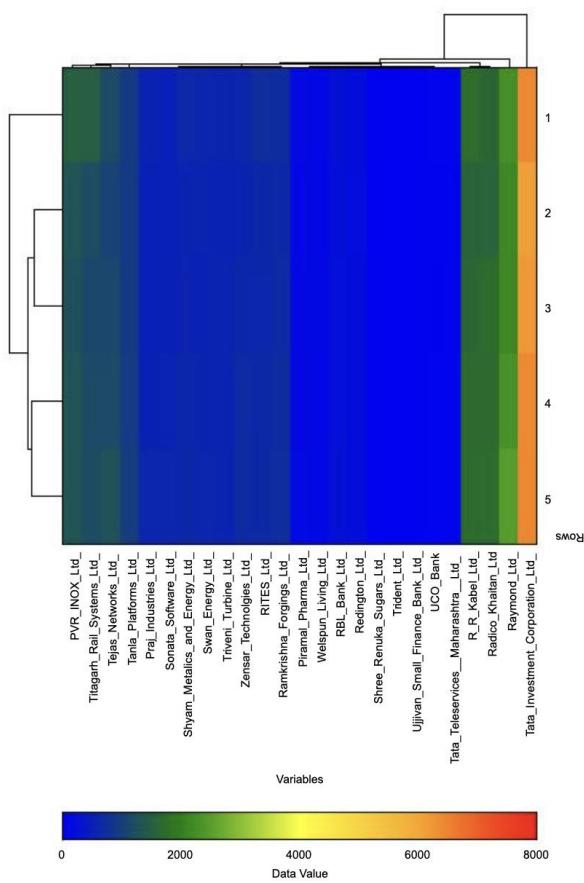
T. NIFTY SMALLCAP 100: Fourth set of 25 Companies (NIFTY SMALLCAP Four25)

Cluster Detail Report when Clustering Variables

Clustering Method: Single Linkage (Nearest Neighbor)
 Distance Type: Euclidean
 Scale Type: None

Cluster Variables in this Cluster

1	PVR_INOX_Ltd_, Piramal_Pharma_Ltd_, Praj_Industries_Ltd_, R_R_Kabel_Ltd_, RBL_Bank_Ltd_, RITES_Ltd_, Radico_Khaitan_Ltd, Ramkrishna_Forgings_Ltd_, Redington_Ltd_, Shree_Renuka_Sugars_Ltd_, Shyam_Metalics_and_Energy_Ltd_, Sonata_Software_Ltd_, Swan_Energy_Ltd_, Tanla_Platforms_Ltd_, Tata_Teleservices_Maharashtra_Ltd_, Tejas_Networks_Ltd_, Titagarh_Rail_Systems_Ltd_, Trident_Ltd_, Triveni_Turbine_Ltd_, UCO_Bank, Ujjivan_Small_Finance_Bank_Ltd_, Welspun_Living_Ltd_, Zensar_Technolgies_Ltd_
None	Raymond_Ltd_, Tata_Investment_Corporation_Ltd_

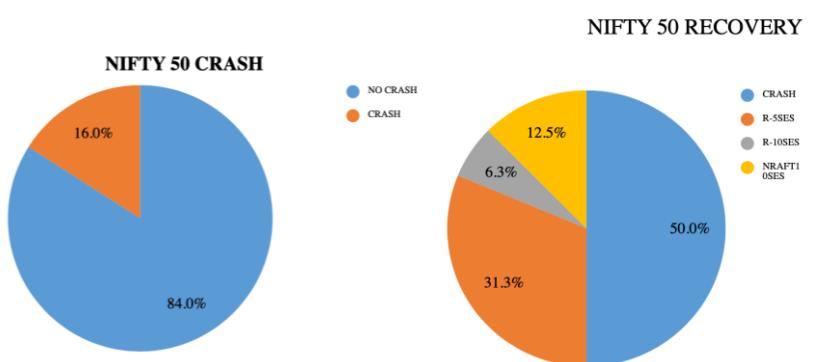


VII. CRASH RECOVERY ANALYSIS

The following data shows the analysis of Crash and recovery of companies from 3/June/2024 to 3/September/2024.

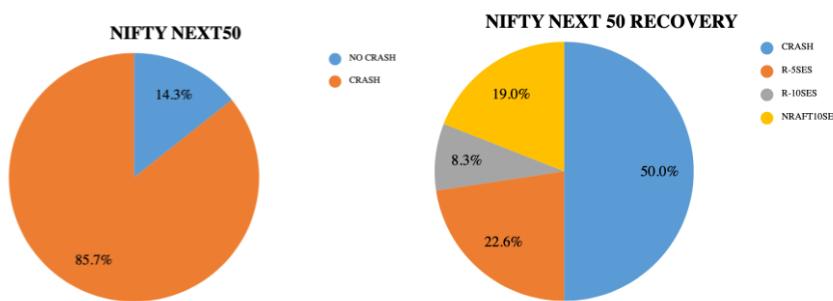
A. Nifty 50 Crash recovery

	No. of Companies
NO CRASH	42
CRASH	8
R-5 SES	5
R-10 SES	1
NRAFT10SES	2



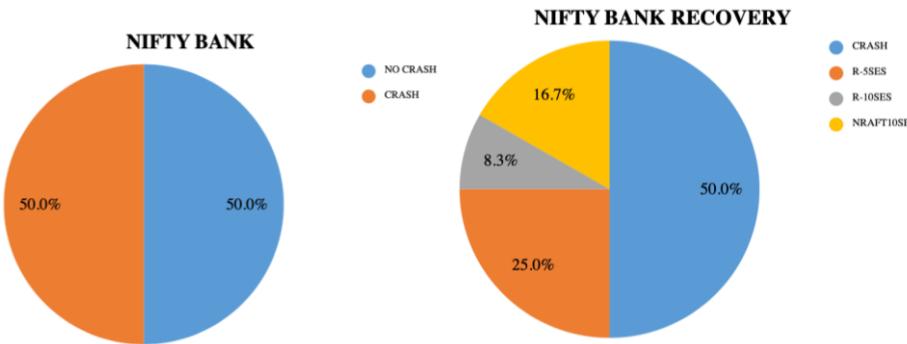
B. Nifty Next 50 Crash recovery

	No. of Companies
NO CRASH	7
CRASH	42
R-5SES	19
R-10SES	7
NRAFT10SES	16



C. Nifty BANK Crash recovery

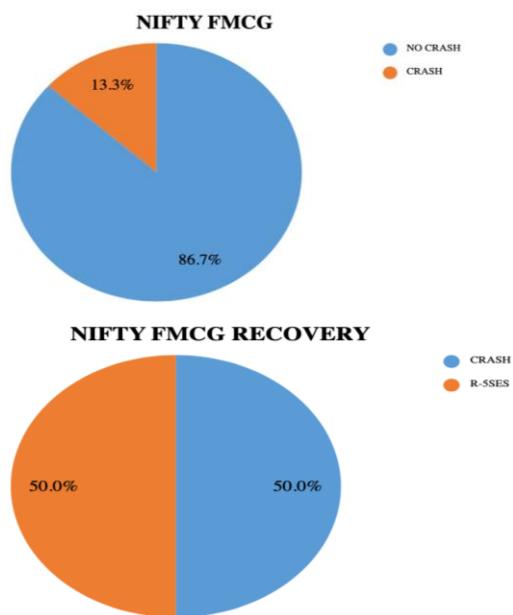
	No. of Companies
NO CRASH	6
CRASH	6
R-5SES	3
R-10SES	1
NRAFT10SES	2



D. Nifty FMCG Crash recovery

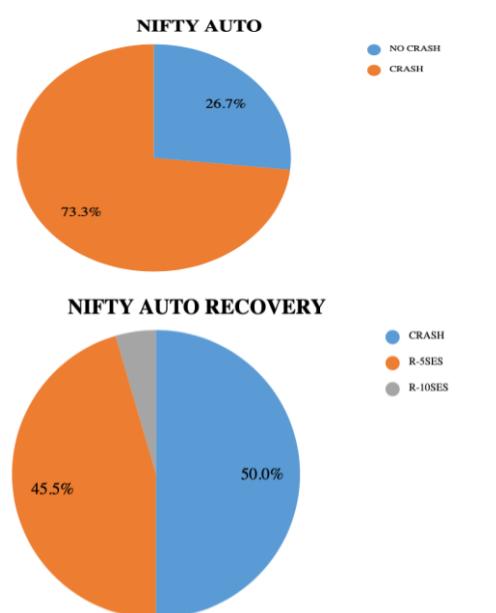
	No. of Companies
NO CRASH	13
CRASH	2

R-5SES	2
R-10SES	0
NRAFT10SES	0



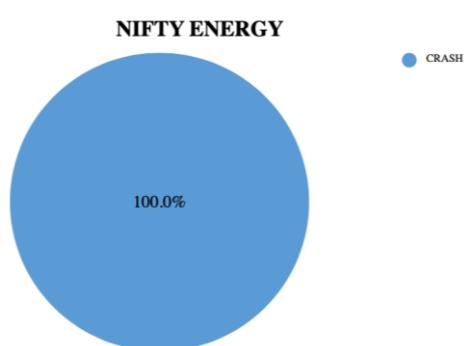
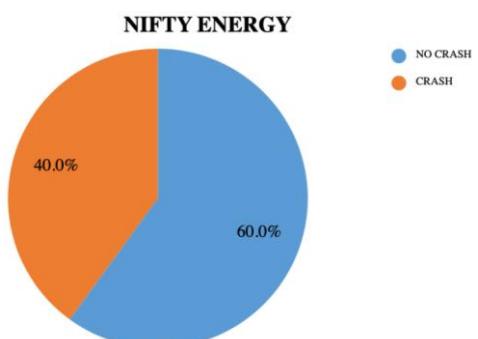
E. Nifty AUTO Crash recovery

	No. of Companies
NO CRASH	4
CRASH	11
R-5SES	10
R-10SES	1
NRAFT10SES	



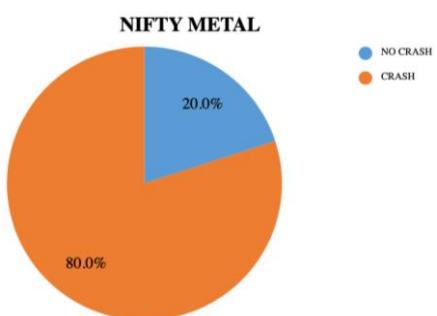
F. Nifty ENERGY Crash recovery

	No. of Companies
NO CRASH	6
CRASH	4
R-5SES	0
R-10SES	
NRAFT10SES	

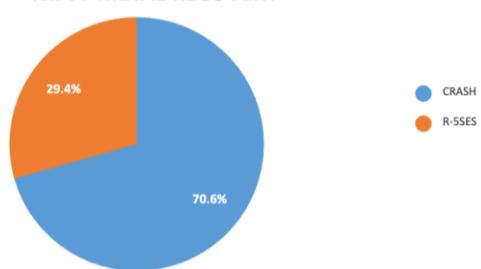


G. Nifty METAL Crash recovery

	No. of Companies
NO CRASH	3
CRASH	3
R-5SES	12
R-10SES	5
NRAFT10SES	



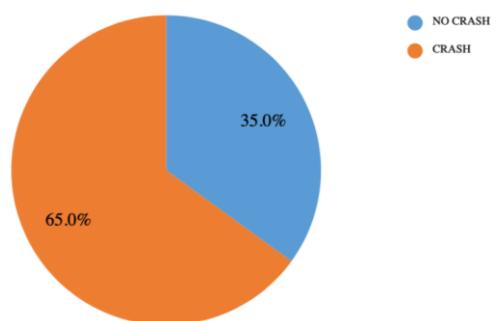
NIFTY METAL RECOVERY



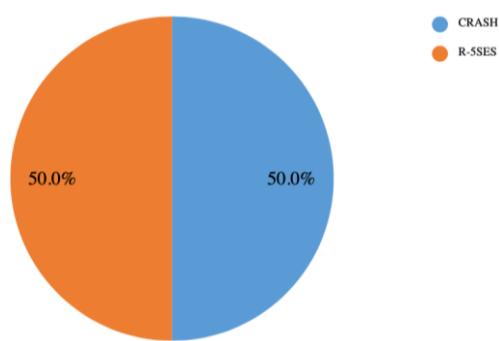
H. Nifty PHARMA Crash recovery

	No. of Companies
NO CRASH	7
CRASH	13
R-5SES	13
R-10SES	
NRAFT10SES	

NIFTY PHARMA

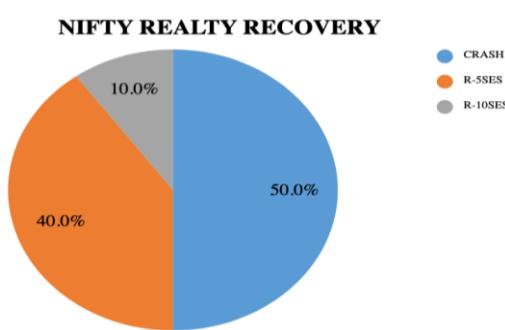
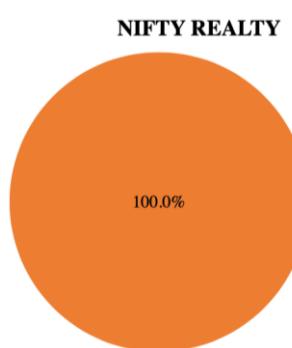


NIFTY PHARMA RECOVERY



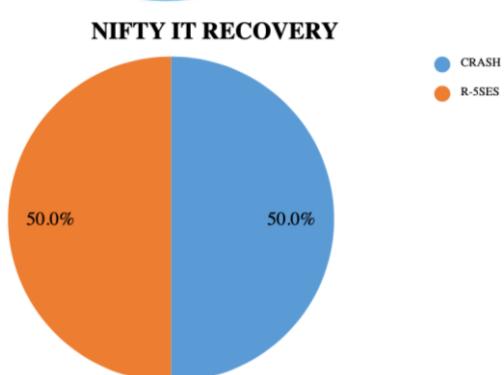
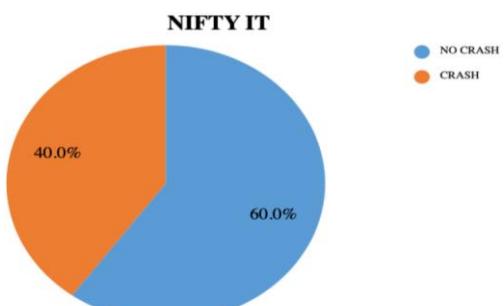
I. Nifty REALTY Crash recovery

	No. of Companies
NO CRASH	0
CRASH	10
R-5SES	8
R-10SES	2
NRAFT10SES	



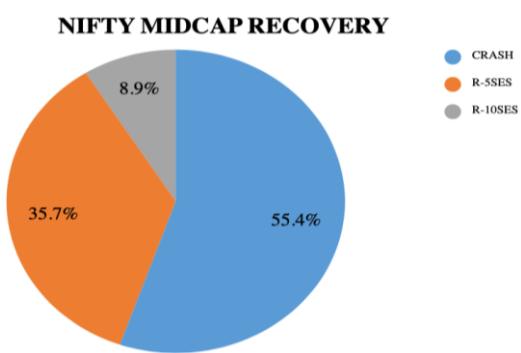
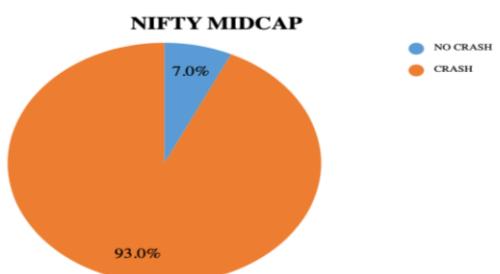
J. Nifty IT Crash recovery

	No. of Companies
NO CRASH	6
CRASH	4
R-5SES	4
R-10SES	
NRAFT10SES	

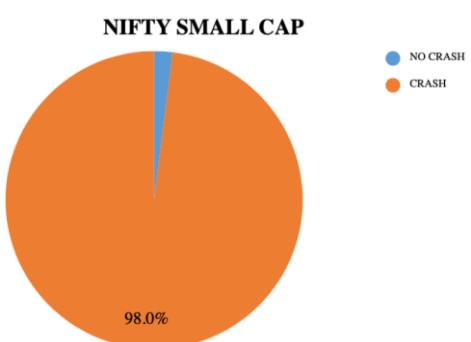


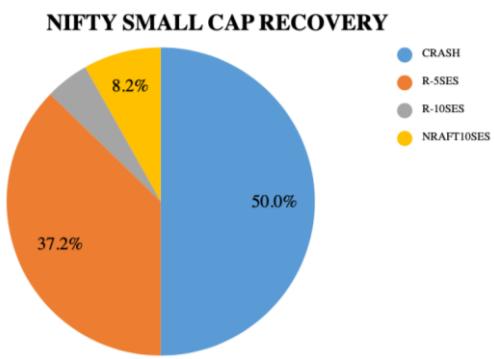
K. Nifty MIDCAP Crash recovery

	No. of Companies
NO CRASH	7
CRASH	93
R-5SES	60
R-10SES	15
NRAFT10SES	

**L. Nifty SMALLCAP Crash recovery**

	No. of Companies
NO CRASH	2
CRASH	98
R-5SES	73
R-10SES	9
NRAFT10SES	16





VIII. HIGHLIGHTS OF THE CRASH

- NIFTY REALTY companies crashed 100% on 4th June 2024, and recovered 100% within 10 trading sessions.
- NIFTY SMALLCAP companies crashed 98% on 4th June 2024. However, all of them recovered within 10 trading sessions after the crash.
- NIFTY MIDCAP 93% of the companies (93) crashed on 4th June 2024 and only 75 companies recovered within 10 trading sessions, while 18 companies did not recover even after 10 trading sessions.
- NIFTY 50 - Just 8 out of 50 companies had crashed on 4th June 2024 and recovered within 10 trading sessions.
- NIFTY NEXT 50 - 86% of the companies crashed on 4th June 2024 and all recovered within 10 trading sessions.
- Just 13% of NIFTY FMCG companies crashed, and all companies recovered within 5 trading sessions.
- 73% of NIFTY AUTO companies crashed and they recovered within 10 trading sessions.
- 60% of NIFTY ENERGY companies crashed and they never recovered within 10 trading sessions.
- 80% of NIFTY METAL companies crashed on 4th June 2024 and 5 companies recovered within 5 trading sessions, while 7 companies did not recover within 10 trading sessions.
- 65% of NIFTY PHARMA companies crashed on 4th June 2024 and all recovered within five trading sessions. 40% NIFTY IT companies crashed and recovered within five trading sessions.

IX. LIMITATIONS & FUTURE SCOPE OF WORK

- NSE (National Stock Exchange) has around 2500 companies, and BSE (Bombay Stock Exchange) has around 5000 companies. However, this study is focused on NIFTY 50, NIFTY Next 50, NIFTY MIDCAP, NIFTY BANK, NIFTY FMCG, NIFTY AUTO, NIFTY METAL, NIFTY ENERGY, NIFTY PHARMA, NIFTY REALTY, NIFTY IT.
- In future, all companies can be included and use this data. This data along with other parameters will be used to build Bayesian Statistical forecasting models which is the author's area of research.

CONCLUSION

- The crash is not uniform across various market segments.
- Many companies recovered in the first five trading sessions.
- Many MIDCAP, NIFTY ENERGY, NIFTY METAL and few Infrastructure, and public sector companies never recovered even after a 90 day period.
- The visual analytics presented in this research work can easily be interpreted by common investors.
- The granular data gathered and presented in this paper can go a long way in preparing investors to formulate strategy for future crashes (KBT, 2024).
- This research paper presents Heat Maps and Clusters to analyze Stock Market Crash which are easy to use and interpret.

REFERENCES

- [1] Bock, T. (2024). *What is a Dendrogram? - Hierarchical Cluster Analysis*. Displayr. Retrieved September 11, 2024, from <https://www.displayr.com/what-is-dendrogram/>
- [2] BSE. (2024). *History and Milestones*. BSE. Retrieved September 3, 2024, from https://www.bseindia.com/static/about/History_Milestones.html

- [3] Canvass, N. (2023, December 4). *35 Types of Candlestick Patterns For Intraday Trading / Finschool By 5paisa*. 5paisa. Retrieved September 11, 2024, from <https://www.5paisa.com/finschool/35-types-of-candlestick-patterns/>
- [4] CNN. (2004, May 17). *Investors flee Gandhi's India*. CNN International. Retrieved September 5, 2024, from <https://edition.cnn.com/2004/BUSINESS/04/21/india.economy/index.html>
- [5] Groww. (2024, May 20). *History of Stock Market Crashes In India - Known And Unknown*. Groww. Retrieved September 11, 2024, from <https://groww.in/blog/history-of-stock-market-crashes-in-india>
- [6] Intraday Screener. (2024). *Nifty-50 heatmap , live NSE Heatmap*. Intraday Screener. Retrieved September 11, 2024, from <https://intradayscreener.com/heatmap/NIFTY-50>
- [7] Jaiswal, T. (2024, August 19). *Scam 1992 - Harshad Mehta Scam Story*. 5paisa. Retrieved September 9, 2024, from <https://www.5paisa.com/blog/scam-1992-harshad-mehta-scam-story>
- [8] Kumar, K. (2024, August 17). *1992 Indian Stock Market Scam - The Complete Case Study of Harshad Mehta*. Intellipaat. Retrieved September 11, 2024, from <https://intellipaat.com/blog/harshad-mehta-1992-stock-market-scam/>
- [9] Mampatta, S. P., & Bhayani, R. (2015, July 8). *How Abraham Lincoln triggered India's first stock market crash*. Business Standard. Retrieved September 11, 2024, from https://www.business-standard.com/article/beyond-business/150-years-later-115071001354_1.html
- [10] Nair, S. (2022). *Bulls, Bears and Other Beasts (5th Anniversary Edition): A Story of the Indian Stock Market* (5th ed.). Penguin Random House India.
- [11] NCSS. (2024). *Statistical, Graphics, and Sample Size Software*. NCSS: Statistical Software | Sample Size Software. Retrieved September 11, 2024, from <https://www.ncss.com>
- [12] Pai, P. (2021, May 7). *Hierarchical clustering explained / by Prasad Pai*. Towards Data Science. Retrieved September 11, 2024, from <https://towardsdatascience.com/hierarchical-clustering-explained-e59b13846da8>
- [13] Sornette, D. (2017). *Why Stock Markets Crash: Critical Events in Complex Financial Systems*. Princeton University Press. 10.1515/9781400841013
- [14] Vyas, H. (2024, July 23). Retail investors flock to market, hold Rs 36 lakh crore worth stocks: Economic Survey. *The Indian Express*. <https://indianexpress.com/article/business/retail-investors-share-in-stock-market-economic-survey-9469273/>
- [15] Wikipedia. (2024, June 24). *Candlestick chart*. Wikipedia. Retrieved September 11, 2024, from https://en.wikipedia.org/wiki/Candlestick_chart
- [16] Wikipedia. (2024, August 10). *Stock market crashes in India*. Wikipedia. Retrieved September 11, 2024, from https://en.wikipedia.org/wiki/Stock_market_crashes_in_India
- [17] Wikipedia. (2024, August 12). *Visual analytics*. Wikipedia. Retrieved September 11, 2024, from https://en.wikipedia.org/wiki/Visual_analytics
- [18] Young, F. W., Valero-Mora, P. M., & Friendly, M. (2011). *Visual Statistics: Seeing Data with Dynamic Interactive Graphics*. Wiley.