feature extraction maysam

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**library**(data.table) **library**(keras) **library**(dplyr)

##

## Attaching package: 'dplyr'

## The following objects are masked from 'package:data.table': ##

## between, first, last

## The following objects are masked from 'package:stats': ##

## filter, lag

## The following objects are masked from 'package:base': ##

## intersect, setdiff, setequal, union

**library**(quantmod)

## Loading required package: xts

## Loading required package: zoo

##

## Attaching package: 'zoo'

## The following objects are masked from 'package:data.table': ##

## yearmon, yearqtr

## The following objects are masked from 'package:base': ##

## as.Date, as.Date.numeric

|  |  |
| --- | --- |
| ##  ## | ######################### Warning from 'xts' package ########################## |
| ## | # # |
| ## | # The dplyr lag() function breaks how base R's lag() function is supposed to # |
| ## | # work, which breaks lag(my\_xts). Calls to lag(my\_xts) that you type or # |
| ## | # source() into this session won't work correctly. # |
| ## | # # |
| ## | # Use stats::lag() to make sure you're not using dplyr::lag(), or you can add # |
| ## | # conflictRules('dplyr', exclude = 'lag') to your .Rprofile to stop # |

## 'data.frame': 1872367 obs. of 48 variables:

## $ Date : chr "2019-07-15" "2019-07-16" "2019-07-17" "2019-07-18" ...

## $ Internal.code : int 2014128 2014128 2014128 2014128 2014128 2014128 2014128

2014128 2014128 2014128 ...

## # dplyr from breaking base R's lag() function.

## #

#

#

## # Code in packages is not affected. It's protected by R's namespace mechanism # ## # Set `options(xts.warn\_dplyr\_breaks\_lag = FALSE)` to suppress this warning. # ## # #

## ###############################################################################

##

## Attaching package: 'xts'

## The following objects are masked from 'package:dplyr': ##

## first, last

## The following objects are masked from 'package:data.table': ##

## first, last

## Loading required package: TTR

## Registered S3 method overwritten by 'quantmod':

##

##

method

from

as.zoo.data.frame zoo

**library**(zoo) **library**(TTR)

*# Attempt to load the CSV file with a suspected delimiter*

data <- read.csv("titlonmoyin.csv", header = TRUE, sep = "c") *# If "c" is suspected as part of the delimiter*

*# try to see if there's a complex delimiter like "c\" or similar*

*#data <- read.csv("titlonmoyin.csv", header = TRUE, sep = 'c') # If 'c"' is the delimiter*

*# Check the structure of the data to see if columns are properly separated*

str(data)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## $ SecurityId :  1304857 1304857 1304857 ... | | | | int | 1304857 1304857 1304857 | | | | | | 1304857 1304857 1304857 | 1304857 |
| ## $ CompanyId :  720 ... | | | | int | 12720 12720 12720 12720 | | | | | | 12720 12720 12720 12720 | 12720 12 |
| ## | $ Symbol | | : | chr | "2020" "2020" "2020" "2020" ... | | | | | | | |
| ## | $ ISIN | | : | chr | "BMG9156K1018" "BMG9156K1018" "BMG9156K1018" "BMG9156K10 | | | | | | | |
| 18" | ... | |  |  |  | | | | | | | |
| ##  rs" | $ Name  ... | | : | chr | "2020 Bulkers" "2020 Bulkers" "2020 Bulkers" "2020 Bulke | | | | | | | |
| ## | $ BestBidPrice | | : | num | 80 80.5 80.4 77.4 78 ... | | | | | | | |
| ## | $ | BestAskPrice : | | num | 81 | 81 | 81 | 80 | 79 | 78.5 79 78 77.4 77 ... | | |
| ## | $ | Open : | | num | 83 | 81 | 81 | 80 | 78 | ... | | |
| ## | $ | High : | | num | 84 | 81 | 81 | 80 | 79 | ... | | |
| ## | $ | Low : | | num | 81 | 80 | 80.5 77 78 ... | | | | | |
| ## | $ | Close : | | num | 81 | 81 | 81 80 79 ... | | | | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | $ | NumberOfTrades : | | int | NA NA NA NA NA NA NA NA NA NA ... | | | | | | | | | | | | | |  |
| ## | $ | Volume : | | int | 8810 21400 12966 4789 5030 8989 500 2151 12126 2195 | | | | | | | | | | | | | | ... |
| ## | $ | Turnover : | | num | 720755 1733377 1049996 382497 397340 ... | | | | | | | | | | | | | |  |
| ## | $ | VolumeWeightedAveragePrice: | | num | 81.8 81 81 79.9 79 ... | | | | | | | | | | | | | |  |
| ## | $ | Price : | | num | 81 81 81 80 79 ... | | | | | | | | | | | | | |  |
| ## | $ | AdjustedPrice : | | num | 49.9 49.9 49.9 49.3 48.7 ... | | | | | | | | | | | | | |  |
| ## | $ | Dividends : | | num | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | | | | |
| ## | $ | LDividends : | | num | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | | | | |
| ## | $ | CorpAdj : | | num | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | ... | | | | |
| ## | $ | DividendAdj | : | num | 0.617 0.617 0.617 0.617 0.617 ... | | | | | | | | | | | | | | |
| ## | $ | Currency | : | chr | "NOK" "NOK" "NOK" "NOK" ... | | | | | | | | | | | | | | |
| ## | $ | NumberOfShares | : | num | 22170906 22170906 22170906 22170906 22170906 ... | | | | | | | | | | | | | | |
| ## | $ | Exchange | : | chr | "OAX" "OAX" "OAX" "OAX" ... | | | | | | | | | | | | | | |
| ## | $ | NOKPerForex | : | int | 1 1 1 1 1 1 1 1 1 1 ... | | | | | | | | | | | | | | |
| ## | $ | mktcap | : | num | 1.80e+09 1.80e+09 1.80e+09 1.77e+09 1.75e+09 ... | | | | | | | | | | | | | | |
| ## | $ | OSEBXmktshare\_prevmnth | : | num | NA NA NA NA NA NA NA NA NA NA ... | | | | | | | | | | | | | | |
| ## | $ | OSEBXAlpha\_prevmnth | : | num | NA NA NA NA NA NA NA NA NA NA ... | | | | | | | | | | | | | | |
| ## | $ | OSEBXBeta\_prevmnth | : | num | NA NA NA NA NA NA NA NA NA NA ... | | | | | | | | | | | | | | |
| ## | $ | SMB | : | num | -0.000806 -0.007297 0.001962 0.009697 -0.004902 ... | | | | | | | | | | | | | | |
| ## | $ | HML | : | num | -0.00519 0.00342 -0.00321 -0.01069 -0.00554 ... | | | | | | | | | | | | | | |
| ## | $ | LIQ | : | num | 0.01343 -0.01184 0.00741 0.00646 -0.00242 ... | | | | | | | | | | | | | | |
| ## | $ | MOM | : | num | -0.01566 0.00819 -0.00329 0.00108 -0.00118 ... | | | | | | | | | | | | | | |
| ## | $ | lnDeltaP | : | num | -0.0244 0 0 -0.0124 -0.0126 ... | | | | | | | | | | | | | | |
| ## | $ | lnDeltaOSEBX | : | num | -0.00144 -0.00728 -0.00721 -0.00687 0.00154 ... | | | | | | | | | | | | | | |
| ## | $ | lnDeltaOBX | : | num | -0.00106 -0.00916 -0.008 -0.00584 0.00289 ... | | | | | | | | | | | | | | |
| ## | $ | NOWA\_DayLnrate | : | num | 5.52e-05 5.52e-05 5.48e-05 5.57e-05 5.52e-05 ... | | | | | | | | | | | | | | |
| ## | $ | bills\_3month\_Lnrate | : | num | 5.61e-05 5.64e-05 5.65e-05 5.66e-05 5.67e-05 ... | | | | | | | | | | | | | | |
| ## | $ | Sector | : | chr | "Industrials" "Industrials" "Industrials" "Industrials" | | | | | | | | | | | | | | |
| ...  ## | $ | IN\_OSEBX | : | int | 0 0 0 0 0 0 0 0 0 0 ... | | | | | | | | | | | | | | |
| ## | $ | Equity : | | num | NA | NA | | NA | NA | | NA | NA | | NA | NA | NA | NA | ... | |
| ## | $ | Debt : | | num | NA | NA | | NA | NA | | NA | NA | | NA | NA | NA | NA | ... | |
| ## | $ | Earnings : | | num | NA | NA | | NA | NA | | NA | NA | | NA | NA | NA | NA | ... | |
| ## | $ | debt\_ratio : | | num | NA | NA | | NA | NA | | NA | NA | | NA | NA | NA | NA | ... | |
| ## | $ | PE : | | num | NA | NA | | NA | NA | | NA | NA | | NA | NA | NA | NA | ... | |
| ## | $ | ID | : | int | 1570527 1437408 1437518 | | | | | | | | | | | 1570897 1571022 1571146 1437961 | | | |

1571374 1571492 1438389 ...

## 'data.frame': 1872358 obs. of 63 variables:

## $ Date : chr "2019-07-29" "2019-07-30" "2019-07-31" "2019-08-01" ...

## $ Internal.code : int 2014128 2014128 2014128 2014128 2014128 2014128 2014128

2014128 2014128 2014128 ...

*# Replace commas with dots and convert to numeric where needed*

data <- data %>%

mutate(across(c(SMB, HML, LIQ, MOM, Close), ~as.numeric(gsub(",", ".", .x))), Date = as.Date(Date, format = "%Y-%m-%d")) *# Convert Date to Date type*

*#write.csv(data, "titlonmoyinready.csv", row.names = FALSE)*

data <- read.csv("titlonmoyinready.csv")

str(data,50)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ## $ SecurityId :  1304857 1304857 1304857 ... | | int | 1304857 1304857 1304857 | 1304857 1304857 1304857 | 1304857 |
| ## $ CompanyId :  720 ... | | int | 12720 12720 12720 12720 | 12720 12720 12720 12720 | 12720 12 |
| ## | $ Symbol : | chr | "2020" "2020" "2020" "2020" ... | | |
| ## | $ ISIN : | chr | "BMG9156K1018" "BMG9156K1018" "BMG9156K1018" "BMG9156K10 | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 18" | ... | |  | | | | | | | | | | | | | | | | | | |
| ##  rs" | $ Name  ... | | : | chr | "2020 | | | Bulkers" "2020 | | | | | | | Bulkers" "2020 | | | | Bulkers" | "2020 | Bulke |
| ## | $ BestBidPrice | | : | num | 76 76 | | | 77 70 70.1 ... | | | | | | |  | | | |  |  |  |
| ## | $ | BestAskPrice : | | num | 77 | 77 | | 78 | 76 | | 76 | 69 71 | | | 70 75 75.5 ... | | | | | | |
| ## | $ | Open : | | num | 76 | 76 | | 77 | 78 | | 76 | ... | | |  | | | | | | |
| ## | $ | High : | | num | 78 | 77 | | 77 | 78 | | 76 | ... | | |  | | | | | | |
| ## | $ | Low : | | num | 76 | 76 | | 76 | 75 | | 75 | ... | | |  | | | | | | |
| ## | $ | Close : | | num | 77 | 77 | | 77 | 75 | | 75 | ... | | |  | | | | | | |
| ## | $ | NumberOfTrades : | | int | NA | NA | | NA | NA | | NA | NA NA | | | NA NA NA ... | | | | | | |
| ## | $ | Volume : | | num | 2195 100 4324 1522 537 ... | | | | | | | | | | | | | | | | |
| ## | $ | Turnover : | | num | 169518 7651 332116 115770 40285 ... | | | | | | | | | | | | | | | | |
| ## | $ | VolumeWeightedAveragePrice: | | num | 77.2 76.5 76.8 76.1 75 ... | | | | | | | | | | | | | | | | |
| ## | $ | Price : | | num | 77 77 77 75 75 ... | | | | | | | | | | | | | | | | |
| ## | $ | AdjustedPrice : | | num | 47.5 47.5 47.5 46.2 46.2 ... | | | | | | | | | | | | | | | | |
| ## | $ | Dividends : | | num | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | | | | | | |
| ## | $ | LDividends : | | num | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ... | | | | | | |
| ## | $ | CorpAdj : | | num | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | ... | | | | | | |
| ## | $ | DividendAdj | : | num | 0.617 0.617 0.617 0.617 0.617 ... | | | | | | | | | | | | | | | | |
| ## | $ | Currency | : | chr | "NOK" "NOK" "NOK" "NOK" ... | | | | | | | | | | | | | | | | |
| ## | $ | NumberOfShares | : | num | 22170906 22170906 22170906 22170906 22170906 ... | | | | | | | | | | | | | | | | |
| ## | $ | Exchange | : | chr | "OAX" "OAX" "OAX" "OAX" ... | | | | | | | | | | | | | | | | |
| ## | $ | NOKPerForex | : | int | 1 1 1 1 1 1 1 1 1 1 ... | | | | | | | | | | | | | | | | |
| ## | $ | mktcap | : | num | 1.71e+09 1.71e+09 1.71e+09 1.66e+09 1.66e+09 ... | | | | | | | | | | | | | | | | |
| ## | $ | OSEBXmktshare\_prevmnth | : | num | NA NA NA NA NA NA NA NA NA NA ... | | | | | | | | | | | | | | | | |
| ## | $ | OSEBXAlpha\_prevmnth | : | num | NA NA NA NA NA NA NA NA NA NA ... | | | | | | | | | | | | | | | | |
| ## | $ | OSEBXBeta\_prevmnth | : | num | NA NA NA NA NA NA NA NA NA NA ... | | | | | | | | | | | | | | | | |
| ## | $ | SMB | : | num | -0.005101 0.004157 0.000479 -0.001486 0.008561 ... | | | | | | | | | | | | | | | | |
| ## | $ | HML | : | num | 0.00818 -0.00442 -0.01274 -0.00161 -0.00127 ... | | | | | | | | | | | | | | | | |
| ## | $ | LIQ | : | num | 0.001633 0.010677 -0.00865 0.000509 0.011394 ... | | | | | | | | | | | | | | | | |
| ## | $ | MOM | : | num | -0.00508 -0.00767 0.00282 -0.00175 0.00339 ... | | | | | | | | | | | | | | | | |
| ## | $ | lnDeltaP | : | num | -0.00531 0.00013 0 -0.02632 0 ... | | | | | | | | | | | | | | | | |
| ## | $ | lnDeltaOSEBX | : | num | 0.00148 -0.01476 0.00787 0.00479 -0.01129 ... | | | | | | | | | | | | | | | | |
| ## | $ | lnDeltaOBX | : | num | 0.000756 -0.015365 0.008592 0.004494 -0.012291 ... | | | | | | | | | | | | | | | | |
| ## | $ | NOWA\_DayLnrate | : | num | 5.57e-05 5.52e-05 5.52e-05 5.48e-05 5.48e-05 ... | | | | | | | | | | | | | | | | |
| ## | $ | bills\_3month\_Lnrate | : | num | 5.70e-05 5.70e-05 5.70e-05 5.70e-05 5.71e-05 ... | | | | | | | | | | | | | | | | |
| ## | $ | Sector | : | chr | "Industrials" "Industrials" "Industrials" "Industrials" | | | | | | | | | | | | | | | | |
| ... |  |  |  |  |  | | | | | | | | | | | | | | | | |
| ## | $ | IN\_OSEBX : | | int | 0 0 0 | | | 0 | 0 0 | | 0 0 0 | | | 0 ... | |  |  |  | | | |
| ## | $ | Equity : | | num | NA NA | | | NA | NA | | NA NA | | | NA NA | | NA | NA | ... | | | |
| ## | $ | Debt : | | num | NA NA | | | NA | NA | | NA NA | | | NA NA | | NA | NA | ... | | | |
| ## | $ | Earnings : | | num | NA NA | | | NA | NA | | NA NA | | | NA NA | | NA | NA | ... | | | |
| ## | $ | debt\_ratio : | | num | NA NA | | | NA | NA | | NA NA | | | NA NA | | NA | NA | ... | | | |
| ## | $ | PE : | | num | NA NA | | | NA | NA | | NA NA | | | NA NA | | NA | NA | ... | | | |
| ## | $ | ID | : | int | 1438389 | | | | 1571848 | | | | 1438611 | | | 1572088 1438840 1572536 1572657 | | | | | |

1572890 1573019 1439748 ...

## $ MA5 : num 370 457 367 341 320 ...

## $ MA10 : num 250 315 310 300 302 ...

## $ MA20 : num NA NA NA NA NA NA NA NA NA NA ...

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | $ BIAS5 : | | num | -79.2 | | -83.2 | | -79 -78 -76.6 ... | | | | | | |
| ## | $ BIAS10 : | | num | -69.2 | | -75.5 | | -75.2 -75 -75.1 ... | | | | | | |
| ## | $ | RSI6 : | num | NA | NA | NA | NA | NA | ... |  |  |  |  |  |
| ## | $ | RSI12 : | num | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | ... |
| ## | $ | Stoch\_K : | num | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | ... |
| ## | $ | Stoch\_D : | num | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | ... |
| ## | $ | MACD : | num | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | ... |
| ## | $ | Signal : | num | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | ... |
| ## | $ | WPR : | num | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | ... |
| ## | $ | VOL1 : | num | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | ... |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## $ VOL2  ## $ Delta\_MA5 | | | : num  : num | | NA NA NA NA NA NA NA NA NA NA ...  NA 87 -90 -26 -20.5 -115 -107 0.5 0.5 -0.5 ... | | | | | | |
| summary(data,50) | | |  | |  | | | | | | |
| ## | Date | | Internal.code | | SecurityId | | | CompanyId | | | |
| ## | Length:1872358 | | Min. :2004834 | | Min. : 6000 | | | Min. : 1007 | | | |
| ## | Class :character | | 1st Qu.:2015528 | | 1st Qu.: 6212 | | | 1st Qu.: 2237 | | | |
| ## | Mode :character | | Median :2015566 | | Median : 24518 | | | Median : 5203 | | | |
| ## | Mean :2037838 | | | | Mean : | | 170204 | Mean : | | 5307 | |
| ## | 3rd Qu.:2015611 | | | | 3rd Qu.: | | 60388 | 3rd Qu.: | | 7953 | |
| ## | Max. | | | :9067757 | Max. | :1305713 | | Max. | :12811 | | |
| ## | NA's | | | :812035 | NA's | :112444 | | NA's | :112547 | | |
| ## Symbol ISIN Name BestBidPrice  ## Length:1872358 Length:1872358 Length:1872358 Min. :-999999999 | | | | | | | | | | | |
| ## | Class | :character | Class | :character | Class | :character | | 1st Qu.: | | | 9 |
| ## | Mode | :character | Mode | :character | Mode | :character | | Median : | | | 40 |

## Mean : -372601

## 3rd Qu.: 110

## Max. : 24000

## NA's 12898

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## BestAskPrice  ## Min. :-999999999 Min. | | | | Open  : | 0.0 | Min. | High  : | 0.00 | Min. | Low  : | 0.00 |
| ## | 1st Qu.: | 9 | 1st Qu.: | | 8.0 | 1st Qu.: | | 9.00 | 1st Qu.: | | 8.70 |
| ## | Median : | 40 | Median : | | 34.9 | Median : | | 40.00 | Median : | | 39.00 |
| ## | Mean : | -649848 | Mean : | | 76.8 | Mean : | | 89.05 | Mean : | | 87.36 |
| ## | 3rd Qu.: | 110 | 3rd Qu.: | | 98.0 | 3rd Qu.: | | 111.50 | 3rd Qu.: | | 109.50 |
| ## Max. : 25000 Max. | | | | :17500.0 | | Max. | :25000.00 | | Max. | :25000.00 | |
| ## NA's :18329 NA's | | | | :116694 | | NA's | :11 | | NA's | :11 | |

## Close NumberOfTrades Volume Turnover

## Min. : 0.00 Min. : 0.0 Min. :-1.819e+09 Min. 0.000e+00

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | 1st Qu.: | | 8.90 | 1st Qu.: | | 12.0 | 1st Qu.: | 3.144e+03 | 1st Qu.:1.128e+05 |
| ## | Median : | | 39.50 | Median : | | 67.0 | Median : | 2.600e+04 | Median :7.358e+05 |
| ## | Mean : | | 88.19 | Mean : | | 451.8 | Mean : | 7.110e+05 | Mean :2.007e+07 |
| ## | 3rd Qu.: | | 110.00 | 3rd Qu.: | | 371.0 | 3rd Qu.: | 1.852e+05 | 3rd Qu.:5.240e+06 |
| ## ## | Max. | :25000.00 | | Max. NA's | :103757.0  :1586306 | | Max. : 1.977e+09 Max. :1.632e+10 NA's :77 NA's :121445 | | |

## VolumeWeightedAveragePrice Price AdjustedPrice

## Min. : -0.55 Min. : 0.00 Min. : 0

## 1st Qu.: 8.41 1st Qu.: 9.30 1st Qu.: 8

## Median : 35.49 Median : 40.00 Median : 27

## Mean : 77.56 Mean : 88.92 Mean : 20263 ## 3rd Qu.: 99.48 3rd Qu.: 111.50 3rd Qu.: 77

## Max. :17500.00 Max. :25000.00 Max. :58612732

## NA's 116811

## Dividends LDividends CorpAdj DividendAdj

## Min. : 0.0000 Min. : 0.0000 Min. : 0 Min. :0.004756

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | 1st Qu.: | | 0.0000 | 1st Qu.: | | 0.0000 | 1st Qu.: | | 1 | 1st Qu.:0.690736 | |
| ## | Median : | | 0.0000 | Median : | | 0.0000 | Median : | | 1 | Median :0.920635 | |
| ## | Mean : | | 0.0121 | Mean : | | 0.0121 | Mean : | | 1636 | Mean :0.812673 | |
| ## | 3rd Qu.: | | 0.0000 | 3rd Qu.: | | 0.0000 | 3rd Qu.: | | 1 | 3rd Qu.:1.000000 | |
| ## ## | Max. | :869.3840 | | Max. NA's | :869.3840  :931 | | Max. | :1695150 | | Max. | :1.000000 |
| ## | Currency | | | NumberOfShares | | | Exchange | | | NOKPerForex | |
| ## | Length:1872358 | | | Min. :0.000e+00 | | | Length:1872358 | | | Min. :1 | |
| ## | Class :character | | | 1st Qu.:1.395e+07 | | | Class :character | | | 1st Qu.:1 | |
| ## | Mode :character | | | Median :4.386e+07 | | | Mode :character | | | Median :1 | |
| ## |  | | | Mean :1.487e+08 | | |  | | | Mean :1 | |
| ## |  | | | 3rd Qu.:1.257e+08 | | |  | | | 3rd Qu.:1 | |

## Max. :2.563e+10 Max. :1

## NA's :13973

## mktcap OSEBXmktshare\_prevmnth OSEBXAlpha\_prevmnth ## Min. :0.000e+00 Min. :0.0 Min. :-0.3

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | 1st Qu.:3.383e+08 | | | | 1st Qu.:0.0 | | | 1st Qu.: | | | 0.0 | | |
| ## | Median :1.103e+09 | | | | Median :0.0 | | | Median : | | | 0.0 | | |
| ## | Mean :7.323e+09 | | | | Mean :0.0 | | | Mean : | | | 0.0 | | |
| ## | 3rd Qu.:3.695e+09 | | | | 3rd Qu.:0.0 | | | 3rd Qu.: | | | 0.0 | | |
| ## | Max. | :1.290e+12 | | | Max. | :0.3 | | Max. : 0.8 | | | | | |
| ## | NA's | :13973 | | | NA's | :1389220 | | NA's :1389295 | | | | | |
| ##  ## | OSEBXBeta\_prevmnth  Min. :-24.7 | | | | Min. | SMB  :-0.1 | | Min. | HML  :-0.2 | | Min. | LIQ  :-0.2 | |
| ## | 1st Qu.: | | 0.4 | | 1st Qu.: | | 0.0 | 1st Qu.: | | 0.0 | 1st Qu.: | | 0.0 |
| ## | Median : | | 0.8 | | Median : | | 0.0 | Median : | | 0.0 | Median : | | 0.0 |
| ## | Mean : | | 0.9 | | Mean : | | 0.0 | Mean : | | 0.0 | Mean : | | 0.0 |
| ## | 3rd Qu.: | | 1.3 | | 3rd Qu.: | | 0.0 | 3rd Qu.: | | 0.0 | 3rd Qu.: | | 0.0 |
| ## | Max. | : 30.8 | | Max. : 0.4 | | | | Max. : 0.8 | | | Max. : 0.5 | | |
| ##  ## | NA's | :1389295  MOM | | NA's :334560  lnDeltaP | | | | NA's :396392  lnDeltaOSEBX | | | NA's :334560  lnDeltaOBX | | |
| ## | Min. | :-0.5 | | Min. :-5.8430 | | | | Min. :-0.685 | | | Min. :-0.7 | | |
| ## | 1st Qu.: | | 0.0 | 1st Qu.:-0.0132 1st Qu.:-0.005 1st Qu.: 0.0 | | | | | | | | | |
| ## | Median : | | 0.0 | Median : 0.0000 Median : 0.000 Median : 0.0 | | | | | | | | | |

## Mean : 0.0 Mean :-0.0004 Mean : 0.000 Mean : 0.0

## 3rd Qu.: 0.0 3rd Qu.: 0.0121 3rd Qu.: 0.006 3rd Qu.: 0.0

## Max. : 0.5 Max. : 6.8365 Max. : 1.776 Max. : 1.9

## NA's :334560 NA's :931 NA's :30218 NA's :332031

## NOWA\_DayLnrate bills\_3month\_Lnrate Sector IN\_OSEBX ## Min. :-4.445e-07 Min. :0 Length:1872358 Min. :0.000

## 1st Qu.: 6.530e-05 1st Qu.:0 Class :character 1st Qu.:0.000 ## Median : 1.232e-04 Median :0 Mode :character Median :0.000 ## Mean : 1.861e-04 Mean :0 Mean :0.263

## 3rd Qu.: 2.678e-04 3rd Qu.:0 3rd Qu.:1.000

## Max. : 2.586e-03 Max. :0 Max. :1.000 ## NA's :93089

## Equity Debt Earnings debt\_ratio

## Min. :-1.270e+11 Min. :0.000e+00 Min. :-6.352e+11 Min. : 0.0 ## 1st Qu.: 1.840e+08 1st Qu.:1.606e+08 1st Qu.:-2.806e+07 1st Qu.: 0.4

## Median : 7.990e+08 Median :1.217e+09 Median : 3.722e+07 Median : 0.6 ## Mean : 4.791e+11 Mean :5.748e+11 Mean : 2.146e+10 Mean : 0.6 ## 3rd Qu.: 3.462e+09 3rd Qu.:7.982e+09 3rd Qu.: 3.418e+08 3rd Qu.: 0.7

|  |  |  |
| --- | --- | --- |
| Max. | :9.036e+14 | Max. |
| NA's | :695665 | NA's |

## Max. : 1.015e+15 ## NA's :553474

: 8.456e+13 Max. :159.1

:696329 NA's :696822

## PE ID MA5 MA10

## Min. :-1883157.9 Min. : 1 Min. : 0.00 Min. : 0.00

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | 1st Qu.: | -2.2 | 1st Qu.: | 468090 | 1st Qu.: | 31.01 | 1st Qu.: | 39.73 |
| ## | Median : | 5.9 | Median : | 936180 | Median : | 60.60 | Median : | 64.91 |
| ## | Mean : | -7.3 | Mean : | 936181 | Mean : | 88.19 | Mean : | 88.19 |

## 3rd Qu.: 17.3 3rd Qu.:1404269 3rd Qu.: 105.85 3rd Qu.: 103.63 ## Max. : 374153.9 Max. :1872368 Max. :5237.80 Max. :3184.00

## NA's :713263

## MA20 BIAS5 BIAS10

## Min. : 0.00 Min. :-3.800e+15 Min. :-5.142e+16

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | 1st Qu.: 45.68 | | 1st Qu.:-8.600e+01 | | 1st Qu.:-8.700e+01 | | |  | |
| ##  ## | Median : 67.75  Mean : 88.19 | | Median :-3.700e+01  Mean :-1.794e+12 | | Median :-4.300e+01  Mean : 3.608e+13 | | |
| ## | 3rd Qu.: 100.08 | | 3rd Qu.: 1.100e+02 | | 3rd Qu.: 8.000e+01 | | |
| ##  ## | Max. :1885.15  NA's :10 | | Max. : 2.682e+05 | | Max. : 2.364e+17 | | |
| ## | RSI6 | | RSI12 | | Stoch\_K | | | Stoch\_D | |
| ## | Min. | :-164100.00 | Min. | :-36.67 | Min. | : -6.667 | Min. | | : 0.00 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | 1st Qu.: | | 30.00 | 1st Qu.: | | 36.84 | 1st Qu.: | | 22.222 | 1st Qu.: | | 25.69 | |
| ## | Median : | | 50.00 | Median : | | 50.00 | Median : | | 50.000 | Median : | | 50.37 | |
| ## | Mean : | | 53.57 | Mean : | | 49.81 | Mean : | | 50.379 | Mean : | | 50.38 | |
| ## | 3rd Qu.: | | 69.23 | 3rd Qu.: | | 62.92 | 3rd Qu.: | | 79.487 | 3rd Qu.: | | 75.33 | |
| ## | Max. | : | 187528.57 | Max. | :100.00 | | Max. | :114.286 | | Max. | :100.00 | | |
| ##  ## | NA's | :6  MACD |  | NA's | :12  Signal | | NA's | :1595  WPR | | NA's | :2159  VOL1 | | |
| ## | Min. :-100.00000 | | | Min. :-100.00000 | | | | Min. :-106.67 | | | Min. : | | 0.00 |
| ## | 1st Qu.: -2.02671 | | | 1st Qu.: -1.96772 | | | | 1st Qu.: -78.05 | | | 1st Qu.: | | 1.46 |
| ## | Median : -0.04564 | | | Median : -0.05985 | | | | Median : -50.00 | | | Median : | | 2.30 |
| ## | Mean : -0.64041 | | | Mean : -0.64044 | | | | Mean : -49.68 | | | Mean : | | 3.62 |
| ## | 3rd Qu.: 1.73382 | | | 3rd Qu.: 1.64356 | | | | 3rd Qu.: -20.51 | | | 3rd Qu.: | | 3.69 |
| ## | Max. : 107.69231 Max. : 67.88527 | | | | | | | Max. | : 14.29 | | Max. | :311.86 | |
| ## | NA's :25 NA's :33 | | | | | | | NA's | :1962 | | NA's | :80076 | |
| ##  ## | VOL2 Delta\_MA5  Min. : 0.00 Min. :-4984.500 | | | | | | |  |  | |  |  | |
| ## | 1st Qu.: 68.84 1st Qu.: -9.740 | | | | | | |  |  | |  |  | |
| ##  ## | Median :109.65 Median : -0.004  Mean :125.58 Mean : 0.000 | | | | | | |  |  | |  |  | |
| ##  ## | 3rd Qu.:166.07 3rd Qu.: 9.900  Max. :838.13 Max. : 4980.500 | | | | | | |  |  | |  |  | |
| ## | NA's :80846 NA's :1 | | | | | | |  |  | |  |  | |

*# Load necessary libraries*

**library**(quantmod)

stock\_data\_xts <- xts(data[, -1], order.by = as.Date(data$Date))

*# Calculate Moving Averages*

data$MA5 <- SMA(stock\_data\_xts$Close, n=5) data$MA10 <- SMA(stock\_data\_xts$Close, n=10)

data$MA20 <- SMA(stock\_data\_xts$Close, n=20)

*# Save data frame to a CSV file*

*#write.csv(data, "700mb.csv", row.names = FALSE) # Load data frame from the CSV file*

*#data <- read.csv("700mb.csv")*

*#Remove rows with NAs in MA5 and MA10*

data <- data[!is.na(data$MA5) & !is.na(data$MA10), ]

data$Close <- as.numeric(as.character(data$Close)) data$MA5 <- as.numeric(as.character(data$MA5))

*# Check for unique values in 'Close' and 'MA5' columns*

print(head(unique(data$Close), 10))

## [1] 75.30 75.00 74.99 79.79 78.00 77.98 79.00 76.99 77.00 78.80

print(head(unique(data$MA5), 10))

## [1] 370.0 457.0 367.0 341.0 320.5 205.5 98.5 99.0 99.5 229.0

*# Now calculate BIAS*

data$BIAS5 <- (data$Close - data$MA5) / data$MA5 \* 100 data$BIAS10 <- (data$Close - data$MA10) / data$MA10 \* 100

*# Save data frame to a CSV file*

*#write.csv(data, "700mb.csv", row.names = FALSE)*

**library**(zoo) **library**(data.table)

calculate\_RSI <- **function**(prices, n) { *# Calculate daily changes in price* deltas <- diff(prices)

*# Separate gains and losses* gains <- pmax(deltas, 0) losses <- pmax(-deltas, 0)

*# Calculate the average gains and losses using a rolling mean* avg\_gains <- rollapply(gains, n, mean, fill = NA, align = 'right') avg\_losses <- rollapply(losses, n, mean, fill = NA, align = 'right')

*# Calculate the RS (Relative Strength)*

rs <- avg\_gains / avg\_losses

*# Calculate the RSI (Relative Strength Index)*

rsi <- 100 - (100 / (1 + rs))

**return**(rsi)

}

*#*

*# Convert 'Close' column to numeric if it's not #data[, Close := as.numeric(as.character(Close))]*

*# Calculate RSI for 6 periods*

rsi6\_values <- calculate\_RSI(data$Close, 6)

*# Prepend NA to the rsi6\_values to match the length of the data*

rsi6\_values <- c(NA, rsi6\_values)

*# Now the lengths match and you can assign it to the data table*

data$RSI6 <- rsi6\_values

*# Do the same for RSI12 if needed*

rsi12\_values <- c(NA, calculate\_RSI(data$Close, 12)) data$RSI12 <- rsi12\_values

*# Save data frame to a CSV file*

*#write.csv(data, "700mb.csv", row.names = FALSE)*

calculate\_stoch <- **function**(high, low, close, n, smoothK, smoothD) {

*# Calculate %K*

lowest\_low <- rollapply(low, n, min, fill = NA, align = 'right') highest\_high <- rollapply(high, n, max, fill = NA, align = 'right') fastK <- (close - lowest\_low) / (highest\_high - lowest\_low) \* 100

*# Smooth %K to get the slow %K*

slowK <- rollapply(fastK, smoothK, mean, fill = NA, align = 'right')

*# Calculate %D as a moving average of %K*

fastD <- rollapply(slowK, smoothD, mean, fill = NA, align = 'right')

**return**(list(fastK = fastK, fastD = fastD))

}

*#*

high\_prices <- data$High low\_prices <- data$Low close\_prices <- data$Close

*# Set the parameters*

n <- 14 *# The look-back period for %K* smoothK <- 3 *# The smoothing period for %K* smoothD <- 3 *# The smoothing period for %D*

*# Calculate stochastic oscillator*

stoch\_values <- calculate\_stoch(high\_prices, low\_prices, close\_prices, n, smoothK, smoothD)

*# Add the stochastic values to data frame* data$Stoch\_K <- stoch\_values$fastK data$Stoch\_D <- stoch\_values$fastD

*# Save data frame to a CSV file*

*#write.csv(data, "700mb.csv", row.names = FALSE)*

*#load the TTR package*

**library**(TTR)

*# Convert the 'Close' column of data to numeric (if it's not already)*

data$Close <- as.numeric(as.character(data$Close))

*# Calculate MACD*

macd\_results <- MACD(x = data$Close)

print(head(macd\_results,30) ) *# This will show the output structure*

|  |  |  |  |
| --- | --- | --- | --- |
| ## |  | macd | signal |
| ## | [1,] | NA | NA |
| ## | [2,] | NA | NA |
| ## | [3,] | NA | NA |
| ## | [4,] | NA | NA |
| ## | [5,] | NA | NA |
| ## | [6,] | NA | NA |
| ## | [7,] | NA | NA |
| ## | [8,] | NA | NA |
| ## | [9,] | NA | NA |
| ## | [10,] | NA | NA |
| ## | [11,] | NA | NA |
| ## | [12,] | NA | NA |
| ## | [13,] | NA | NA |
| ## | [14,] | NA | NA |

|  |  |  |  |
| --- | --- | --- | --- |
| ## | [15,] | NA | NA |
| ## | [16,] | NA | NA |
| ## | [17,] | NA | NA |
| ## | [18,] | NA | NA |
| ## | [19,] | NA | NA |
| ## | [20,] | NA | NA |
| ## | [21,] | NA | NA |
| ## | [22,] | NA | NA |
| ## | [23,] | NA | NA |
| ## | [24,] | NA | NA |
| ## | [25,] | NA | NA |
| ## | [26,] | 2.444412 | NA |
| ## | [27,] | 2.467804 | NA |
| ## | [28,] | 2.308527 | NA |
| ## | [29,] | 2.108842 | NA |
| ## | [30,] | 1.976866 | NA |

print(class(macd\_results)) *# Check the class/type of macd\_results*

## [1] "matrix" "array"

data$MACD <- macd\_results[, 1] data$Signal <- macd\_results[, 2]

*# Calculate Williams*

calculate\_WPR <- **function**(high, low, close, n) {

highest\_high <- rollapply(high, n, max, fill = NA, align = 'right') lowest\_low <- rollapply(low, n, min, fill = NA, align = 'right') wpr <- ((highest\_high - close) / (highest\_high - lowest\_low)) \* -100 **return**(wpr)

}

*#*

**library**(zoo) *# for rollapply*

data$WPR <- calculate\_WPR(data$High, data$Low, data$Close, 12)

*# Calculate Volatility*

calculate\_volatility <- **function**(series, n) { *# Calculate the percentage change* pct\_change <- diff(log(series)) \* 100

*# Calculate the rolling standard deviation (volatility)*

vol <- rollapply(pct\_change, width = n, FUN = sd, fill = NA, align = 'right')

**return**(vol)

}

*#data <- data[, !names(data) %in% c("Volume", "VOL1" ,"VOL2")]*

colnames(data)

|  |  |  |  |
| --- | --- | --- | --- |
| ## | [1] | "Date" | "Internal.code" |
| ## | [3] | "SecurityId" | "CompanyId" |
| ## | [5] | "Symbol" | "ISIN" |
| ## | [7] | "Name" | "BestBidPrice" |
| ## | [9] | "BestAskPrice" | "Open" |
| ## | [11] | "High" | "Low" |
| ## | [13] | "Close" | "NumberOfTrades" |
| ## | [15] | "Volume" | "Turnover" |
| ## | [17] | "VolumeWeightedAveragePrice" | "Price" |
| ## | [19] | "AdjustedPrice" | "Dividends" |
| ## | [21] | "LDividends" | "CorpAdj" |
| ## | [23] | "DividendAdj" | "Currency" |
| ## | [25] | "NumberOfShares" | "Exchange" |
| ## | [27] | "NOKPerForex" | "mktcap" |
| ## | [29] | "OSEBXmktshare\_prevmnth" | "OSEBXAlpha\_prevmnth" |
| ## | [31] | "OSEBXBeta\_prevmnth" | "SMB" |
| ## | [33] | "HML" | "LIQ" |
| ## | [35] | "MOM" | "lnDeltaP" |
| ## | [37] | "lnDeltaOSEBX" | "lnDeltaOBX" |
| ## | [39] | "NOWA\_DayLnrate" | "bills\_3month\_Lnrate" |
| ## | [41] | "Sector" | "IN\_OSEBX" |
| ## | [43] | "Equity" | "Debt" |
| ## | [45] | "Earnings" | "debt\_ratio" |
| ## | [47] | "PE" | "ID" |
| ## | [49] | "MA5" | "MA10" |
| ## | [51] | "MA20" | "BIAS5" |
| ## | [53] | "BIAS10" | "RSI6" |
| ## | [55] | "RSI12" | "Stoch\_K" |
| ## | [57] | "Stoch\_D" | "MACD" |
| ## | [59] | "Signal" | "WPR" |
| ## | [61] | "VOL1" | "VOL2" |
| ## | [63] | "Delta\_MA5" |  |

**library**(zoo) *# for rollapply*

*# Specify numeric columns*

numeric\_columns <- c("Open", "High", "Low", "Close","OfficialVolume")

*# Convert 'Close' and 'Volume' to numeric*

data$Close <- as.numeric(as.character(data$Close))

data$Volume <- as.numeric(as.character(data$Volume))

*# Prepend NA to the volatility vectors*

vol1\_values <- c(NA, calculate\_volatility(data$Close, 10))

vol2\_values <- c(NA, calculate\_volatility(data$Volume, 10))

## Warning in log(series): NaNs produced

*# Now assign the values to the data table*

data$VOL1 <- vol1\_values data$VOL2 <- vol2\_values

*# Calculate Differential Technical Indicators (ΔMA5: the change in MA5 from one period to the n ext)*

*# Add NA to the beginning to align lengths*

data$Delta\_MA5 <- c(NA, diff(data$MA5, lag = 1))

colnames(data)

|  |  |  |  |
| --- | --- | --- | --- |
| ## | [1] | "Date" | "Internal.code" |
| ## | [3] | "SecurityId" | "CompanyId" |
| ## | [5] | "Symbol" | "ISIN" |
| ## | [7] | "Name" | "BestBidPrice" |
| ## | [9] | "BestAskPrice" | "Open" |
| ## | [11] | "High" | "Low" |
| ## | [13] | "Close" | "NumberOfTrades" |
| ## | [15] | "Volume" | "Turnover" |
| ## | [17] | "VolumeWeightedAveragePrice" | "Price" |
| ## | [19] | "AdjustedPrice" | "Dividends" |
| ## | [21] | "LDividends" | "CorpAdj" |
| ## | [23] | "DividendAdj" | "Currency" |
| ## | [25] | "NumberOfShares" | "Exchange" |
| ## | [27] | "NOKPerForex" | "mktcap" |
| ## | [29] | "OSEBXmktshare\_prevmnth" | "OSEBXAlpha\_prevmnth" |
| ## | [31] | "OSEBXBeta\_prevmnth" | "SMB" |
| ## | [33] | "HML" | "LIQ" |
| ## | [35] | "MOM" | "lnDeltaP" |
| ## | [37] | "lnDeltaOSEBX" | "lnDeltaOBX" |
| ## | [39] | "NOWA\_DayLnrate" | "bills\_3month\_Lnrate" |
| ## | [41] | "Sector" | "IN\_OSEBX" |
| ## | [43] | "Equity" | "Debt" |
| ## | [45] | "Earnings" | "debt\_ratio" |
| ## | [47] | "PE" | "ID" |
| ## | [49] | "MA5" | "MA10" |
| ## | [51] | "MA20" | "BIAS5" |
| ## | [53] | "BIAS10" | "RSI6" |
| ## | [55] | "RSI12" | "Stoch\_K" |
| ## | [57] | "Stoch\_D" | "MACD" |
| ## | [59] | "Signal" | "WPR" |
| ## | [61] | "VOL1" | "VOL2" |
| ## | [63] | "Delta\_MA5" |  |

*# Corrected list of columns to check for NAs*

columns\_to\_check <- c("MA5", "MA10", "MA20", "BIAS5", "BIAS10", "RSI6", "RSI12", "Stoch\_K", "St

och\_D", "MACD", "Signal", "WPR", "VOL1", "VOL2", "Delta\_MA5")

*# Subset the dataframe to keep only rows that are complete cases in the specified columns*

data <- data[complete.cases(data[, columns\_to\_check]), ]

*# Check the structure of the cleaned data #str(data,10)*

*#unique(data$CompanyId) #summary(data) #typeof(data$Date)*

*# Defining the columns to keep*

*# Updated list of columns to keep*

columns\_to\_keep <- c("Date", "CompanyId", "Close","SMB", "HML", "LIQ", "MOM", "MA5", "MA10", "M A20", "BIAS5", "BIAS10", "RSI6", "RSI12",

"Stoch\_K", "Stoch\_D", "MACD", "Signal", "WPR", "VOL1", "VOL2", "Delta\_MA5"

)

**library**(dplyr)

*# Subset the dataframe to include only specified columns*

data <- select(data, all\_of(columns\_to\_keep))

*# Optionally, check the structure of the new subset*

print(head(unique(data$CompanyId), 10))

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## [1] 12720 8380 | | | | 12440 2017 8548 | | | | 8408 12348 | | | 2407 | 7811 2202 | | | |
|  | | | |  | | | |  | | |  |  | | | |
| summary(data) | | | |  | | | |  | | |  |  | | | |
| ## Date | | | | CompanyId | | | | Close | | |  | SMB | | | |
| ## | Length:1790443 | | | Min. | | : | 1007 | Min. | : | | 0.002 | Min. | | :-0.1 | |
| ## | Class | :character | | 1st Qu.: | | | 2231 | 1st Qu.: | | | 9.350 | 1st Qu.: | | | 0.0 |
| ## | Mode | :character | | Median : | | | 5203 | Median : | | | 40.810 | Median : | | | 0.0 |
| ##  ## |  |  | | Mean :  3rd Qu.: | | | 5261  7942 | Mean  3rd | : 89.360  Qu.: 111.500 | | | Mean :  3rd Qu.: | | | 0.0  0.0 |
| ## ## | Max. NA's | | | | | :12811  :70971 | | Max. | :25000.000 | | | Max. : 0.4  NA's :321416 | | | |
| ## ## | Min. | HML  :-0.2 | | Min. | LIQ  :-0.2 | | | Min. | MOM  :-0.5 | | Min. | | MA5  : | 0.00 | |
| ## | 1st Qu.: | | 0.0 | 1st Qu.: | | 0.0 | | 1st Qu.: | | 0.0 | 1st Qu.: 31.00 | | | | |
| ## | Median : | | 0.0 | Median : | | 0.0 | | Median : | | 0.0 | Median : 60.59 | | | | |
| ## | Mean : | | 0.0 | Mean : | | 0.0 | | Mean : | | 0.0 | Mean : 88.33 | | | | |
| ## | 3rd Qu.: | | 0.0 | 3rd Qu.: | | 0.0 | | 3rd Qu.: | | 0.0 | 3rd Qu.: 105.90 | | | | |
| ## | Max. : | | 0.8 | Max. : | | 0.5 | | Max. : | | 0.5 | Max. :5237.80 | | | | |

:321416

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ##  ## | NA's | :383123  MA10.Index | NA's :321416 NA's  MA10.X[[i]] | | | |
| ## | Min. | :1980-01-04 | | Min. | : | 0.000 |
| ## | 1st Qu.:1999-07-06 | | | 1st Qu.: | | 39.712 |
| ## | Median :2009-05-13 | | | Median : | | 64.897 |
| ## | Mean :2008-01-01 | | | Mean : | | 88.318 |
| ## | 3rd Qu.:2017-10-26 | | | 3rd Qu.: | | 103.650 |

## Max. :2024-04-04 Max. :3184.000 ##

## MA20.Index MA20.X[[i]] BIAS5

## Min. :1980-01-04 Min. : 0.0000 Min. :-3.800e+15

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ## | 1st Qu.:1999-07-06 | | 1st Qu.: | | 45.6730 | 1st Qu.:-8.500e+01 |
| ## | Median :2009-05-13 | | Median : | | 67.7370 | Median :-3.500e+01 |
| ## | Mean :2008-01-01 | | Mean : | | 88.3183 | Mean :-1.454e+12 |
| ## | 3rd Qu.:2017-10-26 | | 3rd Qu.: | | 100.0586 | 3rd Qu.: 1.140e+02 |
| ## | Max. | :2024-04-04 | Max. | :1885.1500 Max. : 2.905e+05 | | |
| ##  ## |  | BIAS10.Index |  | BIAS10.X[[i]] | | |
| ## | Min. | :1980-01-04 |  | Min. :-51423313052900000 | | |
| ## | 1st Qu.:1999-07-06 | | 1st Qu.: | | | -87 |
| ## | Median :2009-05-13 | | Median : | | | -41 |
| ## | Mean :2008-01-01 | | Mean : | | | 13760395599800 |
| ## | 3rd Qu.:2017-10-26 | | 3rd Qu.: | | | 83 |

## Max. :2024-04-04 Max. :236438980437000000 ##

## RSI6 RSI12 Stoch\_K Stoch\_D

## Min. :-164100.00 Min. :-36.67 Min. : -6.667 Min. : 0.00

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ## | 1st Qu.: | 29.41 | 1st Qu.: 36.36 | 1st Qu.: | 22.059 | 1st Qu.: | 25.00 |
| ## | Median : | 50.00 | Median : 50.00 | Median : | 50.000 | Median : | 49.21 |

## Mean :

52.66 Mean : 49.89 Mean : 49.443 Mean : 49.59

##

## ## ##

##

Max.

:107.38287 Max. : 67.88527 Max. : 14.29 Max. :283.504

Min.

VOL2

: 0.00

Delta\_MA5

Min.

:-4984.500

## 'data.frame':

## ## ## ## ## ## ## ##

##

$ Date

: chr

$ CompanyId: int

$ Close

$ SMB

$ HML

$ LIQ

$ MOM

$ MA5

$ MA10

: num

: num

: num

: num

: num

: num

10 obs. of 22 variables:

"2019-09-30" "2019-10-01" "2019-10-02" "2019-10-03" ...

12720 12720 12720 12720 12720 12720 12720 12720 12720 12720

83 83 81 80.8 80.8 81.8 82.4 83.4 81.6 82

-0.01322 0.00532 0.00465 0.01004 -0.01364 ...

-0.00281 -0.00886 0.0235 -0.01351 -0.0041 ...

-0.0037 -0.00532 0.00761 -0.00195 0.01229 ...

-1.01e-04 3.09e-05 1.06e-02 -7.09e-03 -1.02e-03 ...

92 102 121 128 144 ...

:An xts object on 1980-01-04 / 1980-01-04 containing:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## 3rd Qu.: 69.57 3rd Qu.: 63.46 3rd Qu.: 76.923 | | | | | | | | 3rd Qu.: 74.32 | | |
| ## Max. : 187528.57 Max. :100.00 Max. | | | | | | :114.286 | | Max. | :100.00 | |
| ## MACD Signal | | | | | | WPR | |  | VOL1 | |
| ## Min. :-93.05972 Min. :-92.71547 Min. | | | | | | :-106.67 | | Min. | : | 0.000 |
| ## | 1st Qu.: | -1.88572 | 1st Qu.: | -1.80856 | 1st Qu.: | | -78.26 | 1st Qu.: | | 1.463 |
| ## | Median : | -0.01107 | Median : | -0.00711 | Median : | | -50.00 | Median : | | 2.300 |
| ## | Mean : | -0.48776 | Mean : | -0.48076 | Mean : | | -50.64 | Mean : | | 3.623 |
| ## | 3rd Qu.: | 1.72478 | 3rd Qu.: | 1.66327 | 3rd Qu.: | | -23.08 | 3rd Qu.: | | 3.692 |

|  |  |  |  |
| --- | --- | --- | --- |
| ## | 1st Qu.: 68.83 | 1st Qu.: | -9.732 |
| ## | Median :109.62 | Median : | -0.006 |
| ## | Mean :125.56 | Mean : | 0.000 |
| ## | 3rd Qu.:166.05 | 3rd Qu.: | 9.900 |
| ## | Max. :838.13 | Max. : | 4980.500 |
| ## |  |  |  |

print(typeof(data$Date))

## [1] "character"

str(head(data, 10))

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ##  ## | Data:  Index: | double [10, 1]  Date [10] (TZ: "UTC") | | | | |
| ## | $ MA20 | :An xts object on 1980-01-04 / 1980-01-04 containing: | | | | |
| ## | Data: | double [10, 1] | | | | |
| ## | Index: | Date [10] (TZ: "UTC") | | | | |
| ## | $ BIAS5 | : num -9.78 -18.47 -32.95 -36.88 -43.81 ... | | | | |
| ## | $ BIAS10 | :An xts object on 1980-01-04 / 1980-01-04 containing: | | | | |
| ## | Data: | double [10, 1] | | | | |
| ## | Index: | Date [10] (TZ: "UTC") | | | | |
| ## | $ RSI6 : | | num | 59.3 | 62.1 | 50 65.6 0 ... |
| ## | $ RSI12 : | | num | 60.5 | 58.5 | 45.9 45.5 40.2 ... |
| ## | $ Stoch\_K : | | num | 75.9 | 70.2 | 40 40 40.1 ... |
| ## | $ Stoch\_D : | | num | 67.9 | 74.4 | 73.3 62.8 50.7 ... |
| ## | $ MACD : | | num | 1.95 | 1.94 | 1.72 1.5 1.32 ... |
| ## | $ Signal : | | num | 2.06 | 2.04 | 1.97 1.88 1.77 ... |
| ## | $ WPR : | | num | -33.3 -28.6 -57.1 -59.9 -52.5 ... | | |
| ## | $ VOL1 : | | num | 2.95 2.95 2.98 2.94 2.89 ... | | |
| ## | $ VOL2 : | | num | 130 119 112 120 160 ... | | |
| ## | $ Delta\_MA5: num 25 9.8 19 7.2 15.8 ... | | | | | |

data <- read.csv("titlonmoyinreadyfinalsubset 17.5.2024.csv")

*# Prepare the output data (target variable)*

*# Shift the closing price by one time step to create the target output*

cnn\_output <- data$Close[(sequence\_length + 1):nrow(data)]

*# Make sure the length of cnn\_output matches the number of samples in cnn\_input*

*# The last value of 'Close' will not have a corresponding future value to predict, so we remove it*

cnn\_output <- cnn\_output[1:n\_samples]

*# Load necessary libraries* **library**(quantmod) **library**(keras) **library**(data.table) **library**(keras) **library**(tensorflow)

*# Remove rows with any NA values from cnn\_output dataframe*

data <- na.omit(data)

*# Select the columns to be used as features*

features <- data[, c("Close","SMB", "HML", "LIQ", "MOM", "MA5", "MA10", "MA20", "BIAS5", "BIAS1 0", "RSI6", "RSI12",

"Stoch\_K", "Stoch\_D", "MACD", "Signal", "WPR", "VOL1", "VOL2", "Delta\_MA

5")]

*# Normalize the features*

*# We will perform min-max scaling here. You can also use other methods like Z-score standardiza tion*

min\_vals <- sapply(features, min, na.rm = TRUE) max\_vals <- sapply(features, max, na.rm = TRUE)

scaled\_features <- as.data.table(scale(features, center = min\_vals, scale = max\_vals - min\_val s))

*# Prepare the data for the CNN*

*# use a sequence length of 'n' days for each prediction*

sequence\_length <- 10 *# using the past 10 days to predict the next day*

n\_features <- ncol(features)

n\_samples <- nrow(features) - sequence\_length + 1

*# Initialize an array to hold the reshaped data*

cnn\_input <- array(NA, dim = c(n\_samples, sequence\_length, n\_features)) dates <- data$Date[(11:(nrow(data) + 1))]

*# Reshape the data into a 3D array*

**for**(i **in** 1:n\_samples) {

cnn\_input[i,,] <- as.matrix(scaled\_features[i:(i + sequence\_length - 1),])

}

*# Now, cnn\_input is ready to be used as an input for the CNN*

*# It has the shape: (number of samples, sequence length, number of features)*

print(dim(cnn\_input))

## [1] 1336811

10

20

*# If the CNN model's output layer has one neuron, ensure the target is a matrix with one column*

cnn\_output <- matrix(cnn\_output, ncol = 1) print(length(cnn\_output)) *# Should match n\_samples*

## [1] 1336811

*# Convert the list element 'Output' into a dataframe*

cnn\_output <- data.frame(cnn\_output)

*# Now add the 'dates' vector as a new column to the dataframe*

cnn\_output$Date <- dates

*### check data*

*# Apply is.na() and is.infinite() to each element in the data frame*

na\_or\_inf <- sapply(data, **function**(x) is.na(x) | is.infinite(x))

*# Count the number of rows that have any NA or Inf*

count\_rows\_with\_na\_or\_inf <- sum(rowSums(na\_or\_inf) > 0)

*# Print the result*

print(paste("Number of rows with NA or Inf:", count\_rows\_with\_na\_or\_inf))

## [1] "Number of rows with NA or Inf: 0"

*# Check for NA, NaN, or Inf in each column*

columns\_with\_issues <- sapply(data, **function**(x) any(is.na(x) | is.infinite(x)))

*# Get names of columns with any NA, NaN, or Inf*

columns\_names\_with\_issues <- names(data)[columns\_with\_issues]

*# Print the result*

print(columns\_names\_with\_issues)

## character(0)

*# Identified columns with issues*

columns\_with\_issues <- c("CompanyId", "SMB", "HML", "MOM")

*# Count NA, NaN, or Inf in each identified column*

count\_issues\_per\_column <- sapply(data[columns\_with\_issues], **function**(x) sum(is.na(x) | is.infi nite(x)))

*# Print the counts*

print(count\_issues\_per\_column)

## CompanyId

## 0

SMB

0

HML

0

MOM

0

*# Function to remove rows with any NaN values*

remove\_NaN\_rows <- **function**(input, output) { nan\_rows\_input <- apply(is.na(input), c(1), any) nan\_rows\_output <- is.na(output)

nan\_rows <- nan\_rows\_input | nan\_rows\_output

input\_clean <- input[!nan\_rows, , ] output\_clean <- output[!nan\_rows]

**return**(list("input\_clean" = input\_clean, "output\_clean" = output\_clean))

}

*# Remove NaN values from cnn\_input and cnn\_output #clean\_data <- remove\_NaN\_rows(cnn\_input, cnn\_output) #cnn\_input <- clean\_data$input\_clean*

*#cnn\_output <- clean\_data$output\_clean*

*# Function to check for NaN, Inf, or -Inf values in an array*

check\_for\_bad\_values <- **function**(arr) { nan\_count <- sum(is.na(arr)) inf\_count <- sum(arr == Inf) neg\_inf\_count <- sum(arr == -Inf)

**return**(list("NaN Count" = nan\_count, "Inf Count" = inf\_count, "-Inf Count" = neg\_inf\_count))

}

cnn\_output <- na.omit(cnn\_output)

*# Check for bad values in cnn\_input*

input\_check <- check\_for\_bad\_values(cnn\_input)

print(input\_check)

## $`NaN Count` ## [1] 0

##

## $`Inf Count` ## [1] 0

##

## $`-Inf Count` ## [1] 0

*# Check for bad values in cnn\_output* output\_check <- check\_for\_bad\_values(cnn\_output) print(output\_check)

## $`NaN Count` ## [1] 0

##

## $`Inf Count` ## [1] 0

##

## $`-Inf Count` ## [1] 0

cnn\_input<- cnn\_input[1:1336810, , ]

*# Now cnn\_output is ready to be used as the target for training the CNN # Save cnn\_input*

## ── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──

save(cnn\_input, file = "cnn\_input17.5.2024.RData") save(cnn\_output, file = "cnn\_output17.5.2024.RData")

*# Load cnn\_input* load("cnn\_input17.5.2024.RData") load("cnn\_output17.5.2024.RData")

*# Now cnn\_output is ready to be used as the target for training the CNN*

*###model running testing*

*# Load cnn\_input* load("cnn\_input17.5.2024.RData") load("cnn\_output17.5.2024.RData")

summary(cnn\_input)

##

Min. 1st Qu. Median

Mean 3rd Qu.

Max.

## 0.00000 0.06211 0.32636 0.36304 0.58998 1.00000

data <- read.csv("titlonmoyinreadyfinalsubset 17.5.2024.csv")

features <- data[, c("Close","SMB", "HML", "LIQ", "MOM", "MA5", "MA10", "MA20", "BIAS5", "BIAS1 0", "RSI6", "RSI12",

"Stoch\_K", "Stoch\_D", "MACD", "Signal", "WPR", "VOL1", "VOL2", "Delta\_MA

5")]

*# Prepare the data for the CNN*

*# use a sequence length of 'n' days for each prediction*

sequence\_length <- 10 *# using the past 10 days to predict the next day*

n\_features <- ncol(features)

n\_samples <- nrow(features) - sequence\_length + 1

**library**(keras) **library**(tidyverse)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ## | ✔ | forcats | 1.0.0 | ✔ | readr | 2.1.5 |
| ## | ✔ | ggplot2 | 3.5.1 | ✔ | stringr | 1.5.1 |
| ## | ✔ | lubridate | 1.9.3 | ✔ | tibble | 3.2.1 |
| ## | ✔ | purrr | 1.0.2 | ✔ | tidyr | 1.3.1 |
| ## | ── | Conflicts ────────────────────────────────────────── tidyverse\_conflicts() ── | | | | |
| ## | ✖ | dplyr::between() masks data.table::between() | | | | |
| ## | ✖ | dplyr::filter() masks stats::filter() | | | | |
| ## | ✖ | xts::first() masks dplyr::first(), data.table::first() | | | | |
| ## | ✖ | lubridate::hour() masks data.table::hour() | | | | |
| ## | ✖ | lubridate::isoweek() masks data.table::isoweek() | | | | |
| ## | ✖ | dplyr::lag() masks stats::lag() | | | | |
| ## | ✖ | xts::last() masks dplyr::last(), data.table::last() | | | | |
| ## | ✖ | lubridate::mday() masks data.table::mday() | | | | |
| ## | ✖ | lubridate::minute() masks data.table::minute() | | | | |
| ## | ✖ | lubridate::month() masks data.table::month() | | | | |
| ## | ✖ | lubridate::quarter() masks data.table::quarter() | | | | |
| ## | ✖ | lubridate::second() masks data.table::second() | | | | |
| ## | ✖ | purrr::transpose() masks data.table::transpose() | | | | |
| ## | ✖ | lubridate::wday() masks data.table::wday() | | | | |

## ✖ lubridate::week() ## ✖ lubridate::yday() ## ✖ lubridate::year()

masks data.table::week()

masks data.table::yday() masks data.table::year()

## ℹ Use the conflicted package [(<http://conflicted.r-lib.org/>)](http://conflicted.r-lib.org/) to force all conflicts to beco

me errors

*# Specify TensorFlow version #install\_keras(tensorflow = "2.16.1")*

*# Load necessary libraries* **library**(quantmod) **library**(keras) **library**(data.table) **library**(tensorflow) *#install.packages("tensorflo* **library**(keras)

*# Adding 1D Convolutional layers with different kernel sizes as per the paper*

*# Note that 'input\_shape' is set according to input data's dimensions (sequence\_length, n\_feat ures)*

*# Define the model*

model <- keras\_model\_sequential()

model2 <- keras\_model\_sequential() %>% layer\_conv\_1d(

filters = 32,

kernel\_size = 3, activation = 'relu',

input\_shape = c(sequence\_length, n\_features), padding = "same",

kernel\_regularizer = regularizer\_l2(0.01), *# Adding L2 regularization*

kernel\_initializer = initializer\_glorot\_uniform() *# Changing the initializer*

) %>%

layer\_max\_pooling\_1d(pool\_size = 2, strides = 2) %>% layer\_conv\_1d(

filters = 64,

kernel\_size = 3, activation = 'relu', padding = "same",

kernel\_regularizer = regularizer\_l2(0.01), *# Adding L2 regularization to another layer*

kernel\_initializer = initializer\_glorot\_uniform() *# Applying initializer here as well*

) %>%

layer\_max\_pooling\_1d(pool\_size = 2, strides = 2) %>% layer\_flatten()

model2 %>% compile(

loss = 'mse', *# Mean Squared Error for regression tasks*

optimizer = optimizer\_adam(learning\_rate = 0.00005, clipnorm = 1),*## learnin rate nesf kardam 0.0001 bood*

metrics = c('mean\_absolute\_error', 'accuracy') *# Combining metrics into one vector*

)

*# Print the model summary*

summary(model2)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ## | Model: "sequential\_1" | | | | |
| ## |  | | | | |
| ## | Layer (type) Output Shape Param # | | | | |
| ## | ================================================================================ | | | | |
| ## | conv1d\_1 (Conv1D) (None, 10, 32) 1952 | | | | |
| ## | max\_pooling1d\_1 (MaxPooling1D) | (None, | 5, | 32) | 0 |
| ## | conv1d (Conv1D) | (None, | 5, | 64) | 6208 |
| ## | max\_pooling1d (MaxPooling1D) | (None, | 2, | 64) | 0 |
| ## | flatten (Flatten) (None, 128) 0 | | | | |
| ## | ================================================================================ | | | | |
| ## | Total params: 8160 (31.88 KB) | | | | |
| ## | Trainable params: 8160 (31.88 KB) | | | | |
| ## | Non-trainable params: 0 (0.00 Byte) | | | | |
| ## |  | | | | |

*# Train the model*

history <- model2 %>% fit( x = cnn\_input,

y = cnn\_output$cnn\_output,

epochs = 10,

batch\_size = 32,

validation\_split = 0.2

)

## Epoch 1/10

## 33421/33421 - 98s - loss: 34143.5742 - mean\_absolute\_error: 67.7059 - accuracy: 0.0014 - val

\_loss: 17255.3828 - val\_mean\_absolute\_error: 63.2252 - val\_accuracy: 0.0018 - 98s/epoch - 3ms/s tep

## Epoch 2/10

## 33421/33421 - 136s - loss: 31293.7422 - mean\_absolute\_error: 65.2233 - accuracy: 0.0013 - va l\_loss: 15351.7783 - val\_mean\_absolute\_error: 59.3631 - val\_accuracy: 0.0017 - 136s/epoch - 4m s/step

## Epoch 3/10

## 33421/33421 - 144s - loss: 24956.6895 - mean\_absolute\_error: 57.5307 - accuracy: 0.0013 - va l\_loss: 10672.9082 - val\_mean\_absolute\_error: 49.0417 - val\_accuracy: 0.0016 - 144s/epoch - 4m s/step

## Epoch 4/10

## 33421/33421 - 81s - loss: 13519.9033 - mean\_absolute\_error: 40.8776 - accuracy: 0.0013 - val

\_loss: 4075.7043 - val\_mean\_absolute\_error: 28.5433 - val\_accuracy: 0.0018 - 81s/epoch - 2ms/st ep

## Epoch 5/10

## 33421/33421 - 100s - loss: 3231.6775 - mean\_absolute\_error: 18.0687 - accuracy: 0.0013 - val

\_loss: 1003.8926 - val\_mean\_absolute\_error: 9.5267 - val\_accuracy: 0.0020 - 100s/epoch - 3ms/st ep

## Epoch 6/10

## 33421/33421 - 133s - loss: 874.7887 - mean\_absolute\_error: 6.8794 - accuracy: 0.0015 - val\_l oss: 775.6360 - val\_mean\_absolute\_error: 5.7688 - val\_accuracy: 0.0021 - 133s/epoch - 4ms/step ## Epoch 7/10

## 33421/33421 - 141s - loss: 719.8345 - mean\_absolute\_error: 4.6062 - accuracy: 0.0015 - val\_l oss: 682.2665 - val\_mean\_absolute\_error: 4.5168 - val\_accuracy: 0.0017 - 141s/epoch - 4ms/step ## Epoch 8/10

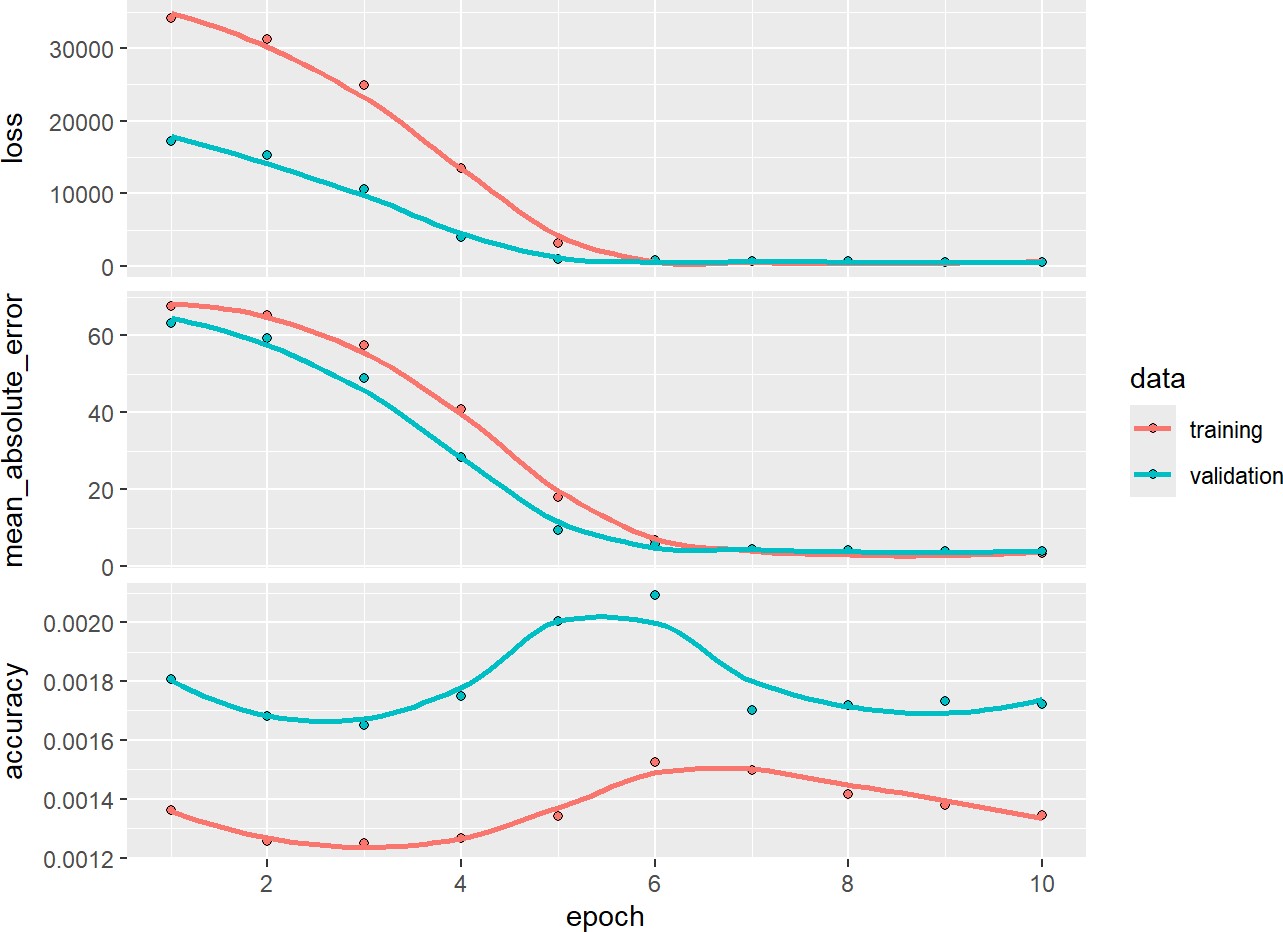
## 33421/33421 - 146s - loss: 649.9177 - mean\_absolute\_error: 3.7987 - accuracy: 0.0014 - val\_l

oss: 638.8582 - val\_mean\_absolute\_error: 4.1336 - val\_accuracy: 0.0017 - 146s/epoch - 4ms/step ## Epoch 9/10

## 33421/33421 - 98s - loss: 611.9424 - mean\_absolute\_error: 3.6009 - accuracy: 0.0014 - val\_lo ss: 613.8934 - val\_mean\_absolute\_error: 3.9820 - val\_accuracy: 0.0017 - 98s/epoch - 3ms/step

## Epoch 10/10

## 33421/33421 - 88s - loss: 589.1505 - mean\_absolute\_error: 3.5075 - accuracy: 0.0013 - val\_lo ss: 596.9057 - val\_mean\_absolute\_error: 3.9482 - val\_accuracy: 0.0017 - 88s/epoch - 3ms/step



*# Create a feature extraction model that outputs from the second convolutional layer*

feature\_extractor <- keras\_model(inputs = model2$input, outputs = get\_layer(model2, index = 2)

$output)

*# Now, use this model to predict features*

extracted\_features <- predict(feature\_extractor, cnn\_input)

## 41776/41776 - 56s - 56s/epoch - 1ms/step

*# Saving the extracted features for later use*

saveRDS(extracted\_features, file = "extracted\_features\_medel2.19.5.2024fama frenchfinalgetbette r pca.rds")

*# Plot training and validation loss*

plot(history)

*# Load the RDS file*

extracted\_features <- readRDS("extracted\_features\_medel2.19.5.2024fama frenchfinalgetbetter pc a.rds")

*# View the dimensions of the loaded features*

dim(extracted\_features)

## [1] 1336810

5

32

*# Check the summary statistics for the features*

summary(extracted\_features)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ## | Min. 1st Qu. Median | Mean | 3rd Qu. | Max. |
| ## | 0.000 1.972 2.422 | 3.145 | 2.943 | 31.698 |

*# If you want to see the first few rows to understand what the features look like*

head(extracted\_features)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ## ##  ## | , , 1 | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 2.954318 | 2.902958 | 2.793275 | 2.851139 | 2.940864 |
| ## | [2,] | 2.902958 | 2.842877 | 2.786640 | 2.940864 | 2.905286 |
| ## | [3,] | 2.842877 | 2.793275 | 2.851139 | 2.940864 | 2.843683 |
| ## | [4,] | 2.793275 | 2.786640 | 2.940864 | 2.905286 | 2.774110 |
| ## | [5,] | 2.734892 | 2.851139 | 2.940864 | 2.843683 | 2.761003 |
| ## | [6,] | 2.786640 | 2.940864 | 2.905286 | 2.774110 | 2.787590 |
| ##  ## | , , 2 |  |  |  |  |  |
| ##  ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 2.319855 | 2.291306 | 2.190804 | 2.231504 | 2.316408 |
| ## | [2,] | 2.291306 | 2.230147 | 2.184289 | 2.316408 | 2.312615 |
| ## | [3,] | 2.230147 | 2.190804 | 2.231504 | 2.316408 | 2.278483 |
| ## | [4,] | 2.190804 | 2.184289 | 2.316408 | 2.312615 | 2.237279 |
| ## | [5,] | 2.116596 | 2.231504 | 2.316408 | 2.278483 | 2.191635 |
| ##  ## | [6,] | 2.184289 | 2.316408 | 2.312615 | 2.237279 | 2.210824 |
| ##  ## | , , 3 |  |  |  |  |  |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 2.781562 | 2.721928 | 2.652502 | 2.691606 | 2.728589 |
| ## | [2,] | 2.721928 | 2.682832 | 2.633554 | 2.728589 | 2.723169 |
| ## | [3,] | 2.682832 | 2.652502 | 2.691606 | 2.728589 | 2.633924 |
| ## | [4,] | 2.652502 | 2.633554 | 2.728589 | 2.723169 | 2.633364 |
| ## | [5,] | 2.587069 | 2.691606 | 2.728589 | 2.633924 | 2.598199 |
| ## | [6,] | 2.633554 | 2.728589 | 2.723169 | 2.633364 | 2.626759 |
| ##  ## | , , 4 |  |  |  |  |  |
| ##  ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 3.767569 | 3.715847 | 3.565057 | 3.604253 | 3.722660 |
| ## | [2,] | 3.715847 | 3.624586 | 3.544922 | 3.722660 | 3.709620 |
| ## | [3,] | 3.624586 | 3.565057 | 3.604253 | 3.722660 | 3.590407 |
| ## | [4,] | 3.565057 | 3.544922 | 3.722660 | 3.709620 | 3.516551 |
| ## | [5,] | 3.429116 | 3.604253 | 3.722660 | 3.590407 | 3.412183 |
| ##  ## | [6,] | 3.544922 | 3.722660 | 3.709620 | 3.516551 | 3.456850 |
| ## | , , 5 |  |  |  |  |  |
| ##  ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 2.848643 | 2.810842 | 2.705670 | 2.720306 | 2.800961 |
| ## | [2,] | 2.810842 | 2.754901 | 2.669765 | 2.800961 | 2.784938 |
| ## | [3,] | 2.754901 | 2.705670 | 2.720306 | 2.800961 | 2.735616 |

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| ## | [4,] | 2.705670 | | 2.669765 | | 2.800961 | | 2.784938 | | 2.683870 | |
| ## | [5,] | 2.604631 | | 2.720306 | | 2.800961 | | 2.735616 | | 2.633394 | |
| ## | [6,] | 2.669765 | | 2.800961 | | 2.784938 | | 2.683870 | | 2.616972 | |
| ##  ## | , , 6 |  | |  | |  | |  | |  | |
| ## |  |  | |  | |  | |  | |  | |
| ## |  | [,1] | [,2] | [,3] | [,4] | | [,5] | | | | |
| ## | [1,] | 0 | 0 | 0 | 0 | | 0 | | | | |
| ## | [2,] | 0 | 0 | 0 | 0 | | 0 | | | | |
| ## | [3,] | 0 | 0 | 0 | 0 | | 0 | | | | |
| ## | [4,] | 0 | 0 | 0 | 0 | | 0 | | | | |
| ## | [5,] | 0 | 0 | 0 | 0 | | 0 | | | | |
| ##  ## | [6,] | 0 | 0 | 0 | 0 | | 0 | | | | |
| ##  ## | , , 7 |  | |  | |  | |  | |  | |
| ## |  | [,1] | | [,2] | | [,3] | | [,4] | | [,5] | |
| ## | [1,] | 2.622634 | | 2.567065 | | 2.455908 | | 2.480480 | | 2.557527 | |
| ## | [2,] | 2.567065 | | 2.499005 | | 2.424078 | | 2.557527 | | 2.561853 | |
| ## | [3,] | 2.499005 | | 2.455908 | | 2.480480 | | 2.561853 | | 2.502497 | |
| ## | [4,] | 2.455908 | | 2.424078 | | 2.557527 | | 2.561853 | | 2.450645 | |
| ## | [5,] | 2.389630 | | 2.480480 | | 2.561853 | | 2.502497 | | 2.395728 | |
| ## | [6,] | 2.424078 | | 2.557527 | | 2.561853 | | 2.450645 | | 2.441107 | |
| ## |  |  | |  | |  | |  | |  | |
| ##  ## | , , 8 |  | |  | |  | |  | |  | |
| ## |  | [,1] | | [,2] | | [,3] | | [,4] | | [,5] | |
| ## | [1,] | 3.050714 | | 2.996390 | | 2.893982 | | 2.919470 | | 2.971909 | |
| ## | [2,] | 2.996390 | | 2.934685 | | 2.870043 | | 2.971909 | | 2.985106 | |
| ## | [3,] | 2.934685 | | 2.893982 | | 2.919470 | | 2.985106 | | 2.924108 | |
| ## | [4,] | 2.893982 | | 2.870043 | | 2.971909 | | 2.985106 | | 2.913815 | |
| ## | [5,] | 2.812239 | | 2.919470 | | 2.985106 | | 2.924108 | | 2.867736 | |
| ## | [6,] | 2.870043 | | 2.971909 | | 2.985106 | | 2.913815 | | 2.896150 | |
| ##  ## | , , 9 |  | |  | |  | |  | |  | |
| ## |  |  | |  | |  | |  | |  | |
| ## |  | [,1] | | [,2] | | | [,3] | | [,4] | | [,5] |
| ## | [1,] | 0.6281550 | | 0.6120690 | | | 0.5777699 | | 0.5939625 | | 0.6120415 |
| ## | [2,] | 0.6120690 | | 0.5933056 | | | 0.5932828 | | 0.6120415 | | 0.5913891 |
| ## | [3,] | 0.5933056 | | 0.5777699 | | | 0.5939625 | | 0.6120415 | | 0.5878857 |
| ## | [4,] | 0.5777699 | | 0.5932828 | | | 0.6120415 | | 0.5913891 | | 0.5689480 |
| ## | [5,] | 0.5409214 | | 0.5939625 | | | 0.6120415 | | 0.5878857 | | 0.5353054 |
| ##  ## | [6,] | 0.5932828 | | 0.6120415 | | | 0.5913891 | | 0.5689480 | | 0.5662389 |

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| ##  ## | , , 10 | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 3.129924 | 3.078132 | 2.966232 | 3.002552 | 3.111548 |
| ## | [2,] | 3.078132 | 3.003875 | 2.966014 | 3.111548 | 3.087477 |
| ## | [3,] | 3.003875 | 2.966232 | 3.002552 | 3.111548 | 2.995544 |
| ## | [4,] | 2.966232 | 2.966014 | 3.111548 | 3.087477 | 2.954662 |
| ## | [5,] | 2.831478 | 3.002552 | 3.111548 | 2.995544 | 2.894800 |
| ## | [6,] | 2.966014 | 3.111548 | 3.087477 | 2.954662 | 2.913656 |
| ## |  |  |  |  |  |  |
| ## | , , 11 | | | | | |
| ## |  | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 2.208476 | 2.156288 | 2.093285 | 2.190548 | 2.211378 |
| ## | [2,] | 2.156288 | 2.107503 | 2.144052 | 2.211378 | 2.172805 |
| ## | [3,] | 2.107503 | 2.093285 | 2.190548 | 2.211378 | 2.090384 |

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| ## | [4,] | 2.093285 | 2.144052 | 2.211378 | 2.172805 | 2.065701 |
| ## | [5,] | 2.010753 | 2.190548 | 2.211378 | 2.090384 | 2.064604 |
| ## | [6,] | 2.144052 | 2.211378 | 2.172805 | 2.065701 | 2.084885 |
| ## |  |  |  |  |  |  |
| ## | , , 12 | | | | | |
| ## |  | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 3.087142 | 3.062483 | 2.960894 | 2.979788 | 3.060022 |
| ## | [2,] | 3.062483 | 3.002443 | 2.915417 | 3.060022 | 3.074085 |
| ## | [3,] | 3.002443 | 2.960894 | 2.979788 | 3.074085 | 3.010867 |
| ## | [4,] | 2.960894 | 2.915417 | 3.060022 | 3.074085 | 2.962034 |
| ## | [5,] | 2.876361 | 2.979788 | 3.074085 | 3.010867 | 2.900420 |
| ##  ## | [6,] | 2.915417 | 3.060022 | 3.074085 | 2.962034 | 2.883407 |
| ##  ## | , , 13 | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 2.740625 | 2.671417 | 2.627221 | 2.713439 | 2.699677 |
| ## | [2,] | 2.671417 | 2.636334 | 2.659643 | 2.713439 | 2.694354 |
| ## | [3,] | 2.636334 | 2.627221 | 2.713439 | 2.699677 | 2.594595 |
| ## | [4,] | 2.627221 | 2.659643 | 2.713439 | 2.694354 | 2.566846 |
| ## | [5,] | 2.526364 | 2.713439 | 2.699677 | 2.594595 | 2.559771 |
| ## | [6,] | 2.659643 | 2.713439 | 2.694354 | 2.566846 | 2.595991 |
| ## |  |  |  |  |  |  |
| ##  ## | , , 14 | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 2.641452 | 2.617517 | 2.521078 | 2.516832 | 2.615083 |
| ## | [2,] | 2.617517 | 2.565220 | 2.465686 | 2.615083 | 2.623219 |
| ## | [3,] | 2.565220 | 2.521078 | 2.516832 | 2.623219 | 2.589463 |
| ## | [4,] | 2.521078 | 2.465686 | 2.615083 | 2.623219 | 2.528605 |
| ## | [5,] | 2.427723 | 2.516832 | 2.623219 | 2.589463 | 2.490943 |
| ## | [6,] | 2.465686 | 2.615083 | 2.623219 | 2.528605 | 2.498967 |
| ## |  |  |  |  |  |  |
| ## | , , 15 | | | | | |
| ## |  | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 2.967037 | 2.923476 | 2.792659 | 2.813413 | 2.898127 |
| ## | [2,] | 2.923476 | 2.842431 | 2.754575 | 2.898127 | 2.871614 |
| ## | [3,] | 2.842431 | 2.792659 | 2.813413 | 2.898127 | 2.831438 |
| ## | [4,] | 2.792659 | 2.754575 | 2.898127 | 2.871614 | 2.771378 |
| ## | [5,] | 2.700878 | 2.813413 | 2.898127 | 2.831438 | 2.705415 |
| ##  ## | [6,] | 2.754575 | 2.898127 | 2.871614 | 2.771378 | 2.688599 |
| ##  ## | , , 16 | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 3.345538 | 3.304990 | 3.204113 | 3.254920 | 3.354094 |
| ## | [2,] | 3.304990 | 3.251389 | 3.179498 | 3.354094 | 3.321936 |
| ## | [3,] | 3.251389 | 3.204113 | 3.254920 | 3.354094 | 3.241472 |
| ## | [4,] | 3.204113 | 3.179498 | 3.354094 | 3.321936 | 3.211694 |
| ## | [5,] | 3.123771 | 3.254920 | 3.354094 | 3.241472 | 3.179174 |
| ## | [6,] | 3.179498 | 3.354094 | 3.321936 | 3.211694 | 3.219393 |
| ## |  |  |  |  |  |  |
| ## | , , 17 | | | | | |
| ## |  | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 3.056042 | 3.017359 | 2.893963 | 2.954183 | 3.041197 |
| ## | [2,] | 3.017359 | 2.936780 | 2.892976 | 3.041197 | 3.017299 |
| ## | [3,] | 2.936780 | 2.893963 | 2.954183 | 3.041197 | 2.967087 |

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| ## | [4,] | 2.893963 | 2.892976 | 3.041197 | | 3.017299 | | 2.915750 | |
| ## | [5,] | 2.828662 | 2.954183 | 3.041197 | | 2.967087 | | 2.870609 | |
| ## | [6,] | 2.892976 | 3.041197 | 3.017299 | | 2.915750 | | 2.902232 | |
| ## |  |  |  |  | |  | |  | |
| ## | , , 18 | | | | | | | | |
| ## |  | | | | | | | | |
| ## |  | [,1] | [,2] | [,3] | | [,4] | | [,5] | |
| ## | [1,] | 3.251759 | 3.197350 | 3.118888 | | 3.119411 | | 3.178431 | |
| ## | [2,] | 3.197350 | 3.147736 | 3.061527 | | 3.178431 | | 3.168839 | |
| ## | [3,] | 3.147736 | 3.118888 | 3.119411 | | 3.178431 | | 3.119441 | |
| ## | [4,] | 3.118888 | 3.061527 | 3.178431 | | 3.168839 | | 3.077954 | |
| ## | [5,] | 3.044368 | 3.119411 | 3.178431 | | 3.119441 | | 3.077577 | |
| ##  ## | [6,] | 3.061527 | 3.178431 | 3.168839 | | 3.077954 | | 3.065518 | |
| ##  ## | , , 19 | | | | | | | | |
| ## |  | [,1] | [,2] | [,3] | | [,4] | | [,5] | |
| ## | [1,] | 2.873053 | 2.843155 | 2.719352 | | 2.771043 | | 2.870885 | |
| ## | [2,] | 2.843155 | 2.763168 | 2.734197 | | 2.870885 | | 2.819052 | |
| ## | [3,] | 2.763168 | 2.719352 | 2.771043 | | 2.870885 | | 2.773652 | |
| ## | [4,] | 2.719352 | 2.734197 | 2.870885 | | 2.819052 | | 2.722332 | |
| ## | [5,] | 2.640645 | 2.771043 | 2.870885 | | 2.773652 | | 2.643290 | |
| ## | [6,] | 2.734197 | 2.870885 | 2.819052 | | 2.722332 | | 2.688293 | |
| ## |  |  |  |  | |  | |  | |
| ##  ## | , , 20 | | | | | | | | |
| ## |  | [,1] | [,2] | [,3] | | [,4] | | [,5] | |
| ## | [1,] | 1.527283 | 1.493188 | 1.419245 | | 1.431216 | | 1.490720 | |
| ## | [2,] | 1.493188 | 1.450546 | 1.396144 | | 1.490720 | | 1.479255 | |
| ## | [3,] | 1.450546 | 1.419245 | 1.431216 | | 1.490720 | | 1.444307 | |
| ## | [4,] | 1.419245 | 1.396144 | 1.490720 | | 1.479255 | | 1.403357 | |
| ## | [5,] | 1.335613 | 1.431216 | 1.490720 | | 1.444307 | | 1.332538 | |
| ## | [6,] | 1.396144 | 1.490720 | 1.479255 | | 1.403357 | | 1.317446 | |
| ## |  |  |  |  | |  | |  | |
| ## | , , 21 | | | | | | | | |
| ## |  | | | | | | | | |
| ## |  | [,1] | [,2] | | [,3] | | [,4] | | [,5] |
| ## | [1,] | 0.6173271 | 0.5984175 | | 0.5602492 | | 0.5740771 | | 0.5869714 |
| ## | [2,] | 0.5984175 | 0.5719535 | | 0.5740771 | | 0.5869714 | | 0.5929846 |
| ## | [3,] | 0.5719535 | 0.5602492 | | 0.5740771 | | 0.5929846 | | 0.5765064 |
| ## | [4,] | 0.5602492 | 0.5740771 | | 0.5869714 | | 0.5929846 | | 0.5503516 |
| ## | [5,] | 0.5377978 | 0.5740771 | | 0.5929846 | | 0.5765064 | | 0.5348529 |
| ##  ## | [6,] | 0.5740771 | 0.5869714 | | 0.5929846 | | 0.5503516 | | 0.5501267 |

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| ##  ## | , , 22 | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 3.141166 | 3.113188 | 3.000761 | 3.011733 | 3.101300 |
| ## | [2,] | 3.113188 | 3.055427 | 2.973862 | 3.101300 | 3.096423 |
| ## | [3,] | 3.055427 | 3.000761 | 3.011733 | 3.101300 | 3.066905 |
| ## | [4,] | 3.000761 | 2.973862 | 3.101300 | 3.096423 | 2.975310 |
| ## | [5,] | 2.902640 | 3.011733 | 3.101300 | 3.066905 | 2.900775 |
| ## | [6,] | 2.973862 | 3.101300 | 3.096423 | 2.975310 | 2.898582 |
| ## |  |  |  |  |  |  |
| ## | , , 23 | | | | | |
| ## |  | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 2.973756 | 2.938513 | 2.828700 | 2.846973 | 2.920516 |
| ## | [2,] | 2.938513 | 2.881334 | 2.801356 | 2.920516 | 2.929999 |
| ## | [3,] | 2.881334 | 2.828700 | 2.846973 | 2.929999 | 2.884977 |

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| ## | [4,] | 2.828700 | 2.801356 | 2.920516 | 2.929999 | 2.833885 |
| ## | [5,] | 2.735139 | 2.846973 | 2.929999 | 2.884977 | 2.768606 |
| ## | [6,] | 2.801356 | 2.920516 | 2.929999 | 2.833885 | 2.806856 |
| ## |  |  |  |  |  |  |
| ## | , , 24 | | | | | |
| ## |  | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 16.91631 | 16.76044 | 15.97400 | 16.04786 | 16.66906 |
| ## | [2,] | 16.76044 | 16.33565 | 15.75999 | 16.66906 | 16.59522 |
| ## | [3,] | 16.33565 | 15.97400 | 16.04786 | 16.66906 | 16.36987 |
| ## | [4,] | 15.97400 | 15.75999 | 16.66906 | 16.59522 | 16.04740 |
| ## | [5,] | 15.57182 | 16.04786 | 16.66906 | 16.36987 | 15.63823 |
| ##  ## | [6,] | 15.75999 | 16.66906 | 16.59522 | 16.04740 | 15.65354 |
| ##  ## | , , 25 | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 3.207378 | 3.185500 | 3.056593 | 3.116370 | 3.208179 |
| ## | [2,] | 3.185500 | 3.107914 | 3.038446 | 3.208179 | 3.208334 |
| ## | [3,] | 3.107914 | 3.056593 | 3.116370 | 3.208334 | 3.147545 |
| ## | [4,] | 3.056593 | 3.038446 | 3.208179 | 3.208334 | 3.082471 |
| ## | [5,] | 2.943789 | 3.116370 | 3.208334 | 3.147545 | 3.003130 |
| ## | [6,] | 3.038446 | 3.208179 | 3.208334 | 3.082471 | 3.024259 |
| ## |  |  |  |  |  |  |
| ##  ## | , , 26 | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 1.986640 | 1.966478 | 1.906163 | 1.918697 | 1.970094 |
| ## | [2,] | 1.966478 | 1.929324 | 1.892851 | 1.970094 | 1.959148 |
| ## | [3,] | 1.929324 | 1.906163 | 1.918697 | 1.970094 | 1.932972 |
| ## | [4,] | 1.906163 | 1.892851 | 1.970094 | 1.959148 | 1.899286 |
| ## | [5,] | 1.867426 | 1.918697 | 1.970094 | 1.932972 | 1.864228 |
| ## | [6,] | 1.892851 | 1.970094 | 1.959148 | 1.899286 | 1.874582 |
| ## |  |  |  |  |  |  |
| ## | , , 27 | | | | | |
| ## |  | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 2.622403 | 2.588847 | 2.483687 | 2.510450 | 2.580549 |
| ## | [2,] | 2.588847 | 2.521481 | 2.472068 | 2.580549 | 2.573039 |
| ## | [3,] | 2.521481 | 2.483687 | 2.510450 | 2.580549 | 2.523389 |
| ## | [4,] | 2.483687 | 2.472068 | 2.580549 | 2.573039 | 2.471047 |
| ## | [5,] | 2.425348 | 2.510450 | 2.580549 | 2.523389 | 2.432238 |
| ##  ## | [6,] | 2.472068 | 2.580549 | 2.573039 | 2.471047 | 2.427258 |
| ##  ## | , , 28 | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 3.557818 | 3.509318 | 3.392532 | 3.453823 | 3.524165 |
| ## | [2,] | 3.509318 | 3.451707 | 3.402643 | 3.524165 | 3.515938 |
| ## | [3,] | 3.451707 | 3.392532 | 3.453823 | 3.524165 | 3.444752 |
| ## | [4,] | 3.392532 | 3.402643 | 3.524165 | 3.515938 | 3.386801 |
| ## | [5,] | 3.290368 | 3.453823 | 3.524165 | 3.444752 | 3.316172 |
| ## | [6,] | 3.402643 | 3.524165 | 3.515938 | 3.386801 | 3.320003 |
| ## |  |  |  |  |  |  |
| ## | , , 29 | | | | | |
| ## |  | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 2.812152 | 2.782400 | 2.695077 | 2.693002 | 2.757360 |
| ## | [2,] | 2.782400 | 2.735908 | 2.665402 | 2.757360 | 2.745985 |
| ## | [3,] | 2.735908 | 2.695077 | 2.693002 | 2.757360 | 2.702783 |

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| --- | --- | --- | --- | --- | --- | --- |
| ## | [4,] | 2.695077 | 2.665402 | 2.757360 | 2.745985 | 2.659160 |
| ## | [5,] | 2.624502 | 2.693002 | 2.757360 | 2.702783 | 2.614398 |
| ## | [6,] | 2.665402 | 2.757360 | 2.745985 | 2.659160 | 2.628008 |
| ## |  |  |  |  |  |  |
| ## | , , 30 | | | | | |
| ## |  | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 16.58248 | 16.42806 | 15.62566 | 15.67463 | 16.31684 |
| ## | [2,] | 16.42806 | 15.99365 | 15.37027 | 16.31684 | 16.24078 |
| ## | [3,] | 15.99365 | 15.62566 | 15.67463 | 16.31684 | 16.01666 |
| ## | [4,] | 15.62566 | 15.37027 | 16.31684 | 16.24078 | 15.67296 |
| ## | [5,] | 15.20001 | 15.67463 | 16.31684 | 16.01666 | 15.22410 |
| ##  ## | [6,] | 15.37027 | 16.31684 | 16.24078 | 15.67296 | 15.21288 |
| ##  ## | , , 31 | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 2.918725 | 2.873864 | 2.743254 | 2.755913 | 2.849358 |
| ## | [2,] | 2.873864 | 2.805976 | 2.721694 | 2.849358 | 2.854462 |
| ## | [3,] | 2.805976 | 2.743254 | 2.755913 | 2.854462 | 2.795372 |
| ## | [4,] | 2.743254 | 2.721694 | 2.849358 | 2.854462 | 2.712779 |
| ## | [5,] | 2.670018 | 2.755913 | 2.854462 | 2.795372 | 2.631255 |
| ## | [6,] | 2.721694 | 2.849358 | 2.854462 | 2.712779 | 2.669034 |
| ## |  |  |  |  |  |  |
| ##  ## | , , 32 | | | | | |
| ## |  | [,1] | [,2] | [,3] | [,4] | [,5] |
| ## | [1,] | 2.883401 | 2.850788 | 2.747334 | 2.824714 | 2.895210 |
| ## | [2,] | 2.850788 | 2.791325 | 2.769894 | 2.895210 | 2.865869 |
| ## | [3,] | 2.791325 | 2.747334 | 2.824714 | 2.895210 | 2.797762 |
| ## | [4,] | 2.747334 | 2.769894 | 2.895210 | 2.865869 | 2.758550 |
| ## | [5,] | 2.690532 | 2.824714 | 2.895210 | 2.797762 | 2.714154 |
| ## | [6,] | 2.769894 | 2.895210 | 2.865869 | 2.758550 | 2.730249 |

*######PCA TEST ###########*

*# Flatten the array into a 2D matrix*

flattened\_data <- array(extracted\_features, dim = c(dim(extracted\_features)[1], dim(extracted\_f eatures)[2] \* dim(extracted\_features)[3]))

summary(flattened\_data)*## dataha too ranega an scaleled ok*

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## |  | V1 |  |  | V2 |  |  | V3 |  |  | V4 |  |
| ## | Min. | : | 1.545 | Min. | : | 1.550 | Min. | : | 1.550 | Min. | : | 1.550 |
| ## | 1st Qu.: | | 2.265 | 1st Qu.: | | 2.290 | 1st Qu.: | | 2.290 | 1st Qu.: | | 2.290 |
| ## | Median : | | 2.483 | Median : | | 2.506 | Median : | | 2.506 | Median : | | 2.506 |
| ## | Mean : | | 2.676 | Mean : | | 2.700 | Mean : | | 2.700 | Mean : | | 2.700 |
| ## | 3rd Qu.: | | 2.806 | 3rd Qu.: | | 2.830 | 3rd Qu.: | | 2.830 | 3rd Qu.: | | 2.830 |
| ## ## | Max. | :30.945  V5 | | Max. | :30.945  V6 | | Max. | :30.945  V7 | | Max. | :30.945  V8 | |
| ## | Min. : | | 1.545 | Min. : | | 1.032 | Min. : | | 1.070 | Min. : | | 1.070 |
| ## | 1st Qu.: | | 2.265 | 1st Qu.: | | 1.608 | 1st Qu.: | | 1.635 | 1st Qu.: | | 1.635 |
| ## | Median : | | 2.483 | Median : | | 1.862 | Median : | | 1.887 | Median : | | 1.887 |
| ## | Mean : | | 2.676 | Mean : | | 2.039 | Mean : | | 2.064 | Mean : | | 2.064 |
| ## | 3rd Qu.: | | 2.806 | 3rd Qu.: | | 2.188 | 3rd Qu.: | | 2.211 | 3rd Qu.: | | 2.211 |
| ## | Max. | :30.945 | | Max. | :30.287 | | Max. | :30.287 | | Max. | :30.287 | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## |  | V9 |  |  | V10 |  |  | V11 |  |  | V12 |  |
| ## | Min. | : | 1.070 | Min. | : | 1.032 | Min. | : | 1.572 | Min. | : | 1.575 |
| ## | 1st Qu.: | | 1.635 | 1st Qu.: | | 1.608 | 1st Qu.: | | 2.089 | 1st Qu.: | | 2.110 |
| ## | Median : | | 1.887 | Median : | | 1.862 | Median : | | 2.289 | Median : | | 2.309 |
| ## | Mean : | | 2.064 | Mean : | | 2.039 | Mean : | | 2.496 | Mean : | | 2.516 |
| ## | 3rd Qu.: | | 2.211 | 3rd Qu.: | | 2.188 | 3rd Qu.: | | 2.615 | 3rd Qu.: | | 2.636 |
| ## | Max. | :30.287 | | Max. | :30.287 | | Max. | :31.147 | | Max. | :31.147 | |
| ## |  | V13 | |  | V14 | |  | V15 | |  | V16 | |
| ## | Min. | : 1.575 | | Min. | : 1.575 | | Min. | : 1.572 | | Min. | : 2.182 | |
| ## | 1st Qu.: | | 2.110 | 1st Qu.: | | 2.110 | 1st Qu.: | | 2.089 | 1st Qu.: | | 2.904 |
| ## | Median : | | 2.309 | Median : | | 2.309 | Median : | | 2.289 | Median : | | 3.219 |
| ## | Mean : | | 2.516 | Mean : | | 2.516 | Mean : | | 2.496 | Mean : | | 3.375 |
| ## | 3rd Qu.: | | 2.636 | 3rd Qu.: | | 2.636 | 3rd Qu.: | | 2.615 | 3rd Qu.: | | 3.573 |
| ## | Max. | :31.147 | | Max. | :31.147 | | Max. | :31.147 | | Max. | :31.698 | |
| ##  ## | Min. | V17  : 2.186 | | Min. | V18  : 2.186 | | Min. | V19  : 2.186 | | Min. | V20  : 2.182 | |
| ## | 1st Qu.: | | 2.942 | 1st Qu.: | | 2.942 | 1st Qu.: | | 2.942 | 1st Qu.: | | 2.904 |
| ## | Median : | | 3.257 | Median : | | 3.257 | Median : | | 3.257 | Median : | | 3.219 |
| ## | Mean : | | 3.410 | Mean : | | 3.410 | Mean : | | 3.410 | Mean : | | 3.375 |
| ## | 3rd Qu.: | | 3.605 | 3rd Qu.: | | 3.605 | 3rd Qu.: | | 3.605 | 3rd Qu.: | | 3.573 |
| ## | Max. | :31.698 | | Max. | :31.698 | | Max. | :31.698 | | Max. | :31.698 | |
| ##  ## | Min. | V21  : 1.310 | | Min. | V22  : 1.314 | | Min. | V23  : 1.314 | | Min. | V24  : 1.314 | |
| ## | 1st Qu.: | | 2.044 | 1st Qu.: | | 2.074 | 1st Qu.: | | 2.074 | 1st Qu.: | | 2.074 |
| ## | Median : | | 2.351 | Median : | | 2.381 | Median : | | 2.381 | Median : | | 2.381 |
| ## Mean : 2.514 Mean : 2.543 | | | | | | | Mean | : | 2.543 Mean : 2.543 | | | |
| ## 3rd Qu.: 2.707 3rd Qu.: 2.733 | | | | | | | 3rd | Qu.: | 2.733 3rd Qu.: 2.733 | | | |

## Max. :30.948 Max. :30.948 Max. :30.948 Max. :30.948

## V25 V26 V27 V28 V29 V30 ## Min. : 1.310 Min. :0 Min. :0 Min. :0 Min. :0 Min. :0

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ## | 1st Qu.: | 2.044 | 1st Qu.:0 | 1st Qu.:0 | 1st Qu.:0 | 1st Qu.:0 | 1st Qu.:0 |
| ## | Median : | 2.351 | Median :0 | Median :0 | Median :0 | Median :0 | Median :0 |

## Mean : 2.514 Mean :0 Mean :0 Mean :0 Mean :0 Mean :0 ## 3rd Qu.: 2.707 3rd Qu.:0 3rd Qu.:0 3rd Qu.:0 3rd Qu.:0 3rd Qu.:0 ## Max. :30.948 Max. :0 Max. :0 Max. :0 Max. :0 Max. :0 ## V31 V32 V33 V34

## Min. : 1.250 Min. : 1.274 Min. : 1.274 Min. : 1.274

1st Qu.: 1.874 1st Qu.: 1.874

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ## | 1st Qu.: | 1.847 | 1st Qu.: | 1.874 |
| ## | Median : | 2.109 | Median : | 2.135 |

Median : 2.135 Median : 2.135

## Mean : 2.286 Mean : 2.312 Mean : 2.312 Mean : 2.312

## 3rd Qu.: 2.442 3rd Qu.: 2.467 3rd Qu.: 2.467 3rd Qu.: 2.467

## Max. :30.819 Max. :30.819 Max. :30.819 Max. :30.819 ## V35 V36 V37 V38

## Min. : 1.250 Min. : 1.258 Min. : 1.273 Min. : 1.273

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | 1st Qu.: | | 1.847 | 1st Qu.: | | 2.188 | 1st Qu.: | | 2.221 | 1st Qu.: | | 2.221 |
| ## | Median : | | 2.109 | Median : | | 2.509 | Median : | | 2.541 | Median : | | 2.541 |
| ## | Mean : | | 2.286 | Mean : | | 2.665 | Mean : | | 2.695 | Mean : | | 2.695 |
| ## | 3rd Qu.: | | 2.442 | 3rd Qu.: | | 2.871 | 3rd Qu.: | | 2.899 | 3rd Qu.: | | 2.899 |
| ## | Max. | :30.819 | | Max. | :31.167 | | Max. | :31.167 | | Max. | :31.167 | |
| ##  ## | Min. | V39  : 1.273 | | Min. | V40  : 1.258 | | Min. | V41  : 0.0000 | | Min. | V42  : 0.0000 | |
| ## | 1st Qu.: | | 2.221 | 1st Qu.: | | 2.188 | 1st Qu.: | | 0.1014 | 1st Qu.: | | 0.1105 |
| ## | Median : | | 2.541 | Median : | | 2.509 | Median : | | 0.2445 | Median : | | 0.2543 |
| ## | Mean : | | 2.695 | Mean : | | 2.665 | Mean : | | 0.4946 | Mean : | | 0.5045 |
| ## | 3rd Qu.: | | 2.899 | 3rd Qu.: | | 2.871 | 3rd Qu.: | | 0.5923 | 3rd Qu.: | | 0.6034 |
| ## Max. :31.167 Max. :31.167 Max. | | | | | | | | :29.0143 | | Max. | :29.0143 | |
| ## V43 V44 | | | | | | | | V45 | |  | V46 | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## Min. : 0.0000 Min. : 0.0000 Min. | | | | | | : | 0.0000 | Min. | : | 1.517 |
| ## | 1st Qu.: | 0.1105 | 1st Qu.: | 0.1105 | 1st Qu.: | | 0.1010 | 1st Qu.: | | 2.287 |
| ## | Median : | 0.2543 | Median : | 0.2543 | Median : | | 0.2444 | Median : | | 2.603 |

## Mean : 0.5045 Mean : 0.5045 Mean : 0.4943 Mean : 2.764

## 3rd Qu.: 0.6034 3rd Qu.: 0.6034 3rd Qu.: 0.5922 3rd Qu.: 2.961

## Max. :29.0143 Max. :29.0143 Max. :29.0143 Max. :31.517 ## V47 V48 V49 V50

## Min. : 1.530 Min. : 1.530 Min. : 1.530 Min. : 1.517

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | 1st Qu.: | 2.324 | 1st Qu.: | 2.324 | 1st Qu.: | 2.324 | 1st Qu.: | 2.287 |
| ## | Median : | 2.639 | Median : | 2.639 | Median : | 2.639 | Median : | 2.603 |
| ## | Mean : | 2.798 | Mean : | 2.798 | Mean : | 2.798 | Mean : | 2.764 |
| ## | 3rd Qu.: | 2.992 | 3rd Qu.: | 2.992 | 3rd Qu.: | 2.992 | 3rd Qu.: | 2.961 |

## Max. :31.517 Max. :31.517 Max. :31.517 Max. :31.517 ## V51 V52 V53 V54

## Min. : 0.6825 Min. : 0.6872 Min. : 0.6872 Min. : 0.6872

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | 1st Qu.: | 1.5748 | 1st Qu.: | 1.5986 | 1st Qu.: | 1.5986 | 1st Qu.: | 1.5986 |
| ## | Median : | 1.7743 | Median : | 1.7946 | Median : | 1.7946 | Median : | 1.7946 |
| ## | Mean : | 1.9826 | Mean : | 2.0048 | Mean : | 2.0048 | Mean : | 2.0048 |
| ## | 3rd Qu.: | 2.1049 | 3rd Qu.: | 2.1269 | 3rd Qu.: | 2.1269 | 3rd Qu.: | 2.1269 |

## Max. :30.5721 Max. :30.5721 Max. :30.5721 Max. :30.5721 ## V55 V56 V57 V58

## Min. : 0.6825 Min. : 1.614 Min. : 1.616 Min. : 1.616

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | 1st Qu.: | 1.5748 | 1st Qu.: | 2.324 | 1st Qu.: | 2.353 | 1st Qu.: | 2.353 |
| ## | Median : | 1.7743 | Median : | 2.613 | Median : | 2.641 | Median : | 2.641 |
| ## | Mean : | 1.9826 | Mean : | 2.776 | Mean : | 2.803 | Mean : | 2.803 |
| ## | 3rd Qu.: | 2.1049 | 3rd Qu.: | 2.951 | 3rd Qu.: | 2.976 | 3rd Qu.: | 2.976 |

## Max. :30.5721 Max. :30.770 Max. :30.770 Max. :30.770

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| ## V59 V60  ## Min. : 1.616 Min. : | | | | | | 1.614 | V61  Min. : | | 1.294 | V62  Min. : | | 1.302 |
| ## | 1st Qu.: | | 2.353 | 1st Qu.: | | 2.324 | 1st Qu.: | | 2.078 | 1st Qu.: | | 2.105 |
| ## | Median : | | 2.641 | Median : | | 2.613 | Median : | | 2.293 | Median : | | 2.317 |
| ## | Mean : | | 2.803 | Mean : | | 2.776 | Mean : | | 2.490 | Mean : | | 2.515 |
| ## | 3rd Qu.: | | 2.976 | 3rd Qu.: | | 2.951 | 3rd Qu.: | | 2.619 | 3rd Qu.: | | 2.644 |
| ## ## | Max. | :30.770  V63 | | Max. | :30.770  V64 | | Max. | :30.842  V65 | | Max. | :30.842  V66 | |
| ## | Min. | : 1.302 | | Min. | : 1.302 | | Min. | : 1.294 | | Min. | : 1.197 | |
| ## | 1st Qu.: | | 2.105 | 1st Qu.: | | 2.105 | 1st Qu.: | | 2.078 | 1st Qu.: | | 1.858 |
| ## | Median : | | 2.317 | Median : | | 2.317 | Median : | | 2.293 | Median : | | 2.159 |
| ## | Mean : | | 2.515 | Mean : | | 2.515 | Mean : | | 2.490 | Mean : | | 2.322 |
| ## | 3rd Qu.: | | 2.644 | 3rd Qu.: | | 2.644 | 3rd Qu.: | | 2.619 | 3rd Qu.: | | 2.508 |
| ## ## | Max. | :30.842  V67 | | Max. | :30.842  V68 | | Max. | :30.842  V69 | | Max. | :30.849  V70 | |
| ## | Min. | : 1.232 | | Min. | : 1.232 | | Min. | : 1.232 | | Min. | : 1.197 | |
| ## | 1st Qu.: | | 1.888 | 1st Qu.: | | 1.888 | 1st Qu.: | | 1.888 | 1st Qu.: | | 1.858 |
| ## | Median : | | 2.189 | Median : | | 2.189 | Median : | | 2.189 | Median : | | 2.159 |
| ## | Mean : | | 2.350 | Mean : | | 2.350 | Mean : | | 2.350 | Mean : | | 2.322 |
| ## | 3rd Qu.: | | 2.533 | 3rd Qu.: | | 2.533 | 3rd Qu.: | | 2.533 | 3rd Qu.: | | 2.508 |
| ## ## | Max. | :30.849  V71 | | Max. | :30.849  V72 | | Max. | :30.849  V73 | | Max. | :30.849  V74 | |
| ## | Min. | : 1.427 | | Min. | : 1.432 | | Min. | : 1.432 | | Min. | : 1.432 | |
| ## | 1st Qu.: | | 2.121 | 1st Qu.: | | 2.153 | 1st Qu.: | | 2.153 | 1st Qu.: | | 2.153 |
| ## | Median : | | 2.430 | Median : | | 2.461 | Median : | | 2.461 | Median : | | 2.461 |
| ## | Mean : | | 2.592 | Mean : | | 2.622 | Mean : | | 2.622 | Mean : | | 2.622 |
| ## | 3rd Qu.: | | 2.787 | 3rd Qu.: | | 2.814 | 3rd Qu.: | | 2.814 | 3rd Qu.: | | 2.814 |
| ## ## | Max. | :31.179  V75 | | Max. | :31.179  V76 | | Max. | :31.179  V77 | | Max. | :31.179  V78 | |
| ## | Min. | : 1.427 | | Min. | : 2.012 | | Min. | : 2.018 | | Min. | : 2.018 | |
| ## | 1st Qu.: | | 2.121 | 1st Qu.: | | 2.647 | 1st Qu.: | | 2.674 | 1st Qu.: | | 2.674 |
| ## | Median : | | 2.430 | Median : | | 2.883 | Median : | | 2.909 | Median : | | 2.909 |
| ## | Mean : | | 2.592 | Mean : | | 3.064 | Mean : | | 3.090 | Mean : | | 3.090 |
| ## | 3rd Qu.: | | 2.787 | 3rd Qu.: | | 3.202 | 3rd Qu.: | | 3.227 | 3rd Qu.: | | 3.227 |
| ## | Max. :31.179 | | | Max. :31.124 | | | Max. :31.124 | | | Max. :31.124 | | |
| ## | V79 | | | V80 | | | V81 | | | V82 | | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | Min. : | | 2.018 | Min. : | | 2.012 | Min. : | | | 1.714 | | Min. : | | | | 1.722 | | |
| ## | 1st Qu.: | | 2.674 | 1st Qu.: | | 2.647 | 1st Qu.: | | | 2.341 | | 1st Qu.: | | | | 2.368 | | |
| ## | Median : | | 2.909 | Median : | | 2.883 | Median : | | | 2.579 | | Median : | | | | 2.604 | | |
| ## | Mean : | | 3.090 | Mean : | | 3.064 | Mean : | | | 2.763 | | Mean : | | | | 2.788 | | |
| ## | 3rd Qu.: | | 3.227 | 3rd Qu.: | | 3.202 | 3rd Qu.: | | | 2.902 | | 3rd Qu.: | | | | 2.926 | | |
| ##  ## | Max. | :31.124  V83 | | Max. | :31.124  V84 | | Max. | :30.970  V85 | | | | Max. | | :30.970  V86 | | | | |
| ## | Min. | : 1.722 | | Min. | : 1.722 | | Min. | : 1.714 | | | | Min. | | : 1.712 | | | | |
| ## | 1st Qu.: | | 2.368 | 1st Qu.: | | 2.368 | 1st Qu.: | | | 2.341 | | 1st Qu.: | | | | 2.472 | | |
| ## | Median : | | 2.604 | Median : | | 2.604 | Median : | | | 2.579 | | Median : | | | | 2.731 | | |
| ## | Mean : | | 2.788 | Mean : | | 2.788 | Mean : | | | 2.763 | | Mean : | | | | 2.909 | | |
| ## | 3rd Qu.: | | 2.926 | 3rd Qu.: | | 2.926 | 3rd Qu.: | | | 2.902 | | 3rd Qu.: | | | | 3.068 | | |
| ##  ## | Max. | :30.970  V87 | | Max. | :30.970  V88 | | Max. | :30.970  V89 | | | | Max. | | :31.394  V90 | | | | |
| ## | Min. | : 1.760 | | Min. | : 1.760 | | Min. | : 1.760 | | | | Min. | | : 1.712 | | | | |
| ## | 1st Qu.: | | 2.497 | 1st Qu.: | | 2.497 | 1st Qu.: | | | 2.497 | | 1st Qu.: | | | | 2.472 | | |
| ## | Median : | | 2.756 | Median : | | 2.756 | Median : | | | 2.756 | | Median : | | | | 2.731 | | |
| ## | Mean : | | 2.933 | Mean : | | 2.933 | Mean : | | | 2.933 | | Mean : | | | | 2.909 | | |
| ## | 3rd Qu.: | | 3.091 | 3rd Qu.: | | 3.091 | 3rd Qu.: | | | 3.091 | | 3rd Qu.: | | | | 3.068 | | |
| ##  ## | Max. | :31.394  V91 | | Max. | :31.394  V92 | | Max. | :31.394  V93 | | | | Max. | | :31.394  V94 | | | | |
| ## | Min. | : 1.451 | | Min. | : 1.453 | | Min. | : 1.453 | | | | Min. | | : 1.453 | | | | |
| ## | 1st Qu.: | | 2.139 | 1st Qu.: | | 2.167 | 1st Qu.: | | | 2.167 | | 1st Qu.: | | | | 2.167 | | |
| ## | Median : | | 2.399 | Median : | | 2.426 | Median : | | | 2.426 | | Median : | | | | 2.426 | | |
| ## | Mean : | | 2.574 | Mean : | | 2.600 | Mean : | | | 2.600 | | Mean : | | | | 2.600 | | |
| ## | 3rd Qu.: | | 2.728 | 3rd Qu.: | | 2.752 | 3rd Qu.: | | | 2.752 | | 3rd Qu.: | | | | 2.752 | | |
| ##  ## | Max. | :30.862  V95 | | Max. | :30.862  V96 | | Max. | :30.862  V97 | | | | Max. | | | :30.862  V98 | | | |
| ## | Min. | : 1.451 | | Min. | : 0.1324 | | Min. | : 0.1730 | | | | Min. | | | : 0.1730 | | | |
| ## | 1st Qu.: | | 2.139 | 1st Qu.: | | 0.8280 | 1st Qu.: | | | 0.8512 | | 1st Qu.: | | | | | 0.8512 | |
| ## | Median : | | 2.399 | Median : | | 1.0691 | Median : | | | 1.0912 | | Median : | | | | | 1.0912 | |
| ## | Mean : | | 2.574 | Mean : | | 1.2589 | Mean : | | | 1.2811 | | Mean : | | | | | 1.2811 | |
| ## | 3rd Qu.: | | 2.728 | 3rd Qu.: | | 1.4022 | 3rd Qu.: | | | 1.4241 | | 3rd Qu.: | | | | | 1.4241 | |
| ##  ## | Max. | :30.862  V99 | | Max. | :29.8339  V100 | | Max. | :29.8339  V101 | | | | Max. | | | :29.8339  V102 | | | |
| ## | Min. | : 0.1730 | | Min. | : 0.173 | | Min. | : 0.00000 | | | | Min. | | | : 0.0000 | | | |
| ## | 1st Qu.: | | 0.8512 | 1st Qu.: | | 0.828 | 1st Qu.: | | | 0.09587 | | 1st Qu.: | | | | | 0.1038 | |
| ## | Median : | | 1.0912 | Median : | | 1.069 | Median : | | | 0.23625 | | Median : | | | | | 0.2447 | |
| ## | Mean : | | 1.2811 | Mean : | | 1.259 | Mean : | | | 0.48458 | | Mean : | | | | | 0.4935 | |
| ## | 3rd Qu.: | | 1.4241 | 3rd Qu.: | | 1.402 | 3rd Qu.: | | | 0.58040 | | 3rd Qu.: | | | | | 0.5900 | |
| ##  ## | Max. | :29.8339  V103 | | Max. | :29.834  V104 | | Max. | | :28.75524  V105 | | | | Max. | | | :28.7552  V106 | | |
| ## | Min. | : 0.0000 | | Min. | : 0.0000 | | Min. | | : 0.00000 | | | | Min. | | | : 1.480 | | |
| ## | 1st Qu.: | | 0.1038 | 1st Qu.: | | 0.1038 | 1st Qu.: | | | | 0.09589 | | 1st Qu.: | | | | | 2.332 |
| ## | Median : | | 0.2447 | Median : | | 0.2447 | Median : | | | | 0.23625 | | Median : | | | | | 2.643 |
| ## | Mean : | | 0.4935 | Mean : | | 0.4935 | Mean : | | | | 0.48465 | | Mean : | | | | | 2.803 |
| ## | 3rd Qu.: | | 0.5900 | 3rd Qu.: | | 0.5900 | 3rd Qu.: | | | | 0.58035 | | 3rd Qu.: | | | | | 2.997 |

## Max. :28.7552 Max. :28.7552 Max. :28.75524 Max. :31.328 ## V107 V108 V109 V110

## Min. : 1.496 Min. : 1.496 Min. : 1.496 Min. : 1.480

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| ## | 1st Qu.: | | 2.363 | 1st Qu.: | | 2.363 | 1st Qu.: | | 2.363 | 1st Qu.: | | 2.332 |
| ## | Median : | | 2.673 | Median : | | 2.673 | Median : | | 2.673 | Median : | | 2.643 |
| ## | Mean : | | 2.832 | Mean : | | 2.832 | Mean : | | 2.832 | Mean : | | 2.803 |
| ## | 3rd Qu.: | | 3.024 | 3rd Qu.: | | 3.024 | 3rd Qu.: | | 3.024 | 3rd Qu.: | | 2.997 |
| ## | Max. | :31.328 | | Max. | :31.328 | | Max. | :31.328 | | Max. | :31.328 | |
| ## |  | V111 | |  | V112 | |  | V113 | |  | V114 | |
| ## | Min. | : 1.591 | | Min. | : 1.596 | | Min. | : 1.596 | | Min. | : 1.596 | |
| ## | 1st Qu.: | | 2.228 | 1st Qu.: | | 2.255 | 1st Qu.: | | 2.255 | 1st Qu.: | | 2.255 |
| ## | Median : | | 2.492 | Median : | | 2.519 | Median : | | 2.519 | Median : | | 2.519 |
| ## | Mean : | | 2.667 | Mean : | | 2.693 | Mean : | | 2.693 | Mean : | | 2.693 |

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| ## | 3rd Qu.: 2.825 | | 3rd Qu.: 2.849 | 3rd Qu.: 2.849 | 3rd Qu.: 2.849 |
| ## | Max. :31.080 | | Max. :31.080 | Max. :31.080 | Max. :31.080 |
| ## | V115 | | V116 | V117 | V118 |
| ## | Min. : 1.591 | | Min. : 0.00 | Min. : 0.00 | Min. : 0.00 |
| ## | 1st Qu.: | 2.228 | 1st Qu.:13.99 | 1st Qu.:14.16 | 1st Qu.:14.16 |
| ## | Median : | 2.492 | Median :15.26 | Median :15.46 | Median :15.46 |
| ## | Mean : | 2.667 | Mean :15.22 | Mean :15.38 | Mean :15.38 |
| ## | 3rd Qu.: | 2.825 | 3rd Qu.:16.55 | 3rd Qu.:16.71 | 3rd Qu.:16.71 |

## Max. :31.080 Max. :21.18 Max. :21.18 Max. :21.18 ## V119 V120 V121 V122

## Min. : 0.00 Min. : 0.00 Min. : 1.766 Min. : 1.784

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| ## | 1st Qu.:14.16 | 1st Qu.:13.99 | 1st Qu.: | 2.408 | 1st Qu.: | 2.443 |
| ## | Median :15.46 | Median :15.26 | Median : | 2.727 | Median : | 2.762 |
| ## | Mean :15.38 | Mean :15.22 | Mean : | 2.883 | Mean : | 2.916 |
| ## | 3rd Qu.:16.71 | 3rd Qu.:16.55 | 3rd Qu.: | 3.079 | 3rd Qu.: | 3.109 |

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| ## Max. :21.18 Max. :21.18 Max. | | | | | | | | :31.381 | | Max. | :31.381 | |
| ## V123 V124 | | | | | | | | V125 | |  | V126 | |
| ## Min. : 1.784 Min. : 1.784 Min. | | | | | | | | : | 1.766 | Min. | : | 0.9736 |
| ## | 1st Qu.: | | 2.443 | 1st Qu.: | | 2.443 | 1st Qu.: | | 2.408 | 1st Qu.: | | 1.4141 |
| ## | Median : | | 2.762 | Median : | | 2.762 | Median : | | 2.727 | Median : | | 1.5857 |
| ## | Mean : | | 2.916 | Mean : | | 2.916 | Mean : | | 2.883 | Mean : | | 1.7983 |
| ## | 3rd Qu.: | | 3.109 | 3rd Qu.: | | 3.109 | 3rd Qu.: | | 3.079 | 3rd Qu.: | | 1.9024 |
| ## | Max. | :31.381 | | Max. | :31.381 | | Max. | :31.381 | | Max. | :29.5175 | |
| ## |  | V127 | |  | V128 | |  | V129 | |  | V130 | |
| ## | Min. | : 0.975 | | Min. | : 0.975 | | Min. | : 0.975 | | Min. | : 0.9736 | |
| ## | 1st Qu.: | | 1.428 | 1st Qu.: | | 1.428 | 1st Qu.: | | 1.428 | 1st Qu.: | | 1.4141 |
| ## | Median : | | 1.598 | Median : | | 1.598 | Median : | | 1.598 | Median : | | 1.5857 |
| ## | Mean : | | 1.812 | Mean : | | 1.812 | Mean : | | 1.812 | Mean : | | 1.7983 |
| ## | 3rd Qu.: | | 1.917 | 3rd Qu.: | | 1.917 | 3rd Qu.: | | 1.917 | 3rd Qu.: | | 1.9023 |
| ## | Max. | :29.518 | | Max. | :29.518 | | Max. | :29.518 | | Max. | :29.5175 | |
| ##  ## | Min. | V131  : 1.175 | | Min. | V132  : 1.190 | | Min. | V133  : 1.190 | | Min. | V134  : 1.190 | |
| ## | 1st Qu.: | | 1.916 | 1st Qu.: | | 1.939 | 1st Qu.: | | 1.939 | 1st Qu.: | | 1.939 |
| ## | Median : | | 2.148 | Median : | | 2.168 | Median : | | 2.168 | Median : | | 2.168 |
| ## | Mean : | | 2.342 | Mean : | | 2.363 | Mean : | | 2.363 | Mean : | | 2.363 |
| ## | 3rd Qu.: | | 2.479 | 3rd Qu.: | | 2.500 | 3rd Qu.: | | 2.500 | 3rd Qu.: | | 2.500 |
| ## | Max. | :31.248 | | Max. | :31.248 | | Max. | :31.248 | | Max. | :31.248 | |
| ##  ## | Min. | V135  : 1.175 | | Min. | V136  : 2.083 | | Min. | V137  : 2.093 | | Min. | V138  : 2.093 | |
| ## | 1st Qu.: | | 1.916 | 1st Qu.: | | 2.748 | 1st Qu.: | | 2.781 | 1st Qu.: | | 2.781 |
| ## | Median : | | 2.148 | Median : | | 3.054 | Median : | | 3.087 | Median : | | 3.087 |
| ## | Mean : | | 2.342 | Mean : | | 3.214 | Mean : | | 3.245 | Mean : | | 3.245 |
| ## | 3rd Qu.: | | 2.479 | 3rd Qu.: | | 3.403 | 3rd Qu.: | | 3.432 | 3rd Qu.: | | 3.432 |
| ## | Max. | :31.248 | | Max. | :31.436 | | Max. | :31.436 | | Max. | :31.436 | |
| ##  ## | Min. | V139  : 2.093 | | Min. | V140  : 2.083 | | Min. | V141  : 1.452 | | Min. | V142  : 1.462 | |
| ## | 1st Qu.: | | 2.781 | 1st Qu.: | | 2.748 | 1st Qu.: | | 2.107 | 1st Qu.: | | 2.131 |
| ## | Median : | | 3.087 | Median : | | 3.054 | Median : | | 2.340 | Median : | | 2.362 |
| ## | Mean : | | 3.245 | Mean : | | 3.214 | Mean : | | 2.524 | Mean : | | 2.547 |
| ## | 3rd Qu.: | | 3.432 | 3rd Qu.: | | 3.403 | 3rd Qu.: | | 2.663 | 3rd Qu.: | | 2.685 |
| ## | Max. | :31.436 | | Max. | :31.436 | | Max. | :30.691 | | Max. | :30.691 | |
| ##  ## | Min. | V143  : 1.462 | | Min. | V144  : 1.462 | | Min. | V145  : 1.452 | | Min. | V146  : 0.00 | |
| ## | 1st Qu.: | | 2.131 | 1st Qu.: | | 2.131 | 1st Qu.: | | 2.107 | 1st Qu.:13.52 | | |
| ## | Median : | | 2.362 | Median : | | 2.362 | Median : | | 2.340 | Median :14.86 | | |
| ## | Mean : | | 2.547 | Mean : | | 2.547 | Mean : | | 2.524 | Mean :14.82 | | |
| ## | 3rd Qu.: | | 2.685 | 3rd Qu.: | | 2.685 | 3rd Qu.: | | 2.663 | 3rd Qu.:16.22 | | |

## Max. :30.691 Max. :30.691 Max. :30.691 Max. :20.73 ## V147 V148 V149 V150

## Min. : 0.00 Min. : 0.00 Min. : 0.00 Min. : 0.00

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| ##  ## | 1st Qu.:13.70  Median :15.06 | | | 1st Qu.:13.70  Median :15.06 | | | 1st Qu.:13.70  Median :15.06 | | | 1st Qu.:13.52  Median :14.86 | | |
| ## Mean :14.99 Mean :14.99 Mean :14.99  ## 3rd Qu.:16.39 3rd Qu.:16.39 3rd Qu.:16.39 | | | | | | | | | | Mean :14.82  3rd Qu.:16.22 | | |
| ## Max. :20.73 Max. :20.73 Max. | | | | | | | | :20.73 | | Max. | :20.73 | |
| ## V151 V152 | | | | | | | | V153 | |  | V154 | |
| ## Min. : 1.517 Min. : 1.524 Min. | | | | | | | | : | 1.524 | Min. | : | 1.524 |
| ## | 1st Qu.: | | 2.131 | 1st Qu.: | | 2.160 | 1st Qu.: | | 2.160 | 1st Qu.: | | 2.160 |
| ## | Median : | | 2.404 | Median : | | 2.432 | Median : | | 2.432 | Median : | | 2.432 |
| ## | Mean : | | 2.576 | Mean : | | 2.604 | Mean : | | 2.604 | Mean : | | 2.604 |
| ## | 3rd Qu.: | | 2.740 | 3rd Qu.: | | 2.766 | 3rd Qu.: | | 2.766 | 3rd Qu.: | | 2.766 |
| ## | Max. | :31.077 | | Max. | :31.077 | | Max. | :31.077 | | Max. | :31.077 | |
| ##  ## | Min. | V155  : 1.517 | | Min. | V156  : 1.306 | | Min. | V157  : 1.314 | | Min. | V158  : 1.314 | |
| ## | 1st Qu.: | | 2.131 | 1st Qu.: | | 2.237 | 1st Qu.: | | 2.259 | 1st Qu.: | | 2.259 |
| ## | Median : | | 2.404 | Median : | | 2.441 | Median : | | 2.461 | Median : | | 2.461 |
| ## | Mean : | | 2.576 | Mean : | | 2.641 | Mean : | | 2.662 | Mean : | | 2.662 |
| ## | 3rd Qu.: | | 2.740 | 3rd Qu.: | | 2.764 | 3rd Qu.: | | 2.785 | 3rd Qu.: | | 2.785 |
| ## | Max. | :31.077 | | Max. | :30.892 | | Max. | :30.892 | | Max. | :30.892 | |
| ##  ## | Min. | V159  : 1.314 | | Min. | V160  : 1.306 | |  |  | |  |  | |
| ## | 1st Qu.: | | 2.259 | 1st Qu.: | | 2.237 | | | | | | |
| ## | Median : | | 2.461 | Median : | | 2.441 | | | | | | |
| ## | Mean : | | 2.662 | Mean : | | 2.641 | | | | | | |
| ## | 3rd Qu.: | | 2.785 | 3rd Qu.: | | 2.764 | | | | | | |
| ## | Max. | :30.892 | | Max. | :30.892 | | | | | | | |

summary(flattened\_data)*## dataha too ranega an scaleled ok*

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| ## |  | V1 |  |  | V2 |  |  | V3 |  |  | V4 |  |
| ## | Min. | : | 1.545 | Min. | : | 1.550 | Min. | : | 1.550 | Min. | : | 1.550 |
| ## | 1st Qu.: | | 2.265 | 1st Qu.: | | 2.290 | 1st Qu.: | | 2.290 | 1st Qu.: | | 2.290 |
| ## | Median : | | 2.483 | Median : | | 2.506 | Median : | | 2.506 | Median : | | 2.506 |
| ## | Mean : | | 2.676 | Mean : | | 2.700 | Mean : | | 2.700 | Mean : | | 2.700 |
| ## | 3rd Qu.: | | 2.806 | 3rd Qu.: | | 2.830 | 3rd Qu.: | | 2.830 | 3rd Qu.: | | 2.830 |
| ## ## | Max. | :30.945  V5 | | Max. | :30.945  V6 | | Max. | :30.945  V7 | | Max. | :30.945  V8 | |
| ## | Min. | : 1.545 | | Min. | : 1.032 | | Min. | : 1.070 | | Min. | : 1.070 | |
| ## | 1st Qu.: | | 2.265 | 1st Qu.: | | 1.608 | 1st Qu.: | | 1.635 | 1st Qu.: | | 1.635 |
| ## | Median : | | 2.483 | Median : | | 1.862 | Median : | | 1.887 | Median : | | 1.887 |
| ## | Mean : | | 2.676 | Mean : | | 2.039 | Mean : | | 2.064 | Mean : | | 2.064 |
| ## | 3rd Qu.: | | 2.806 | 3rd Qu.: | | 2.188 | 3rd Qu.: | | 2.211 | 3rd Qu.: | | 2.211 |
| ## ## | Max. | :30.945  V9 | | Max. | :30.287  V10 | | Max. | :30.287  V11 | | Max. | :30.287  V12 | |
| ## | Min. | : 1.070 | | Min. | : 1.032 | | Min. | : 1.572 | | Min. | : 1.575 | |
| ## | 1st Qu.: | | 1.635 | 1st Qu.: | | 1.608 | 1st Qu.: | | 2.089 | 1st Qu.: | | 2.110 |
| ## | Median : | | 1.887 | Median : | | 1.862 | Median : | | 2.289 | Median : | | 2.309 |
| ## | Mean : | | 2.064 | Mean : | | 2.039 | Mean : | | 2.496 | Mean : | | 2.516 |
| ## | 3rd Qu.: | | 2.211 | 3rd Qu.: | | 2.188 | 3rd Qu.: | | 2.615 | 3rd Qu.: | | 2.636 |
| ## | Max. | :30.287 | | Max. | :30.287 | | Max. | :31.147 | | Max. | :31.147 | |
| ## |  | V13 | |  | V14 | |  | V15 | |  | V16 | |
| ## | Min. | : 1.575 | | Min. | : 1.575 | | Min. | : 1.572 | | Min. | : 2.182 | |
| ## | 1st Qu.: | | 2.110 | 1st Qu.: | | 2.110 | 1st Qu.: | | 2.089 | 1st Qu.: | | 2.904 |
| ## | Median : | | 2.309 | Median : | | 2.309 | Median : | | 2.289 | Median : | | 3.219 |
| ## | Mean : | | 2.516 | Mean : | | 2.516 | Mean : | | 2.496 | Mean : | | 3.375 |
| ## | 3rd Qu.: | | 2.636 | 3rd Qu.: | | 2.636 | 3rd Qu.: | | 2.615 | 3rd Qu.: | | 3.573 |
| ## | Max. | :31.147 | | Max. | :31.147 | | Max. | :31.147 | | Max. | :31.698 | |
| ## |  | V17 | |  | V18 | |  | V19 | |  | V20 | |
| ## | Min. | : 2.186 | | Min. | : 2.186 | | Min. | : 2.186 | | Min. | : 2.182 | |

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| ## | 1st Qu.: | | 2.942 | 1st Qu.: | | 2.942 | 1st Qu.: | | 2.942 | 1st Qu.: | | 2.904 |
| ## | Median : | | 3.257 | Median : | | 3.257 | Median : | | 3.257 | Median : | | 3.219 |
| ## | Mean : | | 3.410 | Mean : | | 3.410 | Mean : | | 3.410 | Mean : | | 3.375 |
| ## | 3rd Qu.: | | 3.605 | 3rd Qu.: | | 3.605 | 3rd Qu.: | | 3.605 | 3rd Qu.: | | 3.573 |
| ## | Max. | :31.698 | | Max. | :31.698 | | Max. | :31.698 | | Max. | :31.698 | |
| ##  ## | Min. | V21  : 1.310 | | Min. | V22  : 1.314 | | Min. | V23  : 1.314 | | Min. | V24  : 1.314 | |
| ## | 1st Qu.: | | 2.044 | 1st Qu.: | | 2.074 | 1st Qu.: | | 2.074 | 1st Qu.: | | 2.074 |
| ## | Median : | | 2.351 | Median : | | 2.381 | Median : | | 2.381 | Median : | | 2.381 |
| ## Mean : 2.514 Mean : 2.543 | | | | | | | Mean | : | 2.543 Mean : 2.543 | | | |
| ## 3rd Qu.: 2.707 3rd Qu.: 2.733 | | | | | | | 3rd | Qu.: | 2.733 3rd Qu.: 2.733 | | | |

## Max. :30.948 Max. :30.948 Max. :30.948 Max. :30.948

## V25 V26 V27 V28 V29 V30 ## Min. : 1.310 Min. :0 Min. :0 Min. :0 Min. :0 Min. :0

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| ## | 1st Qu.: | 2.044 | 1st Qu.:0 | 1st Qu.:0 | 1st Qu.:0 | 1st Qu.:0 | 1st Qu.:0 |
| ## | Median : | 2.351 | Median :0 | Median :0 | Median :0 | Median :0 | Median :0 |

## Mean : 2.514 Mean :0 Mean :0 Mean :0 Mean :0 Mean :0 ## 3rd Qu.: 2.707 3rd Qu.:0 3rd Qu.:0 3rd Qu.:0 3rd Qu.:0 3rd Qu.:0 ## Max. :30.948 Max. :0 Max. :0 Max. :0 Max. :0 Max. :0 ## V31 V32 V33 V34

## Min. : 1.250 Min. : 1.274 Min. : 1.274 Min. : 1.274

1st Qu.: 1.874 1st Qu.: 1.874

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| ## | 1st Qu.: | 1.847 | 1st Qu.: | 1.874 |
| ## | Median : | 2.109 | Median : | 2.135 |

Median : 2.135 Median : 2.135

## Mean : 2.286 Mean : 2.312 Mean : 2.312 Mean : 2.312

## 3rd Qu.: 2.442 3rd Qu.: 2.467 3rd Qu.: 2.467 3rd Qu.: 2.467

## Max. :30.819 Max. :30.819 Max. :30.819 Max. :30.819 ## V35 V36 V37 V38

## Min. : 1.250 Min. : 1.258 Min. : 1.273 Min. : 1.273

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| ## | 1st Qu.: | | 1.847 | 1st Qu.: | | 2.188 | 1st Qu.: | | 2.221 | 1st Qu.: | | 2.221 |
| ## | Median : | | 2.109 | Median : | | 2.509 | Median : | | 2.541 | Median : | | 2.541 |
| ## | Mean : | | 2.286 | Mean : | | 2.665 | Mean : | | 2.695 | Mean : | | 2.695 |
| ## | 3rd Qu.: | | 2.442 | 3rd Qu.: | | 2.871 | 3rd Qu.: | | 2.899 | 3rd Qu.: | | 2.899 |
| ## | Max. | :30.819 | | Max. | :31.167 | | Max. | :31.167 | | Max. | :31.167 | |
| ##  ## | Min. | V39  : 1.273 | | Min. | V40  : 1.258 | | Min. | V41  : 0.0000 | | Min. | V42  : 0.0000 | |
| ## | 1st Qu.: | | 2.221 | 1st Qu.: | | 2.188 | 1st Qu.: | | 0.1014 | 1st Qu.: | | 0.1105 |
| ## | Median : | | 2.541 | Median : | | 2.509 | Median : | | 0.2445 | Median : | | 0.2543 |
| ## | Mean : | | 2.695 | Mean : | | 2.665 | Mean : | | 0.4946 | Mean : | | 0.5045 |
| ## | 3rd Qu.: | | 2.899 | 3rd Qu.: | | 2.871 | 3rd Qu.: | | 0.5923 | 3rd Qu.: | | 0.6034 |
| ## Max. :31.167 Max. :31.167 Max. | | | | | | | | :29.0143 | | Max. | :29.0143 | |
| ## V43 V44 | | | | | | | | V45 | |  | V46 | |

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| ## Min. : 0.0000 Min. : 0.0000 Min. | | | | | | : | 0.0000 | Min. | : | 1.517 |
| ## | 1st Qu.: | 0.1105 | 1st Qu.: | 0.1105 | 1st Qu.: | | 0.1010 | 1st Qu.: | | 2.287 |
| ## | Median : | 0.2543 | Median : | 0.2543 | Median : | | 0.2444 | Median : | | 2.603 |
| ## | Mean : | 0.5045 | Mean : | 0.5045 | Mean : | | 0.4943 | Mean : | | 2.764 |
| ## | 3rd Qu.: | 0.6034 | 3rd Qu.: | 0.6034 | 3rd Qu.: | | 0.5922 | 3rd Qu.: | | 2.961 |

## Max. :29.0143 Max. :29.0143 Max. :29.0143 Max. :31.517 ## V47 V48 V49 V50

## Min. : 1.530 Min. : 1.530 Min. : 1.530 Min. : 1.517

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| ## | 1st Qu.: | 2.324 | 1st Qu.: | 2.324 | 1st Qu.: | 2.324 | 1st Qu.: | 2.287 |
| ## | Median : | 2.639 | Median : | 2.639 | Median : | 2.639 | Median : | 2.603 |
| ## | Mean : | 2.798 | Mean : | 2.798 | Mean : | 2.798 | Mean : | 2.764 |
| ## | 3rd Qu.: | 2.992 | 3rd Qu.: | 2.992 | 3rd Qu.: | 2.992 | 3rd Qu.: | 2.961 |

## Max. :31.517 Max. :31.517 Max. :31.517 Max. :31.517 ## V51 V52 V53 V54

## Min. : 0.6825 Min. : 0.6872 Min. : 0.6872 Min. : 0.6872

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| ## | 1st Qu.: | 1.5748 | 1st Qu.: | 1.5986 | 1st Qu.: | 1.5986 | 1st Qu.: | 1.5986 |
| ## | Median : | 1.7743 | Median : | 1.7946 | Median : | 1.7946 | Median : | 1.7946 |
| ## | Mean : | 1.9826 | Mean : | 2.0048 | Mean : | 2.0048 | Mean : | 2.0048 |
| ## | 3rd Qu.: | 2.1049 | 3rd Qu.: | 2.1269 | 3rd Qu.: | 2.1269 | 3rd Qu.: | 2.1269 |

## Max. :30.5721 Max. :30.5721 Max. :30.5721 Max. :30.5721 ## V55 V56 V57 V58

## Min. : 0.6825 Min. : 1.614 Min. : 1.616 Min. : 1.616

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| ## | 1st Qu.: | 1.5748 | 1st Qu.: | 2.324 | 1st Qu.: | 2.353 | 1st Qu.: | 2.353 |
| ## | Median : | 1.7743 | Median : | 2.613 | Median : | 2.641 | Median : | 2.641 |
| ## | Mean : | 1.9826 | Mean : | 2.776 | Mean : | 2.803 | Mean : | 2.803 |
| ## | 3rd Qu.: | 2.1049 | 3rd Qu.: | 2.951 | 3rd Qu.: | 2.976 | 3rd Qu.: | 2.976 |

## Max. :30.5721 Max. :30.770 Max. :30.770 Max. :30.770

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| ## V59 V60  ## Min. : 1.616 Min. : | | | | | | 1.614 | V61  Min. : | | 1.294 | V62  Min. : | | 1.302 |
| ## | 1st Qu.: | | 2.353 | 1st Qu.: | | 2.324 | 1st Qu.: | | 2.078 | 1st Qu.: | | 2.105 |
| ## | Median : | | 2.641 | Median : | | 2.613 | Median : | | 2.293 | Median : | | 2.317 |
| ## | Mean : | | 2.803 | Mean : | | 2.776 | Mean : | | 2.490 | Mean : | | 2.515 |
| ## | 3rd Qu.: | | 2.976 | 3rd Qu.: | | 2.951 | 3rd Qu.: | | 2.619 | 3rd Qu.: | | 2.644 |
| ## ## | Max. | :30.770  V63 | | Max. | :30.770  V64 | | Max. | :30.842  V65 | | Max. | :30.842  V66 | |
| ## | Min. | : 1.302 | | Min. | : 1.302 | | Min. | : 1.294 | | Min. | : 1.197 | |
| ## | 1st Qu.: | | 2.105 | 1st Qu.: | | 2.105 | 1st Qu.: | | 2.078 | 1st Qu.: | | 1.858 |
| ## | Median : | | 2.317 | Median : | | 2.317 | Median : | | 2.293 | Median : | | 2.159 |
| ## | Mean : | | 2.515 | Mean : | | 2.515 | Mean : | | 2.490 | Mean : | | 2.322 |
| ## | 3rd Qu.: | | 2.644 | 3rd Qu.: | | 2.644 | 3rd Qu.: | | 2.619 | 3rd Qu.: | | 2.508 |
| ## ## | Max. | :30.842  V67 | | Max. | :30.842  V68 | | Max. | :30.842  V69 | | Max. | :30.849  V70 | |
| ## | Min. | : 1.232 | | Min. | : 1.232 | | Min. | : 1.232 | | Min. | : 1.197 | |
| ## | 1st Qu.: | | 1.888 | 1st Qu.: | | 1.888 | 1st Qu.: | | 1.888 | 1st Qu.: | | 1.858 |
| ## | Median : | | 2.189 | Median : | | 2.189 | Median : | | 2.189 | Median : | | 2.159 |
| ## | Mean : | | 2.350 | Mean : | | 2.350 | Mean : | | 2.350 | Mean : | | 2.322 |
| ## | 3rd Qu.: | | 2.533 | 3rd Qu.: | | 2.533 | 3rd Qu.: | | 2.533 | 3rd Qu.: | | 2.508 |
| ## ## | Max. | :30.849  V71 | | Max. | :30.849  V72 | | Max. | :30.849  V73 | | Max. | :30.849  V74 | |
| ## | Min. | : 1.427 | | Min. | : 1.432 | | Min. | : 1.432 | | Min. | : 1.432 | |
| ## | 1st Qu.: | | 2.121 | 1st Qu.: | | 2.153 | 1st Qu.: | | 2.153 | 1st Qu.: | | 2.153 |
| ## | Median : | | 2.430 | Median : | | 2.461 | Median : | | 2.461 | Median : | | 2.461 |
| ## | Mean : | | 2.592 | Mean : | | 2.622 | Mean : | | 2.622 | Mean : | | 2.622 |
| ## | 3rd Qu.: | | 2.787 | 3rd Qu.: | | 2.814 | 3rd Qu.: | | 2.814 | 3rd Qu.: | | 2.814 |
| ## ## | Max. | :31.179  V75 | | Max. | :31.179  V76 | | Max. | :31.179  V77 | | Max. | :31.179  V78 | |
| ## | Min. | : 1.427 | | Min. | : 2.012 | | Min. | : 2.018 | | Min. | : 2.018 | |
| ## | 1st Qu.: | | 2.121 | 1st Qu.: | | 2.647 | 1st Qu.: | | 2.674 | 1st Qu.: | | 2.674 |
| ## | Median : | | 2.430 | Median : | | 2.883 | Median : | | 2.909 | Median : | | 2.909 |
| ## | Mean : | | 2.592 | Mean : | | 3.064 | Mean : | | 3.090 | Mean : | | 3.090 |
| ## | 3rd Qu.: | | 2.787 | 3rd Qu.: | | 3.202 | 3rd Qu.: | | 3.227 | 3rd Qu.: | | 3.227 |
| ## ## | Max. | :31.179  V79 | | Max. | :31.124  V80 | | Max. | :31.124  V81 | | Max. | :31.124  V82 | |
| ## | Min. | : 2.018 | | Min. | : 2.012 | | Min. | : 1.714 | | Min. | : 1.722 | |
| ## | 1st Qu.: | | 2.674 | 1st Qu.: | | 2.647 | 1st Qu.: | | 2.341 | 1st Qu.: | | 2.368 |
| ## | Median : | | 2.909 | Median : | | 2.883 | Median : | | 2.579 | Median : | | 2.604 |
| ## | Mean : | | 3.090 | Mean : | | 3.064 | Mean : | | 2.763 | Mean : | | 2.788 |
| ## | 3rd Qu.: | | 3.227 | 3rd Qu.: | | 3.202 | 3rd Qu.: | | 2.902 | 3rd Qu.: | | 2.926 |
| ## ## | Max. | :31.124  V83 | | Max. | :31.124  V84 | | Max. | :30.970  V85 | | Max. | :30.970  V86 | |
| ## | Min. | : 1.722 | | Min. | : 1.722 | | Min. | : 1.714 | | Min. | : 1.712 | |
| ## | 1st Qu.: | | 2.368 | 1st Qu.: | | 2.368 | 1st Qu.: | | 2.341 | 1st Qu.: | | 2.472 |
| ## | Median : | | 2.604 | Median : | | 2.604 | Median : | | 2.579 | Median : | | 2.731 |
| ## | Mean : | | 2.788 | Mean : | | 2.788 | Mean : | | 2.763 | Mean : | | 2.909 |
| ## | 3rd Qu.: | | 2.926 | 3rd Qu.: | | 2.926 | 3rd Qu.: | | 2.902 | 3rd Qu.: | | 3.068 |
| ## | Max. :30.970 | | | Max. :30.970 | | | Max. :30.970 | | | Max. :31.394 | | |
| ## | V87 | | | V88 | | | V89 | | | V90 | | |
| ## | Min. : 1.760 | | | Min. : 1.760 | | | Min. : 1.760 | | | Min. : 1.712 | | |
| ## | 1st Qu.: 2.497 | | | 1st Qu.: 2.497 | | | 1st Qu.: 2.497 | | | 1st Qu.: 2.472 | | |

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| ## | Median : | | 2.756 | Median : | | 2.756 | Median : | | | 2.756 | | Median : | | | | 2.731 | | |
| ## | Mean : | | 2.933 | Mean : | | 2.933 | Mean : | | | 2.933 | | Mean : | | | | 2.909 | | |
| ## | 3rd Qu.: | | 3.091 | 3rd Qu.: | | 3.091 | 3rd Qu.: | | | 3.091 | | 3rd Qu.: | | | | 3.068 | | |
| ##  ## | Max. | :31.394  V91 | | Max. | :31.394  V92 | | Max. | :31.394  V93 | | | | Max. | | :31.394  V94 | | | | |
| ## | Min. | : 1.451 | | Min. | : 1.453 | | Min. | : 1.453 | | | | Min. | | : 1.453 | | | | |
| ## | 1st Qu.: | | 2.139 | 1st Qu.: | | 2.167 | 1st Qu.: | | | 2.167 | | 1st Qu.: | | | | 2.167 | | |
| ## | Median : | | 2.399 | Median : | | 2.426 | Median : | | | 2.426 | | Median : | | | | 2.426 | | |
| ## | Mean : | | 2.574 | Mean : | | 2.600 | Mean : | | | 2.600 | | Mean : | | | | 2.600 | | |
| ## | 3rd Qu.: | | 2.728 | 3rd Qu.: | | 2.752 | 3rd Qu.: | | | 2.752 | | 3rd Qu.: | | | | 2.752 | | |
| ##  ## | Max. | :30.862  V95 | | Max. | :30.862  V96 | | Max. | :30.862  V97 | | | | Max. | | | :30.862  V98 | | | |
| ## | Min. | : 1.451 | | Min. | : 0.1324 | | Min. | : 0.1730 | | | | Min. | | | : 0.1730 | | | |
| ## | 1st Qu.: | | 2.139 | 1st Qu.: | | 0.8280 | 1st Qu.: | | | 0.8512 | | 1st Qu.: | | | | | 0.8512 | |
| ## | Median : | | 2.399 | Median : | | 1.0691 | Median : | | | 1.0912 | | Median : | | | | | 1.0912 | |
| ## | Mean : | | 2.574 | Mean : | | 1.2589 | Mean : | | | 1.2811 | | Mean : | | | | | 1.2811 | |
| ## | 3rd Qu.: | | 2.728 | 3rd Qu.: | | 1.4022 | 3rd Qu.: | | | 1.4241 | | 3rd Qu.: | | | | | 1.4241 | |
| ##  ## | Max. | :30.862  V99 | | Max. | :29.8339  V100 | | Max. | :29.8339  V101 | | | | Max. | | | :29.8339  V102 | | | |
| ## | Min. | : 0.1730 | | Min. | : 0.173 | | Min. | : 0.00000 | | | | Min. | | | : 0.0000 | | | |
| ## | 1st Qu.: | | 0.8512 | 1st Qu.: | | 0.828 | 1st Qu.: | | | 0.09587 | | 1st Qu.: | | | | | 0.1038 | |
| ## | Median : | | 1.0912 | Median : | | 1.069 | Median : | | | 0.23625 | | Median : | | | | | 0.2447 | |
| ## | Mean : | | 1.2811 | Mean : | | 1.259 | Mean : | | | 0.48458 | | Mean : | | | | | 0.4935 | |
| ## | 3rd Qu.: | | 1.4241 | 3rd Qu.: | | 1.402 | 3rd Qu.: | | | 0.58040 | | 3rd Qu.: | | | | | 0.5900 | |
| ##  ## | Max. | :29.8339  V103 | | Max. | :29.834  V104 | | Max. | | :28.75524  V105 | | | | Max. | | | :28.7552  V106 | | |
| ## | Min. | : 0.0000 | | Min. | : 0.0000 | | Min. | | : 0.00000 | | | | Min. | | | : 1.480 | | |
| ## | 1st Qu.: | | 0.1038 | 1st Qu.: | | 0.1038 | 1st Qu.: | | | | 0.09589 | | 1st Qu.: | | | | | 2.332 |
| ## | Median : | | 0.2447 | Median : | | 0.2447 | Median : | | | | 0.23625 | | Median : | | | | | 2.643 |
| ## | Mean : | | 0.4935 | Mean : | | 0.4935 | Mean : | | | | 0.48465 | | Mean : | | | | | 2.803 |
| ## | 3rd Qu.: | | 0.5900 | 3rd Qu.: | | 0.5900 | 3rd Qu.: | | | | 0.58035 | | 3rd Qu.: | | | | | 2.997 |

## Max. :28.7552 Max. :28.7552 Max. :28.75524 Max. :31.328 ## V107 V108 V109 V110

## Min. : 1.496 Min. : 1.496 Min. : 1.496 Min. : 1.480

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| ## | 1st Qu.: | | 2.363 | 1st Qu.: | | 2.363 | 1st Qu.: | | 2.363 | 1st Qu.: | | 2.332 |
| ## | Median : | | 2.673 | Median : | | 2.673 | Median : | | 2.673 | Median : | | 2.643 |
| ## | Mean : | | 2.832 | Mean : | | 2.832 | Mean : | | 2.832 | Mean : | | 2.803 |
| ## | 3rd Qu.: | | 3.024 | 3rd Qu.: | | 3.024 | 3rd Qu.: | | 3.024 | 3rd Qu.: | | 2.997 |
| ## | Max. | :31.328 | | Max. | :31.328 | | Max. | :31.328 | | Max. | :31.328 | |
| ## |  | V111 | |  | V112 | |  | V113 | |  | V114 | |
| ## | Min. | : 1.591 | | Min. | : 1.596 | | Min. | : 1.596 | | Min. | : 1.596 | |
| ## | 1st Qu.: | | 2.228 | 1st Qu.: | | 2.255 | 1st Qu.: | | 2.255 | 1st Qu.: | | 2.255 |
| ## | Median : | | 2.492 | Median : | | 2.519 | Median : | | 2.519 | Median : | | 2.519 |
| ## | Mean : | | 2.667 | Mean : | | 2.693 | Mean : | | 2.693 | Mean : | | 2.693 |
| ## | 3rd Qu.: | | 2.825 | 3rd Qu.: | | 2.849 | 3rd Qu.: | | 2.849 | 3rd Qu.: | | 2.849 |

## Max. :31.080 Max. :31.080 Max. :31.080 Max. :31.080 ## V115 V116 V117 V118

## Min. : 1.591 Min. : 0.00 Min. : 0.00 Min. : 0.00

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| ## | 1st Qu.: | 2.228 | 1st Qu.:13.99 | 1st Qu.:14.16 | 1st Qu.:14.16 |
| ## | Median : | 2.492 | Median :15.26 | Median :15.46 | Median :15.46 |
| ## | Mean : | 2.667 | Mean :15.22 | Mean :15.38 | Mean :15.38 |
| ## | 3rd Qu.: | 2.825 | 3rd Qu.:16.55 | 3rd Qu.:16.71 | 3rd Qu.:16.71 |

## Max. :31.080 Max. :21.18 Max. :21.18 Max. :21.18 ## V119 V120 V121 V122

## Min. : 0.00 Min. : 0.00 Min. : 1.766 Min. : 1.784

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| ## | 1st Qu.:14.16 | | 1st Qu.:13.99 | | 1st Qu.: | | 2.408 | 1st Qu.: | | 2.443 |
| ## | Median :15.46 | | Median :15.26 | | Median : | | 2.727 | Median : | | 2.762 |
| ## | Mean :15.38 | | Mean :15.22 | | Mean : | | 2.883 | Mean : | | 2.916 |
| ## | 3rd Qu.:16.71 | | 3rd Qu.:16.55 | | 3rd Qu.: | | 3.079 | 3rd Qu.: | | 3.109 |
| ## | Max. | :21.18 | Max. | :21.18 | Max. | :31.381 | | Max. | :31.381 | |

## V123 V124 V125 V126

## Min. : 1.784 Min. : 1.784 Min. : 1.766 Min. : 0.9736

## 1st Qu.: 2.443 1st Qu.: 2.443 1st Qu.: 2.408 1st Qu.: 1.4141

## Median : 2.762 Median : 2.762 Median : 2.727 Median : 1.5857

## Mean : 2.916 Mean : 2.916 Mean : 2.883 Mean : 1.7983

## 3rd Qu.: 3.109 3rd Qu.: 3.109 3rd Qu.: 3.079 3rd Qu.: 1.9024

## Max. :31.381 Max. :31.381 Max. :31.381 Max. :29.5175 ## V127 V128 V129 V130

## Min. : 0.975 Min. : 0.975 Min. : 0.975 Min. : 0.9736

## 1st Qu.: 1.428 1st Qu.: 1.428 1st Qu.: 1.428 1st Qu.: 1.4141

## Median : 1.598 Median : 1.598 Median : 1.598 Median : 1.5857

## Mean : 1.812 Mean : 1.812 Mean : 1.812 Mean : 1.7983

## 3rd Qu.: 1.917 3rd Qu.: 1.917 3rd Qu.: 1.917 3rd Qu.: 1.9023

## Max. :29.518 Max. :29.518 Max. :29.518 Max. :29.5175 ## V131 V132 V133 V134

## Min. : 1.175 Min. : 1.190 Min. : 1.190 Min. : 1.190

## 1st Qu.: 1.916 1st Qu.: 1.939 1st Qu.: 1.939 1st Qu.: 1.939

## Median : 2.148 Median : 2.168 Median : 2.168 Median : 2.168

## Mean : 2.342 Mean : 2.363 Mean : 2.363 Mean : 2.363

## 3rd Qu.: 2.479 3rd Qu.: 2.500 3rd Qu.: 2.500 3rd Qu.: 2.500

## Max. :31.248 Max. :31.248 Max. :31.248 Max. :31.248 ## V135 V136 V137 V138

## Min. : 1.175 Min. : 2.083 Min. : 2.093 Min. : 2.093

## 1st Qu.: 1.916 1st Qu.: 2.748 1st Qu.: 2.781 1st Qu.: 2.781

## Median : 2.148 Median : 3.054 Median : 3.087 Median : 3.087

## Mean : 2.342 Mean : 3.214 Mean : 3.245 Mean : 3.245

## 3rd Qu.: 2.479 3rd Qu.: 3.403 3rd Qu.: 3.432 3rd Qu.: 3.432

## Max. :31.248 Max. :31.436 Max. :31.436 Max. :31.436 ## V139 V140 V141 V142

## Min. : 2.093 Min. : 2.083 Min. : 1.452 Min. : 1.462

## 1st Qu.: 2.781 1st Qu.: 2.748 1st Qu.: 2.107 1st Qu.: 2.131

## Median : 3.087 Median : 3.054 Median : 2.340 Median : 2.362

## Mean : 3.245 Mean : 3.214 Mean : 2.524 Mean : 2.547

## 3rd Qu.: 3.432 3rd Qu.: 3.403 3rd Qu.: 2.663 3rd Qu.: 2.685

## Max. :31.436 Max. :31.436 Max. :30.691 Max. :30.691 ## V143 V144 V145 V146

## Min. : 1.462 Min. : 1.462 Min. : 1.452 Min. : 0.00

## 1st Qu.: 2.131 1st Qu.: 2.131 1st Qu.: 2.107 1st Qu.:13.52

## Median : 2.362 Median : 2.362 Median : 2.340 Median :14.86

## Mean : 2.547 Mean : 2.547 Mean : 2.524 Mean :14.82 ## 3rd Qu.: 2.685 3rd Qu.: 2.685 3rd Qu.: 2.663 3rd Qu.:16.22 ## Max. :30.691 Max. :30.691 Max. :30.691 Max. :20.73 ## V147 V148 V149 V150

## Min. : 0.00 Min. : 0.00 Min. : 0.00 Min. : 0.00

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| ##  ## | 1st Qu.:13.70  Median :15.06 | | | 1st Qu.:13.70  Median :15.06 | | | 1st Qu.:13.70  Median :15.06 | | | 1st Qu.:13.52  Median :14.86 | | |
| ## Mean :14.99 Mean :14.99 Mean :14.99 ## 3rd Qu.:16.39 3rd Qu.:16.39 3rd Qu.:16.39 | | | | | | | | | | Mean :14.82 3rd Qu.:16.22 | | |
| ## Max. :20.73 Max. :20.73 Max. | | | | | | | | :20.73 | | Max. | :20.73 | |
| ## V151 V152 | | | | | | | | V153 | |  | V154 | |
| ## Min. : 1.517 Min. : 1.524 Min. | | | | | | | | : | 1.524 | Min. | : | 1.524 |
| ## | 1st Qu.: | | 2.131 | 1st Qu.: | | 2.160 | 1st Qu.: | | 2.160 | 1st Qu.: | | 2.160 |
| ## | Median : | | 2.404 | Median : | | 2.432 | Median : | | 2.432 | Median : | | 2.432 |
| ## | Mean : | | 2.576 | Mean : | | 2.604 | Mean : | | 2.604 | Mean : | | 2.604 |
| ## | 3rd Qu.: | | 2.740 | 3rd Qu.: | | 2.766 | 3rd Qu.: | | 2.766 | 3rd Qu.: | | 2.766 |
| ## | Max. | :31.077 | | Max. | :31.077 | | Max. | :31.077 | | Max. | :31.077 | |
| ##  ## | Min. | V155  : 1.517 | | Min. | V156  : 1.306 | | Min. | V157  : 1.314 | | Min. | V158  : 1.314 | |
| ## | 1st Qu.: | | 2.131 | 1st Qu.: | | 2.237 | 1st Qu.: | | 2.259 | 1st Qu.: | | 2.259 |
| ## | Median : | | 2.404 | Median : | | 2.441 | Median : | | 2.461 | Median : | | 2.461 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | Mean | : 2.576 | Mean | : 2.641 | Mean | : 2.662 | Mean | : 2.662 |
| ## | 3rd Qu.: 2.740 | | 3rd Qu.: 2.764 | | 3rd Qu.: 2.785 | | 3rd Qu.: 2.785 | |
| ## | Max. :31.077 | | Max. :30.892 | | Max. :30.892 | | Max. :30.892 | |
| ##  ## | V159  Min. : 1.314 | | V160  Min. : 1.306 | |  | |  | |
| ##  ## | 1st Qu.: 2.259  Median : 2.461 | | 1st Qu.: 2.237  Median : 2.441 | |  | |  | |
| ## | Mean : 2.662 | | Mean : 2.641 | |  | |  | |
| ##  ## | 3rd Qu.: 2.785  Max. :30.892 | | 3rd Qu.: 2.764  Max. :30.892 | |  | |  | |

*# Identify columns where all rows are zero*

columns\_all\_zeros <- apply(flattened\_data, 2, **function**(x) all(x == 0))

*# Get the names of these columns (if the matrix has column names)*

columns\_with\_all\_zeros <- names(columns\_all\_zeros)[columns\_all\_zeros]

*# Print the names of columns with all zeros*

print(columns\_with\_all\_zeros)

## NULL

*# Remove these columns from extracted\_features*

flattened\_data <- flattened\_data[, !columns\_all\_zeros]

*# Display the dimensions of the cleaned extracted\_features*

print(dim(flattened\_data))

## [1] 1336810

155

*# Step 1: Identify columns that contain at least one zero #columns\_with\_zeros <- apply(flattened\_data, 2, function(x) any(x == 0))*

*# Step 2: Filter out these columns from the matrix #flattened\_data <- flattened\_data[, !columns\_with\_zeros]*

*# Show dimensions or summary of the filtered data #print(dim(filtered\_data)) #summary(filtered\_data)*

**library**(stats)

*#*

pca <- prcomp(flattened\_data, scale. = TRUE, center = TRUE)

*# Extracting the importance of components* explained\_variance <- summary(pca)$importance[2,] cumulative\_variance <- cumsum(explained\_variance) num\_components <- which(cumulative\_variance >= 0.999)[1]

*# Using the number of components to reduce dimensions*

reduced\_data <- pca$x[, 1:num\_components]

summary(reduced\_data)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ##  ## | Min. | PC1  :-321.156 | | Min. | PC2  :-10.43790 | | Min. | PC3  :-22.3097 | Min. | PC4  :-22.60498 | |
| ## | 1st Qu.: -1.464 | | | 1st Qu.: -2.20609 | | | 1st Qu.: -1.0018 | | 1st Qu.: | | -0.42571 |
| ## | Median : 2.298 | | | Median : -0.04554 | | | Median : 0.0193 | | Median : | | -0.01867 |
| ## | Mean : 0.000 | | | Mean : 0.00000 | | | Mean : 0.0000 | | Mean : | | 0.00000 |
| ## | 3rd Qu.: 4.691 | | | 3rd Qu.: 2.13991 | | | 3rd Qu.: 1.0148 | | 3rd Qu.: | | 0.40148 |
| ##  ## | Max. : 11.300  PC5 | | | Max. : 14.30648  PC6 | | | Max. : 87.2442  PC7 | | Max. : | | 45.61329 |
| ## | Min. :-22.32528 | | | Min. :-41.33976 | | | Min. :-9.51994 | |  | |  |
| ##  ## | 1st Qu.: -0.09744  Median : -0.00279 | | | 1st Qu.: -0.19908  Median : 0.00184 | | | 1st Qu.:-0.11711  Median : 0.02676 | |  | |  |
| ##  ## | Mean : 0.00000  3rd Qu.: 0.09110 | | | Mean : 0.00000  3rd Qu.: 0.20026 | | | Mean : 0.00000  3rd Qu.: 0.14409 | |  | |  |
| ## ## | Max. | : PC8 | 97.42868 | Max. : | | 18.73958 | Max. | :11.17001 | | | |

|  |  |
| --- | --- |
| ## | Min. :-14.486692 |
| ## | 1st Qu.: -0.128074 |
| ## | Median : -0.008422 |
| ## | Mean : 0.000000 |
| ## | 3rd Qu.: 0.119418 |
| ## | Max. : 15.148364 |

*# Combine df1 and df2 side by side*

combined\_df <- cbind(cnn\_output, reduced\_data)

data <- rename(combined\_df, c("close"= "cnn\_output" )) combined\_df <- rename(combined\_df, c("close"= "cnn\_output" ))

*# Display the combined data frame*

print(head(combined\_df,100))

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| ## |  | close | Date | PC1 | PC2 | PC3 | PC4 |
| ## | 1 | 83.0 | 2019-10-01 | -2.26918747 | -2.24243821 | 0.43747432 | -1.104238831 |
| ## | 2 | 81.0 | 2019-10-02 | -2.16304539 | -2.15324518 | -0.08013630 | -1.050565237 |
| ## | 3 | 80.8 | 2019-10-03 | -1.95001609 | -1.92132539 | -0.29606686 | -0.463170987 |
| ## | 4 | 80.8 | 2019-10-04 | -1.86825572 | -1.83262084 | -0.33459373 | 0.282201038 |
| ## | 5 | 81.8 | 2019-10-07 | -1.58824028 | -1.56645507 | -0.12940610 | 0.772491511 |
| ## | 6 | 82.4 | 2019-10-08 | -1.78946263 | -1.70874145 | 0.42550469 | 0.547143425 |
| ## | 7 | 83.4 | 2019-10-09 | -1.82946503 | -1.66088641 | 0.53428766 | -0.090016863 |
| ## | 8 | 81.6 | 2019-10-10 | -2.11481635 | -2.04738572 | 0.33184996 | -0.939907068 |
| ## | 9 | 82.0 | 2019-10-11 | -2.07436920 | -2.04127037 | -0.13550107 | -1.124886587 |
| ## | 10 | 81.0 | 2019-10-14 | -1.97948701 | -2.02827851 | -0.50641104 | -0.741481434 |
| ## | 11 | 81.6 | 2019-10-15 | -1.80047321 | -1.81618493 | -0.46024136 | 0.185197214 |
| ## | 12 | 87.6 | 2019-10-16 | -1.76901564 | -1.77161515 | -0.41581906 | 0.609646282 |
| ## | 13 | 86.0 | 2019-10-17 | -1.87868331 | -1.76201342 | 0.07385843 | 0.515288868 |
| ## | 14 | 86.6 | 2019-10-18 | -2.10050495 | -1.92921059 | 0.21190047 | 0.150690565 |
| ## | 15 | 85.8 | 2019-10-21 | -2.20685552 | -2.07602461 | 0.29518447 | -0.776919697 |
| ## | 16 | 86.8 | 2019-10-22 | -2.27141868 | -2.09924641 | 0.28924172 | -0.699691975 |
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| ## | 18 | 88.6 | 2019-10-24 | -2.15653411 | -1.89323013 | -0.53335582 | -0.181463880 |
| ## | 19 | 88.8 | 2019-10-25 | -2.30962010 | -2.02295434 | -0.79206654 | -0.237598123 |
| ## | 20 | 89.8 | 2019-10-28 | -2.66426537 | -2.33916804 | -0.84058779 | -0.317825640 |
| ## | 21 | 91.4 | 2019-10-29 | -2.92668286 | -2.68046668 | -1.07369855 | -0.650816495 |
| ## | 22 | 91.0 | 2019-10-30 | -3.29315936 | -3.17567513 | -1.16222373 | -0.606267353 |
| ## | 23 | 91.0 | 2019-10-31 | -3.37337779 | -3.29751806 | -1.37422738 | -0.380515571 |
| ## | 24 | 92.0 | 2019-11-01 | -3.63663800 | -3.63010951 | -0.98148336 | 0.042730214 |
| ## | 25 | 91.0 | 2019-11-04 | -3.73465371 | -3.75081117 | -0.83116012 | 0.183157775 |
| ## | 26 | 91.2 | 2019-11-05 | -3.91955986 | -3.93417642 | -0.23427501 | 0.135159727 |
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| ## | 28 | 89.0 | 2019-11-07 | -3.87294512 | -3.85707105 | 0.73846120 | -0.061387691 |
| ## | 29 | 89.2 | 2019-11-08 | -3.72909426 | -3.66463604 | 1.16968084 | 0.078936839 |
| ## | 30 | 86.0 | 2019-11-11 | -3.33243600 | -3.10848591 | 1.72403860 | 0.192704833 |
| ## | 31 | 87.0 | 2019-11-12 | -2.87638596 | -2.52515861 | 2.17714491 | 0.587525197 |
| ## | 32 | 85.4 | 2019-11-13 | -2.39332372 | -1.81263032 | 2.61381184 | 0.368351782 |
| ## | 33 | 86.0 | 2019-11-14 | -1.77956855 | -1.02668148 | 3.23907562 | 0.359880257 |
| ## | 34 | 87.4 | 2019-11-15 | -1.26497139 | -0.26610007 | 3.26517231 | -0.055107899 |
| ## | 35 | 85.8 | 2019-11-18 | -0.52280041 | 0.71823961 | 3.02501991 | -0.336243617 |
| ## | 36 | 85.2 | 2019-11-19 | -0.09023679 | 1.40460439 | 2.48001842 | -0.483996844 |
| ## | 37 | 84.4 | 2019-11-20 | 0.45635335 | 2.12760951 | 1.74166844 | -0.799698865 |
| ## | 38 | 83.6 | 2019-11-21 | 0.87482352 | 2.62209541 | 1.20154216 | -0.478076466 |
| ## | 39 | 87.0 | 2019-11-22 | 1.20327072 | 3.09246417 | 0.67047704 | -0.285909803 |
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| ## | 42 | 86.4 | 2019-11-27 | 0.94388597 | 2.78888918 | -1.10479067 | -0.507064954 |
| ## | 43 | 85.2 | 2019-11-28 | 0.62189102 | 2.32931943 | -1.43435315 | -0.365269347 |
| ## | 44 | 85.6 | 2019-11-29 | 0.47738895 | 2.01454628 | -1.58243290 | -0.138680874 |
| ## | 45 | 84.2 | 2019-12-02 | 0.23293777 | 1.63606990 | -1.68120761 | 0.330478804 |
| ## | 46 | 82.8 | 2019-12-03 | 0.15391679 | 1.43555132 | -1.33933134 | 0.810697552 |
| ## | 47 | 84.2 | 2019-12-04 | 0.01876250 | 1.20325274 | -0.56237682 | 0.971086736 |
| ## | 48 | 84.0 | 2019-12-05 | -0.02107456 | 1.18774465 | 0.20783168 | 0.969179411 |
| ## | 49 | 85.0 | 2019-12-06 | 0.01450782 | 1.17293836 | 0.84275167 | 0.679366112 |
| ## | 50 | 84.4 | 2019-12-09 | 0.01762329 | 1.28972747 | 1.03043637 | 0.112660807 |
| ## | 51 | 83.2 | 2019-12-10 | 0.11542934 | 1.37624439 | 0.98425327 | -0.272169573 |
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| ## | 54 | 82.8 | 2019-12-13 | 0.75900077 | 2.19233444 | 0.11681619 | -0.029833737 |
| ## | 55 | 82.6 | 2019-12-16 | 0.83400864 | 2.36889111 | 0.07329674 | 0.258093102 |
| ## | 56 | 85.8 | 2019-12-17 | 0.92906705 | 2.46946898 | 0.14609029 | 0.373480242 |
| ## | 57 | 85.2 | 2019-12-18 | 0.78245465 | 2.38274336 | 0.14741609 | -0.041326022 |
| ## | 58 | 85.4 | 2019-12-19 | 0.53306824 | 2.10467578 | -0.34754527 | -0.482614749 |
| ## | 59 | 85.0 | 2019-12-20 | 0.23287265 | 1.63441119 | -1.15958310 | -0.895492059 |
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| ## | 63 | 87.6 | 2020-01-02 | -1.11323531 | -0.31347470 | -2.31085956 | 0.555689525 |
| ## | 64 | 84.0 | 2020-01-03 | -1.72371125 | -1.08398979 | -2.33611884 | 0.114666835 |
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| ## | 66 | 84.4 | 2020-01-07 | -2.22009538 | -1.94850152 | -0.89139994 | 0.408579784 |
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| ## | 71 | 81.0 | 2020-01-14 | -1.31559180 | -0.73348698 | 2.80414401 | -0.318379287 |
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| ## | 73 | 81.0 | 2020-01-16 | 0.06563980 | 1.08417256 | 2.53196712 | 0.159249101 |
| ## | 74 | 81.0 | 2020-01-17 | 0.60346976 | 1.90411462 | 2.36195092 | 0.387907350 |
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| ## | 82 | 79.0 | 2020-01-29 | 2.62762207 | 4.42004029 | -0.90444363 | 0.104059824 |
| ## | 83 | 78.2 | 2020-01-30 | 2.47608353 | 4.20224665 | -1.24639174 | 0.319798799 |
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| ## | 85 | 74.0 | 2020-02-03 | 1.80554927 | 3.16784492 | -1.56436564 | 0.086048304 |
| ## | 86 | 77.8 | 2020-02-04 | 1.74657402 | 2.95518311 | -1.18594897 | 0.347736430 |
| ## | 87 | 77.6 | 2020-02-05 | 1.26429845 | 2.31615660 | -1.40774483 | 0.172177092 |

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| ## | 88 | 75.2 | 2020-02-06 | | 0.88152992 | | 1.72414631 | -1.85344725 | 0.001693554 |
| ## | 89 | 73.0 | 2020-02-07 | | 0.32767077 | | 0.88627101 | -2.19550138 | -0.363349166 |
| ## | 90 | 71.4 | 2020-02-10 | | 0.06980170 | | 0.39623438 | -2.00618404 | 0.084444200 |
| ## | 91 | 72.8 | 2020-02-11 | | -0.12779380 | | 0.06737101 | -1.42574091 | 0.511518919 |
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| ## | 93 | 73.0 | 2020-02-13 | | -0.09677602 | | -0.12498061 | -0.43274396 | 1.395513722 |
| ## | 94 | 74.0 | 2020-02-14 | | -0.28590765 | | -0.31754288 | 0.50731135 | 0.749812637 |
| ## | 95 | 73.2 | 2020-02-17 | | -0.44930305 | | -0.47699315 | 0.69068682 | -0.161874456 |
| ## | 96 | 75.0 | 2020-02-18 | | -0.46837405 | | -0.57997864 | 0.78599037 | -0.817567536 |
| ## | 97 | 75.0 | 2020-02-19 | | -0.33857288 | | -0.31401934 | 0.18442645 | -0.847124431 |
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| ## | 2 | 1.677207e-01 | | 0.265566009 | | -0.128344815 | | -1.647790e-01 | |
| ## | 3 | 2.053564e-01 | | 0.440556055 | | -0.030381288 | | -2.725254e-02 | |
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| ## | 5 | -1.502566e-02 | | 0.108259543 | | 0.023184723 | | 8.987586e-02 | |
| ## | 6 | -8.638432e-02 | | -0.365059557 | | -0.058743162 | | 9.835542e-03 | |
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| ## | 16 | -6.582975e-03 | | 0.068847437 | | -0.357656349 | | -1.348573e-01 | |
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| ## | 22 | 1.328698e-01 | | 0.107678006 | | 0.037540276 | | 7.095434e-02 | |
| ## | 23 | 1.037875e-01 | | 0.065225953 | | 0.053421690 | | 5.140690e-02 | |
| ## | 24 | 4.393296e-02 | | 0.106554185 | | 0.105053873 | | 5.505759e-02 | |
| ## | 25 | 7.607837e-03 | | 0.028745028 | | 0.094649359 | | 3.158046e-02 | |
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| ## | 29 | 6.207960e-02 | | 0.344149457 | | -0.132150644 | | -1.903670e-01 | |
| ## | 30 | 4.076205e-02 | | 0.444937330 | | 0.014417772 | | 4.730249e-02 | |
| ## | 31 | 4.168247e-05 | | 0.373427742 | | 0.015094523 | | 8.092872e-02 | |
| ## | 32 | -7.018407e-02 | | 0.212956544 | | -0.054341012 | | 1.784656e-02 | |
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| ## | 47 | 6.575522e-02 | -0.014394352 | -0.218851591 | -2.980175e-01 |
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| ## | 60 | 2.208069e-01 | 0.070212064 | -0.103510369 | -1.564288e-01 |
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| ## | 79 | 3.746224e-02 | 0.018624673 | 0.072581359 | 2.492040e-02 |
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| ## | 82 | 1.325887e-01 | 0.004140257 | 0.108116146 | 6.267537e-02 |
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| ## | 86 | 1.413849e-01 | 0.221458151 | -0.134193749 | -2.026747e-01 |
| ## | 87 | 4.555657e-02 | -0.112695835 | 0.079798874 | 2.020417e-01 |
| ## | 88 | 2.325527e-02 | -0.311094007 | 0.042739334 | 2.696694e-01 |
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| ## | 93 | -1.570128e-01 | -0.399100916 | -0.249346976 | 2.590960e-01 |
| ## | 94 | -2.496885e-01 | -0.701296673 | -0.448498144 | 4.375985e-02 |
| ## | 95 | -1.363792e-01 | -0.688052785 | -0.430170716 | 1.067822e-01 |
| ## | 96 | 9.365824e-02 | 0.031906446 | -0.412011590 | 1.313277e-01 |
| ## | 97 | 5.022116e-02 | 0.050704413 | -0.339130562 | 2.479776e-01 |
| ## | 98 | 4.099108e-02 | 0.181005502 | -0.176246652 | 3.676044e-01 |
| ## | 99 | 6.941029e-02 | 0.015793282 | -0.200227650 | 3.146651e-01 |
| ## | 100 | 5.373250e-02 | -0.134789751 | -0.224100815 | 1.505442e-01 |

write.csv(combined\_df, file = "final.feature.feed\_to\_other\_models19.05.2024better pca +++.csv", row.names = FALSE, na = "NA")

save(reduced\_data, file = "datatabnetwithpcafinal+19.5.2024.RData")

*################################# pca histogrms*

*# Load necessary libraries*

**library**(ggplot2) **library**(gridExtra)

##

## Attaching package: 'gridExtra'

## The following object is masked from 'package:dplyr': ##

## combine

*#install.packages("gridExtra") # Load data*

*# Load necessary libraries* **library**(ggplot2) **library**(gridExtra) **library**(dplyr)

*# Load data*

*#data <- read.csv("final.feature.feed\_to\_other\_models17.05.2024+++.csv")*

*# List of PCA components*

pca\_columns <- c( "close", "PC1", "PC2", "PC3", "PC4", "PC5", "PC6", "PC7")

pca\_columns <- c( "close")

*# Create a list to hold the plots*

plots <- list()

*# Generate histograms using tidy evaluation*

**for** (pca **in** pca\_columns) {

p <- ggplot(data, aes(x = .data[[pca]])) +

geom\_histogram(aes(y = ..density..), bins = 30, fill = "blue", alpha = 0.5) + geom\_density(color = "red", linewidth = 1) +

labs(title = paste("Distribution of", pca), x = pca, y = "Density") plots[[pca]] <- p

}

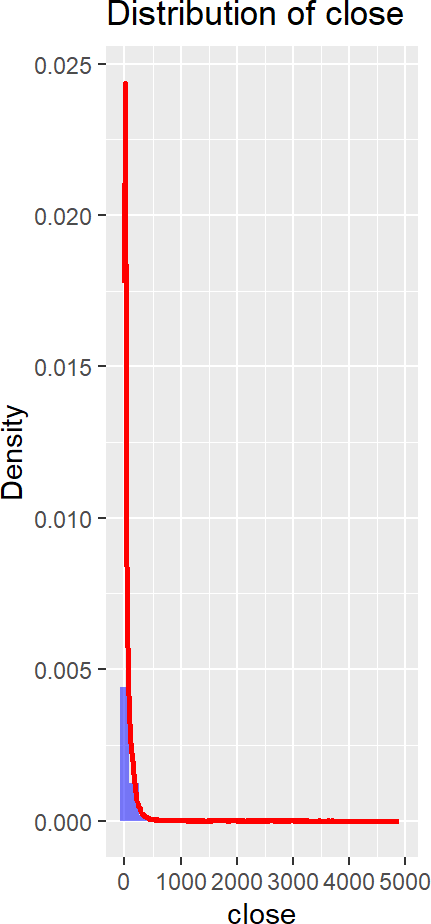
*# Arrange the plots in a grid*

do.call(grid.arrange, c(plots, ncol = 3))

## Warning: The dot-dot notation (`..density..`) was deprecated in ggplot2 3.4.0. ## ℹ Please use `after\_stat(density)` instead.

## This warning is displayed once every 8 hours.

## Call `lifecycle::last\_lifecycle\_warnings()` to see where this warning was ## generated.



summary(data)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## | close | | Date | | PC1 | | | PC2 | | |
| ## | Min. : 0.013 | | Length:1336810 | | Min. :-321.156 | | | Min. :-10.43790 | | |
| ## | 1st Qu.: 6.950 | | Class :character | | 1st Qu.: -1.464 | | | 1st Qu.: -2.20609 | | |
| ##  ## | Median : 29.800  Mean : 72.798 | | Mode :character | | Median : 2.298  Mean : 0.000 | | | Median : -0.04554  Mean : 0.00000 | | |
| ##  ## | 3rd Qu.: 86.000  Max. :4900.000 | |  | | 3rd Qu.: 4.691  Max. : 11.300 | | | 3rd Qu.: 2.13991  Max. : 14.30648 | | |
| ## |  | PC3 |  | PC4 |  | PC5 | |  | PC6 | |
| ## | Min. | :-22.3097 | Min. | :-22.60498 | Min. | :-22.32528 | | Min. | :-41.33976 | |
| ## | 1st Qu.: -1.0018 | | 1st Qu.: -0.42571 | | 1st Qu.: | | -0.09744 | 1st Qu.: | | -0.19908 |
| ## | Median : 0.0193 | | Median : -0.01867 | | Median : | | -0.00279 | Median : | | 0.00184 |
| ## | Mean : 0.0000 | | Mean : 0.00000 | | Mean : | | 0.00000 | Mean : | | 0.00000 |
| ## | 3rd Qu.: 1.0148 | | 3rd Qu.: 0.40148 | | 3rd Qu.: | | 0.09110 | 3rd Qu.: | | 0.20026 |
| ## | Max. : 87.2442 | | Max. : 45.61329 | | Max. : | | 97.42868 | Max. : | | 18.73958 |
| ## | PC7 | | PC8 | |  | |  |  | |  |
| ##  ## | Min. :-9.51994  1st Qu.:-0.11711 | | Min. :-14.486692  1st Qu.: -0.128074 | |  | |  |  | |  |
| ##  ## | Median : 0.02676  Mean : 0.00000 | | Median : -0.008422  Mean : 0.000000 | |  | |  |  | |  |
| ##  ## | 3rd Qu.: 0.14409  Max. :11.17001 | | 3rd Qu.: 0.119418  Max. : 15.148364 | |  | |  |  | |  |

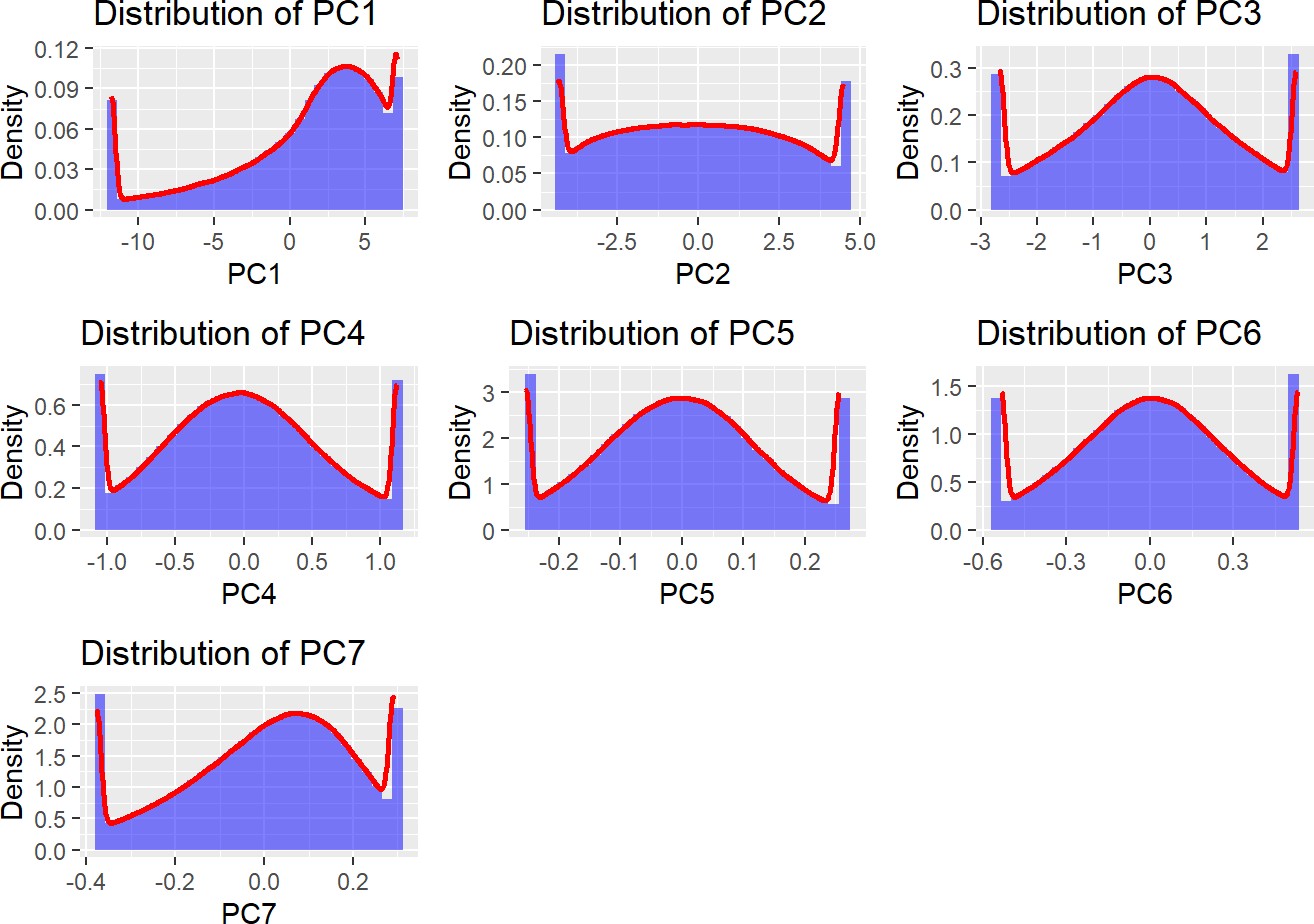
*#install.packages("DescTools") # Load necessary libraries* **library**(DescTools)

##

## Attaching package: 'DescTools'

## The following object is masked from 'package:data.table': ##

## %like%



**library**(ggplot2) **library**(gridExtra)

*# Load data*

*#data <- read.csv("final.feature.feed\_to\_other\_models17.05.2024+++.csv")*

*# List of PCA components*

pca\_columns <- c("PC1", "PC2", "PC3", "PC4", "PC5", "PC6", "PC7")

*# Apply winsorization to each PCA component*

**for** (pca **in** pca\_columns) {

data[[pca]] <- Winsorize(data[[pca]], probs = c(0.05, 0.95))

}

*# Create a list to hold the plots*

plots <- list()

*# Generate histograms using tidy evaluation*

**for** (pca **in** pca\_columns) {

p <- ggplot(data, aes(x = .data[[pca]])) +

geom\_histogram(aes(y = ..density..), bins = 30, fill = "blue", alpha = 0.5) + geom\_density(color = "red", linewidth = 1) +

labs(title = paste("Distribution of", pca), x = pca, y = "Density") plots[[pca]] <- p

}

*# Arrange the plots in a grid*

do.call(grid.arrange, c(plots, ncol = 3))

*# Load necessary libraries* **library**(DescTools) **library**(dplyr)

*# Load data*

*#data <- read.csv("final.feature.feed\_to\_other\_models17.05.2024+++.csv")*

*# Ensure the date column is in datetime format*

data$Date <- as.Date(data$Date)

*# List of PCA components and other features to winsorize*

pca\_columns <- c("PC1", "PC2", "PC3", "PC4", "PC5", "PC6", "PC7")

*# Store the number of rows before winsorization*

num\_rows\_before <- nrow(data)

*# Apply winsorization to each PCA component*

**for** (pca **in** pca\_columns) {

data[[pca]] <- Winsorize(data[[pca]], probs = c(0.05, 0.95))

}

*# Store the number of rows after winsorization*

num\_rows\_after <- nrow(data)

*# Print the number of rows before and after winsorization to verify they are the same*

cat("Number of rows before winsorization:", num\_rows\_before, "\n")

## Number of rows before winsorization: 1336810

cat("Number of rows after winsorization:", num\_rows\_after, "\n")

## Number of rows after winsorization: 1336810

*# Function to check for NA, NaN, and infinite values in each column*

check\_missing\_values <- **function**(df) { sapply(df, **function**(x) {

list(

`NA` = sum(is.na(x)),

`NaN` = sum(is.nan(x)),

`PosInf` = sum(is.infinite(x) & x > 0),

`NegInf` = sum(is.infinite(x) & x < 0)

)

})

}

*# Check for missing values in the dataset* missing\_values\_summary <- check\_missing\_values(data) print(missing\_values\_summary)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ## |  | close | Date | PC1 | PC2 | PC3 | PC4 | PC5 | PC6 | PC7 | PC8 |
| ## | NA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ## | NaN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ## | PosInf | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ## | NegInf | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*# Save the updated data frame if needed*

write.csv(data, "winsorized\_datapca final 18.5.2024.csv", row.names = FALSE)

*# Check the structure of the updated data*

str(data)

## 'data.frame': 1336810 obs. of 10 variables:

## ## ## ## ## ## ## ## ##

##

$ close: num 83 81 80.8 80.8 81.8 82.4 83.4 81.6 82 81 ...

$ Date : Date, format: "2019-10-01" "2019-10-02" ...

$ PC1

$ PC2

$ PC3

$ PC4

$ PC5

$ PC6

$ PC7

$ PC8

: num

: num

: num

: num

: num

: num

: num

: num

-2.27 -2.16 -1.95 -1.87 -1.59 ...

-2.24 -2.15 -1.92 -1.83 -1.57 ...

0.4375 -0.0801 -0.2961 -0.3346 -0.1294 ...

-1.058 -1.051 -0.463 0.282 0.772 ...

0.00852 0.16772 0.20536 0.16463 -0.01503 ...

-0.285 0.266 0.441 0.491 0.108 ...

0.00741 -0.12834 -0.03038 0.14817 0.02318 ...

0.0335 -0.1648 -0.0273 0.2401 0.0899 ...

*########### close prices assessing*

*# Load necessary libraries*

**library**(dplyr)

*# Define the ranges*

ranges <- list(

"0-50" = c(0, 50),

"50-100" = c(50, 100),

"100-500" = c(100, 500),

"500-1000" = c(500, 1000), "1000+" = c(1000, Inf)

)

*# Function to calculate percentage of values in each range*

calculate\_percentage <- **function**(data, column, ranges) { total\_count <- nrow(data)

percentages <- sapply(ranges, **function**(range) {

count <- sum(data[[column]] >= range[1] & data[[column]] < range[2]) percentage <- (count / total\_count) \* 100

**return**(percentage)

})

**return**(percentages)

}

*# Calculate percentages for 'close' prices*

percentages <- calculate\_percentage(data, "close", ranges)

*# Print the results*

percentages

##

0-50

50-100

100-500 500-1000

1000+

## 62.0204816 16.3770469 20.4624442 0.6977057 0.4423216

*# Load necessary libraries*

**library**(ggplot2)

*# Define the ranges and percentages*

ranges <- c("0-50", "50-100", "100-500", "500-1000", "1000+")

percentages <- c(62.02, 16.38, 20.46, 0.70, 0.44)

*# Create a data frame for plotting*

percentage\_data <- data.frame(

Range = factor(ranges, levels = ranges), Percentage = percentages

)

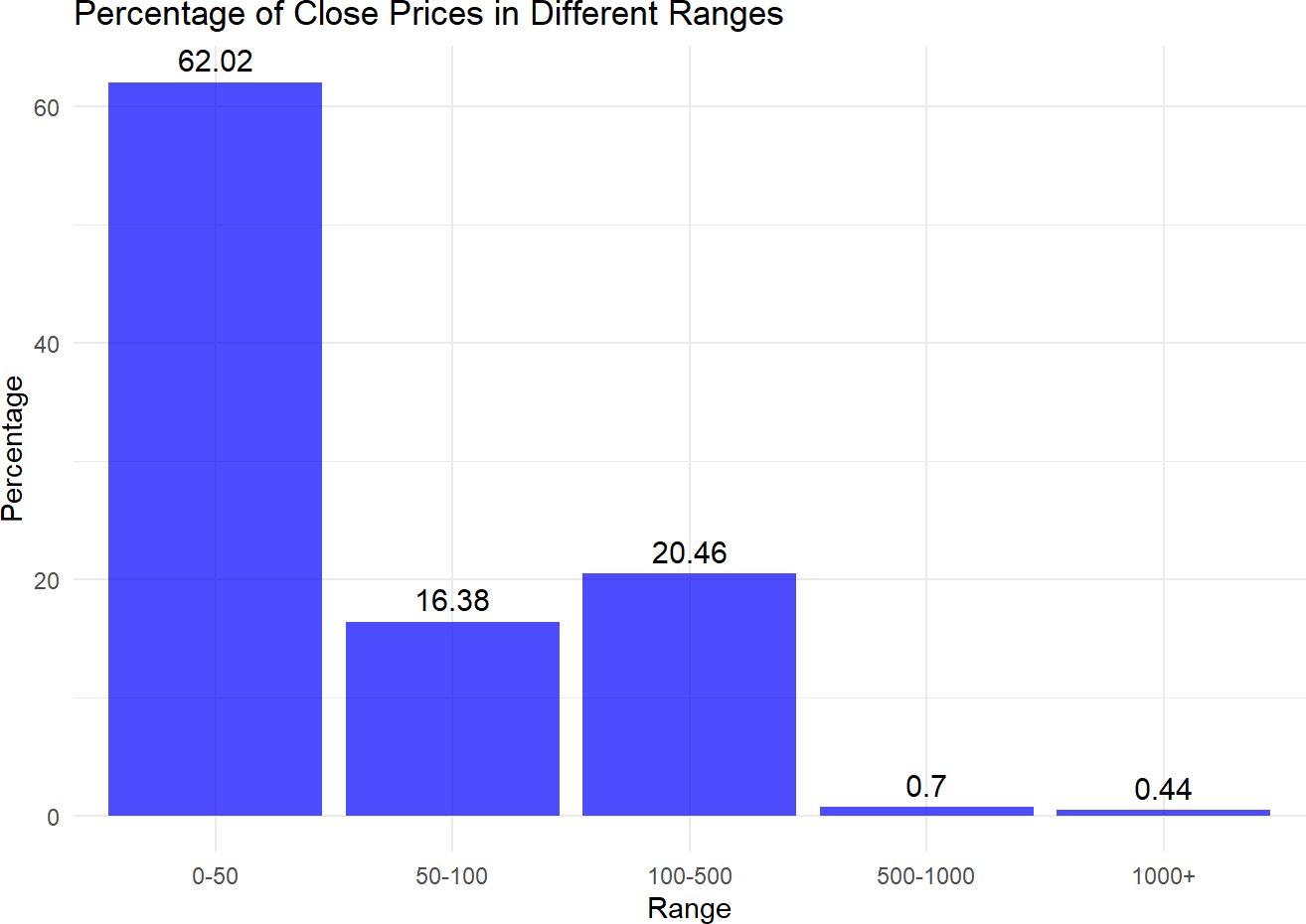
*# Plot the histogram*

ggplot(percentage\_data, aes(x = Range, y = Percentage)) + geom\_bar(stat = "identity", fill = "blue", alpha = 0.7) +

geom\_text(aes(label = round(Percentage, 2)), vjust = -0.5, size = 4) + labs(title = "Percentage of Close Prices in Different Ranges",

x = "Range",

y = "Percentage") + theme\_minimal()



**library**(dplyr) **library**(DescTools)

*# Winsorize the 'close' column*

data$close <- Winsorize(data$close, probs = c(0.05, 0.95))

*# Check the summary of the winsorized 'close' column*

summary(data$close)

|  |  |  |  |
| --- | --- | --- | --- |
| ## | Min. 1st Qu. | Median | Mean 3rd Qu. Max. |
| ## | 1.098 6.950 | 29.800 | 58.159 86.000 238.000 |

*# Plot distribution of winsorized 'close' prices*

ggplot(data, aes(x = close)) +

geom\_histogram(aes(y = ..density..), bins = 30, fill = "blue", alpha = 0.5) + geom\_density(color = "red", size = 1) +

labs(title = "Distribution of Winsorized Close Prices", x = "Winsorized Close", y = "Densit

y")



## Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0. ## ℹ Please use `linewidth` instead.

## This warning is displayed once every 8 hours.

## Call `lifecycle::last\_lifecycle\_warnings()` to see where this warning was ## generated.

*# Save the updated data frame if needed*

write.csv(data, "winsorized\_datapca and clsoe prices final 18.5.2024.csv", row.names = FALSE)