

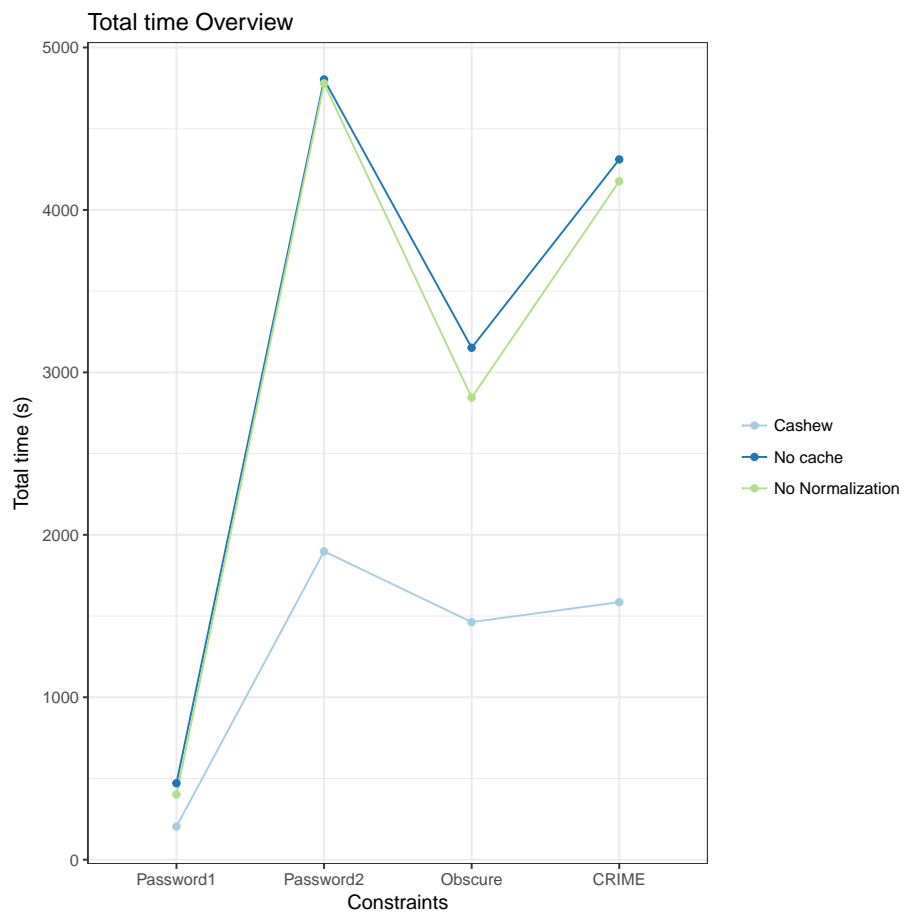
Constraint Normalization and Parameterized Caching for Quantitative Program Analysis

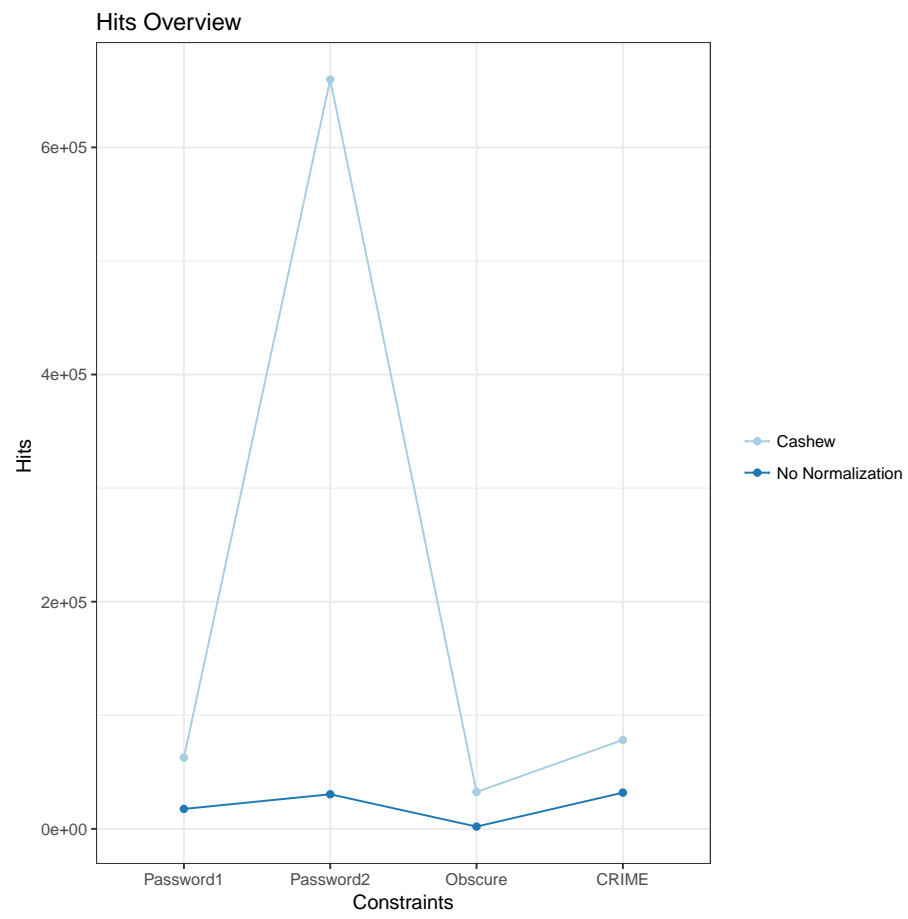
June 23, 2018

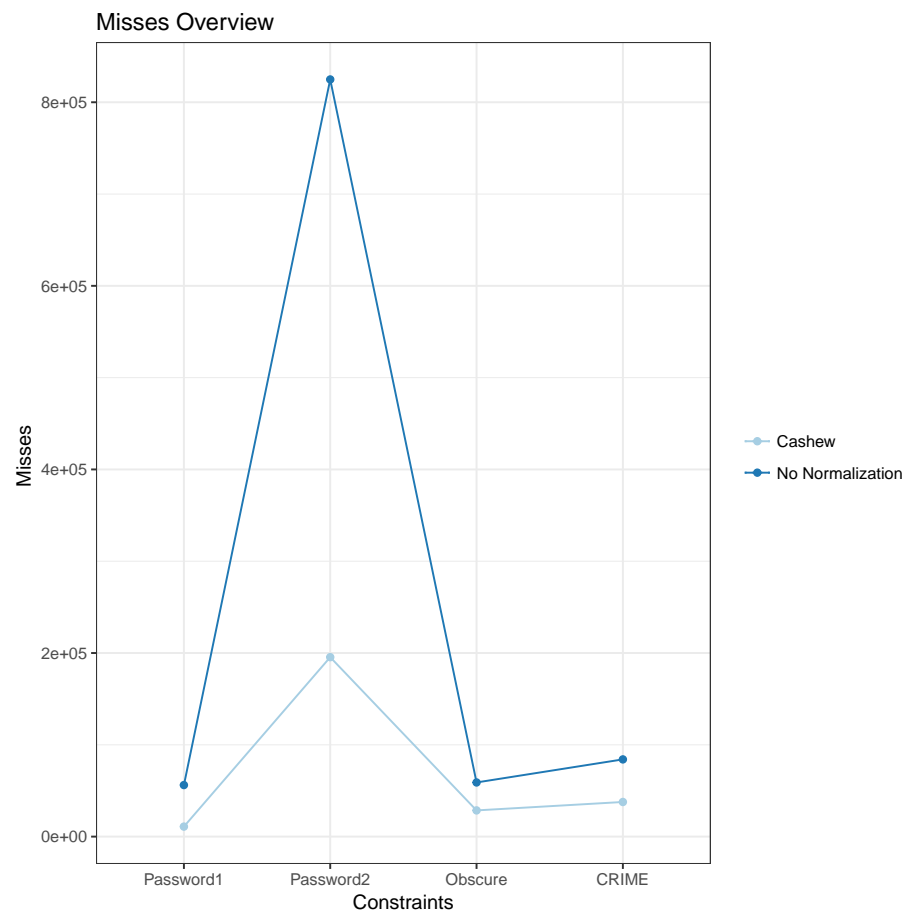
1 Description

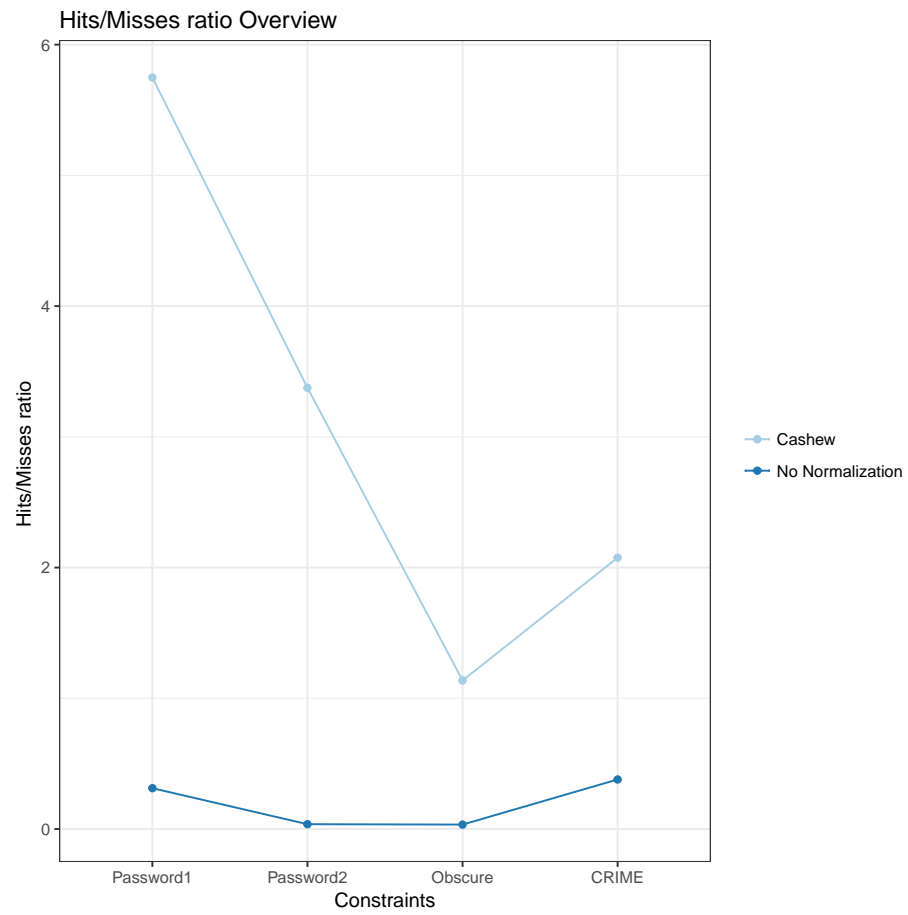
Constraint Normalization and Parameterized Caching for Quantitative Program Analysis

2 Overview



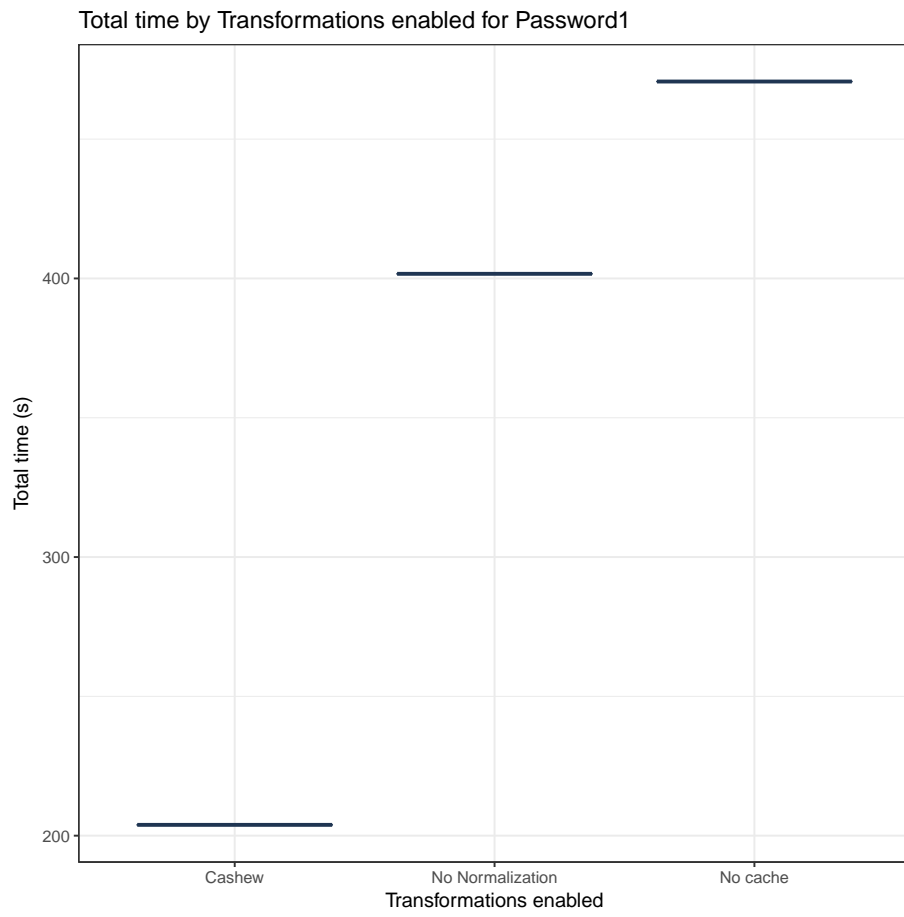


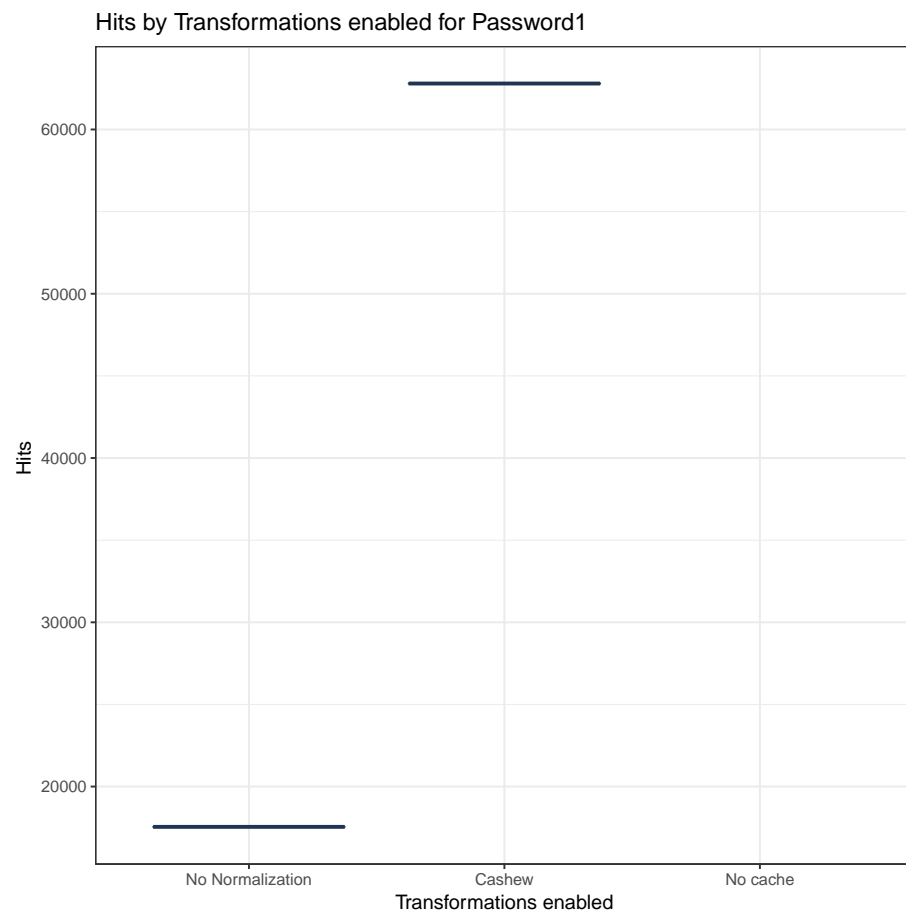


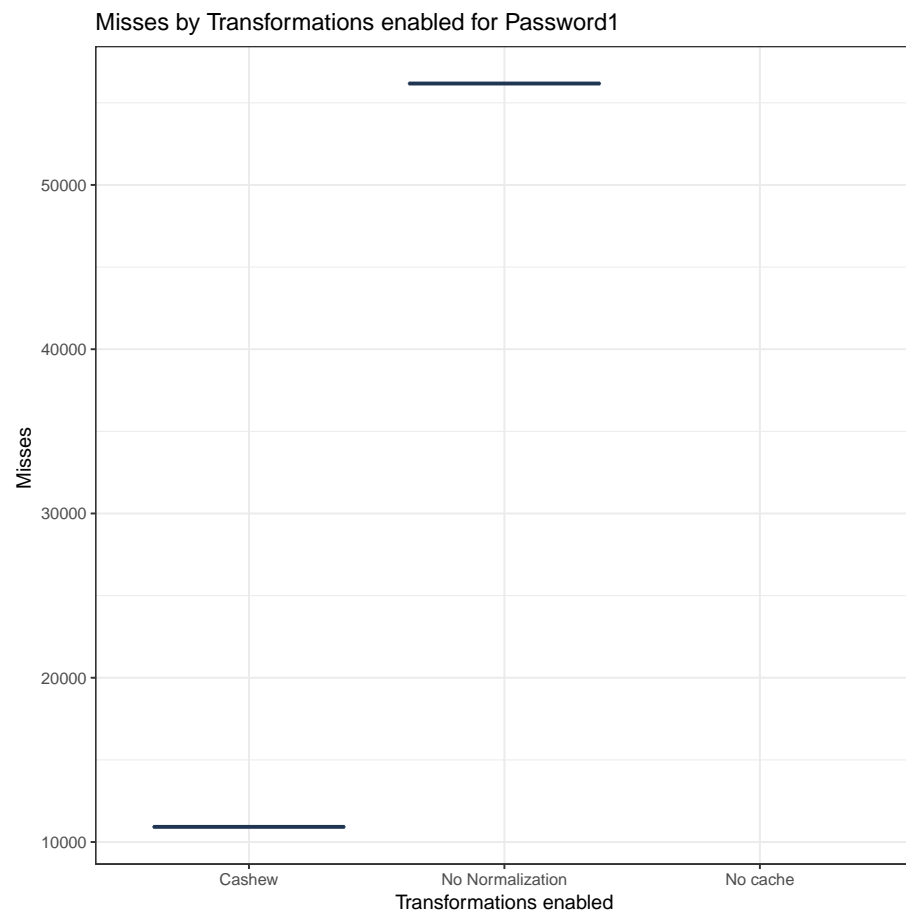


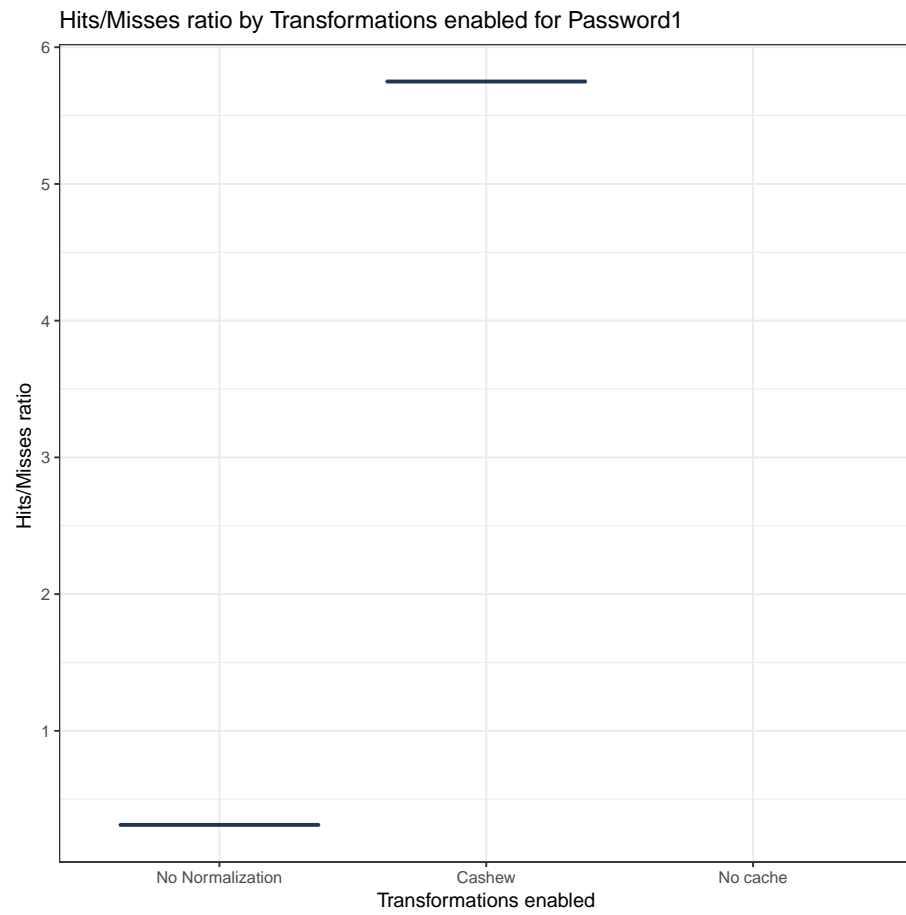
2.1 Objects Overview

2.1.1 Overview for Password1

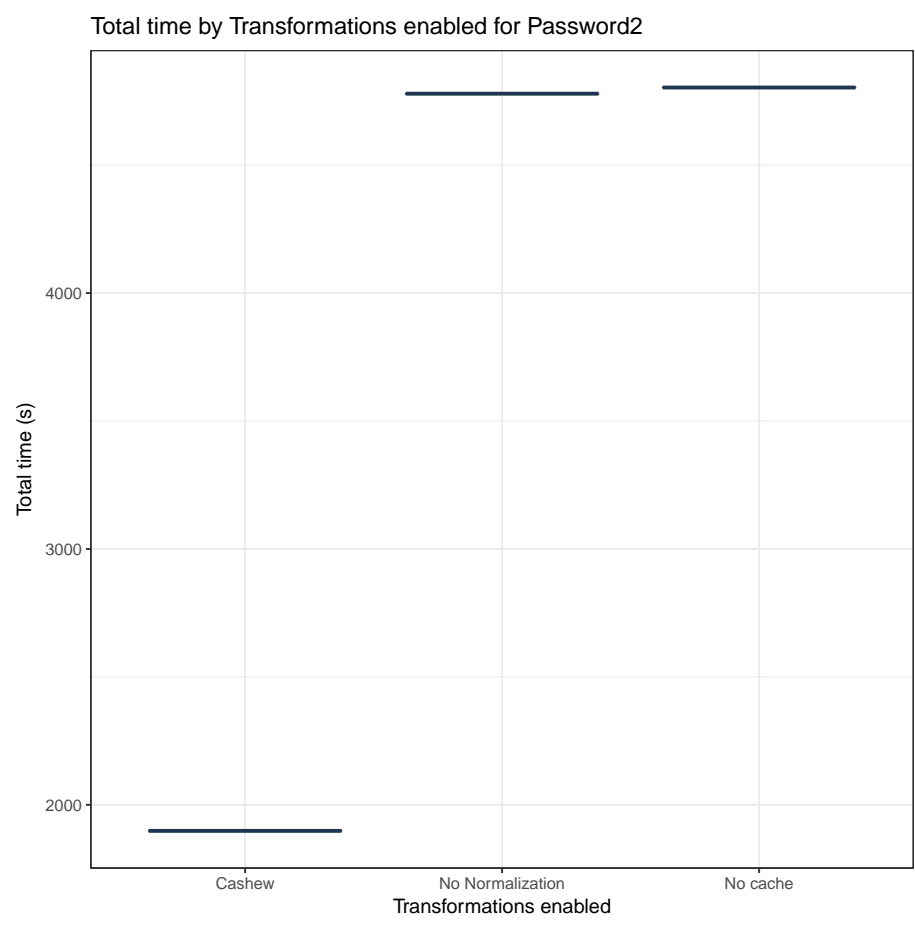


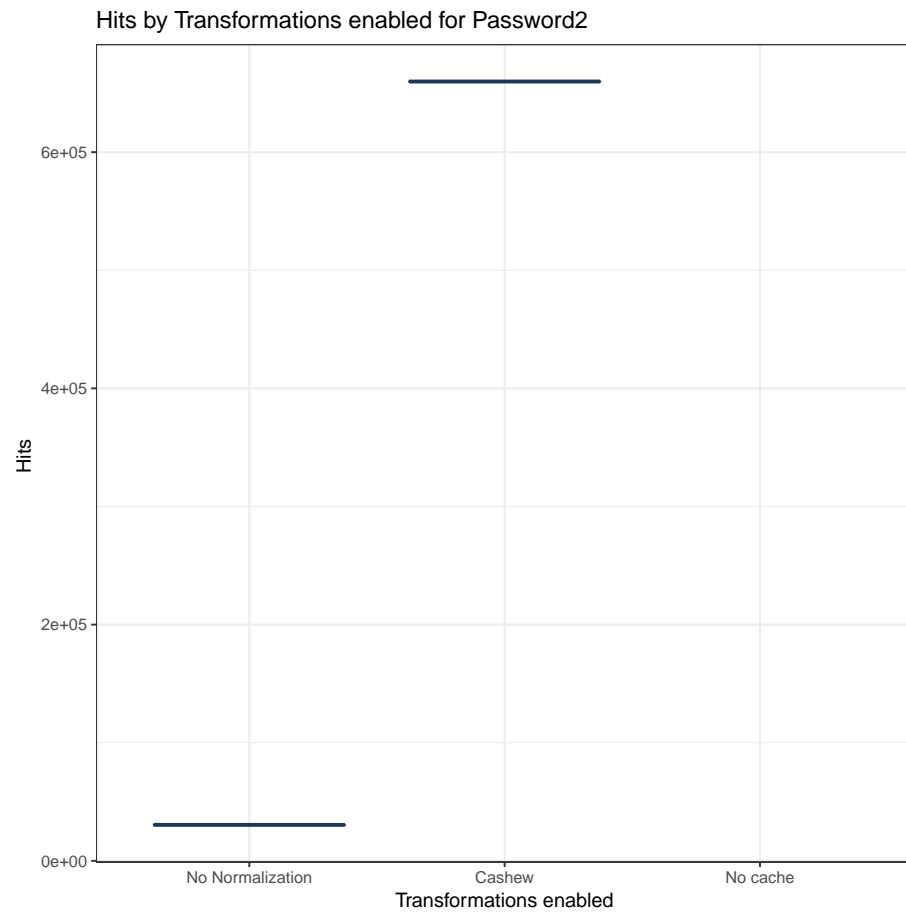


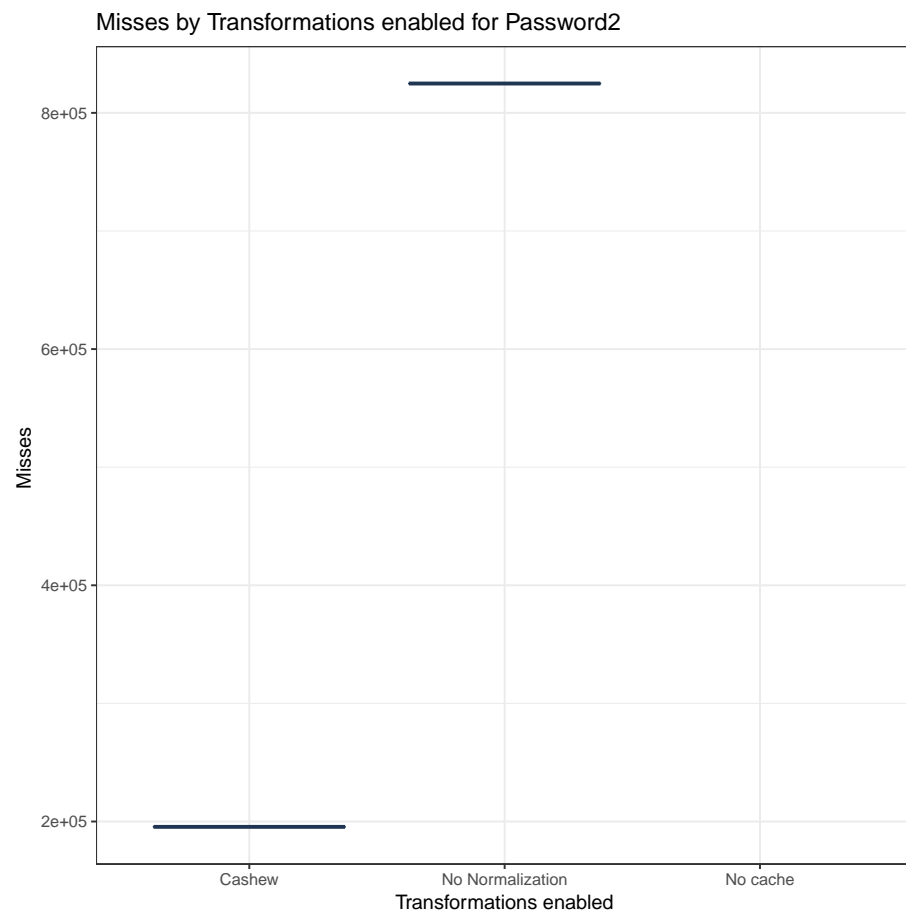


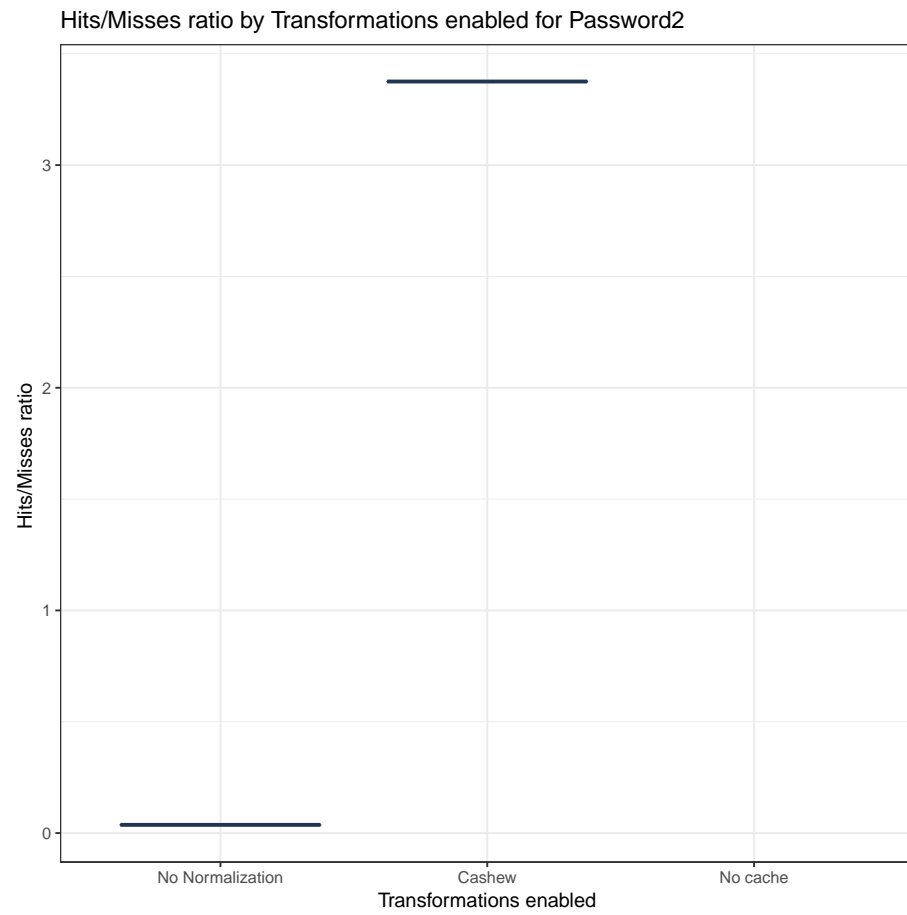


2.1.2 Overview for Password2

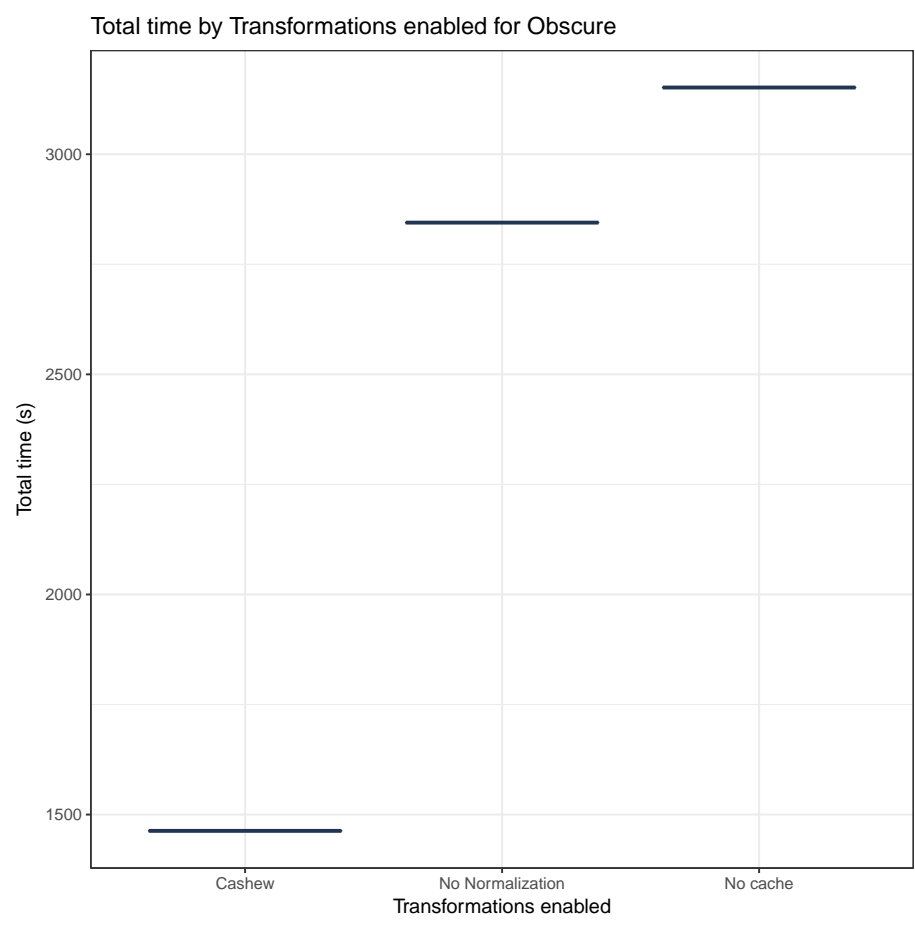


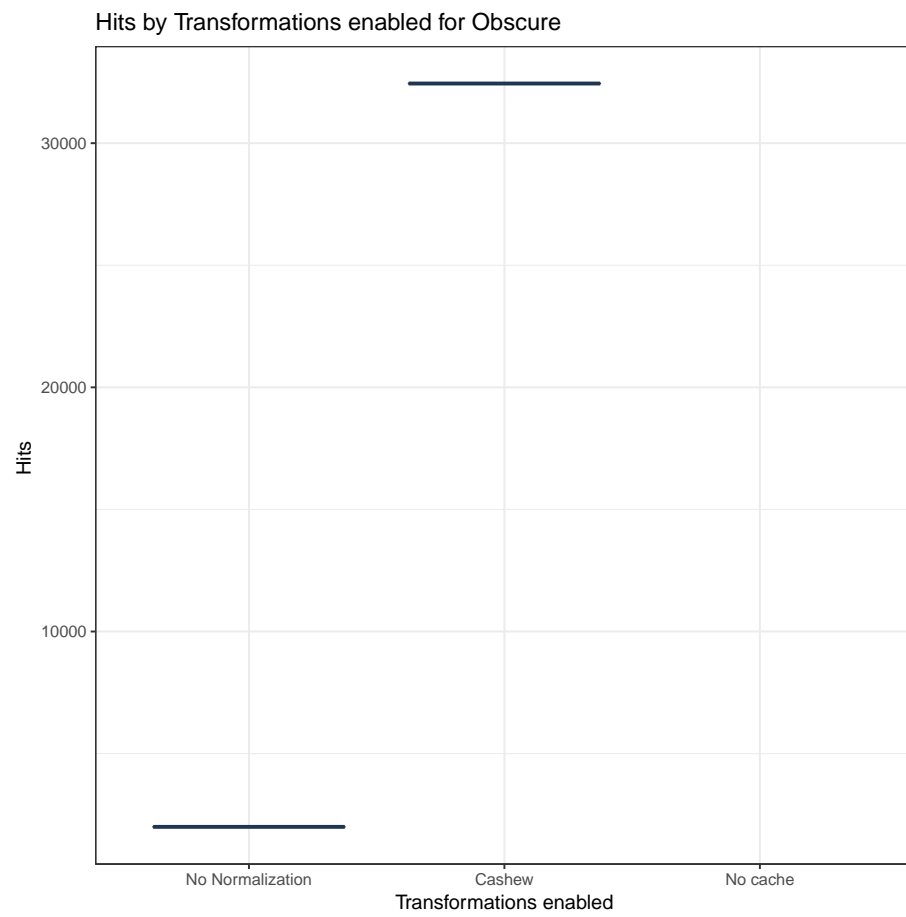


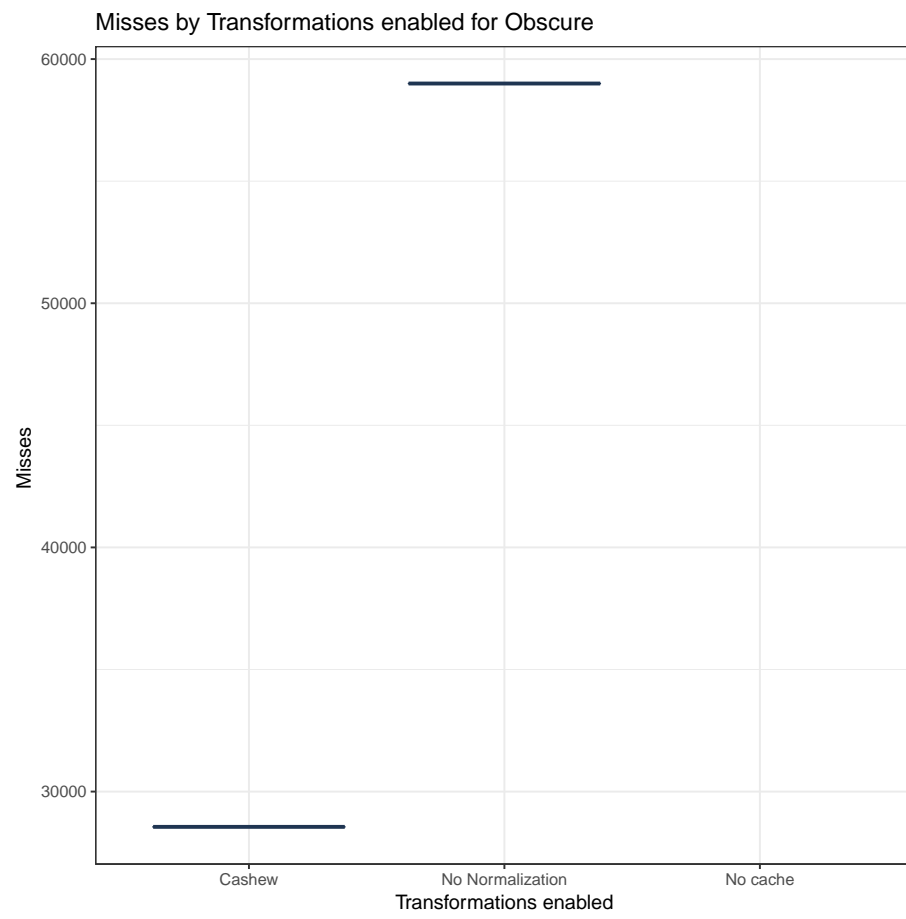


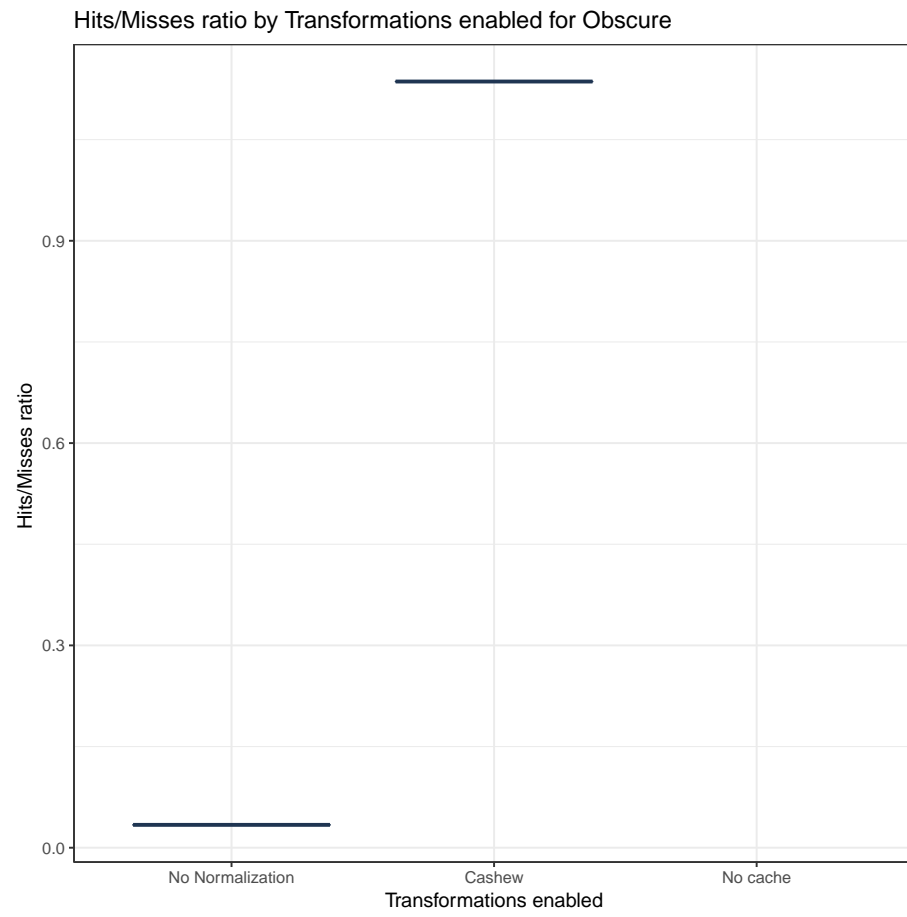


2.1.3 Overview for Obscure

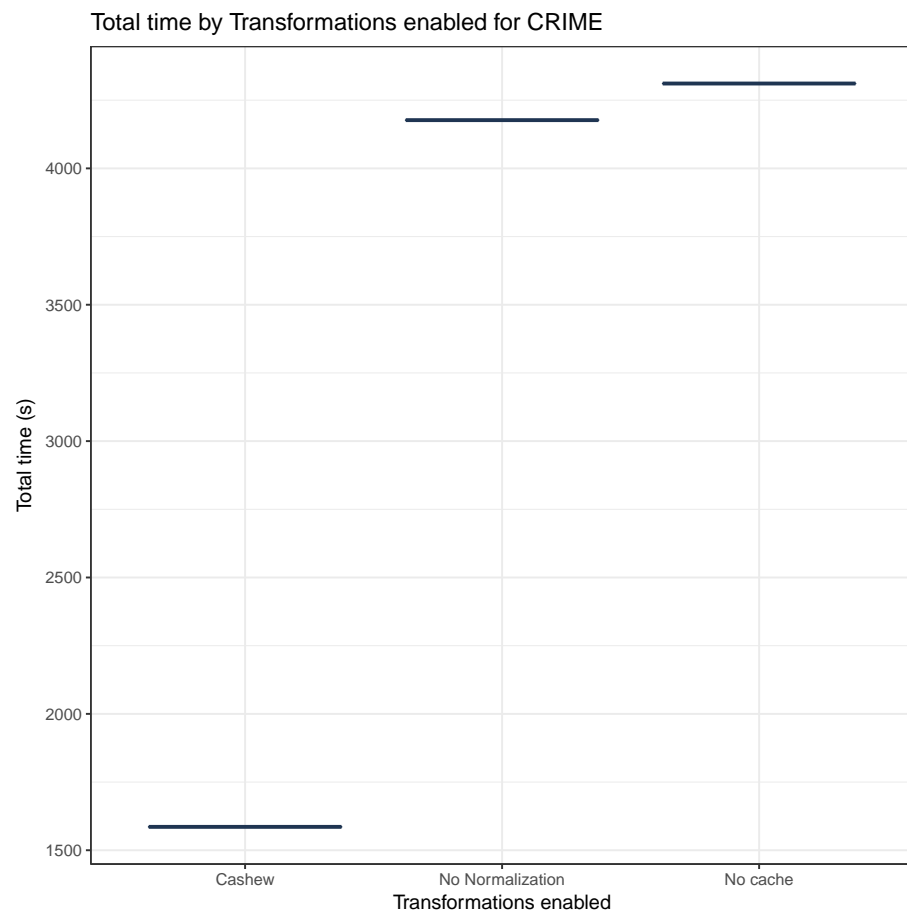


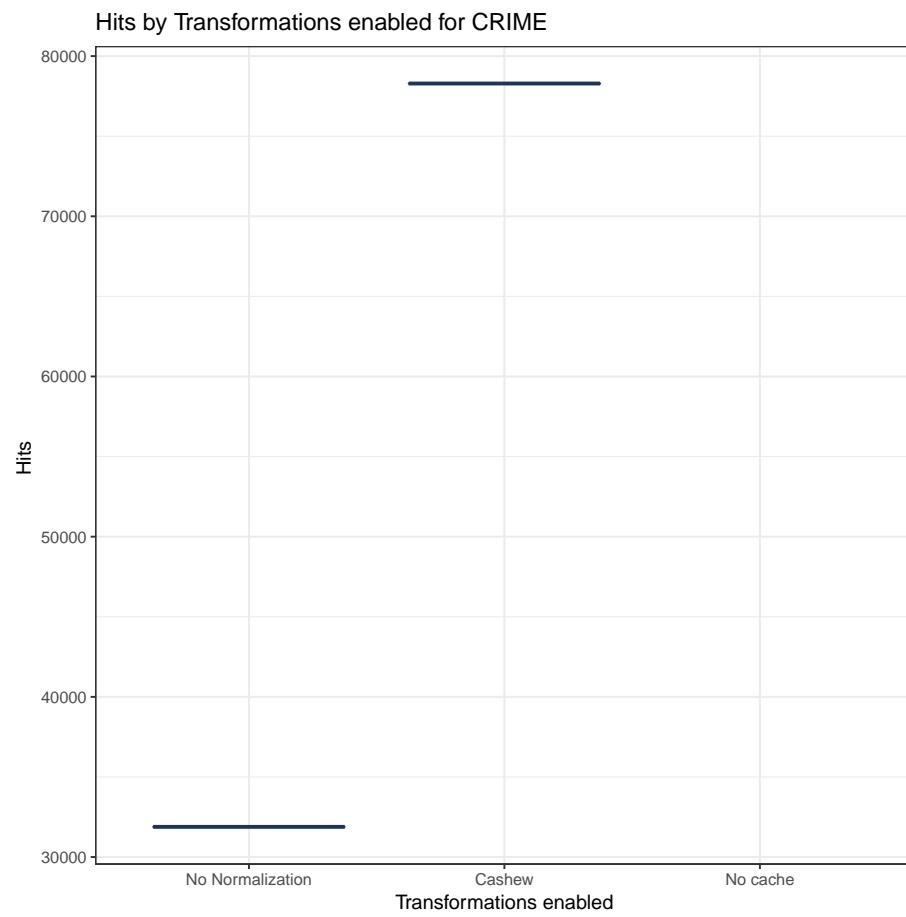


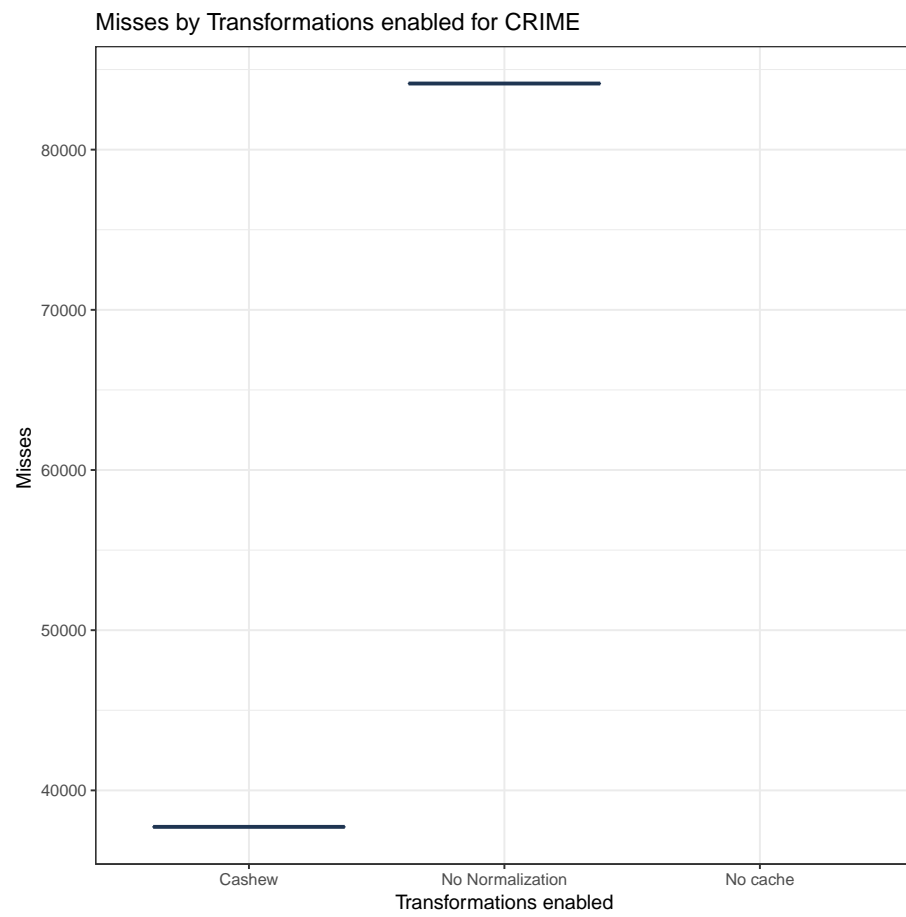


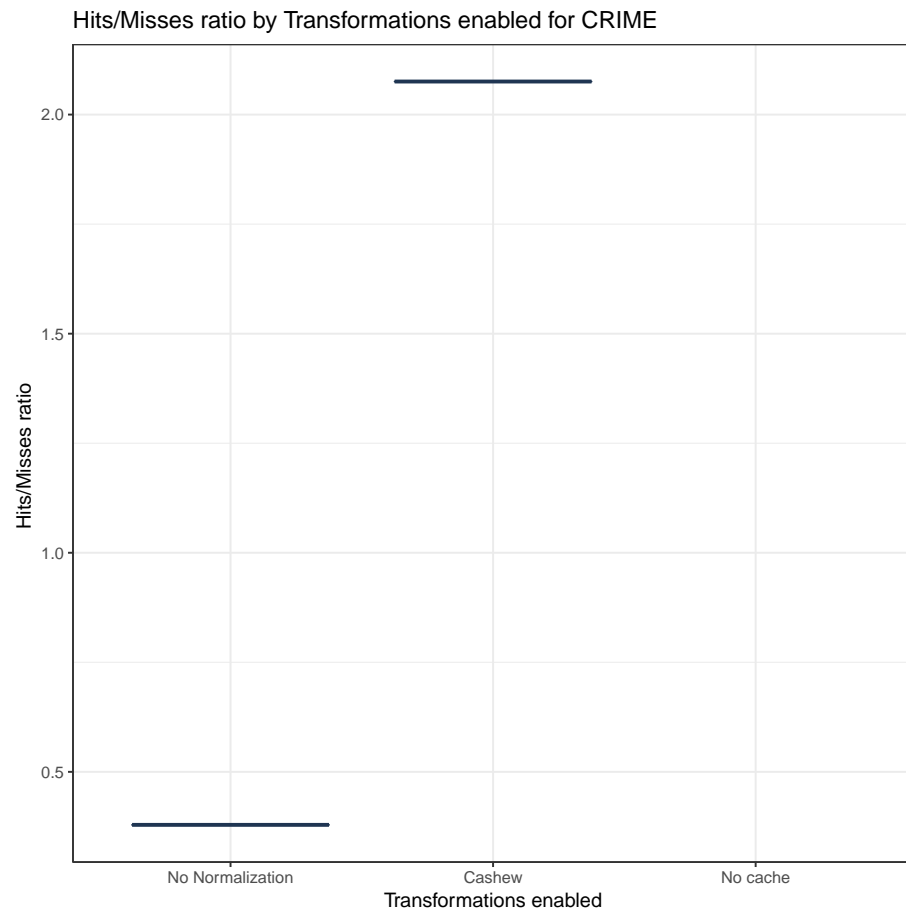


2.1.4 Overview for CRIME



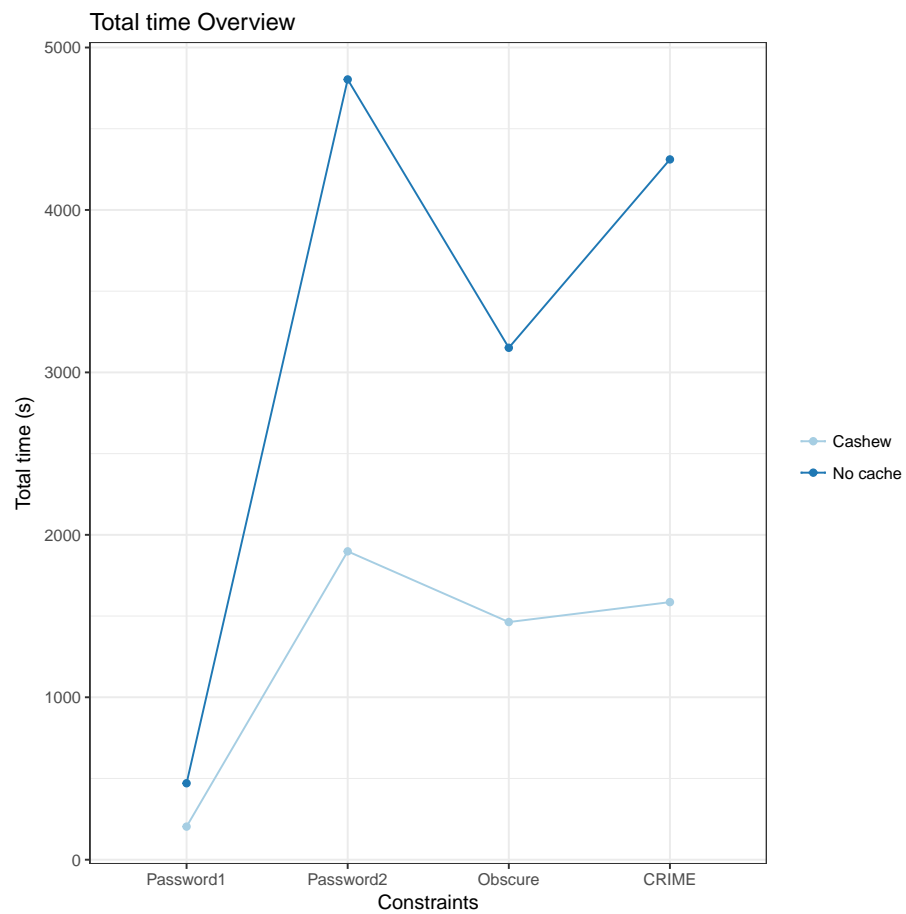






3 Research Hypotheses

3.1 RH1: Total time for Cashew is equals than Total time for No Cache

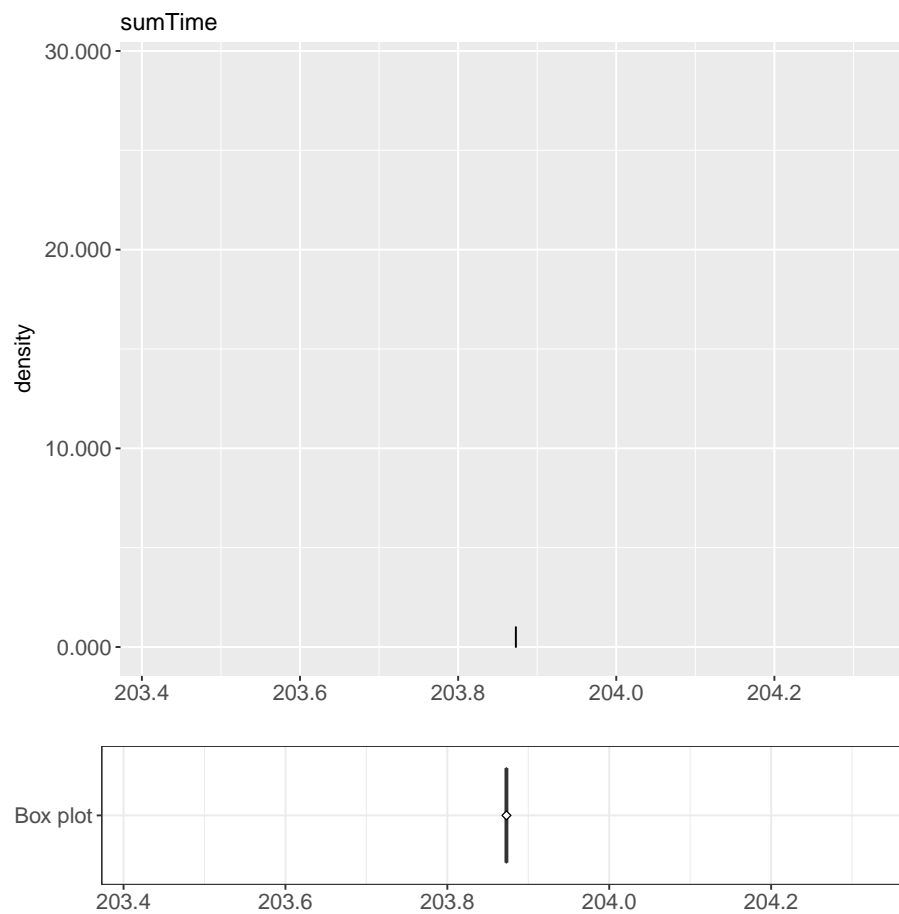


3.1.1 RH1.1: Object Password1

Total time for Cashew

```
## [1] "Sample size: 1"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   203.9   203.9   203.9   203.9   203.9   203.9

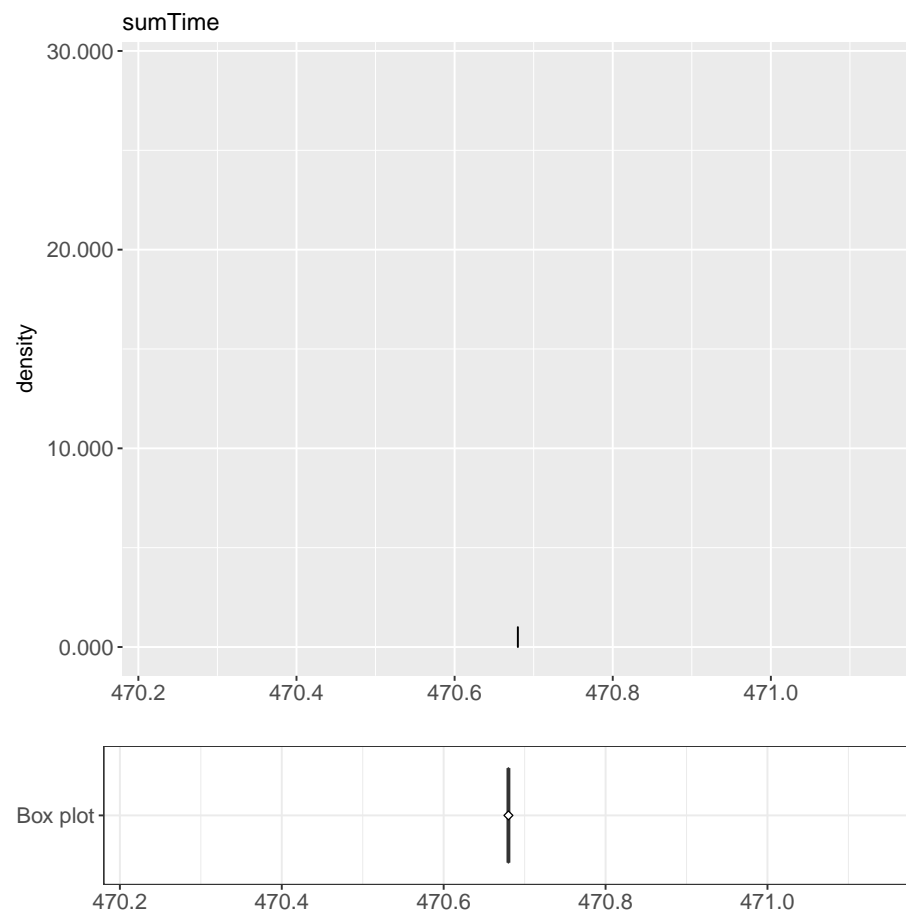
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



Total time for No cache

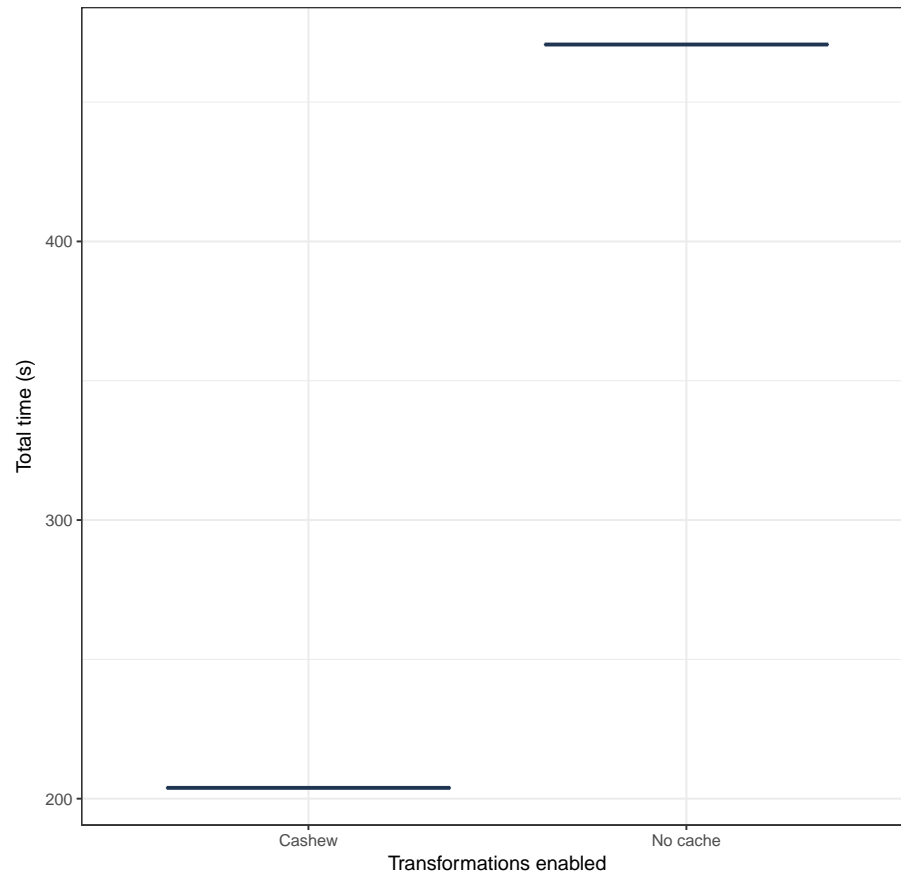
```
## [1] "Sample size: 1"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   470.7  470.7   470.7   470.7  470.7   470.7

## Error in shapiro.test(subset(json_data, treatment == "nocache" &
## object == : sample size must be between 3 and 5000
```



Comparison

Total time by Transformations enabled for Password1



```
## Error in eval(expr, envir, enclos): object 'shap_cashew_password'
not found
```

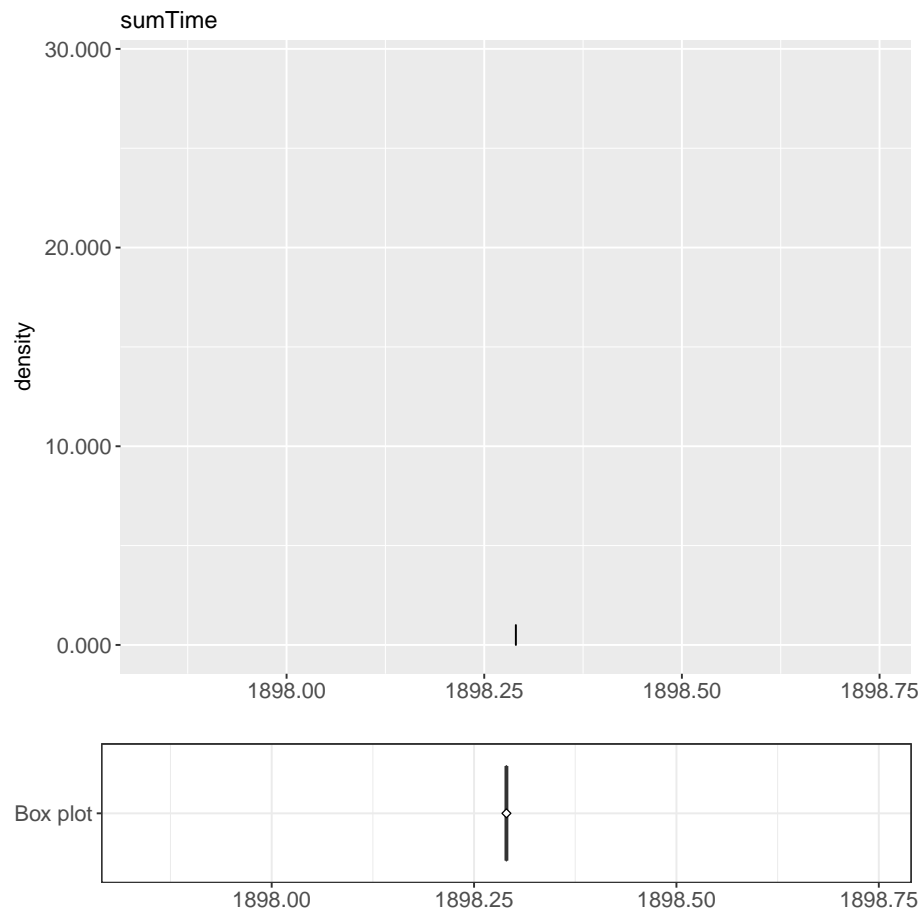
```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Total time for Cashew: 203.873"
## [1] "Mean Total time for No cache: 470.68"
## [1] "Absolute difference: 266.807"
## Total time for No cache is 130.869217601154 % greater than
## Total time for Cashew
```

3.1.2 RH1.2: Object Password2

Total time for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1898     1898     1898     1898     1898     1898

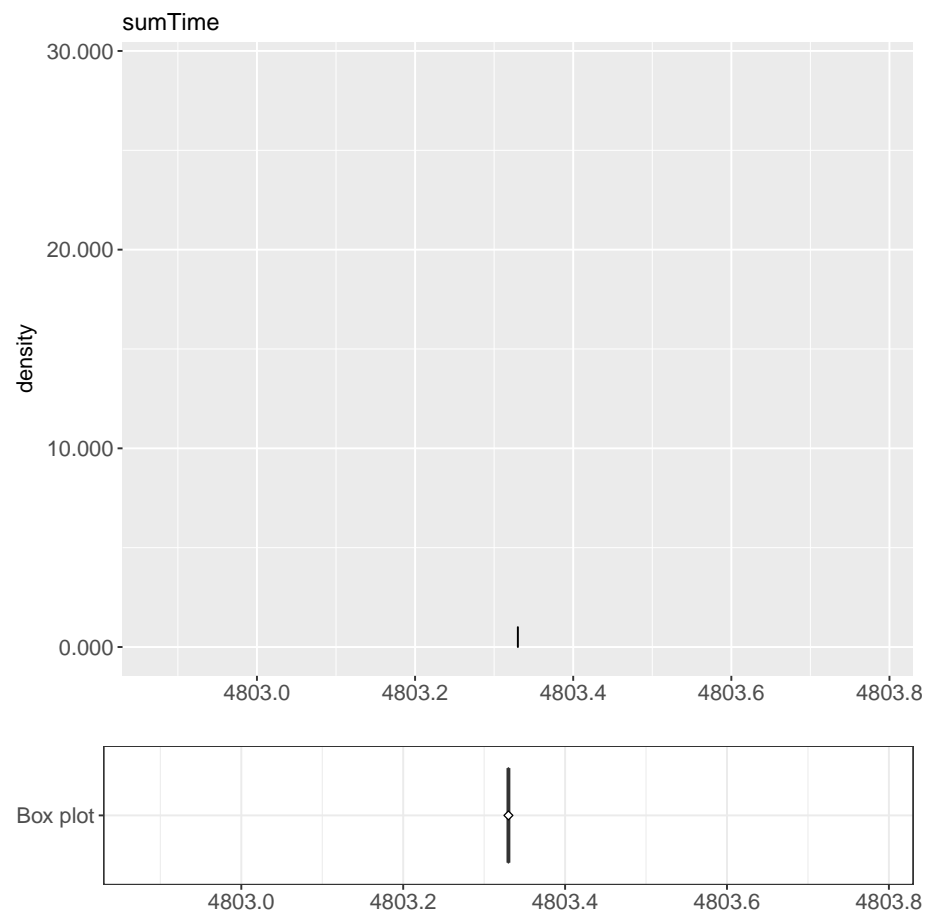
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



Total time for No cache

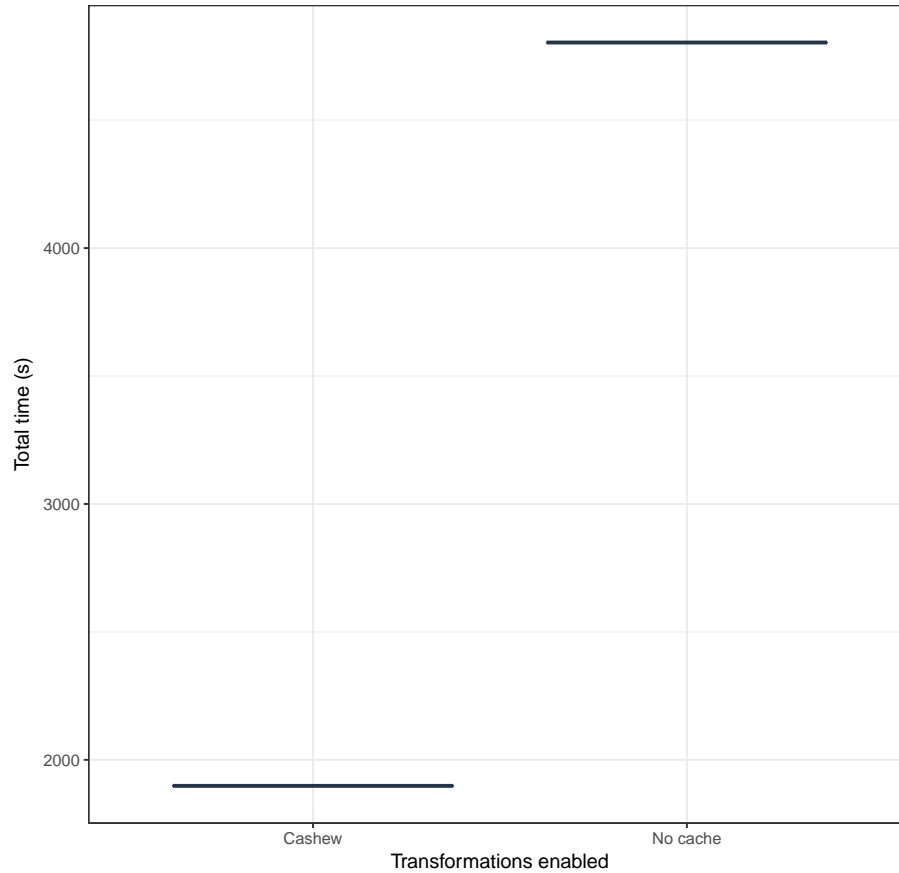
```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      4803     4803     4803     4803     4803     4803

## Error in shapiro.test(subset(json_data, treatment == "nocache" &
## object == : sample size must be between 3 and 5000
```



Comparison

Total time by Transformations enabled for Password2



```
## Error in eval(expr, envir, enclos): object 'shap.cashew_password2'
not found
```

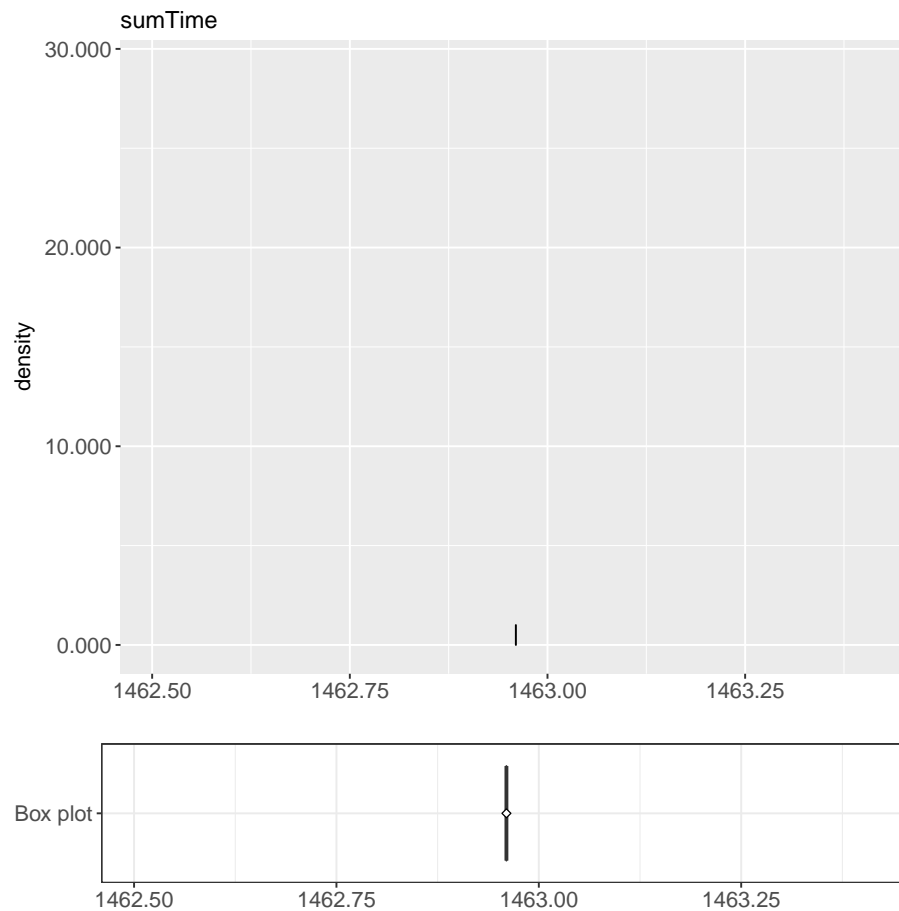
```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Total time for Cashew: 1898.29"
## [1] "Mean Total time for No cache: 4803.33"
## [1] "Absolute difference: 2905.04"
## Total time for No cache is 153.034573221162 % greater than
## Total time for Cashew
```

3.1.3 RH1.3: Object Obscure

Total time for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1463     1463     1463     1463     1463     1463

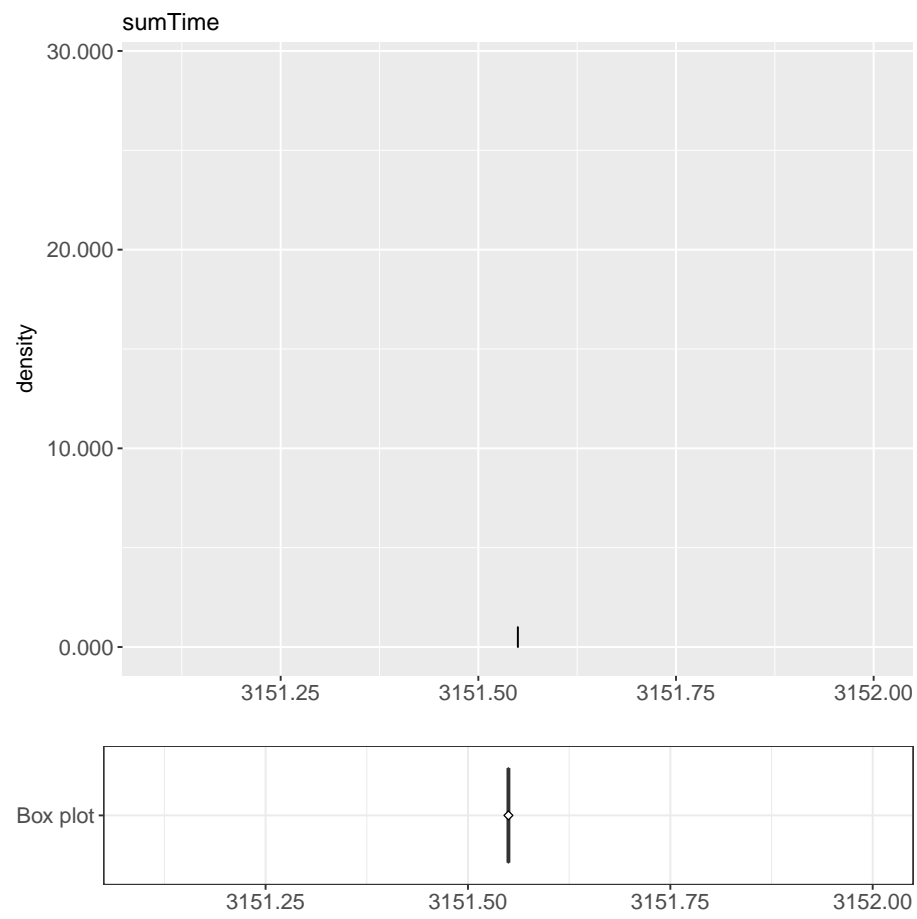
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



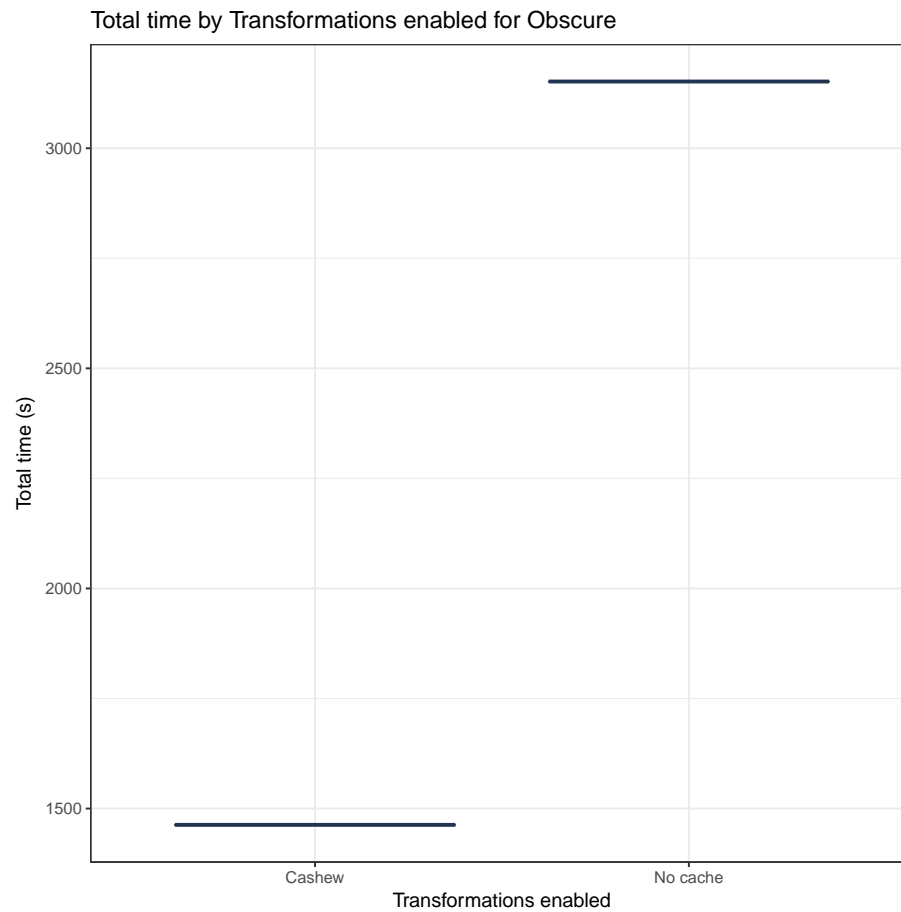
Total time for No cache

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      3152     3152     3152     3152     3152     3152

## Error in shapiro.test(subset(json_data, treatment == "nocache" &
## object == : sample size must be between 3 and 5000
```



Comparison



```
## Error in eval(expr, envir, enclos): object 'shap_cashew_obscore'
not found
```

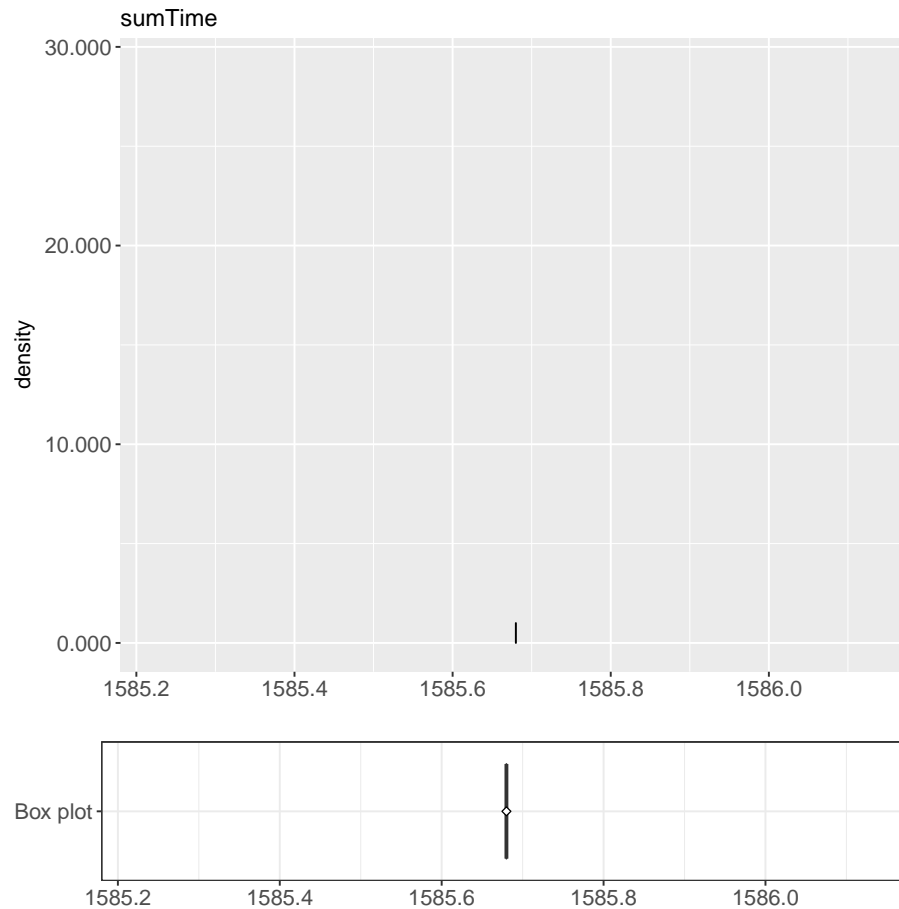
```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Total time for Cashew: 1462.96"
## [1] "Mean Total time for No cache: 3151.55"
## [1] "Absolute difference: 1688.59"
## Total time for No cache is 115.422841362717 % greater than
## Total time for Cashew
```

3.1.4 RH1.4: Object CRIME

Total time for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1586    1586    1586    1586    1586    1586

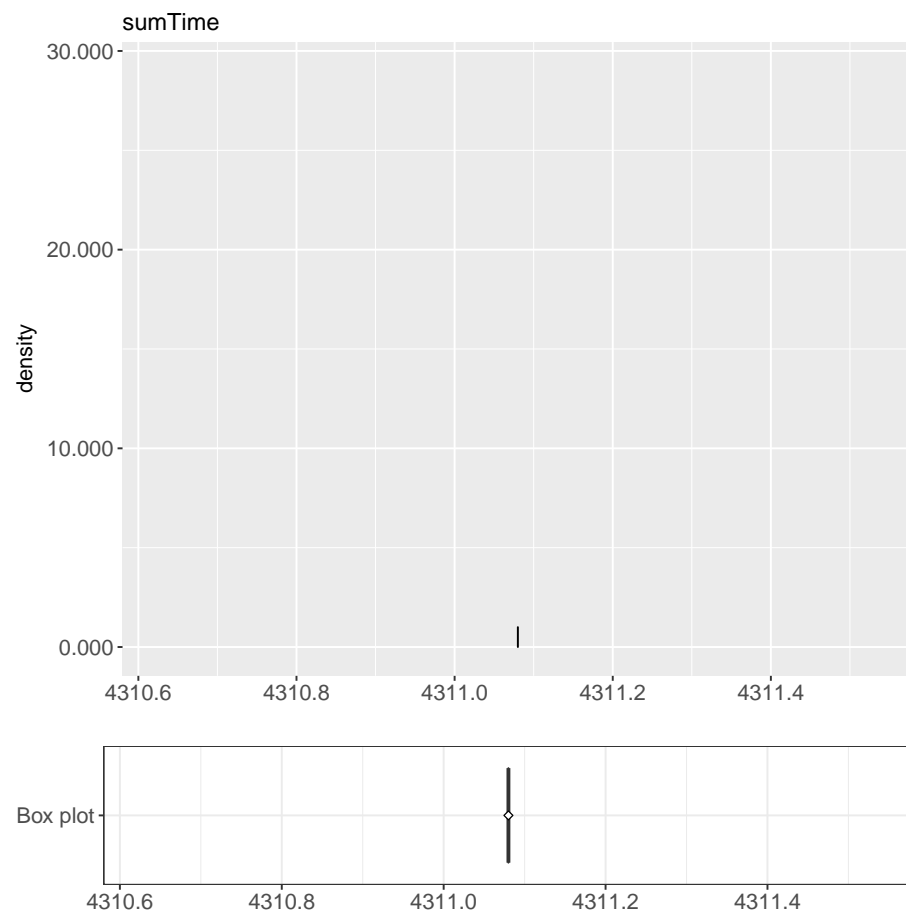
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



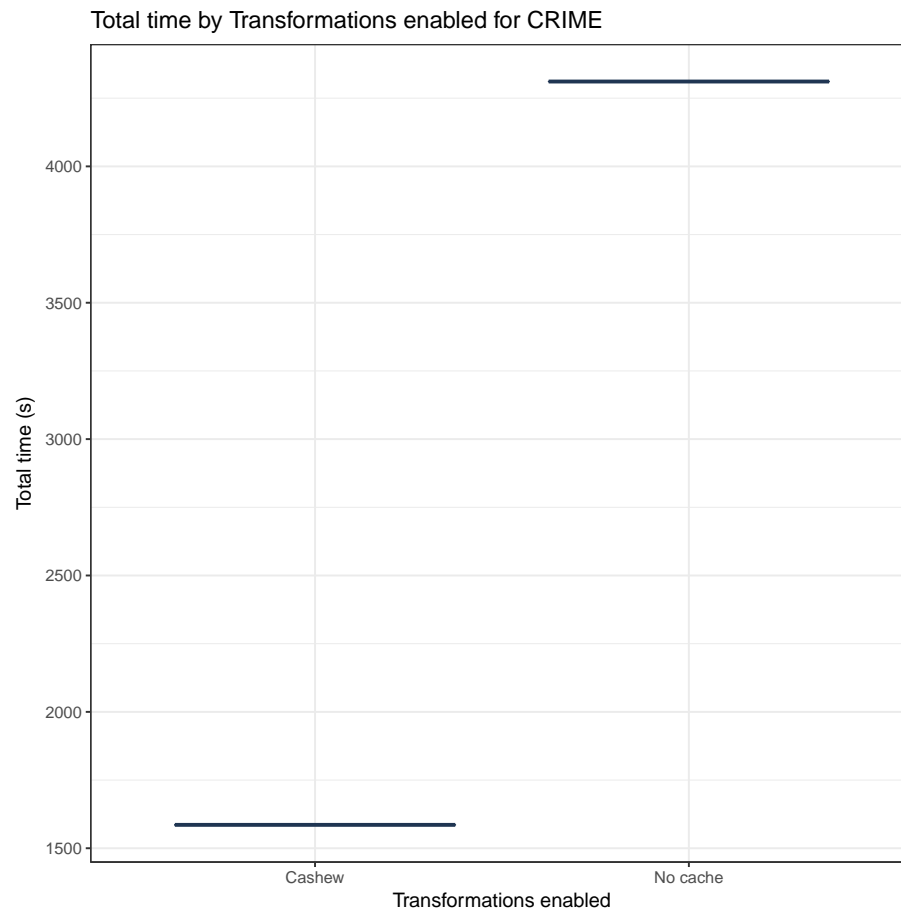
Total time for No cache

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      4311    4311    4311    4311    4311    4311

## Error in shapiro.test(subset(json_data, treatment == "nocache" &
## object == : sample size must be between 3 and 5000
```

Comparison



```
## Error in eval(expr, envir, enclos): object 'shap_cashew_crime' not found
```

```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Total time for Cashew: 1585.68"
## [1] "Mean Total time for No cache: 4311.08"
## [1] "Absolute difference: 2725.4"
## Total time for No cache is 171.875788305333 % greater than
## Total time for Cashew
```

3.1.5 RH1 Results: Total time Cashew = No cache

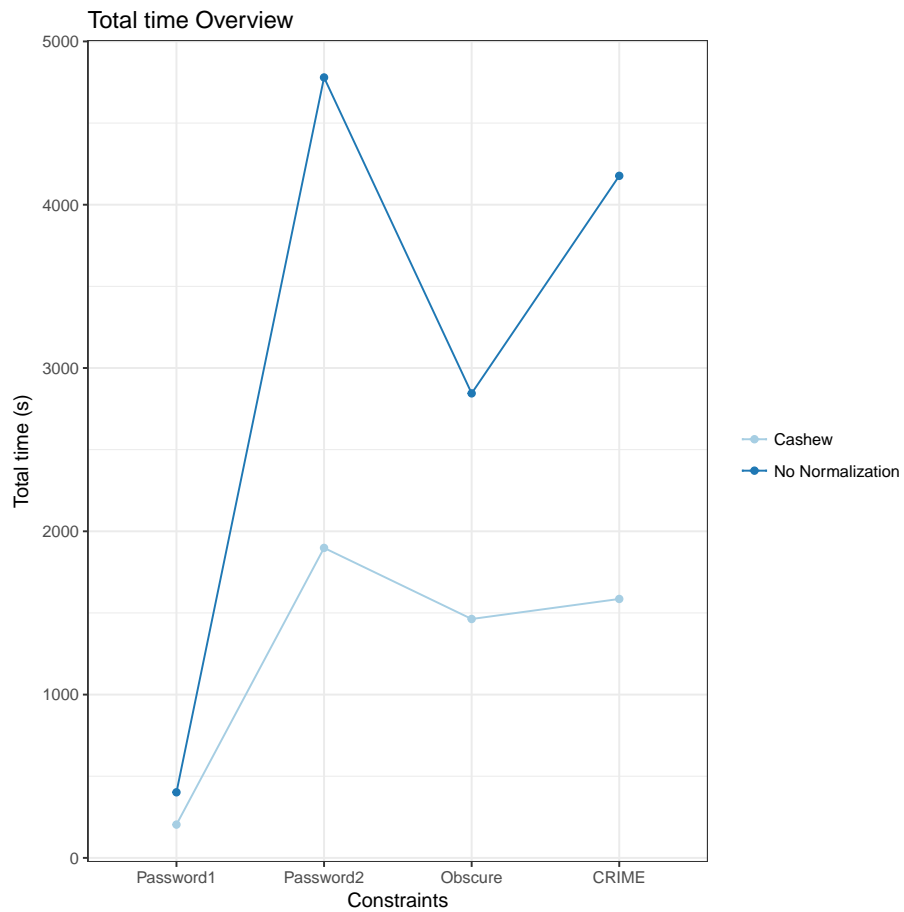
Table 1: RH1 Results per Object

Password1	Inconclusive
Password2	Inconclusive
Obscure	Inconclusive
CRIME	Inconclusive

Table 2: RH1 Results Summary

Cashew < No cache:	0%
Cashew > No cache:	0%
Cashew:	0%
No cache:	0%
None:	0%
Inconclusive:	100%

3.2 RH2: Total time for Cashew is equals than Total time for No Normalization

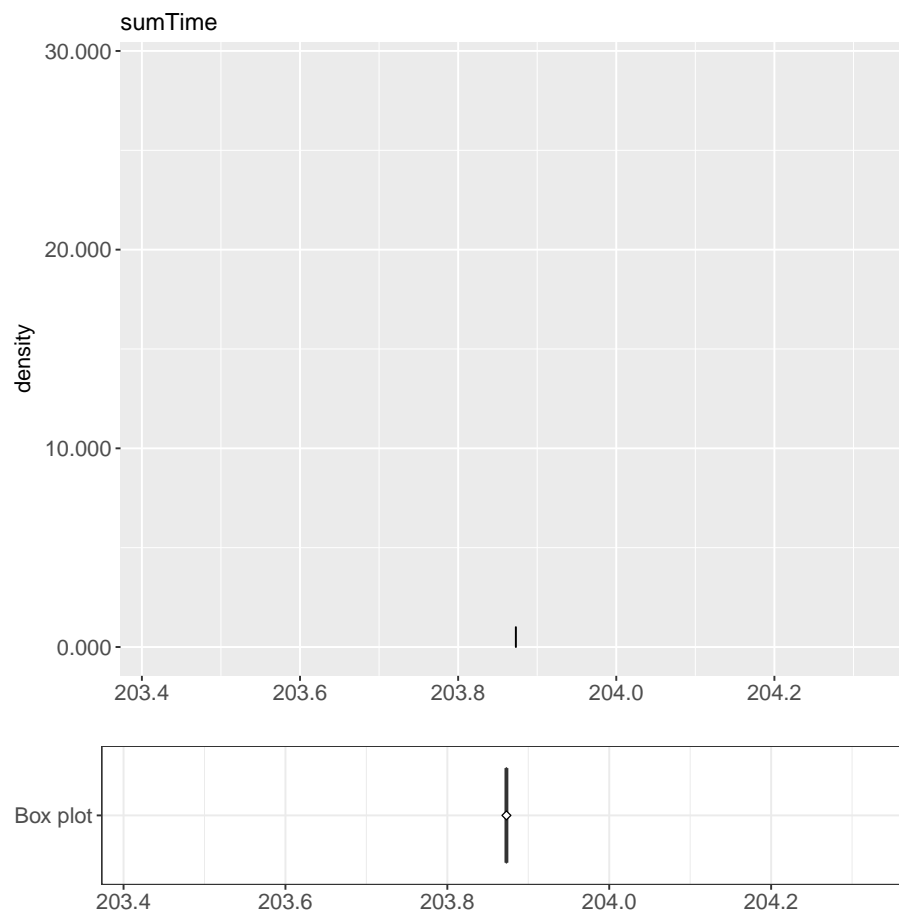


3.2.1 RH2.1: Object Password1

Total time for Cashew

```
## [1] "Sample size: 1"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   203.9   203.9   203.9   203.9   203.9   203.9

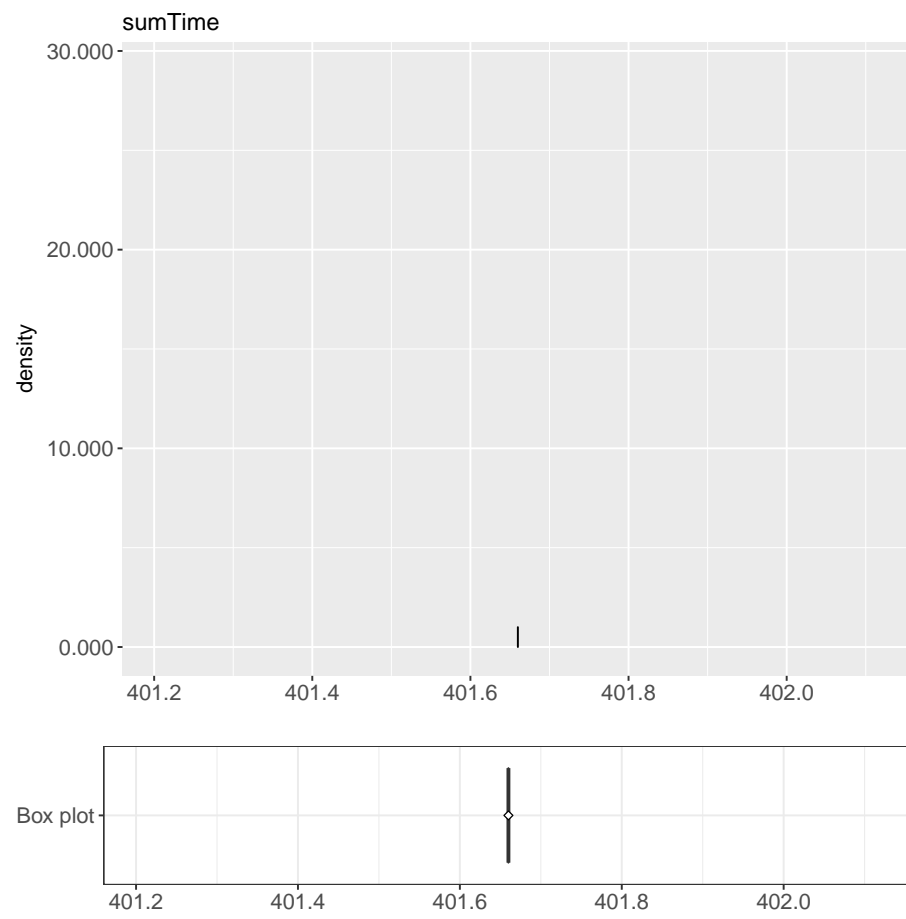
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



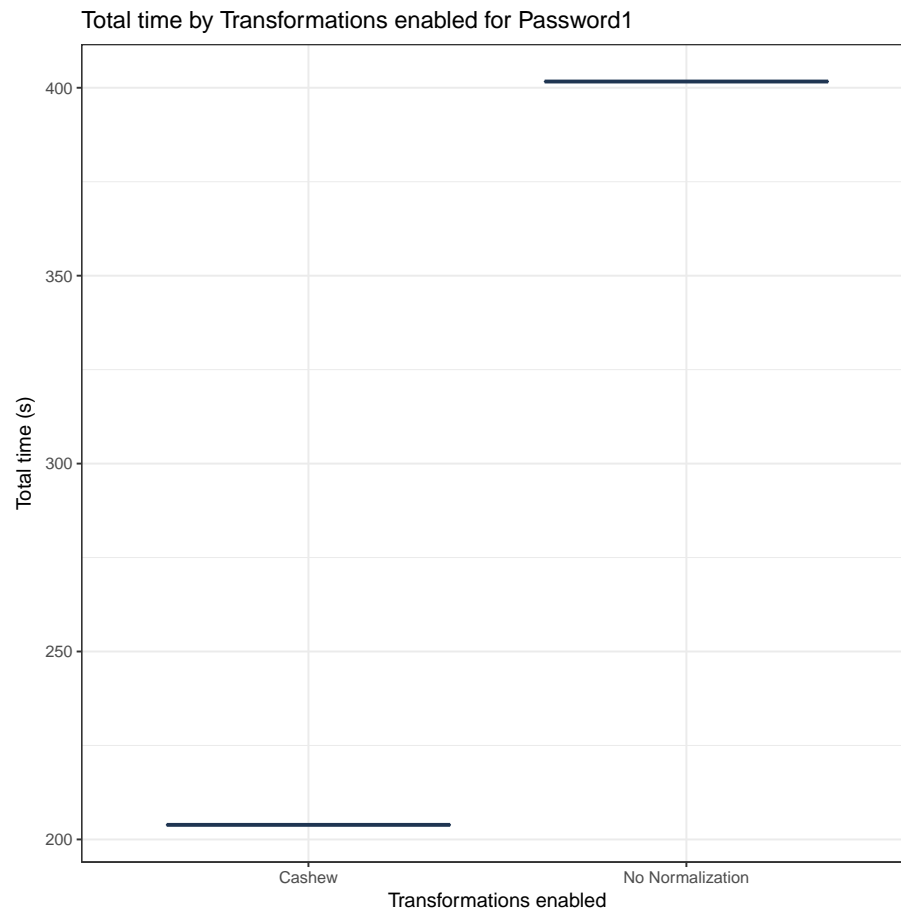
Total time for No Normalization

```
## [1] "Sample size: 1"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   401.7  401.7   401.7   401.7  401.7   401.7

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching")
## : sample size must be between 3 and 5000
```



Comparison



```
## Error in eval(expr, envir, enclos): object 'shap.cashew.password'
## not found

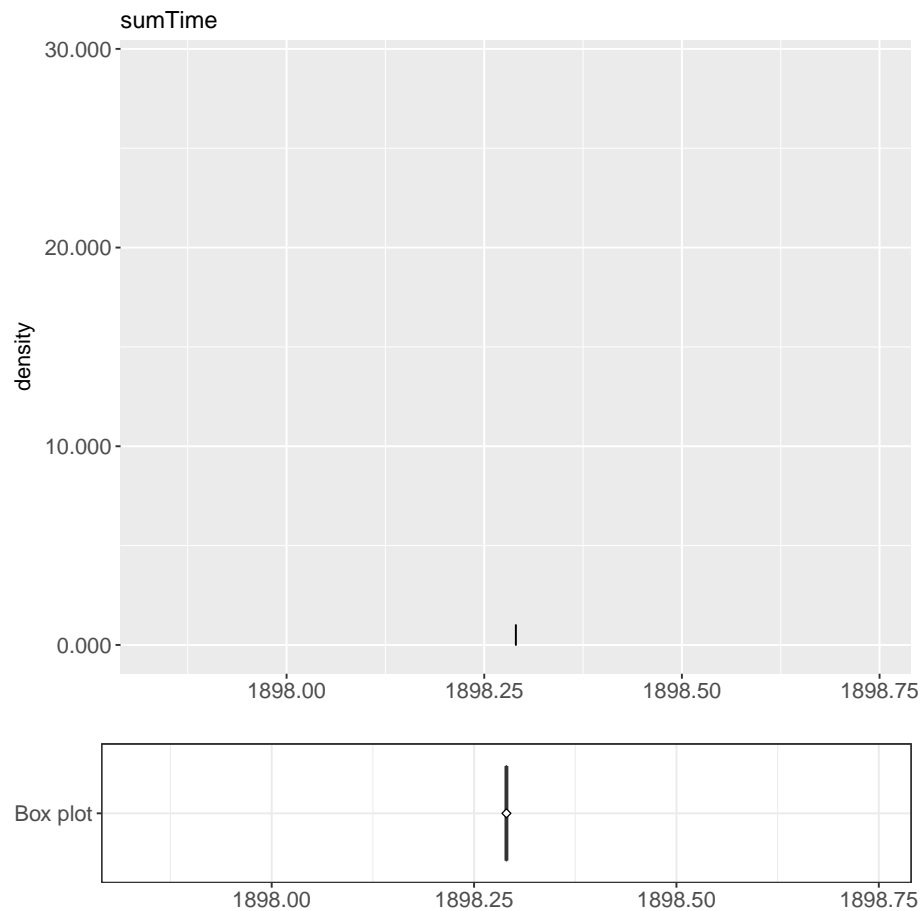
## [1] ""
## [1] "Means comparison"
## [1] "Mean Total time for Cashew: 203.873"
## [1] "Mean Total time for No Normalization: 401.66"
## [1] "Absolute difference: 197.787"
## Total time for No Normalization is 97.0148082384622 % greater than
## Total time for Cashew
```

3.2.2 RH2.2: Object Password2

Total time for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1898     1898     1898     1898     1898     1898

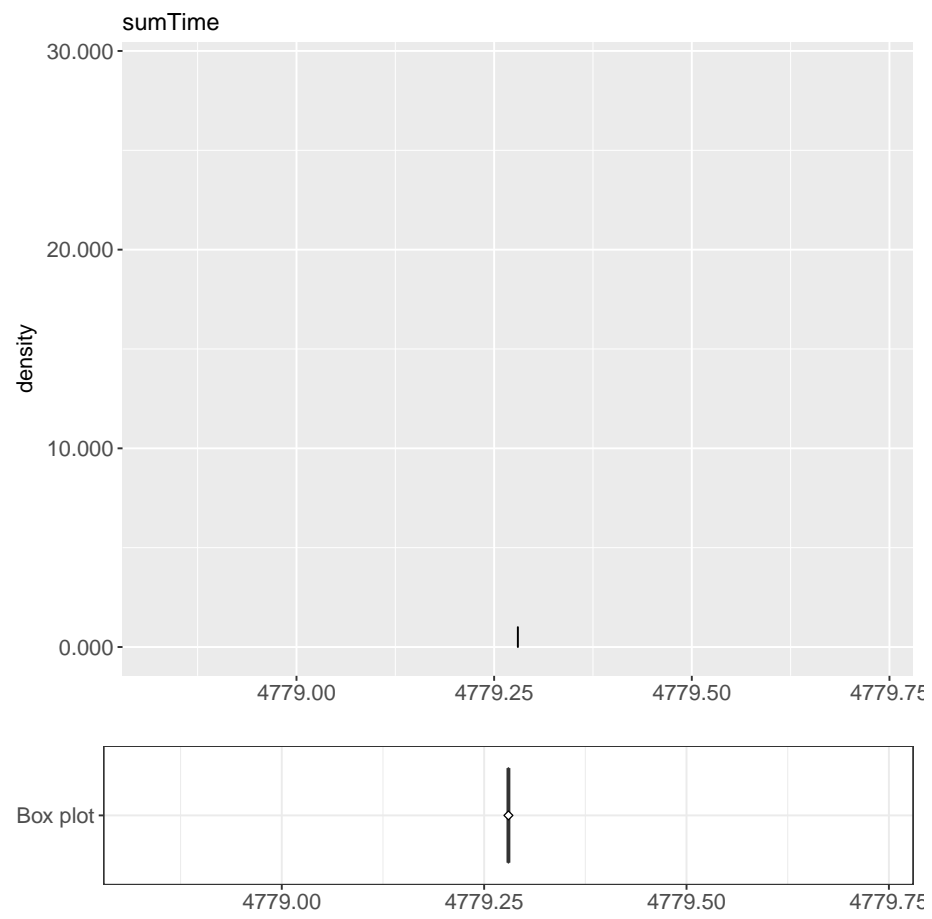
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



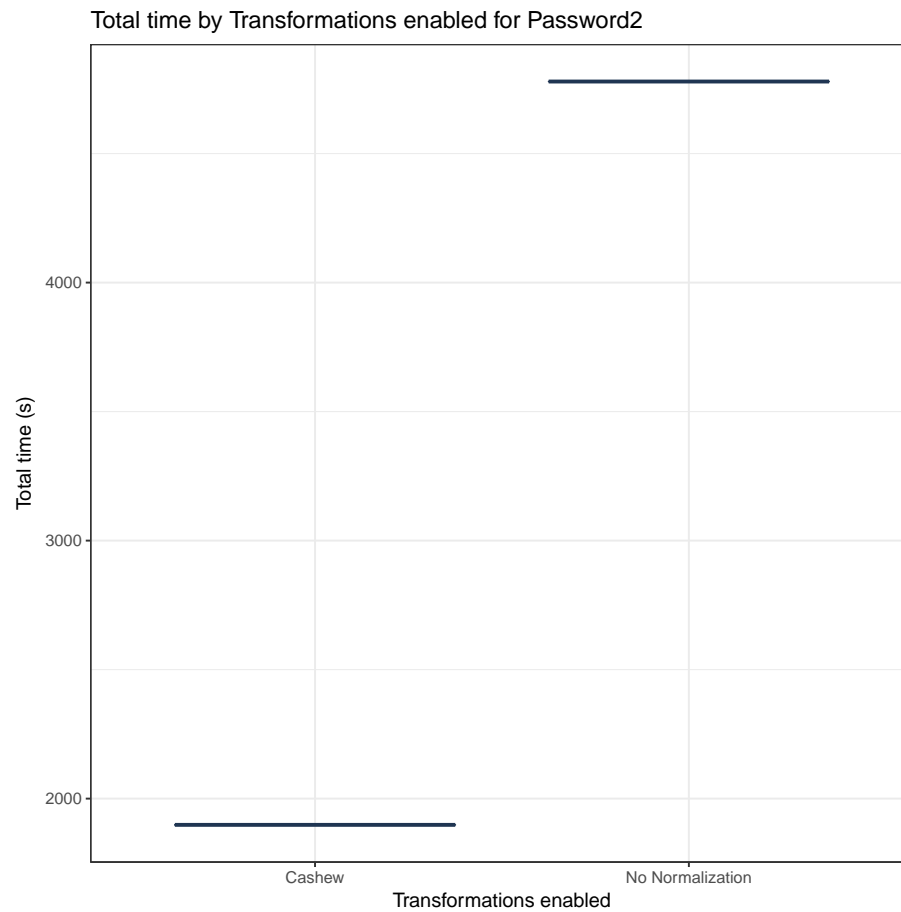
Total time for No Normalization

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      4779     4779     4779     4779     4779     4779

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching"
## & : sample size must be between 3 and 5000
```

Comparison



```
## Error in eval(expr, envir, enclos): object 'shap.cashew_password2'
## not found

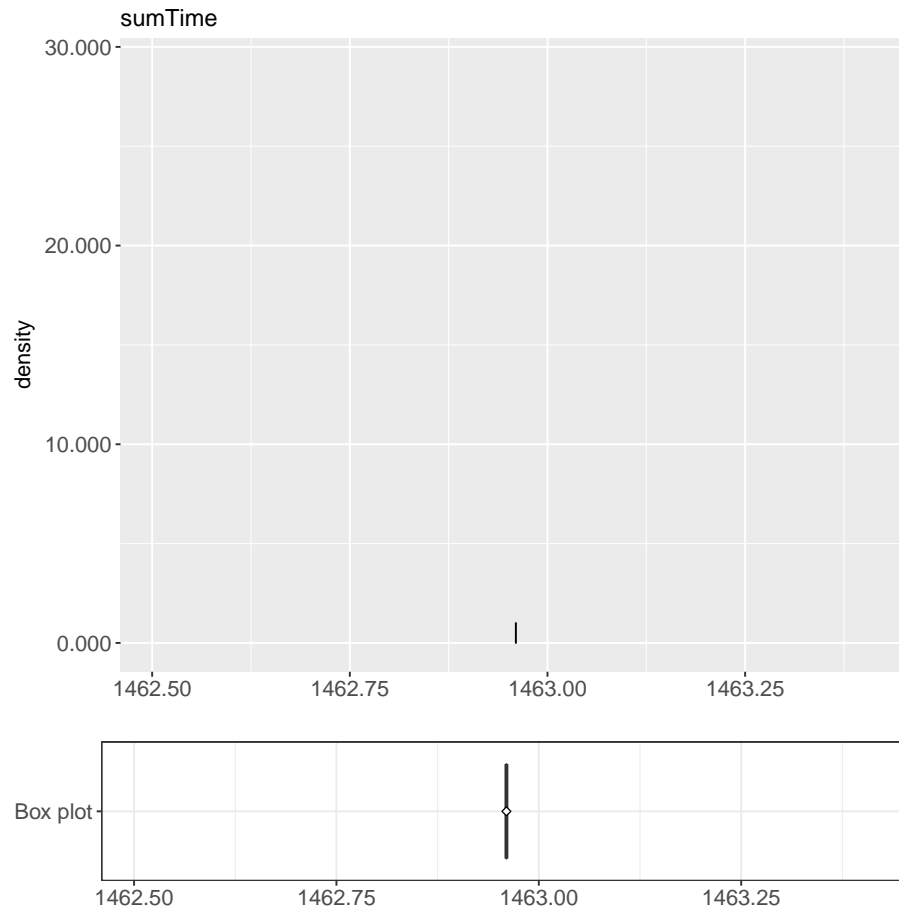
## [1] ""
## [1] "Means comparison"
## [1] "Mean Total time for Cashew: 1898.29"
## [1] "Mean Total time for No Normalization: 4779.28"
## [1] "Absolute difference: 2880.99"
## Total time for No Normalization is 151.767643510739 % greater than
## Total time for Cashew
```

3.2.3 RH2.3: Object Obscure

Total time for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1463    1463    1463    1463    1463    1463

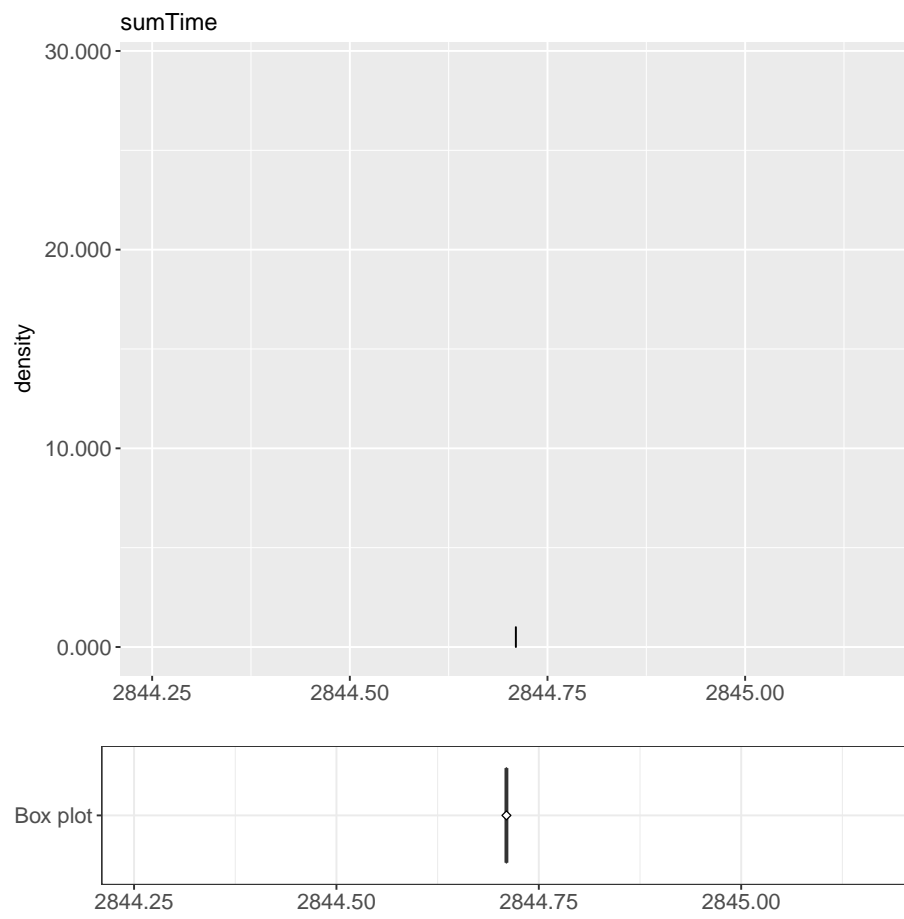
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



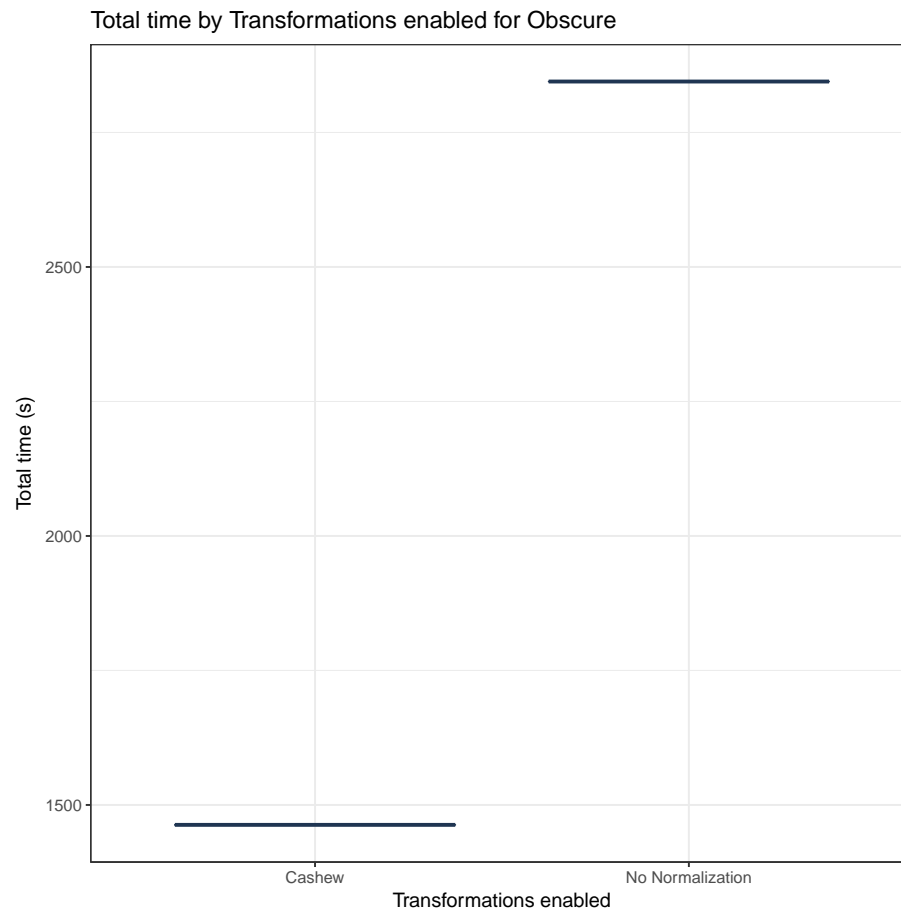
Total time for No Normalization

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      2845    2845    2845    2845    2845    2845

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching"
## & : sample size must be between 3 and 5000
```



Comparison



```
## Error in eval(expr, envir, enclos): object 'shap_cashew_obscore'
## not found

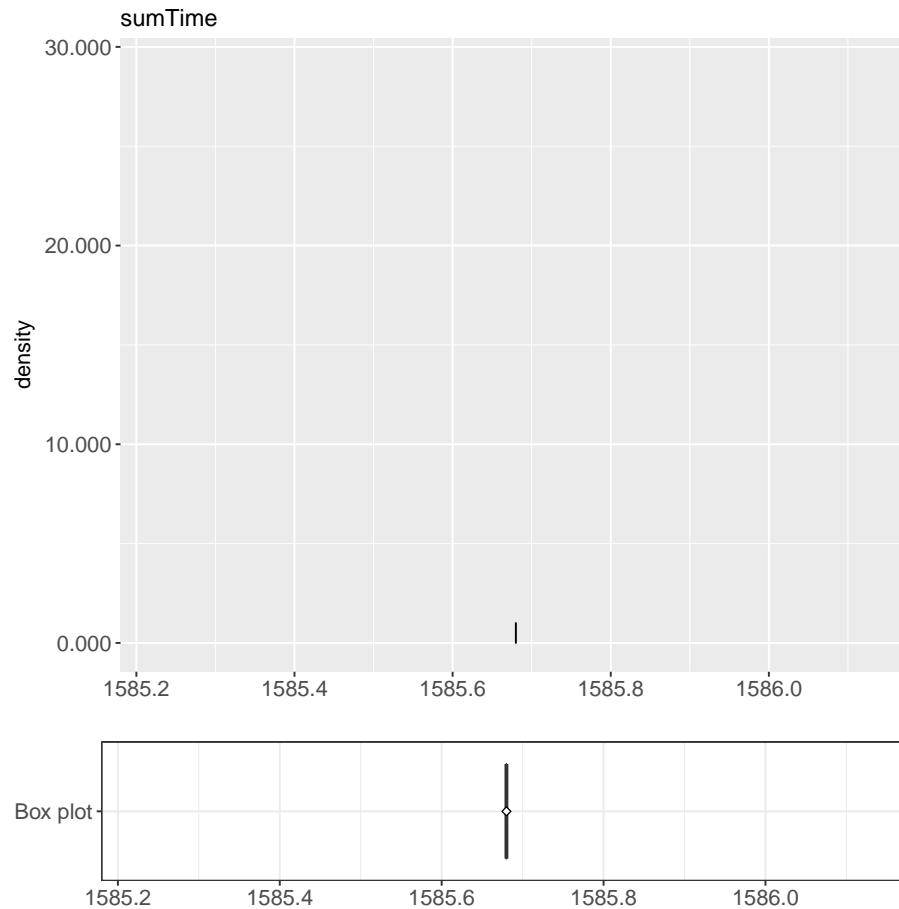
## [1] ""
## [1] "Means comparison"
## [1] "Mean Total time for Cashew: 1462.96"
## [1] "Mean Total time for No Normalization: 2844.71"
## [1] "Absolute difference: 1381.75"
## Total time for No Normalization is 94.4489254661782 % greater than
## Total time for Cashew
```

3.2.4 RH2.4: Object CRIME

Total time for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1586    1586    1586    1586    1586    1586

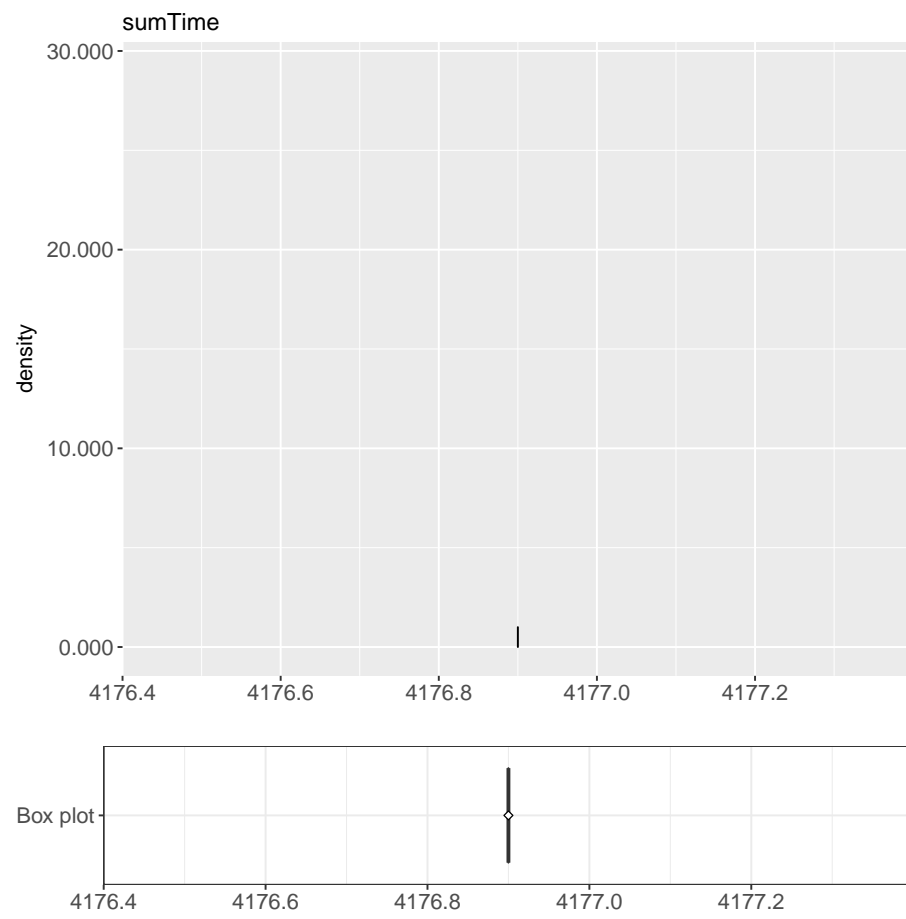
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



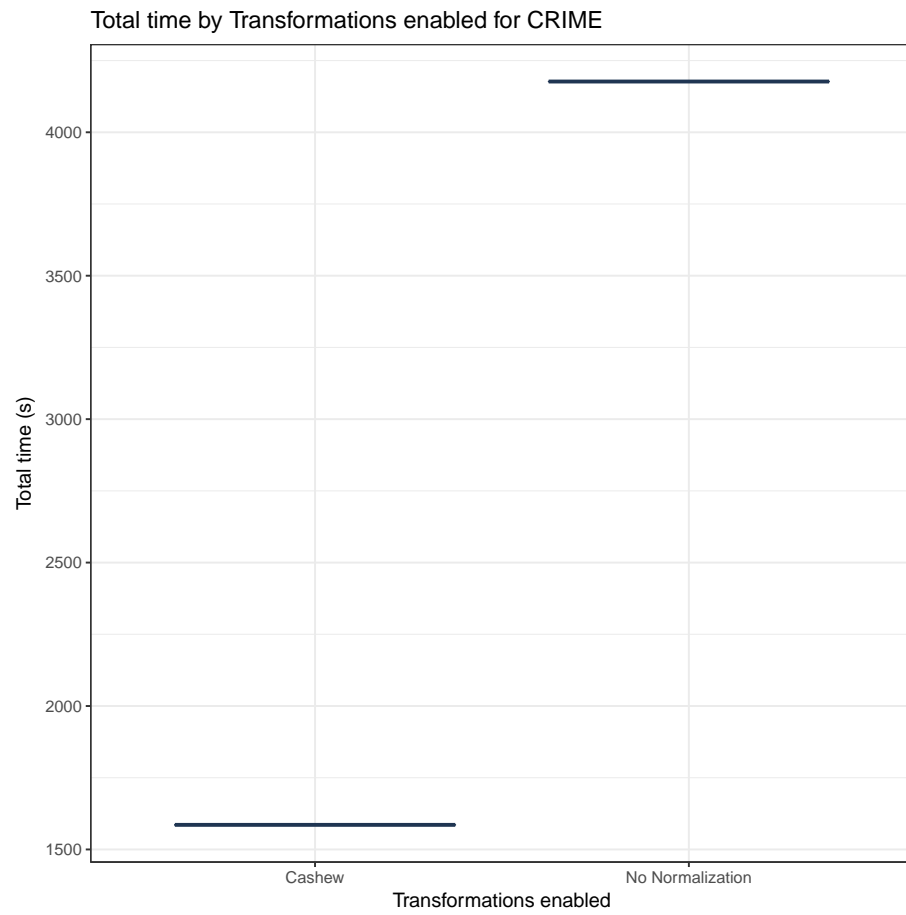
Total time for No Normalization

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      4177    4177    4177    4177    4177    4177

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching"
## & : sample size must be between 3 and 5000
```



Comparison



```
## Error in eval(expr, envir, enclos): object 'shap_cashew_crime' not
found

## [1] ""
## [1] "Means comparison"
## [1] "Mean Total time for Cashew: 1585.68"
## [1] "Mean Total time for No Normalization: 4176.9"
## [1] "Absolute difference: 2591.22"
## Total time for No Normalization is 163.413803541698 % greater than
## Total time for Cashew
```


3.2.5 RH2 Results: Total time Cashew = No Normalization

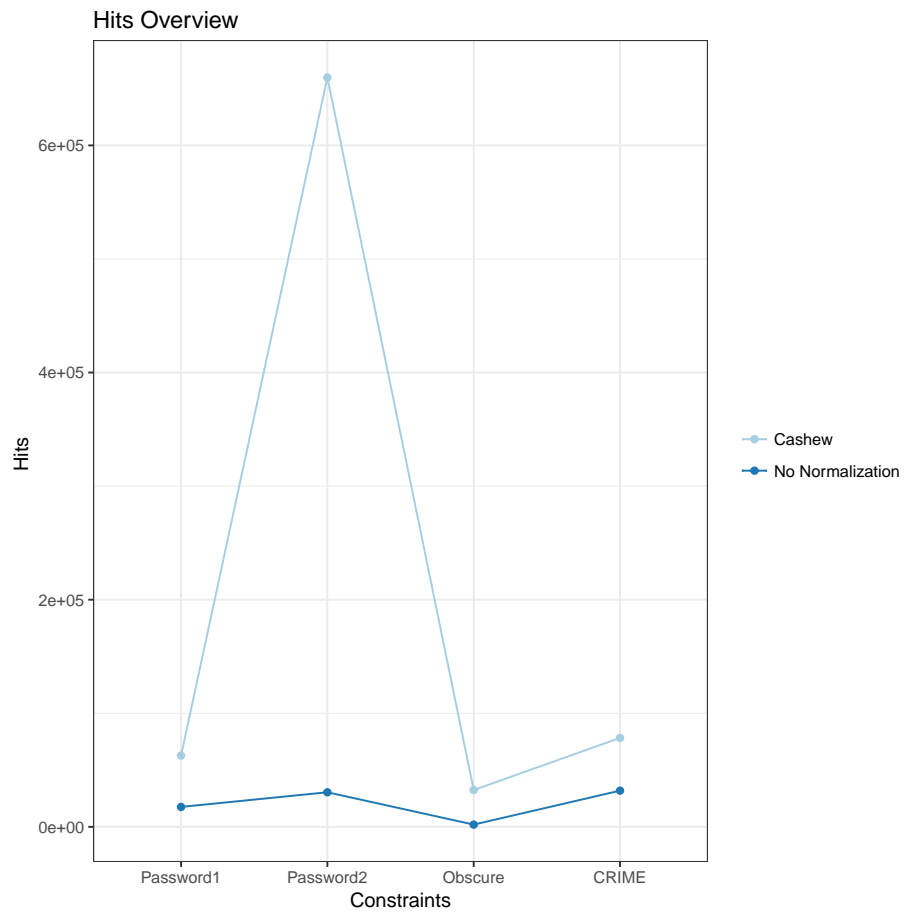
Table 3: RH2 Results per Object

Password1	Inconclusive
Password2	Inconclusive
Obscure	Inconclusive
CRIME	Inconclusive

Table 4: RH2 Results Summary

Cashew < No Normalization:	0%
Cashew > No Normalization:	0%
Cashew:	0%
No Normalization:	0%
None:	0%
Inconclusive:	100%

3.3 RH3: Number of hits for Cashew is equals than Number of hits for No Normalization

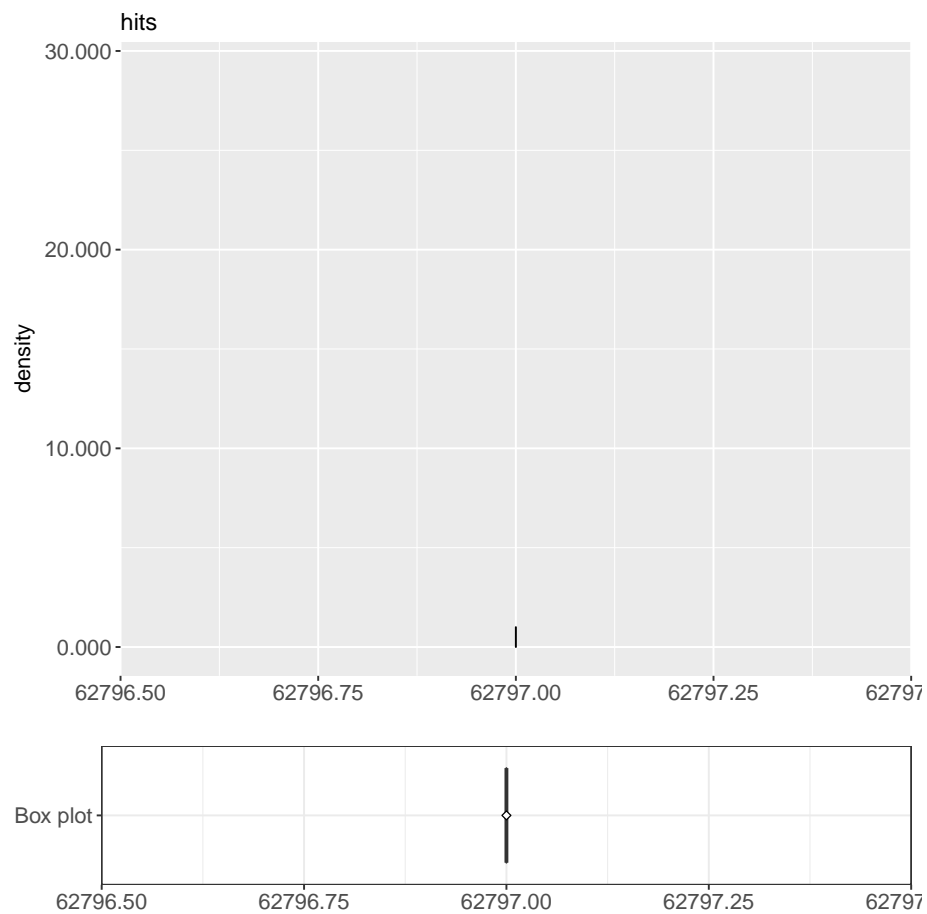


3.3.1 RH3.1: Object Password1

Hits for Cashew

```
## [1] "Sample size: 1"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   62800   62800   62800   62800   62800   62800

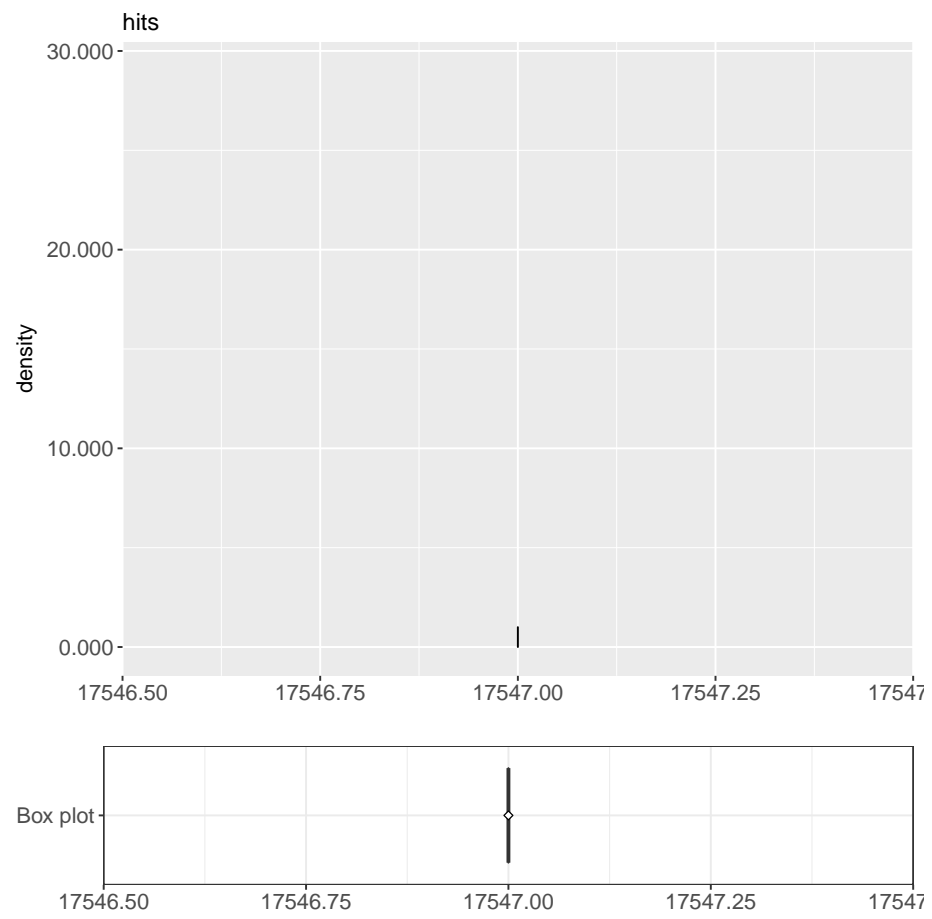
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



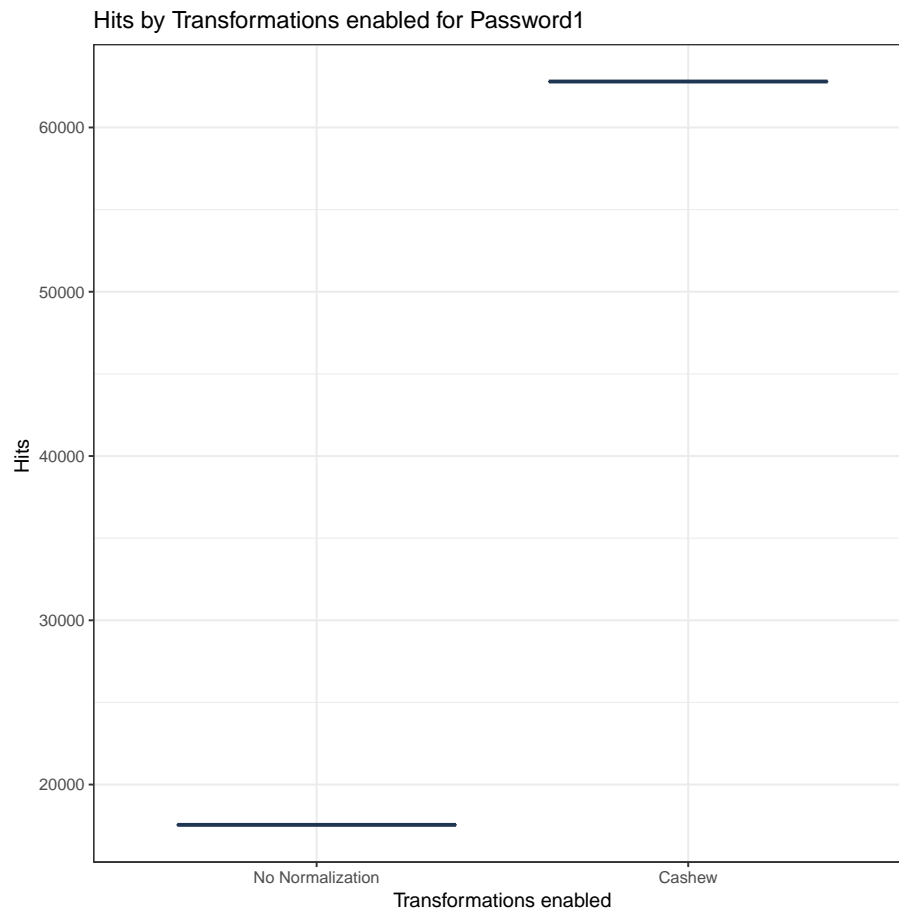
Hits for No Normalization

```
## [1] "Sample size: 1"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   17550   17550   17550   17550   17550   17550

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching")
## : sample size must be between 3 and 5000
```



Comparison



```
## Error in eval(expr, envir, enclos): object 'shap.cashew_password'
not found
```

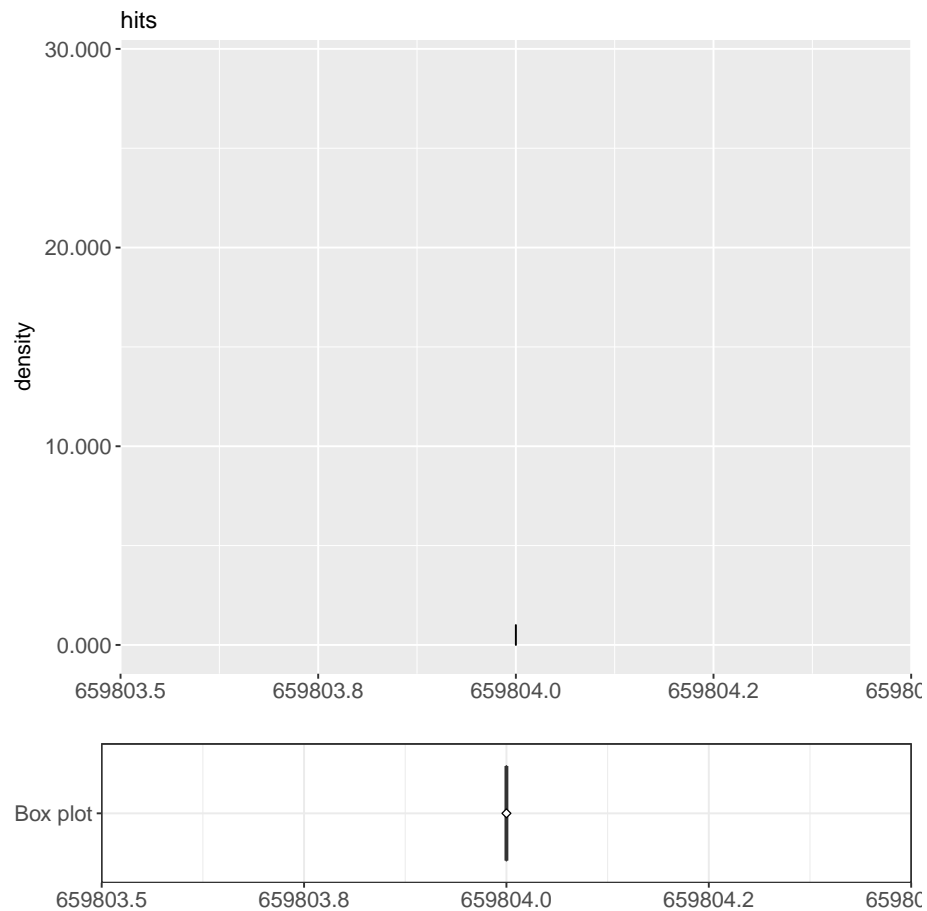
```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Hits for Cashew: 62797"
## [1] "Mean Hits for No Normalization: 17547"
## [1] "Absolute difference: 45250"
## Hits for Cashew is 257.878839687696 % greater than
## Hits for No Normalization
```

3.3.2 RH3.2: Object Password2

Hits for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 659800 659800 659800 659800 659800 659800

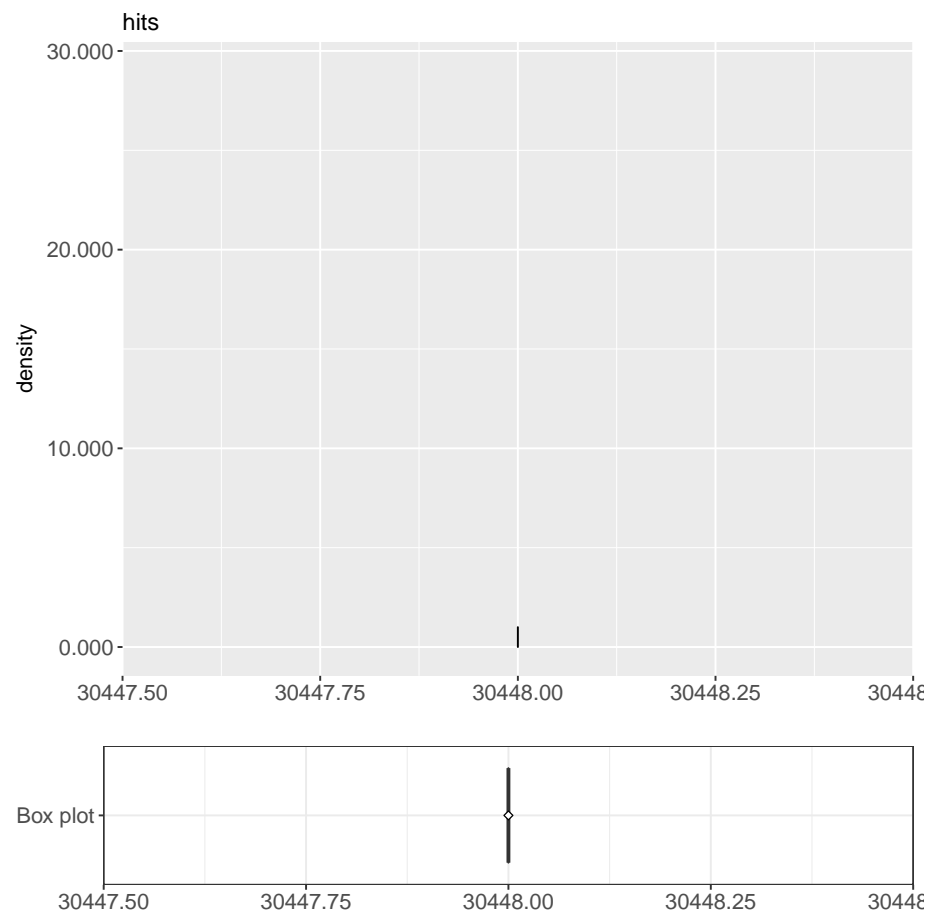
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



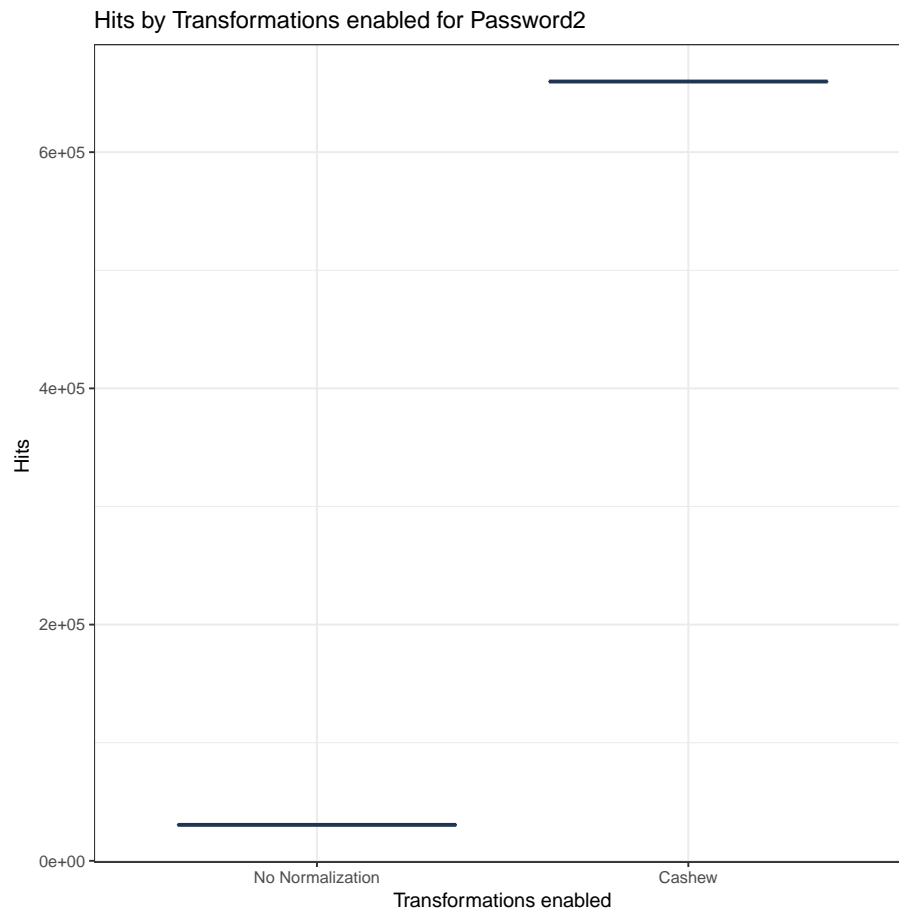
Hits for No Normalization

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 30450 30450 30450 30450 30450 30450

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching"
## & : sample size must be between 3 and 5000
```



Comparison



```
## Error in eval(expr, envir, enclos): object 'shap.cashew_password2'
not found
```

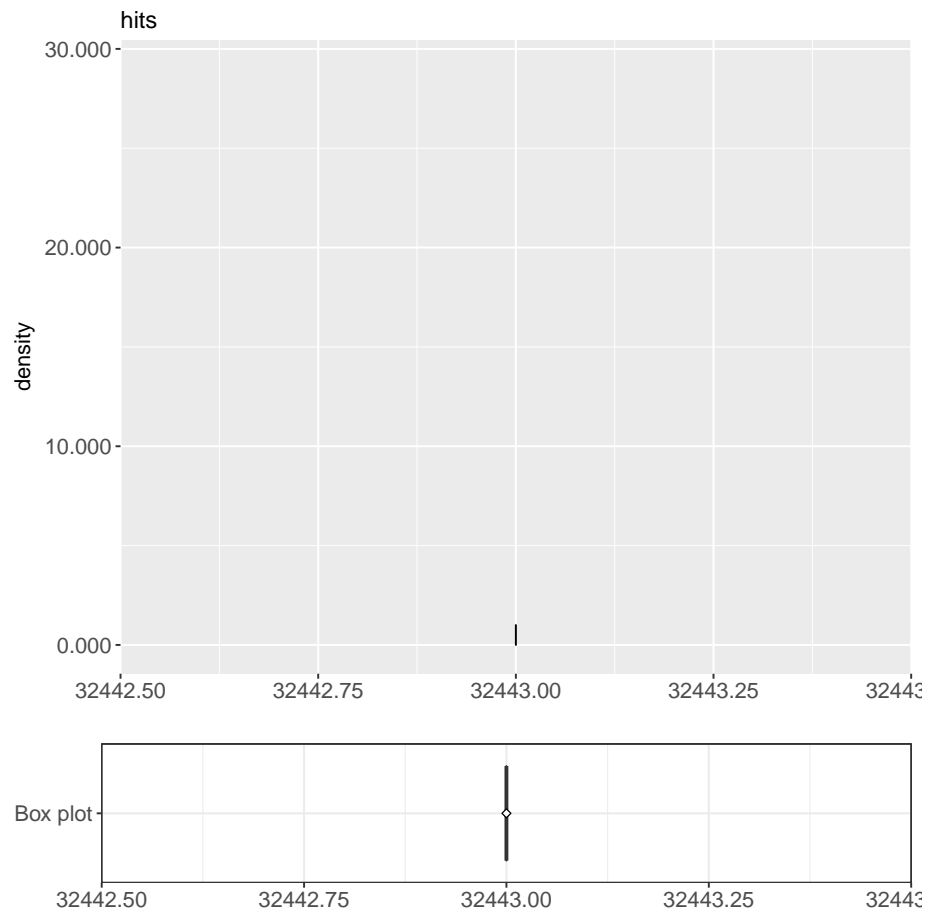
```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Hits for Cashew: 659804"
## [1] "Mean Hits for No Normalization: 304448"
## [1] "Absolute difference: 629356"
## Hits for Cashew is 2066.98633736206 % greater than
## Hits for No Normalization
```

3.3.3 RH3.3: Object Obscure

Hits for Cashew


```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      32440   32440   32440   32440   32440   32440

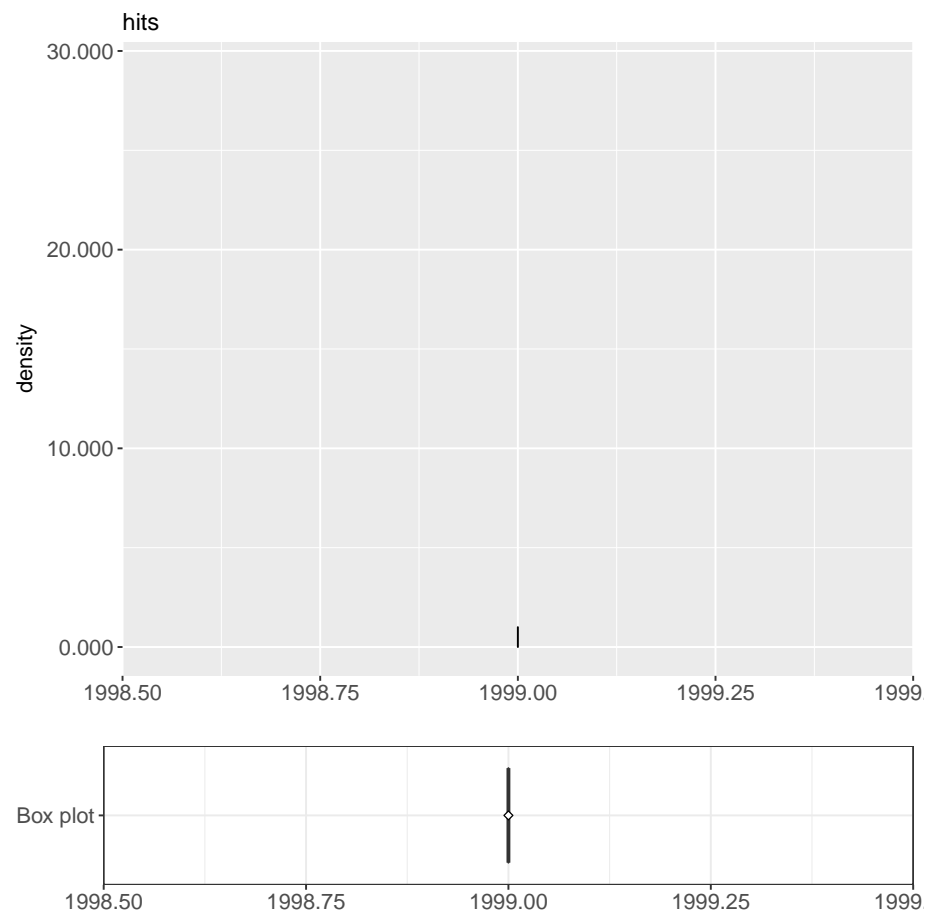
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



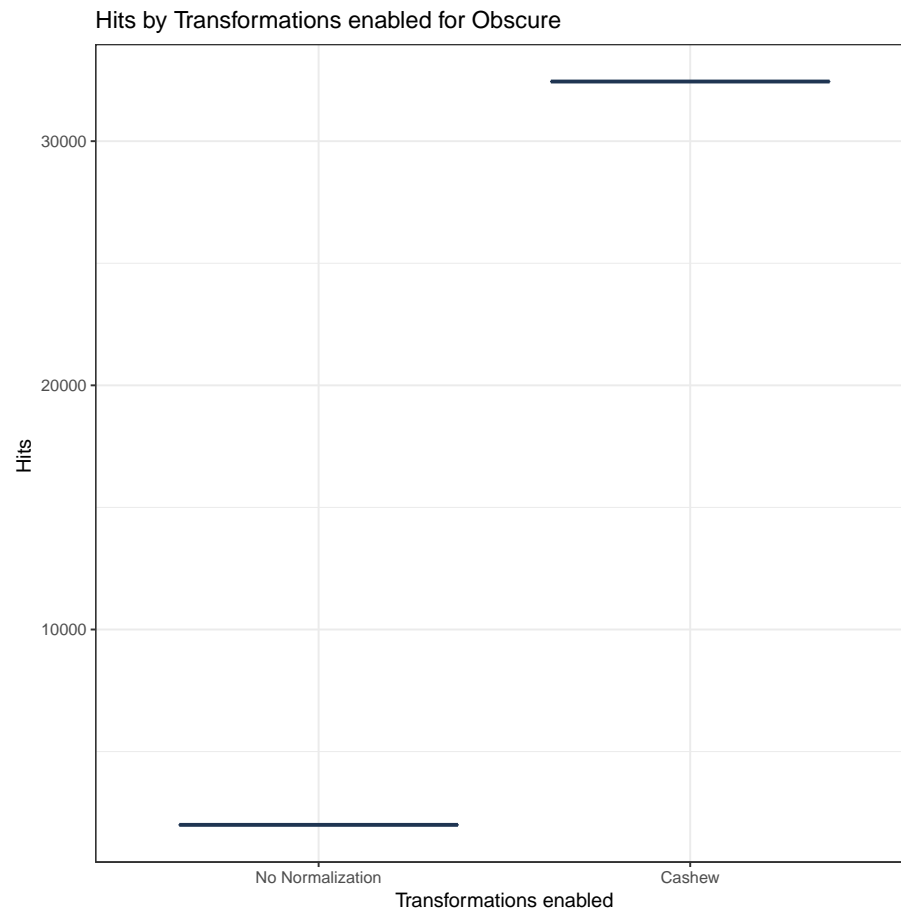
Hits for No Normalization

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1999   1999   1999   1999   1999   1999

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching"
## & : sample size must be between 3 and 5000
```



Comparison



```
## Error in eval(expr, envir, enclos): object 'shap_cashew_obscur'
not found
```

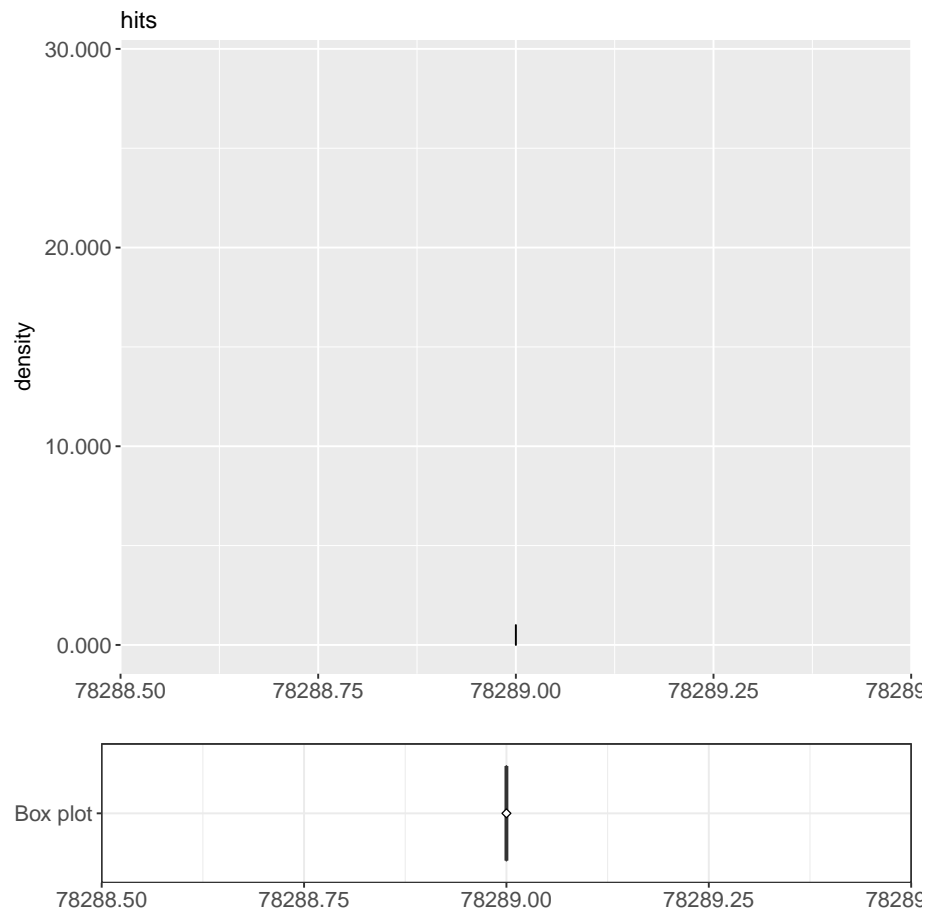
```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Hits for Cashew: 32443"
## [1] "Mean Hits for No Normalization: 1999"
## [1] "Absolute difference: 30444"
## Hits for Cashew is 1522.96148074037 % greater than
## Hits for No Normalization
```

3.3.4 RH3.4: Object CRIME

Hits for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      78290   78290   78290   78290   78290   78290

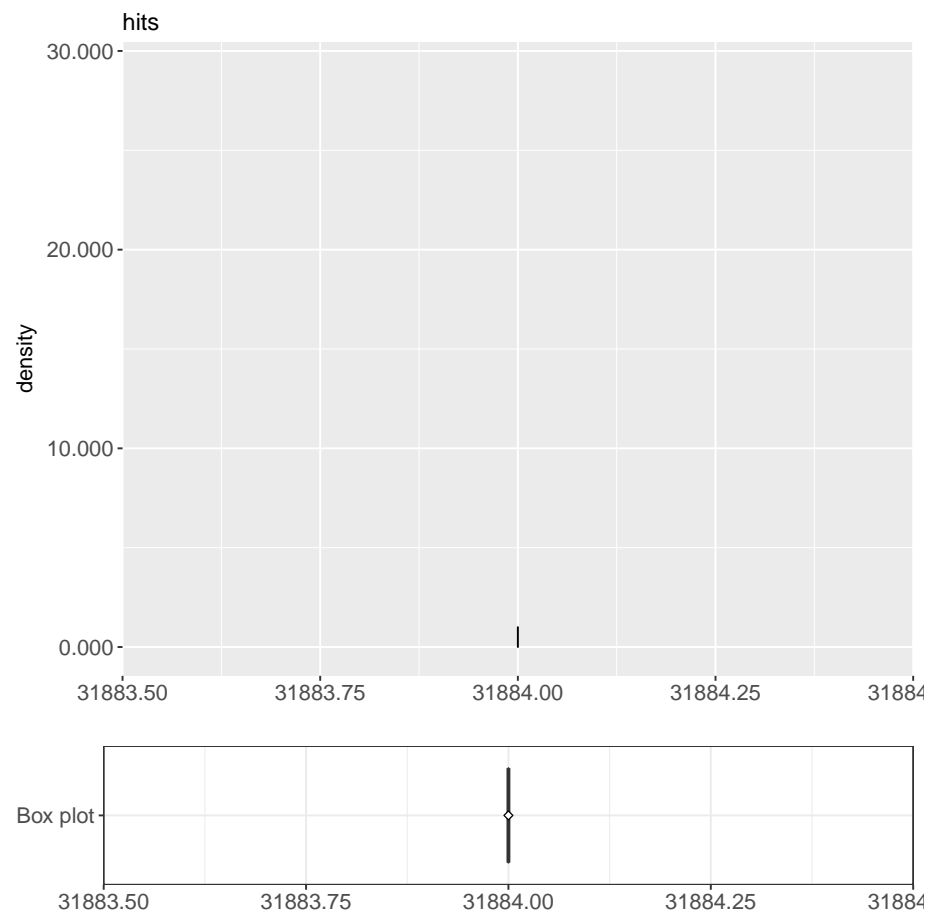
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



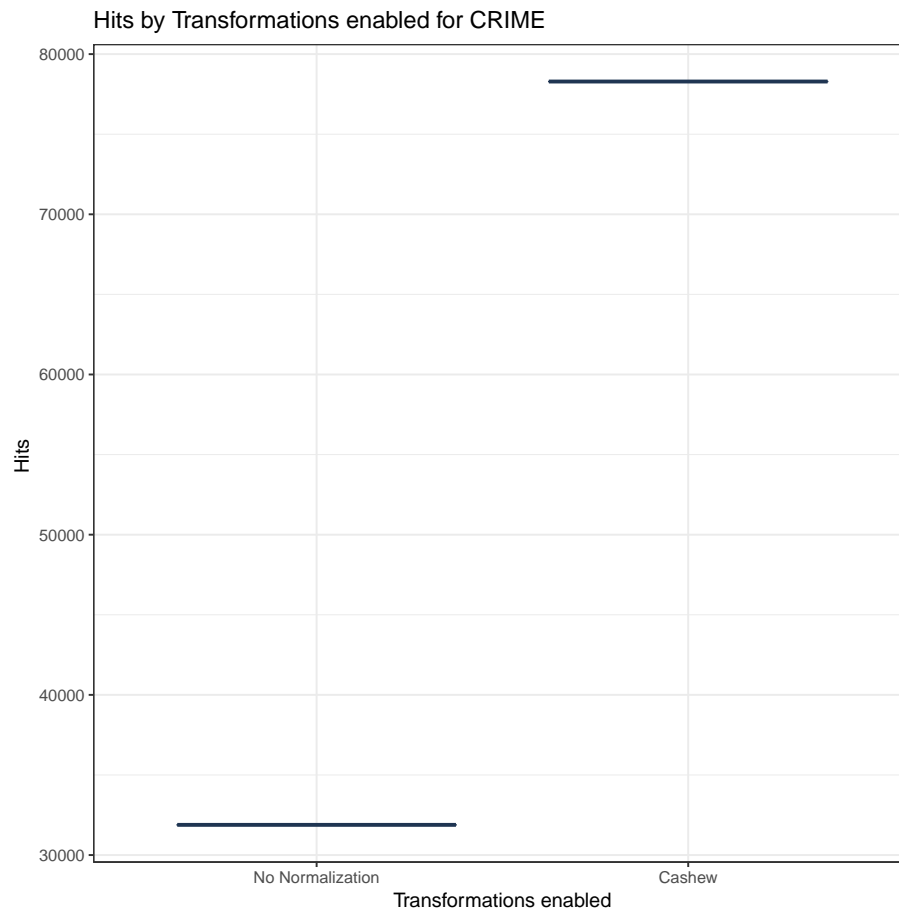
Hits for No Normalization

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      31880   31880   31880   31880   31880   31880

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching"
## & : sample size must be between 3 and 5000
```



Comparison



```
## Error in eval(expr, envir, enclos): object 'shap.cashew.crime' not found
```

```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Hits for Cashew: 78289"
## [1] "Mean Hits for No Normalization: 31884"
## [1] "Absolute difference: 46405"
## Hits for Cashew is 145.543219169489 % greater than
## Hits for No Normalization
```

3.3.5 RH3 Results: Hits Cashew = No Normalization

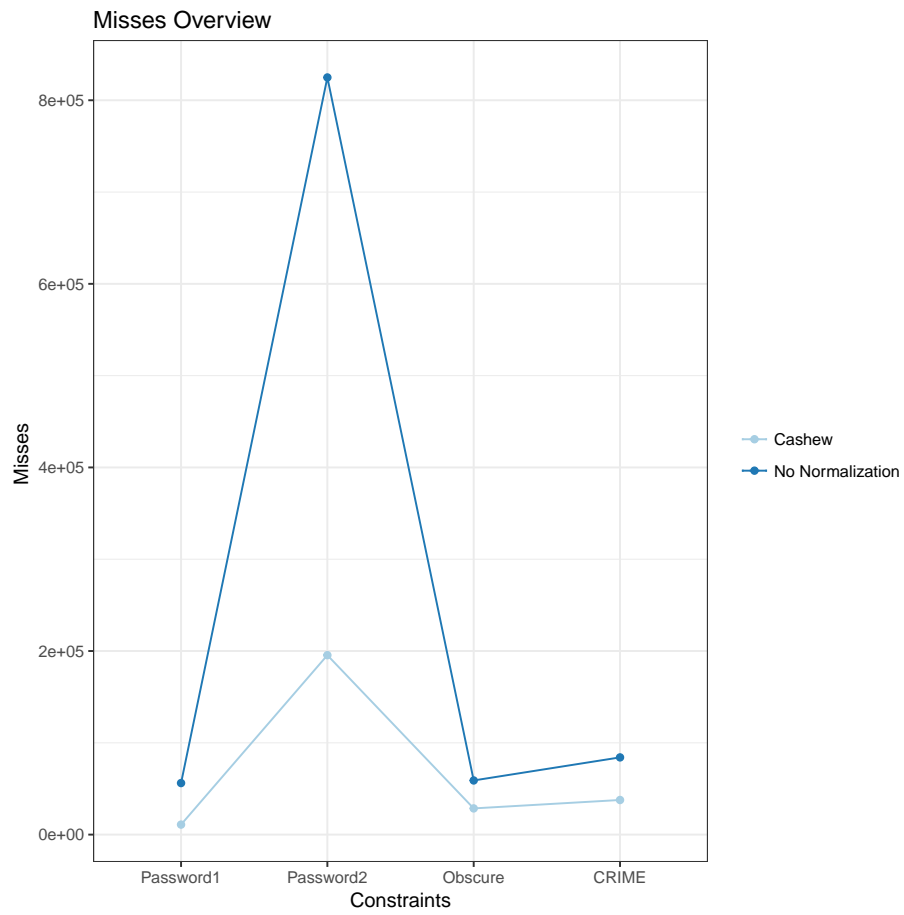
Table 5: RH3 Results per Object

Password1	Inconclusive
Password2	Inconclusive
Obscure	Inconclusive
CRIME	Inconclusive

Table 6: RH3 Results Summary

Cashew < No Normalization:	0%
Cashew > No Normalization:	0%
Cashew:	0%
No Normalization:	0%
None:	0%
Inconclusive:	100%

3.4 RH4: Number of misses for Cashew is equals than Number of misses for No Normalization

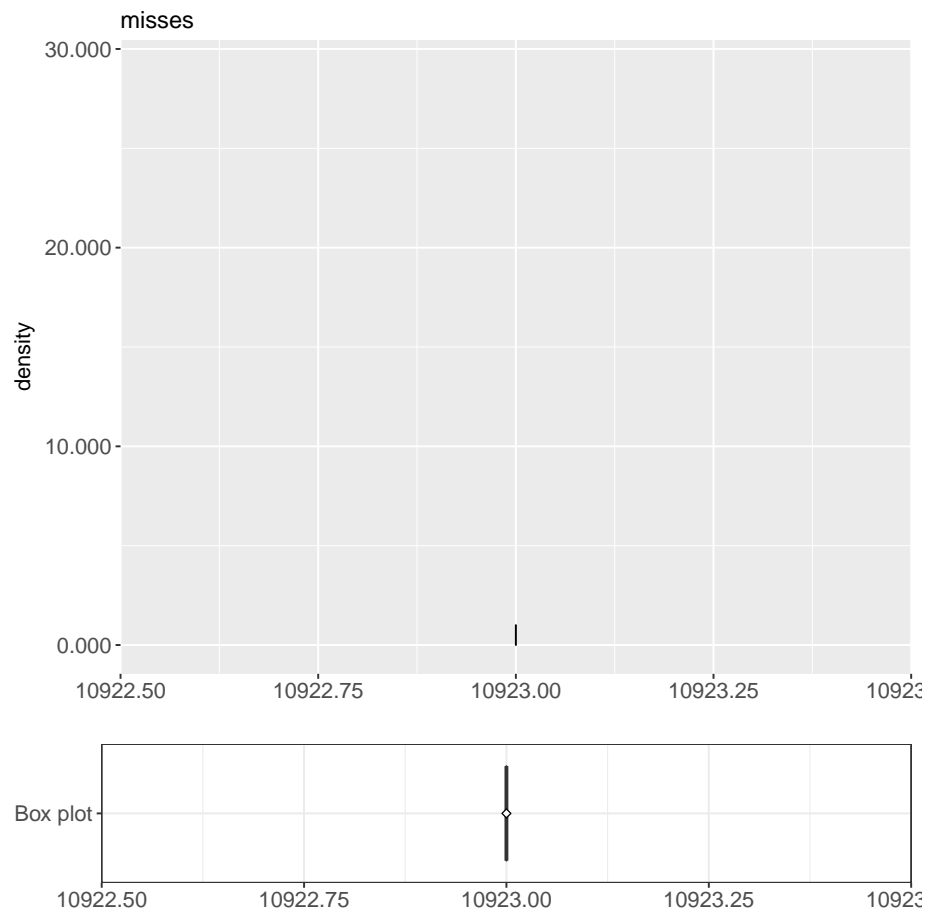


3.4.1 RH4.1: Object Password1

Misses for Cashew

```
## [1] "Sample size: 1"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  10920  10920   10920   10920  10920   10920

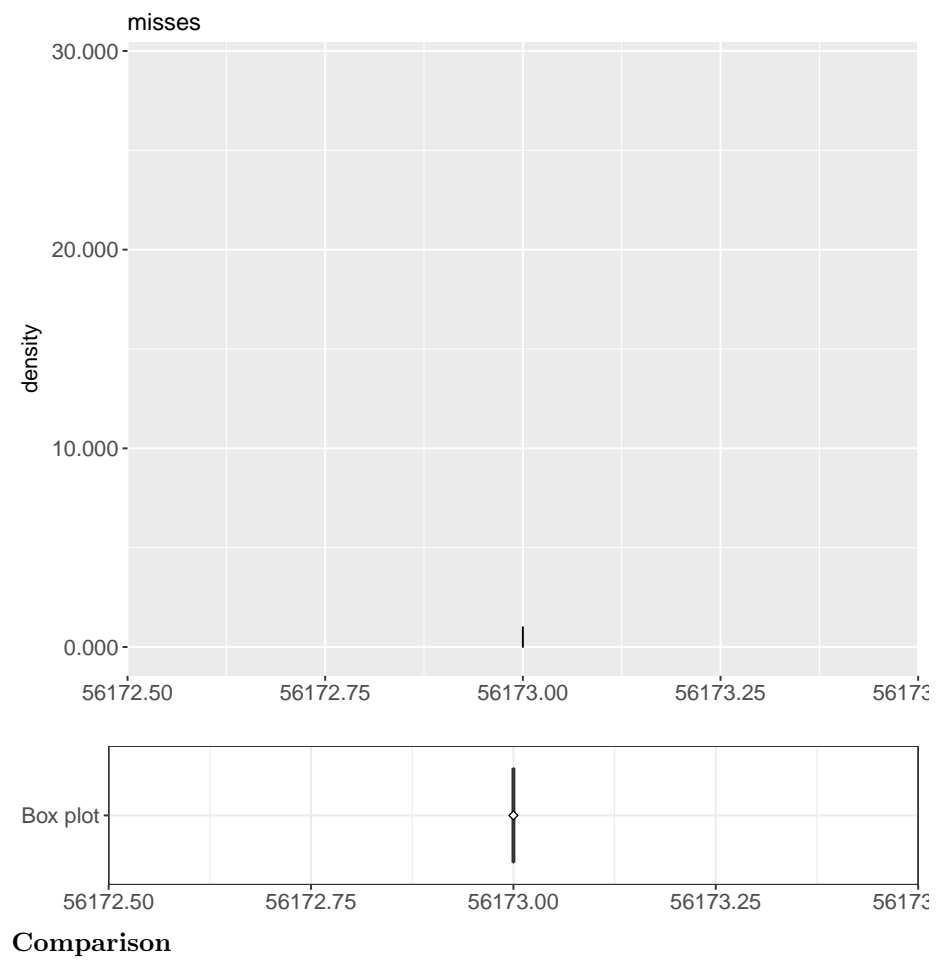
## Error in shapiro.test(subset(json.data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```

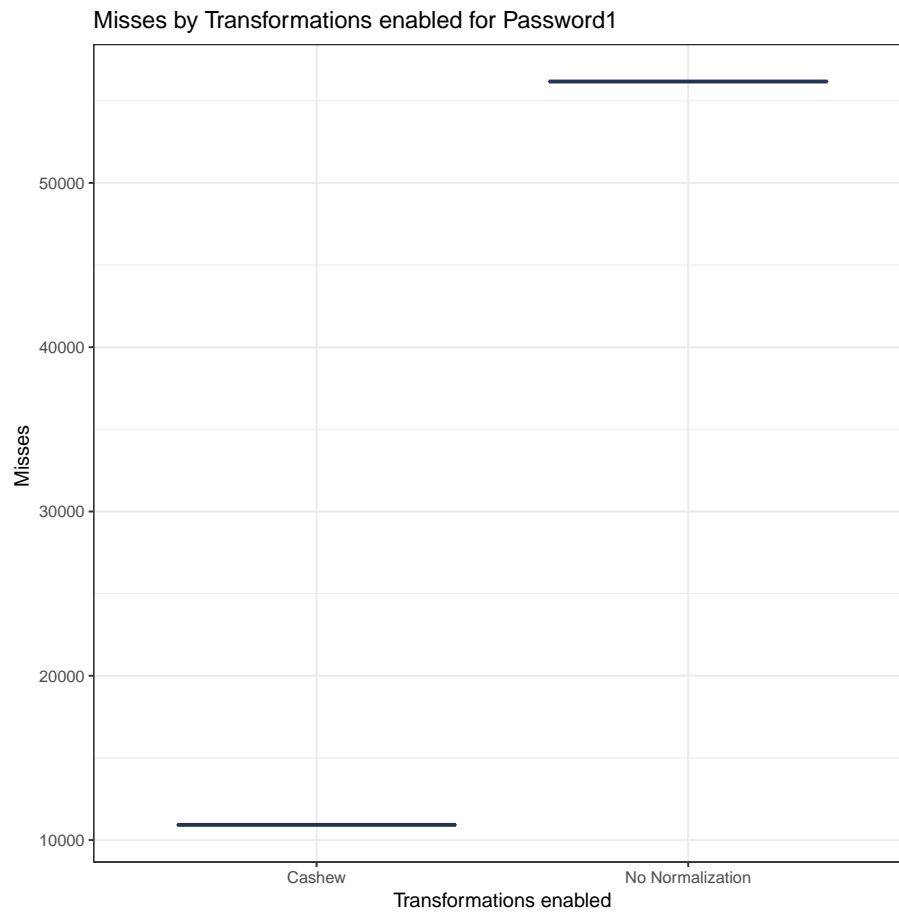



Misses for No Normalization

```
## [1] "Sample size: 1"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   56170   56170   56170   56170   56170   56170

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching")
## : sample size must be between 3 and 5000
```





```
## Error in eval(expr, envir, enclos): object 'shap.cashew_password'
not found
```

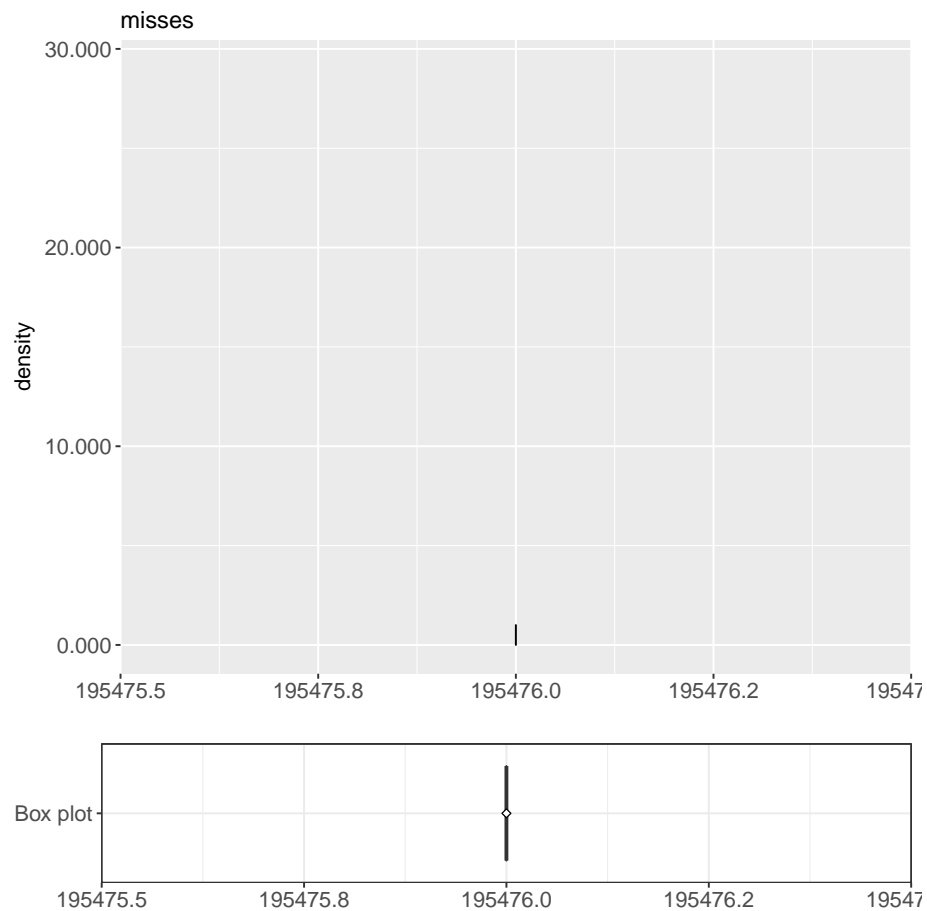
```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Misses for Cashew: 10923"
## [1] "Mean Misses for No Normalization: 56173"
## [1] "Absolute difference: 45250"
## Misses for No Normalization is 414.263480728737 % greater than
## Misses for Cashew
```

3.4.2 RH4.2: Object Password2

Misses for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 195500 195500 195500 195500 195500 195500

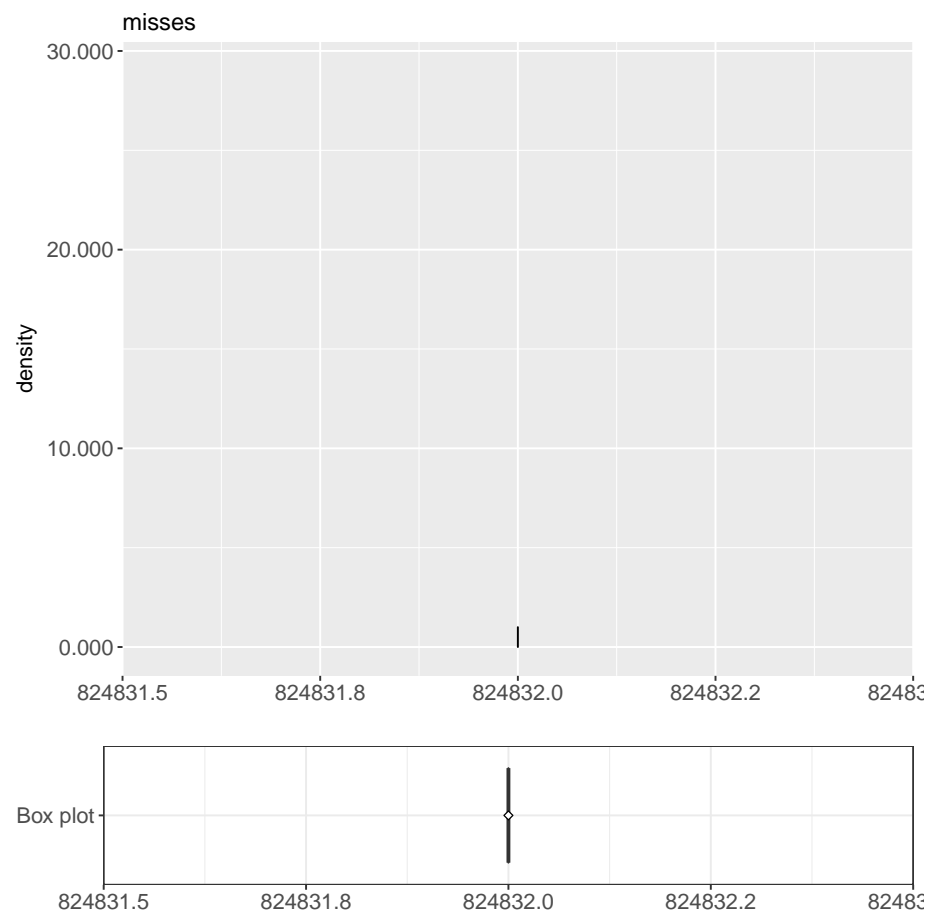
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



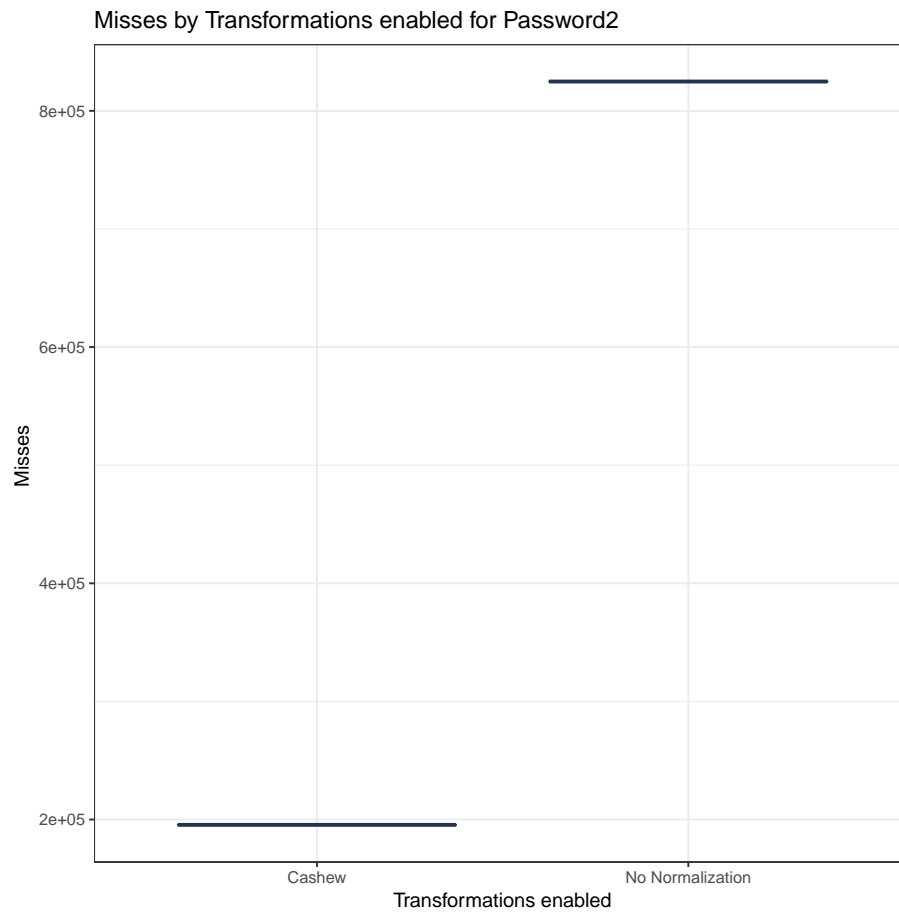
Misses for No Normalization

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 824800 824800 824800 824800 824800 824800

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching"
## & : sample size must be between 3 and 5000
```



Comparison



```
## Error in eval(expr, envir, enclos): object 'shap.cashew_password2'
not found
```

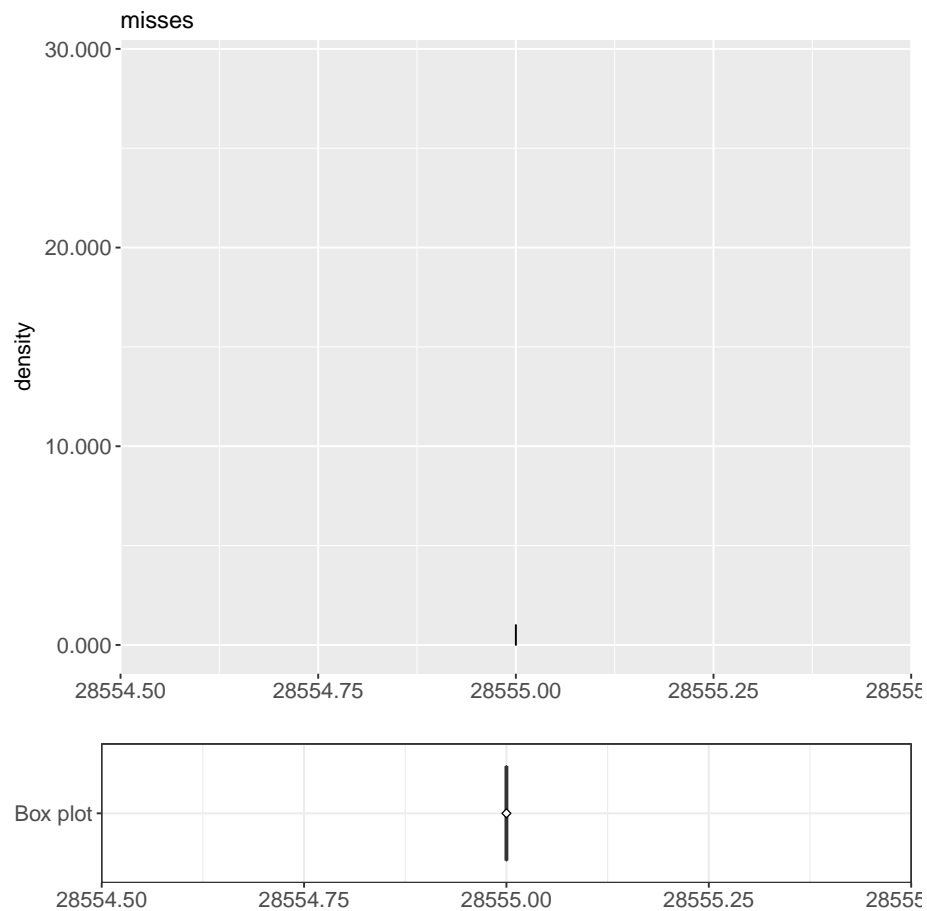
```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Misses for Cashew: 195476"
## [1] "Mean Misses for No Normalization: 824832"
## [1] "Absolute difference: 629356"
## Misses for No Normalization is 321.960752215106 % greater than
## Misses for Cashew
```

3.4.3 RH4.3: Object Obscure

Misses for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      28560   28560   28560   28560   28560   28560

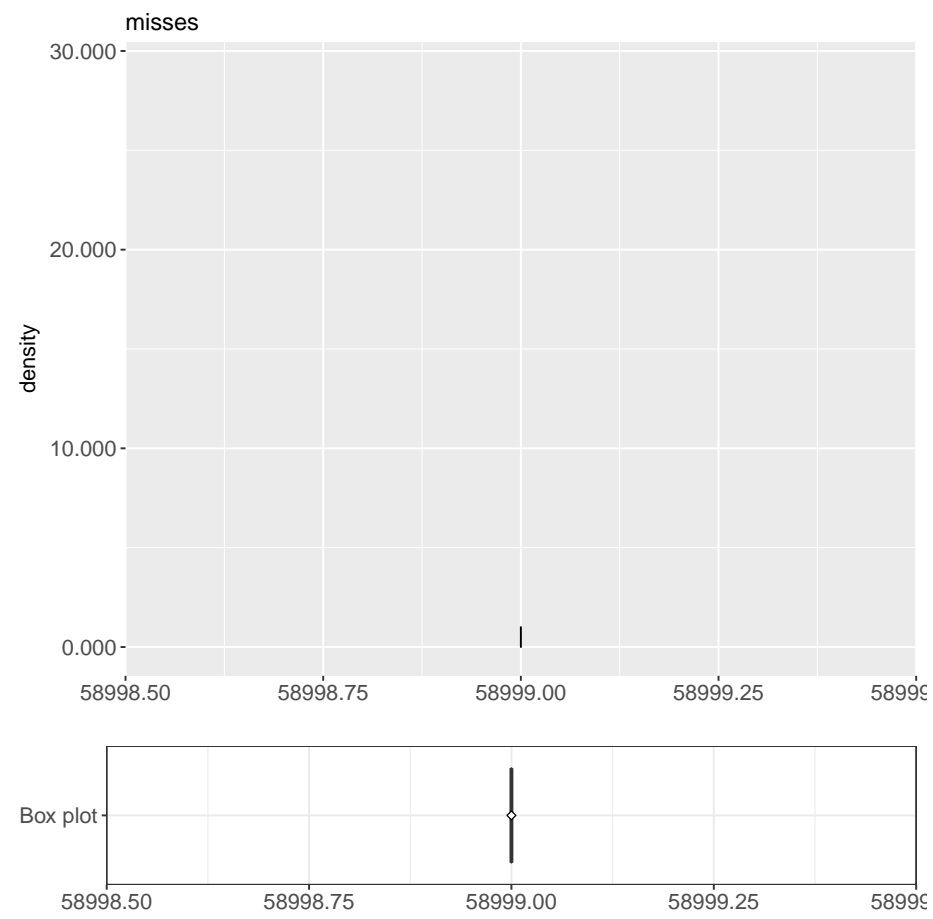
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```

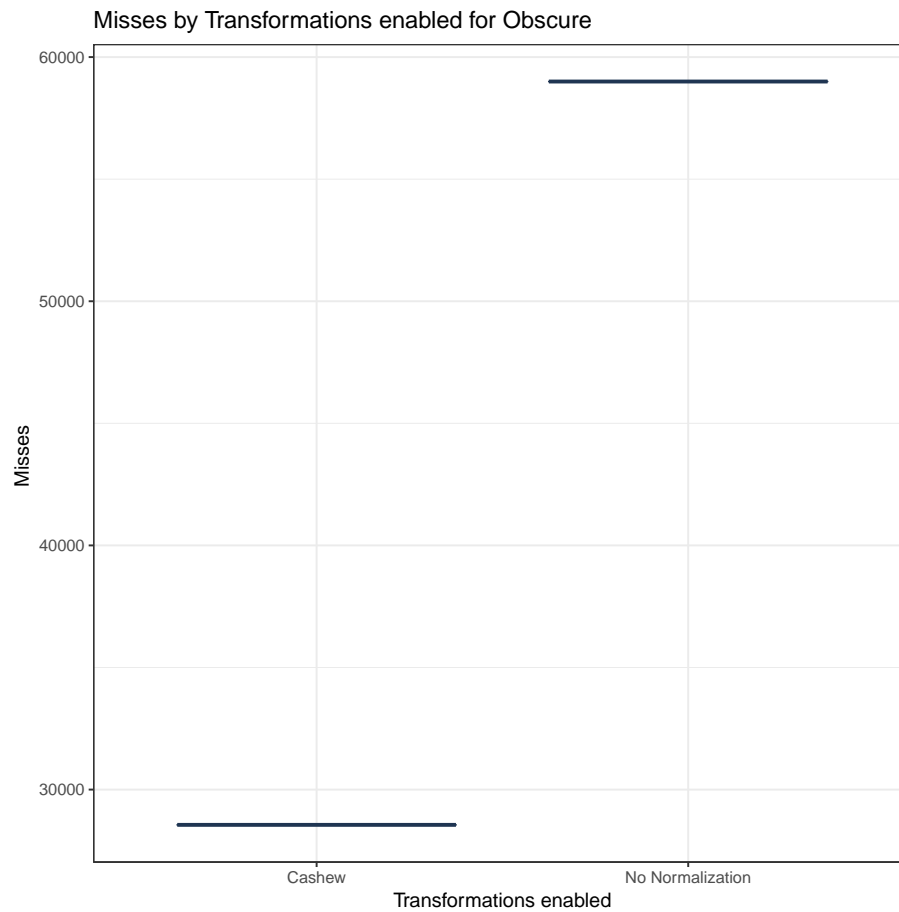


Misses for No Normalization

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      59000   59000   59000   59000   59000   59000

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching"
## & : sample size must be between 3 and 5000
```





```
## Error in eval(expr, envir, enclos): object 'shap_cashew_obscur'
not found
```

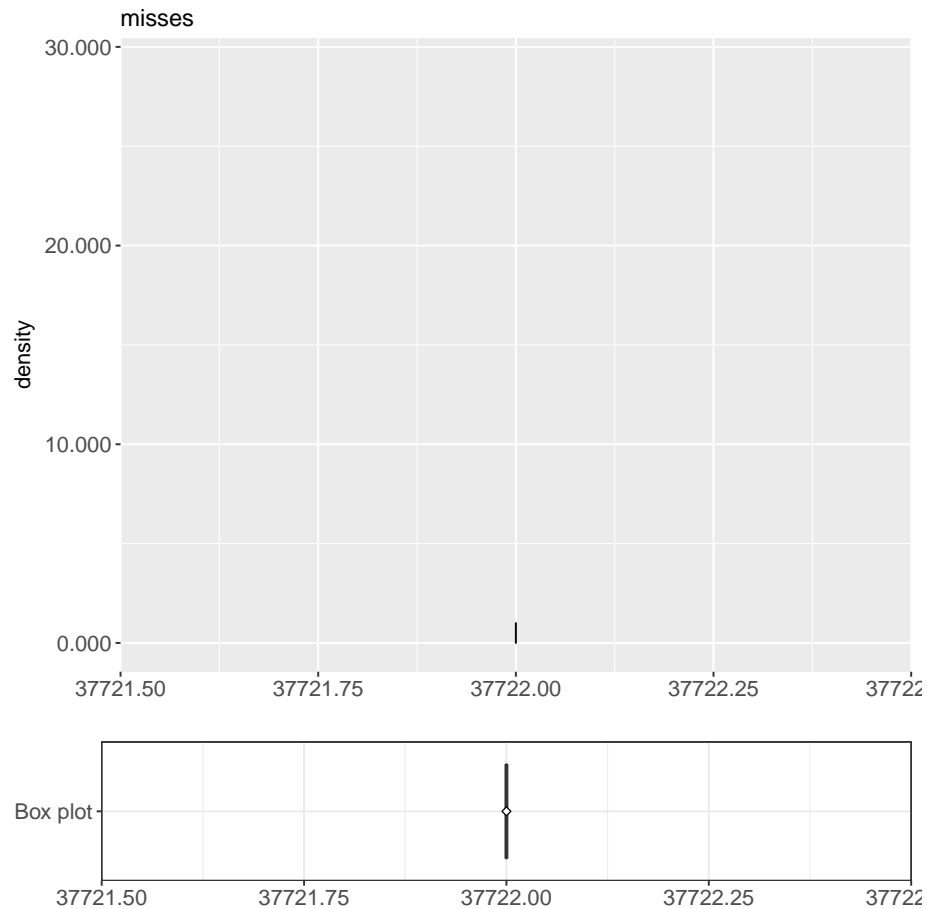
```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Misses for Cashew: 28555"
## [1] "Mean Misses for No Normalization: 58999"
## [1] "Absolute difference: 30444"
## Misses for No Normalization is 106.615303799685 % greater than
## Misses for Cashew
```

3.4.4 RH4.4: Object CRIME

Misses for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    37720  37720   37720   37720  37720   37720

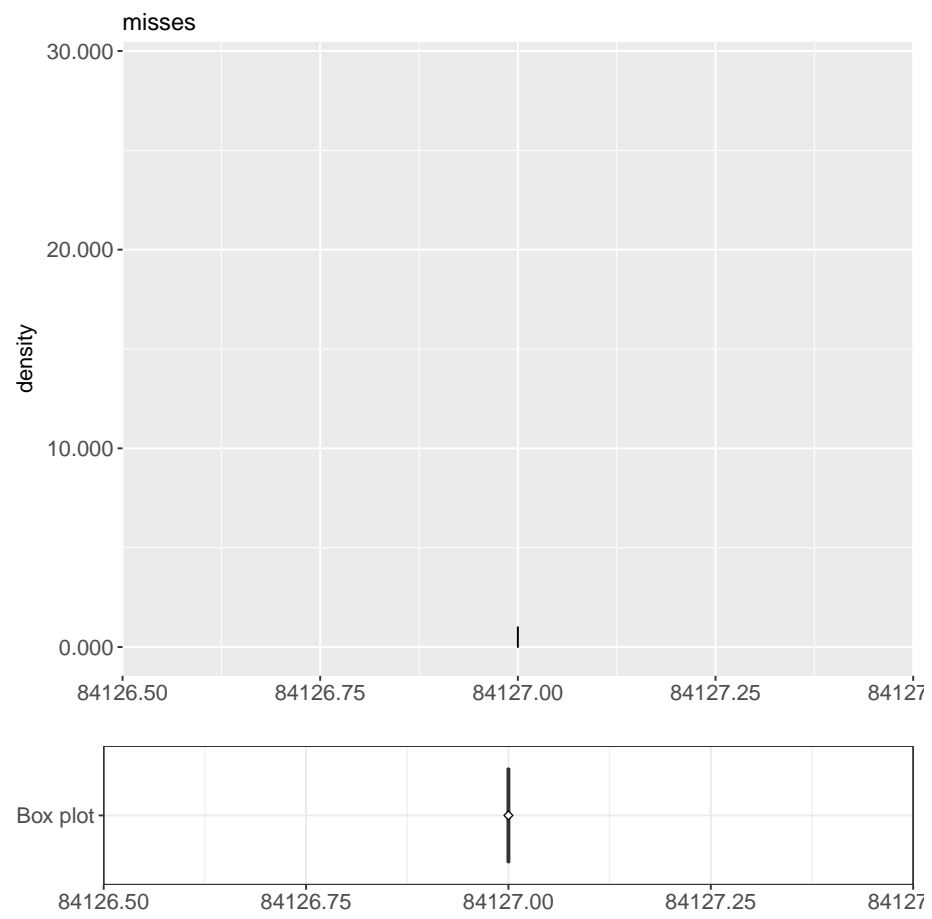
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```



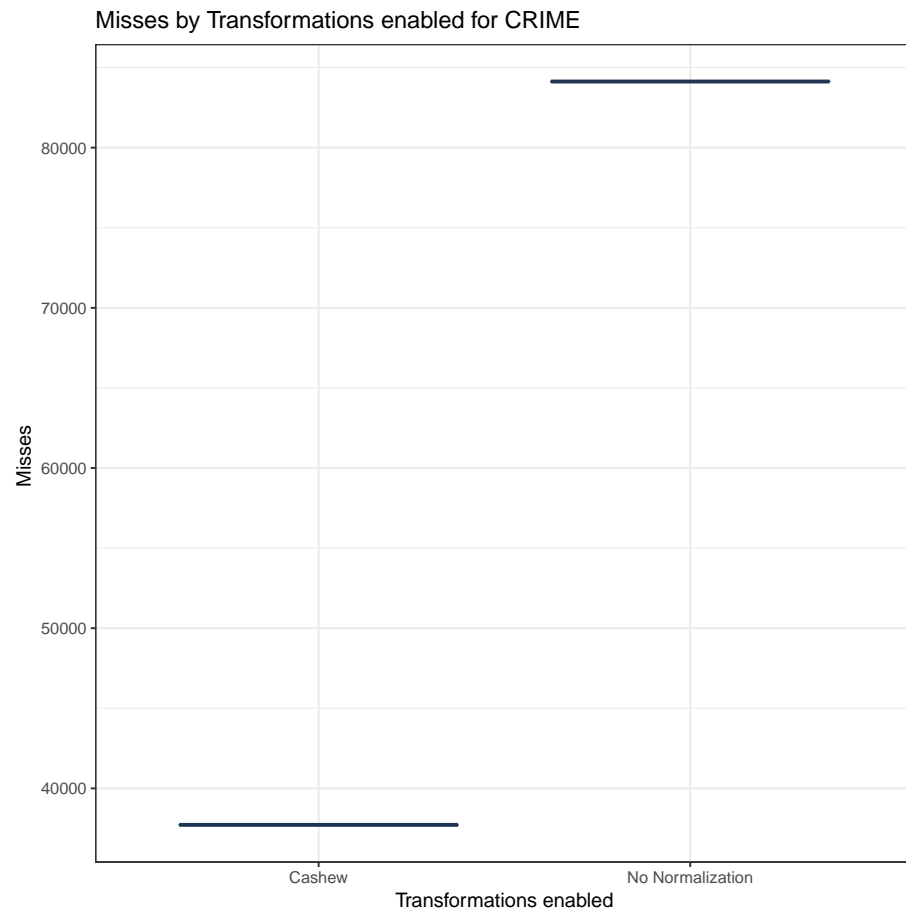
Misses for No Normalization

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    84130  84130   84130   84130  84130   84130

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching"
## & : sample size must be between 3 and 5000
```



Comparison



```
## Error in eval(expr, envir, enclos): object 'shap_cashew_crime' not found
```

```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Misses for Cashew: 37722"
## [1] "Mean Misses for No Normalization: 84127"
## [1] "Absolute difference: 46405"
## Misses for No Normalization is 123.018397751975 % greater than
## Misses for Cashew
```

3.4.5 RH4 Results: Misses Cashew = No Normalization

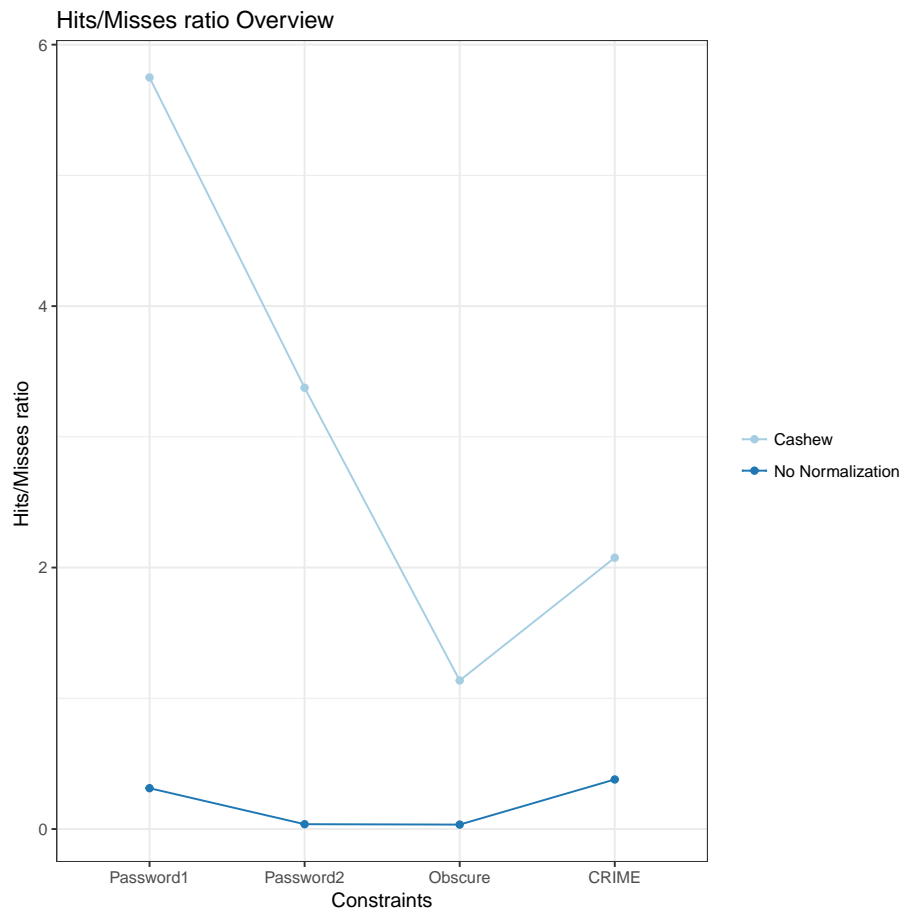
Table 7: RH4 Results per Object

Password1	Inconclusive
Password2	Inconclusive
Obscure	Inconclusive
CRIME	Inconclusive

Table 8: RH4 Results Summary

Cashew < No Normalization:	0%
Cashew > No Normalization:	0%
Cashew:	0%
No Normalization:	0%
None:	0%
Inconclusive:	100%

3.5 RH5: Hits/Misses ratio for Cashew is equals than Hits/Misses ratio for No Normalization

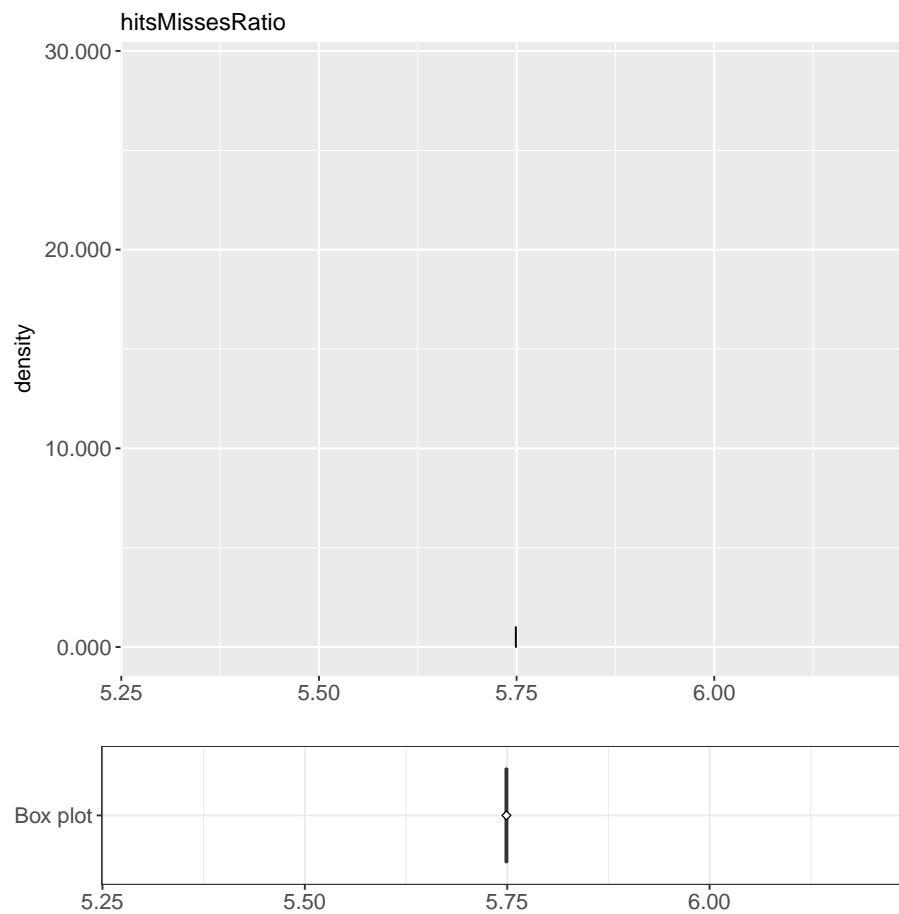


3.5.1 RH5.1: Object Password1

Hits/Misses ratio for Cashew

```
## [1] "Sample size: 1"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   5.749   5.749   5.749   5.749   5.749   5.749

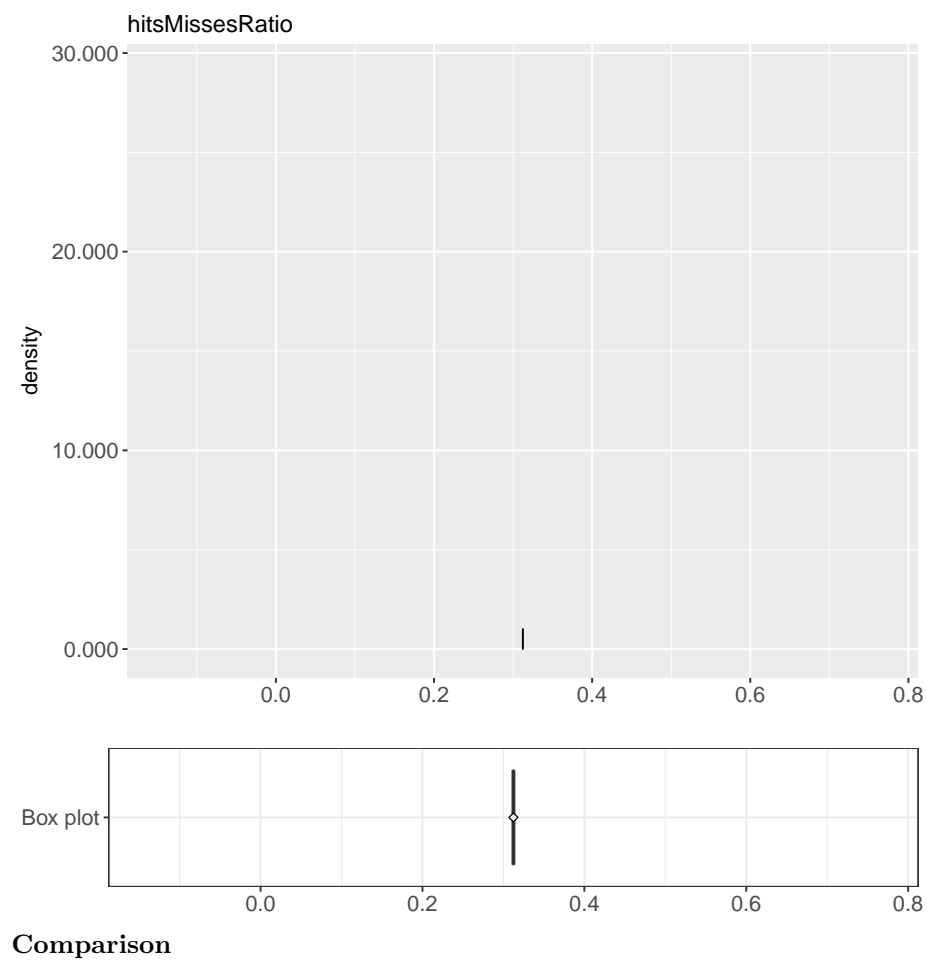
## Error in shapiro.test(subset(json.data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```

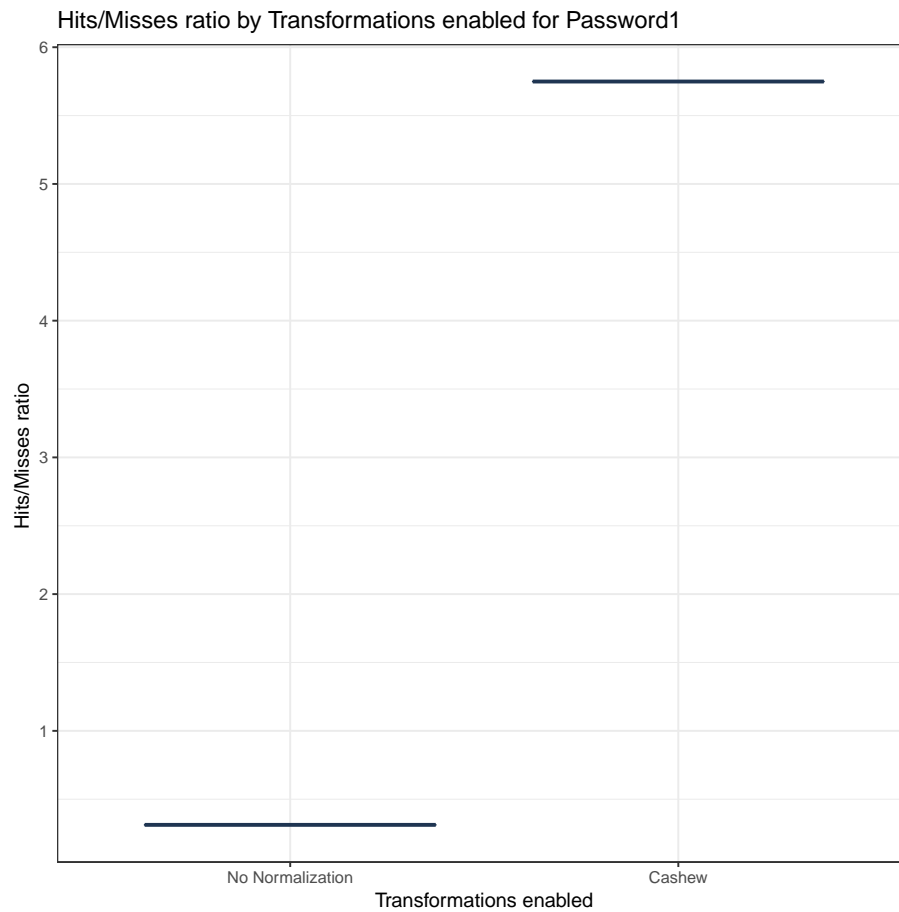


Hits/Misses ratio for No Normalization

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.3124 0.3124 0.3124 0.3124 0.3124 0.3124

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching")
## : sample size must be between 3 and 5000
```





```
## Error in eval(expr, envir, enclos): object 'shap.cashew_password'
not found
```

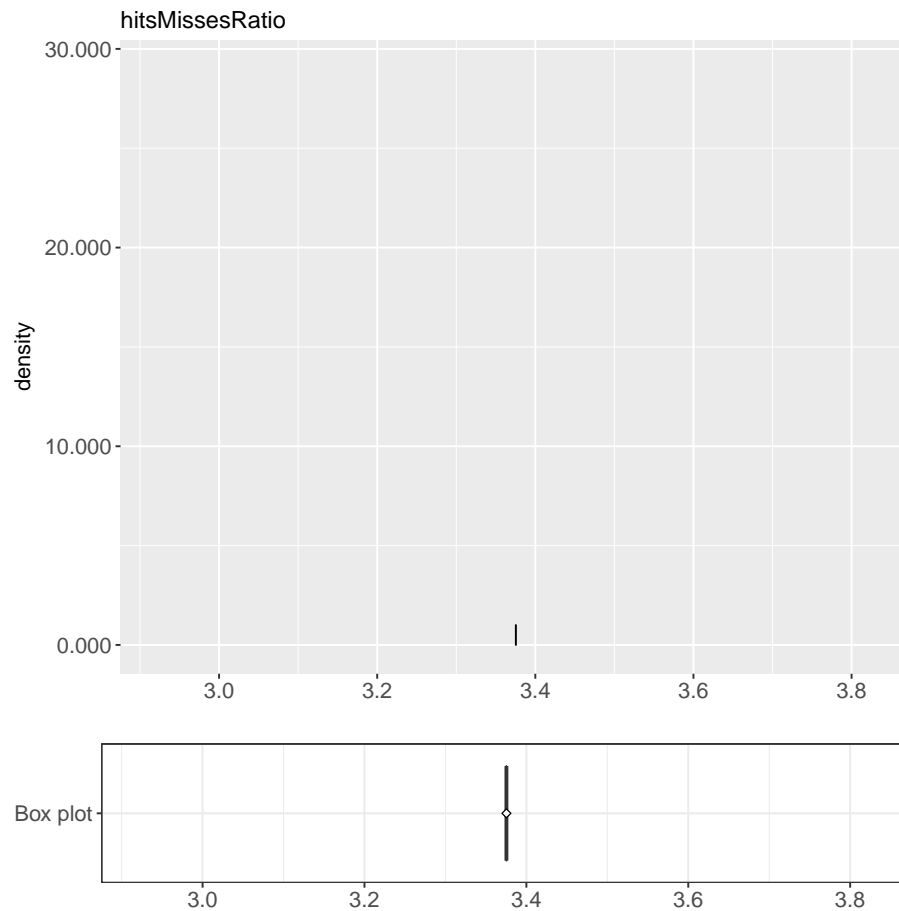
```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Hits/Misses ratio for Cashew: 5.74906"
## [1] "Mean Hits/Misses ratio for No Normalization: 0.312374"
## [1] "Absolute difference: 5.436686"
## Hits/Misses ratio for Cashew is 1740.44126591842 % greater than
## Hits/Misses ratio for No Normalization
```

3.5.2 RH5.2: Object Password2

Hits/Misses ratio for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      3.375   3.375   3.375   3.375   3.375   3.375

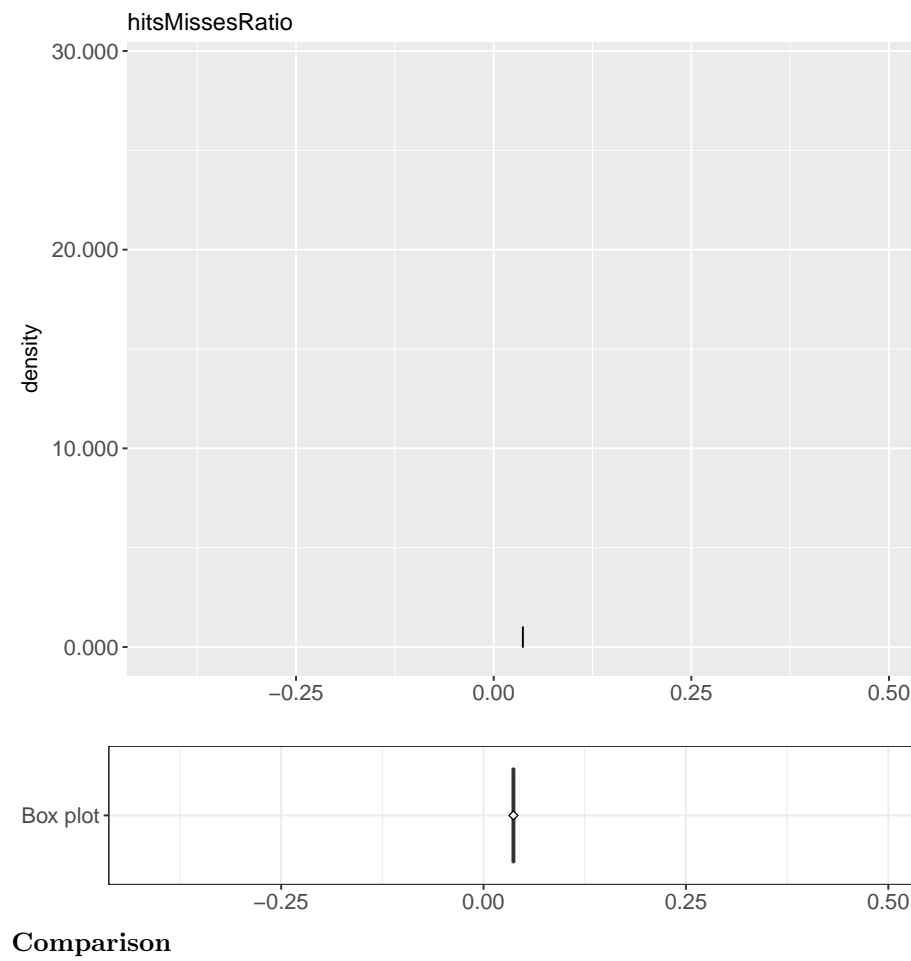
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```

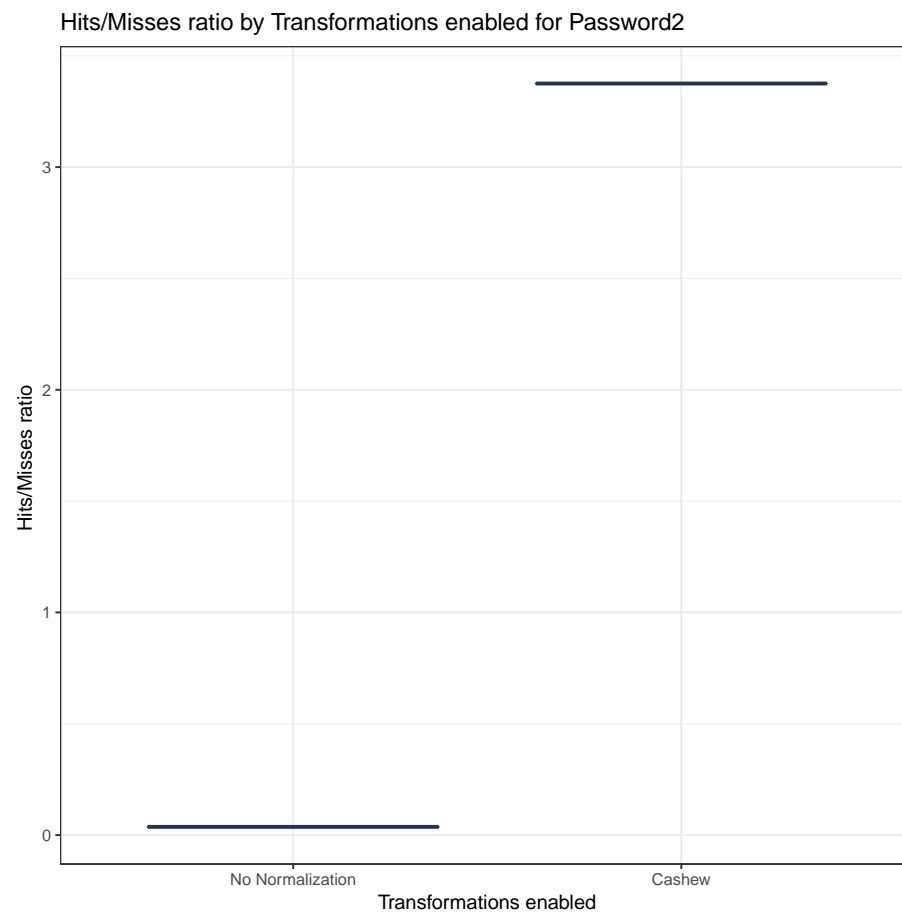


Hits/Misses ratio for No Normalization

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      0.03691 0.03691 0.03691 0.03691 0.03691 0.03691

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching"
## & : sample size must be between 3 and 5000
```





```
## Error in eval(expr, envir, enclos): object 'shap.cashew_password2'
not found
```

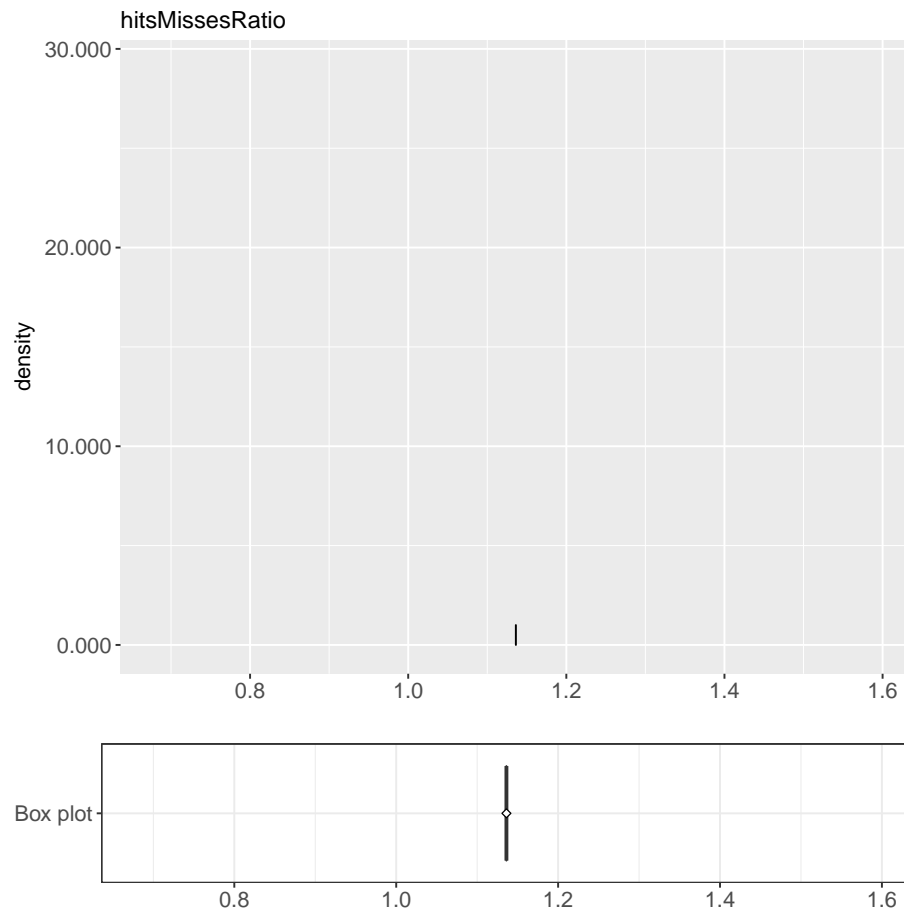
```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Hits/Misses ratio for Cashew: 3.37537"
## [1] "Mean Hits/Misses ratio for No Normalization: 0.0369142"
## [1] "Absolute difference: 3.3384558"
## Hits/Misses ratio for Cashew is 9043.82541135931 % greater than
## Hits/Misses ratio for No Normalization
```

3.5.3 RH5.3: Object Obscure

Hits/Misses ratio for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1.136   1.136   1.136   1.136   1.136   1.136

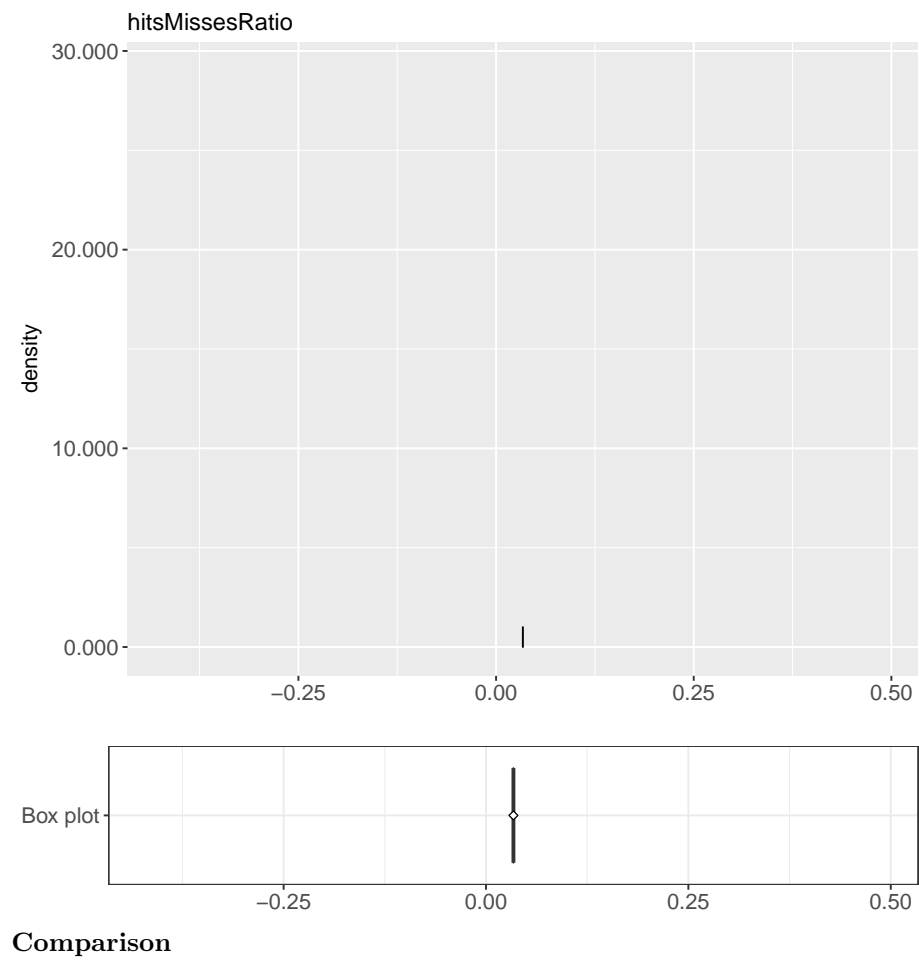
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```

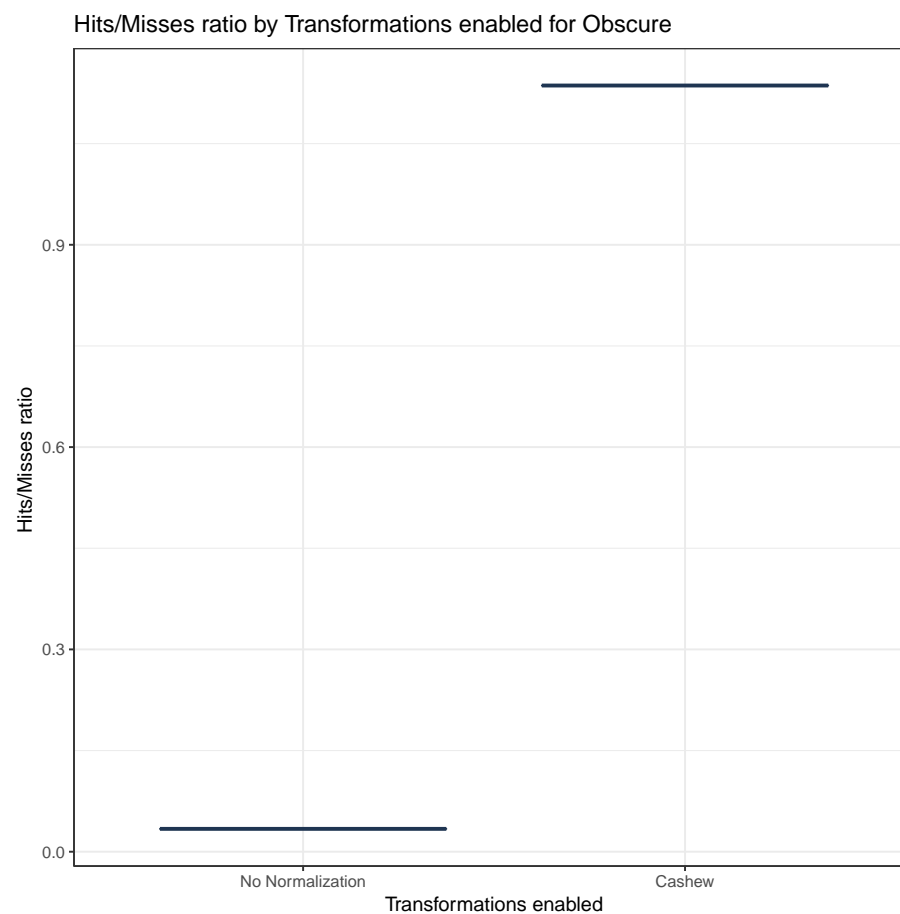


Hits/Misses ratio for No Normalization

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      0.03388 0.03388 0.03388 0.03388 0.03388 0.03388

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching"
## & : sample size must be between 3 and 5000
```





```
## Error in eval(expr, envir, enclos): object 'shap.cashew.obscure'
not found
```

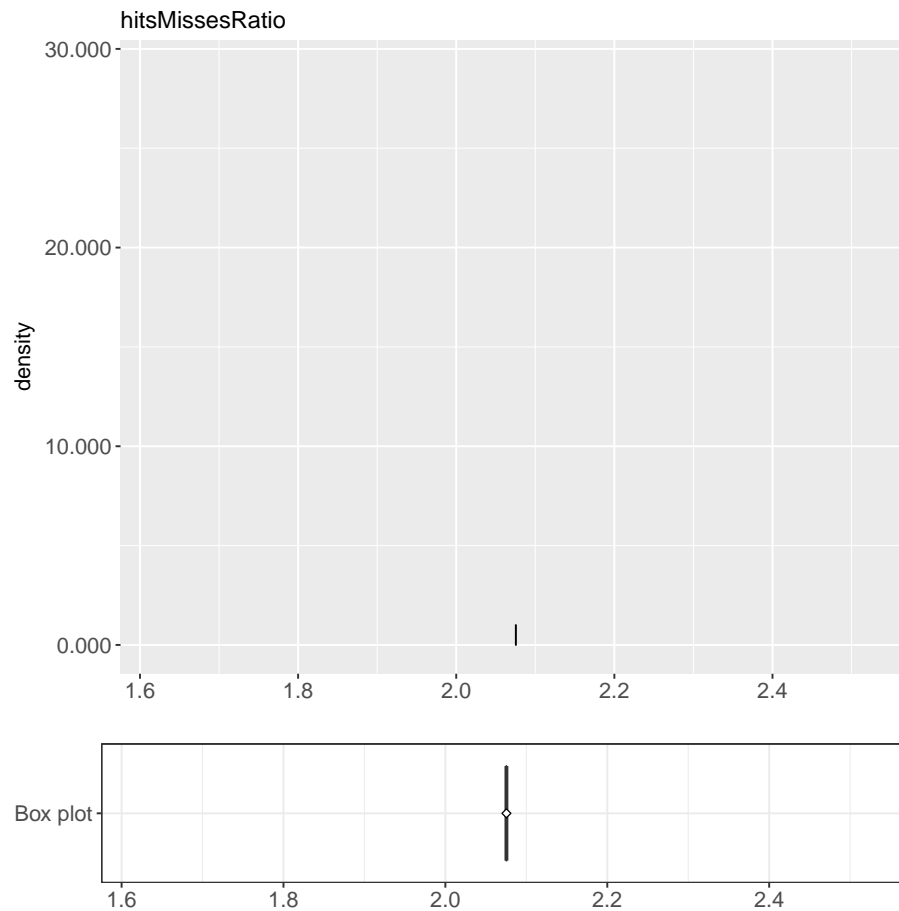
```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Hits/Misses ratio for Cashew: 1.13616"
## [1] "Mean Hits/Misses ratio for No Normalization: 0.0338819"
## [1] "Absolute difference: 1.1022781"
## Hits/Misses ratio for Cashew is 3253.29482703154 % greater than
## Hits/Misses ratio for No Normalization
```

3.5.4 RH5.4: Object CRIME

Hits/Misses ratio for Cashew

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      2.075   2.075   2.075   2.075   2.075   2.075

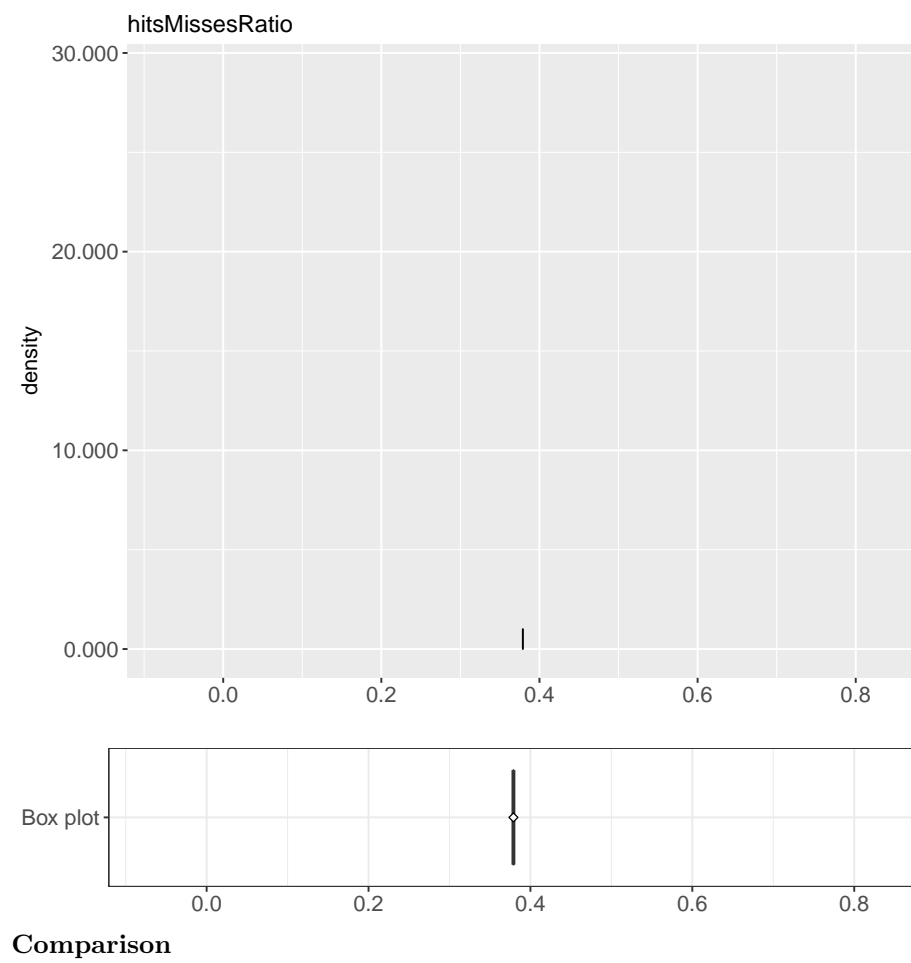
## Error in shapiro.test(subset(json_data, treatment == "cashew" &
## object == : sample size must be between 3 and 5000
```

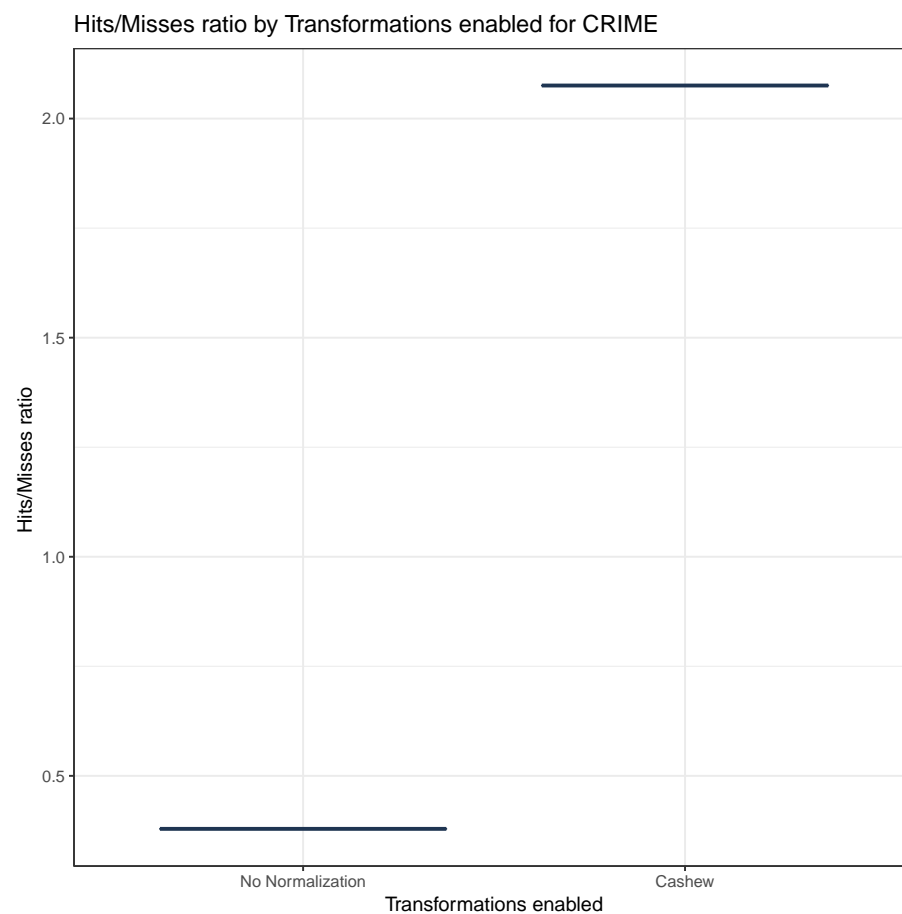


Hits/Misses ratio for No Normalization

```
## [1] "Sample size: 1"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      0.379   0.379   0.379   0.379   0.379   0.379

## Error in shapiro.test(subset(json_data, treatment == "trivialcaching"
## & : sample size must be between 3 and 5000
```



```
## Error in eval(expr, envir, enclos): object 'shap_cashew_crime' not found
```

```
## [1] ""
## [1] "Means comparison"
## [1] "Mean Hits/Misses ratio for Cashew: 2.07542"
## [1] "Mean Hits/Misses ratio for No Normalization: 0.378998"
## [1] "Absolute difference: 1.696422"
## Hits/Misses ratio for Cashew is 447.607111383174 % greater than
## Hits/Misses ratio for No Normalization
```

3.5.5 RH5 Results: Hits/Misses ratio Cashew = No Normalization

Table 9: RH5 Results per Object

Password1	Inconclusive
Password2	Inconclusive
Obscure	Inconclusive
CRIME	Inconclusive

Table 10: RH5 Results Summary

Cashew < No Normalization:	0%
Cashew > No Normalization:	0%
Cashew:	0%
No Normalization:	0%
None:	0%
Inconclusive:	100%

4 Result Summary

4.1 Research Hypotheses

4.1.1 RH1 Results: Total time Cashew = No cache

Table 11: RH1 Results per Object

Password1	Inconclusive
Password2	Inconclusive
Obscure	Inconclusive
CRIME	Inconclusive

Table 12: RH1 Results Summary

Cashew < No cache:	0%
Cashew > No cache:	0%
Cashew:	0%
No cache:	0%
None:	0%
Inconclusive:	100%

4.1.2 RH2 Results: Total time Cashew = No Normalization

Table 13: RH2 Results per Object

Password1	Inconclusive
Password2	Inconclusive
Obscure	Inconclusive
CRIME	Inconclusive

Table 14: RH2 Results Summary

Cashew < No Normalization:	0%
Cashew > No Normalization:	0%
Cashew:	0%
No Normalization:	0%
None:	0%
Inconclusive:	100%

4.1.3 RH3 Results: Hits Cashew = No Normalization

Table 15: RH3 Results per Object

Password1	Inconclusive
Password2	Inconclusive
Obscure	Inconclusive
CRIME	Inconclusive

Table 16: RH3 Results Summary

Cashew < No Normalization:	0%
Cashew > No Normalization:	0%
Cashew:	0%
No Normalization:	0%
None:	0%
Inconclusive:	100%

4.1.4 RH4 Results: Misses Cashew = No Normalization

Table 17: RH4 Results per Object

Password1	Inconclusive
Password2	Inconclusive
Obscure	Inconclusive
CRIME	Inconclusive

Table 18: RH4 Results Summary

Cashew < No Normalization:	0%
Cashew > No Normalization:	0%
Cashew:	0%
No Normalization:	0%
None:	0%
Inconclusive:	100%

4.1.5 RH5 Results: Hits/Misses ratio Cashew = No Normalization

Table 19: RH5 Results per Object

Password1	Inconclusive
Password2	Inconclusive
Obscure	Inconclusive
CRIME	Inconclusive

Table 20: RH5 Results Summary

Cashew < No Normalization:	0%
Cashew > No Normalization:	0%
Cashew:	0%
No Normalization:	0%
None:	0%
Inconclusive:	100%

A Session Information

```
## R version 3.3.1 (2016-06-21)
## Platform: x86_64-pc-linux-gnu (64-bit)
## Running under: Ubuntu 16.10
##
## locale:
##  [1] LC_CTYPE=pt_BR.UTF-8      LC_NUMERIC=C
##  [3] LC_TIME=pt_BR.UTF-8      LC_COLLATE=en_US.UTF-8
##  [5] LC_MONETARY=pt_BR.UTF-8  LC_MESSAGES=en_US.UTF-8
##  [7] LC_PAPER=pt_BR.UTF-8     LC_NAME=C
##  [9] LC_ADDRESS=C             LC_TELEPHONE=C
## [11] LC_MEASUREMENT=pt_BR.UTF-8 LC_IDENTIFICATION=C
##
## attached base packages:
## [1] stats      graphics  grDevices  utils      datasets  methods    base
##
## other attached packages:
## [1] plyr_1.8.4      jsonlite_1.5    ggplot2_2.2.1    reproducer_0.1.8
## [5] knitr_1.17
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_0.12.16      digest_0.6.12     grid_3.3.1
##  [4] gtable_0.2.0      magrittr_1.5       evaluate_0.10
##  [7] scales_0.4.1      rlang_0.2.0       stringi_1.1.5
## [10] lazyeval_0.2.0    labeling_0.3       RColorBrewer_1.1-2
## [13] tools_3.3.1       stringr_1.2.0     munsell_0.4.3
## [16] colorspace_1.3-2  gridExtra_2.2.1   tibble_1.3.1
```