Bitcoin Analysis and Forecasting

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Abstract

This is a Bitcoin analysis and forecasting report for the Harvard-X Data Science Capstone Project.

Contents

1 Executive Summary

In the 17th and 18th centuries, the Dutch pioneered several financial innovations that lay the foundations for modern financial systems across the globe. First came government bonds, then the actual capital market, better known as the stock market. The Dutch East India Company became the first to issue bonds and shares to the general public in the 1600's. Stock trading emerged in 1602 in company stocks on the Amsterdam Stock Exchange. Stock market's enables companies to raise money through public investment, with rising stock prices associated with increased investment and vice versa.

Central banking systems uses fiat currencies to transfer money electronically from one account to another. This presents two problems to the account holder, i.e. high banking fees and the time it takes to complete the transaction. Due to globalisation of industries, a mechanism was required to securely transfer money from one user to another across the globe, with minimal fees and a reduced transaction time. In 1983, electronic money, e-cash, was developed by David Chaum. He further developed Digicash in 1995, by incorporating cryptography into electronic payments. Various developments resulted in the first crypto currency developed in 2009 by Satoshi Nakamototo. Crypto currencies can solve the problem of borderless secure money transfer (just to name one application!).

Crypto currencies are decentralized digital assets which uses cryptography to secure financial transactions, the creation of additional units and verifying the transfer has taken place. Decentralization is a distributed-technology, consisting of a decentralized ledger with peer-to-peer transactions. This is basically a public database for financial transactions.

In 2009, Bitcoin was the first developed crypto currency and available for public trading on crypto exchanges (similar to stock exchanges). Variants of Bitcoin, namely altcoins, has been developed since 2009 and there is currently more than 6000 altcoins available on various exchanges for the public to trade. Investment in crypto currencies has been chosen by crypto enthusiasts, due to the staggering gains that was yielded since it's inception.

This report describes a various machine learning algorithms and Bitcoin price forecasting techniques using the cryptocurrencypricehistory datasets available on www.kaggle.com. The datasets consists of time-series trading data for various crypto currencies. This time-series datasets will be used for future price prediction by using publically available forecasting libraries in r.

The key metric for the machine learning models being tested is the Root Mean Squared Error (RMSE) value, with the best model yielding an RMSE of 57.83 on the price of Bitcoin.

The RMSE formula used in this report:

$$\text{RMSE} = \sqrt{\frac{1}{n}\sum_{t=1}^{n} e_t^2}$$

To achieve the lowest possible RMSE, various algorithms was tested on a test and training set created from the main dataset.

The forecasting models uses the Mean absolute scaled error (MASE) indicator to evaluate it's accuracy.

This report consist of the following sections:
Section 2: Initial Dataset Exploration
Section 3: Feature Engineering/Data Cleansing
Section 4: Data Analysis
Section 5: Methods/Analysis
Section 6: Results
Section 7: Conclusion
Section 8: References
Section 9: Environmental Variables

2 Initial Dataset Exploration

The datasets used for this project was downloaded from https://www.kaggle.com/jessevent/all-crypto-currencies. The dataset consists of a .csv file with trading data for all the crypto currencies from 2010 - 2018 (dependant on when a crypto currency was released). The csv file needs to be download and saved into the same directory as the .R and .RMD file.

Initial data exploration of crypto datasets are discussed in the sections below.

2.1 Check Dataset Composition

First 5 rows of data_all_markets Dataset

slug	symbol	name	date	ranknow	open	high	low	close	volume	market	close_ratio	spread
bitcoin	BTC	Bitcoin	2013-04-28	1	135.30	135.98	132.10	134.21	0	1488566728	0.5438	3.88
bitcoin	BTC	Bitcoin	2013-04-29	1	134.44	147.49	134.00	144.54	0	1603768865	0.7813	13.49
bitcoin	BTC	Bitcoin	2013-04-30	1	144.00	146.93	134.05	139.00	0	1542813125	0.3843	12.88
bitcoin	BTC	Bitcoin	2013-05-01	1	139.00	139.89	107.72	116.99	0	1298954594	0.2882	32.17
bitcoin	BTC	Bitcoin	2013-05-02	1	116.38	125.60	92.28	105.21	0	1168517495	0.3881	33.32

Note: All Cryptos Columns Overview

Dataset Features/Variables/Columns

```
## Observations: 942,297
## Variables: 13
## $ slug        <fct> bitcoin, bitcoin, bitcoin, bitcoin, bitcoin, bitcoin, bit...
## $ symbol      <fct> BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BT...
## $ name        <fct> Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bit...
## $ date        <fct> 2013-04-28, 2013-04-29, 2013-04-30, 2013-05-01, 2013-05-0...
## $ ranknow     <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, ...
## $ open        <dbl> 135.30, 134.44, 144.00, 139.00, 116.38, 106.25, 98.10, 11...
## $ high        <dbl> 135.98, 147.49, 146.93, 139.89, 125.60, 108.13, 115.00, 1...
## $ low         <dbl> 132.10, 134.00, 134.05, 107.72, 92.28, 79.10, 92.50, 107....
## $ close       <dbl> 134.21, 144.54, 139.00, 116.99, 105.21, 97.75, 112.50, 11...
## $ volume      <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ...
## $ market      <dbl> 1488566728, 1603768865, 1542813125, 1298954594, 116851749...
## $ close_ratio <dbl> 0.5438, 0.7813, 0.3843, 0.2882, 0.3881, 0.6424, 0.8889, 0...
## $ spread      <dbl> 3.88, 13.49, 12.88, 32.17, 33.32, 29.03, 22.50, 11.66, 18...
```

The variables can be described as follows:

Observations: 942,000 Variables: 13 Crypto Tokens: 2,071

- All historic open, high, low, close values for all cryptocurrencies (Data current as of 21 May 2018).
- slug: Crypto Currency
- symbol: Ticker for Crypto Currency
- name: Crypto Currency
- date: Transaction date
- ranknow: Rank of Crypto Currency for specific date
- open: Opening Price in USD
- high: Highest price over 24 Hours in USD
- low: Lowest price over 24 Hours in USD
- close: Closing Price for day in USD
- volume: Volume for day
- market: Market cap for day
- close_ratio: Daily close rate, min-maxed with the high and low values for the day.

- spread: $USD difference between the high and low values for the day.

The data set has been identified as an univariate time series which consists of single (scalar) observation recorded sequentially over equal time increments (in this case, daily).

2.2 Check Dataset For NA's

data_all_markets dataset

	x
slug	0
symbol	0
name	0
date	0
ranknow	0
open	0
high	0
low	0
close	0
volume	0
market	0
close_ratio	0
spread	0

Note: Check NA's data_all_markets Dataset

data_bitcoin dataset

	x
slug	0
symbol	0
name	0
date	0
ranknow	0
open	0
high	0
low	0
close	0
volume	0
market	0
close_ratio	0
spread	0

Note: Check NA's data_bitcoin Dataset

This indicates that no records needs to be removed (for the accuracy and operation of the algorithm)

3 Feature Engineering/Data Cleansing

The aim of feature engineering or data cleansing is to modify (add/delete/update) existing columns in the datasets to provide the required functionality for the machine learning algorithm

3.1 Date Format

As identified in the exploratory data analysis section, the date column is in factor format. Converting this column to a character field will enable for ease of data analysis.

```
#Convert date from factor to character
data_all_markets$date <- ymd(as.character(data_all_markets$date))
data_bitcoin$date <- ymd(as.character(data_bitcoin$date))
```

The resultant summary for both datasets are as follows:

```
## Observations: 942,297
## Variables: 13
## $ slug        <fct> bitcoin, bitcoin, bitcoin, bitcoin, bitcoin, bitcoin, bit...
## $ symbol      <fct> BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BT...
## $ name        <fct> Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bit...
## $ date        <date> 2013-04-28, 2013-04-29, 2013-04-30, 2013-05-01, 2013-05-...
## $ ranknow     <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, ...
## $ open        <dbl> 135.30, 134.44, 144.00, 139.00, 116.38, 106.25, 98.10, 11...
## $ high        <dbl> 135.98, 147.49, 146.93, 139.89, 125.60, 108.13, 115.00, 1...
## $ low         <dbl> 132.10, 134.00, 134.05, 107.72, 92.28, 79.10, 92.50, 107....
## $ close       <dbl> 134.21, 144.54, 139.00, 116.99, 105.21, 97.75, 112.50, 11...
## $ volume      <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ...
## $ market      <dbl> 1488566728, 1603768865, 1542813125, 1298954594, 116851749...
## $ close_ratio <dbl> 0.5438, 0.7813, 0.3843, 0.2882, 0.3881, 0.6424, 0.8889, 0...
## $ spread      <dbl> 3.88, 13.49, 12.88, 32.17, 33.32, 29.03, 22.50, 11.66, 18...

## Observations: 2,042
## Variables: 13
## $ slug        <fct> bitcoin, bitcoin, bitcoin, bitcoin, bitcoin, bitcoin, bit...
## $ symbol      <fct> BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BT...
## $ name        <fct> Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bit...
## $ date        <date> 2013-04-28, 2013-04-29, 2013-04-30, 2013-05-01, 2013-05-...
## $ ranknow     <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, ...
## $ open        <dbl> 135.30, 134.44, 144.00, 139.00, 116.38, 106.25, 98.10, 11...
## $ high        <dbl> 135.98, 147.49, 146.93, 139.89, 125.60, 108.13, 115.00, 1...
## $ low         <dbl> 132.10, 134.00, 134.05, 107.72, 92.28, 79.10, 92.50, 107....
## $ close       <dbl> 134.21, 144.54, 139.00, 116.99, 105.21, 97.75, 112.50, 11...
## $ volume      <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ...
## $ market      <dbl> 1488566728, 1603768865, 1542813125, 1298954594, 116851749...
## $ close_ratio <dbl> 0.5438, 0.7813, 0.3843, 0.2882, 0.3881, 0.6424, 0.8889, 0...
## $ spread      <dbl> 3.88, 13.49, 12.88, 32.17, 33.32, 29.03, 22.50, 11.66, 18...
```

3.2 Extracting Year, Month and Day of Price

From the new converted date column, the year, month and day of the currency price can be extracted for data analysis and algorithm feature addition.

```
# Extract the year and month and day of crypto currency price
data_all_markets$priceYear <- format(data_all_markets$date,"%Y")
data_all_markets$priceMonth <- format(data_all_markets$date,"%m")
data_all_markets$priceDay <- format(data_all_markets$date,"%d")

data_bitcoin$priceYear <- format(data_bitcoin$date,"%Y")
data_bitcoin$priceMonth <- format(data_bitcoin$date,"%m")
data_bitcoin$priceDay<- format(data_bitcoin$date,"%d")
```

```
## Observations: 942,297
## Variables: 16
## $ slug        <fct> bitcoin, bitcoin, bitcoin, bitcoin, bitcoin, bitcoin, bit...
## $ symbol      <fct> BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BT...
## $ name        <fct> Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bit...
## $ date        <date> 2013-04-28, 2013-04-29, 2013-04-30, 2013-05-01, 2013-05-...
## $ ranknow     <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, ...
## $ open        <dbl> 135.30, 134.44, 144.00, 139.00, 116.38, 106.25, 98.10, 11...
## $ high        <dbl> 135.98, 147.49, 146.93, 139.89, 125.60, 108.13, 115.00, 1...
## $ low         <dbl> 132.10, 134.00, 134.05, 107.72, 92.28, 79.10, 92.50, 107....
## $ close       <dbl> 134.21, 144.54, 139.00, 116.99, 105.21, 97.75, 112.50, 11...
## $ volume      <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ...
## $ market      <dbl> 1488566728, 1603768865, 1542813125, 1298954594, 116851749...
## $ close_ratio <dbl> 0.5438, 0.7813, 0.3843, 0.2882, 0.3881, 0.6424, 0.8889, 0...
## $ spread      <dbl> 3.88, 13.49, 12.88, 32.17, 33.32, 29.03, 22.50, 11.66, 18...
## $ priceYear   <chr> "2013", "2013", "2013", "2013", "2013", "2013", "2013", "...
## $ priceMonth  <chr> "04", "04", "04", "05", "05", "05", "05", "05", "05", "05...
## $ priceDay    <chr> "28", "29", "30", "01", "02", "03", "04", "05", "06", "07...
```

```
## Observations: 2,042
## Variables: 16
## $ slug        <fct> bitcoin, bitcoin, bitcoin, bitcoin, bitcoin, bitcoin, bit...
## $ symbol      <fct> BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BTC, BT...
## $ name        <fct> Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bitcoin, Bit...
## $ date        <date> 2013-04-28, 2013-04-29, 2013-04-30, 2013-05-01, 2013-05-...
## $ ranknow     <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, ...
## $ open        <dbl> 135.30, 134.44, 144.00, 139.00, 116.38, 106.25, 98.10, 11...
## $ high        <dbl> 135.98, 147.49, 146.93, 139.89, 125.60, 108.13, 115.00, 1...
## $ low         <dbl> 132.10, 134.00, 134.05, 107.72, 92.28, 79.10, 92.50, 107....
## $ close       <dbl> 134.21, 144.54, 139.00, 116.99, 105.21, 97.75, 112.50, 11...
## $ volume      <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ...
## $ market      <dbl> 1488566728, 1603768865, 1542813125, 1298954594, 116851749...
## $ close_ratio <dbl> 0.5438, 0.7813, 0.3843, 0.2882, 0.3881, 0.6424, 0.8889, 0...
## $ spread      <dbl> 3.88, 13.49, 12.88, 32.17, 33.32, 29.03, 22.50, 11.66, 18...
## $ priceYear   <chr> "2013", "2013", "2013", "2013", "2013", "2013", "2013", "...
## $ priceMonth  <chr> "04", "04", "04", "05", "05", "05", "05", "05", "05", "05...
## $ priceDay    <chr> "28", "29", "30", "01", "02", "03", "04", "05", "06", "07...
```

3.3 Convert Slug, Symbol and Name to Character Fields

The slug, symbol and name fields will be converted to character fields to ensure conformatiry accross column types.

```
#Convert slug,symbol and name to character fields
data_all_markets$slug <- as.character(data_all_markets$slug)
data_all_markets$symbol <- as.character(data_all_markets$symbol)
data_all_markets$name <- as.character(data_all_markets$name)

data_bitcoin$slug <- as.character(data_bitcoin$slug)
data_bitcoin$symbol <- as.character(data_bitcoin$symbol)
data_bitcoin$name <- as.character(data_bitcoin$name)
```

```
## Observations: 942,297
## Variables: 16
## $ slug        <chr> "bitcoin", "bitcoin", "bitcoin", "bitcoin", "bitcoin", "b...
## $ symbol      <chr> "BTC", "BTC", "BTC", "BTC", "BTC", "BTC", "BTC", "BTC", "...
## $ name        <chr> "Bitcoin", "Bitcoin", "Bitcoin", "Bitcoin", "Bitcoin", "B...
## $ date        <date> 2013-04-28, 2013-04-29, 2013-04-30, 2013-05-01, 2013-05-...
## $ ranknow     <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, ...
## $ open        <dbl> 135.30, 134.44, 144.00, 139.00, 116.38, 106.25, 98.10, 11...
## $ high        <dbl> 135.98, 147.49, 146.93, 139.89, 125.60, 108.13, 115.00, 1...
## $ low         <dbl> 132.10, 134.00, 134.05, 107.72, 92.28, 79.10, 92.50, 107....
## $ close       <dbl> 134.21, 144.54, 139.00, 116.99, 105.21, 97.75, 112.50, 11...
## $ volume      <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ...
## $ market      <dbl> 1488566728, 1603768865, 1542813125, 1298954594, 116851749...
## $ close_ratio <dbl> 0.5438, 0.7813, 0.3843, 0.2882, 0.3881, 0.6424, 0.8889, 0...
## $ spread      <dbl> 3.88, 13.49, 12.88, 32.17, 33.32, 29.03, 22.50, 11.66, 18...
## $ priceYear   <chr> "2013", "2013", "2013", "2013", "2013", "2013", "2013", "...
## $ priceMonth  <chr> "04", "04", "04", "05", "05", "05", "05", "05", "05", "05...
## $ priceDay    <chr> "28", "29", "30", "01", "02", "03", "04", "05", "06", "07...
```

```
## Observations: 2,042
## Variables: 16
## $ slug        <chr> "bitcoin", "bitcoin", "bitcoin", "bitcoin", "bitcoin", "b...
## $ symbol      <chr> "BTC", "BTC", "BTC", "BTC", "BTC", "BTC", "BTC", "BTC", "...
## $ name        <chr> "Bitcoin", "Bitcoin", "Bitcoin", "Bitcoin", "Bitcoin", "B...
## $ date        <date> 2013-04-28, 2013-04-29, 2013-04-30, 2013-05-01, 2013-05-...
## $ ranknow     <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, ...
## $ open        <dbl> 135.30, 134.44, 144.00, 139.00, 116.38, 106.25, 98.10, 11...
## $ high        <dbl> 135.98, 147.49, 146.93, 139.89, 125.60, 108.13, 115.00, 1...
## $ low         <dbl> 132.10, 134.00, 134.05, 107.72, 92.28, 79.10, 92.50, 107....
## $ close       <dbl> 134.21, 144.54, 139.00, 116.99, 105.21, 97.75, 112.50, 11...
## $ volume      <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, ...
## $ market      <dbl> 1488566728, 1603768865, 1542813125, 1298954594, 116851749...
## $ close_ratio <dbl> 0.5438, 0.7813, 0.3843, 0.2882, 0.3881, 0.6424, 0.8889, 0...
## $ spread      <dbl> 3.88, 13.49, 12.88, 32.17, 33.32, 29.03, 22.50, 11.66, 18...
## $ priceYear   <chr> "2013", "2013", "2013", "2013", "2013", "2013", "2013", "...
## $ priceMonth  <chr> "04", "04", "04", "05", "05", "05", "05", "05", "05", "05...
## $ priceDay    <chr> "28", "29", "30", "01", "02", "03", "04", "05", "06", "07...
```

4 Data Analysis

The aim of the data analysis was to obtain a better picture on the type of data available in the dataset. Some useful insights were gained on the number of crypto's, top 20 crypto's by market capitalization, price actions and price history.

4.1 General

Data accurate to 21 May 2018.

Number of unique Crypto Currencies

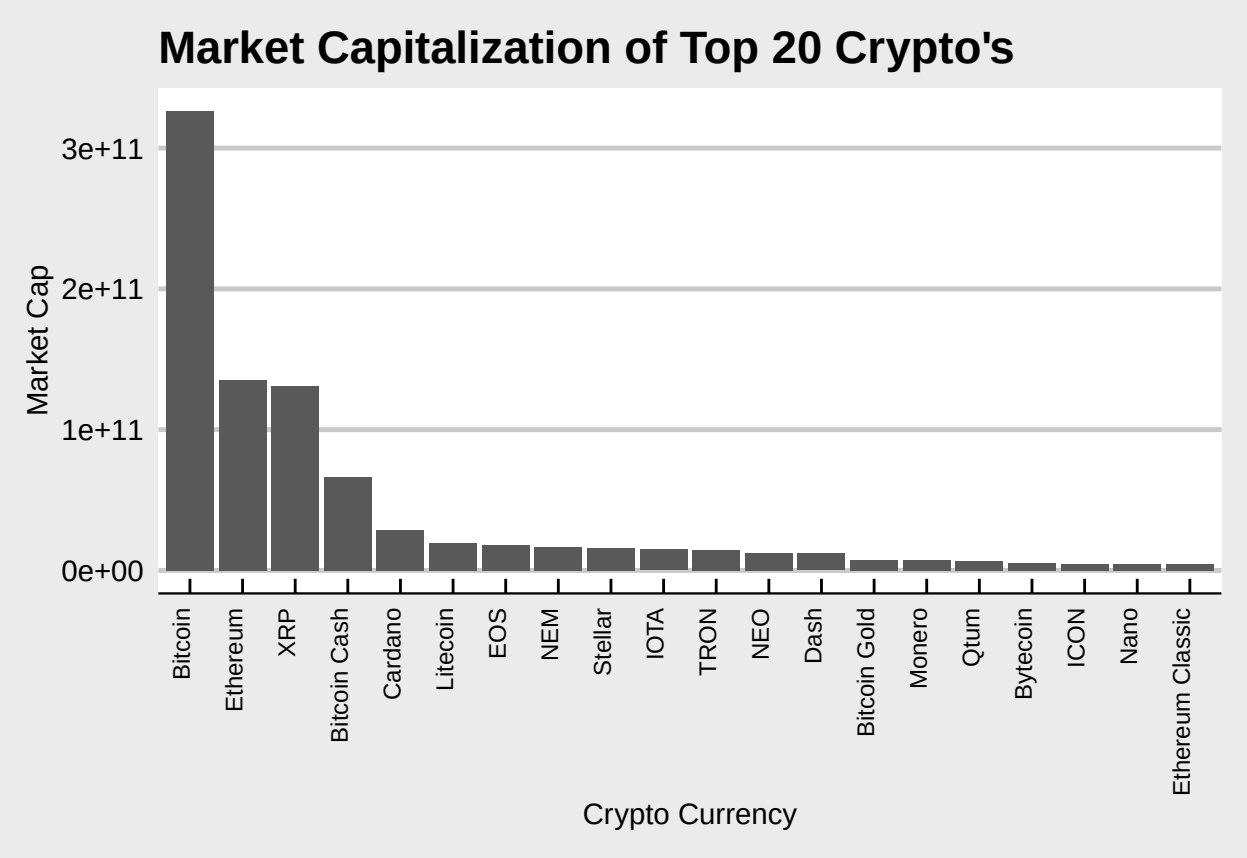
Based on the dataset, the number of unique crypto currencies are:

x
2005

Note: Nr of Unique Crypto Currencies

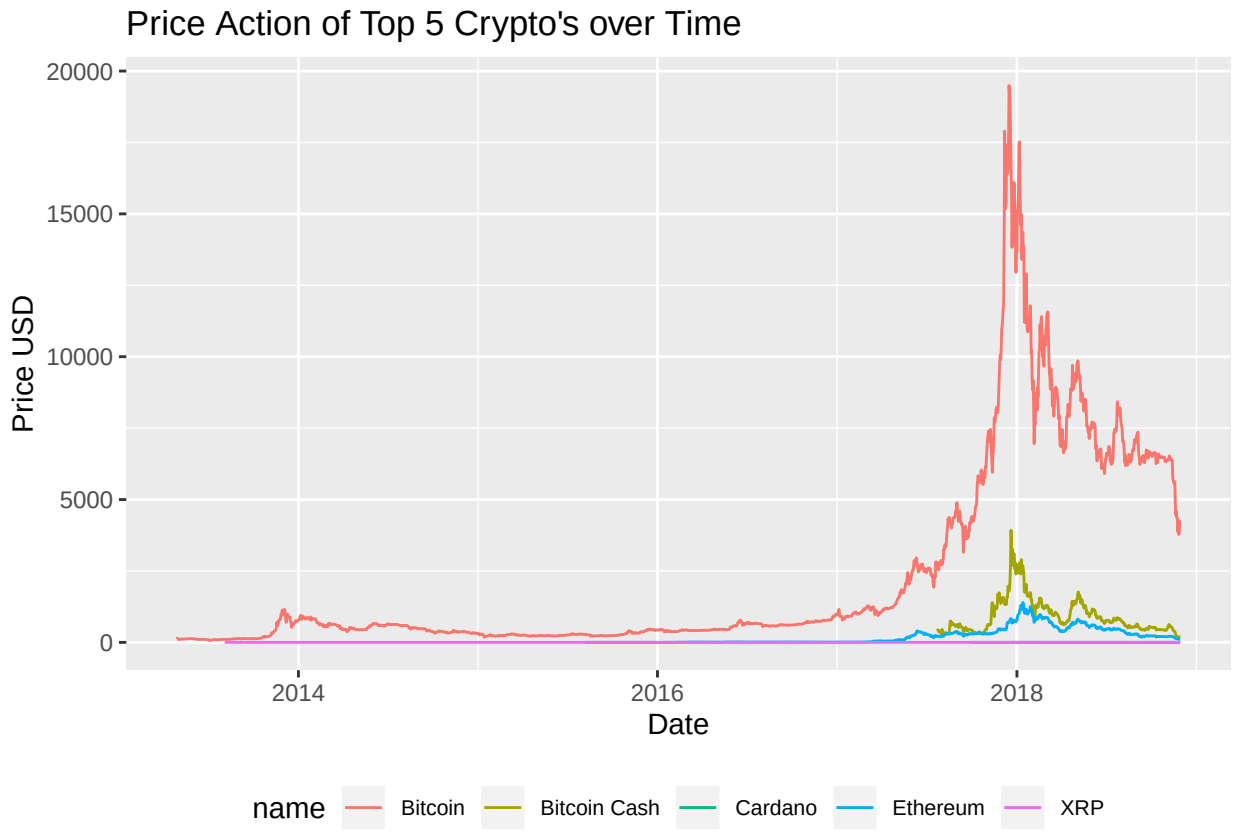
Top 20 Cryptos per Market Capitalization

From the graph below, Bitcoin was still the top crypto to invest in based on market Capitalization



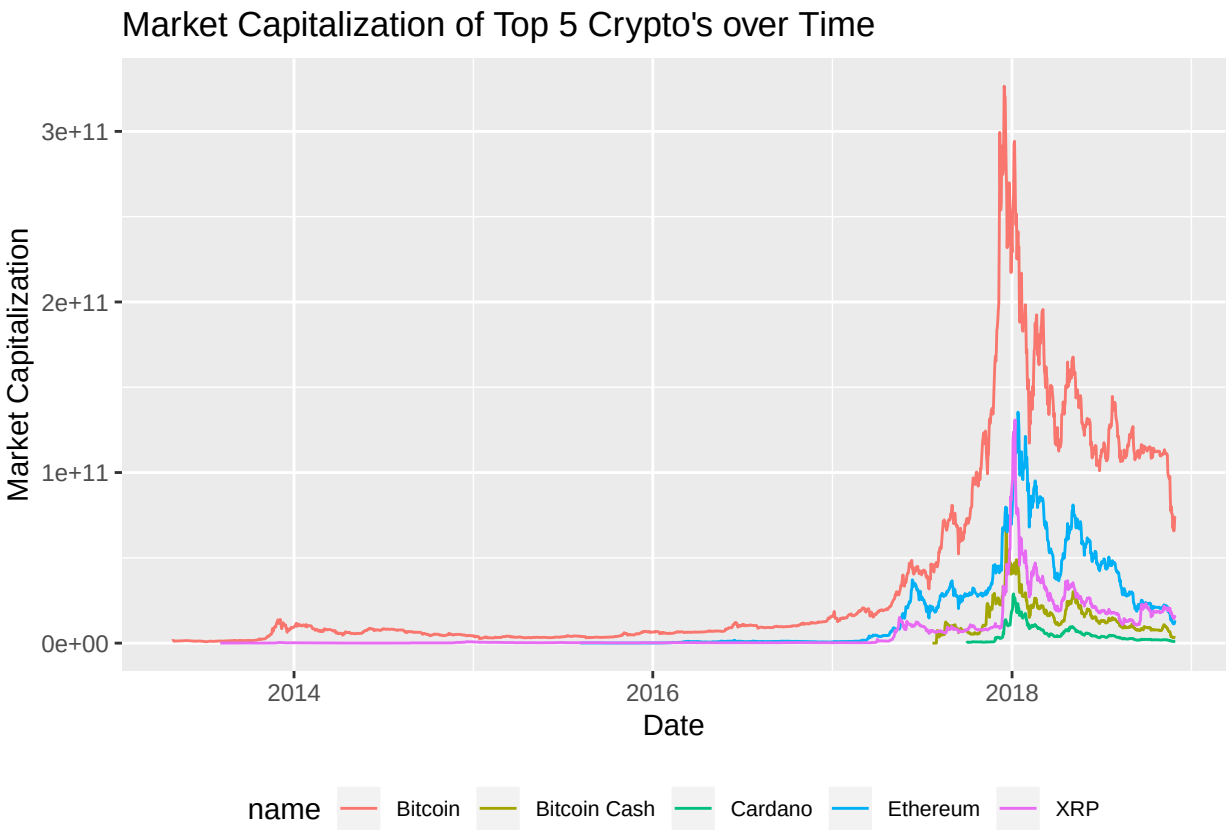
Top 5 Cryptos Price Action over Time

From the graph below, the price actoim for the top 5 cryptos increased rapidly from 2017 to the start of 2018. Bitcoin was the first crypto currency to "break out", followed by the rest of the altcoins. From this data, Bitcoin can be seen as the leading indicator for price movement (meaning if the price of Bitcoin goes up, there is a big probability that the prices of other altcoins will also go up, with a delayed effect).



Top 5 Cryptos Market Capitalization over Time

From the graph below indicates the market Capitalization over time for the top 5 crypto currencies. Bitcoin has the highest market cap.

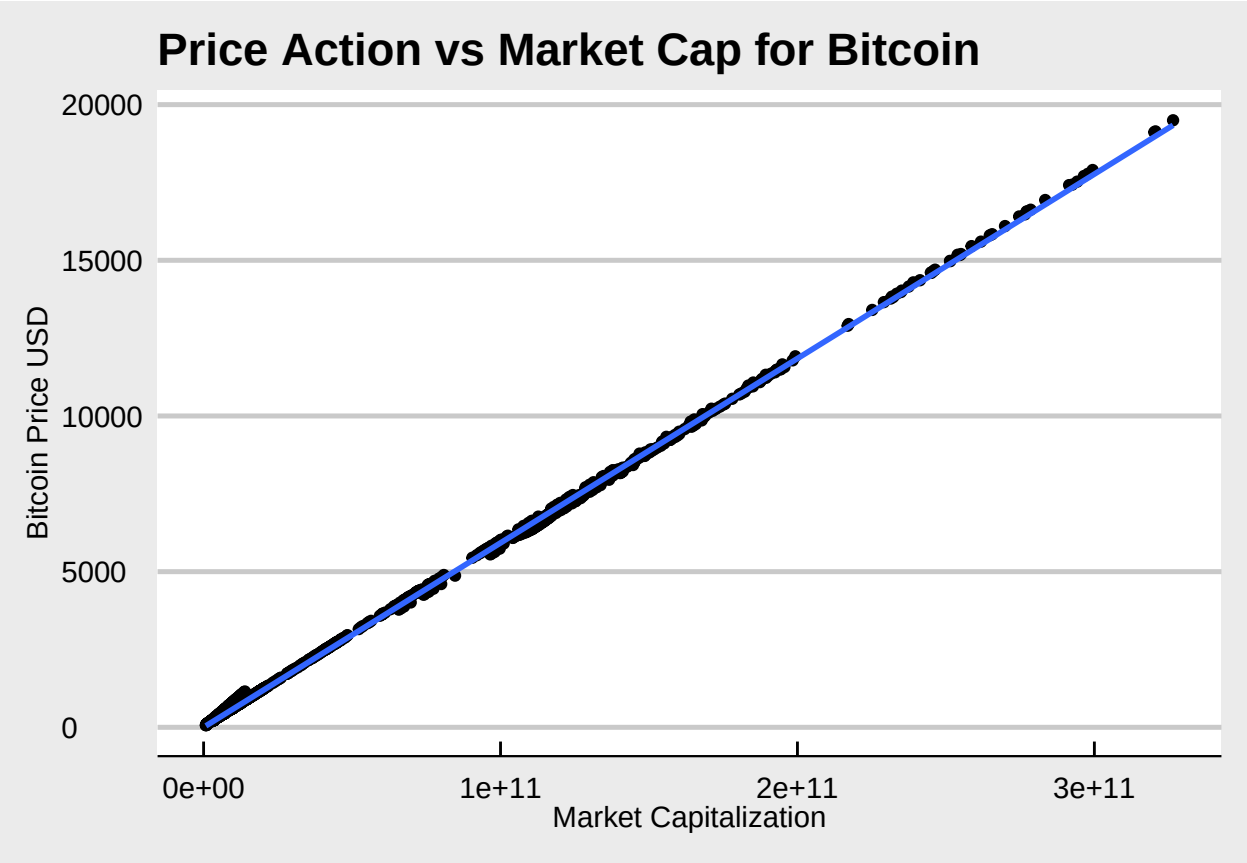


4.2 Bitcoin Specific Analysis

This section focusses on data analysis for Bitcoin only.

Price Action vs Market Capitalization for Bitcoin

From the graph below, the price per Bitcoin (in USD) is directly related to the market Capitalization.

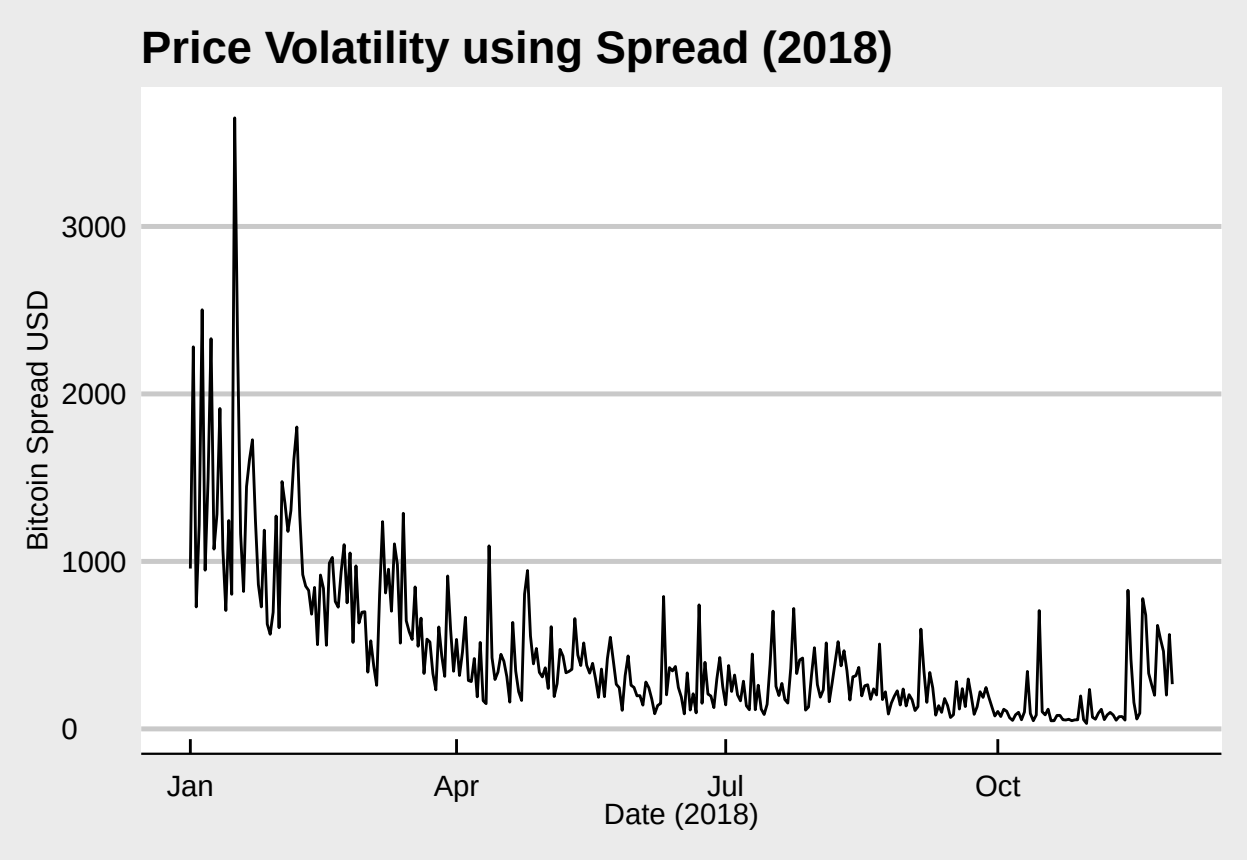


Determine Up and Down Months

From the graph below, the up and down months are investiaged over time using the difference in open and closing spread per month. The limit for the spread is > 0 (indicating an up month). No pattern exists.

Investigate Price Volatility of 2018

From the graph below for the daily spread (difference between start and closing price per day) of Bitcoin price, the price is extremely volatile making it a high risk investment.



Classical Seasonal Decomposition by Moving Averages for Bitcoin

The decompose function in r enables decomposition of a time series into seasonal, trend and irregular components using moving averages (aditive or multiplicative seasonal component).

The function uses the following formulas:

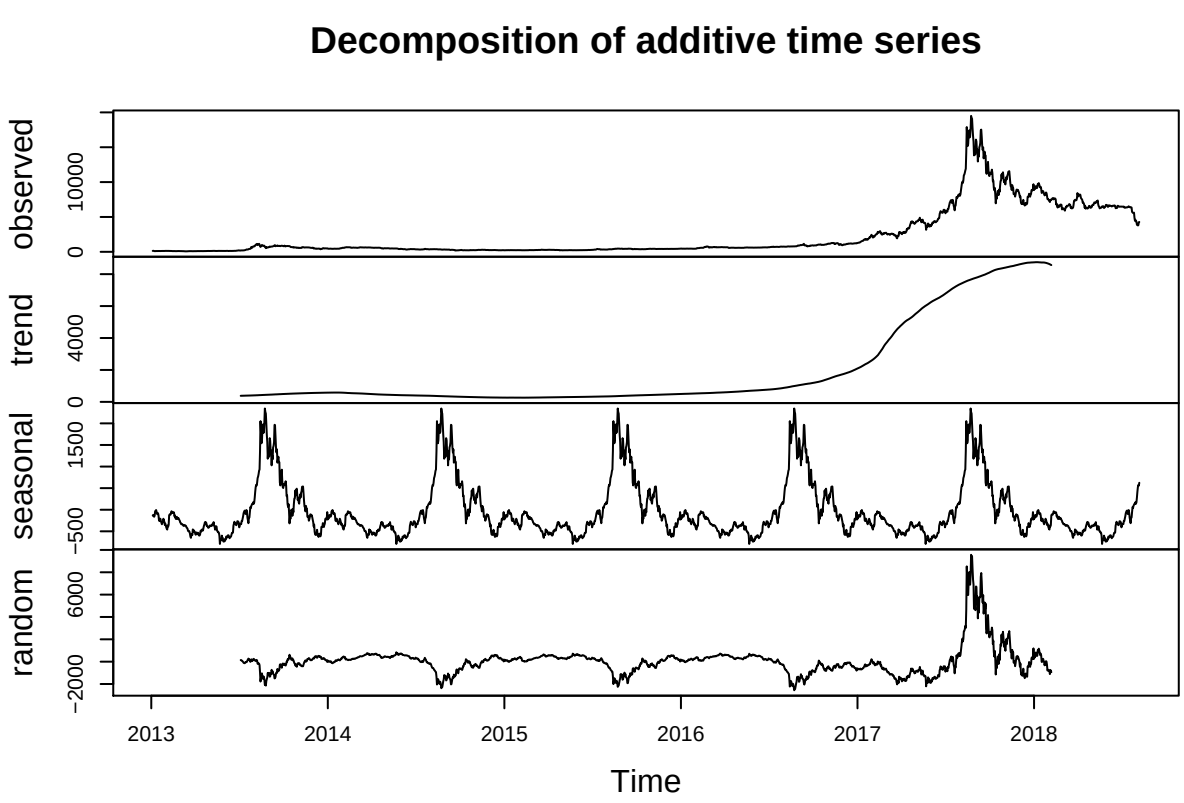
Additive Model:

$$Y_t = T_t + S_t + e_t$$

Multiplicative model Model:

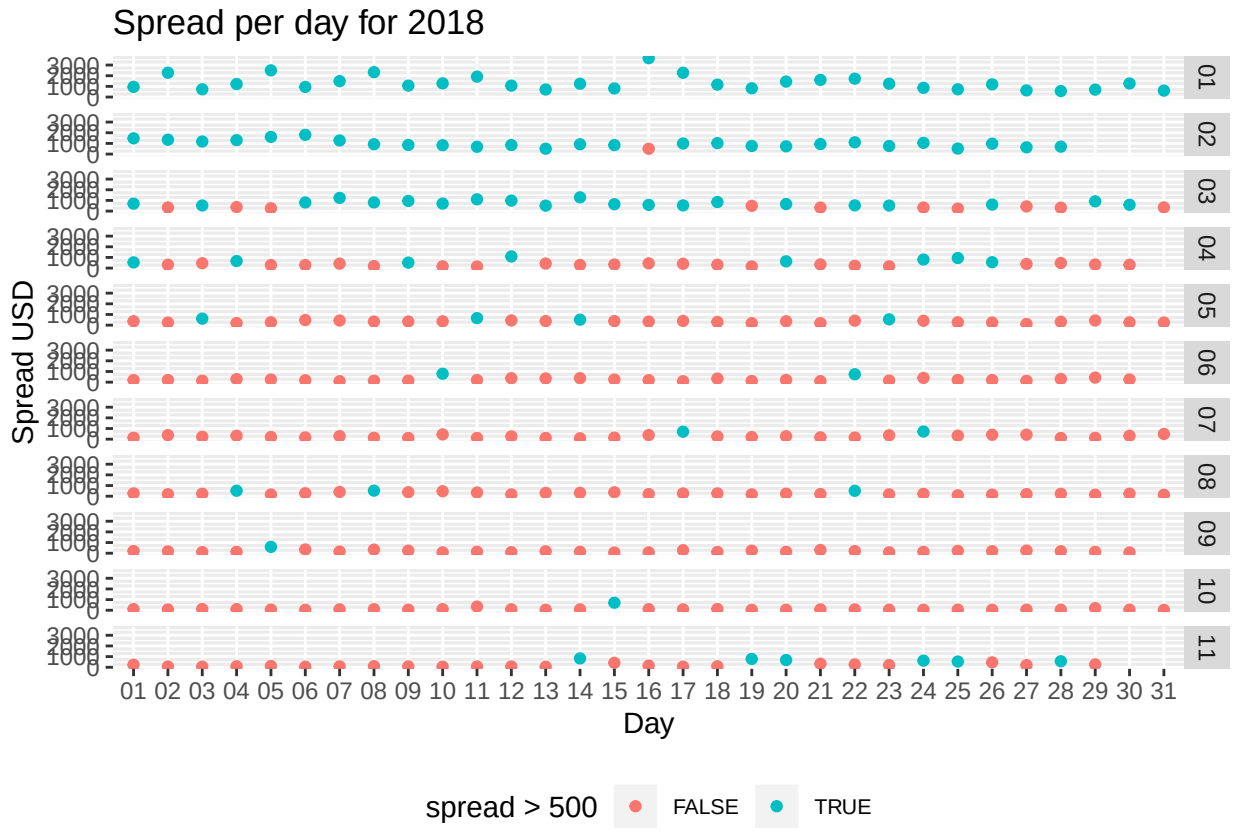
$$Y_t = T_t S_t e_t$$

The graph below indicates the following:
Trend: trend from observed data by using moving averages. The overall trend is upwards.
Seasonal: computed by averaging, for each time unit, over all periods. The selected frequency is 365.25 (one year). The seasonal trend indicates that the market cycle is up and down and repeats itself.
Random: the remainder part



Determine if pattern exists for uptrend using the spread

Using the spread column (difference between start and closing price per day), the graph below tries to identify an uptrend pattern for specific days using a spread cut-off of 500USD. As seen below, there is no pattern that repeats itself.



Estimate Price Change based on changes in Market Cap

Using linear regression (lm), the price increase of one Bitcoin vs changes in market cap can be determined. The intercept is 6.432, which predicts the price of one bitcoin when the total market cap is 0 (i.e $6.432). The slope of 5.873 indicates that the average predicted price of Bitcoin will increase by $5.8 for every $1 increase in total Bitcoin circulation supply.

```
#Determine $ increase in price based on market cap

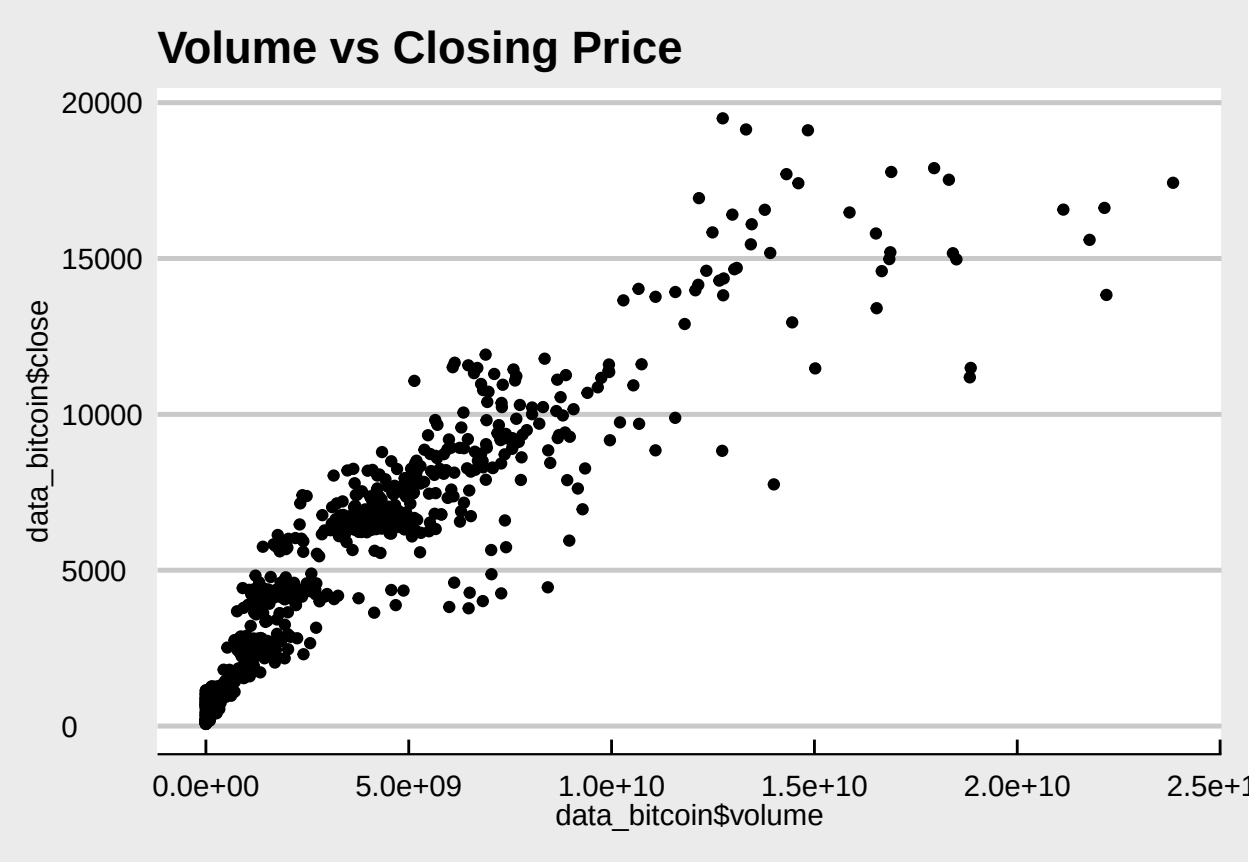
doll_inc <-lm(close~market, data=data_bitcoin)
summary(doll_inc)
```

```
##
## Call:
## lm(formula = close ~ market, data = data_bitcoin)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -193.77  -24.54  -16.72   32.29  270.35
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 6.432e+01  1.899e+00   33.87   <2e-16 ***
## market      5.873e-08  2.725e-11 2155.40   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 72.05 on 2040 degrees of freedom
## Multiple R-squared:  0.9996, Adjusted R-squared:  0.9996
## F-statistic: 4.646e+06 on 1 and 2040 DF,  p-value: < 2.2e-16
```

4.3 Distributions

Normal Distribution Fit Test

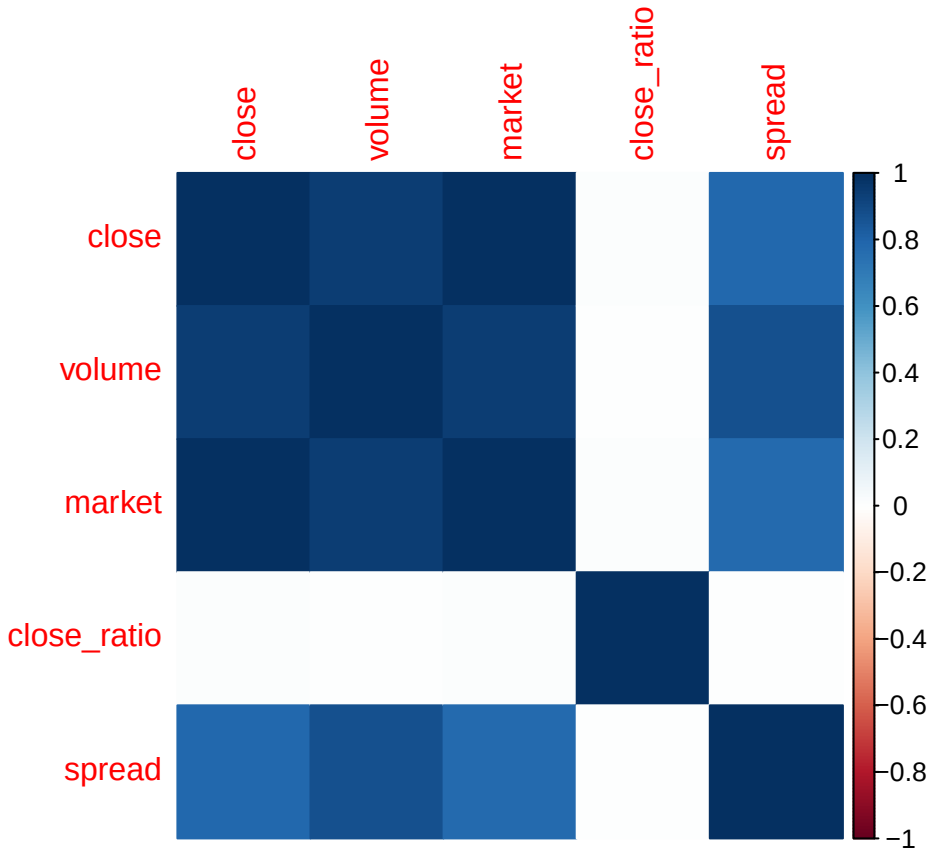
From the QQ-Plot below, the distribution of the bitcoin data is not normal. We are thus using an univariate time series (with a single time-dependent variable).



Correlation Plot

The correlation plot below shows the correlation between the closing price, volume, market cap, close_ratio and spread. The close_ratio is a calculation from different variables, hence 0 correlation.

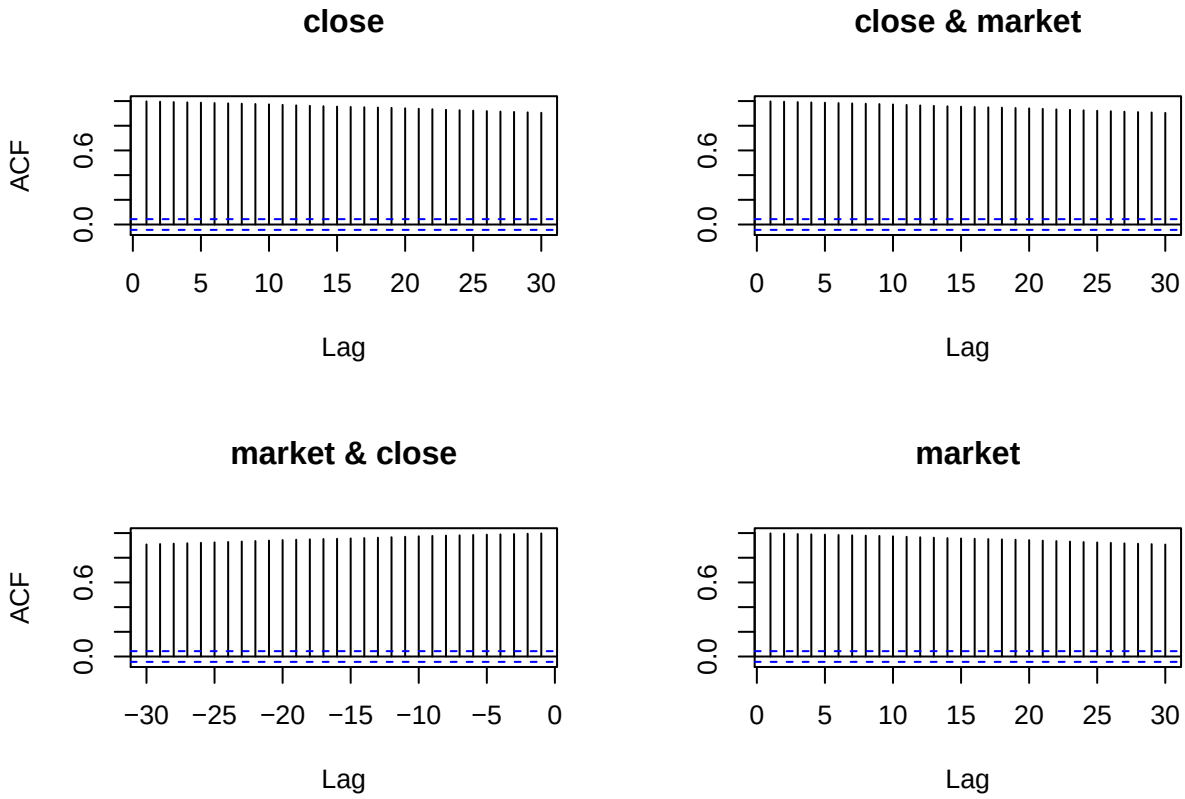
```
#Determine Correlation between price, volume and market cap,close_ratio and spread
cor_set <- cor(data_bitcoin[,9:13])
corrplot::corrplot(cor_set, method =  "color")
```



Auto-Correlation Test

The Auto-Correlation test shows that the relationship between the closing price and market cap. Seeing that the ACF does not fail within the 0 band below, there is correlation between the closing price and the market cap and limited randomness.

```
## List of 6
##  $ acf   : num [1:30, 1:2, 1:2] 0.997 0.995 0.992 0.989 0.987 ...
##  $ type  : chr "correlation"
##  $ n.used: int 2042
##  $ lag   : num [1:30, 1:2, 1:2] 1 2 3 4 5 6 7 8 9 10 ...
##  $ series: chr "ACFdata"
##  $ snames: chr [1:2] "close" "market"
##  - attr(*, "class")= chr "acf"
```



5 Methodology

This section describes the machine learning and forecasting methodology followed.

5.1 Modelling Approach

Due to the dataset being a univariate time-series, the following modelling approaches will be followed:

- glm, svmLinear, knn, gamLoess,rf,bayesglm
- Tuned gamLoess
- Tuned random forest (rf)
- ARIMA (Autoregressive Integrated Moving Average)
- Forecasting using various methods

5.2 Training and Test Data Sets

A training and test data set was created with a 80%/20% split for the machine learning algorithm.

```
set.seed(1, sample.kind="Rounding")

#Create smaller dataset for training and testing models
test_index<-sample(1:nrow(data_bitcoin),0.80*nrow(data_bitcoin), replace=FALSE)
train_set <- data_bitcoin[test_index,]
test_set <- data_bitcoin[-test_index,]

#Check if NA's exist in data sets
train_set_na <- sapply(train_set, function(x) sum(is.na(x)))
kable_table(train_set_na,"Check NA's train_set Dataset")
```

	x
slug	0
symbol	0
name	0
date	0
ranknow	0
open	0
high	0
low	0
close	0
volume	0
market	0
close_ratio	0
spread	0
priceYear	0
priceMonth	0
priceDay	0

Note: Check NA's train_set Dataset

```
test_set_na <- sapply(test_set, function(x) sum(is.na(x)))
kable_table(test_set_na,"Check NA's test_set Dataset")
```

	x
slug	0
symbol	0
name	0
date	0
ranknow	0
open	0
high	0
low	0
close	0
volume	0
market	0
close_ratio	0
spread	0
priceYear	0
priceMonth	0
priceDay	0

Note: Check NA's test_set Dataset

5.3 Machine Learning Algorithms

5.3.1 Model 1: Predicting Values from Various Models in Caret Package

The first approach is to determine whether the "glm", "svmLinear", "knn", "gamLoess","rf" models in the caret package can actually predict an exact price when trained against the market cap predictor.

```
## [1] "glm"
## [1] "svmLinear"
## [1] "knn"
## [1] "gamLoess"
## [1] "rf"
## [1] "bayesglm"
```

	x
glm	0
svmLinear	0
knn	0
gamLoess	0
rf	0
bayesglm	0

Note: Accuracy of various Models

Based on the results table, the different algorithms are able to predict a value, but not the exact same value as in the test set (hence the accuracy of 0).

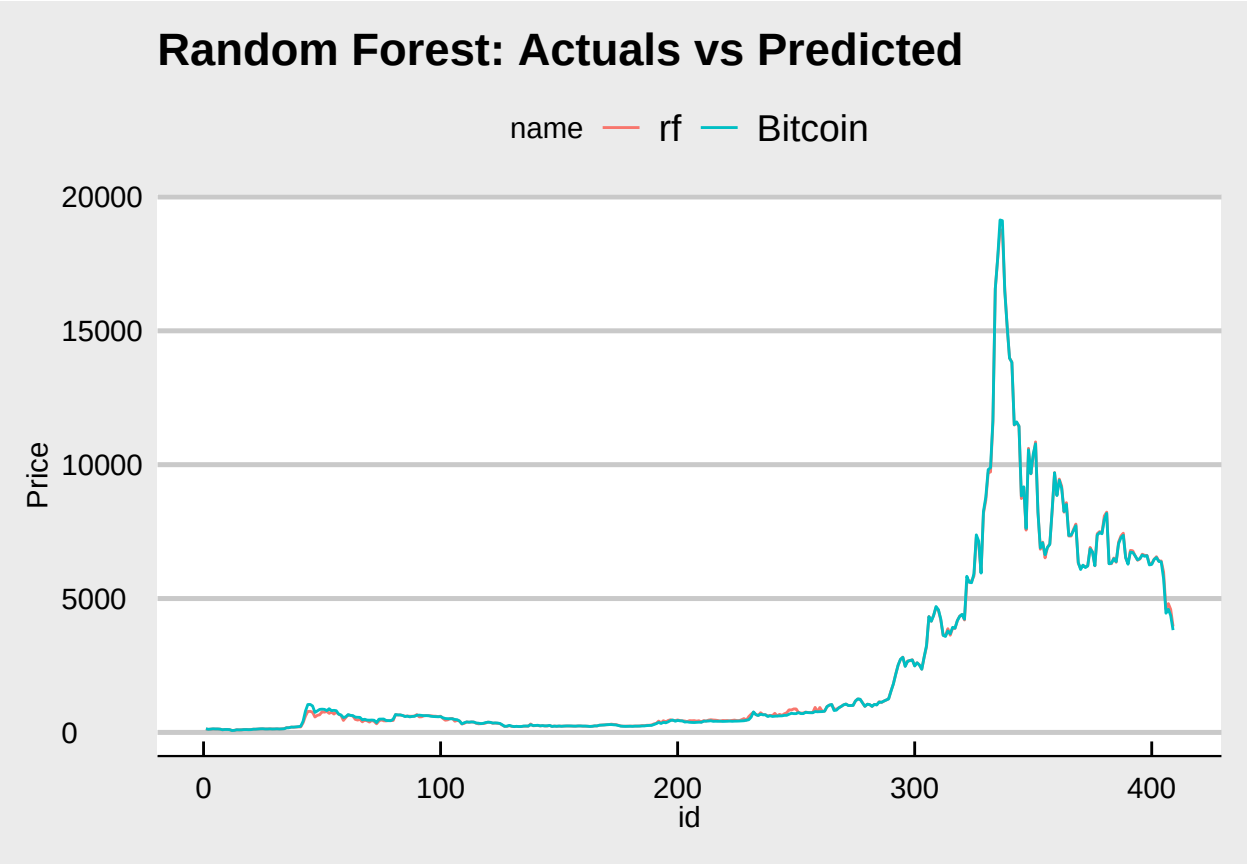
If RMSE is used as a prediction accuracy metric, the results is as follows:

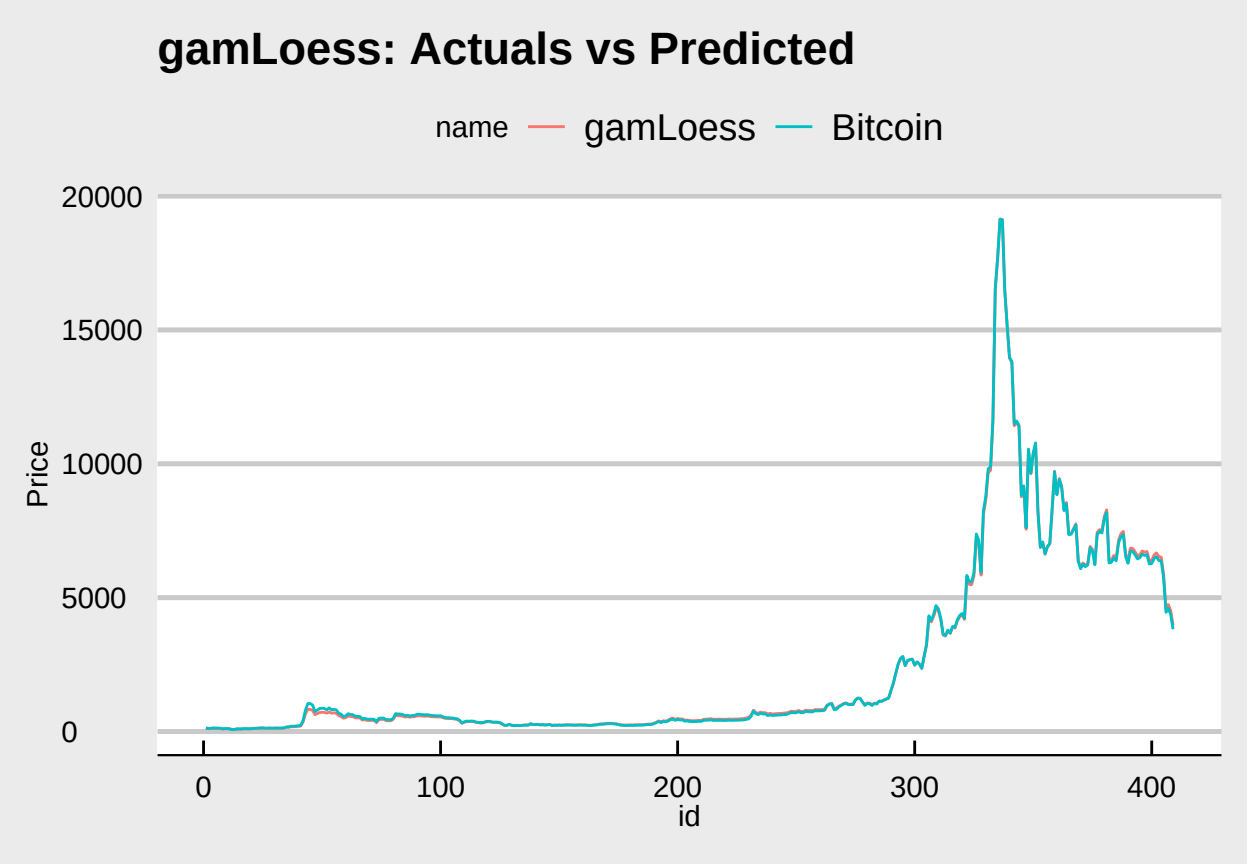
Dataset	Model	RMSE
Train/Test	glm	75.55547
Train/Test	svmLinear	243.89321
Train/Test	knn	93.70216
Train/Test	gamLoess	57.83450
Train/Test	rf	61.62369
Train/Test	bayesglm	75.55547

Note: RMSE of Various Models

From the results above, the gamLoess and random forest methods yield the best prediction of the Bitcoin price (gamLoess = 57.83USD and Random Forest = 61.62USD). The RMSE might seem high, but the Bitcoin price range was between 0-16000USD, so 60USD RMSE is not that bad!

The graphs belows shows the actuals vs predicted values for the Random Forest and gamLoess Models:





5.3.2 Model 2: Tuned gamLoess Model

The only two tuning parameters to tune the gamLoess model is the span and degree parameters. The optimal tuning parameters are as follows:

span	degree
0.5	1

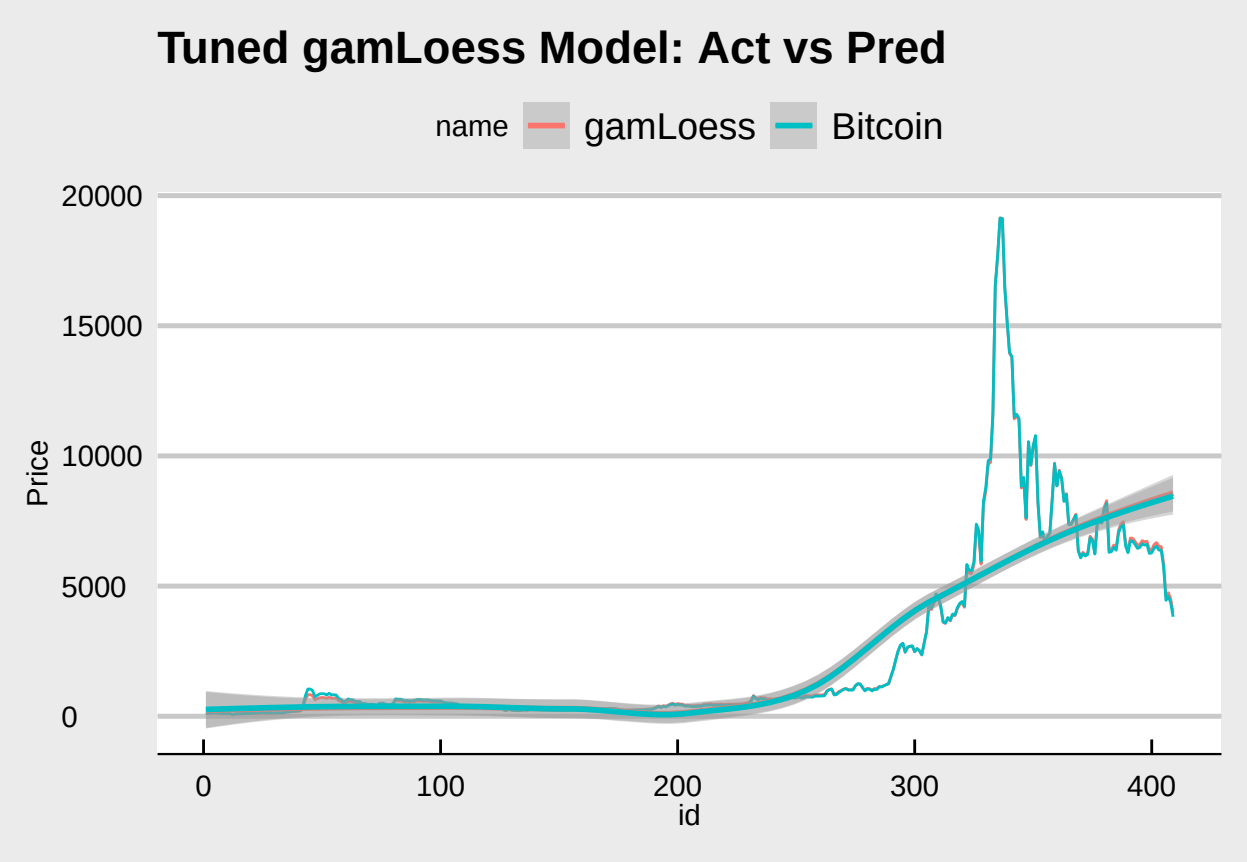
Note: Optimized Tuning Parameters

Applying these tuning parameters, yields the following results:

Dataset	Model	RMSE
Train/Test	gamLoess	57.8345
Train/Test	Tuned gamLoess	57.8345

Note: RMSE of Tuned gamLoess Model

Plotting the actuals vs predicted values yields the following results:



The tuning parameters did not improve the RMSE which indicates that the train function has selected the optimal tuning parameters.

5.3.3 Model 3: Tuned Random Forest Model

From the previous results, the random forest model can be tuned to possibly improve the RMSE by selecting 50 trees and determining the optimal mtry tuning parameter (in this case mtry was 19). The tuned RMSE is as follows:

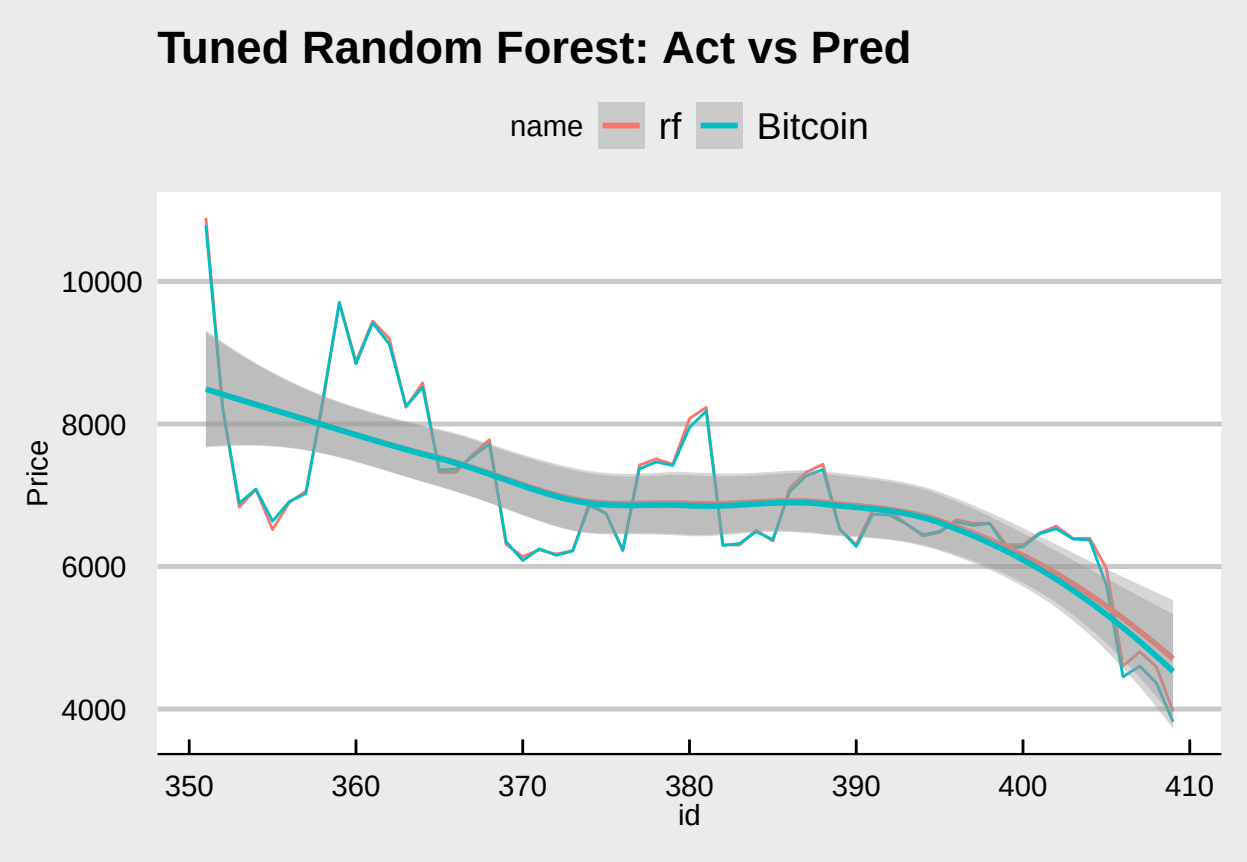
	mtry
19	19

Note: Optimal mtry Parameter for RF Model with 100 trees

Dataset	Model	RMSE
Train/Test	rf	61.62369
Train/Test	Tuned rf	64.35228

Note: RMSE of Tuned Random Forest Model

Plotting the actuals vs predicted values yields the following results:



The tuning parameters did not improve the RMSE which indicates that the train function has selected the optimal tuning parameters.

5.3.4 Model 4: ARIMA Model

"The AR part of ARIMA indicates that the evolving variable of interest is regressed on its own lagged (i.e., prior) values. The MA part indicates that the regression error is actually a linear combination of error terms whose values occurred contemporaneously and at various times in the past. The I (for "integrated") indicates that the data values have been replaced with the difference between their values and the previous values (and this differencing process may have been performed more than once). The purpose of each of these features is to make the model fit the data as well as possible."

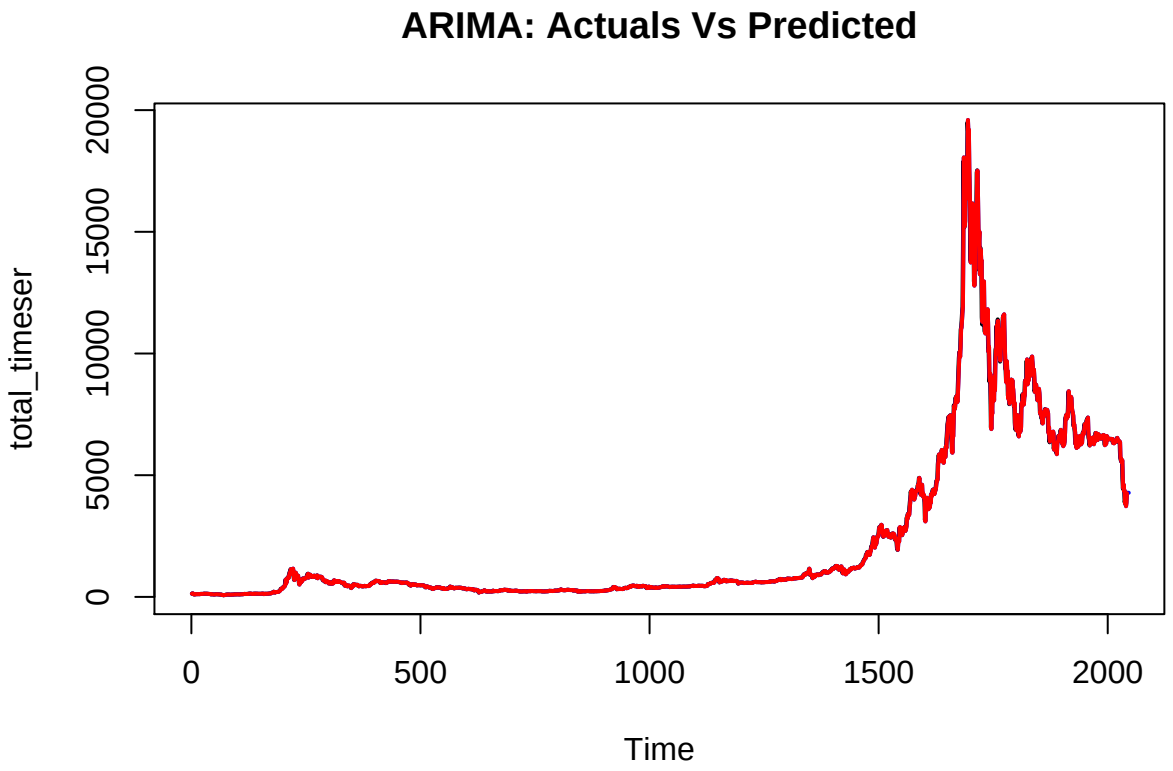
The create the ARIMA model, a time-series object was created for the dataset.

The ARIMA model provides the following metrics

- ME (Mean error): sum(et)/n
- MAE (Mean absolute error): sum(|et|)/n
- MPE (Mean percentage error): sum((et/Yt)*100)/n
- MAPE (Mean absolute percentage error): sum((|et|/Yt)*100)/n
- MSE (Mean squared error): sum(et*et)/n
- RMSE (Root of mean square error): sqrt(sum(et*et)/n)
- U (Theil's U statistic): RMSE of the forecast/RMSE of the naive forecast

- [The Yt is 'observation series'. The Ft is 'Forecasting series'. The et is 'residual series'. The n is size of sample.]

The fitted results of the ARIMA model is shown below:



Tuning the model with a set frequency and start date provide the following results:

	ME	RMSE	MAE	MPE	MAPE	MASE	ACF1
Training set	1.934868	234.1335	79.83212	0.0696678	2.791085	0.0398904	0.0056099

Note: ARIMA Results

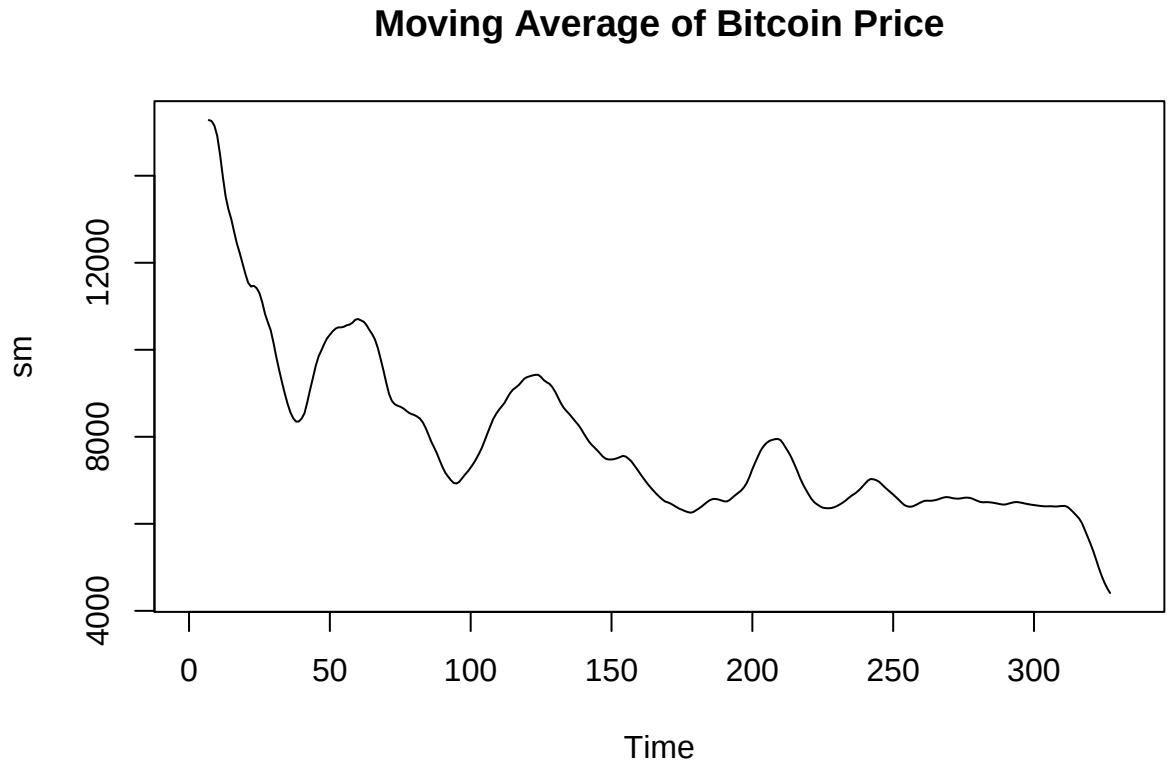
The RMSE of the ARIMA model is 234.1335, which is substantially more than the gamLoess and random forest models.

5.4 Forecasting Future Values

This sections explores the different forecasting packages and their results using some well-known R-libraries for forecasting time-series data from previous data only.

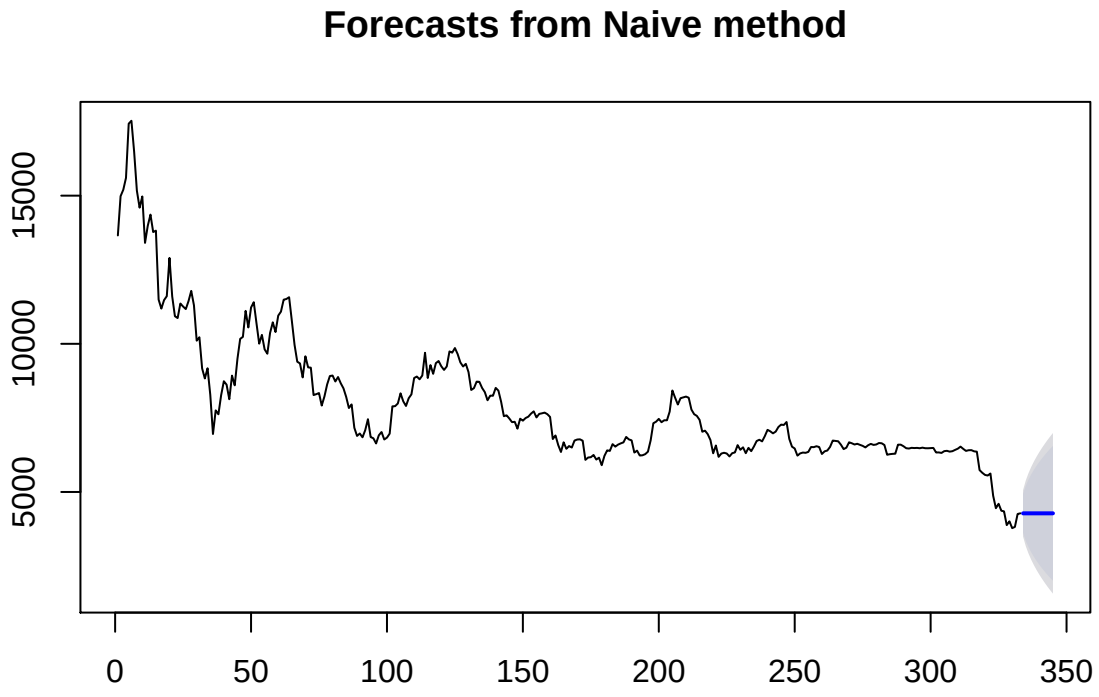
5.4.1 General

12 month Moving-Average The 12 month moving average shows a down-trend.



Naive Forecasting

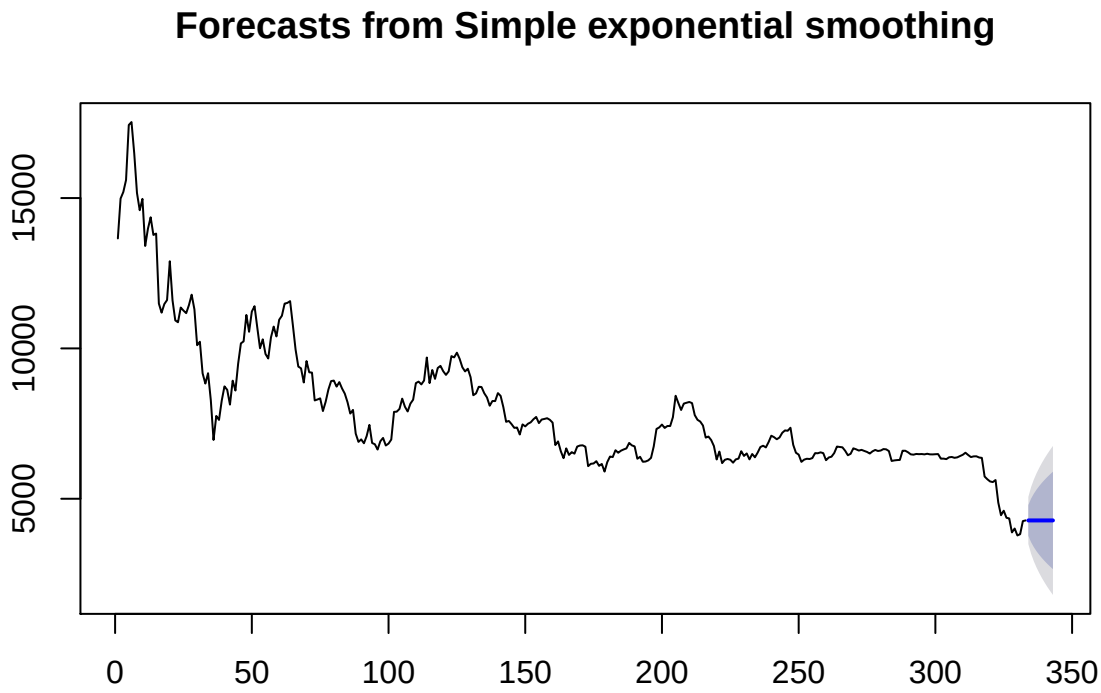
The accuracy of the model is defined by the Mean absolute scaled error (MASE) parameter, in this case it is 1.




```
##                      ME     RMSE      MAE        MPE     MAPE MASE       ACF1
## Training set -28.24804 399.3412 249.7161 -0.4425515 2.948514    1 0.01541794
```

Exponential Smoothing with Forecasting

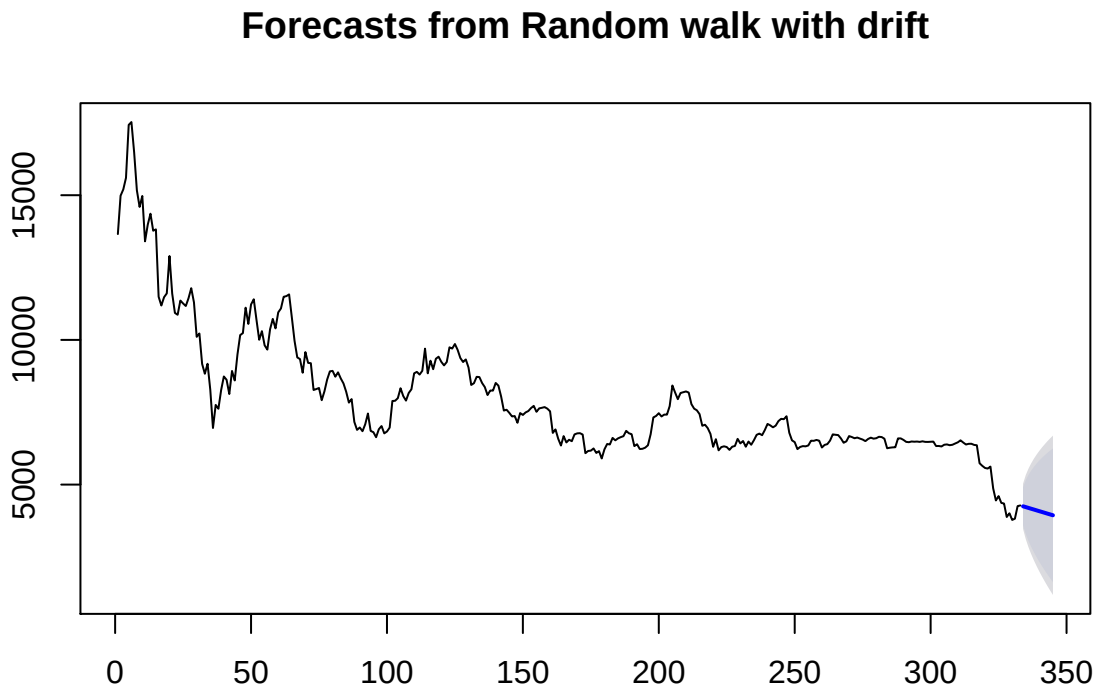
The accuracy of the model is defined by the MASE parameter, in this case it is 0.997011.




```
##                      ME    RMSE      MAE        MPE     MAPE     MASE       ACF1
## Training set -28.16926 398.742 248.9697 -0.4412905 2.939674 0.997011 0.01621933
```

Random Walk Drift Forecasting

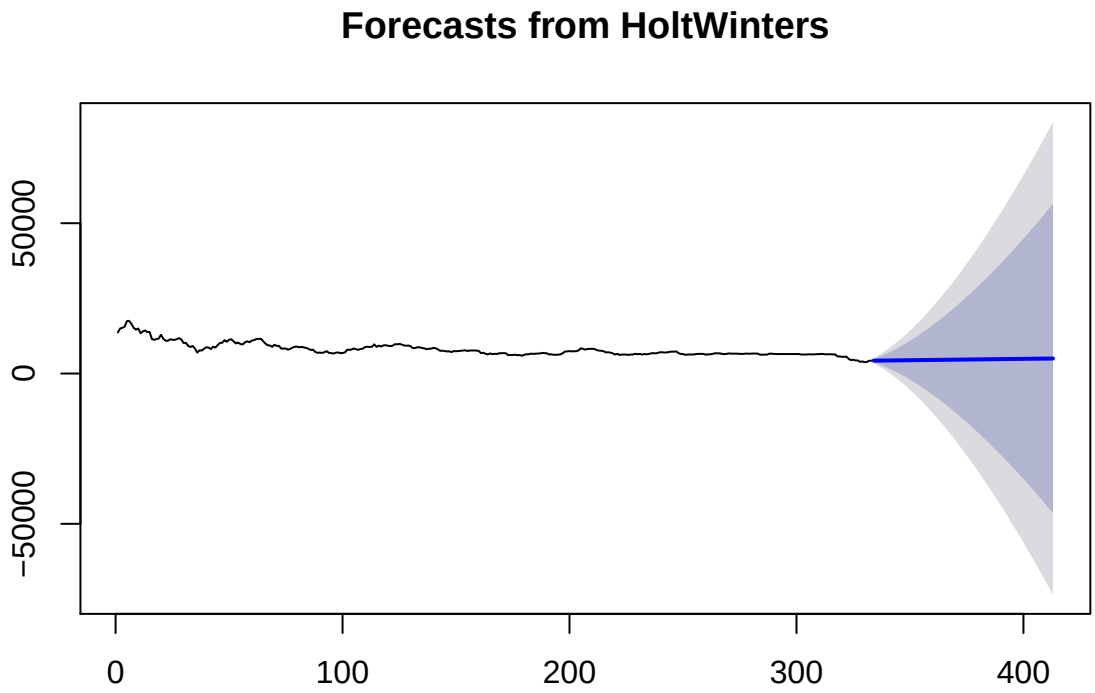
The accuracy of the model is defined by the MASE parameter, in this case it is 1.012579.




```
##                        ME     RMSE      MAE         MPE     MAPE     MASE
## Training set 4.109677e-14 398.3409 252.8573 -0.06247443 2.988355 1.012579
##                     ACF1
## Training set 0.01541794
```

Holts Forecasting

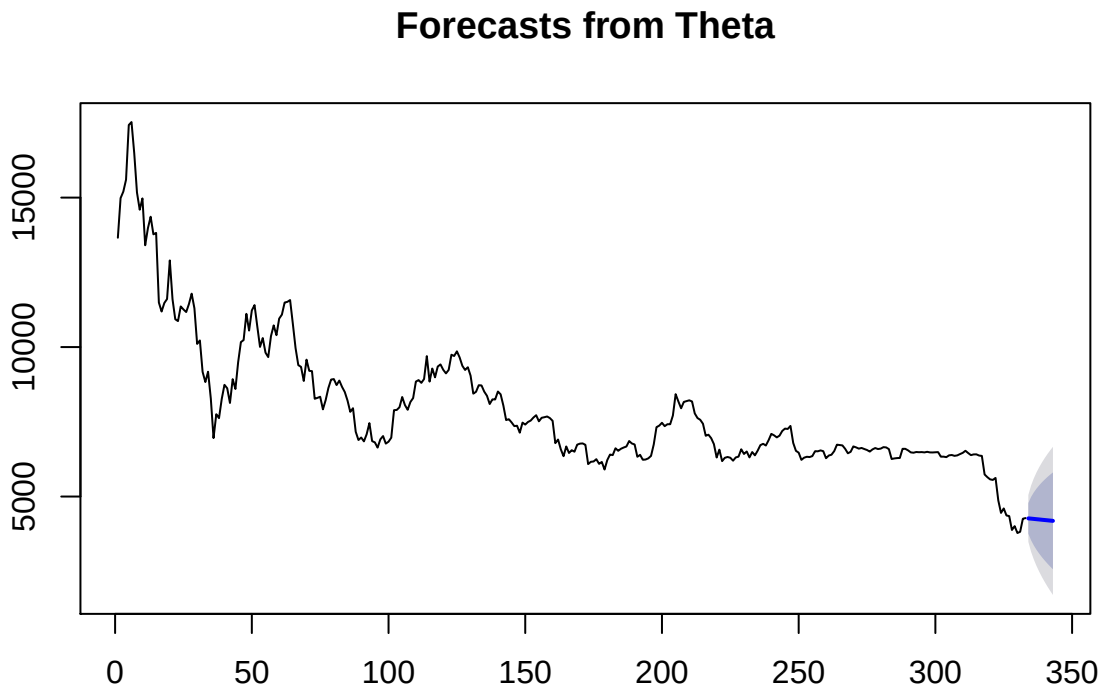
The accuracy of the model is defined by the MASE parameter, in this case it is 1.104114.




```
##                      ME     RMSE      MAE        MPE     MAPE     MASE
## Training set -18.87669 427.9037 275.7151 -0.1021342 3.234142 1.104114
##                       ACF1
## Training set -0.001070133
```

Thetha Forecasting

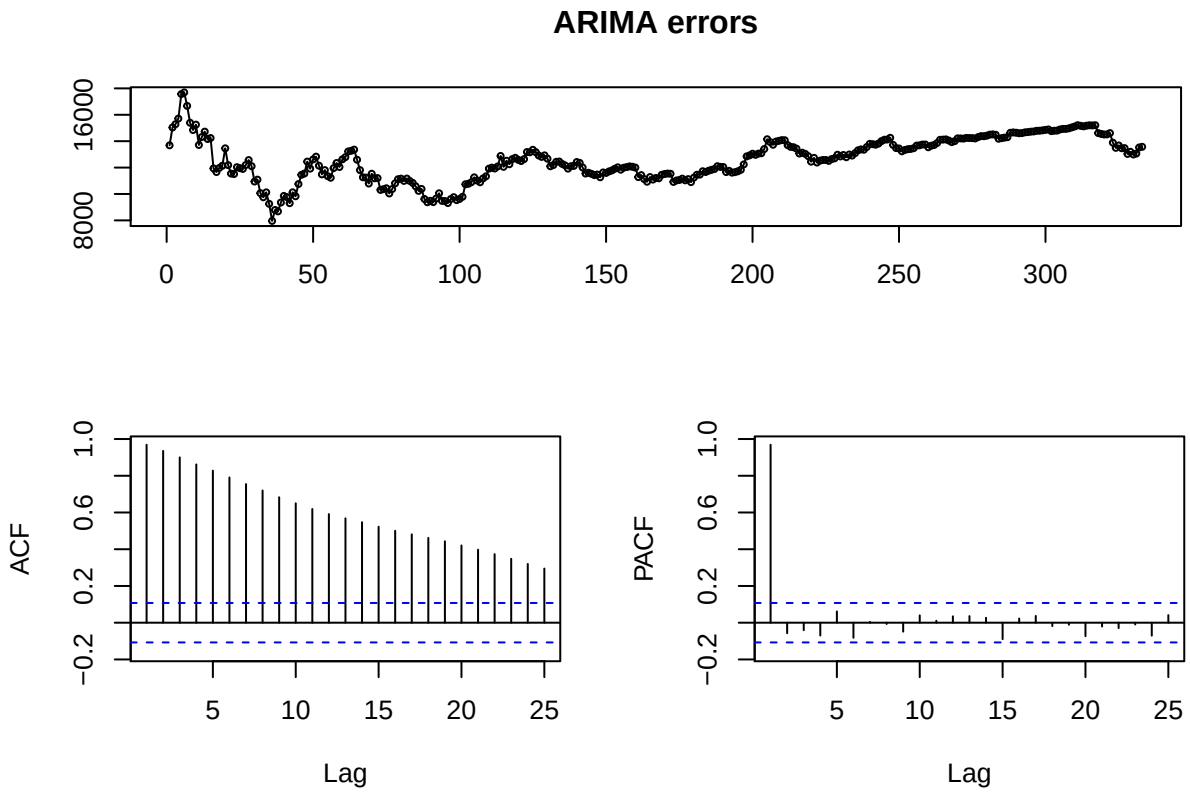
The accuracy of the model is defined by the MASE parameter, in this case it is 0.997011.

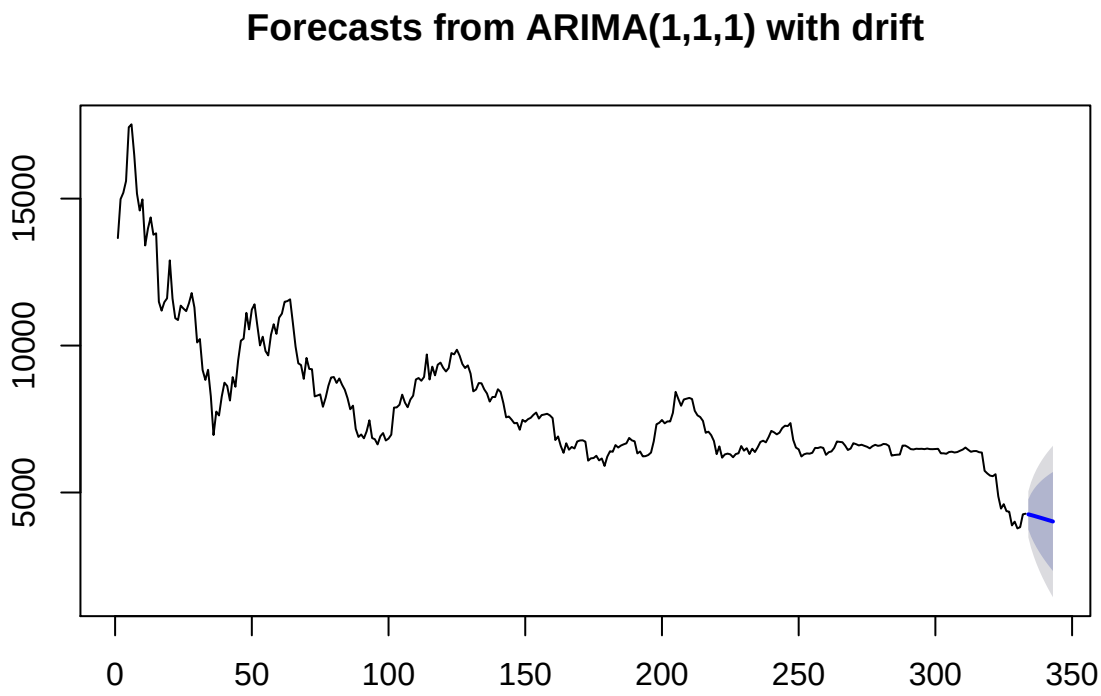



```
##                      ME    RMSE      MAE        MPE     MAPE     MASE       ACF1
## Training set -28.16926 398.742 248.9697 -0.4412905 2.939674 0.997011 0.01621933
```

Auto ARIMA

The accuracy of the model is defined by the MASE parameter, in this case it is 1.008002. The ARIMA Errors graph indicates that there is limited randomness in the data.






```
##                       ME     RMSE      MAE        MPE     MAPE     MASE
## Training set -0.2425097 397.6069 251.7142 -0.0620309 2.976051 1.008002
##                       ACF1
## Training set -0.007551501
```

5.4.2 Estimating Bitcoin Price

Estimate Variance and Mean for next Day using Garch/ARIMA combination

Using the Garch/Arima combination, the price variance and mean for the next day can be forecasted:

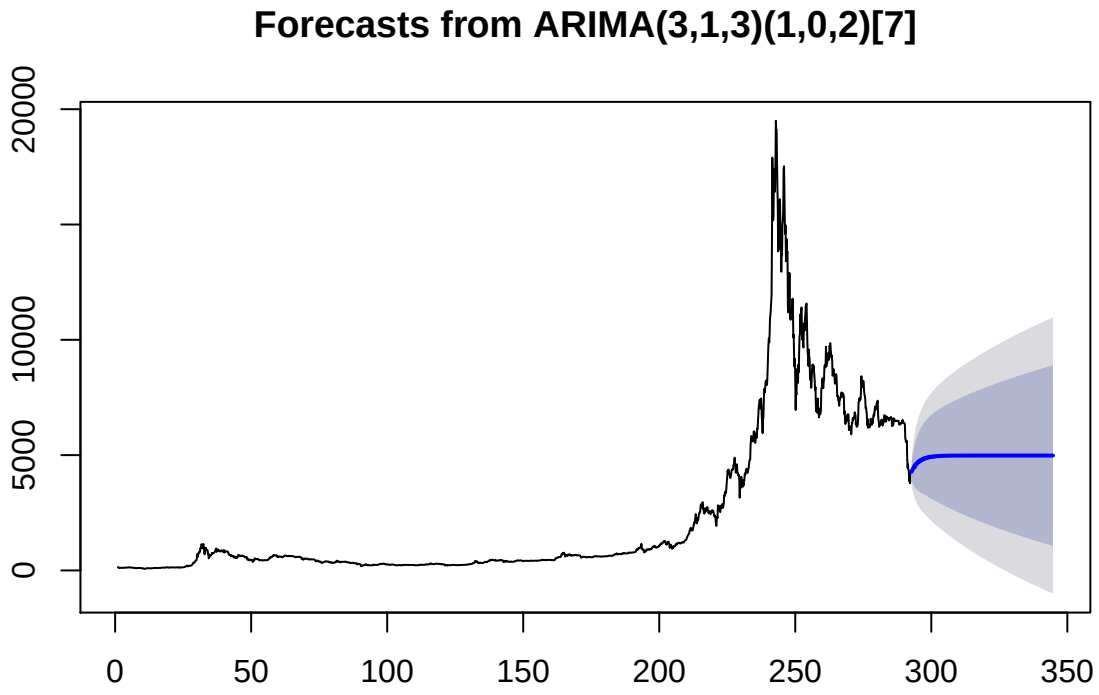
```
##    Point SSL.forecast VAR.forecast
##  (409,3)    -0.001856     0.002949
```

	Point	SSL.forecast	VAR.forecast
	(409,3)	-0.001856	0.002949

Note: Mean and Variance Forecast for next day

Forecast price of Bitcoin for next year

Using the ARIMA model, the price of Bitcoin can be estimated for the next year. The price window limits is between 1975 USD and 9580 USD.



6 Results

Models

From the first set of models evaluated, which includes the glm, svmLinear, knn, gamLoess and rf methods, the gamLoess approach provided the best RMSE results. Tuning of both the random forest and gamLoess models did not improve the RMSE. Using the ARIMA model to model time-series data, the gamLoess model still offered a higher prediction accuracy.

Final RMSE Results

Dataset	Model	RMSE
Train/Test	glm	75.55547
Train/Test	svmLinear	243.89321
Train/Test	knn	93.70216
Train/Test	gamLoess	57.83450
Train/Test	rf	61.62369
Train/Test	bayesglm	75.55547
Train/Test	Tuned gamLoess	57.83450
Train/Test	Tuned rf	64.35228
Bitcoin	Auto ARIMA	234.13355

Note: RMSE of all Models

Forecasting

From the several forecasting methods evaluated, the Exponential Smoothing and Thetha method forecasting provided the lowest MASE of 0.997011. This is less than 1, indicating that it is better than the naive forecasting method. The forecasting takes only only variable into consideration which can lead to inaccurate results in a volatile market.

7 Conclusion

This project offered a unique challenge due to the fact that the data was in univariate time-series format. The machine learning models evaluated provided adeqaute results for a start, but there is still a lot of optimization that can be done. The gamLoess model provided the best accuracy for this project.

Various forecasting libraries are available through the forecast package. The key is to select an appropriate evaluation parameter (in this case it was MASE). Future values can be forecasted within Lo and High bands (which indicates the possible forecasted window).

Based on the analyis performed, investment in Bitcoin is definitely viable.

For investement, the following however needs to be taken into account

- Price volatility is extremely high
- No clear trading patterns exists for "high" days
- Forecasting future prices is extremely difficult just using previous prices. A model needs to be developed that takes various factors into account and not only the previous price.

Recommendations

- Research is important when working with different data formats to understand what is possible with a particular dataset.
- Spending time analyzing data before developing models/algorithms will help to achieve the goal faster.
- Although neural networks was not covered in this course, this can certainly be explored.
- Not all libraries/packages are working when researching what peers have done. Rather start with first principle analysis

Future Work

- Use the Long Short-Term Memory (LSTM) Recurrent Neural Network (RNN) methodology to explore this project further.
- Develop a realtime system by linking with API's from different exchanges.
- Consider time and seasonal effects in more detail.
- Use more methods in the caret package to evaluate RSME.
- Incorporate more variables in future price predication.

8 References

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http://topepo.github.io/caret/train-models-by-tag.html

https://cran.r-project.org/web/packages/AnalyzeTS/AnalyzeTS.pdf

http://r-statistics.co/Time-Series-Analysis-With-R.html

https://bookdown.org/yihui/rmarkdown/

https://www.r-bloggers.com/time-series-analysis-using-r-forecast-package/

9 Environmental Variables

```
#Print OS
print("Operating System:")
```

```
## [1] "Operating System:"
```

```
version
```

```
##                _
## platform       x86_64-w64-mingw32
## arch           x86_64
## os             mingw32
## system         x86_64, mingw32
## status
## major          3
## minor          6.2
## year           2019
## month          12
## day            12
## svn rev        77560
## language       R
## version.string R version 3.6.2 (2019-12-12)
## nickname       Dark and Stormy Night
```

```
#Print Installed Packages
print("All installed packages")
```

```
## [1] "All installed packages"
```

```
installed.packages()
```

```
##                Package          LibPath
## abind          "abind"          "C:/Users/EstelleR/Documents/R/win-library/3.6"
## AnalyzeTS      "AnalyzeTS"      "C:/Users/EstelleR/Documents/R/win-library/3.6"
## annotate       "annotate"       "C:/Users/EstelleR/Documents/R/win-library/3.6"
## AnnotationDbi  "AnnotationDbi"  "C:/Users/EstelleR/Documents/R/win-library/3.6"
## anytime        "anytime"        "C:/Users/EstelleR/Documents/R/win-library/3.6"
## arm            "arm"            "C:/Users/EstelleR/Documents/R/win-library/3.6"
## arules         "arules"         "C:/Users/EstelleR/Documents/R/win-library/3.6"
## askpass        "askpass"        "C:/Users/EstelleR/Documents/R/win-library/3.6"
## assertthat     "assertthat"     "C:/Users/EstelleR/Documents/R/win-library/3.6"
## backports      "backports"      "C:/Users/EstelleR/Documents/R/win-library/3.6"
## base64enc      "base64enc"      "C:/Users/EstelleR/Documents/R/win-library/3.6"
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## zip            "zip"            "C:/Users/EstelleR/Documents/R/win-library/3.6"
## zoo            "zoo"            "C:/Users/EstelleR/Documents/R/win-library/3.6"
## base           "base"           "C:/Program Files/R/R-3.6.2/library"
## boot           "boot"           "C:/Program Files/R/R-3.6.2/library"
## class          "class"          "C:/Program Files/R/R-3.6.2/library"
## cluster        "cluster"        "C:/Program Files/R/R-3.6.2/library"
## codetools      "codetools"      "C:/Program Files/R/R-3.6.2/library"
## compiler       "compiler"       "C:/Program Files/R/R-3.6.2/library"
## datasets       "datasets"       "C:/Program Files/R/R-3.6.2/library"
## foreign        "foreign"        "C:/Program Files/R/R-3.6.2/library"
## graphics       "graphics"       "C:/Program Files/R/R-3.6.2/library"
## grDevices      "grDevices"      "C:/Program Files/R/R-3.6.2/library"
## grid           "grid"           "C:/Program Files/R/R-3.6.2/library"
## KernSmooth     "KernSmooth"     "C:/Program Files/R/R-3.6.2/library"
## lattice        "lattice"        "C:/Program Files/R/R-3.6.2/library"
## MASS           "MASS"           "C:/Program Files/R/R-3.6.2/library"
## Matrix         "Matrix"         "C:/Program Files/R/R-3.6.2/library"
## methods        "methods"        "C:/Program Files/R/R-3.6.2/library"
## mgcv           "mgcv"           "C:/Program Files/R/R-3.6.2/library"
## nlme           "nlme"           "C:/Program Files/R/R-3.6.2/library"
## nnet           "nnet"           "C:/Program Files/R/R-3.6.2/library"
## parallel       "parallel"       "C:/Program Files/R/R-3.6.2/library"
## rpart          "rpart"          "C:/Program Files/R/R-3.6.2/library"
## spatial        "spatial"        "C:/Program Files/R/R-3.6.2/library"
## splines        "splines"        "C:/Program Files/R/R-3.6.2/library"
## stats          "stats"          "C:/Program Files/R/R-3.6.2/library"
## stats4         "stats4"         "C:/Program Files/R/R-3.6.2/library"
## survival       "survival"       "C:/Program Files/R/R-3.6.2/library"
## tcltk          "tcltk"          "C:/Program Files/R/R-3.6.2/library"
## tools          "tools"          "C:/Program Files/R/R-3.6.2/library"
## translations   "translations"   "C:/Program Files/R/R-3.6.2/library"
```

```
## utils          "utils"          "C:/Program Files/R/R-3.6.2/library"
##                Version       Priority
## abind          "1.4-5"       NA
## AnalyzeTS      "2.3"         NA
## annotate       "1.64.0"      NA
## AnnotationDbi  "1.48.0"      NA
## anytime        "0.3.6"       NA
## arm            "1.10-1"      NA
## arules         "1.6-4"       NA
## askpass        "1.1"         NA
## assertthat     "0.2.1"       NA
## backports      "1.1.5"       NA
## base64enc      "0.1-3"       NA
## BH             "1.72.0-2"    NA
## Biobase        "2.46.0"      NA
## BiocGenerics   "0.32.0"      NA
## BiocManager    "1.30.10"     NA
## BiocVersion    "3.10.1"      NA
## bit            "1.1-14"      NA
## bit64          "0.9-7"       NA
## bitops         "1.0-6"       NA
## blob           "1.2.0"       NA
## Boom           "0.9.3"       NA
## BoomSpikeSlab  "1.2.1"       NA
## boot           "1.3-24"      "recommended"
## brew           "1.0-6"       NA
## brnn           "0.7"         NA
## broom          "0.5.3"       NA
## bsts           "0.9.2"       NA
## callr          "3.4.0"       NA
## car            "3.0-6"       NA
## carData        "3.0-3"       NA
## caret          "6.0-84"      NA
## cellranger     "1.1.0"       NA
## cli            "2.0.0"       NA
## clipr          "0.7.0"       NA
## clisymbols     "1.2.0"       NA
## coda           "0.19-3"      NA
## colorspace     "1.4-1"       NA
## commonmark     "1.7"         NA
## config         "0.3"         NA
## corrplot       "0.84"        NA
## covr           "3.4.0"       NA
## crayon         "1.3.4"       NA
## crosstalk      "1.0.0"       NA
## curl           "4.3"         NA
## data.table     "1.12.8"      NA
## DBI            "1.1.0"       NA
## dbplyr         "1.4.2"       NA
## desc           "1.2.0"       NA
## devtools       "2.2.1"       NA
## digest         "0.6.23"      NA
## dplyr          "0.8.3"       NA
## dslabs         "0.7.3"       NA
```

```
## DT             "0.11"        NA
## e1071          "1.7-3"       NA
## ellipsis       "0.3.0"       NA
## evaluate       "0.14"        NA
## expsmooth      "2.3"         NA
## fansi          "0.4.0"       NA
## farver         "2.0.1"       NA
## fastAdaboost   "1.0.0"       NA
## fastmap        "1.0.1"       NA
## fma            "2.3"         NA
## forcats        "0.4.0"       NA
## foreach        "1.4.7"       NA
## forecast       "8.10"        NA
## foreign        "0.8-74"      "recommended"
## formatR        "1.7"         NA
## Formula        "1.2-3"       NA
## fpp2           "2.3"         NA
## fracdiff       "1.5-0"       NA
## fs             "1.3.1"       NA
## gam            "1.16.1"      NA
## genefilter     "1.68.0"      NA
## generics       "0.0.2"       NA
## ggplot2        "3.2.1"       NA
## ggrepel        "0.8.1"       NA
## ggthemes       "4.2.0"       NA
## gh             "1.0.1"       NA
## git2r          "0.26.1"      NA
## glue           "1.3.1"       NA
## gower          "0.2.1"       NA
## greybox        "0.5.7"       NA
## gridBase       "0.4-7"       NA
## gridExtra      "2.3"         NA
## gtable         "0.3.0"       NA
## gutenbergr     "0.1.5"       NA
## haven          "2.2.0"       NA
## hexbin         "1.28.0"      NA
## highr          "0.8"         NA
## HistData       "0.8-4"       NA
## hms            "0.5.2"       NA
## htmltools      "0.4.0"       NA
## htmlwidgets    "1.5.1"       NA
## hts            "5.1.5"       NA
## httpuv         "1.5.2"       NA
## httr           "1.4.1"       NA
## hunspell       "3.0"         NA
## igraph         "1.2.4.2"     NA
## ini            "0.3.1"       NA
## ipred          "0.9-9"       NA
## IRanges        "2.20.1"      NA
## irlba          "2.3.3"       NA
## ISOcodes       "2019.12.22"  NA
## iterators      "1.0.12"      NA
## janeaustenr    "0.1.5"       NA
## jsonlite       "1.6"         NA
```

```
## kableExtra     "1.1.0"       NA
## keras          "2.2.5.0"     NA
## kernlab        "0.9-29"      NA
## KernSmooth     "2.23-16"     "recommended"
## knitr          "1.26"        NA
## labeling       "0.3"         NA
## Lahman         "7.0-1"       NA
## lamW           "1.3.0"       NA
## later          "1.0.0"       NA
## lava           "1.6.6"       NA
## lazyeval       "0.2.2"       NA
## leaps          "3.0"         NA
## lifecycle      "0.1.0"       NA
## lme4           "1.1-21"      NA
## lmtest         "0.9-37"      NA
## locfit         "1.5-9.1"     NA
## lubridate      "1.7.4"       NA
## magrittr       "1.5"         NA
## maptools       "0.9-9"       NA
## markdown       "1.1"         NA
## MASS           "7.3-51.5"    "recommended"
## matrixcalc     "1.0-3"       NA
## MatrixModels   "0.4-1"       NA
## matrixStats    "0.55.0"      NA
## mcmc           "0.9-6"       NA
## MCMCpack       "1.4-5"       NA
## memoise        "1.1.0"       NA
## Metrics        "0.1.4"       NA
## mgcv           "1.8-31"      "recommended"
## mime           "0.8"         NA
## minqa          "1.2.4"       NA
## ModelMetrics   "1.2.2"       NA
## modelr         "0.1.5"       NA
## munsell        "0.5.0"       NA
## naivebayes     "0.9.6"       NA
## nlme           "3.1-143"     "recommended"
## nloptr         "1.2.1"       NA
## numDeriv       "2016.8-1.1"  NA
## openssl        "1.4.1"       NA
## openxlsx       "4.1.4"       NA
## pbkrtest       "0.4-7"       NA
## pdftools       "2.3"         NA
## pillar         "1.4.3"       NA
## pkgbuild       "1.0.6"       NA
## pkgconfig      "2.0.3"       NA
## pkgload        "1.0.2"       NA
## plogr          "0.2.0"       NA
## plotly         "4.9.1"       NA
## plyr           "1.8.5"       NA
## praise         "1.0.0"       NA
## prettyunits    "1.0.2"       NA
## pROC           "1.15.3"      NA
## processx       "3.4.1"       NA
## prodlim        "2019.11.13"  NA
```

```
## progress       "1.2.2"       NA
## promises       "1.1.0"       NA
## proxy          "0.4-23"      NA
## pryr           "0.1.4"       NA
## ps             "1.3.0"       NA
## purrr          "0.3.3"       NA
## qpdf           "1.1"         NA
## quadprog       "1.5-8"       NA
## quantmod       "0.4-15"      NA
## quantreg       "5.54"        NA
## R6             "2.4.1"       NA
## randomForest   "4.6-14"      NA
## rappdirs       "0.3.1"       NA
## rcmdcheck      "1.3.3"       NA
## RColorBrewer   "1.1-2"       NA
## Rcpp           "1.0.3"       NA
## RcppArmadillo  "0.9.800.3.0" NA
## RcppEigen      "0.3.3.7.0"   NA
## RcppParallel   "4.4.4"       NA
## RcppProgress   "0.4.1"       NA
## RCurl          "1.95-4.12"   NA
## readr          "1.3.1"       NA
## readxl         "1.3.1"       NA
## recipes        "0.1.9"       NA
## recommenderlab "0.2-5"       NA
## recosystem     "0.4.2"       NA
## registry       "0.5-1"       NA
## rematch        "1.0.1"       NA
## remotes        "2.1.0"       NA
## reprex         "0.3.0"       NA
## reshape2       "1.4.3"       NA
## reticulate     "1.14"        NA
## rex            "1.1.2"       NA
## rio            "0.5.16"      NA
## rlang          "0.4.2"       NA
## rmarkdown      "2.0"         NA
## roxygen2       "7.0.2"       NA
## rprojroot      "1.3-2"       NA
## RSQLite        "2.1.5"       NA
## rstudioapi     "0.10"        NA
## rticles        "0.13"        NA
## rversions      "2.0.1"       NA
## rvest          "0.3.5"       NA
## S4Vectors      "0.24.1"      NA
## scales         "1.1.0"       NA
## selectr        "0.4-2"       NA
## sessioninfo    "1.1.1"       NA
## shiny          "1.4.0"       NA
## slam           "0.1-47"      NA
## smooth         "2.5.4"       NA
## SnowballC      "0.6.0"       NA
## sourcetools    "0.1.7"       NA
## sp             "1.3-2"       NA
## SparseM        "1.78"        NA
```

```
## SQUAREM        "2017.10-1"   NA
## statmod        "1.4.32"      NA
## stopwords      "1.0"         NA
## stringi        "1.4.3"       NA
## stringr        "1.4.0"       NA
## survival       "3.1-8"       "recommended"
## sys            "3.3"         NA
## tensorflow     "2.0.0"       NA
## testthat       "2.3.1"       NA
## textdata       "0.3.0"       NA
## tfruns         "1.4"         NA
## tibble         "2.1.3"       NA
## tidyr          "1.0.0"       NA
## tidyselect     "0.2.5"       NA
## tidytext       "0.2.2"       NA
## tidyverse      "1.3.0"       NA
## timeDate       "3043.102"    NA
## tinytex        "0.18"        NA
## titanic        "0.1.0"       NA
## tokenizers     "0.2.1"       NA
## treemap        "2.4-2"       NA
## triebeard      "0.3.0"       NA
## truncnorm      "1.0-8"       NA
## TSA            "1.2"         NA
## tseries        "0.10-47"     NA
## TTR            "0.23-6"      NA
## urca           "1.3-0"       NA
## urltools       "1.7.3"       NA
## uroot          "2.1-0"       NA
## usethis        "1.5.1"       NA
## utf8           "1.1.4"       NA
## vctrs          "0.2.1"       NA
## viridisLite    "0.3.0"       NA
## webshot        "0.5.2"       NA
## whisker        "0.4"         NA
## withr          "2.1.2"       NA
## xfun           "0.11"        NA
## XML            "3.98-1.20"   NA
## xml2           "1.2.2"       NA
## xopen          "1.0.0"       NA
## xtable         "1.8-4"       NA
## xts            "0.11-2"      NA
## yaml           "2.2.0"       NA
## zeallot        "0.1.0"       NA
## zip            "2.0.4"       NA
## zoo            "1.8-6"       NA
## base           "3.6.2"       "base"
## boot           "1.3-23"      "recommended"
## class          "7.3-15"      "recommended"
## cluster        "2.1.0"       "recommended"
## codetools      "0.2-16"      "recommended"
## compiler       "3.6.2"       "base"
## datasets       "3.6.2"       "base"
## foreign        "0.8-72"      "recommended"
```

```
## graphics       "3.6.2"       "base"
## grDevices      "3.6.2"       "base"
## grid           "3.6.2"       "base"
## KernSmooth     "2.23-16"     "recommended"
## lattice        "0.20-38"     "recommended"
## MASS           "7.3-51.4"    "recommended"
## Matrix         "1.2-18"      "recommended"
## methods        "3.6.2"       "base"
## mgcv           "1.8-31"      "recommended"
## nlme           "3.1-142"     "recommended"
## nnet           "7.3-12"      "recommended"
## parallel       "3.6.2"       "base"
## rpart          "4.1-15"      "recommended"
## spatial        "7.3-11"      "recommended"
## splines        "3.6.2"       "base"
## stats          "3.6.2"       "base"
## stats4         "3.6.2"       "base"
## survival       "3.1-8"       "recommended"
## tcltk          "3.6.2"       "base"
## tools          "3.6.2"       "base"
## translations   "3.6.2"       NA
## utils          "3.6.2"       "base"
##                Depends
## abind          "R (>= 1.5.0)"
## AnalyzeTS      "MASS,TSA,TTR,tseries, urca"
## annotate       "R (>= 2.10), AnnotationDbi (>= 1.27.5), XML"
## AnnotationDbi  "R (>= 2.7.0), methods, utils, stats4, BiocGenerics (>=\n0.29.2), Biobase (>= 1.17.0)
## anytime        "R (>= 3.2.0)"
## arm            "R (>= 3.1.0), MASS, Matrix (>= 1.0), stats, lme4 (>= 1.0)"
## arules         "R (>= 3.4.0), Matrix (>= 1.2-0)"
## askpass        NA
## assertthat     NA
## backports      "R (>= 3.0.0)"
## base64enc      "R (>= 2.9.0)"
## BH             NA
## Biobase        "R (>= 2.10), BiocGenerics (>= 0.27.1), utils"
## BiocGenerics   "R (>= 3.6.0), methods, utils, graphics, stats, parallel"
## BiocManager    NA
## BiocVersion    "R (>= 3.6.0)"
## bit            "R (>= 2.9.2)"
## bit64          "R (>= 3.0.1), bit (>= 1.1-12), utils, methods, stats"
## bitops         NA
## blob           NA
## Boom           "MASS, R(>= 3.1.0)"
## BoomSpikeSlab  "Boom (>= 0.9.2) , R (>= 3.1.0)"
## boot           "R (>= 3.0.0), graphics, stats"
## brew           NA
## brnn           "R (>= 3.1.2), Formula"
## broom          "R (>= 3.1)"
## bsts           "BoomSpikeSlab (>= 1.2.1), zoo, xts, Boom (>= 0.9.2), R(>=\n3.4.0)"
## callr          NA
## car            "R (>= 3.5.0), carData (>= 3.0-0)"
## carData        "R (>= 3.0)"
## caret          "R (>= 3.2.0), lattice (>= 0.20), ggplot2"
```

```
## cellranger     "R (>= 3.0.0)"
## cli            "R (>= 2.10)"
## clipr          NA
## clisymbols     NA
## coda           "R (>= 2.14.0)"
## colorspace     "R (>= 3.0.0), methods"
## commonmark     NA
## config         NA
## corrplot       NA
## covr           "R (>= 3.1.0), methods"
## crayon         NA
## crosstalk      NA
## curl           "R (>= 3.0.0)"
## data.table     "R (>= 3.1.0)"
## DBI            "methods, R (>= 3.0.0)"
## dbplyr         "R (>= 3.1)"
## desc           "R (>= 3.1.0)"
## devtools       "R (>= 3.0.2), usethis (>= 1.5.0)"
## digest         "R (>= 3.1.0)"
## dplyr          "R (>= 3.2.0)"
## dslabs         "R (>= 3.1.2)"
## DT             NA
## e1071          NA
## ellipsis       "R (>= 3.2)"
## evaluate       "R (>= 3.0.2)"
## expsmooth      "R (>= 2.0.0), forecast"
## fansi          "R (>= 3.1.0)"
## farver         NA
## fastAdaboost   "R (>= 3.1.2)"
## fastmap        NA
## fma            "R (>= 2.0.0), forecast"
## forcats        "R (>= 3.1)"
## foreach        "R (>= 2.5.0)"
## forecast       "R (>= 3.0.2),"
## foreign        "R (>= 3.0.0)"
## formatR        "R (>= 3.0.2)"
## Formula        "R (>= 2.0.0), stats"
## fpp2           "R (>= 2.10), ggplot2, forecast (>= 8.3), fma, expsmooth"
## fracdiff       NA
## fs             "R (>= 3.1)"
## gam            "stats, splines, foreach"
## genefilter     NA
## generics       "R (>= 3.1)"
## ggplot2        "R (>= 3.2)"
## ggrepel        "R (>= 3.0.0), ggplot2 (>= 2.2.0)"
## ggthemes       "R (>= 3.3.0)"
## gh             NA
## git2r          "R (>= 3.1)"
## glue           "R (>= 3.1)"
## gower          NA
## greybox        "R (>= 3.0.2)"
## gridBase       "R (>= 2.3.0)"
## gridExtra      NA
## gtable         "R (>= 3.0)"
```

```
## gutenbergr     "R (>= 2.10)"
## haven          "R (>= 3.2)"
## hexbin         "R (>= 2.0.1), methods"
## highr          "R (>= 3.2.3)"
## HistData       NA
## hms            NA
## htmltools      "R (>= 2.14.1)"
## htmlwidgets    NA
## hts            "R (>= 3.2.0), forecast (>= 8.1)"
## httpuv         "R (>= 2.15.1)"
## httr           "R (>= 3.2)"
## hunspell       "R (>= 3.0.2)"
## igraph         "methods"
## ini            NA
## ipred          "R (>= 2.10)"
## IRanges        "R (>= 3.1.0), methods, utils, stats, BiocGenerics (>= 0.25.3),\nS4Vectors (>= 0.23.2
## irlba          "Matrix"
## ISOcodes       "R (>= 3.5.0)"
## iterators      "R (>= 2.5.0), utils"
## janeaustenr    "R (>= 3.1.2)"
## jsonlite       "methods"
## kableExtra     "R (>= 3.1.0)"
## keras          "R (>= 3.2)"
## kernlab        "R (>= 2.10)"
## KernSmooth     "R (>= 2.5.0), stats"
## knitr          "R (>= 3.2.3)"
## labeling       NA
## Lahman         "R (>= 2.10)"
## lamW           "R (>= 3.0.2)"
## later          NA
## lava           "R (>= 3.0)"
## lazyeval       "R (>= 3.1.0)"
## leaps          ""
## lifecycle      "R (>= 3.2)"
## lme4           "R (>= 3.2.0), Matrix (>= 1.2-1), methods, stats"
## lmtest         "R (>= 3.0.0), stats, zoo"
## locfit         "R (>= 2.0.1)"
## lubridate      "methods, R (>= 3.0.0)"
## magrittr       NA
## maptools       "R (>= 2.10), sp (>= 1.0-11)"
## markdown       "R (>= 2.11.1)"
## MASS           "R (>= 3.1.0), grDevices, graphics, stats, utils"
## matrixcalc     "R (>= 2.0.1)"
## MatrixModels   "R (>= 3.0.1)"
## matrixStats    "R (>= 2.12.0)"
## mcmc           "R (>= 3.0.2)"
## MCMCpack       "R (>= 3.6), coda (>= 0.11-3), MASS, stats"
## memoise        NA
## Metrics        NA
## mgcv           "R (>= 2.14.0), nlme (>= 3.1-64)"
## mime           NA
## minqa          NA
## ModelMetrics   "R (>= 3.2.2)"
## modelr         "R (>= 3.2)"
```

```
## munsell        NA
## naivebayes     NA
## nlme           "R (>= 3.4.0)"
## nloptr         NA
## numDeriv       "R (>= 2.11.1)"
## openssl        NA
## openxlsx       "R (>= 3.3.0)"
## pbkrtest       "R (>= 3.2.3), lme4 (>= 1.1.10)"
## pdftools       NA
## pillar         NA
## pkgbuild       "R (>= 3.1)"
## pkgconfig      NA
## pkgload        NA
## plogr          NA
## plotly         "R (>= 3.2.0), ggplot2 (>= 3.0.0)"
## plyr           "R (>= 3.1.0)"
## praise         NA
## prettyunits    NA
## pROC           "R (>= 2.14)"
## processx       NA
## prodlim        "R (>= 2.9.0)"
## progress       NA
## promises       NA
## proxy          "R (>= 3.4.0)"
## pryr           "R (>= 3.1.0)"
## ps             "R (>= 3.1)"
## purrr          "R (>= 3.2)"
## qpdf           NA
## quadprog       "R (>= 3.1.0)"
## quantmod       "R (>= 3.2.0), xts(>= 0.9-0), zoo, TTR(>= 0.2), methods"
## quantreg       "R (>= 2.6), stats, SparseM"
## R6             "R (>= 3.0)"
## randomForest   "R (>= 3.2.2), stats"
## rappdirs       "R (>= 2.14), methods"
## rcmdcheck      NA
## RColorBrewer   "R (>= 2.0.0)"
## Rcpp           "R (>= 3.0.0)"
## RcppArmadillo  "R (>= 3.3.0)"
## RcppEigen      "R (>= 2.15.1)"
## RcppParallel   "R (>= 3.0.2)"
## RcppProgress   NA
## RCurl          "R (>= 3.0.0), methods, bitops"
## readr          "R (>= 3.1)"
## readxl         NA
## recipes        "R (>= 3.1), dplyr"
## recommenderlab "R (>= 2.10.0), Matrix, arules, proxy, registry"
## recosystem     "R (>= 3.3.0), methods"
## registry       "R (>= 2.6.0)"
## rematch        NA
## remotes        "R (>= 3.0.0)"
## reprex         "R (>= 3.1)"
## reshape2       "R (>= 3.1)"
## reticulate     "R (>= 3.0)"
## rex            NA
```

```
## rio            "R (>= 2.15.0)"
## rlang          "R (>= 3.2.0)"
## rmarkdown      "R (>= 3.0)"
## roxygen2       "R (>= 3.2)"
## rprojroot      "R (>= 3.0.0)"
## RSQLite        "R (>= 3.1.0)"
## rstudioapi     NA
## rticles        NA
## rversions      NA
## rvest          "R (>= 3.2), xml2"
## S4Vectors      "R (>= 3.3.0), methods, utils, stats, stats4, BiocGenerics (>=\n0.31.1)"
## scales         "R (>= 3.2)"
## selectr        "R (>= 3.0)"
## sessioninfo    NA
## shiny          "R (>= 3.0.2), methods"
## slam           "R (>= 3.4.0)"
## smooth         "R (>= 3.0.2), greybox (>= 0.5.3)"
## SnowballC      NA
## sourcetools    "R (>= 3.0.2)"
## sp             "R (>= 3.0.0), methods"
## SparseM        "R (>= 2.15), methods"
## SQUAREM        "R (>= 3.0)"
## statmod        "R (>= 3.0.0)"
## stopwords      "R (>= 2.10)"
## stringi        "R (>= 2.14)"
## stringr        "R (>= 3.1)"
## survival       "R (>= 3.4.0)"
## sys            NA
## tensorflow     "R (>= 3.1)"
## testthat       "R (>= 3.1)"
## textdata       NA
## tfruns         "R (>= 3.1)"
## tibble         "R (>= 3.1.0)"
## tidyr          "R (>= 3.1)"
## tidyselect     "R (>= 3.1)"
## tidytext       "R (>= 2.10)"
## tidyverse      "R (>= 3.2)"
## timeDate       "R (>= 2.15.1), graphics, utils, stats, methods"
## tinytex        NA
## titanic        "R (>= 3.1.2)"
## tokenizers     "R (>= 3.1.3)"
## treemap        "R (>= 2.10)"
## triebeard      NA
## truncnorm      "R (>= 3.4.0)"
## TSA            "R (>= 2.5.1)"
## tseries        "R (>= 2.10.0)"
## TTR            NA
## urca           "R (>= 2.0.0), methods"
## urltools       "R (>= 2.10)"
## uroot          "R (>= 3.0.0), stats"
## usethis        "R (>= 3.2)"
## utf8           "R (>= 2.10)"
## vctrs          "R (>= 3.2)"
## viridisLite    "R (>= 2.10)"
```

```
## webshot        "R (>= 3.0)"
## whisker        NA
## withr          "R (>= 3.0.2)"
## xfun           NA
## XML            "R (>= 2.13.0), methods, utils"
## xml2           "R (>= 3.1.0)"
## xopen          "R (>= 3.1)"
## xtable         "R (>= 2.10.0)"
## xts            "zoo (>= 1.7-12)"
## yaml           NA
## zeallot        NA
## zip            NA
## zoo            "R (>= 3.1.0), stats"
## base           NA
## boot           "R (>= 3.0.0), graphics, stats"
## class          "R (>= 3.0.0), stats, utils"
## cluster        "R (>= 3.3.0)"
## codetools      "R (>= 2.1)"
## compiler       NA
## datasets       NA
## foreign        "R (>= 3.0.0)"
## graphics       NA
## grDevices      NA
## grid           NA
## KernSmooth     "R (>= 2.5.0), stats"
## lattice        "R (>= 3.0.0)"
## MASS           "R (>= 3.1.0), grDevices, graphics, stats, utils"
## Matrix         "R (>= 3.2.0)"
## methods        NA
## mgcv           "R (>= 2.14.0), nlme (>= 3.1-64)"
## nlme           "R (>= 3.4.0)"
## nnet           "R (>= 2.14.0), stats, utils"
## parallel       NA
## rpart          "R (>= 2.15.0), graphics, stats, grDevices"
## spatial        "R (>= 3.0.0), graphics, stats, utils"
## splines        NA
## stats          NA
## stats4         NA
## survival       "R (>= 3.4.0)"
## tcltk          NA
## tools          NA
## translations   NA
## utils          NA
##                Imports
## abind          "methods, utils"
## AnalyzeTS      NA
## annotate       "Biobase, DBI, xtable, graphics, utils, stats, methods,\nBiocGenerics (>= 0.13.8), RC
## AnnotationDbi  "DBI, RSQLite, S4Vectors (>= 0.9.25)"
## anytime        "Rcpp (>= 0.12.9)"
## arm            "abind, coda, graphics, grDevices, methods, nlme, utils"
## arules         "stats, methods, graphics, utils"
## askpass        "sys (>= 2.1)"
## assertthat     "tools"
## backports      "utils"
```

```
## base64enc      NA
## BH             NA
## Biobase        "methods"
## BiocGenerics   "methods, utils, graphics, stats, parallel"
## BiocManager    "utils"
## BiocVersion    NA
## bit            NA
## bit64          NA
## bitops         NA
## blob           "methods, prettyunits, rlang, vctrs (>= 0.2.0)"
## Boom           NA
## BoomSpikeSlab  "igraph"
## boot           NA
## brew           NA
## brnn           NA
## broom          "backports, dplyr, generics (>= 0.0.2), methods, nlme, purrr,\nreshape2, stringr, tibl
## bsts           NA
## callr          "processx (>= 3.4.0), R6, utils"
## car            "abind, MASS, mgcv, nnet, pbkrtest (>= 0.4-4), quantreg,\ngrDevices, utils, stats, gra
## carData        NA
## caret          "foreach, methods, plyr, ModelMetrics (>= 1.1.0), nlme,\nreshape2, stats, stats4, util
## cellranger     "rematch, tibble"
## cli            "assertthat, crayon (>= 1.3.4), glue, methods, utils, fansi"
## clipr          "utils"
## clisymbols     NA
## coda           "lattice"
## colorspace     "graphics, grDevices, stats"
## commonmark     NA
## config         "yaml (>= 2.1.13)"
## corrplot       NA
## covr           "digest, stats, utils, jsonlite, rex, httr, crayon, withr (>=\n1.0.2), yaml"
## crayon         "grDevices, methods, utils"
## crosstalk      "htmltools (>= 0.3.5), jsonlite, lazyeval, R6, shiny (>= 0.11),\nggplot2"
## curl           NA
## data.table     "methods"
## DBI            NA
## dbplyr         "assertthat (>= 0.2.0), DBI (>= 1.0.0), dplyr (>= 0.8.0), glue\n(>= 1.2.0), methods, p
## desc           "assertthat, utils, R6, crayon, rprojroot"
## devtools       "callr, cli, covr (>= 3.2.0), crayon, desc, digest, DT,\nellipsis (>= 0.3.0), glue, gi
## digest         "utils"
## dplyr          "assertthat (>= 0.2.0), glue (>= 1.3.0), magrittr (>= 1.5),\nmethods, pkgconfig, R6, R
## dslabs         "ggplot2"
## DT             "htmltools (>= 0.3.6), htmlwidgets (>= 1.3), jsonlite (>=\n0.9.16), magrittr, crosstal
## e1071          "graphics, grDevices, class, stats, methods, utils"
## ellipsis       "rlang (>= 0.3.0)"
## evaluate       "methods"
## expsmooth      NA
## fansi          NA
## farver         NA
## fastAdaboost   "Rcpp, rpart"
## fastmap        NA
## fma            NA
## forcats        "ellipsis, magrittr, rlang, tibble"
## foreach        "codetools, utils, iterators"
```

```
## forecast       "colorspace, fracdiff, ggplot2 (>= 2.2.1), graphics, lmtest,\nmagrittr, nnet, parallel
## foreign        "methods, utils, stats"
## formatR        NA
## Formula        NA
## fpp2           NA
## fracdiff       "stats"
## fs             "methods, Rcpp"
## gam            NA
## genefilter     "BiocGenerics (>= 0.31.2), AnnotationDbi, annotate, Biobase,\ngraphics, methods, stats
## generics       "methods"
## ggplot2        "digest, grDevices, grid, gtable (>= 0.1.1), lazyeval, MASS,\nmgcv, reshape2, rlang (>
## ggrepel        "grid, Rcpp, scales (>= 0.3.0)"
## ggthemes       "ggplot2 (>= 3.0.0), graphics, grid, methods, purrr, scales,\nstringr, tibble"
## gh             "ini, jsonlite, httr"
## git2r          "graphics, utils"
## glue           "methods"
## gower          NA
## greybox        "forecast, stats, graphics, utils, lamW, numDeriv, nloptr,\nstatmod"
## gridBase       "graphics, grid"
## gridExtra      "gtable, grid, grDevices, graphics, utils"
## gtable         "grid"
## gutenbergr     "dplyr, readr, purrr, urltools, stringr, lazyeval"
## haven          "forcats (>= 0.2.0), hms, Rcpp (>= 0.11.4), readr (>= 0.1.0),\nrlang (>= 0.4.0), tibbl
## hexbin         "lattice, grid, graphics, grDevices, stats, utils"
## highr          NA
## HistData       NA
## hms            "methods, pkgconfig, rlang, vctrs (>= 0.2.0)"
## htmltools      "utils, digest, Rcpp, rlang"
## htmlwidgets    "grDevices, htmltools (>= 0.3), jsonlite (>= 0.9.16), yaml"
## hts            "SparseM, Matrix, matrixcalc, parallel, utils, methods,\ngraphics, grDevices, stats"
## httpuv         "Rcpp (>= 0.11.0), utils, R6, promises, later (>= 0.8.0)"
## httr           "curl (>= 3.0.0), jsonlite, mime, openssl (>= 0.8), R6"
## hunspell       "Rcpp, digest"
## igraph         "graphics, grDevices, magrittr, Matrix, pkgconfig (>= 2.0.0),\nstats, utils"
## ini            NA
## ipred          "rpart (>= 3.1-8), MASS, survival, nnet, class, prodlim"
## IRanges        "stats4"
## irlba          "stats, methods"
## ISOcodes       NA
## iterators      NA
## janeaustenr    NA
## jsonlite       NA
## kableExtra     "knitr (>= 1.16), magrittr, stringr (>= 1.0), xml2 (>= 1.1.1),\nrvest, rmarkdown (>= 1
## keras          "generics (>= 0.0.1), reticulate (>= 1.10), tensorflow (>=\n2.0.0), tfruns (>= 1.0), m
## kernlab        "methods, stats, grDevices, graphics"
## KernSmooth     NA
## knitr          "evaluate (>= 0.10), highr, markdown, stringr (>= 0.6), yaml\n(>= 2.1.19), methods, xf
## labeling       NA
## Lahman         "dplyr"
## lamW           "Rcpp, RcppParallel (>= 4.3.20)"
## later          "Rcpp (>= 0.12.9), rlang"
## lava           "grDevices, graphics, methods, numDeriv, stats, survival,\nSQUAREM, utils"
## lazyeval       NA
## leaps          NA
```

```
## lifecycle      "glue, rlang (>= 0.4.0)"
## lme4           "graphics, grid, splines, utils, parallel, MASS, lattice, boot,\nnlme (>= 3.1-123), m
## lmtest         "graphics"
## locfit         "lattice"
## lubridate      "stringr, Rcpp (>= 0.12.13),"
## magrittr       NA
## maptools       "foreign (>= 0.8), methods, grid, lattice, stats, utils,\ngrDevices"
## markdown       "utils, xfun, mime (>= 0.3)"
## MASS           "methods"
## matrixcalc     NA
## MatrixModels   "stats, methods, Matrix (>= 1.1-5)"
## matrixStats    NA
## mcmc           "stats"
## MCMCpack       "graphics, grDevices, lattice, methods, utils, mcmc, quantreg"
## memoise        "digest (>= 0.6.3)"
## Metrics        NA
## mgcv           "methods, stats, graphics, Matrix, splines, utils"
## mime           "tools"
## minqa          "Rcpp (>= 0.9.10)"
## ModelMetrics   "Rcpp, data.table"
## modelr         "broom, dplyr, magrittr, purrr (>= 0.2.2), rlang (>= 0.2.0),\ntibble, tidyr (>= 0.8.0
## munsell        "colorspace, methods"
## naivebayes     NA
## nlme           "graphics, stats, utils, lattice"
## nloptr         NA
## numDeriv       NA
## openssl        "askpass"
## openxlsx       "grDevices, methods, Rcpp, stats, utils, zip, stringi"
## pbkrtest       "Matrix (>= 1.2.3), parallel, MASS, methods"
## pdftools       "Rcpp (>= 0.12.12), qpdf"
## pillar         "cli, crayon (>= 1.3.4), fansi, rlang (>= 0.3.0), utf8 (>=\n1.1.0), vctrs (>= 0.2.0)"
## pkgbuild       "callr (>= 3.2.0), cli, crayon, desc, prettyunits, R6,\nrprojroot, withr (>= 2.1.2)"
## pkgconfig      "utils"
## pkgload        "desc, methods, pkgbuild, rlang, rprojroot, rstudioapi, utils,\nwithr"
## plogr          NA
## plotly         "tools, scales, httr, jsonlite (>= 1.6), magrittr, digest,\nviridisLite, base64enc, ht
## plyr           "Rcpp (>= 0.11.0)"
## praise         NA
## prettyunits    "magrittr, assertthat, methods"
## pROC           "methods, plyr, Rcpp (>= 0.11.1)"
## processx       "ps (>= 1.2.0), R6, utils"
## prodlim        "Rcpp (>= 0.11.5), stats, grDevices, graphics, survival,\nKernSmooth, lava"
## progress       "hms, prettyunits, R6, crayon"
## promises       "R6, Rcpp, later, rlang, stats, magrittr"
## proxy          "stats, utils"
## pryr           "stringr, codetools, methods, Rcpp (>= 0.11.0)"
## ps             "utils"
## purrr          "magrittr (>= 1.5), rlang (>= 0.3.1)"
## qpdf           "Rcpp, askpass, curl"
## quadprog       NA
## quantmod       "curl"
## quantreg       "methods, graphics, Matrix, MatrixModels"
## R6             NA
## randomForest   NA
```

```
## rappdirs       NA
## rcmdcheck      "callr (>= 3.1.1.9000), cli (>= 1.1.0), crayon, desc (>=\n1.2.0), digest, pkgbuild, pr
## RColorBrewer   NA
## Rcpp           "methods, utils"
## RcppArmadillo  "Rcpp (>= 0.11.0), stats, utils, methods"
## RcppEigen      "Matrix (>= 1.1-0), Rcpp (>= 0.11.0), stats, utils"
## RcppParallel   NA
## RcppProgress   NA
## RCurl          NA
## readr          "Rcpp (>= 0.12.0.5), tibble, hms (>= 0.4.1), R6, clipr, crayon,\nmethods"
## readxl         "cellranger, Rcpp (>= 0.12.18), tibble (>= 1.3.1), utils"
## recipes        "generics, glue, gower, ipred, lubridate, magrittr, Matrix,\npurrr (>= 0.2.3), rlang
## recommenderlab "methods, utils, stats, irlba, recosystem"
## recosystem     "Rcpp (>= 0.11.0)"
## registry       "utils"
## rematch        NA
## remotes        "methods, stats, tools, utils"
## reprex         "callr (>= 2.0.0), clipr (>= 0.4.0), fs, rlang, rmarkdown,\nutils, whisker, withr"
## reshape2       "plyr (>= 1.8.1), Rcpp, stringr"
## reticulate     "graphics, jsonlite, Matrix, methods, rappdirs, Rcpp (>=\n0.12.7), utils"
## rex            "magrittr, lazyeval"
## rio            "tools, stats, utils, foreign, haven (>= 1.1.0), curl (>= 0.6),\ndata.table (>= 1.9.8)
## rlang          NA
## rmarkdown      "tools, utils, knitr (>= 1.22), yaml (>= 2.1.19), htmltools (>=\n0.3.5), evaluate (>=
## roxygen2       "brew, commonmark, desc (>= 1.2.0), digest, methods, pkgload\n(>= 1.0.2), purrr (>= 0
## rprojroot      "backports"
## RSQLite        "bit64, blob (>= 1.2.0), DBI (>= 1.1.0), memoise, methods,\npkgconfig, Rcpp (>= 0.12.1
## rstudioapi     NA
## rticles        "utils, rmarkdown, knitr, yaml, tinytex, xfun"
## rversions      "curl, utils, xml2 (>= 1.0.0)"
## rvest          "httr (>= 0.5), magrittr, selectr"
## S4Vectors      NA
## scales         "farver (>= 2.0.0), labeling, munsell (>= 0.5), R6,\nRColorBrewer, viridisLite, lifecy
## selectr        "methods, stringr, R6"
## sessioninfo    "cli, tools, utils, withr"
## shiny          "utils, grDevices, httpuv (>= 1.5.2), mime (>= 0.3), jsonlite\n(>= 0.9.16), xtable, di
## slam           "stats"
## smooth         "Rcpp (>= 0.12.3), stats, graphics, forecast (>= 7.0), nloptr,\nutils, zoo"
## SnowballC      NA
## sourcetools    NA
## sp             "utils, stats, graphics, grDevices, lattice, grid"
## SparseM        "graphics, stats, utils"
## SQUAREM        NA
## statmod        "stats, graphics"
## stopwords      "ISOcodes"
## stringi        "tools, utils, stats"
## stringr        "glue (>= 1.2.0), magrittr, stringi (>= 1.1.7)"
## survival       "graphics, Matrix, methods, splines, stats, utils"
## sys            NA
## tensorflow     "config, jsonlite (>= 1.2), processx, reticulate (>= 1.10),\ntfruns (>= 1.0), utils, y
## testthat       "cli, crayon (>= 1.3.4), digest, ellipsis, evaluate, magrittr,\nmethods, pkgload, prai
## textdata       "fs, readr, tibble, rappdirs"
## tfruns         "utils, jsonlite (>= 1.2), base64enc, yaml, config, magrittr,\nwhisker, tidyselect, rl
## tibble         "cli, crayon (>= 1.3.4), fansi (>= 0.4.0), methods, pillar (>=\n1.3.1), pkgconfig, rla
```

```
## tidyr          "dplyr (>= 0.8.2), ellipsis (>= 0.1.0), glue, magrittr, purrr,\nRcpp, rlang, stringi,
## tidyselect     "glue (>= 1.3.0), purrr, rlang (>= 0.2.2), Rcpp (>= 0.12.0)"
## tidytext       "rlang, dplyr, stringr, hunspell, generics, Matrix, tokenizers,\njaneaustenr, purrr (
## tidyverse      "broom (>= 0.5.2), cli (>= 1.1.0), crayon (>= 1.3.4), dbplyr\n(>= 1.4.2), dplyr (>= 0
## timeDate       NA
## tinytex        "xfun (>= 0.5)"
## titanic        NA
## tokenizers     "stringi (>= 1.0.1), Rcpp (>= 0.12.3), SnowballC (>= 0.5.1)"
## treemap        "colorspace, data.table (>= 1.8.8), ggplot2, grid, gridBase,\nigraph, methods, RColorB
## triebeard      "Rcpp"
## truncnorm      NA
## TSA            "leaps, locfit, mgcv"
## tseries        "graphics, stats, utils, quadprog, zoo, quantmod (>= 0.4-9)"
## TTR            "xts (>= 0.10-0), zoo, curl"
## urca           "nlme, graphics, stats"
## urltools       "Rcpp, methods, triebeard"
## uroot          NA
## usethis        "clipr (>= 0.3.0), clisymbols, crayon, curl (>= 2.7), desc, fs\n(>= 1.3.0), gh, git2r
## utf8           NA
## vctrs          "backports, ellipsis (>= 0.2.0), digest, glue, rlang (>=\n0.4.0), zeallot"
## viridisLite    NA
## webshot        "magrittr, jsonlite, callr"
## whisker        NA
## withr          "stats, graphics, grDevices"
## xfun           "stats, tools"
## XML            NA
## xml2           "Rcpp, methods"
## xopen          "processx"
## xtable         "stats, utils"
## xts            "methods"
## yaml           NA
## zeallot        NA
## zip            NA
## zoo            "utils, graphics, grDevices, lattice (>= 0.20-27)"
## base           NA
## boot           NA
## class          "MASS"
## cluster        "graphics, grDevices, stats, utils"
## codetools      NA
## compiler       NA
## datasets       NA
## foreign        "methods, utils, stats"
## graphics       "grDevices"
## grDevices      NA
## grid           "grDevices, utils"
## KernSmooth     NA
## lattice        "grid, grDevices, graphics, stats, utils"
## MASS           "methods"
## Matrix         "methods, graphics, grid, stats, utils, lattice"
## methods        "utils, stats"
## mgcv           "methods, stats, graphics, Matrix, splines, utils"
## nlme           "graphics, stats, utils, lattice"
## nnet           NA
## parallel       "tools, compiler"
```

```
## rpart          NA
## spatial        NA
## splines        "graphics, stats"
## stats          "utils, grDevices, graphics"
## stats4         "graphics, methods, stats"
## survival       "graphics, Matrix, methods, splines, stats, utils"
## tcltk          "utils"
## tools          NA
## translations   NA
## utils          NA
##                LinkingTo
## abind          NA
## AnalyzeTS      NA
## annotate       NA
## AnnotationDbi  NA
## anytime        "Rcpp (>= 0.12.9), BH"
## arm            NA
## arules         NA
## askpass        NA
## assertthat     NA
## backports      NA
## base64enc      NA
## BH             NA
## Biobase        NA
## BiocGenerics   NA
## BiocManager    NA
## BiocVersion    NA
## bit            NA
## bit64          NA
## bitops         NA
## blob           NA
## Boom           NA
## BoomSpikeSlab  "Boom(>= 0.9.2)"
## boot           NA
## brew           NA
## brnn           NA
## broom          NA
## bsts           "Boom (>= 0.9.2)"
## callr          NA
## car            NA
## carData        NA
## caret          NA
## cellranger     NA
## cli            NA
## clipr          NA
## clisymbols     NA
## coda           NA
## colorspace     NA
## commonmark     NA
## config         NA
## corrplot       NA
## covr           NA
## crayon         NA
## crosstalk      NA
```

```
## curl           NA
## data.table     NA
## DBI            NA
## dbplyr         NA
## desc           NA
## devtools       NA
## digest         NA
## dplyr          "BH, plogr (>= 0.2.0), Rcpp (>= 1.0.1)"
## dslabs         NA
## DT             NA
## e1071          NA
## ellipsis       NA
## evaluate       NA
## expsmooth      NA
## fansi          NA
## farver         NA
## fastAdaboost   "Rcpp (>= 0.12.0)"
## fastmap        NA
## fma            NA
## forcats        NA
## foreach        NA
## forecast       "Rcpp (>= 0.11.0), RcppArmadillo (>= 0.2.35)"
## foreign        NA
## formatR        NA
## Formula        NA
## fpp2           NA
## fracdiff       NA
## fs             "Rcpp"
## gam            NA
## genefilter     NA
## generics       NA
## ggplot2        NA
## ggrepel        "Rcpp"
## ggthemes       NA
## gh             NA
## git2r          NA
## glue           NA
## gower          NA
## greybox        "Rcpp"
## gridBase       NA
## gridExtra      NA
## gtable         NA
## gutenbergr     NA
## haven          "Rcpp"
## hexbin         NA
## highr          NA
## HistData       NA
## hms            NA
## htmltools      "Rcpp"
## htmlwidgets    NA
## hts            "Rcpp (>= 0.11.0), RcppEigen"
## httpuv         "Rcpp, BH, later"
## httr           NA
## hunspell       "Rcpp (>= 0.12.12)"
```

```
## igraph         NA
## ini            NA
## ipred          NA
## IRanges        "S4Vectors"
## irlba          "Matrix"
## ISOcodes       NA
## iterators      NA
## janeaustenr    NA
## jsonlite       NA
## kableExtra     NA
## keras          NA
## kernlab        NA
## KernSmooth     NA
## knitr          NA
## labeling       NA
## Lahman         NA
## lamW           "Rcpp, RcppParallel (>= 4.3.20)"
## later          "Rcpp, BH"
## lava           NA
## lazyeval       NA
## leaps          NA
## lifecycle      NA
## lme4           "Rcpp (>= 0.10.5), RcppEigen"
## lmtest         NA
## locfit         NA
## lubridate      "Rcpp,"
## magrittr       NA
## maptools       NA
## markdown       NA
## MASS           NA
## matrixcalc     NA
## MatrixModels   NA
## matrixStats    NA
## mcmc           NA
## MCMCpack       NA
## memoise        NA
## Metrics        NA
## mgcv           NA
## mime           NA
## minqa          "Rcpp"
## ModelMetrics   "Rcpp"
## modelr         NA
## munsell        NA
## naivebayes     NA
## nlme           NA
## nloptr         NA
## numDeriv       NA
## openssl        NA
## openxlsx       "Rcpp"
## pbkrtest       NA
## pdftools       "Rcpp"
## pillar         NA
## pkgbuild       NA
## pkgconfig      NA
```

```
## pkgload        NA
## plogr          NA
## plotly         NA
## plyr           "Rcpp"
## praise         NA
## prettyunits    NA
## pROC           "Rcpp"
## processx       NA
## prodlim        "Rcpp"
## progress       NA
## promises       "later, Rcpp"
## proxy          NA
## pryr           "Rcpp"
## ps             NA
## purrr          NA
## qpdf           "Rcpp"
## quadprog       NA
## quantmod       NA
## quantreg       NA
## R6             NA
## randomForest   NA
## rappdirs       NA
## rcmdcheck      NA
## RColorBrewer   NA
## Rcpp           NA
## RcppArmadillo  "Rcpp"
## RcppEigen      "Rcpp"
## RcppParallel   NA
## RcppProgress   NA
## RCurl          NA
## readr          "Rcpp, BH"
## readxl         "progress, Rcpp"
## recipes        NA
## recommenderlab NA
## recosystem     "Rcpp, RcppProgress"
## registry       NA
## rematch        NA
## remotes        NA
## reprex         NA
## reshape2       "Rcpp"
## reticulate     "Rcpp"
## rex            NA
## rio            NA
## rlang          NA
## rmarkdown      NA
## roxygen2       "Rcpp"
## rprojroot      NA
## RSQLite        "BH, plogr (>= 0.2.0), Rcpp"
## rstudioapi     NA
## rticles        NA
## rversions      NA
## rvest          NA
## S4Vectors      NA
## scales         NA
```

```
## selectr        NA
## sessioninfo    NA
## shiny          NA
## slam           NA
## smooth         "Rcpp, RcppArmadillo (>= 0.8.100.0.0)"
## SnowballC      NA
## sourcetools    NA
## sp             NA
## SparseM        NA
## SQUAREM        NA
## statmod        NA
## stopwords      NA
## stringi        NA
## stringr        NA
## survival       NA
## sys            NA
## tensorflow     NA
## testthat       NA
## textdata       NA
## tfruns         NA
## tibble         NA
## tidyr          "Rcpp"
## tidyselect     "Rcpp (>= 0.12.0),"
## tidytext       NA
## tidyverse      NA
## timeDate       NA
## tinytex        NA
## titanic        NA
## tokenizers     "Rcpp"
## treemap        NA
## triebeard      "Rcpp"
## truncnorm      NA
## TSA            NA
## tseries        NA
## TTR            "xts"
## urca           NA
## urltools       "Rcpp"
## uroot          NA
## usethis        NA
## utf8           NA
## vctrs          NA
## viridisLite    NA
## webshot        NA
## whisker        NA
## withr          NA
## xfun           NA
## XML            NA
## xml2           "Rcpp (>= 0.12.12)"
## xopen          NA
## xtable         NA
## xts            "zoo"
## yaml           NA
## zeallot        NA
## zip            NA
```

```
## zoo            NA
## base           NA
## boot           NA
## class          NA
## cluster        NA
## codetools      NA
## compiler       NA
## datasets       NA
## foreign        NA
## graphics       NA
## grDevices      NA
## grid           NA
## KernSmooth     NA
## lattice        NA
## MASS           NA
## Matrix         NA
## methods        NA
## mgcv           NA
## nlme           NA
## nnet           NA
## parallel       NA
## rpart          NA
## spatial        NA
## splines        NA
## stats          NA
## stats4         NA
## survival       NA
## tcltk          NA
## tools          NA
## translations   NA
## utils          NA
##                Suggests
## abind          NA
## AnalyzeTS      "testthat"
## annotate       "hgu95av2.db, genefilter, Biostrings (>= 2.25.10), IRanges,\nrae230a.db, rae230aprobe
## AnnotationDbi  "hgu95av2.db, GO.db, org.Sc.sgd.db, org.At.tair.db, KEGG.db,\nRUnit, TxDb.Hsapiens.UCS
## anytime        "tinytest (>= 1.0.0), gettz"
## arm            NA
## arules         "pmml, XML, arulesViz, testthat"
## askpass        "testthat"
## assertthat     "testthat, covr"
## backports      NA
## base64enc      NA
## BH             NA
## Biobase        "tools, tkWidgets, ALL, RUnit, golubEsets"
## BiocGenerics   "Biobase, S4Vectors, IRanges, GenomicRanges, DelayedArray,\nBiostrings, Rsamtools, Ann
## BiocManager    "BiocStyle, BiocVersion, remotes, testthat, withr, curl, knitr"
## BiocVersion    NA
## bit            NA
## bit64          NA
## bitops         NA
## blob           "covr, crayon, pillar (>= 1.2.1), testthat"
## Boom           "testthat"
## BoomSpikeSlab  "MASS, testthat, mlbench"
```

```
## boot           "MASS, survival"
## brew           NA
## brnn           NA
## broom          "AER, akima, AUC, bbmle, betareg, biglm, binGroup, boot, brms,\nbtergm, car, caret, c
## bsts           "testthat"
## callr          "cliapp, covr, crayon, fansi, knitr, pingr, ps, rmarkdown,\nrprojroot, spelling, test
## car            "alr4, boot, coxme, leaps, lmtest, Matrix, MatrixModels, rgl\n(>= 0.93.960), sandwich
## carData        NA
## caret          "BradleyTerry2, e1071, earth (>= 2.2-3), fastICA, gam (>=\n1.15), ipred, kernlab, kni
## cellranger     "covr, testthat (>= 1.0.0), knitr, rmarkdown"
## cli            "callr, covr, htmlwidgets, knitr, mockery, rmarkdown,\nrstudioapi, prettycode, testtha
## clipr          "covr, knitr, rmarkdown, rstudioapi (>= 0.5), testthat (>=\n2.0.0)"
## clisymbols     "testthat"
## coda           NA
## colorspace     "datasets, utils, KernSmooth, MASS, kernlab, mvtnorm, vcd,\ntcltk, shiny, shinyjs, ggp
## commonmark     "curl, testthat, xml2"
## config         "testthat, knitr"
## corrplot       "knitr, RColorBrewer, testthat"
## covr           "R6, knitr, rmarkdown, htmltools, DT (>= 0.2), testthat,\nrlang, rstudioapi (>= 0.2),
## crayon         "mockery, rstudioapi, testthat, withr"
## crosstalk      NA
## curl           "spelling, testthat (>= 1.0.0), knitr, jsonlite, rmarkdown,\nmagrittr, httpuv (>= 1.4
## data.table     "bit64, curl, R.utils, knitr, xts, nanotime, zoo, yaml"
## DBI            "blob, covr, hms, knitr, magrittr, rmarkdown, rprojroot,\nRSQLite (>= 1.1-2), testtha
## dbplyr         "bit64, covr, knitr, Lahman, nycflights13, RMariaDB (>=\n1.0.2), rmarkdown, RMySQL (>
## desc           "covr, testthat, whoami, withr"
## devtools       "BiocManager, bitops, curl (>= 0.9), evaluate, foghorn (>=\n1.1.0), gmailr (> 0.7.0),
## digest         "tinytest, knitr, rmarkdown"
## dplyr          "bit64, callr, covr, crayon (>= 1.3.4), DBI, dbplyr, dtplyr,\nggplot2, hms, knitr, Lal
## dslabs         NA
## DT             "knitr (>= 1.8), rmarkdown, shiny (>= 1.2.0)"
## e1071          "cluster, mlbench, nnet, randomForest, rpart, SparseM, xtable,\nMatrix, MASS, slam"
## ellipsis       "covr, testthat"
## evaluate       "testthat, lattice, ggplot2"
## expsmooth      NA
## fansi          "unitizer, knitr, rmarkdown"
## farver         "testthat (>= 2.1.0), covr"
## fastAdaboost   "testthat, knitr, MASS"
## fastmap        "testthat (>= 2.1.1)"
## fma            NA
## forcats        "covr, ggplot2, testthat, readr, knitr, rmarkdown, dplyr"
## foreach        "randomForest"
## forecast       "uroot, knitr, rmarkdown, rticles, testthat, methods"
## foreign        NA
## formatR        "codetools, shiny, testit, rmarkdown, knitr"
## Formula        NA
## fpp2           "GGally,gridExtra,Mcomp,purrr,seasonal,tidyverse,vars"
## fracdiff       "longmemo, forecast, urca"
## fs             "testthat, covr, pillar (>= 1.0.0), crayon, rmarkdown, knitr,\nwithr, spelling"
## gam            "akima"
## genefilter     "class, hgu95av2.db, tkWidgets, ALL, ROC, DESeq, pasilla,\nRColorBrewer, BiocStyle, k
## generics       "covr, pkgload, testthat, tibble"
## ggplot2        "covr, dplyr, ggplot2movies, hexbin, Hmisc, knitr, lattice,\nmapproj, maps, maptools,
## ggrepel        "knitr, rmarkdown, testthat, gridExtra, devtools, prettydoc"
```

```
## ggthemes       "dplyr, covr, extrafont, glue, knitr, lattice, lintr, maps,\nmapproj, pander, rlang, r
## gh             "covr, pingr, testthat"
## git2r          "getPass"
## glue           "testthat, covr, magrittr, crayon, knitr, rmarkdown, DBI,\nRSQLite, R.utils, forcats,
## gower          "tinytest (>= 0.9.3),"
## greybox        "smooth (>= 2.5.1), doMC, doParallel, foreach, testthat,\nrmarkdown, knitr"
## gridBase       "lattice"
## gridExtra      "ggplot2, egg, lattice, knitr, testthat"
## gtable         "covr, testthat, knitr, rmarkdown, ggplot2, profvis"
## gutenbergr     "knitr, rmarkdown, testthat, tidytext, ggplot2, tidyr, curl"
## haven          "covr, fs, knitr, rmarkdown, testthat, pillar (>= 1.4.0), cli,\ncrayon"
## hexbin         "marray, affy, Biobase, limma"
## highr          "knitr, testit"
## HistData       "gtools, KernSmooth, maps, ggplot2, scales, proto, grid,\nreshape, plyr, lattice, jpeg
## hms            "crayon, lubridate, pillar (>= 1.1.0), testthat"
## htmltools      "markdown, testthat, withr"
## htmlwidgets    "knitr (>= 1.8)"
## hts            "testthat, knitr, rmarkdown"
## httpuv         "testthat, callr, curl, websocket"
## httr           "covr, httpuv, jpeg, knitr, png, readr, rmarkdown, testthat\n(>= 0.8.0), xml2"
## hunspell       "spelling, testthat, pdftools, janeaustenr, wordcloud2, knitr,\nstopwords, rmarkdown"
## igraph         "ape, digest, graph, igraphdata, rgl, scales, stats4, tcltk,\ntestthat"
## ini            "testthat"
## ipred          "mvtnorm, mlbench, TH.data"
## IRanges        "XVector, GenomicRanges, Rsamtools, GenomicAlignments,\nGenomicFeatures, BSgenome.Cel
## irlba          NA
## ISOcodes       NA
## iterators      "RUnit, foreach"
## janeaustenr    "dplyr, testthat"
## jsonlite       "httr, curl, plyr, testthat, knitr, rmarkdown, R.rsp, sp"
## kableExtra     "testthat, magick, formattable, dplyr"
## keras          "ggplot2, testthat (>= 2.1.0), knitr, rmarkdown, tfdatasets,\njpeg"
## kernlab        NA
## KernSmooth     "MASS"
## knitr          "formatR, testit, digest, rgl (>= 0.95.1201), codetools,\nrmarkdown, htmlwidgets (>= 0
## labeling       NA
## Lahman         "lattice, ggplot2, googleVis, data.table, vcd, reshape2,\ntidyr, zipcode, knitr, rmark
## lamW           "testthat"
## later          "knitr, rmarkdown, testthat"
## lava           "KernSmooth, Matrix, Rgraphviz, data.table, ellipse, fields,\nforeach, geepack, gof (>
## lazyeval       "knitr, rmarkdown (>= 0.2.65), testthat, covr"
## leaps          "biglm"
## lifecycle      "covr, crayon, knitr, rmarkdown, testthat (>= 2.1.0)"
## lme4           "knitr, rmarkdown, PKPDmodels, MEMSS, testthat (>= 0.8.1),\nggplot2, mlmRev, optimx (>
## lmtest         "car, strucchange, sandwich, dynlm, stats4, survival, AER"
## locfit         "akima, gam"
## lubridate      "testthat, knitr, covr"
## magrittr       "testthat, knitr"
## maptools       "rgeos (>= 0.1-8), spatstat (>= 1.60), PBSmapping, maps,\nRColorBrewer, raster, polycl
## markdown       "knitr, RCurl"
## MASS           "lattice, nlme, nnet, survival"
## matrixcalc     NA
## MatrixModels   NA
## matrixStats    "base64enc, ggplot2, knitr, microbenchmark, R.devices, R.rsp"
```

```
## mcmc           "xtable, Iso"
## MCMCpack       NA
## memoise        "testthat, aws.s3, httr, covr"
## Metrics        "testthat"
## mgcv           "parallel, survival, MASS"
## mime           NA
## minqa          NA
## ModelMetrics   "testthat"
## modelr         "compiler, covr, ggplot2, testthat"
## munsell        "ggplot2, testthat"
## naivebayes     "knitr"
## nlme           "Hmisc, MASS"
## nloptr         "testthat (>= 0.8.1), knitr, rmarkdown, inline (>= 0.3.14)"
## numDeriv       NA
## openssl        "testthat, digest, knitr, rmarkdown, jsonlite, jose, sodium"
## openxlsx       "knitr, testthat, roxygen2"
## pbkrtest       NA
## pdftools       "jpeg, png, webp, tesseract, testthat"
## pillar         "knitr, lubridate, testthat (>= 2.0.0), withr"
## pkgbuild       "Rcpp, testthat, covr"
## pkgconfig      "covr, testthat, disposables (>= 1.0.3)"
## pkgload        "bitops, covr, Rcpp, testthat"
## plogr          "Rcpp"
## plotly         "MASS, maps, ggthemes, GGally, testthat, knitr, devtools,\nshiny (>= 1.1.0), shinytes
## plyr           "abind, covr, doParallel, foreach, iterators, itertools,\ntcltk, testthat"
## praise         "testthat"
## prettyunits    "testthat"
## pROC           "microbenchmark, tcltk, MASS, logcondens, doParallel,\ntestthat, vdiffr, ggplot2"
## processx       "callr (>= 3.2.0), codetools, covr, crayon, curl, debugme,\nparallel, testthat, withr
## prodlim        NA
## progress       "Rcpp, testthat, withr"
## promises       "testthat, future, knitr, rmarkdown"
## proxy          "cba"
## pryr           "testthat (>= 0.8.0)"
## ps             "callr, covr, curl, pingr, processx (>= 3.1.0), R6, rlang,\ntestthat, tibble"
## purrr          "covr, crayon, dplyr (>= 0.7.8), knitr, rmarkdown, testthat,\ntibble, tidyselect"
## qpdf           "testthat"
## quadprog       NA
## quantmod       "DBI,RMySQL,RSQLite,timeSeries,XML,downloader,jsonlite(>= 1.1)"
## quantreg       "tripack, akima, MASS, survival, rgl, logspline, nor1mix,\nFormula, zoo, R.rsp"
## R6             "knitr, microbenchmark, pryr, testthat, ggplot2, scales"
## randomForest   "RColorBrewer, MASS"
## rappdirs       "testthat, roxygen2"
## rcmdcheck      "covr, knitr, mockery, rmarkdown, testthat"
## RColorBrewer   NA
## Rcpp           "RUnit, inline, rbenchmark, knitr, rmarkdown, pinp, pkgKitten\n(>= 0.1.2)"
## RcppArmadillo  "tinytest, Matrix, pkgKitten, reticulate, rmarkdown, knitr,\npinp, slam"
## RcppEigen      "inline, tinytest, pkgKitten, microbenchmark"
## RcppParallel   "Rcpp, RUnit, knitr, rmarkdown"
## RcppProgress   "RcppArmadillo, devtools, roxygen2, testthat"
## RCurl          "Rcompression, XML"
## readr          "curl, testthat, knitr, rmarkdown, stringi, covr, spelling"
## readxl         "covr, knitr, rmarkdown, rprojroot (>= 1.1), testthat"
## recipes        "covr, ddalpha, dimRed (>= 0.2.2), fastICA, ggplot2, igraph,\nkernlab, knitr, modelda
```

```
## recommenderlab "ROCR, testthat"
## recosystem     "knitr, prettydoc"
## registry       NA
## rematch        "covr, testthat"
## remotes        "brew, callr, codetools, curl, covr, git2r (>= 0.23.0), knitr,\nmockery, pkgbuild (>=
## reprex         "covr, devtools, fortunes, knitr, miniUI, rprojroot,\nrstudioapi, shiny, styler (>= 1
## reshape2       "covr, lattice, testthat (>= 0.8.0)"
## reticulate     "callr, knitr, rmarkdown, testthat"
## rex            "testthat, knitr, rmarkdown, dplyr, ggplot2, Hmisc, stringr,\nrvest, roxygen2, covr"
## rio            "datasets, bit64, testthat, knitr, magrittr, clipr, csvy,\nfeather, fst, hexView, jso
## rlang          "cli, covr, crayon, magrittr, methods, pillar, rmarkdown,\ntestthat (>= 2.3.0)"
## rmarkdown      "shiny (>= 0.11), tufte, testthat, digest, dygraphs, tibble,\nfs, pkgdown, callr (>= 1
## roxygen2       "covr, devtools, knitr, rmarkdown, testthat (>= 2.1.0),\nR.methodsS3, R.oo"
## rprojroot      "testthat, mockr, knitr, withr, rmarkdown"
## RSQLite        "DBItest (>= 1.7.0), knitr, rmarkdown, testthat"
## rstudioapi     "testthat, knitr, rmarkdown"
## rticles        "testit, bookdown, xtable"
## rversions      "mockery, testthat"
## rvest          "covr, knitr, png, rmarkdown, spelling, stringi (>= 0.3.1),\ntestthat"
## S4Vectors      "IRanges, GenomicRanges, SummarizedExperiment, Matrix,\nDelayedArray, ShortRead, grapl
## scales         "bit64, covr, dichromat, hms, testthat (>= 2.1.0), ggplot2"
## selectr        "testthat, XML, xml2"
## sessioninfo    "callr, covr, mockery, testthat"
## shiny          "datasets, Cairo (>= 1.5-5), testthat (>= 2.1.1), knitr (>=\n1.6), markdown, rmarkdow
## slam           NA
## smooth         "Mcomp, numDeriv, testthat, knitr, rmarkdown"
## SnowballC      NA
## sourcetools    "testthat"
## sp             "RColorBrewer, rgdal (>= 0.8-7), rgeos (>= 0.3-13), gstat,\nmaptools, deldir"
## SparseM        NA
## SQUAREM        "setRNG"
## statmod        "MASS, tweedie"
## stopwords      "covr, lintr, quanteda, spelling, testthat"
## stringi        NA
## stringr        "covr, htmltools, htmlwidgets, knitr, rmarkdown, testthat"
## survival       NA
## sys            "unix (>= 1.4), spelling, testthat"
## tensorflow     "testthat, keras, tfestimators"
## testthat       "covr, curl (>= 0.9.5), devtools, knitr, rmarkdown, usethis,\nvctrs (>= 0.1.0), xml2"
## textdata       "knitr, rmarkdown, testthat (>= 2.1.0)"
## tfruns         "testthat, knitr"
## tibble         "bench, covr, dplyr, htmltools, import, knitr, mockr,\nnycflights13, rmarkdown, testth
## tidyr          "covr, jsonlite, knitr, repurrrsive (>= 1.0.0), rmarkdown,\nreadr, testthat (>= 2.1.0)
## tidyselect     "covr, dplyr, testthat"
## tidytext       "readr, tidyr, XML, tm, quanteda, knitr, rmarkdown, ggplot2,\nreshape2, wordcloud, top
## tidyverse      "covr, feather, glue, knitr, rmarkdown, testthat"
## timeDate       "date, RUnit"
## tinytex        "testit, rstudioapi"
## titanic        "dplyr"
## tokenizers     "covr, knitr, rmarkdown, stopwords (>= 0.9.0), testthat"
## treemap        "knitr"
## triebeard      "knitr, rmarkdown, testthat"
## truncnorm      "testthat"
## TSA            NA
```

```
## tseries        NA
## TTR            "RUnit"
## urca           NA
## urltools       "testthat, knitr"
## uroot          NA
## usethis        "covr, knitr, magick, pkgdown (>= 1.1.0), rmarkdown, roxygen2,\nspelling (>= 1.2), sty
## utf8           "knitr, rmarkdown, testthat"
## vctrs          "bit64, covr, crayon, generics, knitr, pillar (>= 1.4.1),\npkgdown, rmarkdown, testtha
## viridisLite    "hexbin (>= 1.27.0), ggplot2 (>= 1.0.1), testthat, covr"
## webshot        "httpuv, knitr, rmarkdown, shiny"
## whisker        "markdown"
## withr          "testthat, covr, lattice, DBI, RSQLite, methods, knitr,\nrmarkdown"
## xfun           "testit, parallel, rstudioapi, tinytex, mime, markdown, knitr,\nhtmltools, base64enc,
## XML            "bitops, RCurl"
## xml2           "covr, curl, httr, knitr, magrittr, mockery, rmarkdown,\ntestthat (>= 2.1.0)"
## xopen          "ps, testthat"
## xtable         "knitr, plm, zoo, survival"
## xts            "timeSeries, timeDate, tseries, chron, fts, tis, RUnit"
## yaml           "RUnit"
## zeallot        "testthat, knitr, rmarkdown, purrr, magrittr"
## zip            "covr, processx, R6, testthat, withr"
## zoo            "coda, chron, DAAG, fts, ggplot2, mondate, scales,\nstrucchange, timeDate, timeSeries
## base           "methods"
## boot           "MASS, survival"
## class          NA
## cluster        "MASS, Matrix"
## codetools      NA
## compiler       NA
## datasets       NA
## foreign        NA
## graphics       NA
## grDevices      "KernSmooth"
## grid           "lattice"
## KernSmooth     "MASS"
## lattice        "KernSmooth, MASS, latticeExtra"
## MASS           "lattice, nlme, nnet, survival"
## Matrix         "expm, MASS"
## methods        "codetools"
## mgcv           "parallel, survival, MASS"
## nlme           "Hmisc, MASS"
## nnet           "MASS"
## parallel       "methods"
## rpart          "survival"
## spatial        "MASS"
## splines        "Matrix, methods"
## stats          "MASS, Matrix, SuppDists, methods, stats4"
## stats4         NA
## survival       NA
## tcltk          NA
## tools          "codetools, methods, xml2, curl, commonmark"
## translations   NA
## utils          "methods, xml2, commonmark"
##                Enhances
## abind          NA
```

```
## AnalyzeTS      NA
## annotate       NA
## AnnotationDbi  NA
## anytime        NA
## arm            NA
## arules         NA
## askpass        NA
## assertthat     NA
## backports      NA
## base64enc      "png"
## BH             NA
## Biobase        NA
## BiocGenerics   NA
## BiocManager    NA
## BiocVersion    NA
## bit            NA
## bit64          NA
## bitops         NA
## blob           NA
## Boom           NA
## BoomSpikeSlab  NA
## boot           NA
## brew           NA
## brnn           NA
## broom          NA
## bsts           NA
## callr          NA
## car            NA
## carData        NA
## caret          NA
## cellranger     NA
## cli            NA
## clipr          NA
## clisymbols     NA
## coda           NA
## colorspace     NA
## commonmark     NA
## config         NA
## corrplot       NA
## covr           NA
## crayon         NA
## crosstalk      NA
## curl           NA
## data.table     NA
## DBI            NA
## dbplyr         NA
## desc           NA
## devtools       NA
## digest         NA
## dplyr          NA
## dslabs         NA
## DT             NA
## e1071          NA
## ellipsis       NA
```

```
## evaluate       NA
## expsmooth      NA
## fansi          NA
## farver         NA
## fastAdaboost   NA
## fastmap        NA
## fma            NA
## forcats        NA
## foreach        "compiler, doMC, RUnit, doParallel"
## forecast       NA
## foreign        NA
## formatR        NA
## Formula        NA
## fpp2           NA
## fracdiff       NA
## fs             NA
## gam            NA
## genefilter     NA
## generics       NA
## ggplot2        "sp"
## ggrepel        NA
## ggthemes       NA
## gh             NA
## git2r          NA
## glue           NA
## gower          NA
## greybox        "vars"
## gridBase       NA
## gridExtra      NA
## gtable         NA
## gutenbergr     NA
## haven          NA
## hexbin         NA
## highr          NA
## HistData       NA
## hms            NA
## htmltools      "knitr"
## htmlwidgets    "shiny (>= 1.1)"
## hts            NA
## httpuv         NA
## httr           NA
## hunspell       NA
## igraph         NA
## ini            NA
## ipred          NA
## IRanges        NA
## irlba          NA
## ISOcodes       NA
## iterators      NA
## janeaustenr    NA
## jsonlite       NA
## kableExtra     NA
## keras          NA
## kernlab        NA
```

```
## KernSmooth     NA
## knitr          NA
## labeling       NA
## Lahman         NA
## lamW           NA
## later          NA
## lava           NA
## lazyeval       NA
## leaps          NA
## lifecycle      NA
## lme4           NA
## lmtest         NA
## locfit         NA
## lubridate      "chron, fts, timeSeries, timeDate, tis, tseries, xts, zoo"
## magrittr       NA
## maptools       "gpclib, RArcInfo"
## markdown       NA
## MASS           NA
## matrixcalc     NA
## MatrixModels   NA
## matrixStats    NA
## mcmc           NA
## MCMCpack       NA
## memoise        NA
## Metrics        NA
## mgcv           NA
## mime           NA
## minqa          NA
## ModelMetrics   NA
## modelr         NA
## munsell        NA
## naivebayes     NA
## nlme           NA
## nloptr         NA
## numDeriv       NA
## openssl        NA
## openxlsx       NA
## pbkrtest       NA
## pdftools       NA
## pillar         NA
## pkgbuild       NA
## pkgconfig      NA
## pkgload        NA
## plogr          NA
## plotly         NA
## plyr           NA
## praise         NA
## prettyunits    NA
## pROC           NA
## processx       NA
## prodlim        NA
## progress       NA
## promises       NA
## proxy          NA
```

```
## pryr           NA
## ps             NA
## purrr          NA
## qpdf           NA
## quadprog       NA
## quantmod       NA
## quantreg       NA
## R6             NA
## randomForest   NA
## rappdirs       NA
## rcmdcheck      NA
## RColorBrewer   NA
## Rcpp           NA
## RcppArmadillo  NA
## RcppEigen      NA
## RcppParallel   NA
## RcppProgress   NA
## RCurl          NA
## readr          NA
## readxl         NA
## recipes        NA
## recommenderlab NA
## recosystem     NA
## registry       NA
## rematch        NA
## remotes        NA
## reprex         NA
## reshape2       NA
## reticulate     NA
## rex            NA
## rio            NA
## rlang          NA
## rmarkdown      NA
## roxygen2       NA
## rprojroot      NA
## RSQLite        NA
## rstudioapi     NA
## rticles        NA
## rversions      NA
## rvest          NA
## S4Vectors      NA
## scales         NA
## selectr        NA
## sessioninfo    NA
## shiny          NA
## slam           "Matrix, SparseM, spam"
## smooth         NA
## SnowballC      NA
## sourcetools    NA
## sp             NA
## SparseM        NA
## SQUAREM        NA
## statmod        NA
## stopwords      NA
```

```
## stringi        NA
## stringr        NA
## survival       NA
## sys            NA
## tensorflow     NA
## testthat       NA
## textdata       NA
## tfruns         NA
## tibble         NA
## tidyr          NA
## tidyselect     NA
## tidytext       NA
## tidyverse      NA
## timeDate       NA
## tinytex        NA
## titanic        NA
## tokenizers     NA
## treemap        NA
## triebeard      NA
## truncnorm      NA
## TSA            NA
## tseries        NA
## TTR            "quantmod"
## urca           NA
## urltools       NA
## uroot          NA
## usethis        NA
## utf8           NA
## vctrs          NA
## viridisLite    NA
## webshot        NA
## whisker        NA
## withr          NA
## xfun           NA
## XML            NA
## xml2           NA
## xopen          NA
## xtable         NA
## xts            NA
## yaml           NA
## zeallot        NA
## zip            NA
## zoo            NA
## base           NA
## boot           NA
## class          NA
## cluster        NA
## codetools      NA
## compiler       NA
## datasets       NA
## foreign        NA
## graphics       NA
## grDevices      NA
## grid           NA
```

```
## KernSmooth     NA
## lattice        "chron"
## MASS           NA
## Matrix         "MatrixModels, graph, SparseM, sfsmisc"
## methods        NA
## mgcv           NA
## nlme           NA
## nnet           NA
## parallel       "snow, nws, Rmpi"
## rpart          NA
## spatial        NA
## splines        NA
## stats          NA
## stats4         NA
## survival       NA
## tcltk          NA
## tools          NA
## translations   NA
## utils          NA
##                License                                 License_is_FOSS
## abind          "LGPL (>= 2)"                           NA
## AnalyzeTS      "GPL (>= 2.0)"                          NA
## annotate       "Artistic-2.0"                          NA
## AnnotationDbi  "Artistic-2.0"                          NA
## anytime        "GPL (>= 2)"                            NA
## arm            "GPL (>= 3)"                            NA
## arules         "GPL-3"                                 NA
## askpass        "MIT + file LICENSE"                    NA
## assertthat     "GPL-3"                                 NA
## backports      "GPL-2 | GPL-3"                         NA
## base64enc      "GPL-2 | GPL-3"                         NA
## BH             "BSL-1.0"                               NA
## Biobase        "Artistic-2.0"                          NA
## BiocGenerics   "Artistic-2.0"                          NA
## BiocManager    "Artistic-2.0"                          NA
## BiocVersion    "Artistic-2.0"                          NA
## bit            "GPL-2"                                 NA
## bit64          "GPL-2"                                 NA
## bitops         "GPL (>= 2)"                            NA
## blob           "GPL-3"                                 NA
## Boom           "LGPL-2.1 | file LICENSE"               NA
## BoomSpikeSlab  "LGPL-2.1 | file LICENSE"               NA
## boot           "Unlimited"                             NA
## brew           "GPL-2"                                 NA
## brnn           "GPL-2"                                 NA
## broom          "MIT + file LICENSE"                    NA
## bsts           "LGPL-2.1 | file LICENSE"               NA
## callr          "MIT + file LICENSE"                    NA
## car            "GPL (>= 2)"                            NA
## carData        "GPL (>= 2)"                            NA
## caret          "GPL (>= 2)"                            NA
## cellranger     "MIT + file LICENSE"                    NA
## cli            "MIT + file LICENSE"                    NA
## clipr          "GPL-3"                                 NA
```

```
## clisymbols     "MIT + file LICENSE"                    NA
## coda           "GPL (>= 2)"                            NA
## colorspace     "BSD_3_clause + file LICENSE"           NA
## commonmark     "BSD_2_clause + file LICENSE"           NA
## config         "GPL-3"                                 NA
## corrplot       "GPL"                                   NA
## covr           "GPL-3"                                 NA
## crayon         "MIT + file LICENSE"                    NA
## crosstalk      "MIT + file LICENSE"                    NA
## curl           "MIT + file LICENSE"                    NA
## data.table     "MPL-2.0 | file LICENSE"                NA
## DBI            "LGPL (>= 2.1)"                         NA
## dbplyr         "MIT + file LICENSE"                    NA
## desc           "MIT + file LICENSE"                    NA
## devtools       "GPL (>= 2)"                            NA
## digest         "GPL (>= 2)"                            NA
## dplyr          "MIT + file LICENSE"                    NA
## dslabs         "Artistic-2.0"                          NA
## DT             "GPL-3 | file LICENSE"                  NA
## e1071          "GPL-2 | GPL-3"                         NA
## ellipsis       "GPL-3"                                 NA
## evaluate       "MIT + file LICENSE"                    NA
## expsmooth      "GPL (>= 2)"                            NA
## fansi          "GPL (>= 2)"                            NA
## farver         "MIT + file LICENSE"                    NA
## fastAdaboost   "MIT + file LICENSE"                    NA
## fastmap        "MIT + file LICENSE"                    NA
## fma            "GPL (>= 2)"                            NA
## forcats        "GPL-3"                                 NA
## foreach        "Apache License (== 2.0)"               NA
## forecast       "GPL-3"                                 NA
## foreign        "GPL (>= 2)"                            NA
## formatR        "GPL"                                   NA
## Formula        "GPL-2 | GPL-3"                         NA
## fpp2           "GPL (>= 3)"                            NA
## fracdiff       "GPL (>= 2)"                            NA
## fs             "GPL-3"                                 NA
## gam            "GPL-2"                                 NA
## genefilter     "Artistic-2.0"                          NA
## generics       "GPL-2"                                 NA
## ggplot2        "GPL-2 | file LICENSE"                  NA
## ggrepel        "GPL-3 | file LICENSE"                  NA
## ggthemes       "GPL-2"                                 NA
## gh             "MIT + file LICENSE"                    NA
## git2r          "GPL-2"                                 NA
## glue           "MIT + file LICENSE"                    NA
## gower          "GPL-3"                                 NA
## greybox        "GPL (>= 2)"                            NA
## gridBase       "GPL"                                   NA
## gridExtra      "GPL (>= 2)"                            NA
## gtable         "GPL-2"                                 NA
## gutenbergr     "GPL-2"                                 NA
## haven          "MIT + file LICENSE"                    NA
## hexbin         "GPL-2"                                 NA
```

```
## highr          "GPL"                                  NA
## HistData       "GPL"                                  NA
## hms            "GPL-3"                                NA
## htmltools      "GPL (>= 2)"                           NA
## htmlwidgets    "MIT + file LICENSE"                   NA
## hts            "GPL (>= 2)"                           NA
## httpuv         "GPL (>= 2) | file LICENSE"            NA
## httr           "MIT + file LICENSE"                   NA
## hunspell       "GPL-2 | LGPL-2.1 | MPL-1.1"           NA
## igraph         "GPL (>= 2)"                           NA
## ini            "GPL-3"                                NA
## ipred          "GPL (>= 2)"                           NA
## IRanges        "Artistic-2.0"                         NA
## irlba          "GPL-3"                                NA
## ISOcodes       "GPL-2"                                NA
## iterators      "Apache License (== 2.0)"              NA
## janeaustenr    "MIT + file LICENSE"                   NA
## jsonlite       "MIT + file LICENSE"                   NA
## kableExtra     "MIT + file LICENSE"                   NA
## keras          "MIT + file LICENSE"                   NA
## kernlab        "GPL-2"                                NA
## KernSmooth     "Unlimited"                            NA
## knitr          "GPL"                                  NA
## labeling       "MIT + file LICENSE | Unlimited"       NA
## Lahman         "GPL"                                  NA
## lamW           "BSD_2_clause + file LICENSE"          NA
## later          "GPL (>= 2)"                           NA
## lava           "GPL-3"                                NA
## lazyeval       "GPL-3"                                NA
## leaps          "GPL (>= 2)"                           NA
## lifecycle      "GPL-3"                                NA
## lme4           "GPL (>= 2)"                           NA
## lmtest         "GPL-2 | GPL-3"                        NA
## locfit         "GPL (>= 2)"                           NA
## lubridate      "GPL (>= 2)"                           NA
## magrittr       "MIT + file LICENSE"                   NA
## maptools       "GPL (>= 2)"                           NA
## markdown       "GPL-2"                                NA
## MASS           "GPL-2 | GPL-3"                        NA
## matrixcalc     "GPL (>= 2)"                           NA
## MatrixModels   "GPL (>= 2)"                           NA
## matrixStats    "Artistic-2.0"                         NA
## mcmc           "MIT + file LICENSE"                   NA
## MCMCpack       "GPL-3"                                NA
## memoise        "MIT + file LICENSE"                   NA
## Metrics        "BSD_3_clause + file LICENSE"          NA
## mgcv           "GPL (>= 2)"                           NA
## mime           "GPL"                                  NA
## minqa          "GPL-2"                                NA
## ModelMetrics   "GPL (>= 2)"                           NA
## modelr         "GPL-3"                                NA
## munsell        "MIT + file LICENSE"                   NA
## naivebayes     "GPL-2"                                NA
## nlme           "GPL (>= 2) | file LICENCE"            NA
```

```
## nloptr          "LGPL-3"                              NA
## numDeriv        "GPL-2"                               NA
## openssl         "MIT + file LICENSE"                  NA
## openxlsx        "MIT + file LICENSE"                  NA
## pbkrtest        "GPL (>= 2)"                          NA
## pdftools        "MIT + file LICENSE"                  NA
## pillar          "GPL-3"                               NA
## pkgbuild        "GPL-3"                               NA
## pkgconfig       "MIT + file LICENSE"                  NA
## pkgload         "GPL-3"                               NA
## plogr           "MIT + file LICENSE"                  NA
## plotly          "MIT + file LICENSE"                  NA
## plyr            "MIT + file LICENSE"                  NA
## praise          "MIT + file LICENSE"                  NA
## prettyunits     "MIT + file LICENSE"                  NA
## pROC            "GPL (>= 3)"                          NA
## processx        "MIT + file LICENSE"                  NA
## prodlim         "GPL (>= 2)"                          NA
## progress        "MIT + file LICENSE"                  NA
## promises        "MIT + file LICENSE"                  NA
## proxy           "GPL-2"                               NA
## pryr            "GPL-2"                               NA
## ps              "BSD_3_clause + file LICENSE"         NA
## purrr           "GPL-3 | file LICENSE"                NA
## qpdf            "Apache License 2.0"                  NA
## quadprog        "GPL (>= 2)"                          NA
## quantmod        "GPL-3"                               NA
## quantreg        "GPL (>= 2)"                          NA
## R6              "MIT + file LICENSE"                  NA
## randomForest    "GPL (>= 2)"                          NA
## rappdirs        "MIT + file LICENSE"                  NA
## rcmdcheck       "MIT + file LICENSE"                  NA
## RColorBrewer    "Apache License 2.0"                  NA
## Rcpp            "GPL (>= 2)"                          NA
## RcppArmadillo   "GPL (>= 2)"                          NA
## RcppEigen       "GPL (>= 2) | file LICENSE"           NA
## RcppParallel    "GPL-2"                               NA
## RcppProgress    "GPL (>= 3)"                          NA
## RCurl           "BSD"                                 NA
## readr           "GPL (>= 2) | file LICENSE"           NA
## readxl          "GPL-3"                               NA
## recipes         "GPL-2"                               NA
## recommenderlab "GPL-2"                                NA
## recosystem      "BSD_3_clause + file LICENSE"         NA
## registry        "GPL-2"                               NA
## rematch         "MIT + file LICENSE"                  NA
## remotes         "GPL (>= 2)"                          NA
## reprex          "MIT + file LICENSE"                  NA
## reshape2        "MIT + file LICENSE"                  NA
## reticulate      "Apache License 2.0"                  NA
## rex             "MIT + file LICENSE"                  NA
## rio             "GPL-2"                               NA
## rlang           "GPL-3"                               NA
## rmarkdown       "GPL-3"                               NA
```

```
## roxygen2       "GPL (>= 2)"                                NA
## rprojroot      "GPL-3"                                     NA
## RSQLite        "LGPL (>= 2.1)"                             NA
## rstudioapi     "MIT + file LICENSE"                        NA
## rticles        "GPL-3"                                     NA
## rversions      "MIT + file LICENSE"                        NA
## rvest          "GPL-3"                                     NA
## S4Vectors      "Artistic-2.0"                              NA
## scales         "MIT + file LICENSE"                        NA
## selectr        "BSD_3_clause + file LICENCE"               NA
## sessioninfo    "GPL-2"                                     NA
## shiny          "GPL-3 | file LICENSE"                      NA
## slam           "GPL-2"                                     NA
## smooth         "GPL (>= 2)"                                NA
## SnowballC      "BSD_3_clause + file LICENSE"               NA
## sourcetools    "MIT + file LICENSE"                        NA
## sp             "GPL (>= 2)"                                NA
## SparseM        "GPL (>= 2)"                                NA
## SQUAREM        "GPL (>= 2)"                                NA
## statmod        "GPL-2 | GPL-3"                             NA
## stopwords      "MIT + file LICENSE"                        NA
## stringi        "file LICENSE"                              "yes"
## stringr        "GPL-2 | file LICENSE"                      NA
## survival       "LGPL (>= 2)"                               NA
## sys            "MIT + file LICENSE"                        NA
## tensorflow     "Apache License 2.0"                        NA
## testthat       "MIT + file LICENSE"                        NA
## textdata       "MIT + file LICENSE"                        NA
## tfruns         "Apache License 2.0"                        NA
## tibble         "MIT + file LICENSE"                        NA
## tidyr          "MIT + file LICENSE"                        NA
## tidyselect     "GPL-3"                                     NA
## tidytext       "MIT + file LICENSE"                        NA
## tidyverse      "GPL-3 | file LICENSE"                      NA
## timeDate       "GPL (>= 2)"                                NA
## tinytex        "MIT + file LICENSE"                        NA
## titanic        "CC0"                                       NA
## tokenizers     "MIT + file LICENSE"                        NA
## treemap        "GPL-3"                                     NA
## triebeard      "MIT + file LICENSE"                        NA
## truncnorm      "GPL (>= 2)"                                NA
## TSA            "GPL (>= 2)"                                NA
## tseries        "GPL-2"                                     NA
## TTR            "GPL (>= 2)"                                NA
## urca           "GPL (>= 2)"                                NA
## urltools       "MIT + file LICENSE"                        NA
## uroot          "GPL-2"                                     NA
## usethis        "GPL-3"                                     NA
## utf8           "Apache License (== 2.0) | file LICENSE" NA
## vctrs          "GPL-3"                                     NA
## viridisLite    "MIT + file LICENSE"                        NA
## webshot        "GPL-2"                                     NA
## whisker        "GPL-3"                                     NA
## withr          "GPL (>= 2)"                                NA
```

```
## xfun           "MIT + file LICENSE"                    NA
## XML            "BSD_2_clause + file LICENSE"           NA
## xml2           "GPL (>= 2)"                            NA
## xopen          "MIT + file LICENSE"                    NA
## xtable         "GPL (>= 2)"                            NA
## xts            "GPL (>= 2)"                            NA
## yaml           "BSD_3_clause + file LICENSE"           NA
## zeallot        "MIT + file LICENSE"                    NA
## zip            "CC0"                                   NA
## zoo            "GPL-2 | GPL-3"                         NA
## base           "Part of R 3.6.2"                       NA
## boot           "Unlimited"                             NA
## class          "GPL-2 | GPL-3"                         NA
## cluster        "GPL (>= 2)"                            NA
## codetools      "GPL"                                   NA
## compiler       "Part of R 3.6.2"                       NA
## datasets       "Part of R 3.6.2"                       NA
## foreign        "GPL (>= 2)"                            NA
## graphics       "Part of R 3.6.2"                       NA
## grDevices      "Part of R 3.6.2"                       NA
## grid           "Part of R 3.6.2"                       NA
## KernSmooth     "Unlimited"                             NA
## lattice        "GPL (>= 2)"                            NA
## MASS           "GPL-2 | GPL-3"                         NA
## Matrix         "GPL (>= 2) | file LICENCE"             NA
## methods        "Part of R 3.6.2"                       NA
## mgcv           "GPL (>= 2)"                            NA
## nlme           "GPL (>= 2) | file LICENCE"             NA
## nnet           "GPL-2 | GPL-3"                         NA
## parallel       "Part of R 3.6.2"                       NA
## rpart          "GPL-2 | GPL-3"                         NA
## spatial        "GPL-2 | GPL-3"                         NA
## splines        "Part of R 3.6.2"                       NA
## stats          "Part of R 3.6.2"                       NA
## stats4         "Part of R 3.6.2"                       NA
## survival       "LGPL (>= 2)"                           NA
## tcltk          "Part of R 3.6.2"                       NA
## tools          "Part of R 3.6.2"                       NA
## translations   "Part of R 3.6.2"                       NA
## utils          "Part of R 3.6.2"                       NA
##                License_restricts_use OS_type MD5sum NeedsCompilation Built
## abind          NA                    NA      NA     "no"             "3.6.0"
## AnalyzeTS      NA                    NA      NA     "no"             "3.6.2"
## annotate       NA                    NA      NA     "no"             "3.6.1"
## AnnotationDbi  NA                    NA      NA     "no"             "3.6.1"
## anytime        NA                    NA      NA     "yes"            "3.6.2"
## arm            NA                    NA      NA     "no"             "3.6.2"
## arules         NA                    NA      NA     "yes"            "3.6.2"
## askpass        NA                    NA      NA     "yes"            "3.6.1"
## assertthat     NA                    NA      NA     "no"             "3.6.1"
## backports      NA                    NA      NA     "yes"            "3.6.1"
## base64enc      NA                    NA      NA     "yes"            "3.6.0"
## BH             NA                    NA      NA     "no"             "3.6.1"
## Biobase        NA                    NA      NA     "yes"            "3.6.1"
```

```
## BiocGenerics   NA                  NA      NA     "no"            "3.6.1"
## BiocManager    NA                  NA      NA     "no"            "3.6.1"
## BiocVersion    NA                  NA      NA     "no"            "3.6.0"
## bit            NA                  NA      NA     "yes"           "3.6.0"
## bit64          NA                  NA      NA     "yes"           "3.6.0"
## bitops         NA                  NA      NA     "yes"           "3.6.0"
## blob           NA                  NA      NA     "no"            "3.6.1"
## Boom           NA                  NA      NA     "yes"           "3.6.2"
## BoomSpikeSlab  NA                  NA      NA     "yes"           "3.6.2"
## boot           NA                  NA      NA     "no"            "3.6.2"
## brew           NA                  NA      NA     NA              "3.6.0"
## brnn           NA                  NA      NA     "yes"           "3.6.0"
## broom          NA                  NA      NA     "no"            "3.6.1"
## bsts           NA                  NA      NA     "yes"           "3.6.2"
## callr          NA                  NA      NA     "no"            "3.6.1"
## car            NA                  NA      NA     "no"            "3.6.2"
## carData        NA                  NA      NA     "no"            "3.6.1"
## caret          NA                  NA      NA     "yes"           "3.6.1"
## cellranger     NA                  NA      NA     "no"            "3.6.1"
## cli            NA                  NA      NA     "no"            "3.6.1"
## clipr          NA                  NA      NA     "no"            "3.6.1"
## clisymbols     NA                  NA      NA     "no"            "3.6.2"
## coda           NA                  NA      NA     "no"            "3.6.2"
## colorspace     NA                  NA      NA     "yes"           "3.6.1"
## commonmark     NA                  NA      NA     "yes"           "3.6.2"
## config         NA                  NA      NA     "no"            "3.6.2"
## corrplot       NA                  NA      NA     "no"            "3.6.2"
## covr           NA                  NA      NA     "yes"           "3.6.2"
## crayon         NA                  NA      NA     "no"            "3.6.1"
## crosstalk      NA                  NA      NA     "no"            "3.6.2"
## curl           NA                  NA      NA     "yes"           "3.6.1"
## data.table     NA                  NA      NA     "yes"           "3.6.1"
## DBI            NA                  NA      NA     "no"            "3.6.1"
## dbplyr         NA                  NA      NA     "no"            "3.6.1"
## desc           NA                  NA      NA     "no"            "3.6.2"
## devtools       NA                  NA      NA     "no"            "3.6.2"
## digest         NA                  NA      NA     "yes"           "3.6.1"
## dplyr          NA                  NA      NA     "yes"           "3.6.1"
## dslabs         NA                  NA      NA     "no"            "3.6.1"
## DT             NA                  NA      NA     "no"            "3.6.2"
## e1071          NA                  NA      NA     "yes"           "3.6.1"
## ellipsis       NA                  NA      NA     "yes"           "3.6.1"
## evaluate       NA                  NA      NA     "no"            "3.6.1"
## expsmooth      NA                  NA      NA     "no"            "3.6.2"
## fansi          NA                  NA      NA     "yes"           "3.6.1"
## farver         NA                  NA      NA     "yes"           "3.6.1"
## fastAdaboost   NA                  NA      NA     "yes"           "3.6.2"
## fastmap        NA                  NA      NA     "yes"           "3.6.2"
## fma            NA                  NA      NA     "no"            "3.6.2"
## forcats        NA                  NA      NA     "no"            "3.6.1"
## foreach        NA                  NA      NA     "no"            "3.6.1"
## forecast       NA                  NA      NA     "yes"           "3.6.2"
## foreign        NA                  NA      NA     "yes"           "3.6.2"
## formatR        NA                  NA      NA     "no"            "3.6.2"
```

```
## Formula        NA                  NA      NA     "no"            "3.6.0"
## fpp2           NA                  NA      NA     "no"            "3.6.2"
## fracdiff       NA                  NA      NA     "yes"           "3.6.2"
## fs             NA                  NA      NA     "yes"           "3.6.1"
## gam            NA                  NA      NA     "yes"           "3.6.2"
## genefilter     NA                  NA      NA     "yes"           "3.6.1"
## generics       NA                  NA      NA     "no"            "3.6.1"
## ggplot2        NA                  NA      NA     "no"            "3.6.1"
## ggrepel        NA                  NA      NA     "yes"           "3.6.2"
## ggthemes       NA                  NA      NA     "no"            "3.6.2"
## gh             NA                  NA      NA     "no"            "3.6.2"
## git2r          NA                  NA      NA     "yes"           "3.6.2"
## glue           NA                  NA      NA     "yes"           "3.6.1"
## gower          NA                  NA      NA     "yes"           "3.6.1"
## greybox        NA                  NA      NA     "yes"           "3.6.2"
## gridBase       NA                  NA      NA     "no"            "3.6.2"
## gridExtra      NA                  NA      NA     "no"            "3.6.2"
## gtable         NA                  NA      NA     "no"            "3.6.1"
## gutenbergr     NA                  NA      NA     "no"            "3.6.1"
## haven          NA                  NA      NA     "yes"           "3.6.1"
## hexbin         NA                  NA      NA     "yes"           "3.6.2"
## highr          NA                  NA      NA     "no"            "3.6.1"
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## hunspell       NA                  NA      NA     "yes"           "3.6.1"
## igraph         NA                  NA      NA     "yes"           "3.6.2"
## ini            NA                  NA      NA     "no"            "3.6.2"
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## IRanges        NA                  NA      NA     "yes"           "3.6.1"
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## ISOcodes       NA                  NA      NA     "no"            "3.6.2"
## iterators      NA                  NA      NA     "no"            "3.6.1"
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## jsonlite       NA                  NA      NA     "yes"           "3.6.1"
## kableExtra     NA                  NA      NA     "no"            "3.6.2"
## keras          NA                  NA      NA     "no"            "3.6.2"
## kernlab        NA                  NA      NA     "yes"           "3.6.1"
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## Lahman         NA                  NA      NA     "no"            "3.6.1"
## lamW           NA                  NA      NA     "yes"           "3.6.2"
## later          NA                  NA      NA     "yes"           "3.6.2"
## lava           NA                  NA      NA     "no"            "3.6.1"
## lazyeval       NA                  NA      NA     "yes"           "3.6.1"
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## lifecycle      NA                  NA      NA     "no"            "3.6.1"
## lme4           NA                  NA      NA     "yes"           "3.6.2"
## lmtest         NA                  NA      NA     "yes"           "3.6.2"
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## lubridate       NA                    NA      NA     "yes"           "3.6.1"
## magrittr        NA                    NA      NA     "no"            "3.6.1"
## maptools        NA                    NA      NA     "yes"           "3.6.2"
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## rio            NA                  NA      NA     "no"            "3.6.2"
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## rprojroot      NA                  NA      NA     "no"            "3.6.2"
## RSQLite        NA                  NA      NA     "yes"           "3.6.2"
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## rversions      NA                  NA      NA     "no"            "3.6.2"
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## sourcetools    NA                  NA      NA     "yes"           "3.6.2"
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## tidytext       NA                  NA      NA     "no"            "3.6.1"
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## webshot        NA                  NA      NA     "no"            "3.6.2"
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## MASS           NA                  NA      NA     "yes"           "3.6.2"
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## utils          NA                  NA      NA     "yes"           "3.6.2"
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