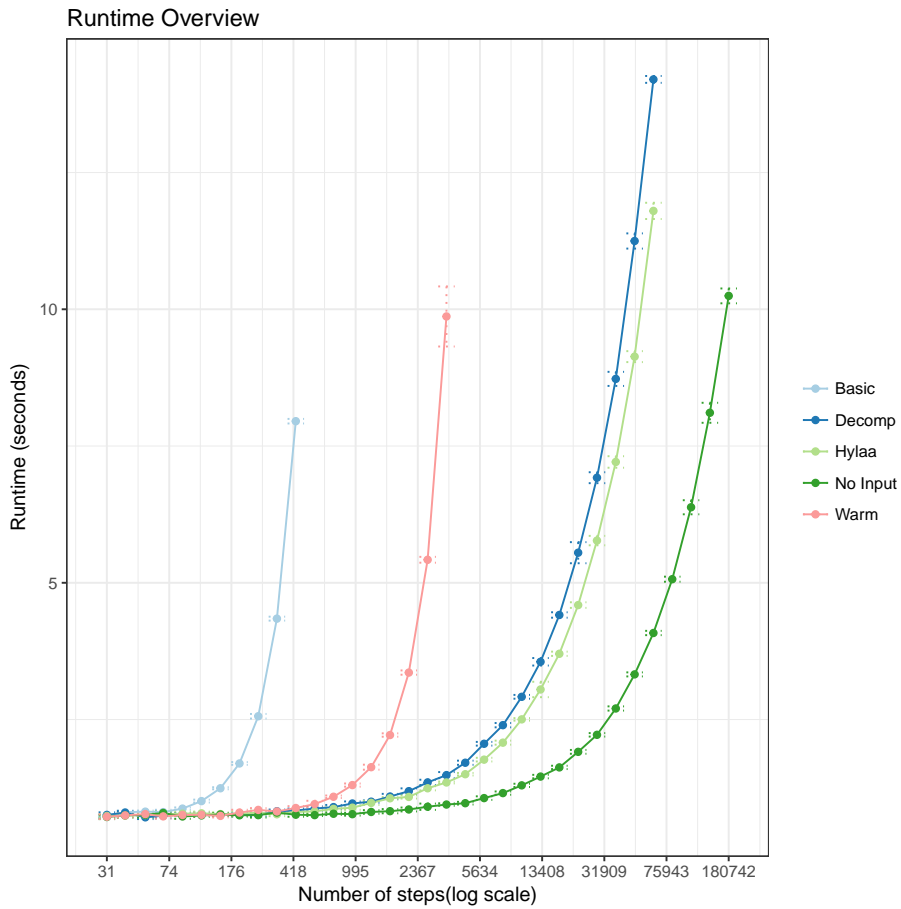


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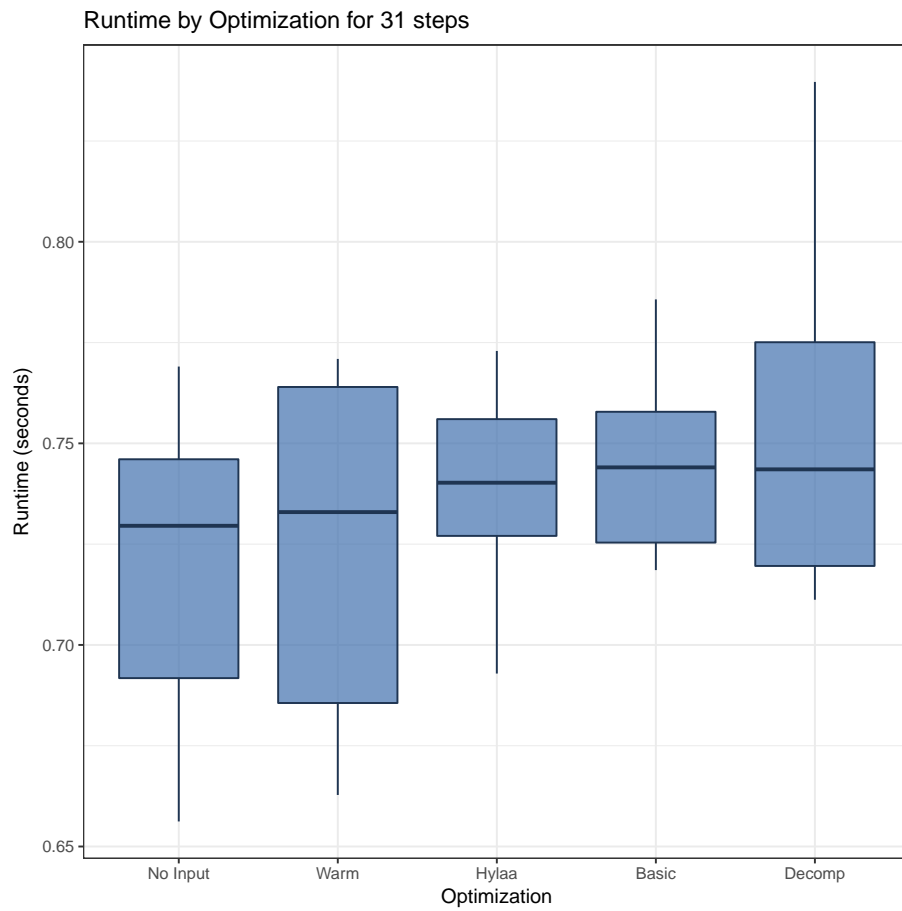
1 Description

2 Overview

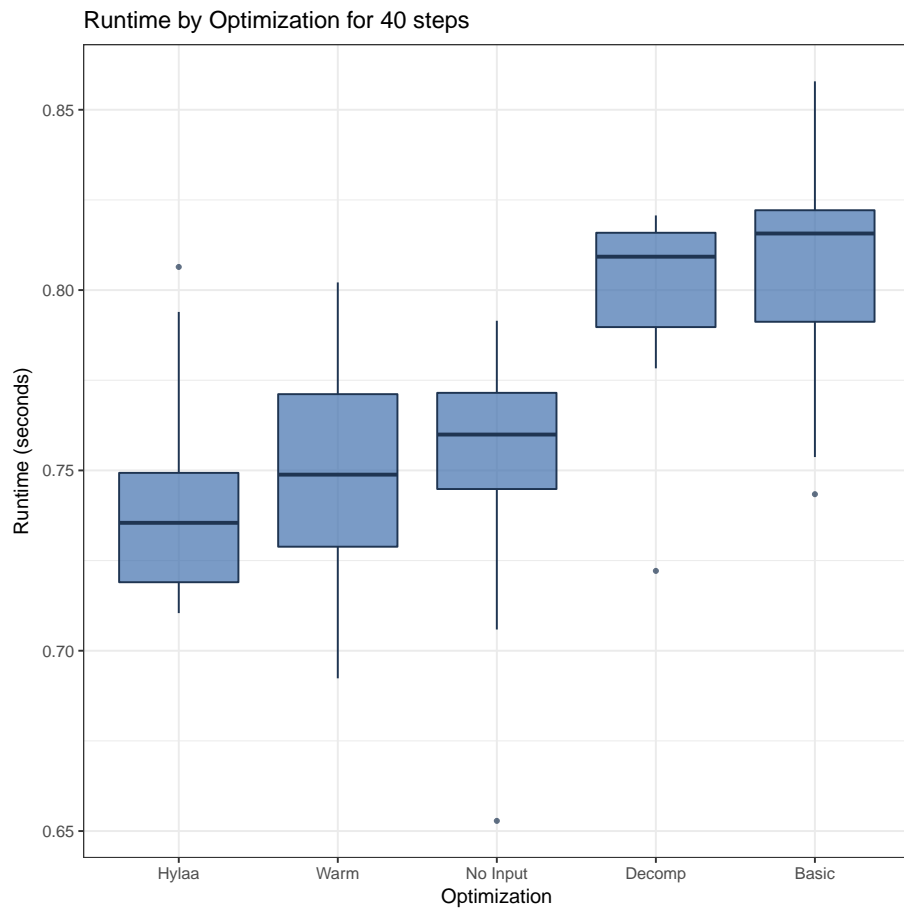


2.1 Objects Overview

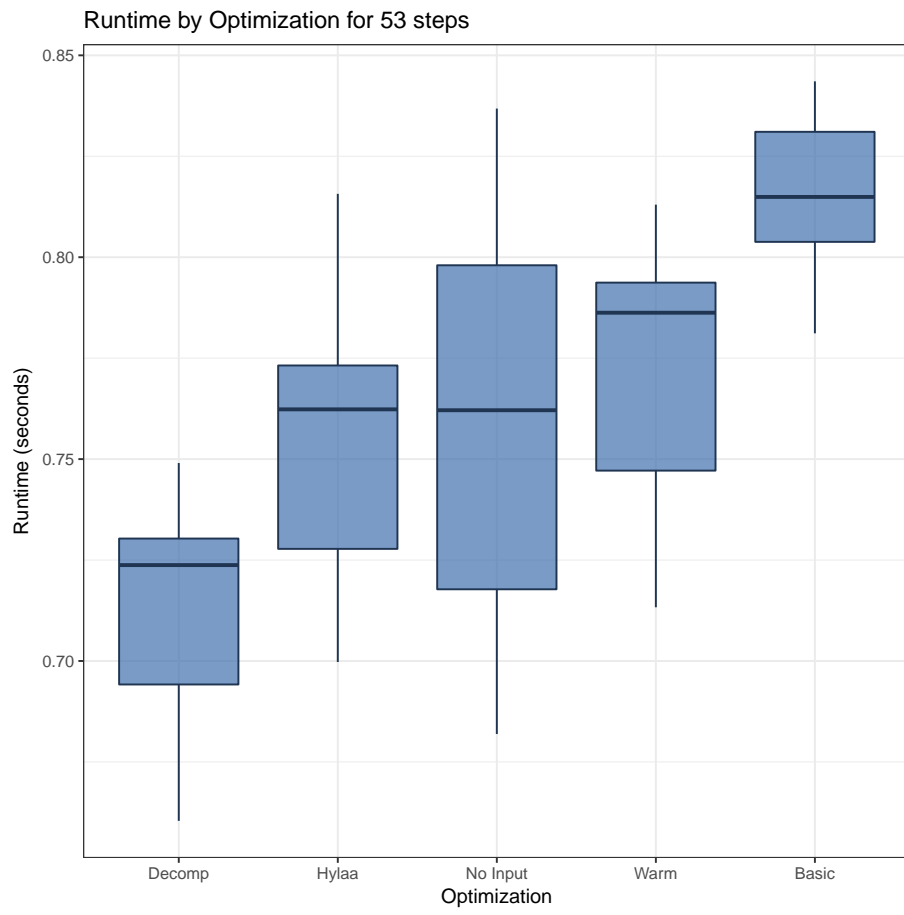
2.1.1 Overview for 31 steps



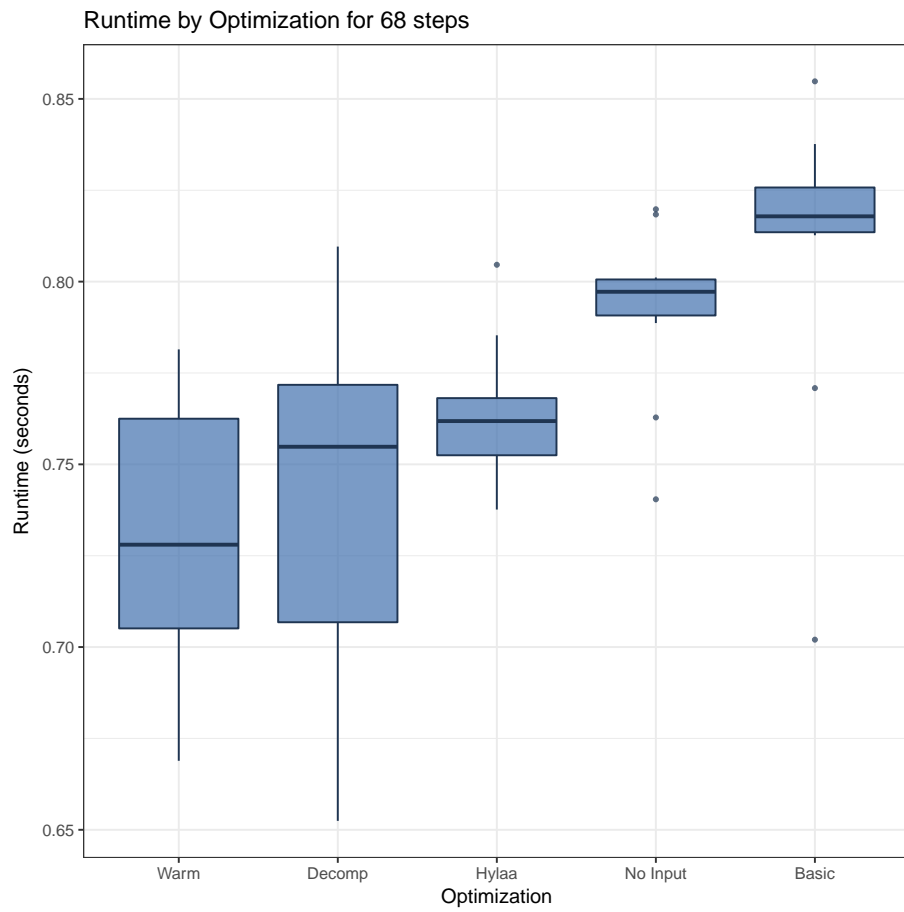
2.1.2 Overview for 40 steps



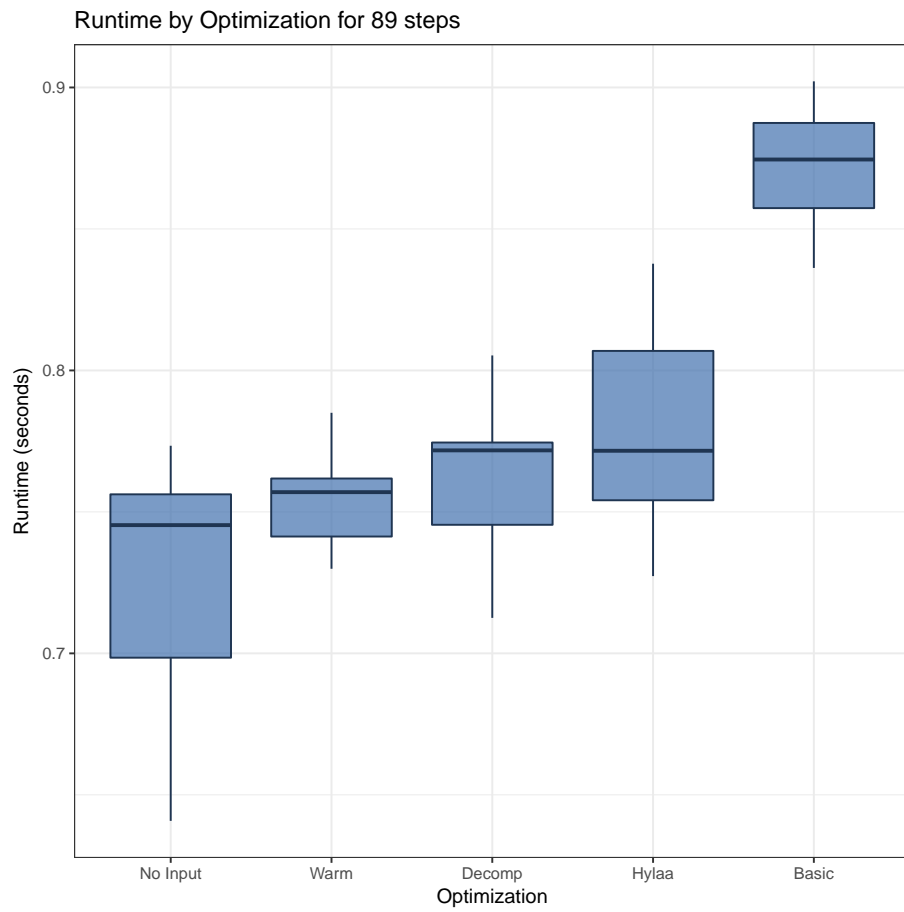
2.1.3 Overview for 53 steps



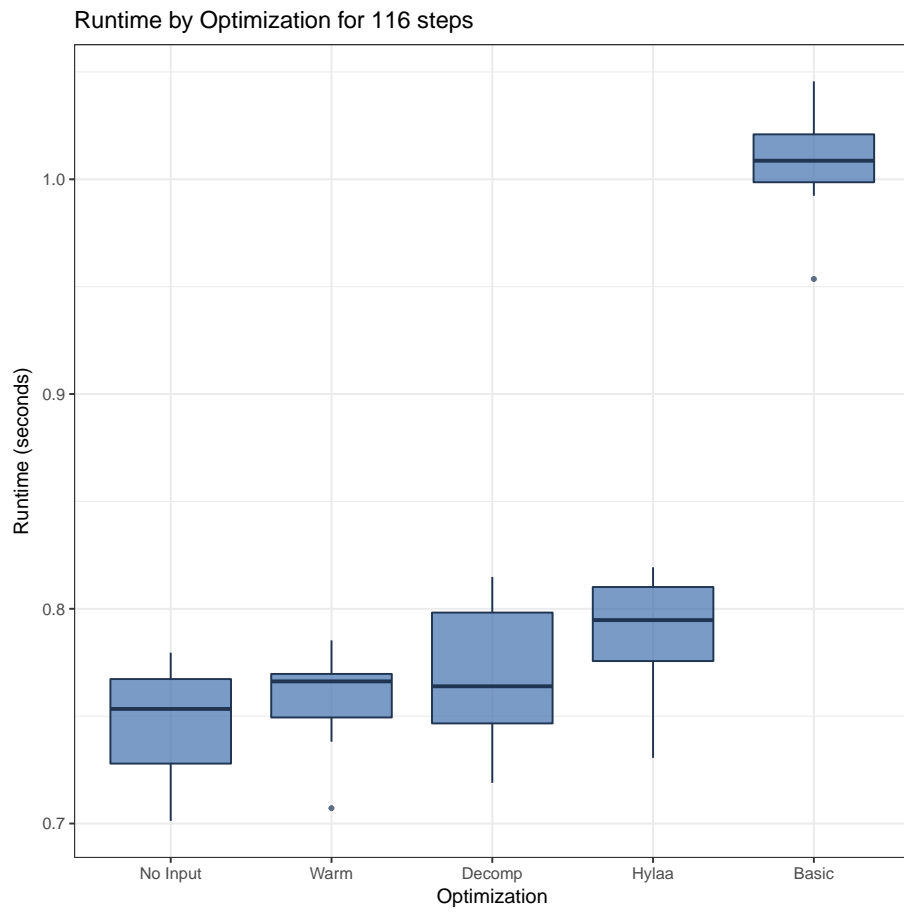
2.1.4 Overview for 68 steps



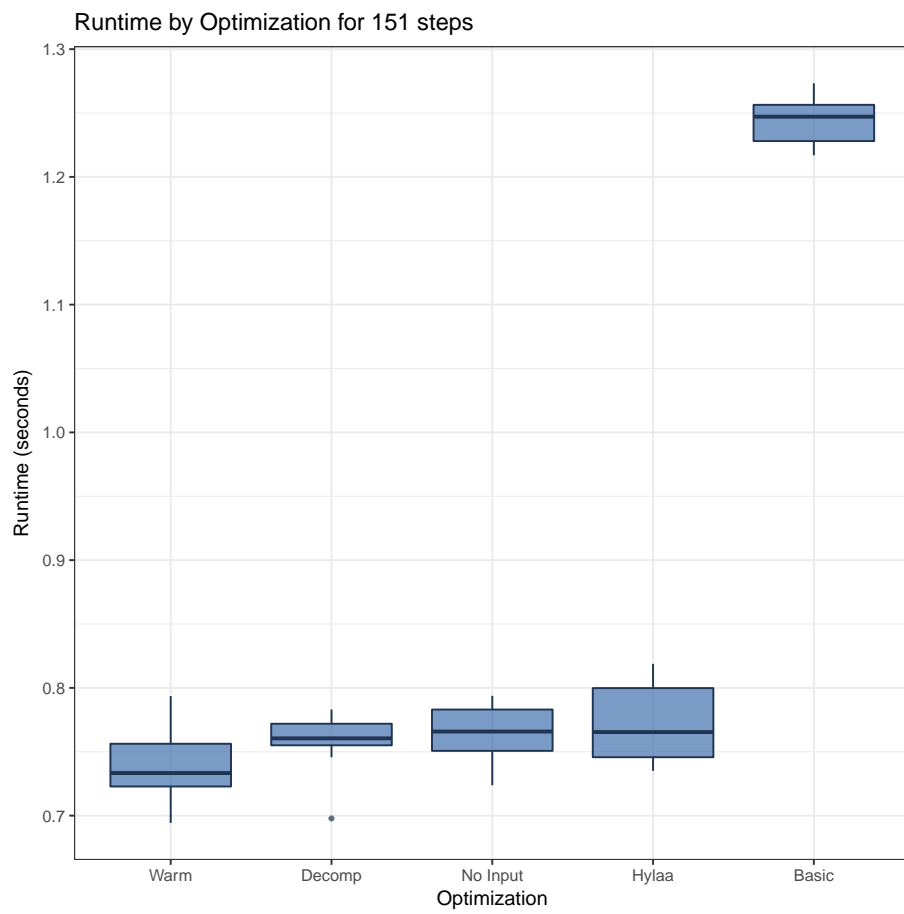
2.1.5 Overview for 89 steps



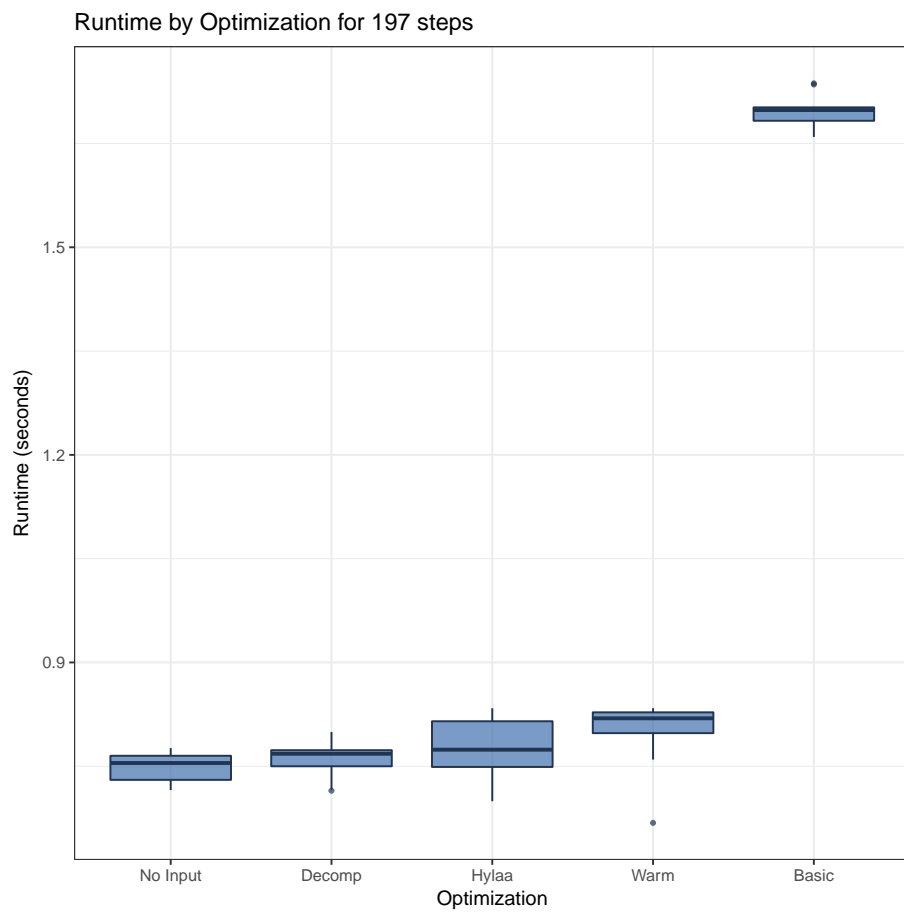
2.1.6 Overview for 116 steps



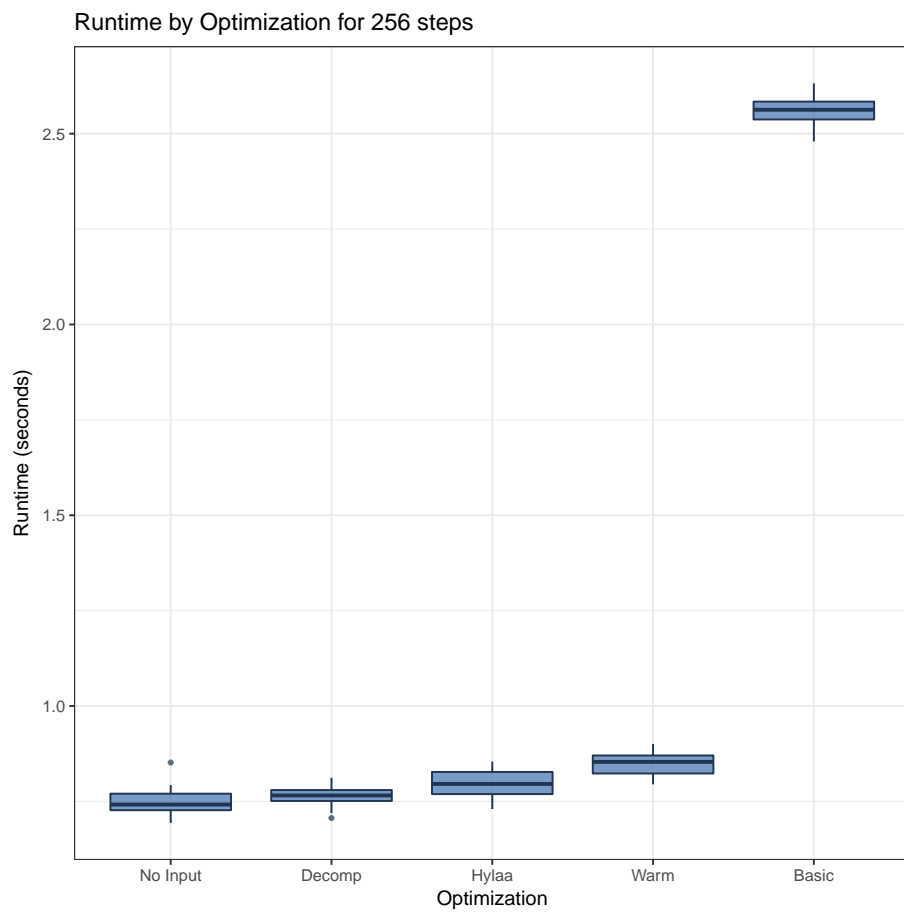
2.1.7 Overview for 151 steps



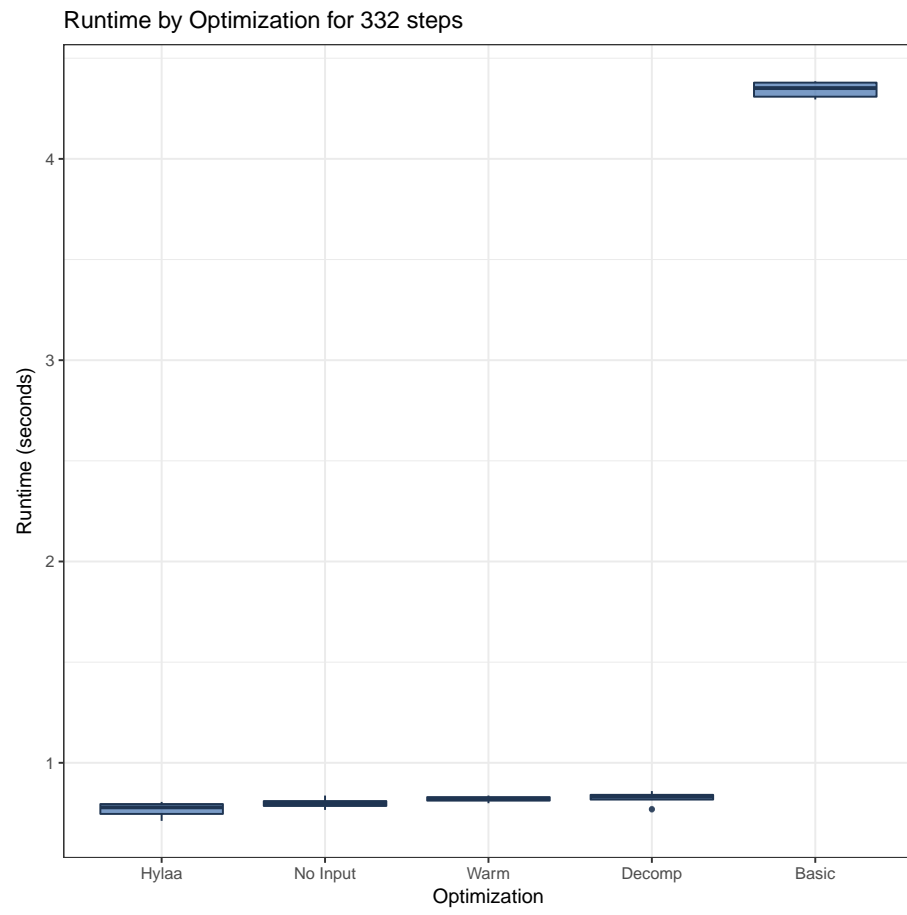
2.1.8 Overview for 197 steps



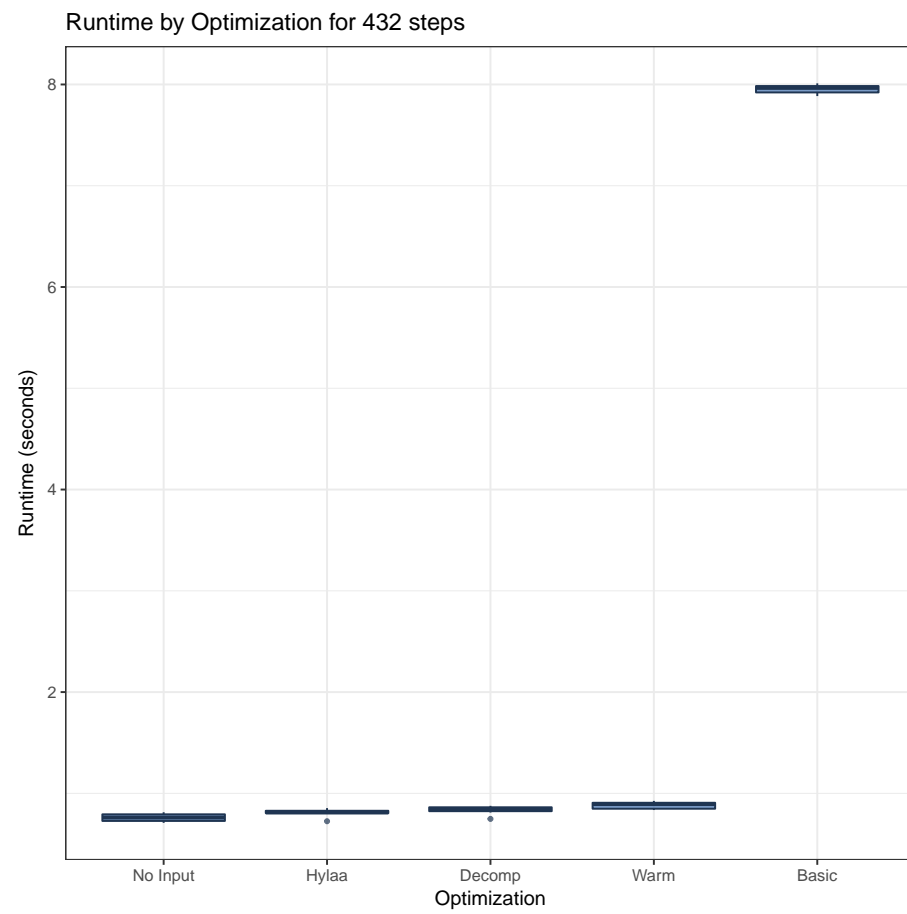
2.1.9 Overview for 256 steps



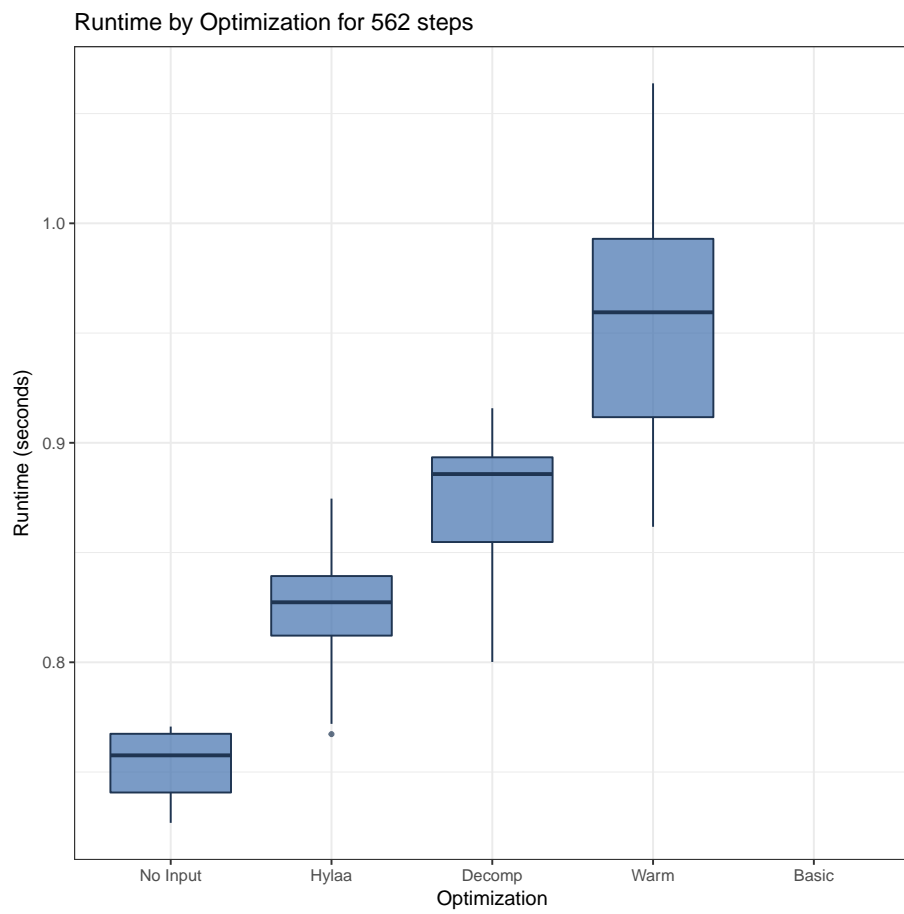
2.1.10 Overview for 332 steps



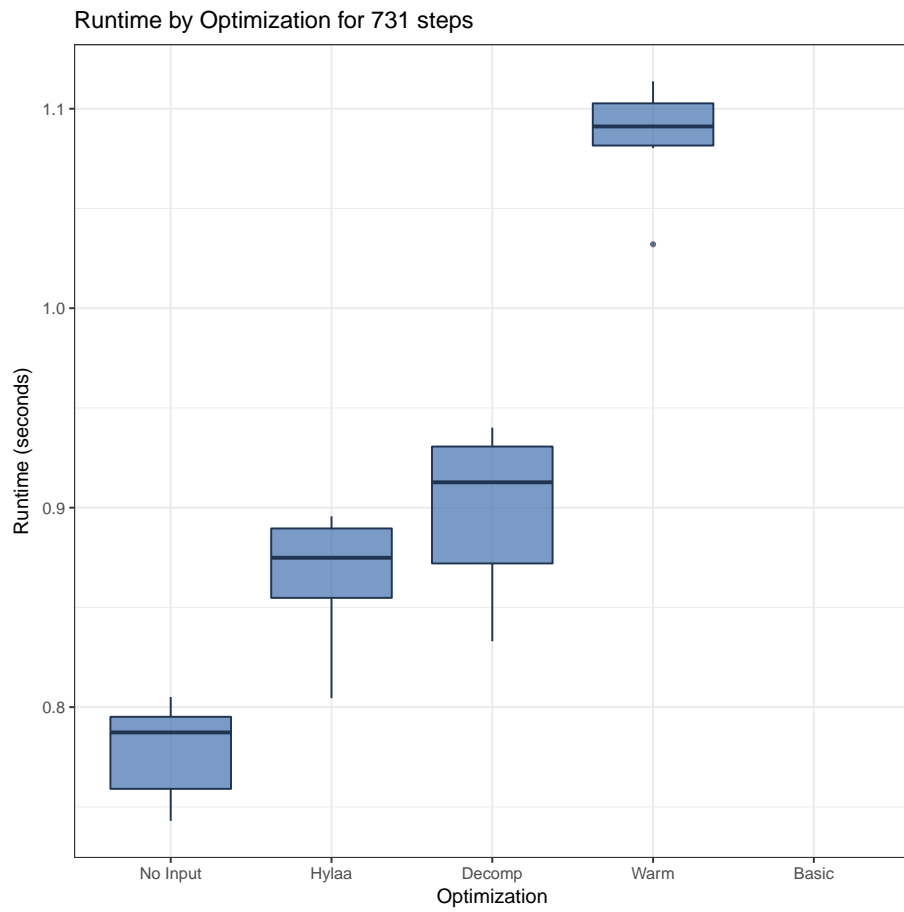
2.1.11 Overview for 432 steps



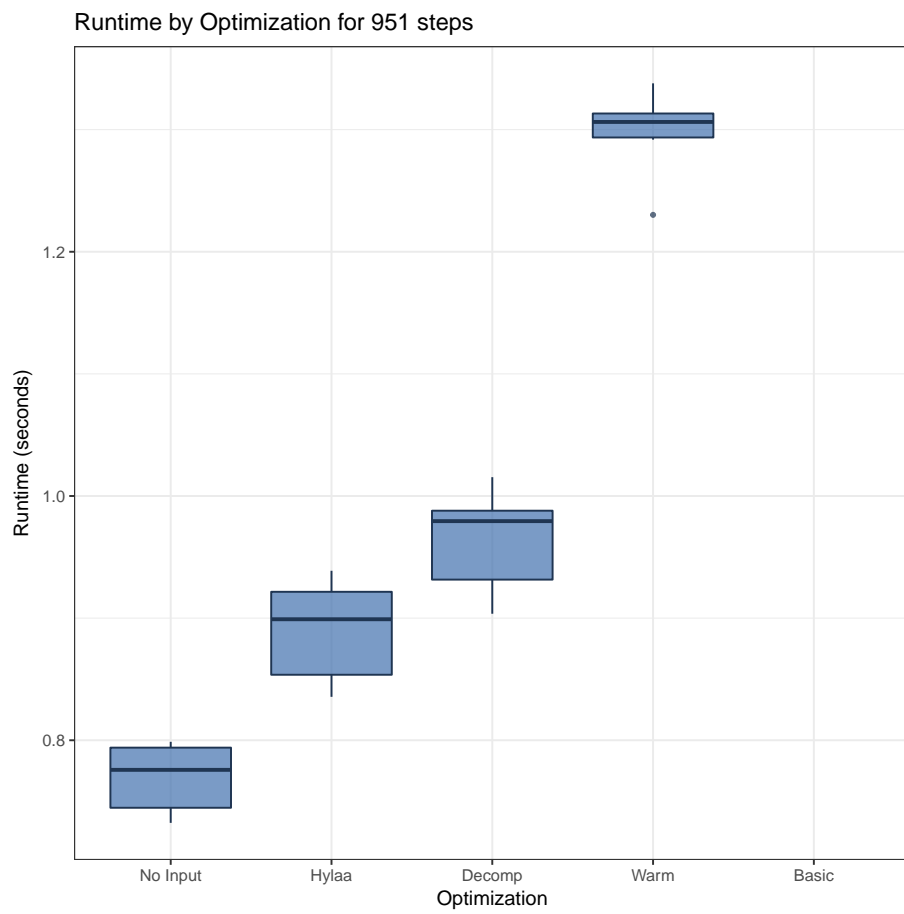
2.1.12 Overview for 562 steps



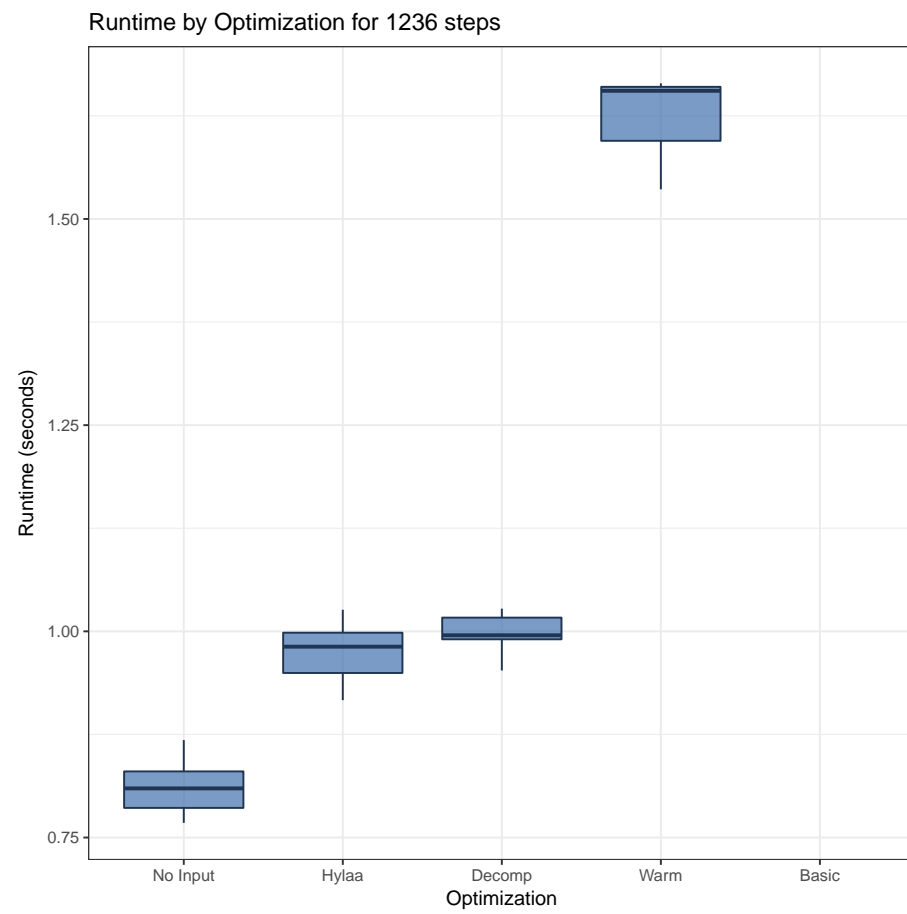
2.1.13 Overview for 731 steps



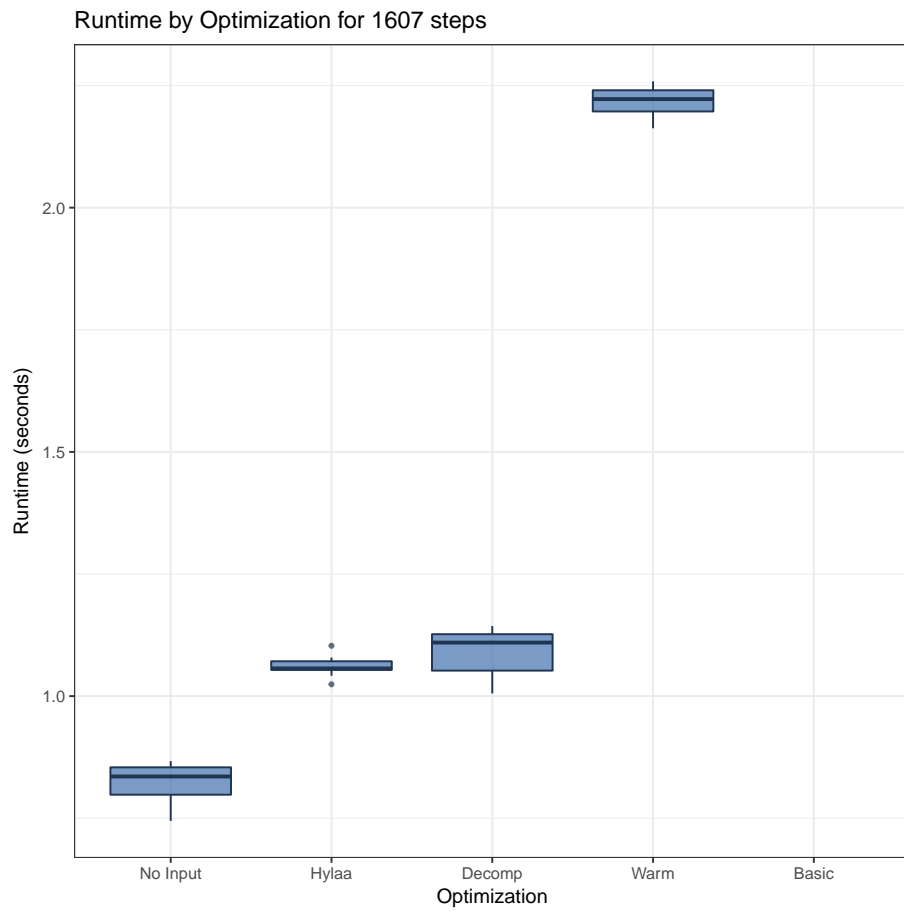
2.1.14 Overview for 951 steps



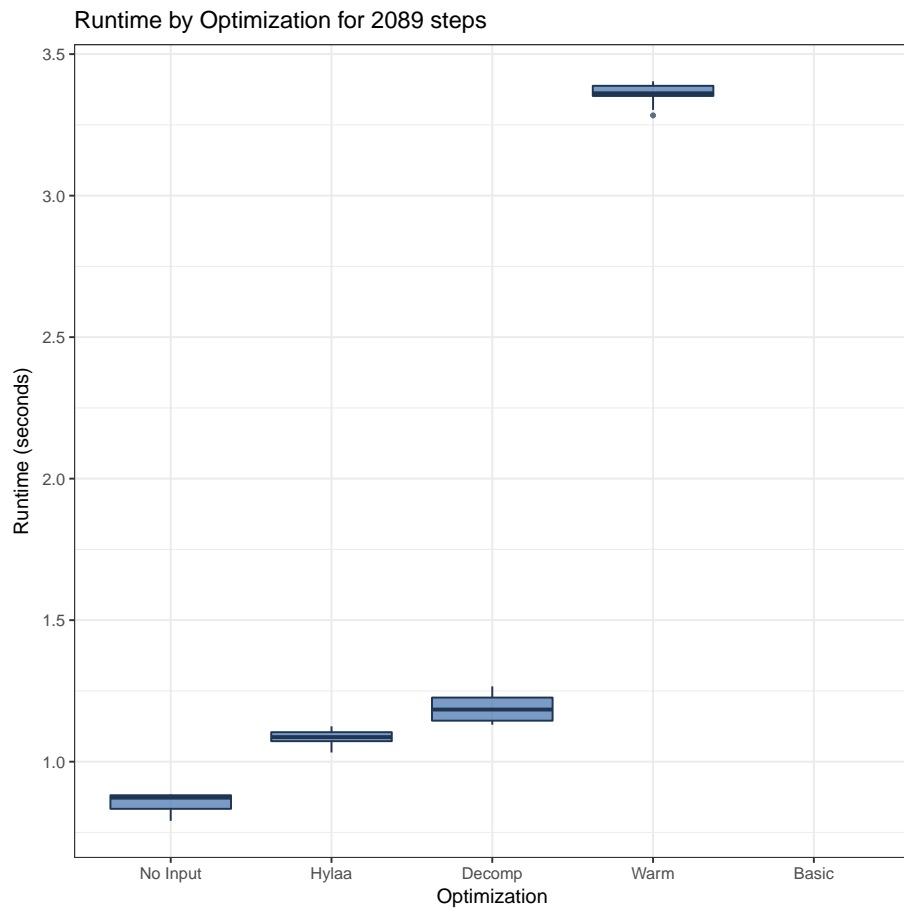
2.1.15 Overview for 1236 steps



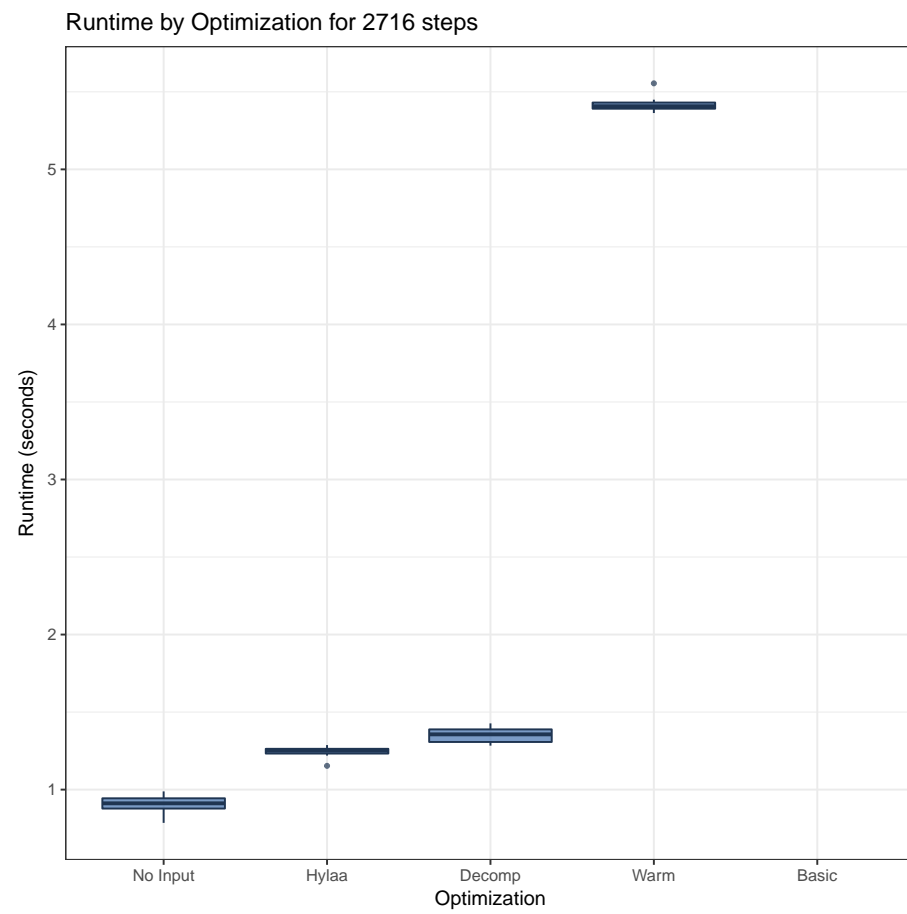
2.1.16 Overview for 1607 steps



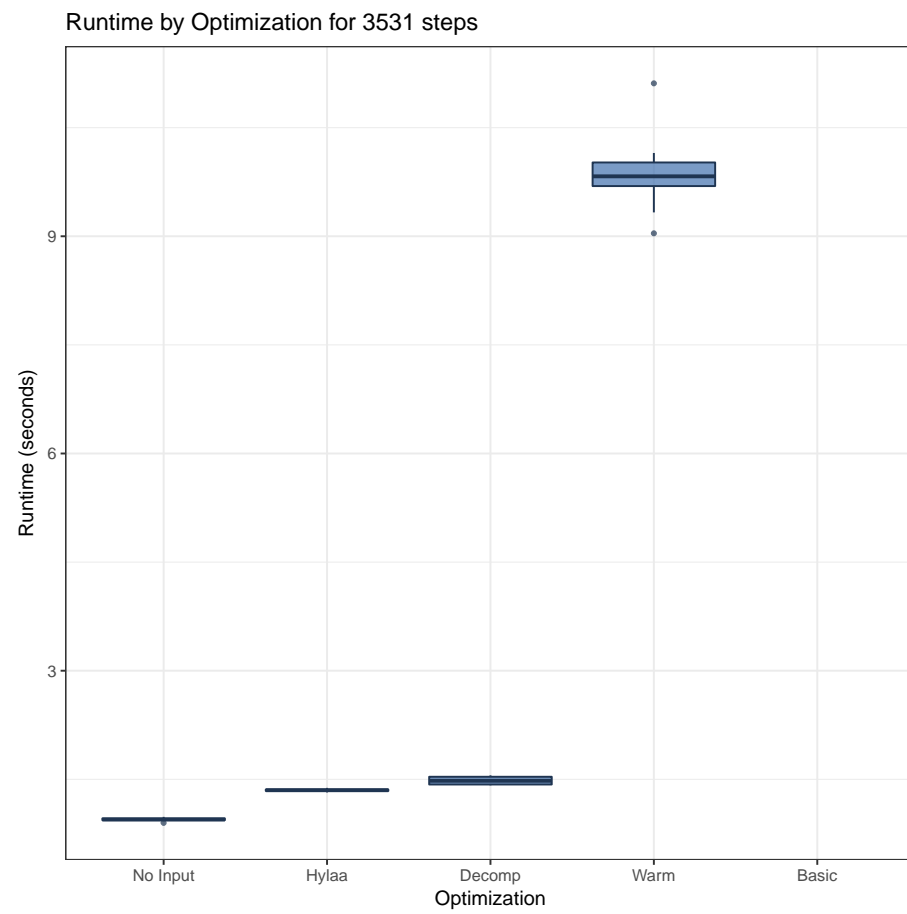
2.1.17 Overview for 2089 steps



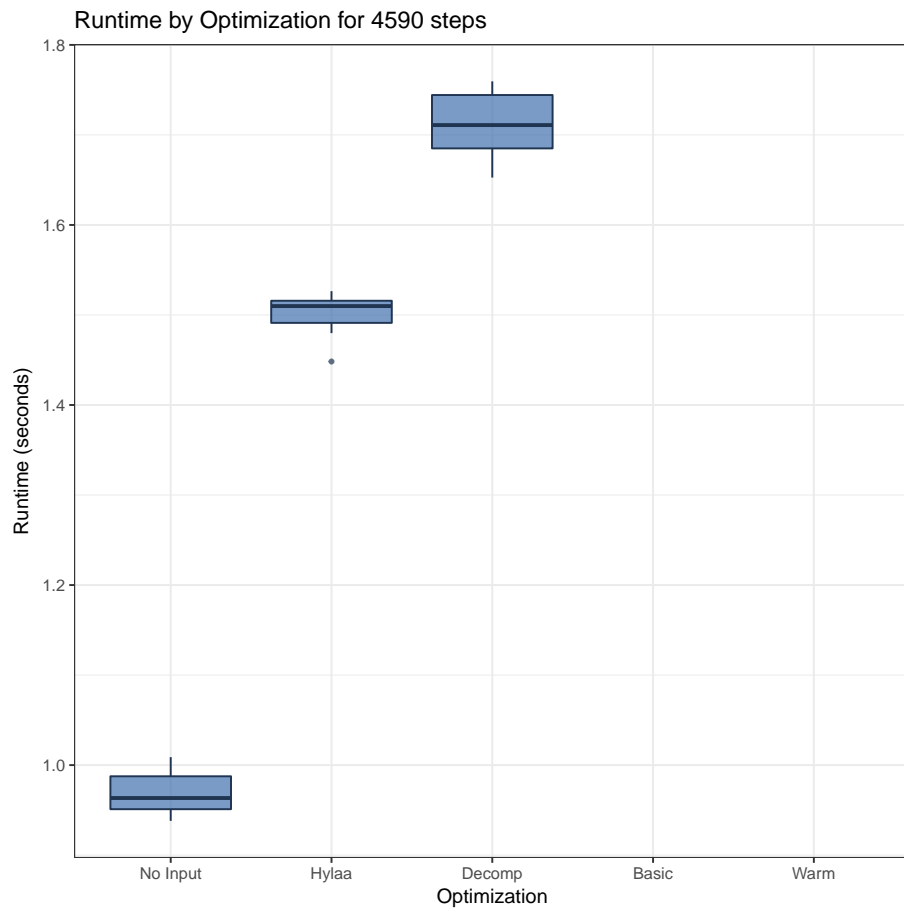
2.1.18 Overview for 2716 steps



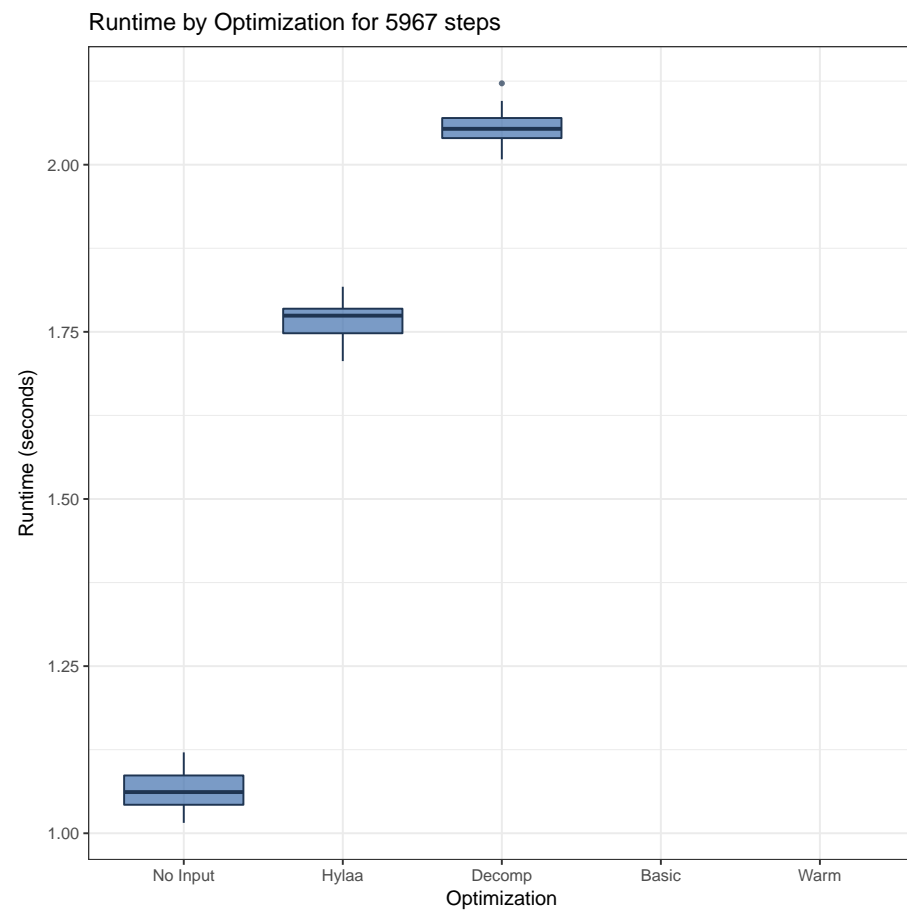
2.1.19 Overview for 3531 steps



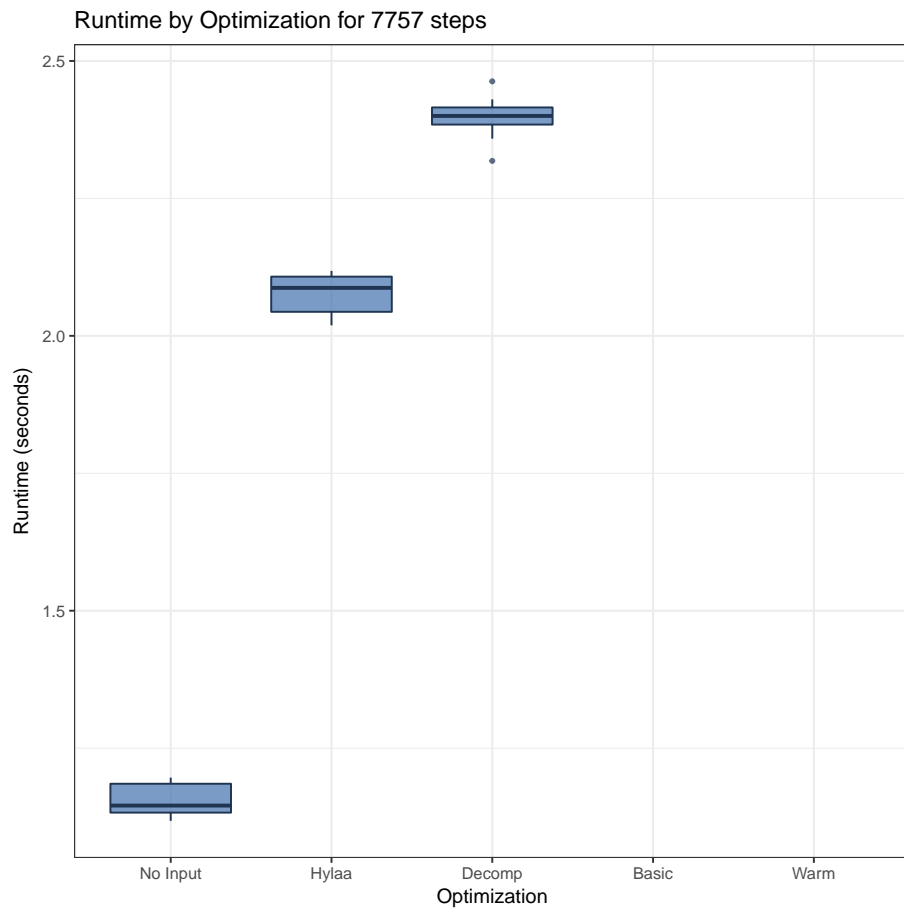
2.1.20 Overview for 4590 steps



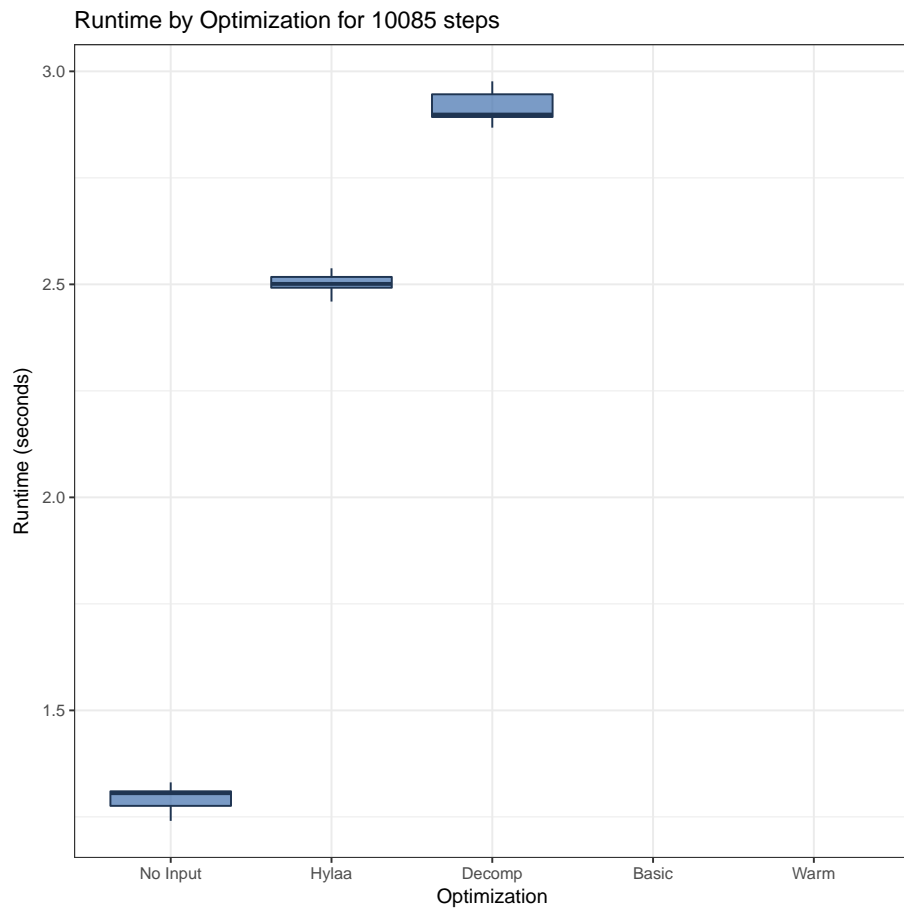
2.1.21 Overview for 5967 steps



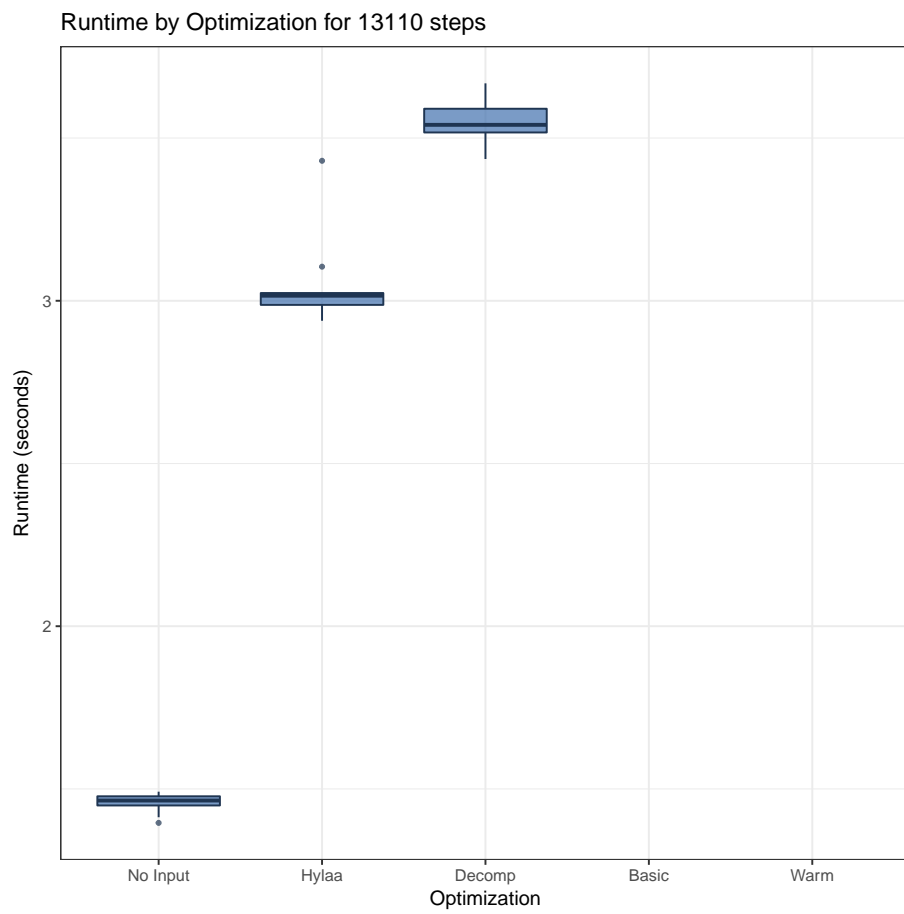
2.1.22 Overview for 7757 steps



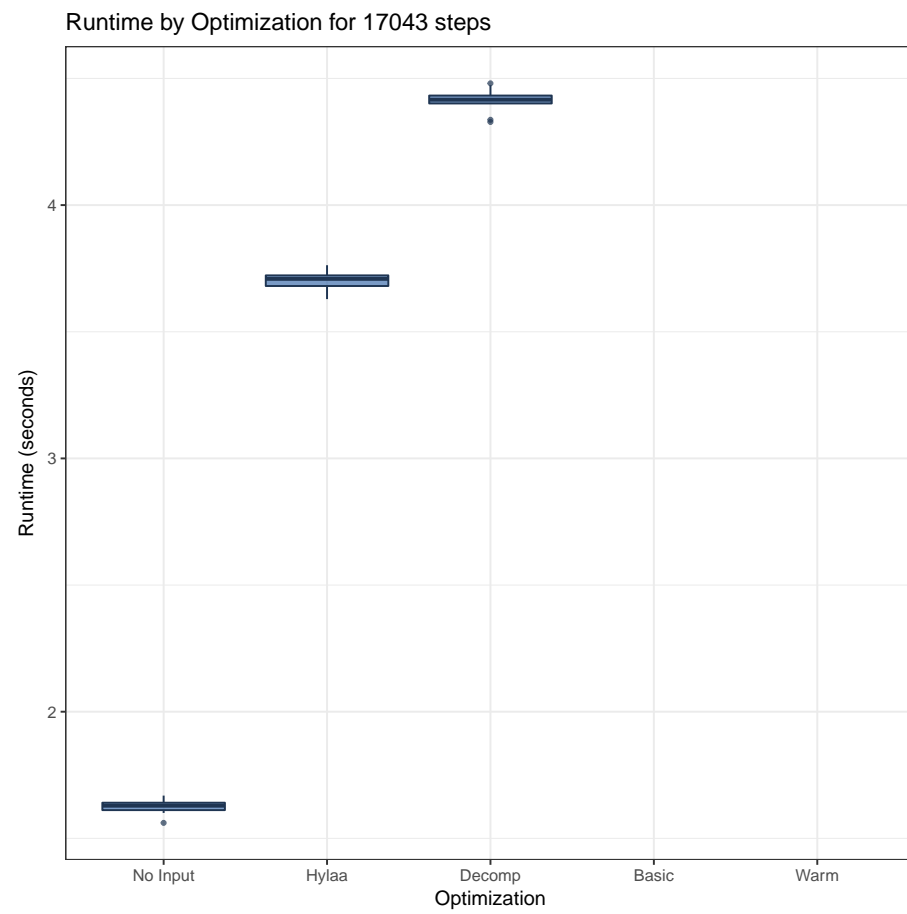
2.1.23 Overview for 10085 steps



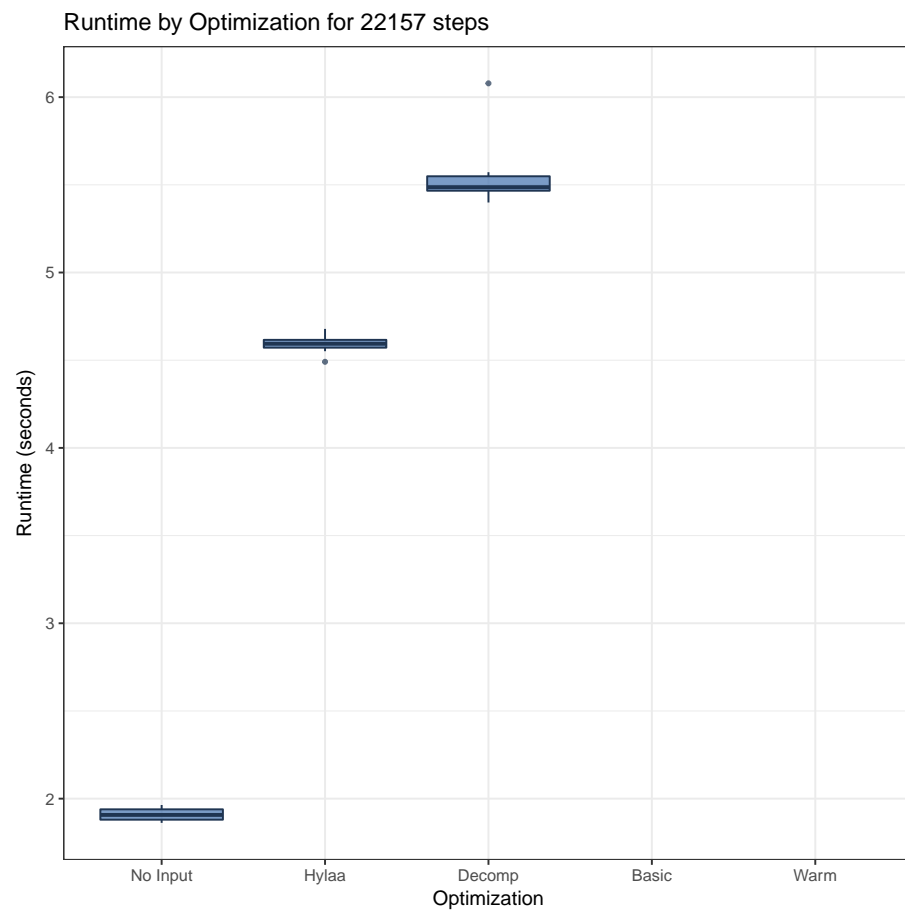
2.1.24 Overview for 13110 steps



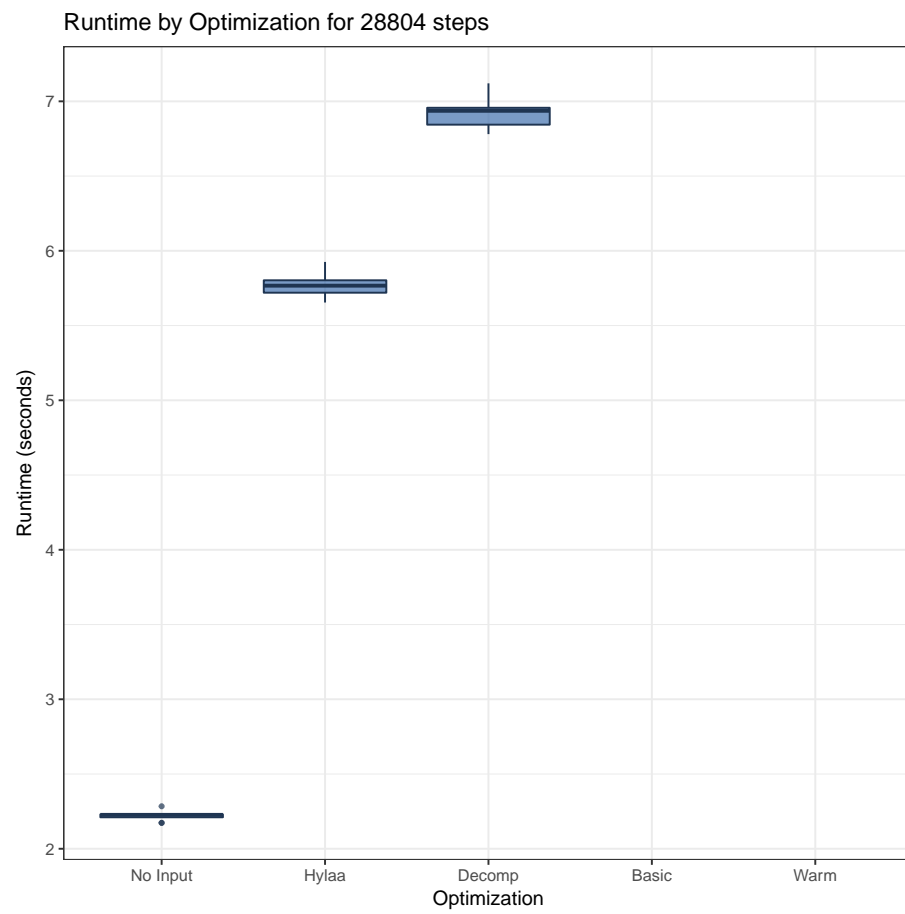
2.1.25 Overview for 17043 steps



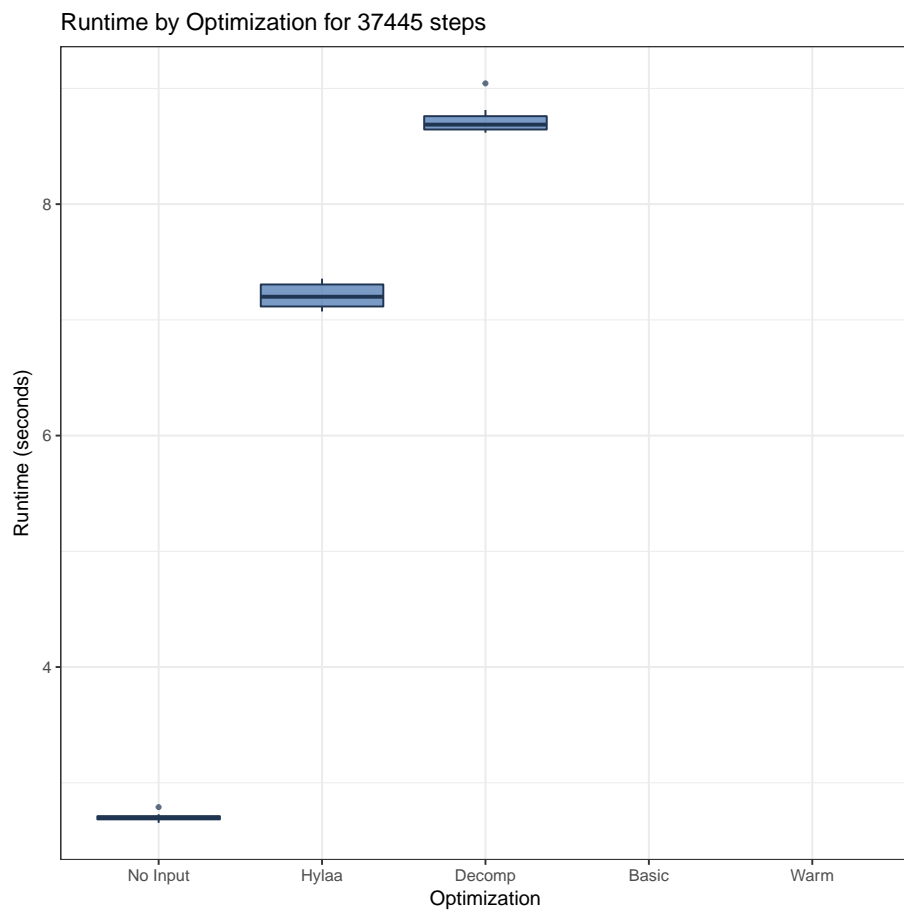
2.1.26 Overview for 22157 steps



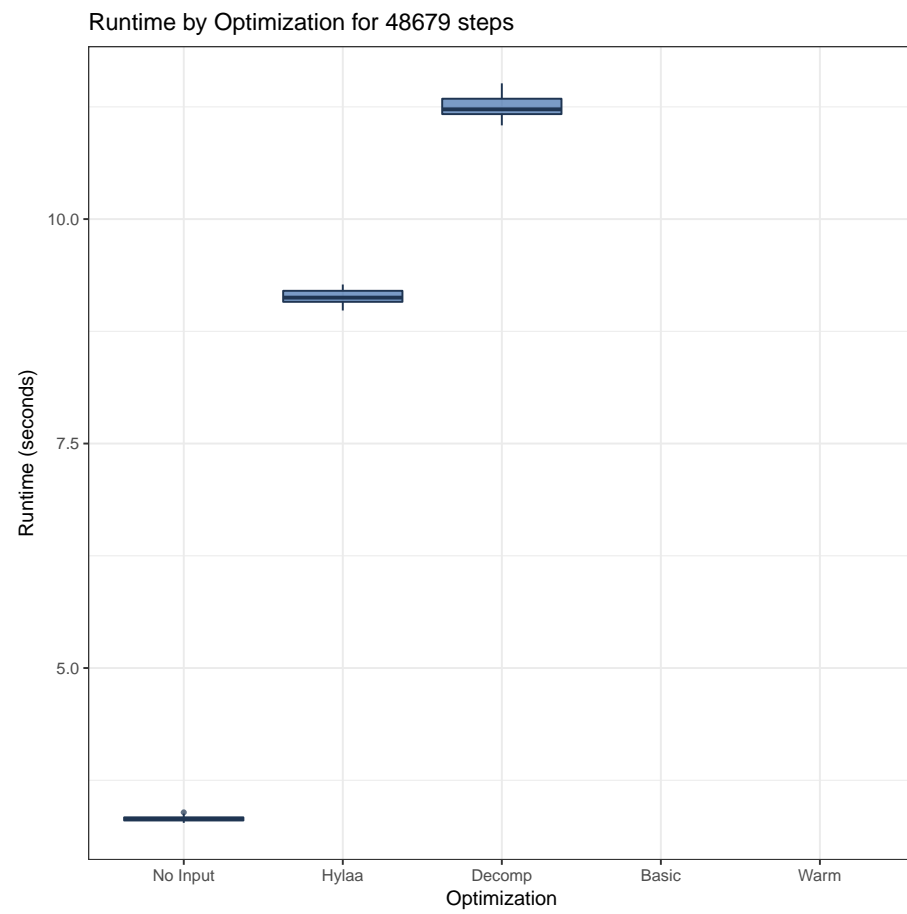
2.1.27 Overview for 28804 steps



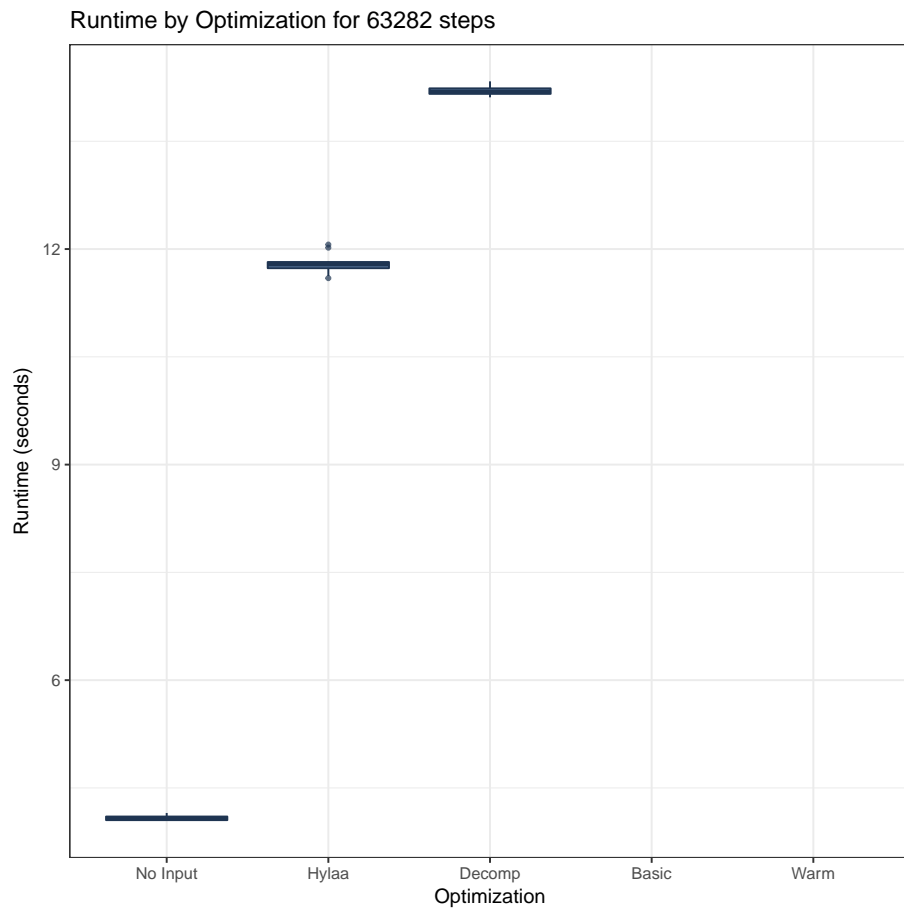
2.1.28 Overview for 37445 steps



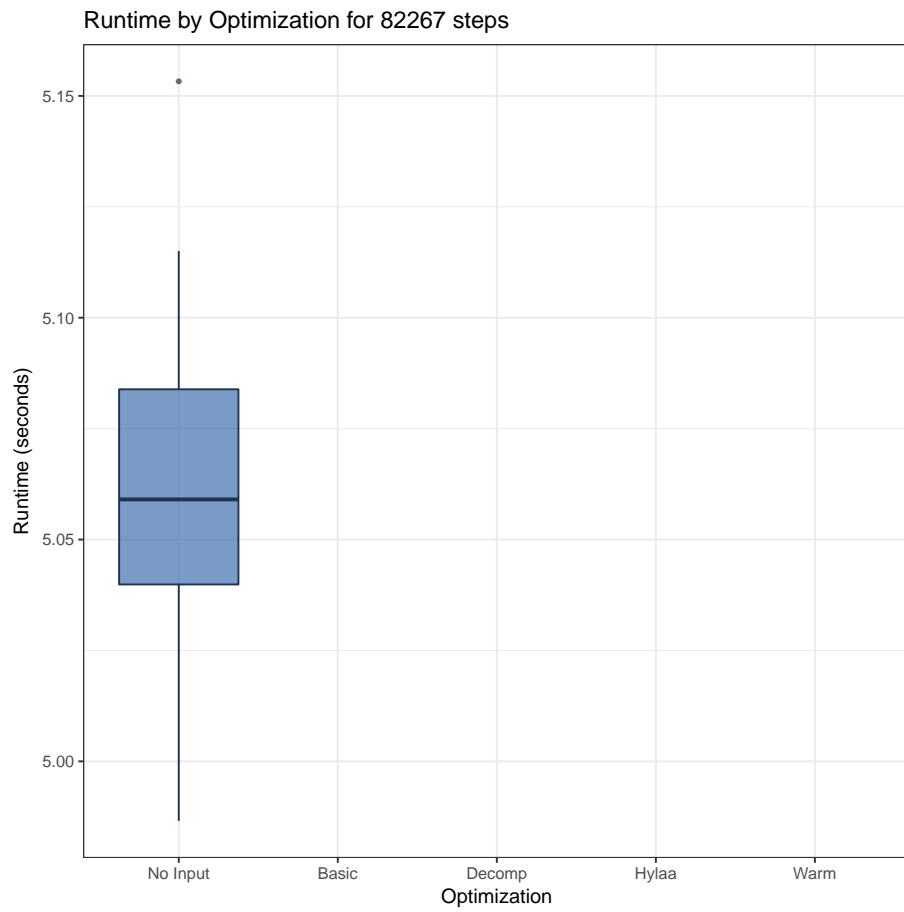
2.1.29 Overview for 48679 steps



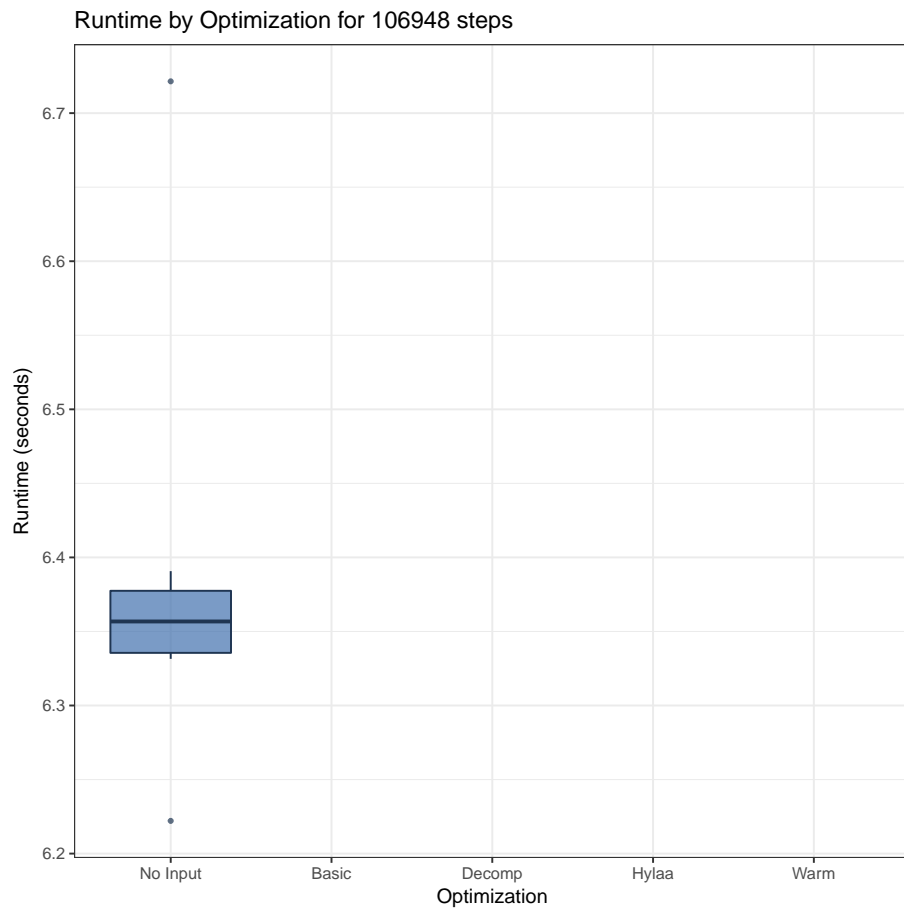
2.1.30 Overview for 63282 steps



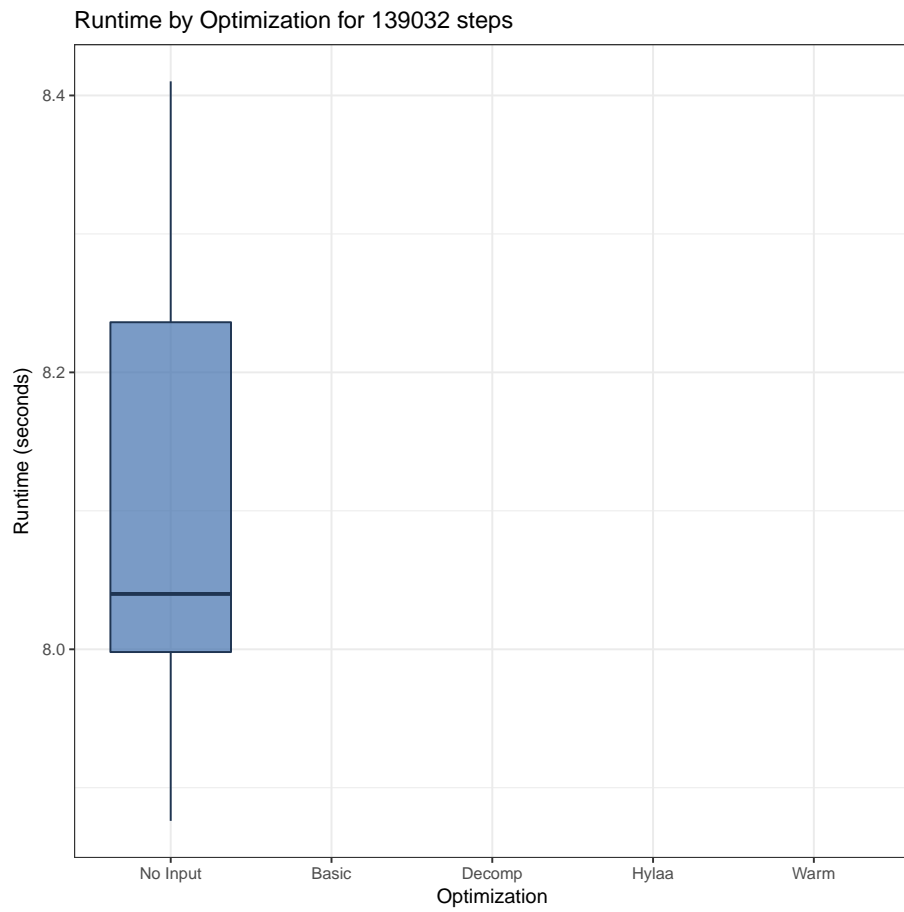
2.1.31 Overview for 82267 steps



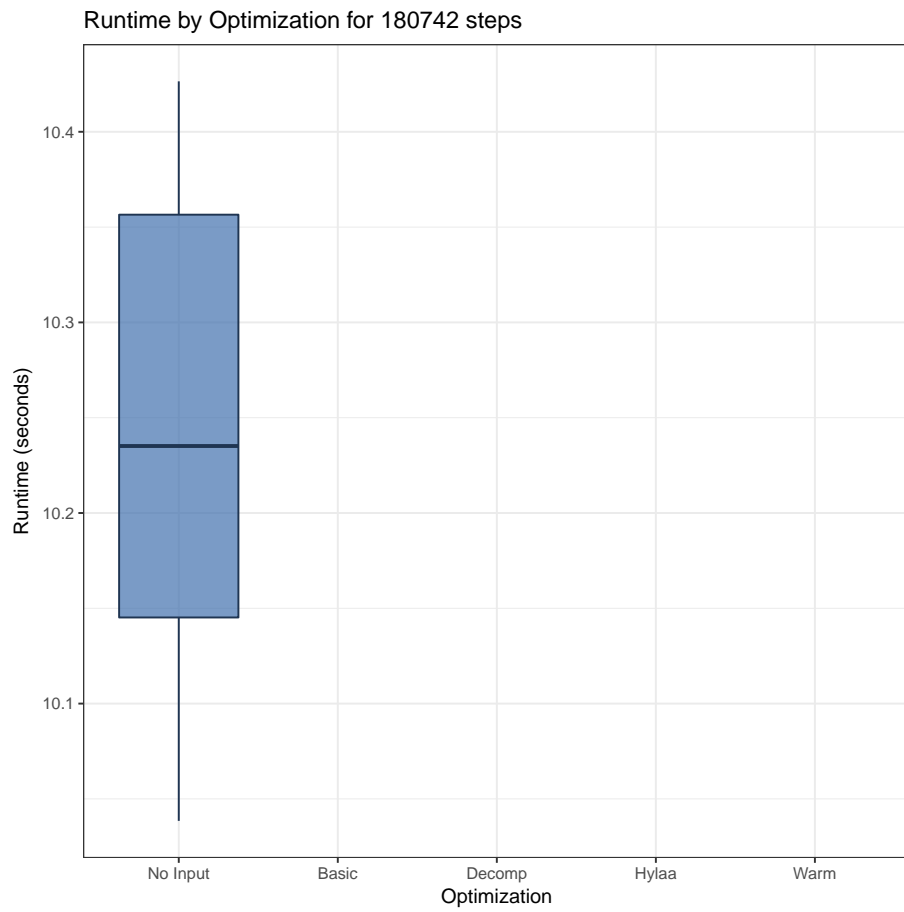
2.1.32 Overview for 106948 steps



2.1.33 Overview for 139032 steps

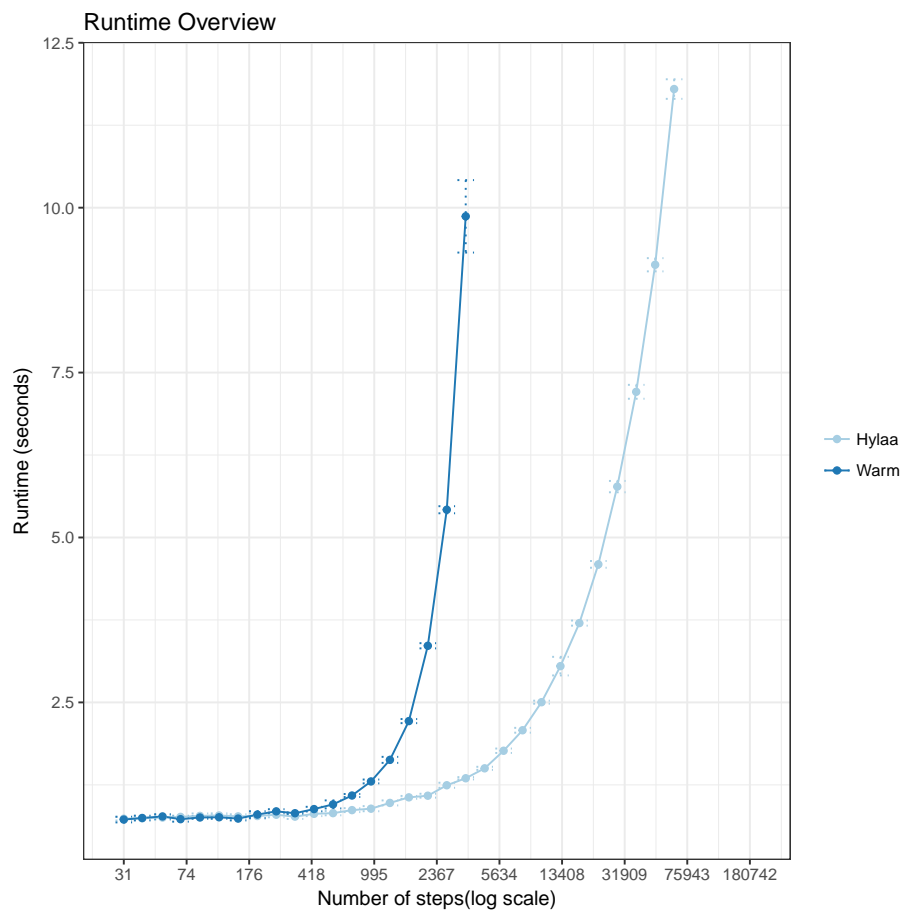


2.1.34 Overview for 180742 steps



3 Research Hypotheses

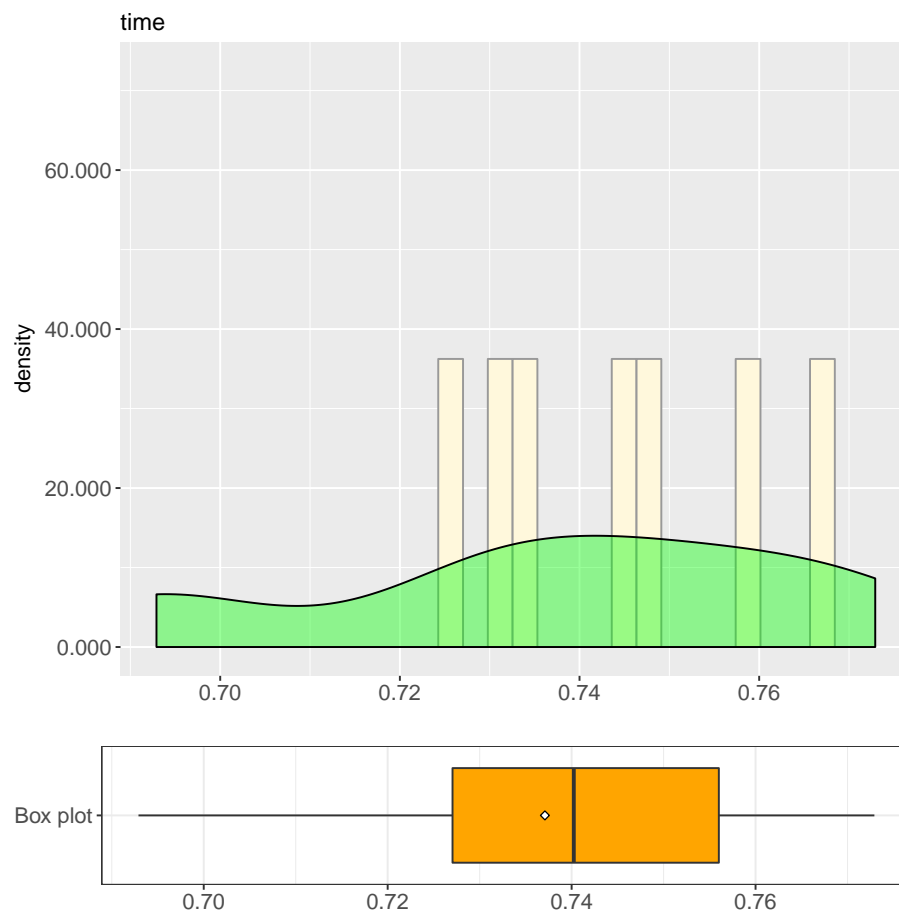
3.1 RH1: Runtime time for Hylaa is equals than runtime time for Warm



3.1.1 RH1.1: Object 31 steps

Runtime for Hylaa

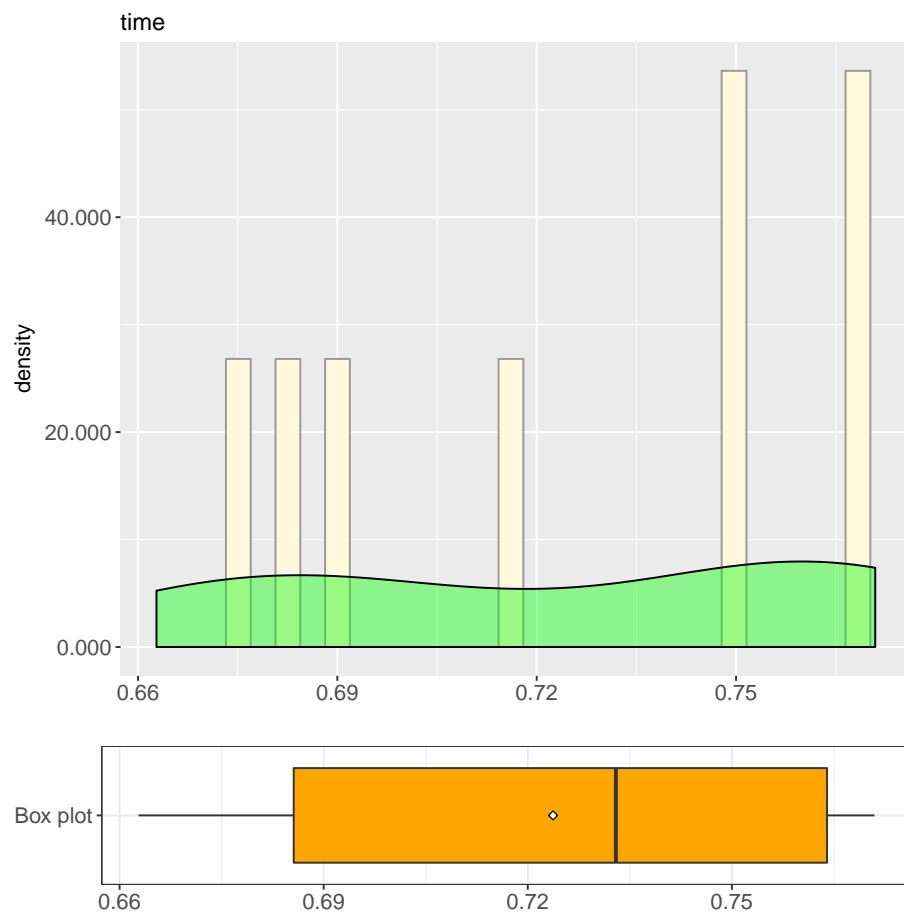
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.6929  0.7270  0.7402  0.7371  0.7560  0.7729
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps31")$time
## W = 0.92348, p-value = 0.3869
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.386919454155626"
```

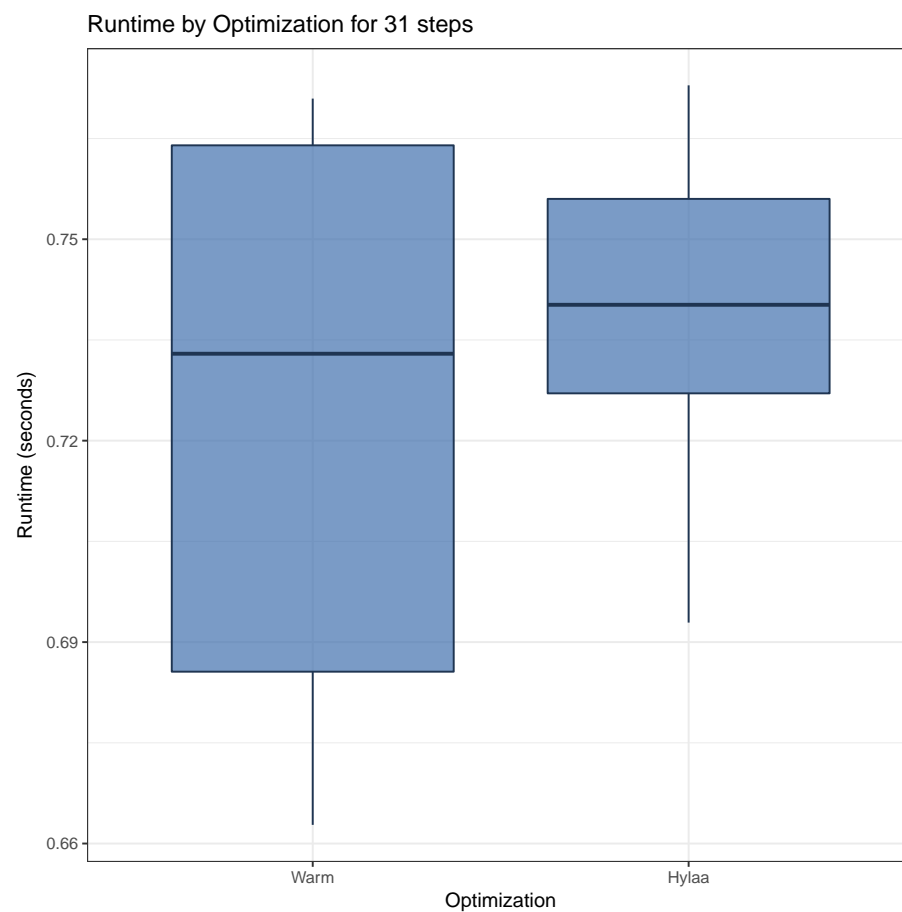
Runtime for Warm

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6628 0.6856 0.7329 0.7237 0.7640 0.7709
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Warm" & object == "steps31")$time
## W = 0.86528, p-value = 0.08804
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0880390766774588"
```

Comparison



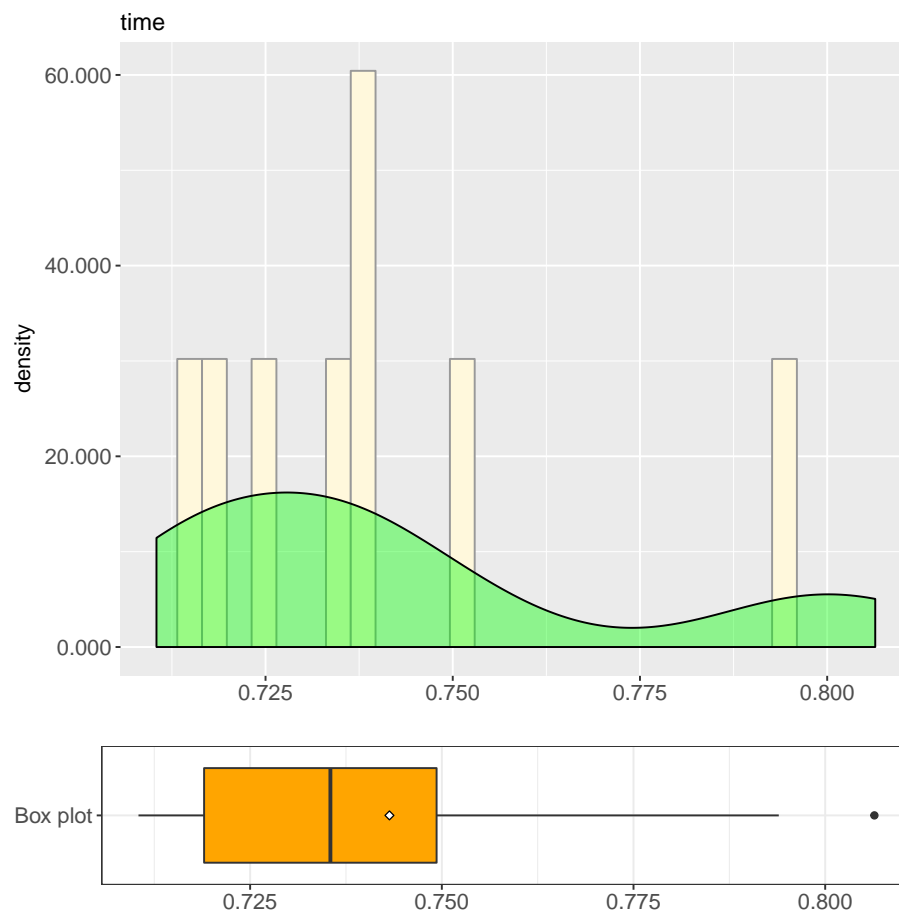
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps31")$time and subset(json_data, treatment == "Warm" & object == "steps31")$time
## F = 0.41659, num df = 9, denom df = 9, p-value = 0.2082
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1034749 1.6771870
## sample estimates:
## ratio of variances
##      0.4165895
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.208187552120455"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps31")$time and subset(json_data, treatment == "Warm" & object == "steps31")$time
## t = 0.82637, df = 18, p-value = 0.4194
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.02062869 0.04737840
## sample estimates:
## mean of x mean of y
## 0.7370949 0.7237201
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.419413568997939"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7370949268343"
## [1] "Mean Runtime for Warm: 0.7237200736998"
## [1] "Absolute difference: 0.0133748531345"
## Runtime for Hylaa is 1.8480699403742 % greater than
## Runtime for Warm
```

3.1.2 RH1.2: Object 40 steps

Runtime for Hylaa

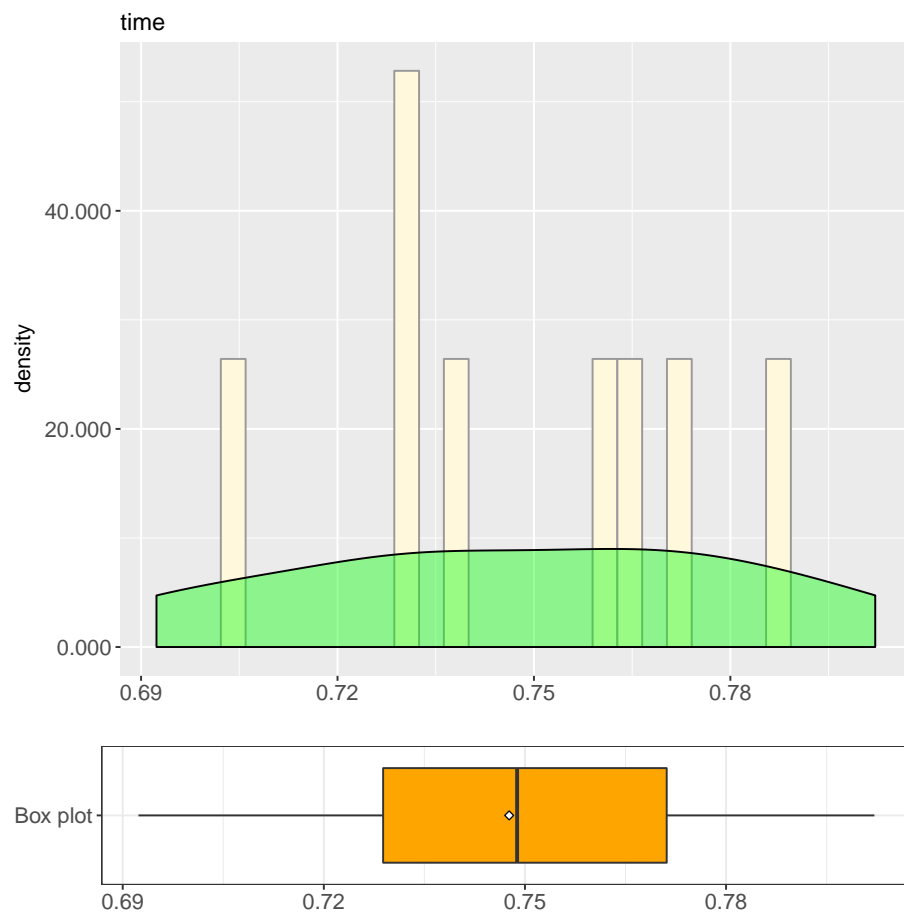
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7104 0.7190 0.7355 0.7432 0.7493 0.8064
```

```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps40")$time
## W = 0.84556, p-value = 0.05142
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0514195741817329"
```

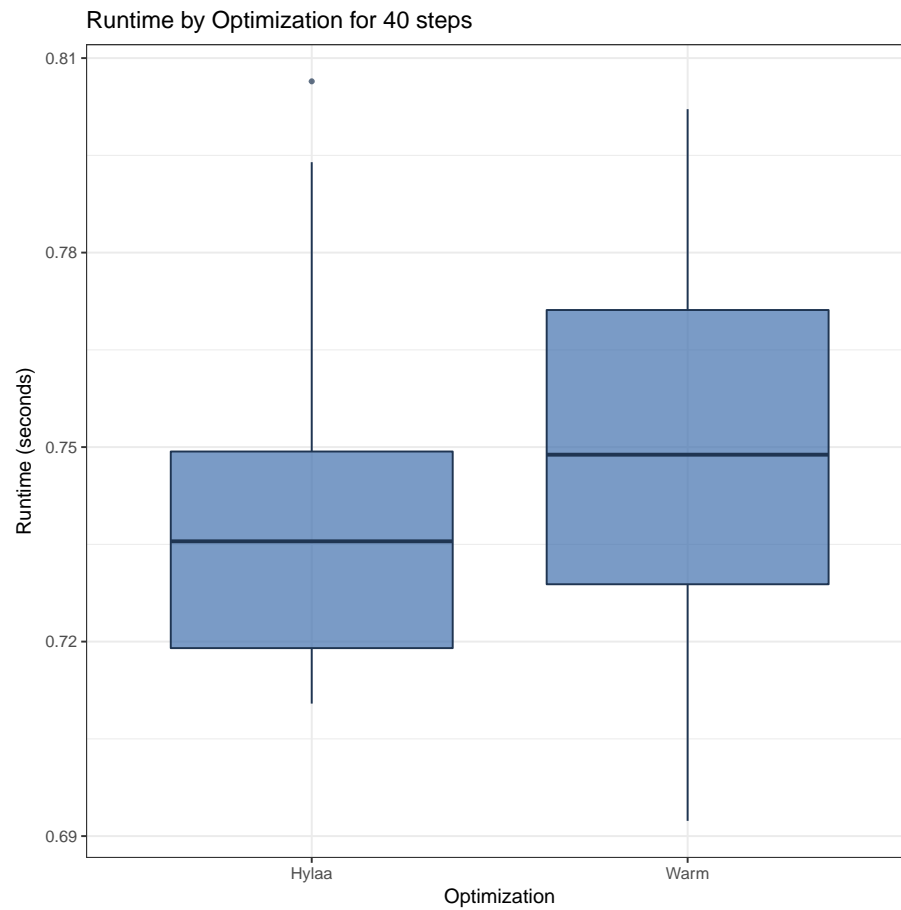
Runtime for Warm

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6924 0.7288 0.7488 0.7476 0.7711 0.8021
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Warm" & object == "steps40")$time
## W = 0.96969, p-value = 0.888
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.887960927324343"
```

Comparison



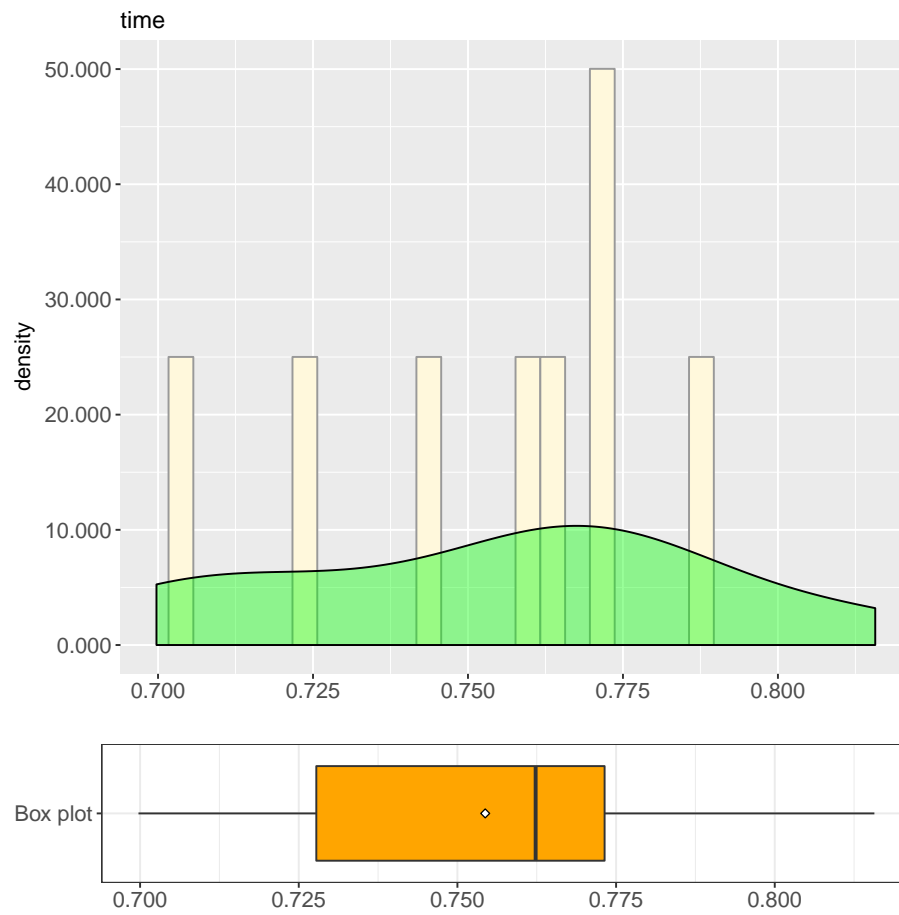
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps40")$time and subset(json_data, treatment == "Warm" & object == "steps40")$time
## F = 0.84799, num df = 9, denom df = 9, p-value = 0.81
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2106286 3.4140009
## sample estimates:
## ratio of variances
##      0.8479895
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.80999212614282"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps40")$time and subset(json_data, treatment == "Warm" & object == "steps40")$time
## t = -0.293, df = 18, p-value = 0.7729
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.03658369 0.02762840
## sample estimates:
## mean of x mean of y
## 0.7431680 0.7476457
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.772870604957377"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7431680440903"
## [1] "Mean Runtime for Warm: 0.7476456880569"
## [1] "Absolute difference: 0.0044776439666"
## Runtime for Warm is 0.60250760271602 % greater than
## Runtime for Hylaa
```

3.1.3 RH1.3: Object 53 steps

Runtime for Hylaa

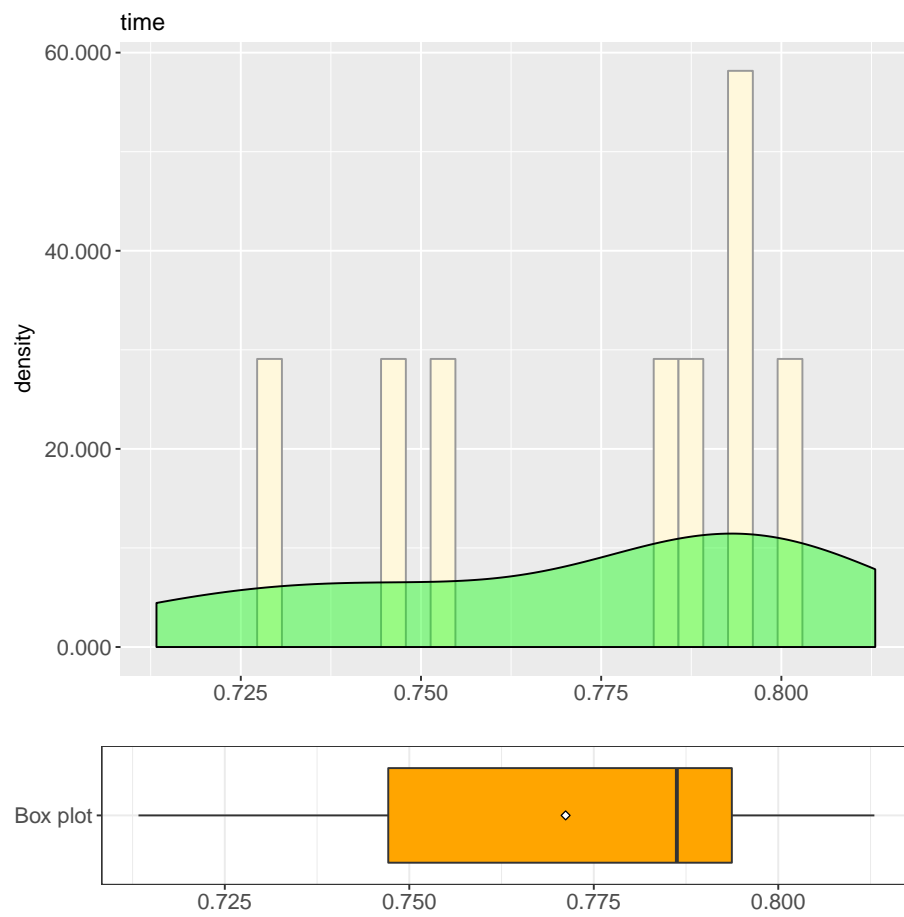
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6997 0.7278 0.7623 0.7544 0.7732 0.8157
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps53")$time
## W = 0.95914, p-value = 0.776
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.776029544672673"
```

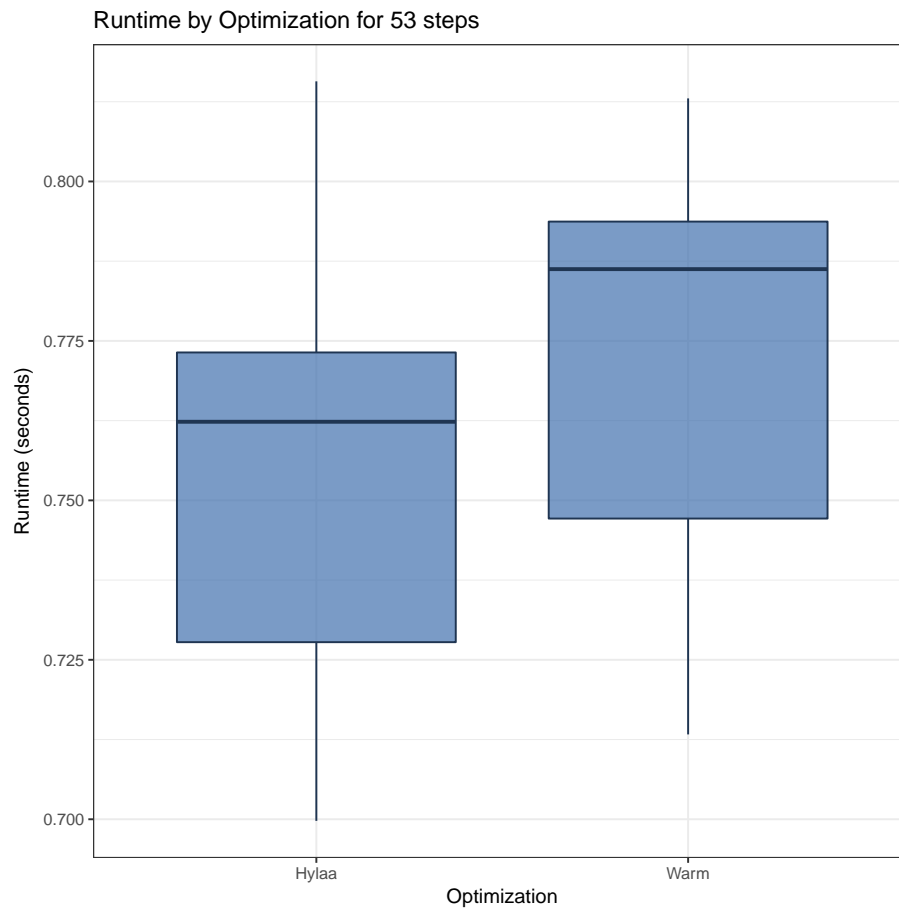
Runtime for Warm

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.7133  0.7471  0.7863  0.7712  0.7937  0.8130
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Warm" & object == "steps53")$time
## W = 0.90652, p-value = 0.2579
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.257924554875211"
```

Comparison



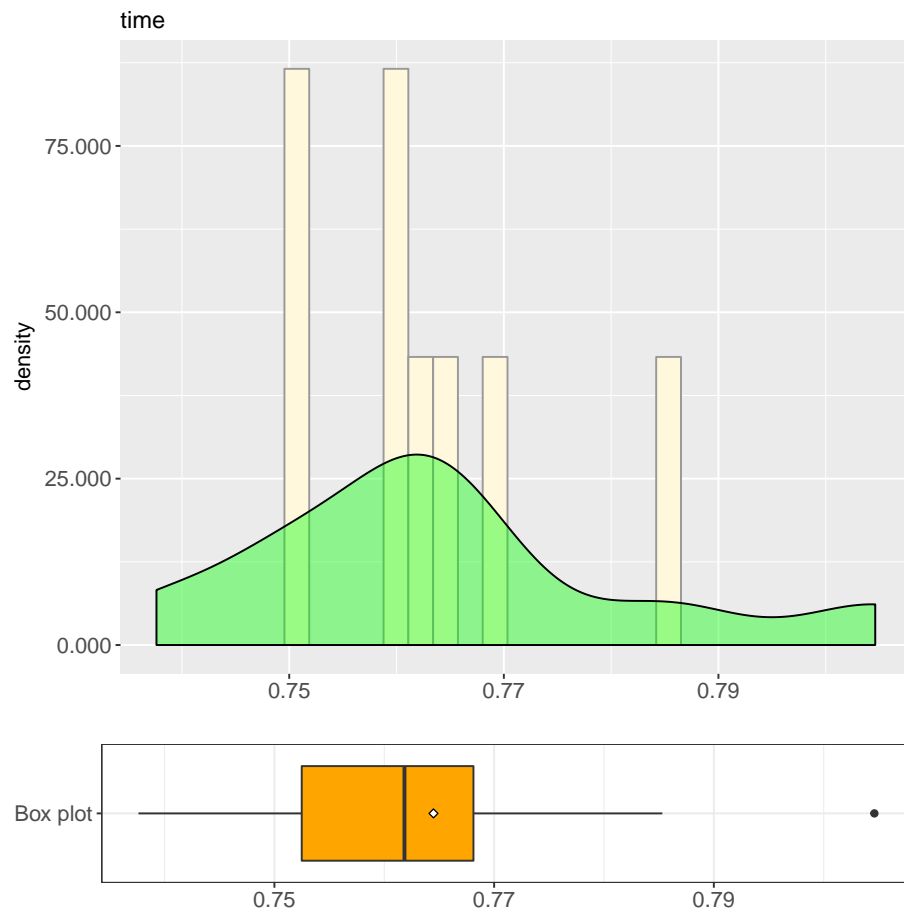
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps53")$time and subset(json_data, treatment == "Warm" & object == "steps53")$time
## F = 1.1697, num df = 9, denom df = 9, p-value = 0.8192
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2905437 4.7093146
## sample estimates:
## ratio of variances
##      1.169727
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.819169805244097"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps53")$time and subset(json_data, treatment == "Warm" & object == "steps53")$time
## t = -1.0624, df = 18, p-value = 0.3021
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.05003068 0.01642558
## sample estimates:
## mean of x mean of y
## 0.7543800 0.7711825
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.302110336252165"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7543799638747"
## [1] "Mean Runtime for Warm: 0.7711825132371"
## [1] "Absolute difference: 0.0168025493624"
## Runtime for Warm is 2.22733240104861 % greater than
## Runtime for Hylaa
```

3.1.4 RH1.4: Object 68 steps

Runtime for Hylaa

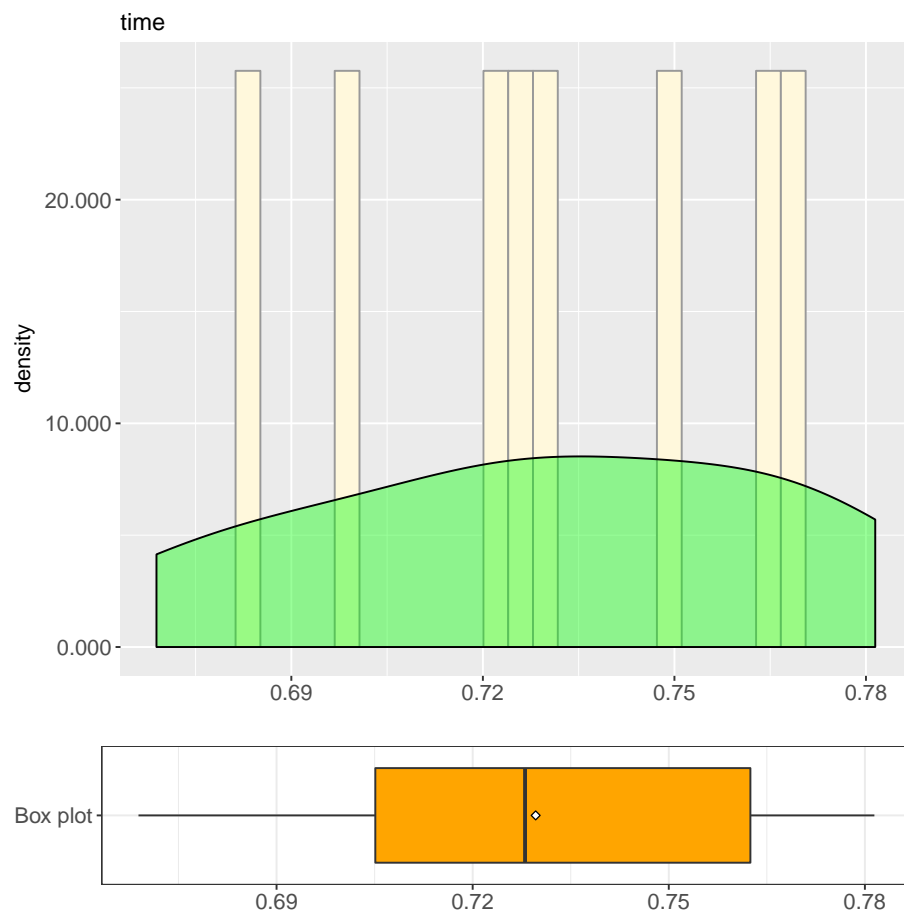
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7376 0.7525 0.7618 0.7645 0.7681 0.8046
```

```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps68")$time
## W = 0.92932, p-value = 0.4412
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.44123425938003"
```

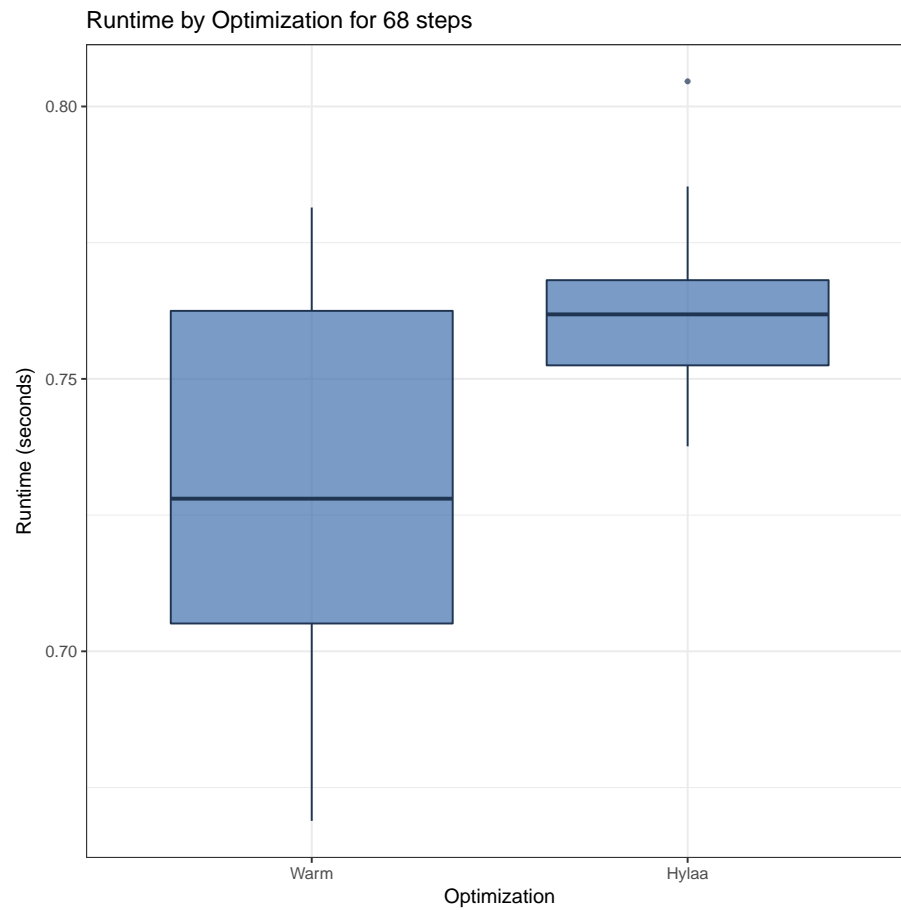
Runtime for Warm

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6689 0.7051 0.7280 0.7296 0.7625 0.7815
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Warm" & object == "steps68")$time
## W = 0.95718, p-value = 0.7533
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.753294225891065"
```

Comparison



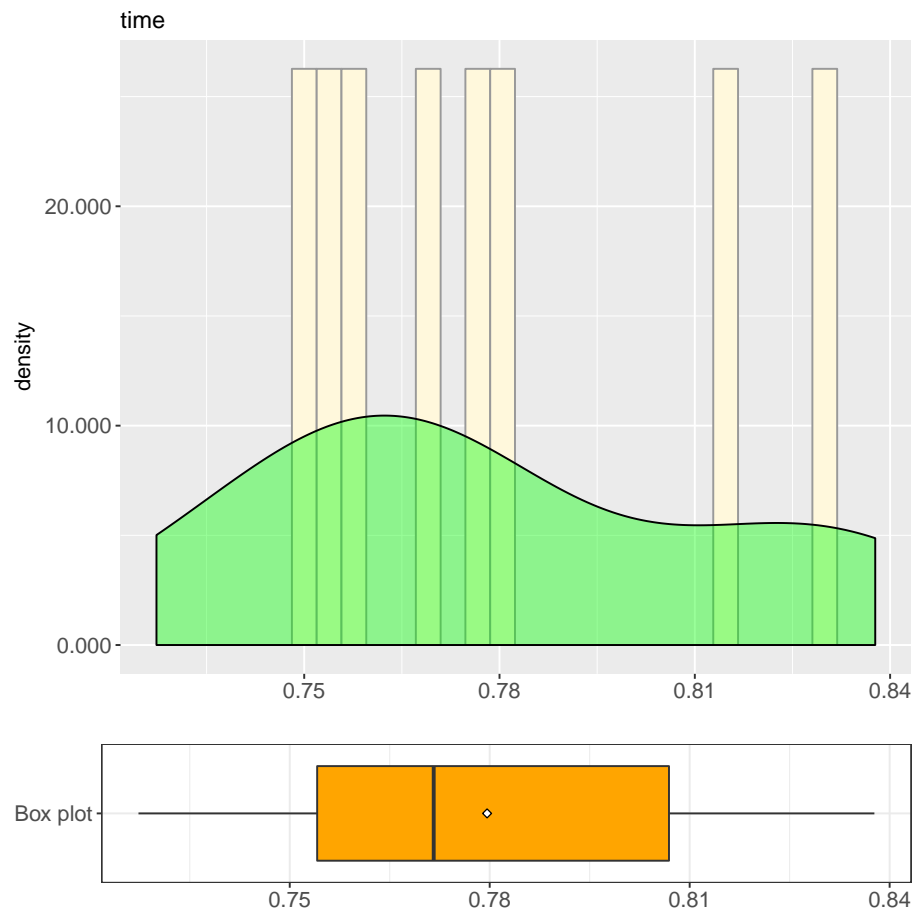
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps68")$time and subset(json_data, treatment == "Warm" & object == "steps68")$time
## F = 0.25801, num df = 9, denom df = 9, p-value = 0.05614
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.06408574 1.03874195
## sample estimates:
## ratio of variances
##      0.2580088
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.0561446074554752"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps68")$time and subset(json_data, treatment == "Warm" & object == "steps68")$time
## t = 2.6236, df = 18, p-value = 0.01722
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.006940516 0.062738744
## sample estimates:
## mean of x mean of y
## 0.7644785 0.7296388
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.0172232044414237"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7644784688949"
## [1] "Mean Runtime for Warm: 0.7296388387681"
## [1] "Absolute difference: 0.0348396301268"
## Runtime for Hylaa is 4.77491442007421 % greater than
## Runtime for Warm
```

3.1.5 RH1.5: Object 89 steps

Runtime for Hylaa

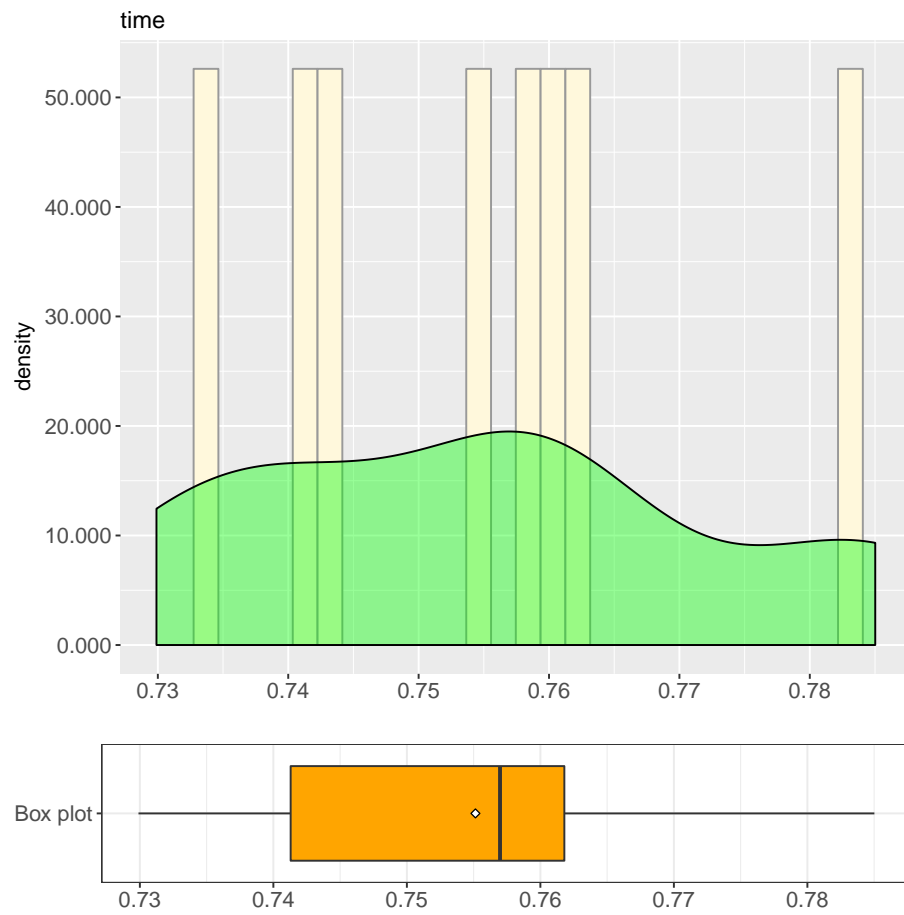
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7273 0.7541 0.7716 0.7796 0.8069 0.8377
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps89")$time
## W = 0.92836, p-value = 0.4319
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.431928741976726"
```

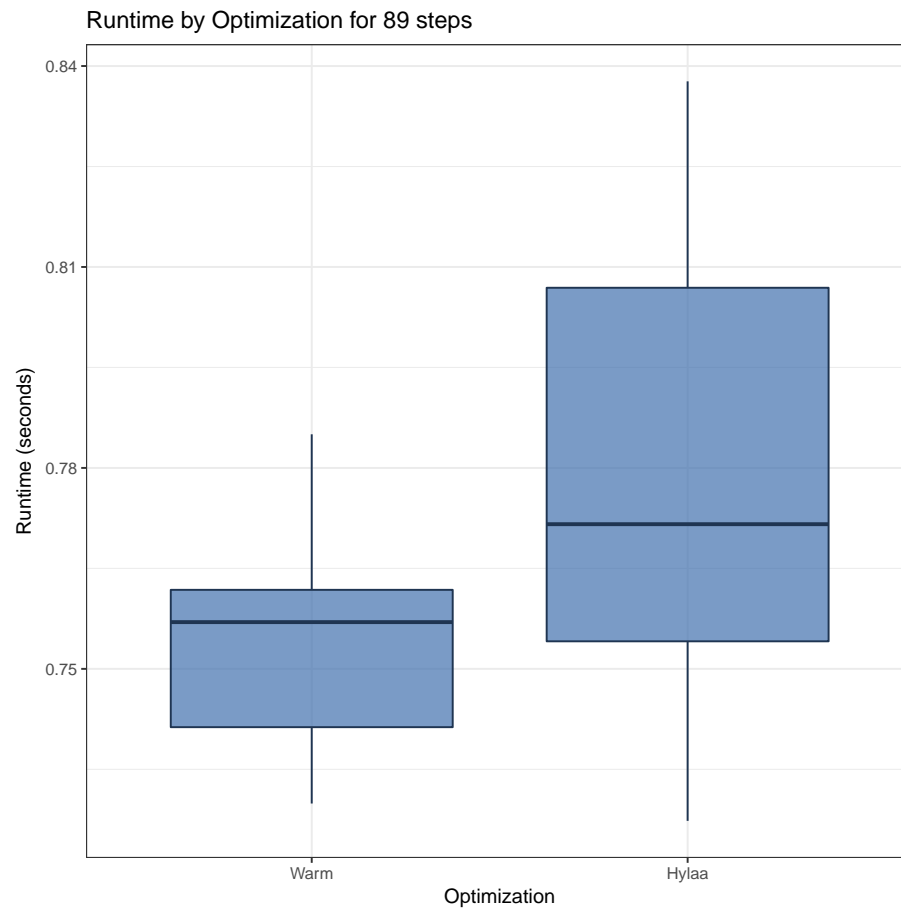
Runtime for Warm

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.7299  0.7413  0.7570  0.7551  0.7618  0.7850
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Warm" & object == "steps89")$time
## W = 0.93381, p-value = 0.4864
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.48644486648755"
```

Comparison



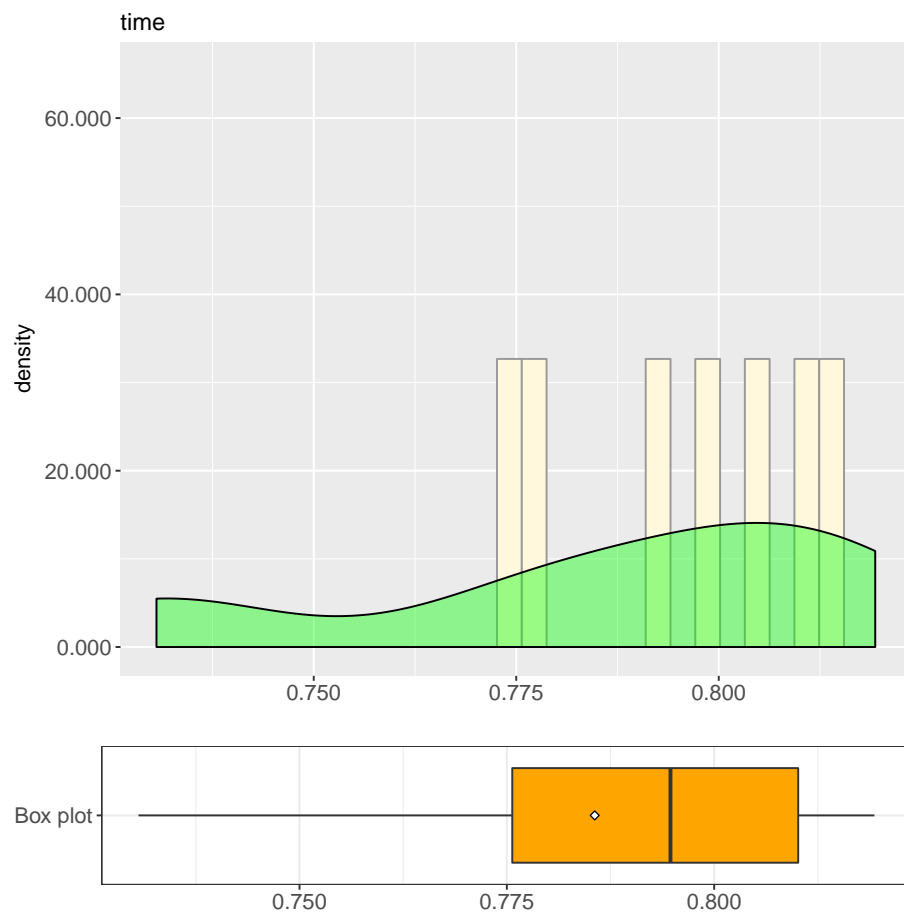
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps89")$time and subset(json_data, treatment == "Warm" & object == "steps89")$time
## F = 3.7978, num df = 9, denom df = 9, p-value = 0.0597
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.9433294 15.2900768
## sample estimates:
## ratio of variances
##      3.797839
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.0596953035873224"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps89")$time and subset(json_data, treatment == "Warm" & object == "steps89")$time
## t = 1.8721, df = 18, p-value = 0.07753
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.002991089 0.051935323
## sample estimates:
## mean of x mean of y
## 0.7796074 0.7551353
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.0775319544685017"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7796074151993"
## [1] "Mean Runtime for Warm: 0.7551352977755"
## [1] "Absolute difference: 0.0244721174238"
## Runtime for Hylaa is 3.24075930444394 % greater than
## Runtime for Warm
```

3.1.6 RH1.6: Object 116 steps

Runtime for Hylaa

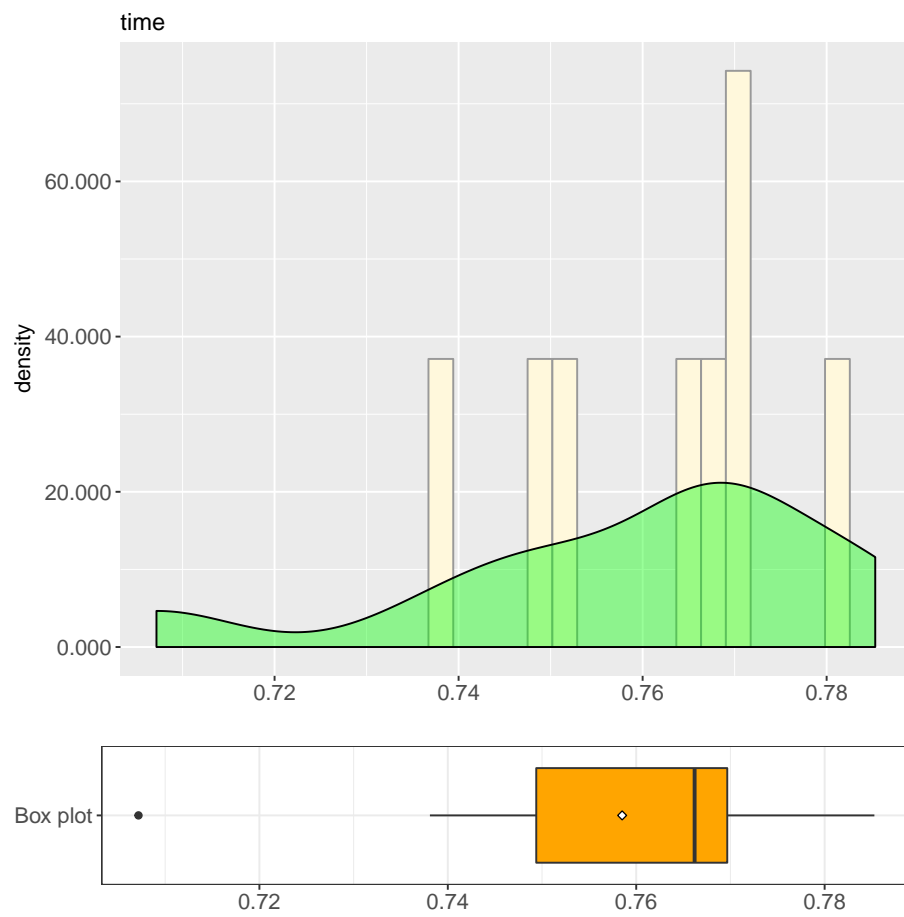
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7306 0.7757 0.7947 0.7856 0.8101 0.8193
```

```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps116")$time
## W = 0.86307, p-value = 0.08294
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0829366496429817"
```

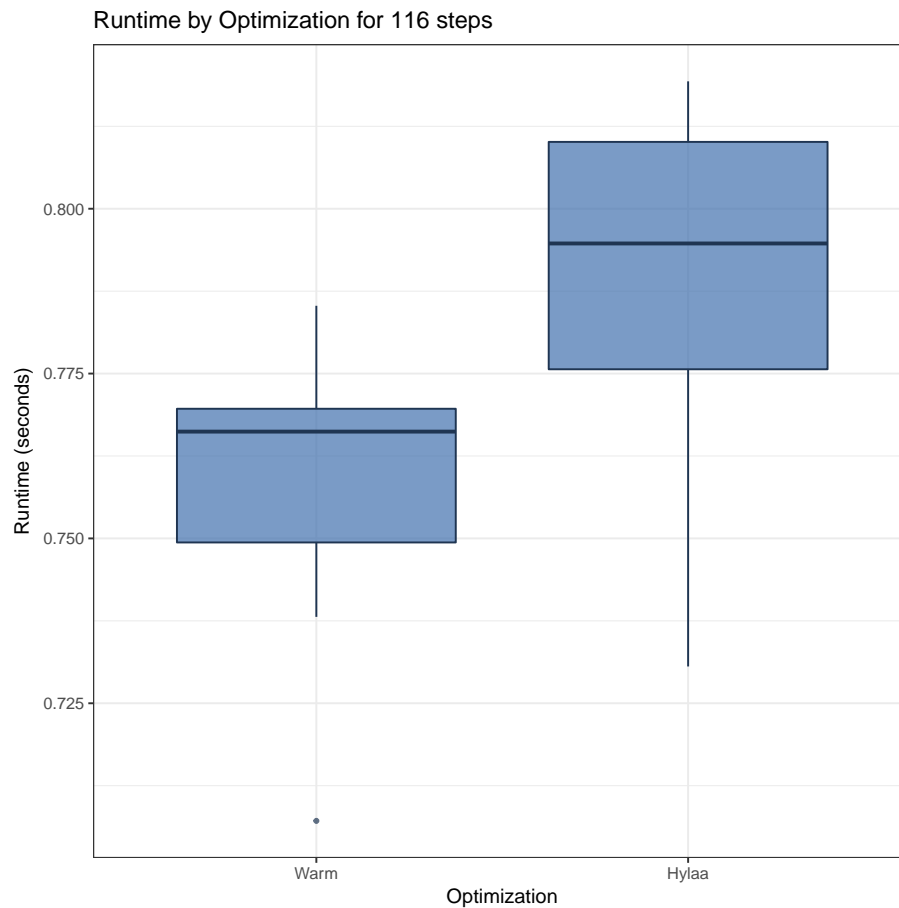
Runtime for Warm

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.7072  0.7494  0.7662  0.7585  0.7697  0.7853
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Warm" & object == "steps116")$time
## W = 0.9028, p-value = 0.2351
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.235105043492915"
```

Comparison



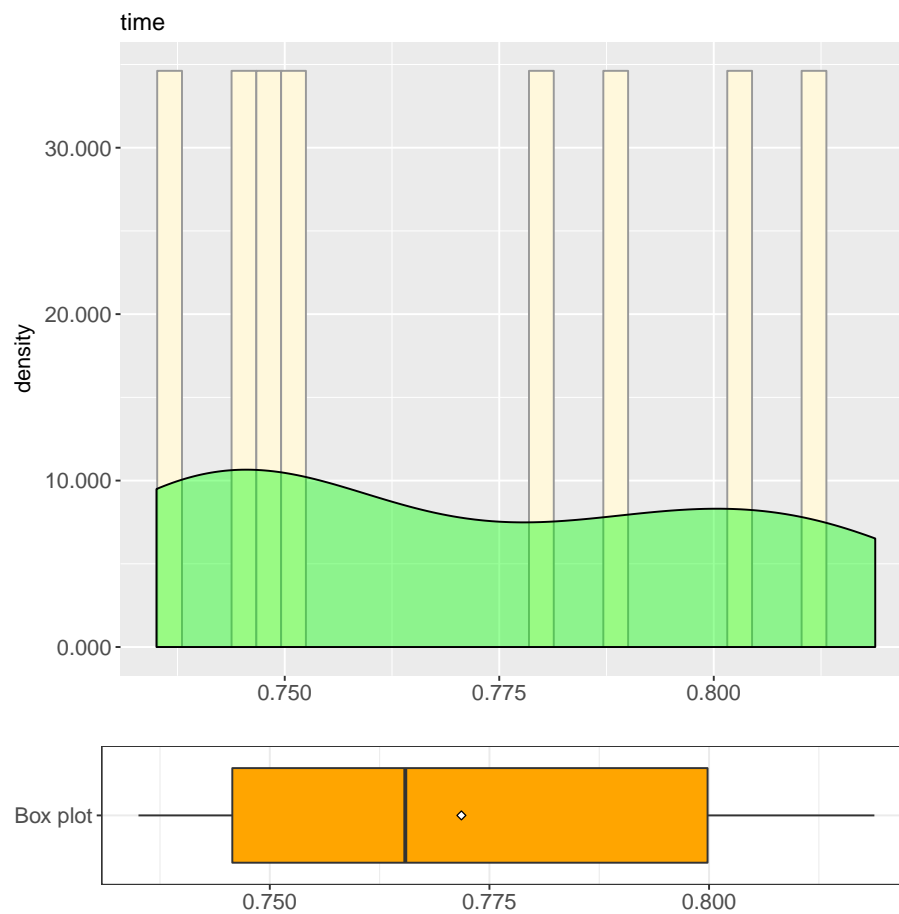
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps116")$time and subset(js
## F = 1.921, num df = 9, denom df = 9, p-value = 0.3449
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.4771615 7.7341344
## sample estimates:
## ratio of variances
##      1.92105
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.34490839218464"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps116")$time and subset(js
## t = 2.1608, df = 18, p-value = 0.04443
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.0007511088 0.0534294656
## sample estimates:
## mean of x mean of y
## 0.7855974 0.7585071
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.0444344497096994"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7855973720549"
## [1] "Mean Runtime for Warm: 0.7585070848467"
## [1] "Absolute difference: 0.0270902872081999"
## Runtime for Hylaa is 3.57152724732625 % greater than
## Runtime for Warm
```

3.1.7 RH1.7: Object 151 steps

Runtime for Hylaa

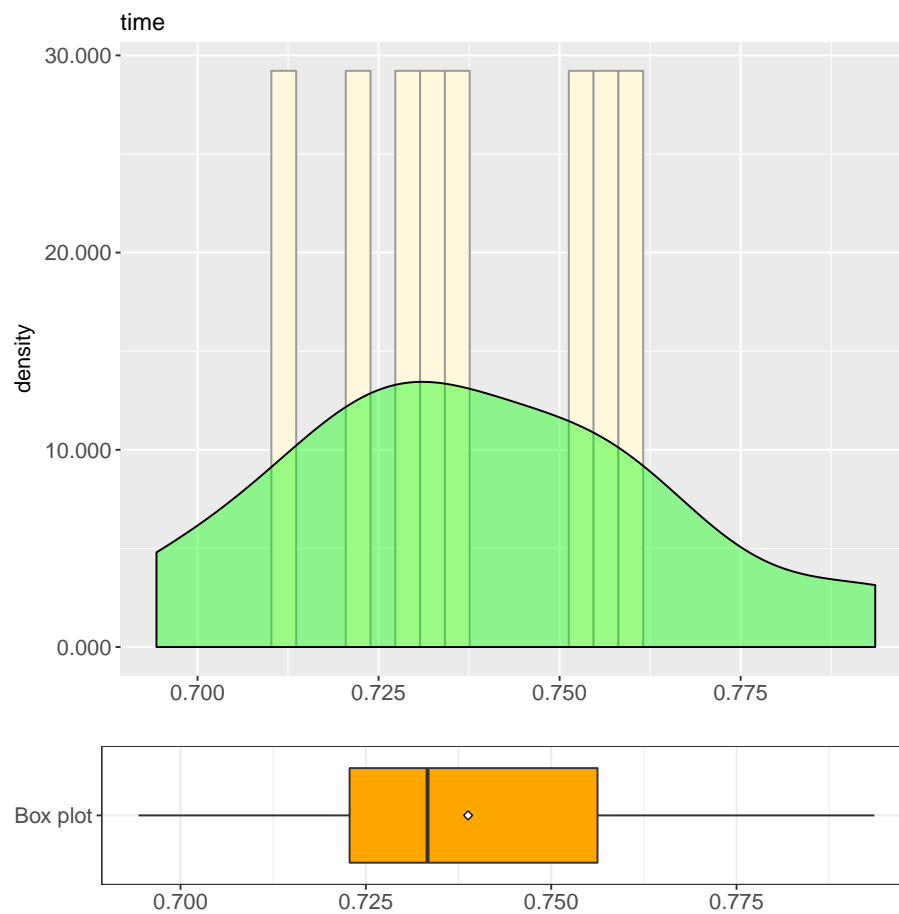
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7351 0.7457 0.7654 0.7718 0.7998 0.8188
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps151")$time
## W = 0.8855, p-value = 0.1508
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.15083040609515"
```

Runtime for Warm

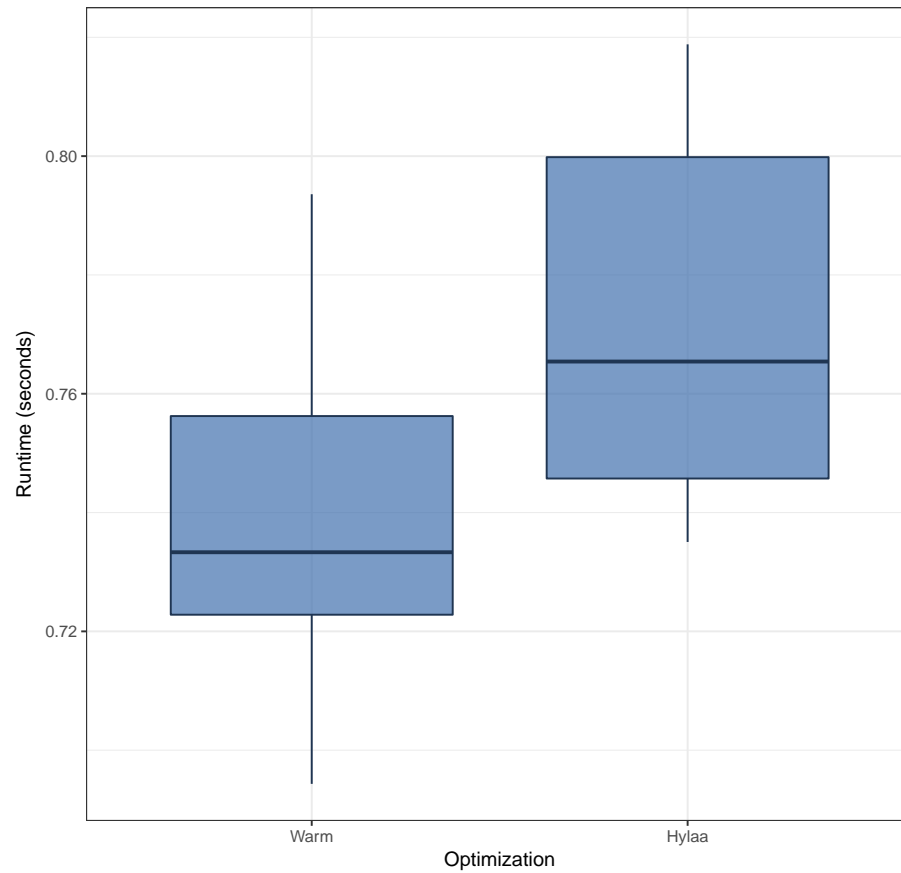
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6943 0.7228 0.7333 0.7388 0.7562 0.7936
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Warm" & object == "steps151")$time
## W = 0.97251, p-value = 0.9131
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.913118876153724"
```

Comparison

Runtime by Optimization for 151 steps



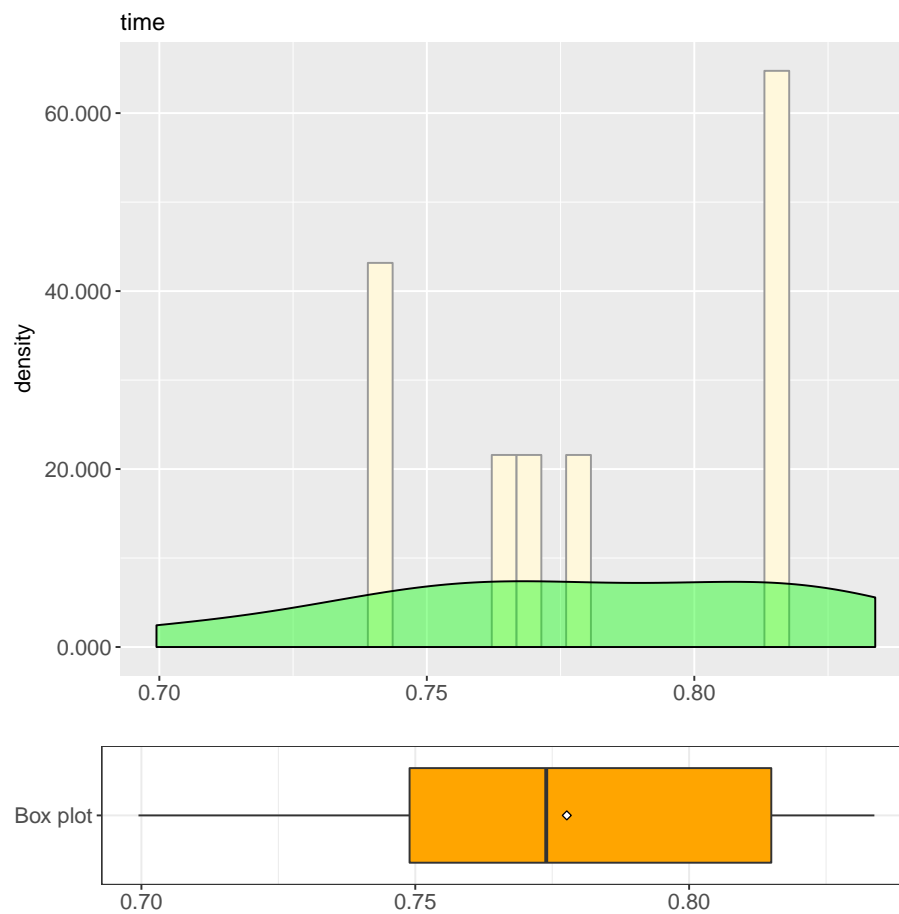
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps151")$time and subset(js
## F = 1.3273, num df = 9, denom df = 9, p-value = 0.68
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3296822 5.3436964
## sample estimates:
## ratio of variances
##      1.327299
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.680017210850041"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps151")$time and subset(js
## t = 2.4293, df = 18, p-value = 0.02583
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.004463071 0.061578399
## sample estimates:
## mean of x mean of y
## 0.7718092 0.7387885
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.0258252063294328"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7718092203141"
## [1] "Mean Runtime for Warm: 0.7387884855271"
## [1] "Absolute difference: 0.0330207347870001"
## Runtime for Hylaa is 4.46957897069023 % greater than
## Runtime for Warm
```

3.1.8 RH1.8: Object 197 steps

Runtime for Hylaa

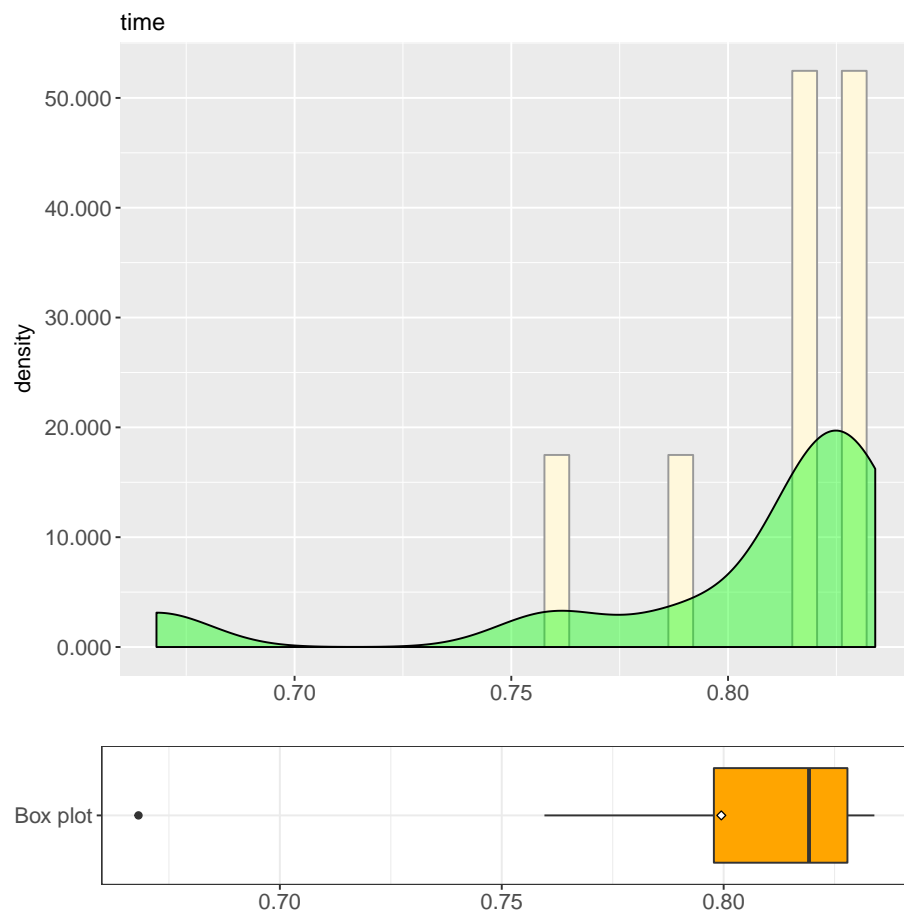
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6995 0.7490 0.7739 0.7777 0.8150 0.8338
```

```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps197")$time
## W = 0.94142, p-value = 0.569
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.568954856828926"
```

Runtime for Warm

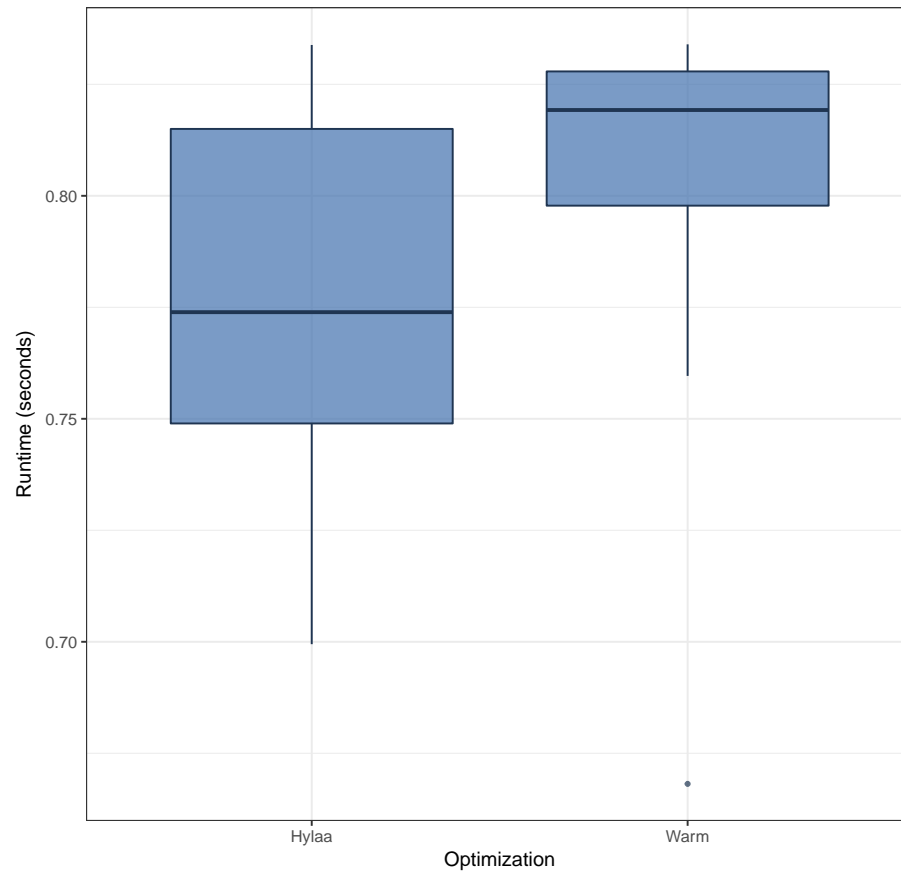
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6681 0.7978 0.8192 0.7995 0.8279 0.8340
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Warm" & object == "steps197")$time
## W = 0.68753, p-value = 0.0006223
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.000622303170797109"
```

Comparison

Runtime by Optimization for 197 steps

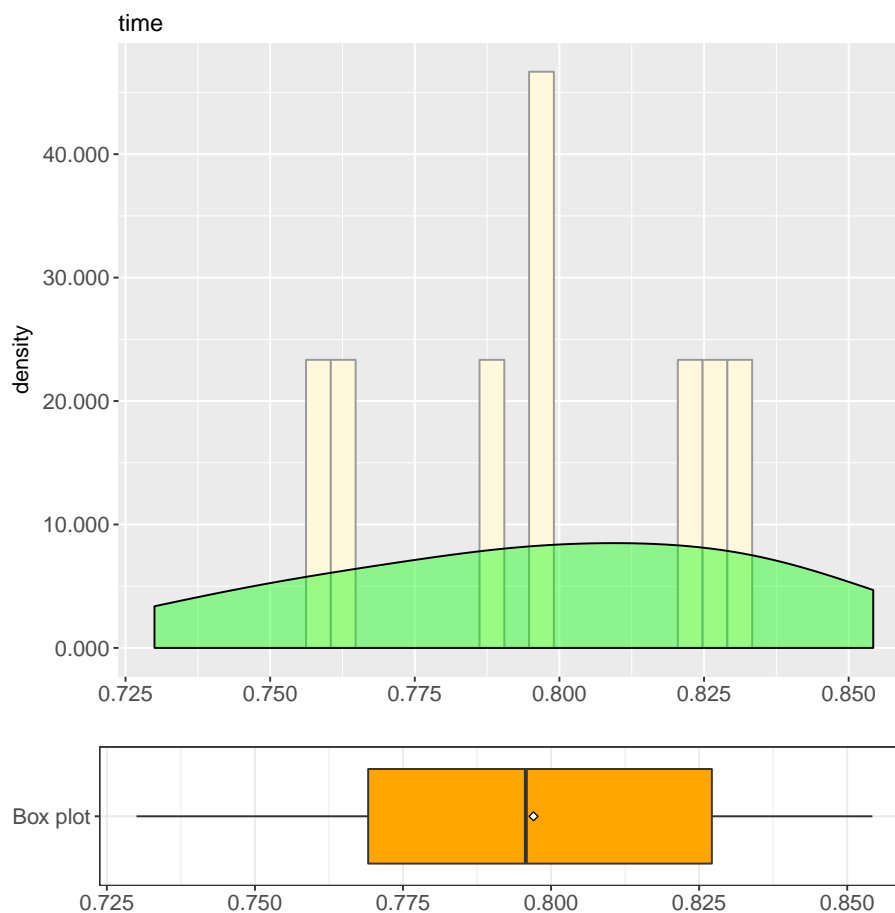


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 27, p-value = 0.08921
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis not rejected. P-value: 0.08920955205784"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.777667427063"
## [1] "Mean Runtime for Warm: 0.799469780922"
## [1] "Absolute difference: 0.021802353859"
## Runtime for Warm is 2.80355754918789 % greater than
## Runtime for Hylaa
```

3.1.9 RH1.9: Object 256 steps

Runtime for Hylaa

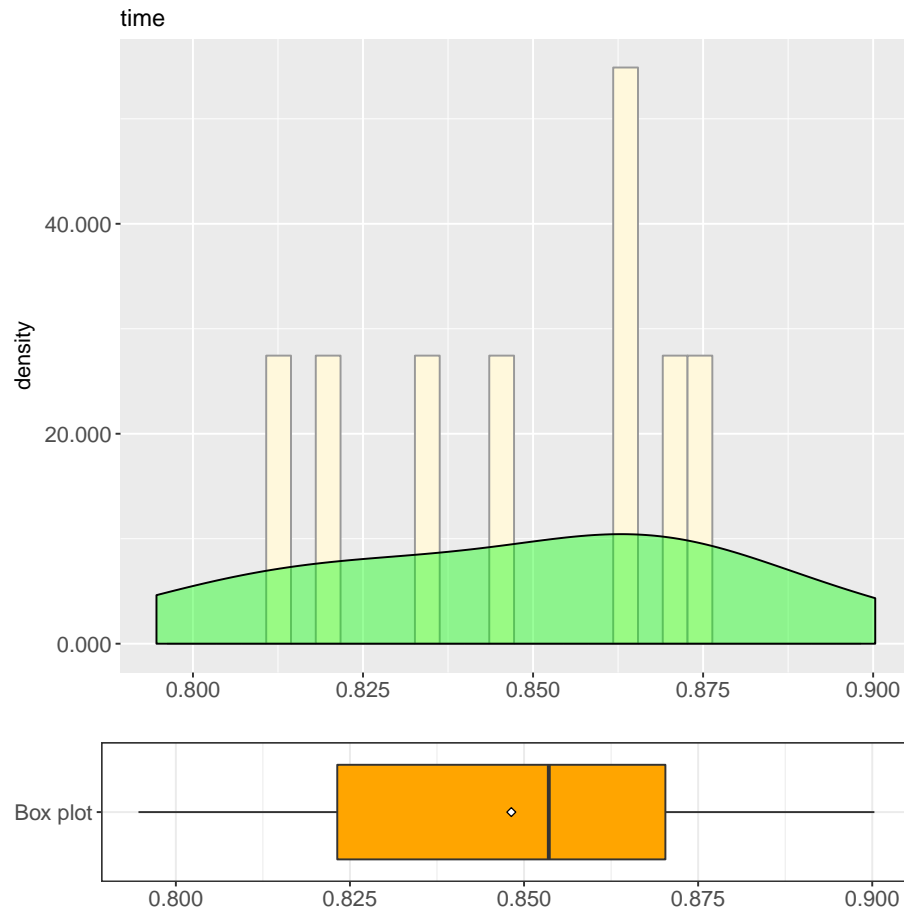
```
## [1] "Sample size: 10"  
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
## 0.7300 0.7691 0.7957 0.7970 0.8271 0.8542
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Hylaa" & object == "steps256")$time  
## W = 0.964, p-value = 0.8303  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.830310406698625"
```

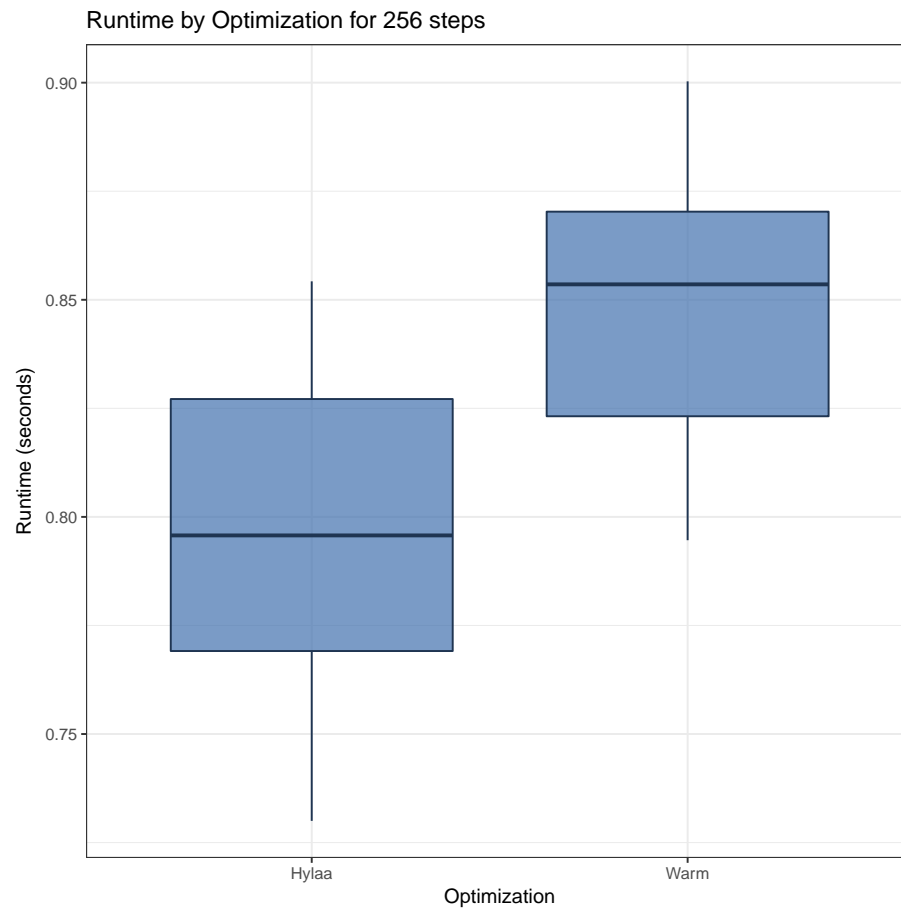
Runtime for Warm

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7946  0.8232  0.8536  0.8482  0.8703  0.9003
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Warm" & object == "steps256")$time
## W = 0.97206, p-value = 0.9092
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.909224489734146"
```

Comparison



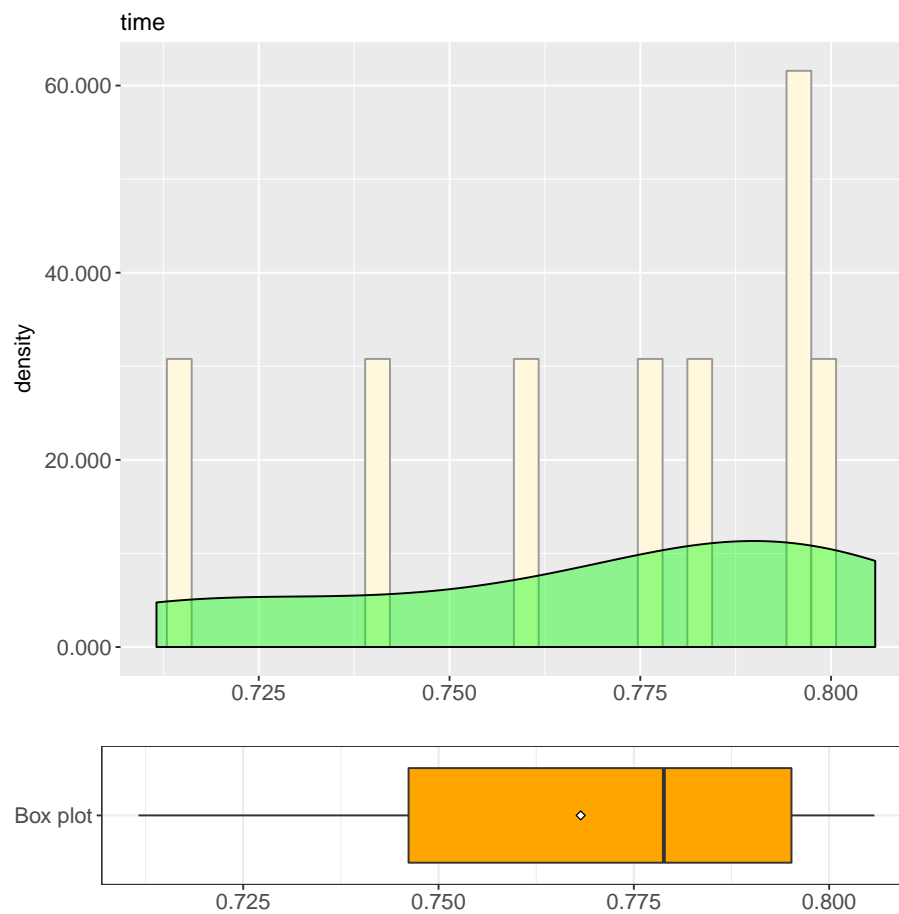
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps256")$time and subset(js
## F = 1.4142, num df = 9, denom df = 9, p-value = 0.614
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3512696 5.6935994
## sample estimates:
## ratio of variances
##      1.41421
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.613964351705911"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps256")$time and subset(js
## t = -3.1826, df = 18, p-value = 0.005156
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.08489653 -0.01738104
## sample estimates:
## mean of x mean of y
## 0.7970330 0.8481718
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.00515550553759939"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.79703299999924"
## [1] "Mean Runtime for Warm: 0.8481717824937"
## [1] "Absolute difference: 0.0511387825013001"
## Runtime for Warm is 6.4161436856175 % greater than
## Runtime for Hylaa
```

3.1.10 RH1.10: Object 332 steps

Runtime for Hylaa

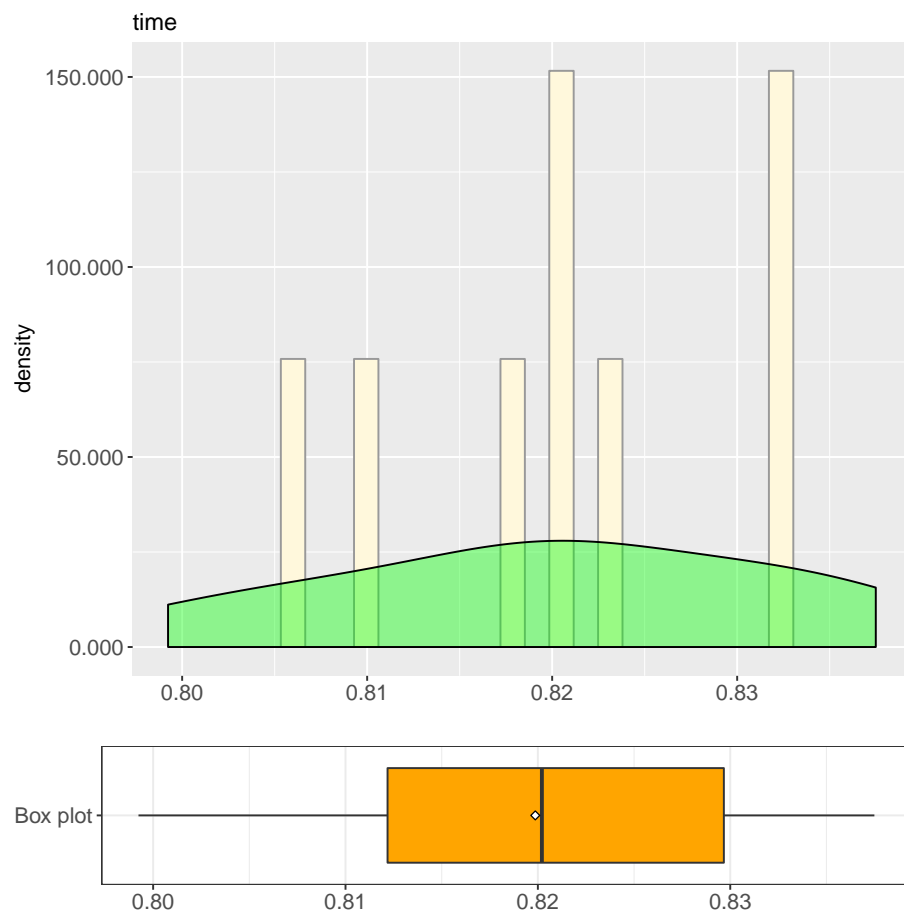
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7116  0.7462  0.7788  0.7682  0.7952  0.8058
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps332")$time
## W = 0.87995, p-value = 0.1303
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.130315495202675"
```

Runtime for Warm

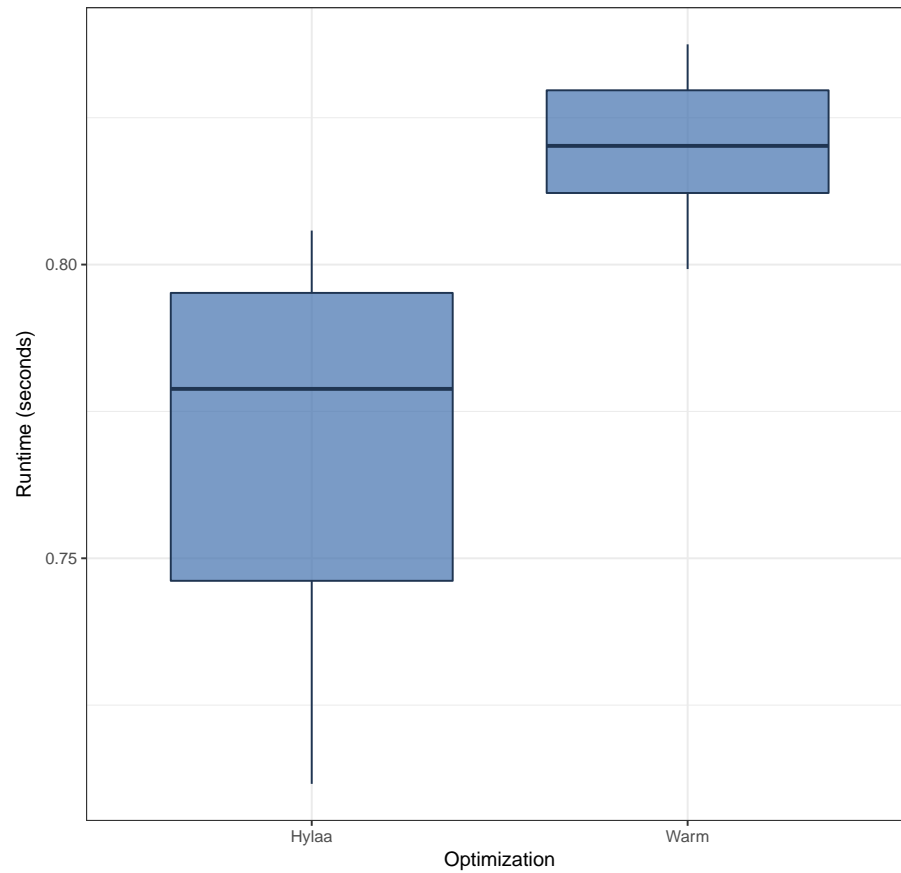
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.7992  0.8122  0.8202  0.8199  0.8297  0.8375
```

```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Warm" & object == "steps332")$time
## W = 0.96673, p-value = 0.859
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.858987863455774"
```

Comparison

Runtime by Optimization for 332 steps



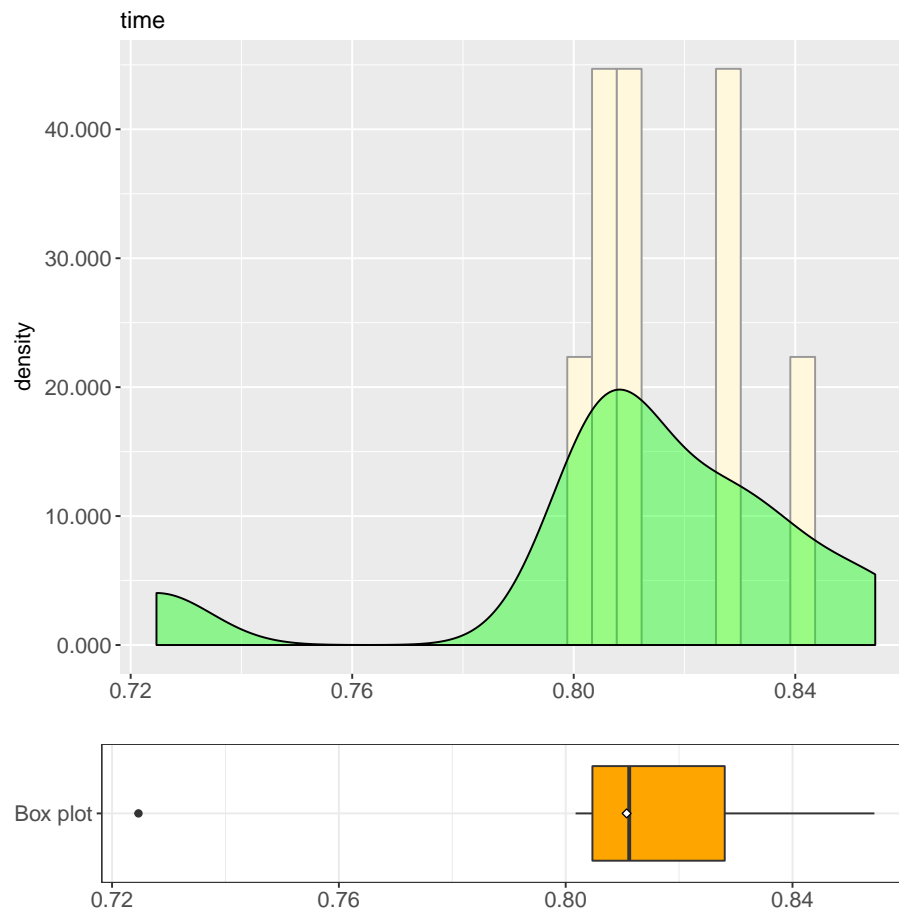
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps332")$time and subset(js
## F = 8.1607, num df = 9, denom df = 9, p-value = 0.004485
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  2.027007 32.855000
## sample estimates:
## ratio of variances
##      8.160717
##
## [1] "Homogeneity of variances: FALSE. P-value: 0.00448525981497427"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Welch Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps332")$time and subset(js
## t = -4.4321, df = 11.173, p-value = 0.0009709
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.07727876 -0.02605801
## sample estimates:
## mean of x mean of y
## 0.7681974 0.8198658
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.000970941286228814"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7681974172593"
## [1] "Mean Runtime for Warm: 0.8198657989502"
## [1] "Absolute difference: 0.0516683816908999"
## Runtime for Warm is 6.72592494195533 % greater than
## Runtime for Hylaa
```

3.1.11 RH1.11: Object 432 steps

Runtime for Hylaa

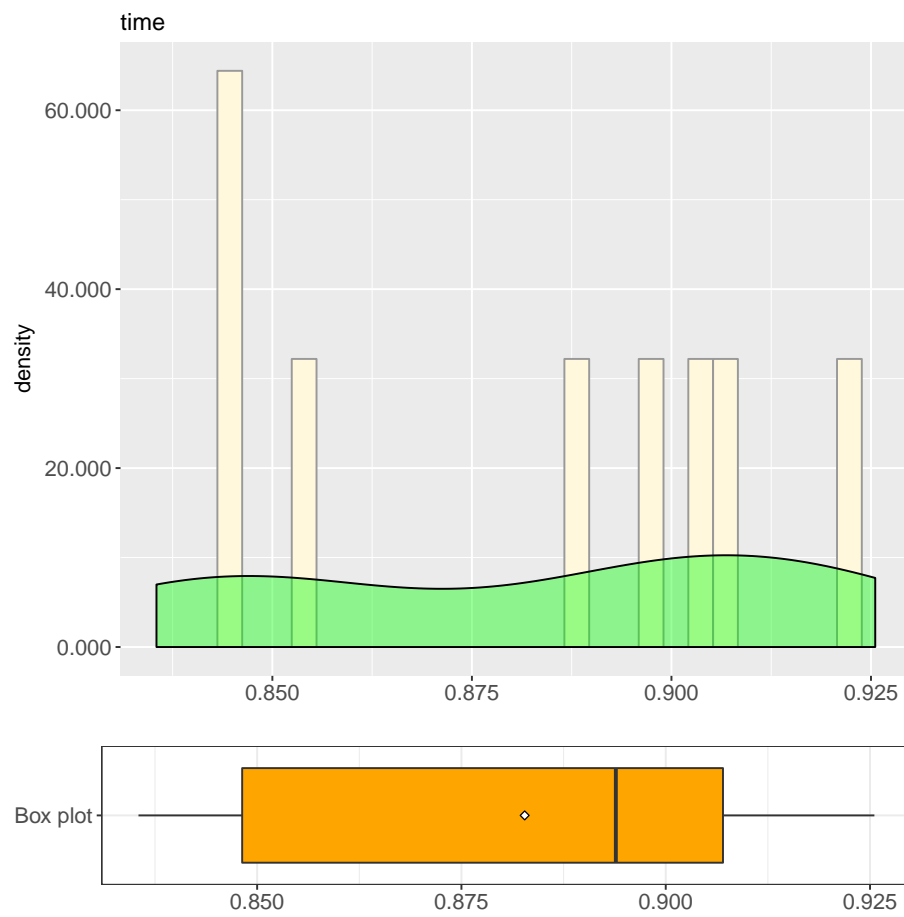
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7247  0.8047  0.8112  0.8107  0.8280  0.8544
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps432")$time
## W = 0.82468, p-value = 0.02887
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.0288658654097958"
```

Runtime for Warm

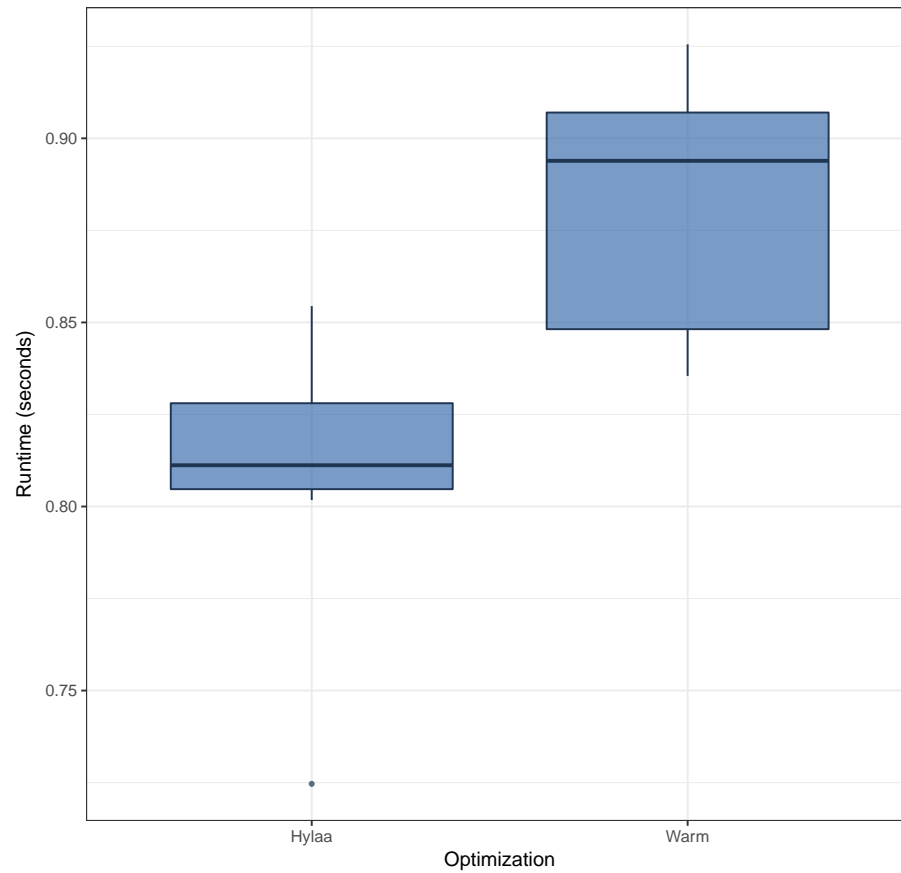
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.8355 0.8482 0.8939 0.8827 0.9070 0.9255
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Warm" & object == "steps432")$time
## W = 0.886, p-value = 0.1528
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.152792850523887"
```

Comparison

Runtime by Optimization for 432 steps

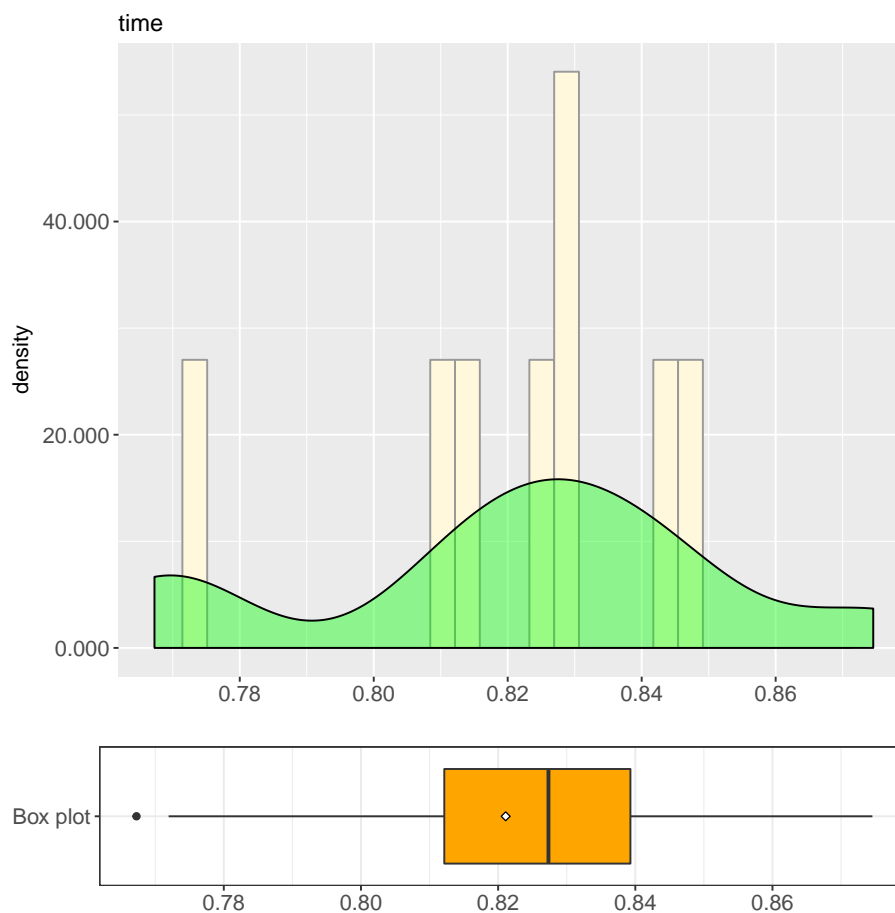


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 4, p-value = 0.0001299
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 0.000129901058693628"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.8107497930526"
## [1] "Mean Runtime for Warm: 0.8827400207519"
## [1] "Absolute difference: 0.0719902276993001"
## Runtime for Warm is 8.87946297565438 % greater than
## Runtime for Hylaa
```

3.1.12 RH1.12: Object 562 steps

Runtime for Hylaa

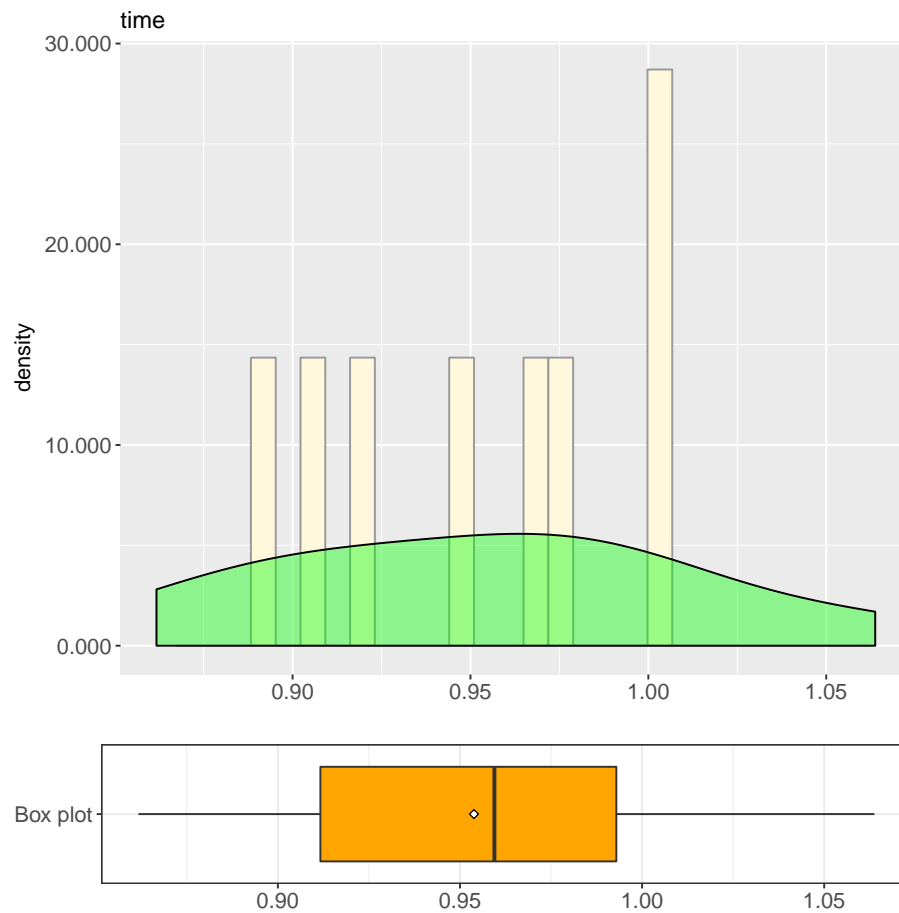
```
## [1] "Sample size: 10"  
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
## 0.7673 0.8121 0.8273 0.8211 0.8393 0.8746
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Hylaa" & object == "steps562")$time  
## W = 0.93601, p-value = 0.5095  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.509497615860695"
```

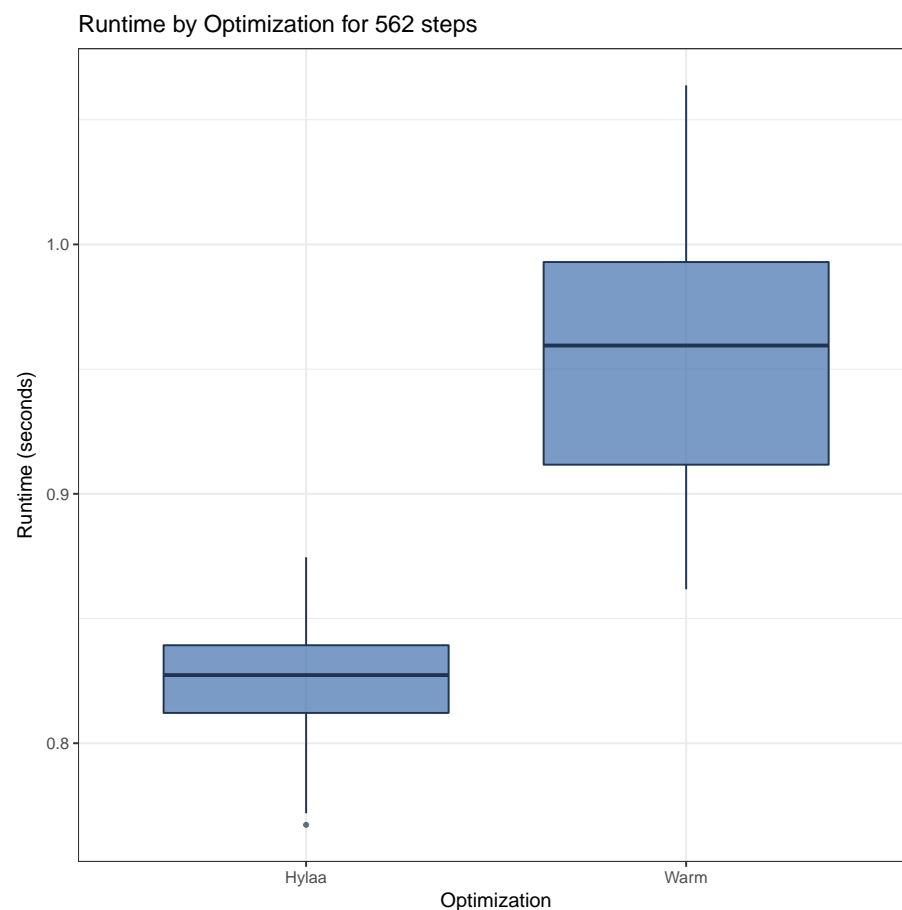
Runtime for Warm

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.8617  0.9117  0.9595  0.9538  0.9929  1.0640
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Warm" & object == "steps562")$time
## W = 0.98206, p-value = 0.9752
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.97524131457127"
```

Comparison



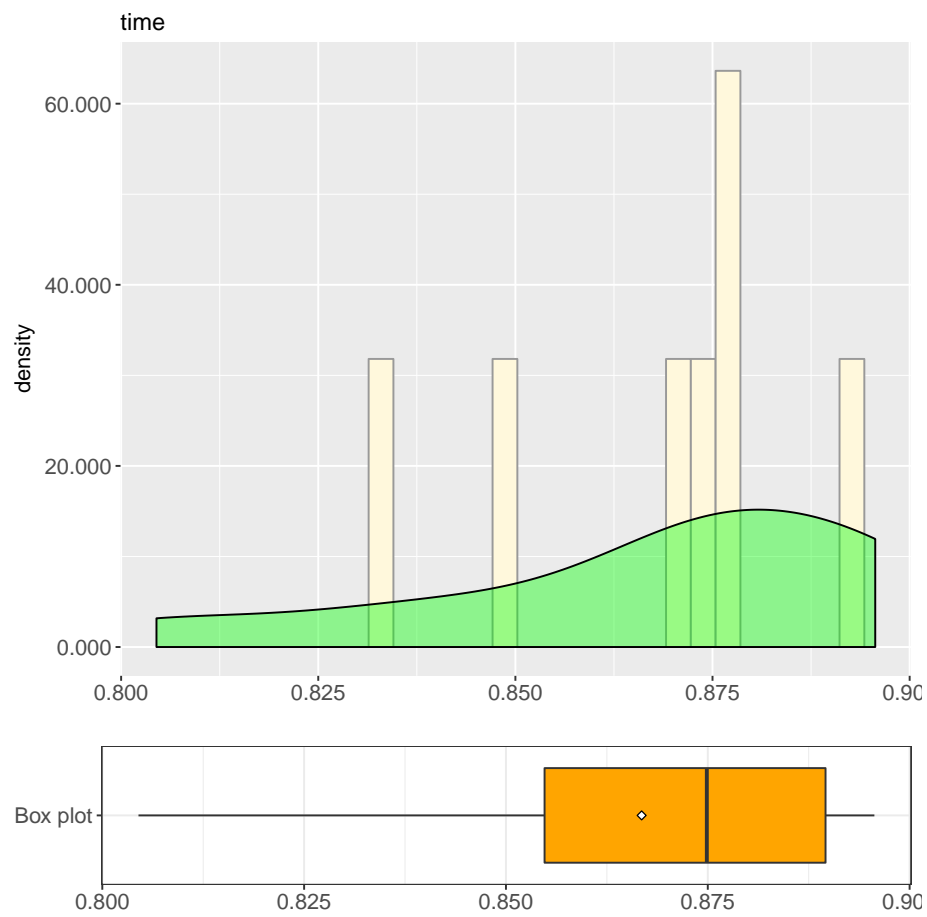
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps562")$time and subset(js
## F = 0.28648, num df = 9, denom df = 9, p-value = 0.0766
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.07115856 1.15338276
## sample estimates:
## ratio of variances
##      0.286484
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.0766012347568488"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps562")$time and subset(js
## t = -6.09, df = 18, p-value = 9.377e-06
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.17854537 -0.08695398
## sample estimates:
## mean of x mean of y
## 0.8210984 0.9538481
##
## [1] "T-test: Null Hypothesis rejected. P-value: 9.37740126068088e-06"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.8210983753205"
## [1] "Mean Runtime for Warm: 0.9538480520249"
## [1] "Absolute difference: 0.1327496767044"
## Runtime for Warm is 16.1673291160251 % greater than
## Runtime for Hylaa
```

3.1.13 RH1.13: Object 731 steps

Runtime for Hylaa

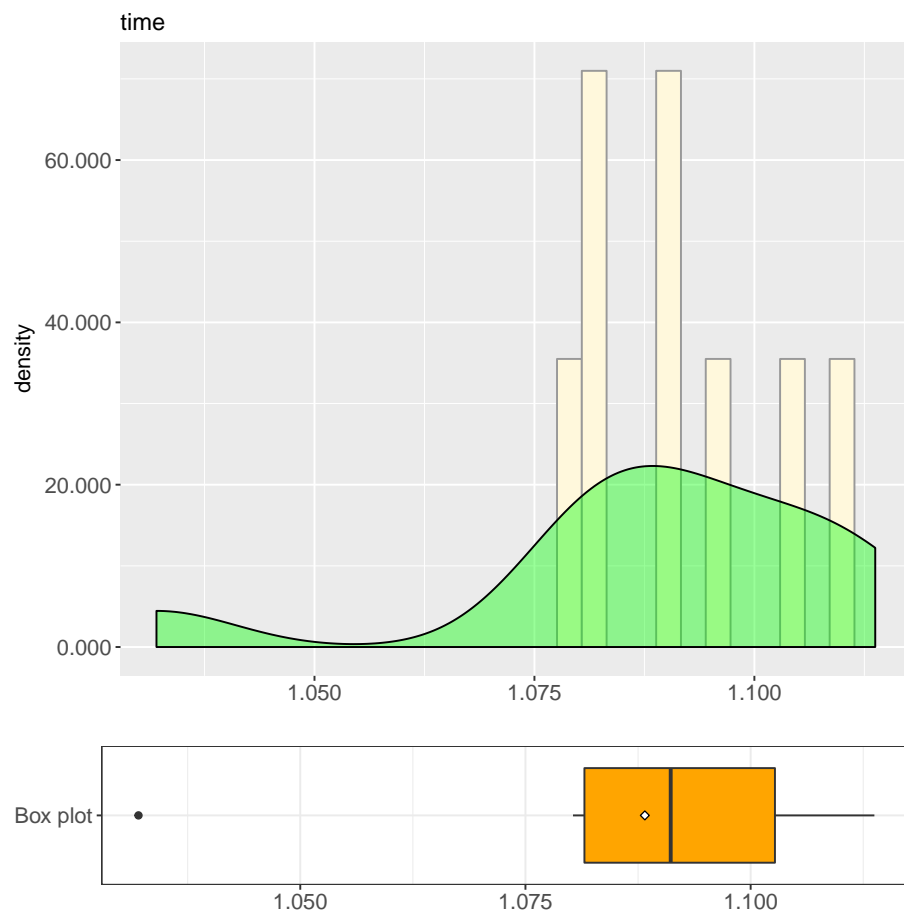
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.8045  0.8548  0.8749  0.8668  0.8896  0.8956
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps731")$time
## W = 0.86638, p-value = 0.09069
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0906925091728528"
```

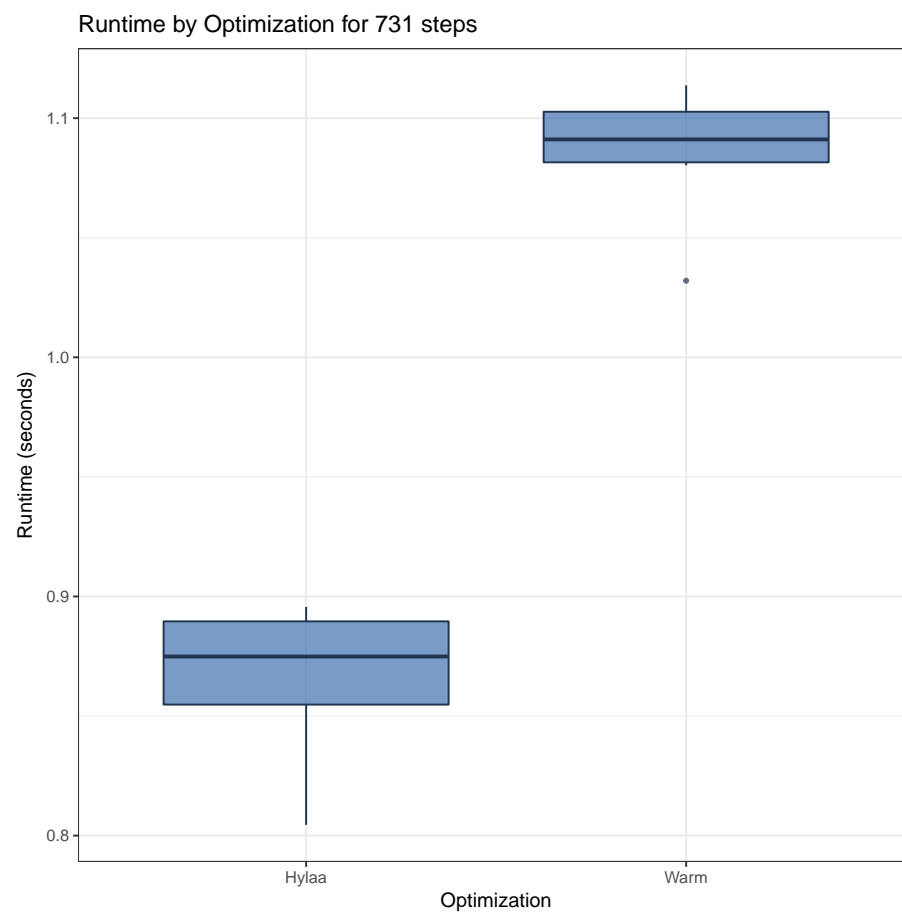
Runtime for Warm

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.032  1.082   1.091   1.088   1.103   1.114
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Warm" & object == "steps731")$time
## W = 0.83997, p-value = 0.04409
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.0440854589795451"
```

Comparison

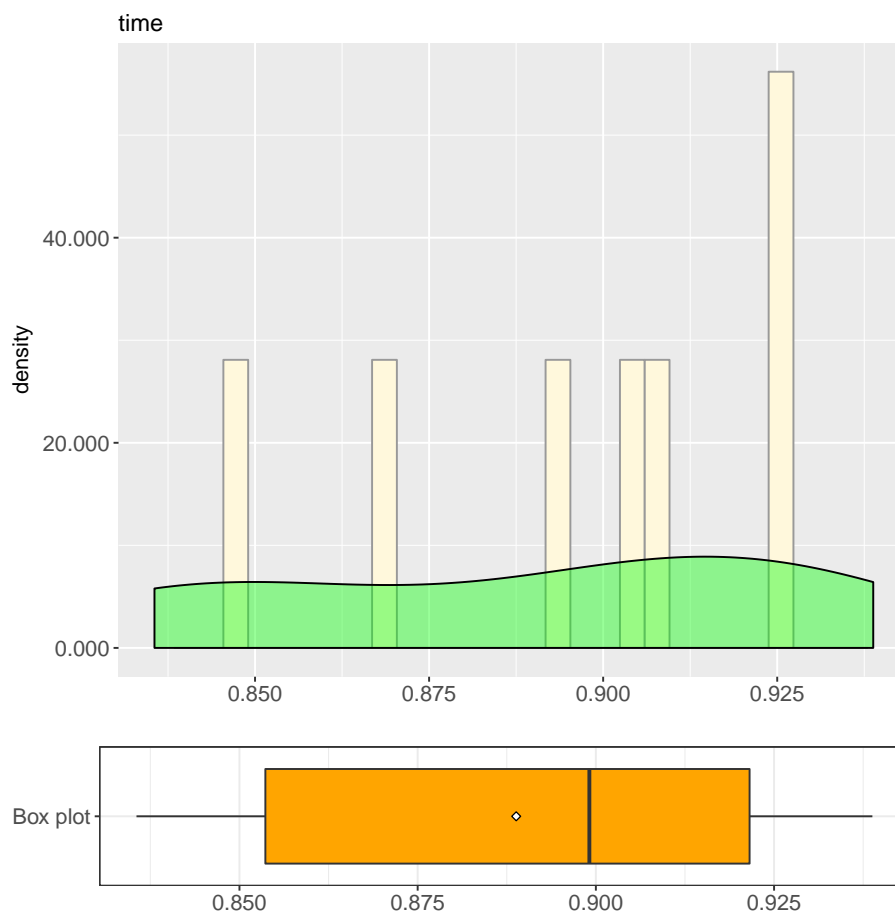


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 0, p-value = 1.083e-05
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 1.0825088224469e-05"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.8668062448501"
## [1] "Mean Runtime for Warm: 1.088253617287"
## [1] "Absolute difference: 0.2214473724369"
## Runtime for Warm is 25.5475054261054 % greater than
## Runtime for Hylaa
```

3.1.14 RH1.14: Object 951 steps

Runtime for Hylaa

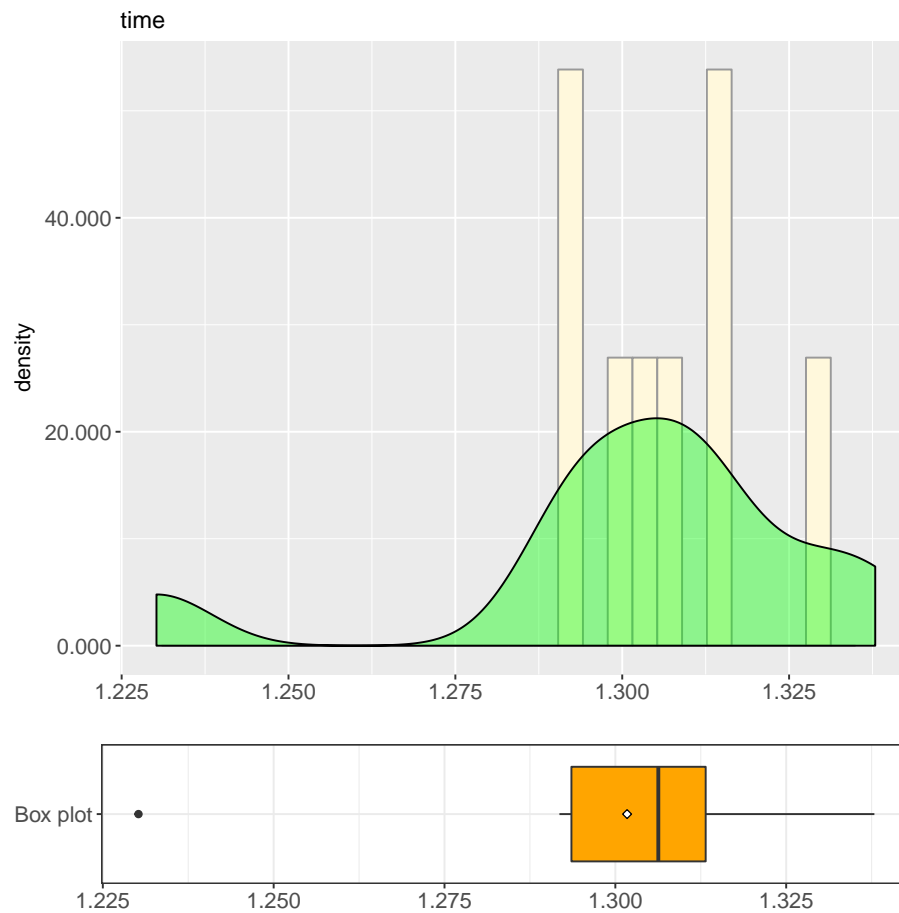
```
## [1] "Sample size: 10"  
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
## 0.8356 0.8536 0.8991 0.8888 0.9216 0.9388
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Hylaa" & object == "steps951")$time  
## W = 0.90483, p-value = 0.2474  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.247358608075924"
```

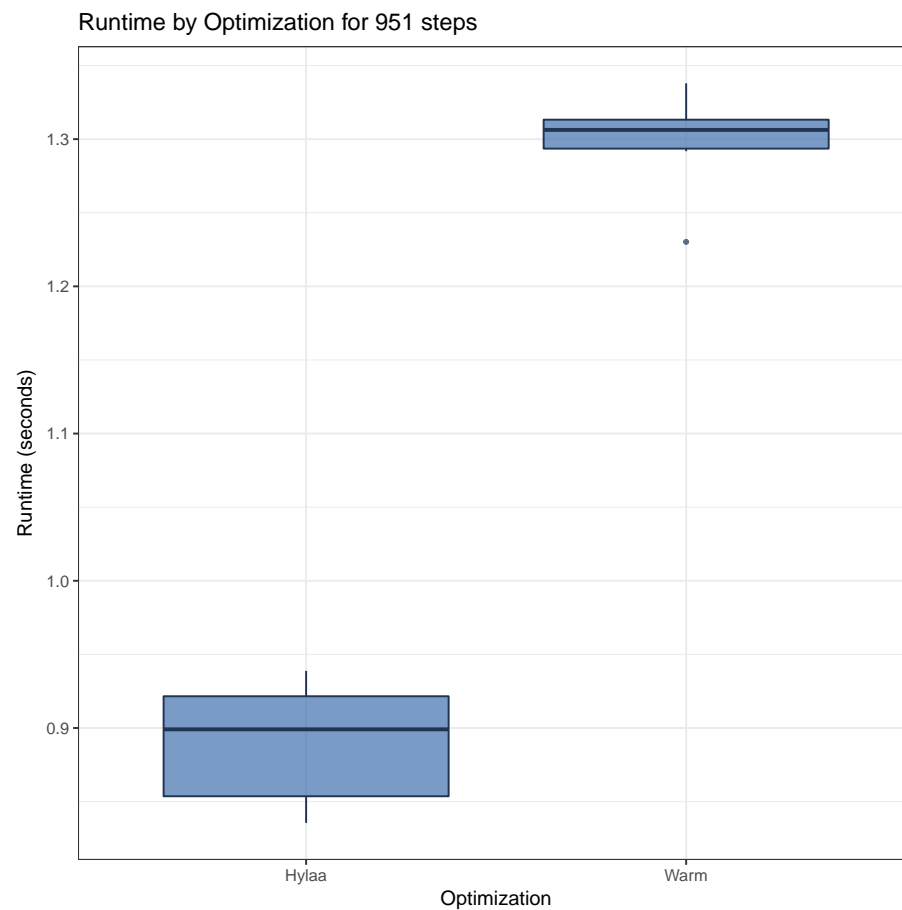
Runtime for Warm

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1.230  1.294   1.306   1.302   1.313   1.338
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Warm" & object == "steps951")$time
## W = 0.84474, p-value = 0.05027
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0502723510901298"
```

Comparison



```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps951")$time and subset(json_data, treatment == "Warm" & object == "steps951")$time
## F = 1.7784, num df = 9, denom df = 9, p-value = 0.404
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.4417271 7.1597900
## sample estimates:
## ratio of variances
##      1.778391
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.404041921624122"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

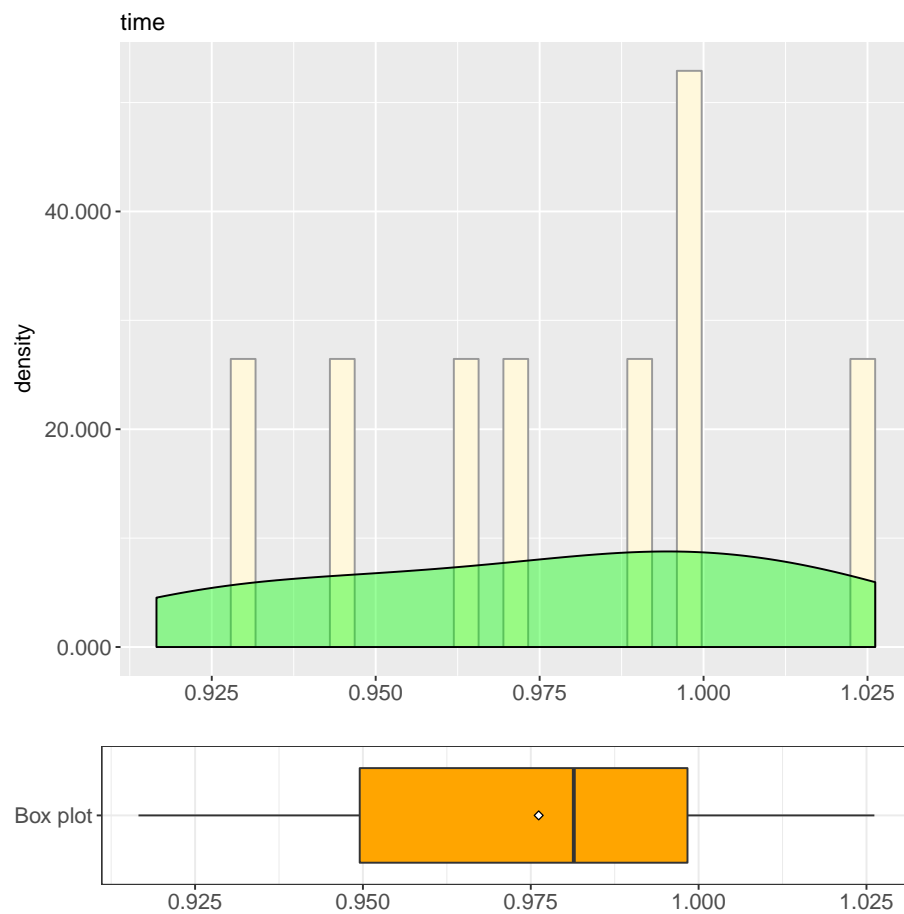


```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps951")$time and subset(js
## t = -26.866, df = 18, p-value = 5.606e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.4451837 -0.3806062
## sample estimates:
## mean of x mean of y
## 0.8888239 1.3017189
##
## [1] "T-test: Null Hypothesis rejected. P-value: 5.606416837992e-16"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.8888238906861"
## [1] "Mean Runtime for Warm: 1.301718878745"
## [1] "Absolute difference: 0.4128949880589"
## Runtime for Warm is 46.4540830175231 % greater than
## Runtime for Hylaa
```

3.1.15 RH1.15: Object 1236 steps

Runtime for Hylaa

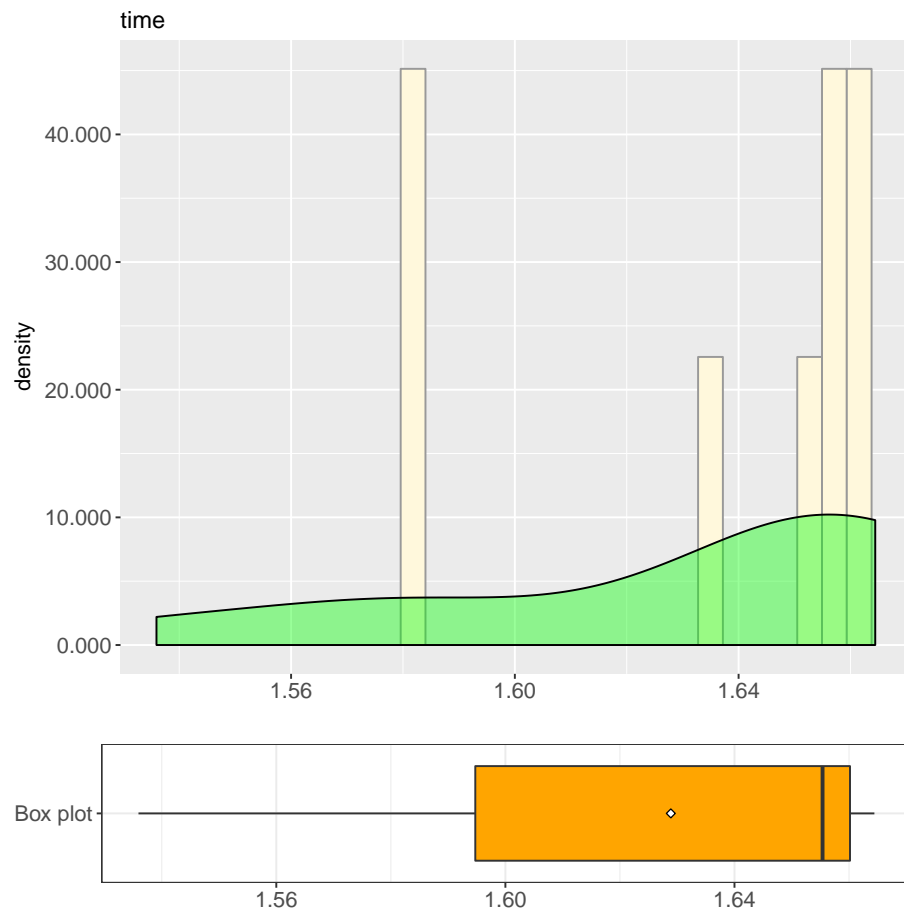
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.9166  0.9495  0.9814  0.9762  0.9983  1.0260
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps1236")$time
## W = 0.94652, p-value = 0.6275
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.627527133287823"
```

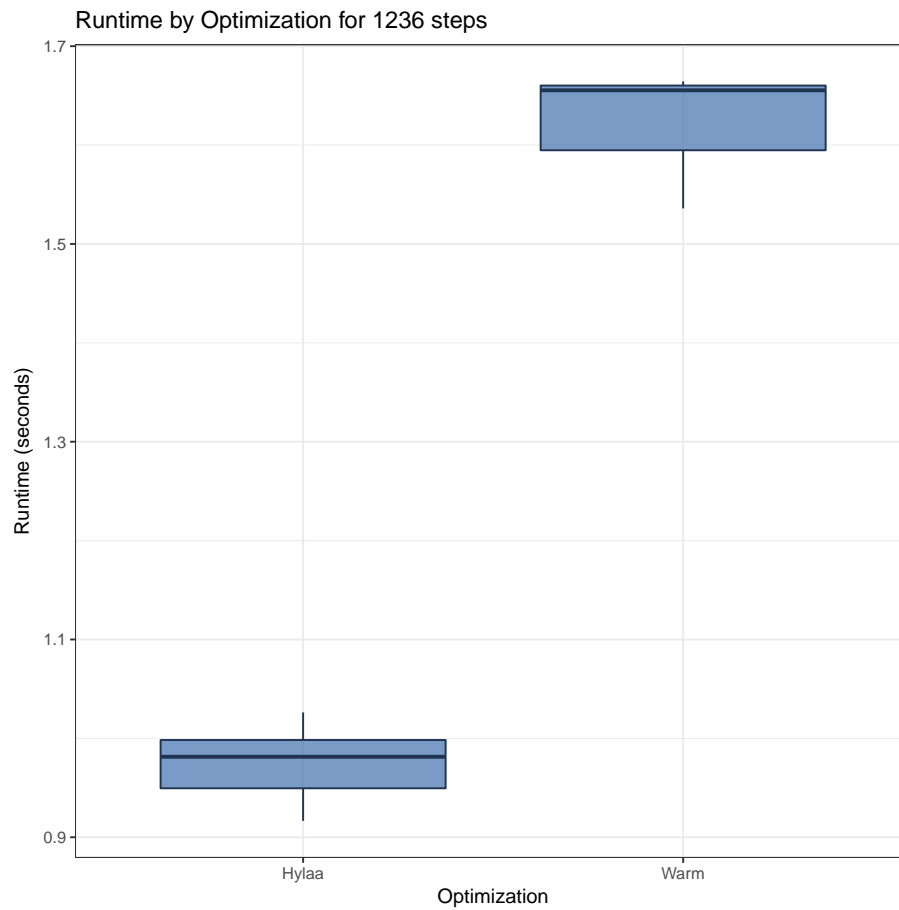
Runtime for Warm

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  1.536  1.595   1.655   1.629  1.660   1.664
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Warm" & object == "steps1236")$time
## W = 0.76803, p-value = 0.005917
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.00591727401564559"
```

Comparison

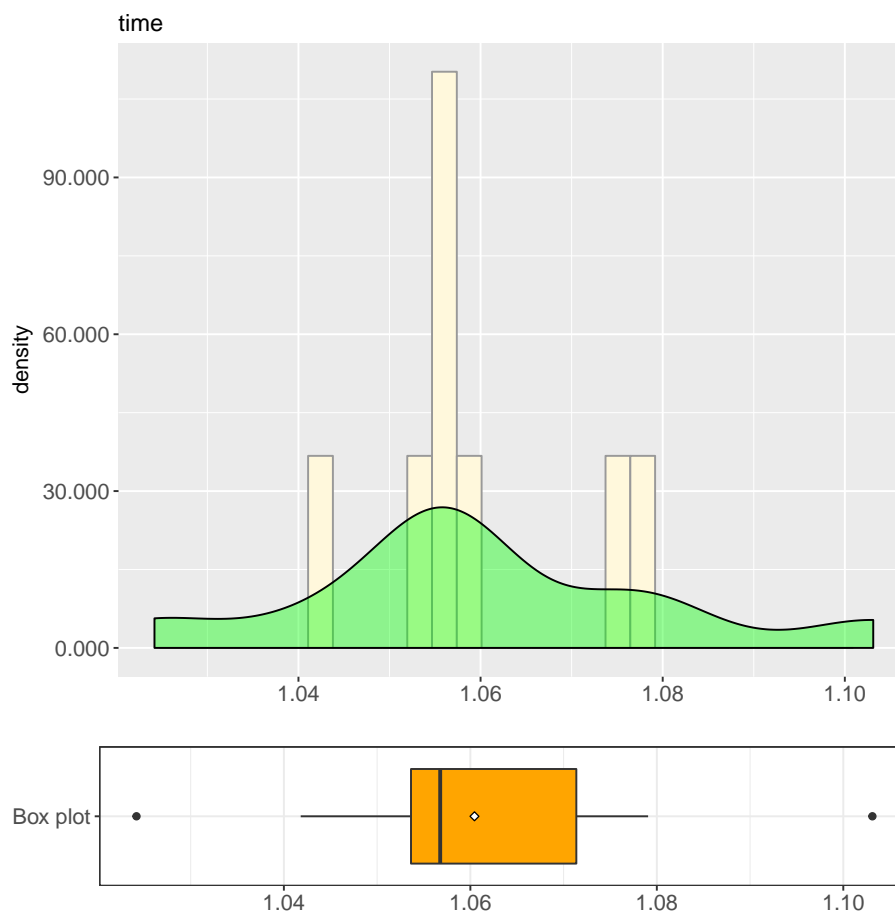


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 0, p-value = 1.083e-05
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 1.0825088224469e-05"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.9761788368224"
## [1] "Mean Runtime for Warm: 1.628886413575"
## [1] "Absolute difference: 0.6527075767526"
## Runtime for Warm is 66.8635246055175 % greater than
## Runtime for Hylaa
```

3.1.16 RH1.16: Object 1607 steps

Runtime for Hylaa

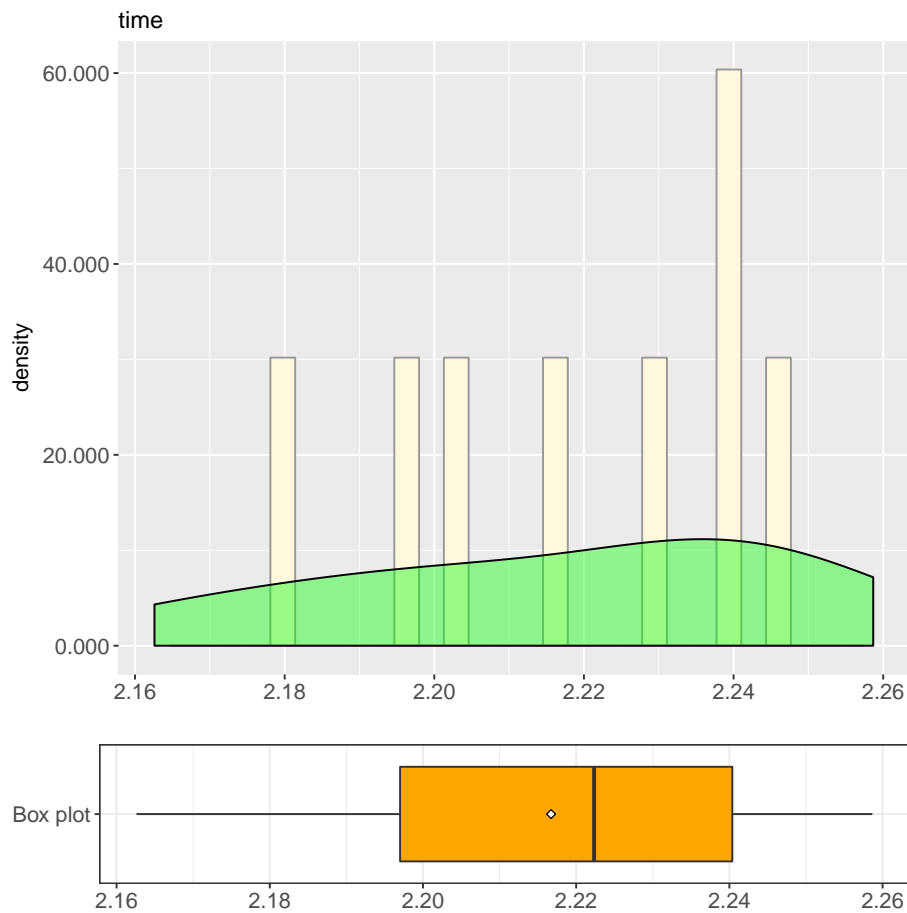
```
## [1] "Sample size: 10"  
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
## 1.024  1.054  1.057  1.060  1.071  1.103
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Hylaa" & object == "steps1607")$time  
## W = 0.9449, p-value = 0.6087  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.608652897163905"
```

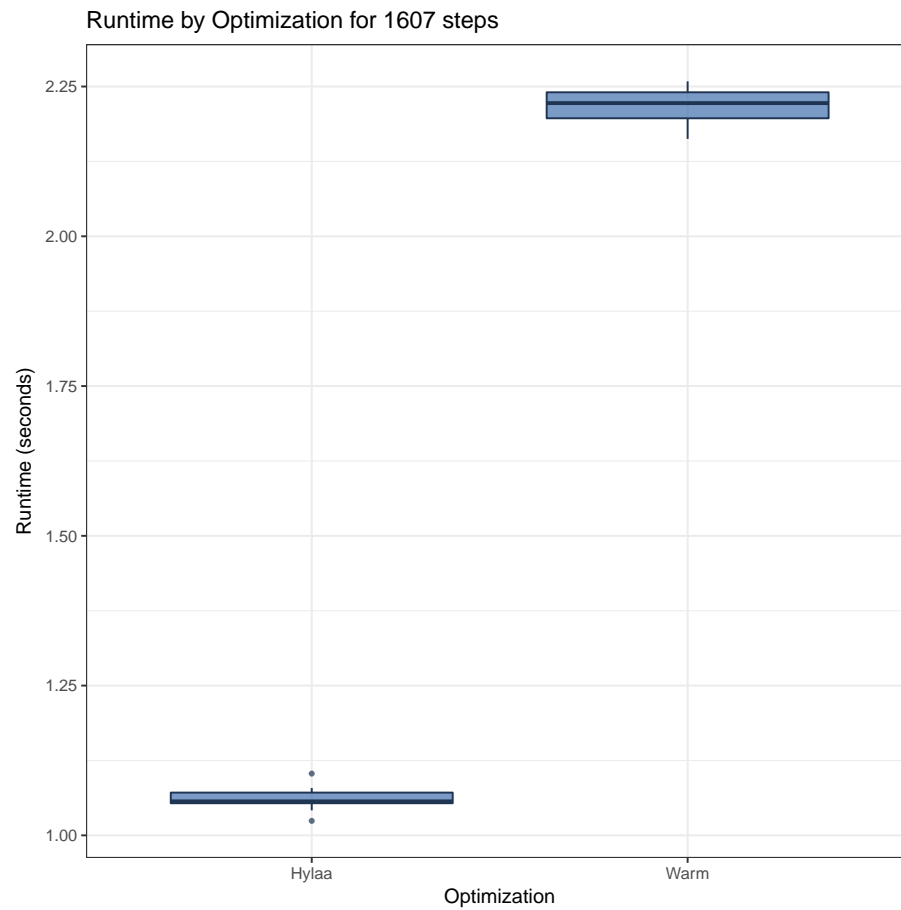
Runtime for Warm

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      2.163   2.197   2.222   2.217   2.240   2.259
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Warm" & object == "steps1607")$time
## W = 0.95354, p-value = 0.7104
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.710439408056453"
```

Comparison



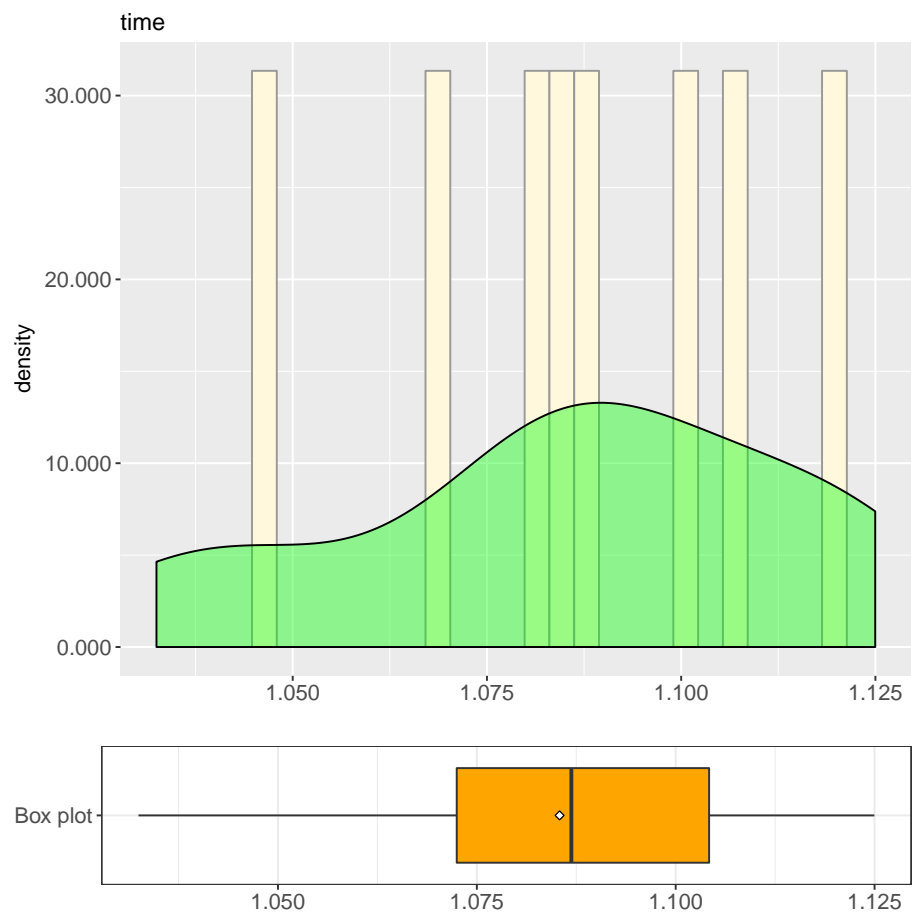
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps1607")$time and subset(j
## F = 0.4755, num df = 9, denom df = 9, p-value = 0.2833
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1181066 1.9143464
## sample estimates:
## ratio of variances
##      0.4754966
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.283340876904901"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps1607")$time and subset(j
## t = -96.424, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -1.181473 -1.131086
## sample estimates:
## mean of x mean of y
## 1.060442 2.216722
##
## [1] "T-test: Null Hypothesis rejected. P-value: 6.97024301271417e-26"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.060442185402"
## [1] "Mean Runtime for Warm: 2.216721510887"
## [1] "Absolute difference: 1.156279325485"
## Runtime for Warm is 109.037469595447 % greater than
## Runtime for Hylaa
```

3.1.17 RH1.17: Object 2089 steps

Runtime for Hylaa

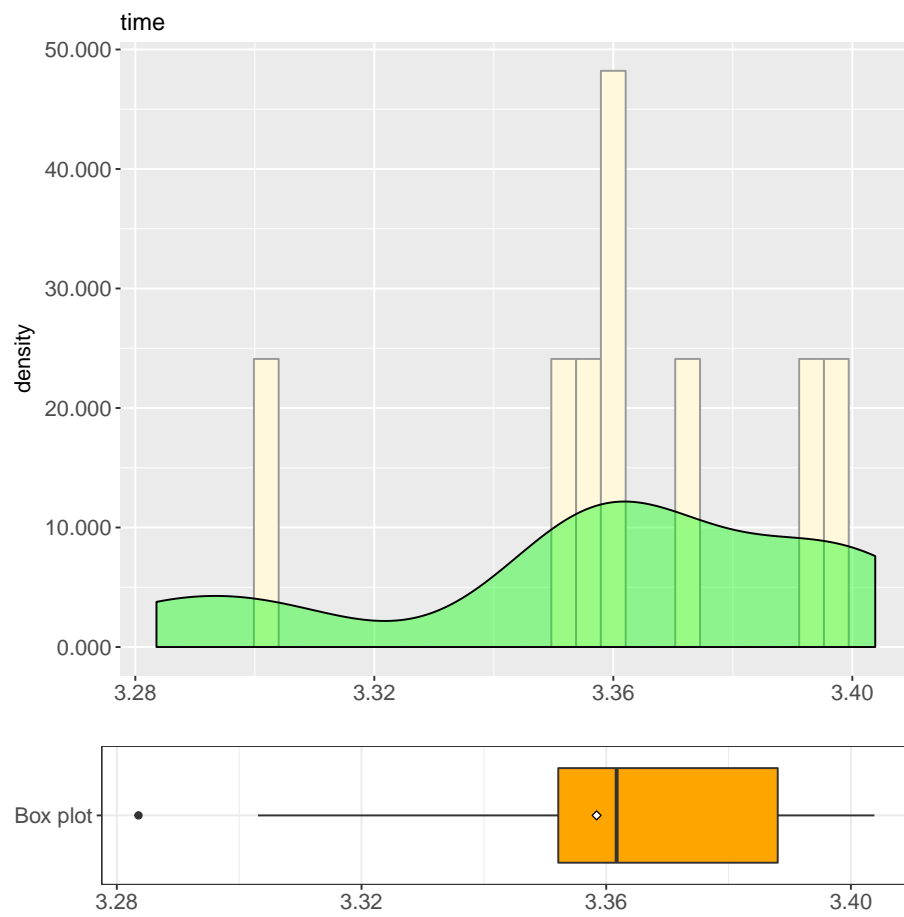
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 1.032   1.072   1.087   1.085   1.104   1.125
```

```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps2089")$time
## W = 0.96099, p-value = 0.7971
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.797065263315739"
```

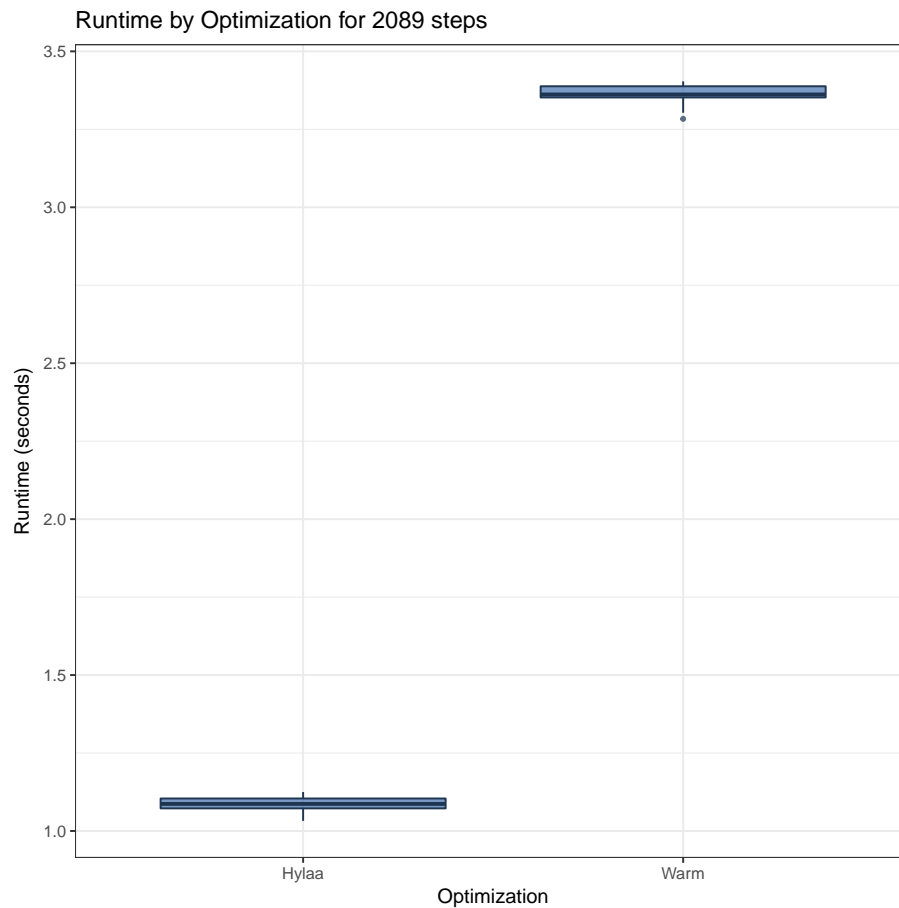
Runtime for Warm

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   3.284  3.352  3.362   3.358  3.388   3.404
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Warm" & object == "steps2089")$time
## W = 0.90037, p-value = 0.2212
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.221178709949945"
```

Comparison



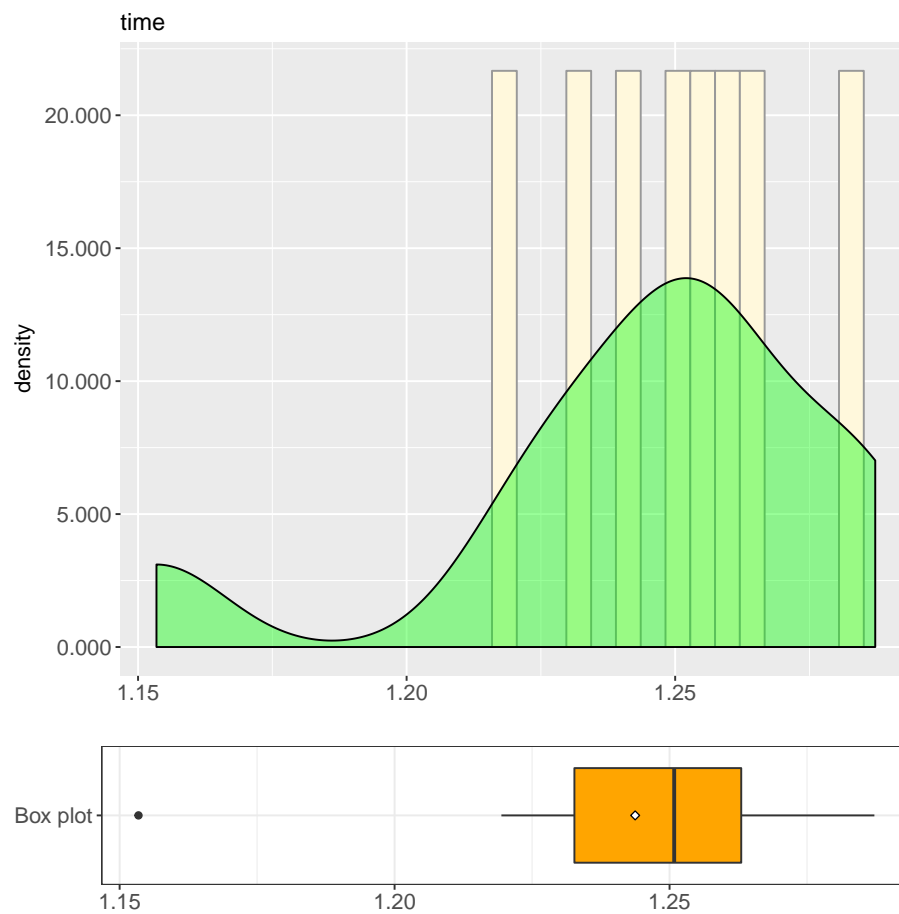
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps2089")$time and subset(json_data, treatment == "Warm" & object == "steps2089")$time
## F = 0.56761, num df = 9, denom df = 9, p-value = 0.4116
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1409856 2.2851830
## sample estimates:
## ratio of variances
##      0.5676071
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.411647724417158"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps2089")$time and subset(j
## t = -146.37, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -2.305652 -2.240401
## sample estimates:
## mean of x mean of y
## 1.085403 3.358430
##
## [1] "T-test: Null Hypothesis rejected. P-value: 3.84104938317838e-29"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.085403156281"
## [1] "Mean Runtime for Warm: 3.358429694177"
## [1] "Absolute difference: 2.273026537896"
## Runtime for Warm is 209.417719558163 % greater than
## Runtime for Hylaa
```

3.1.18 RH1.18: Object 2716 steps

Runtime for Hylaa

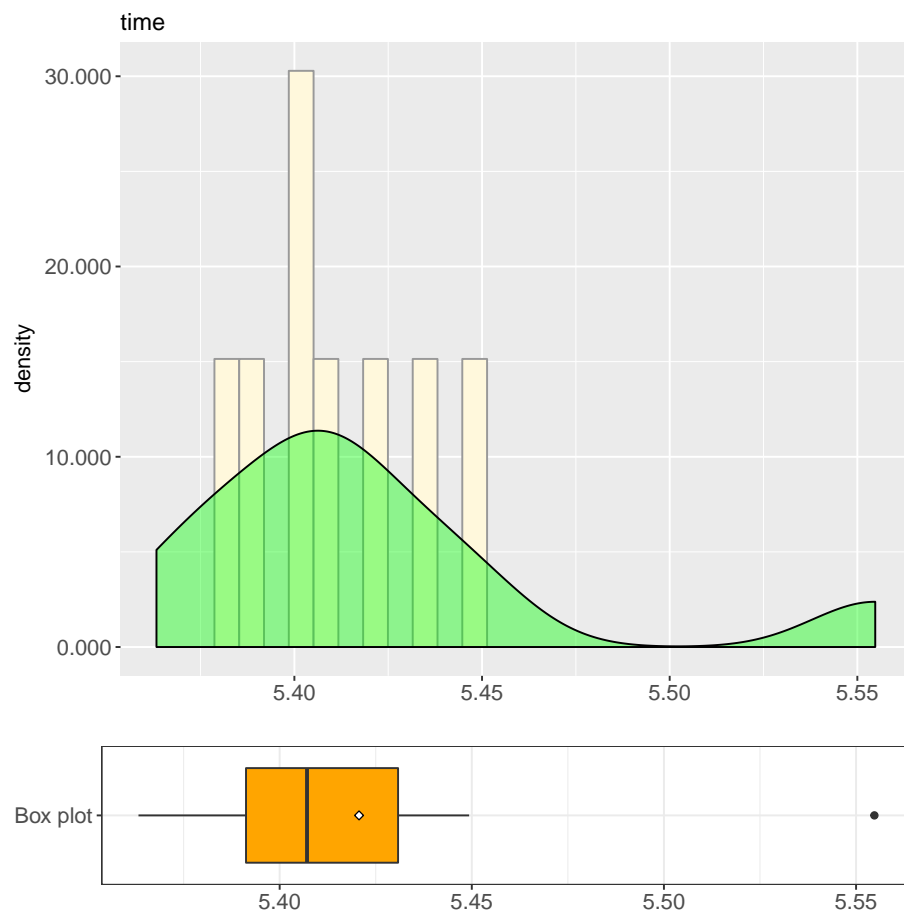
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1.153   1.233   1.251   1.244   1.263   1.287
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps2716")$time
## W = 0.87909, p-value = 0.1274
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.12738118267151"
```

Runtime for Warm

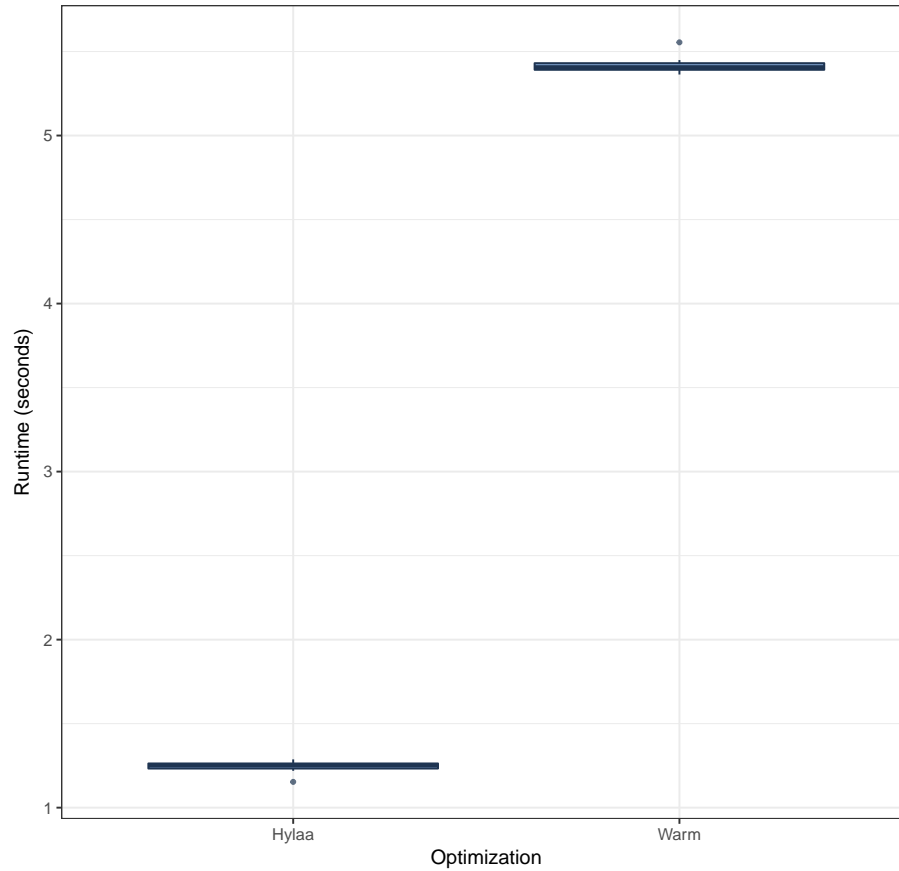
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  5.363  5.391  5.407  5.421  5.431  5.555
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Warm" & object == "steps2716")$time
## W = 0.81793, p-value = 0.02392
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.0239209631124515"
```

Comparison

Runtime by Optimization for 2716 steps

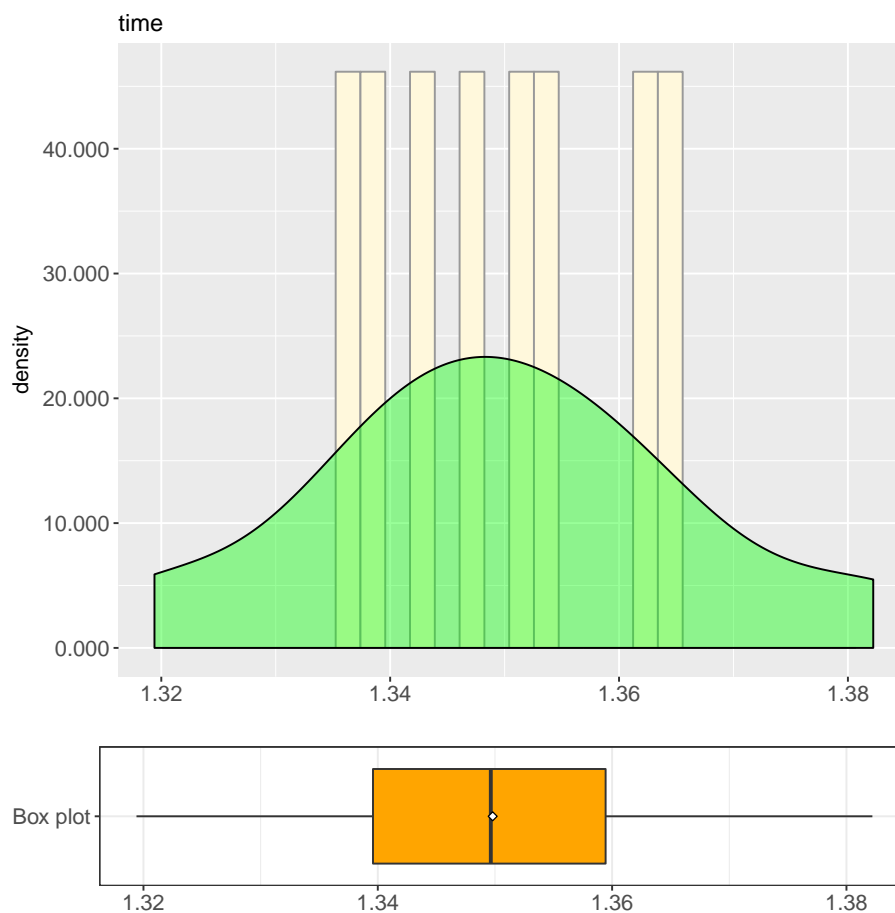


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 0, p-value = 1.083e-05
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 1.0825088224469e-05"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.243748641014"
## [1] "Mean Runtime for Warm: 5.420654869079"
## [1] "Absolute difference: 4.176906228065"
## Runtime for Warm is 335.832023475392 % greater than
## Runtime for Hylaa
```

3.1.19 RH1.19: Object 3531 steps

Runtime for Hylaa

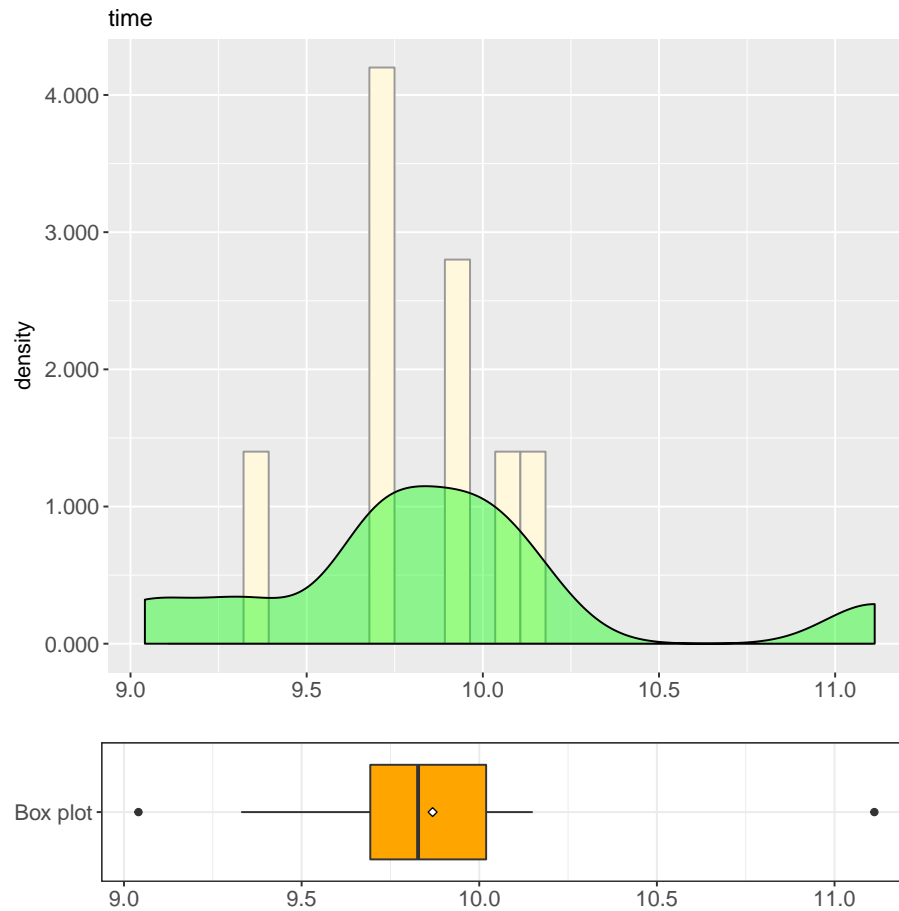
```
## [1] "Sample size: 10"  
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
##  1.319  1.340   1.350   1.350  1.359   1.382
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Hylaa" & object == "steps3531")$time  
## W = 0.98776, p-value = 0.9933  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.993277943776764"
```

Runtime for Warm

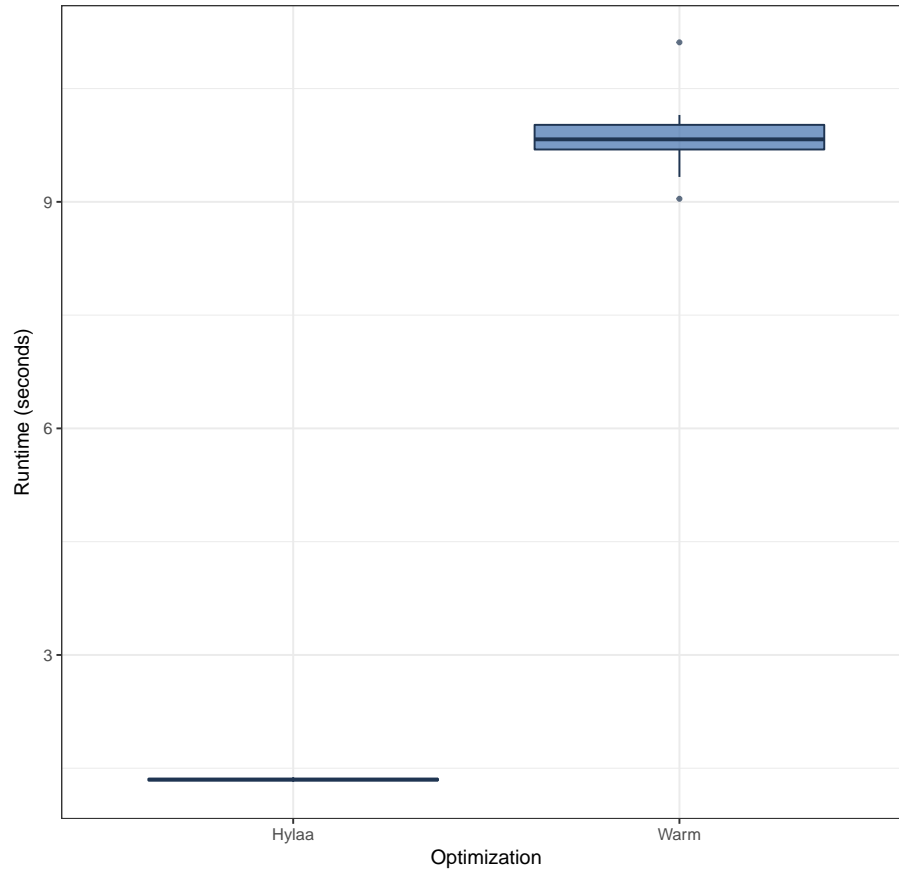

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      9.041   9.693   9.828   9.869  10.020  11.110
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Warm" & object == "steps3531")$time
## W = 0.90929, p-value = 0.2761
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.276148745026355"
```

Comparison

Runtime by Optimization for 3531 steps



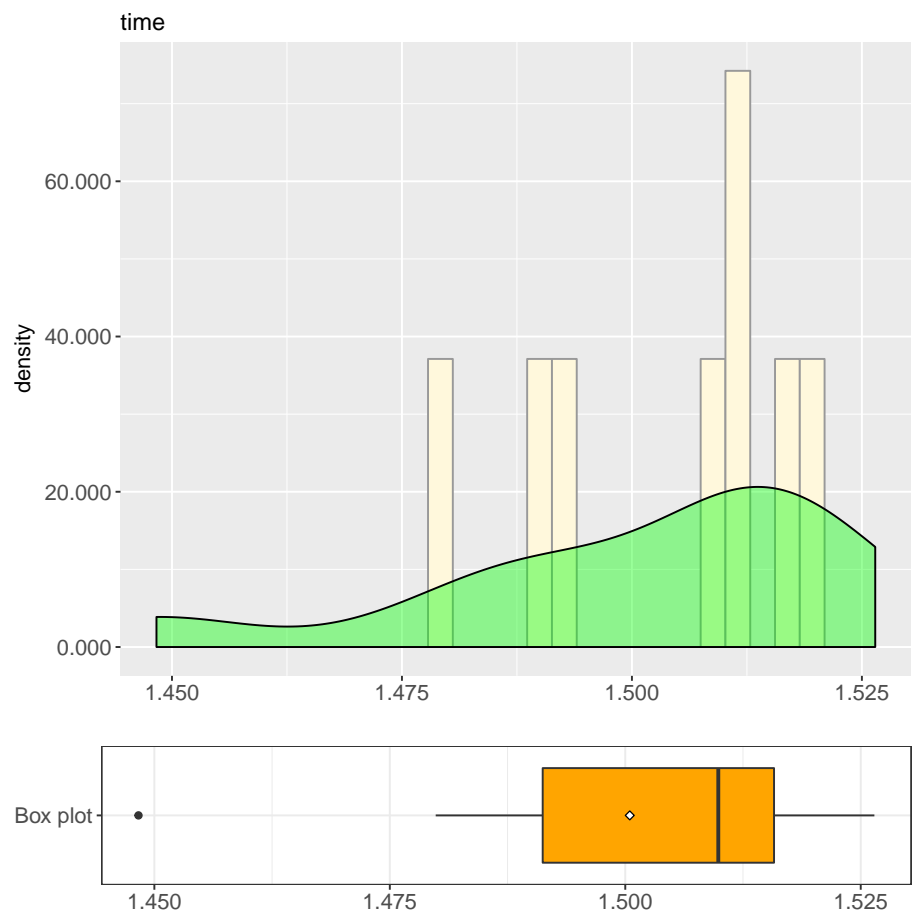
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps3531")$time and subset(json_data, treatment == "Warm" & object == "steps3531")$time
## F = 0.00099512, num df = 9, denom df = 9, p-value = 4.067e-12
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.0002471728 0.0040063328
## sample estimates:
## ratio of variances
##      0.0009951164
##
## [1] "Homogeneity of variances: FALSE. P-value: 4.06725449957138e-12"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Welch Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps3531")$time and subset(j
## t = -49.035, df = 9.0179, p-value = 2.934e-12
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -8.911765 -8.125987
## sample estimates:
## mean of x mean of y
## 1.349807 9.868683
##
## [1] "T-test: Null Hypothesis rejected. P-value: 2.9337317042939e-12"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.349807333946"
## [1] "Mean Runtime for Warm: 9.868683362008"
## [1] "Absolute difference: 8.518876028062"
## Runtime for Warm is 631.117924300951 % greater than
## Runtime for Hylaa
```

3.1.20 RH1.20: Object 4590 steps

Runtime for Hylaa

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 1.448  1.491  1.510  1.500  1.516  1.526
```

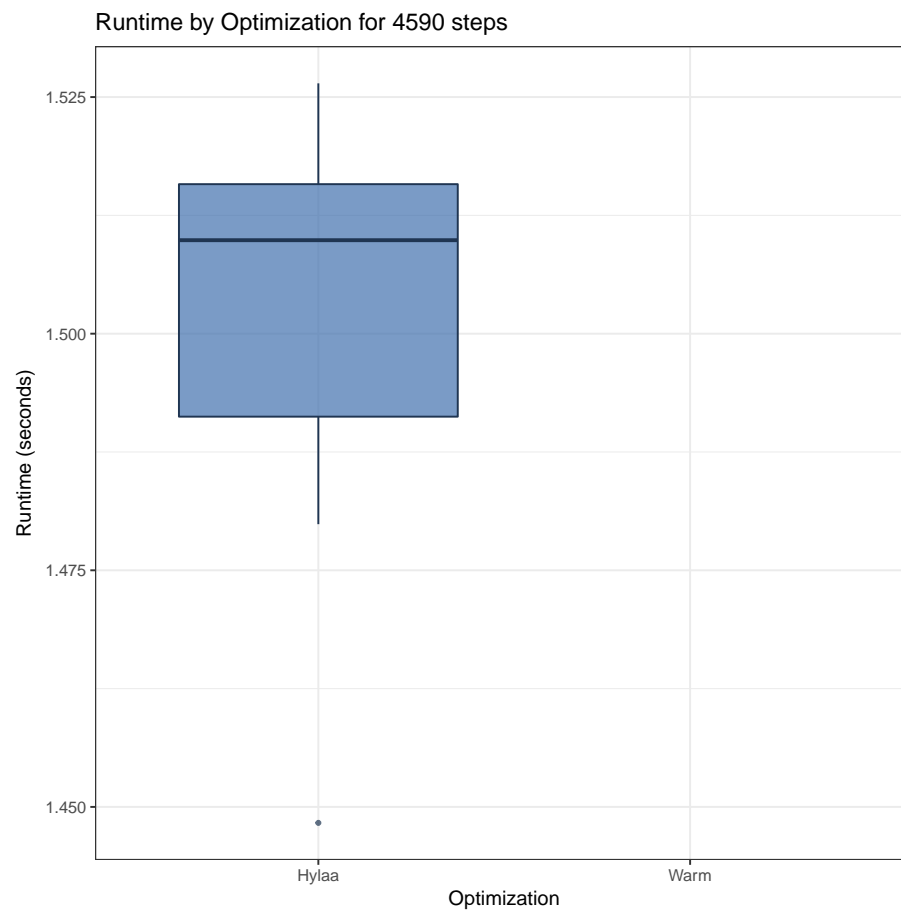


```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps4590")$time
## W = 0.88116, p-value = 0.1346
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.134566691717643"
```

Runtime for Warm

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA    10
```

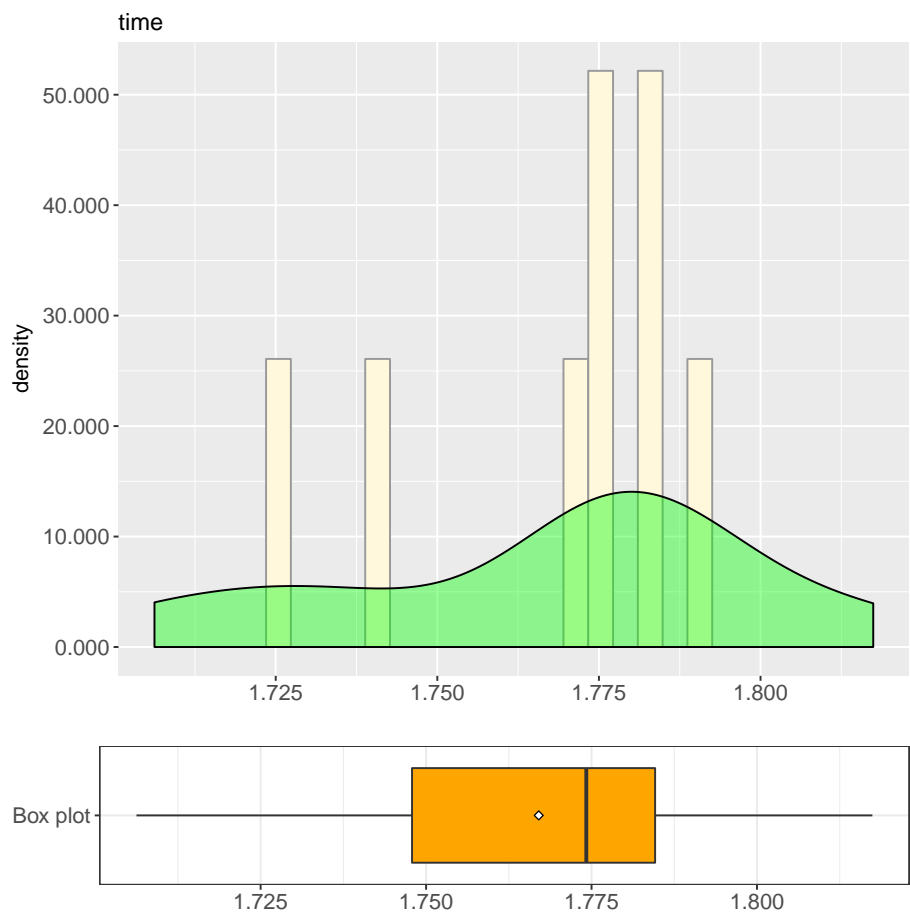
Comparison



3.1.21 RH1.21: Object 5967 steps

Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  1.706  1.748   1.774   1.767   1.785   1.817
```

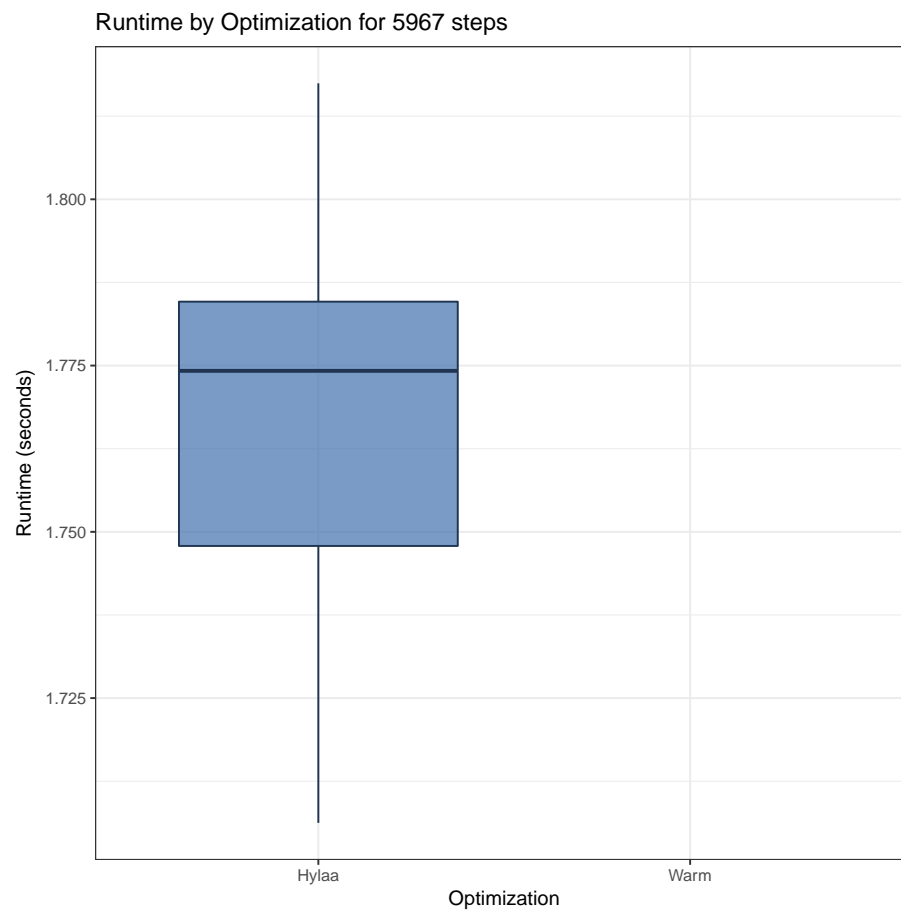


```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps5967")$time
## W = 0.93205, p-value = 0.4683
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.468324949837865"
```

Runtime for Warm

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA     NA    10
```

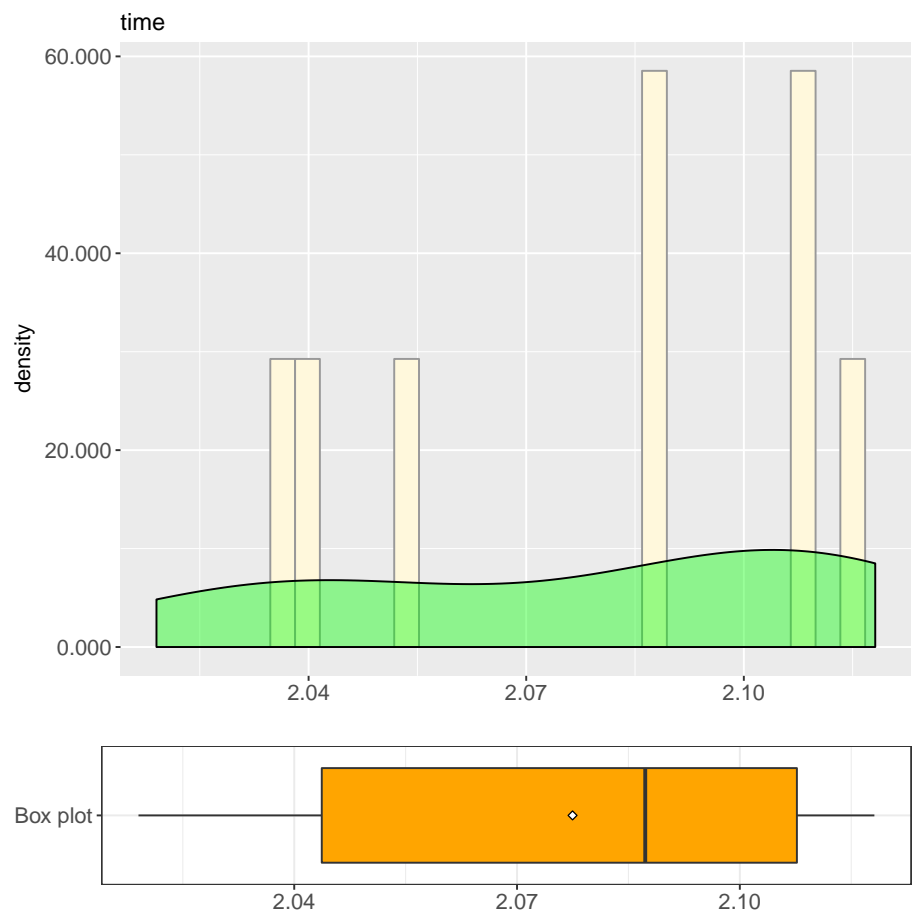
Comparison



3.1.22 RH1.22: Object 7757 steps

Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   2.019  2.044   2.087   2.077   2.108   2.118
```

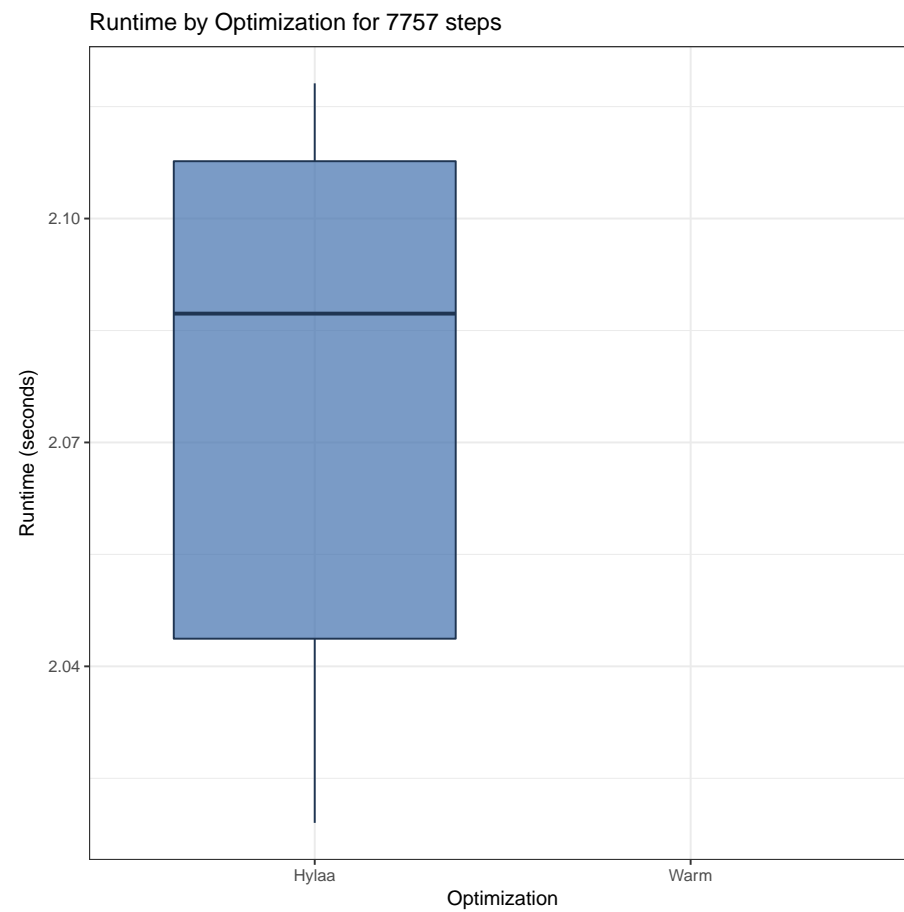


```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps7757")$time
## W = 0.89136, p-value = 0.1756
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.175640560398436"
```

Runtime for Warm

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA    10
```

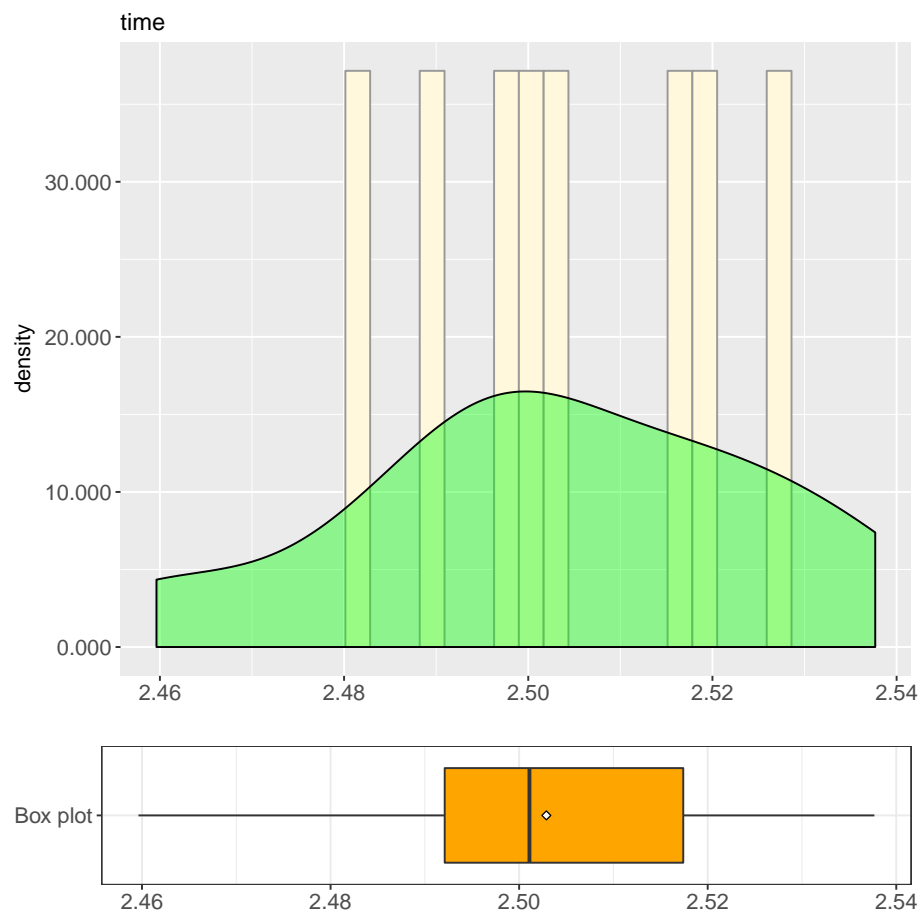
Comparison



3.1.23 RH1.23: Object 10085 steps

Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   2.460  2.492  2.501   2.503  2.517   2.538
```

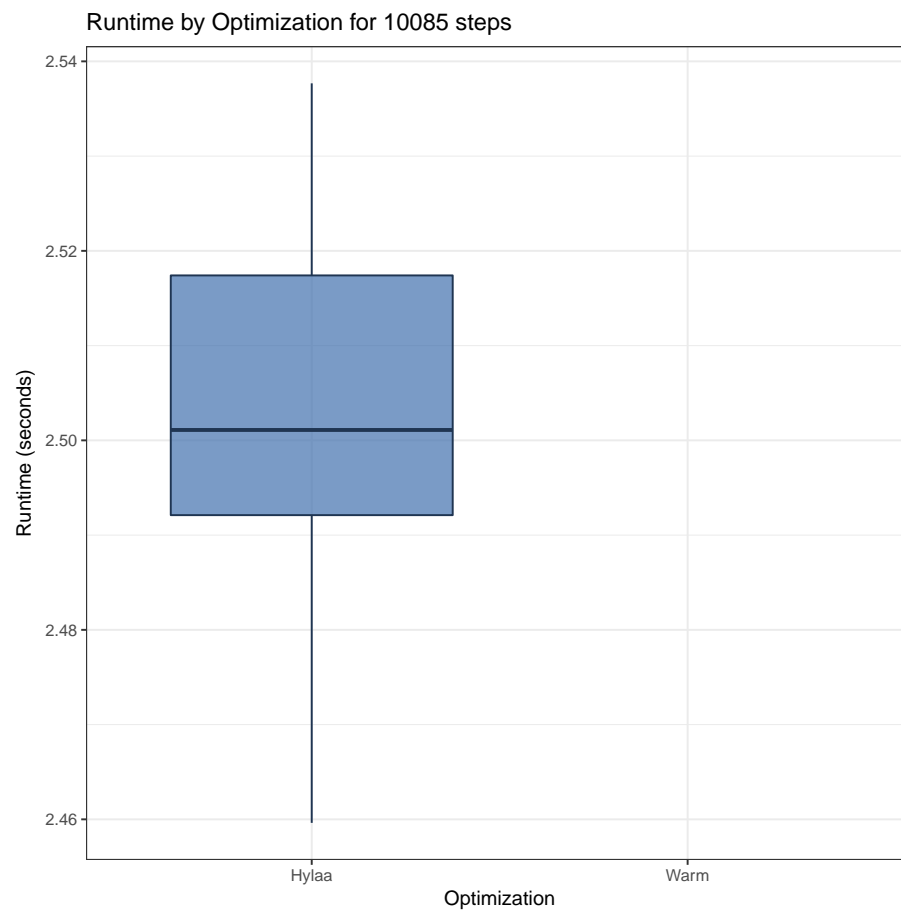


```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps10085")$time
## W = 0.98381, p-value = 0.9823
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.982277067638566"
```

Runtime for Warm

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA    10
```

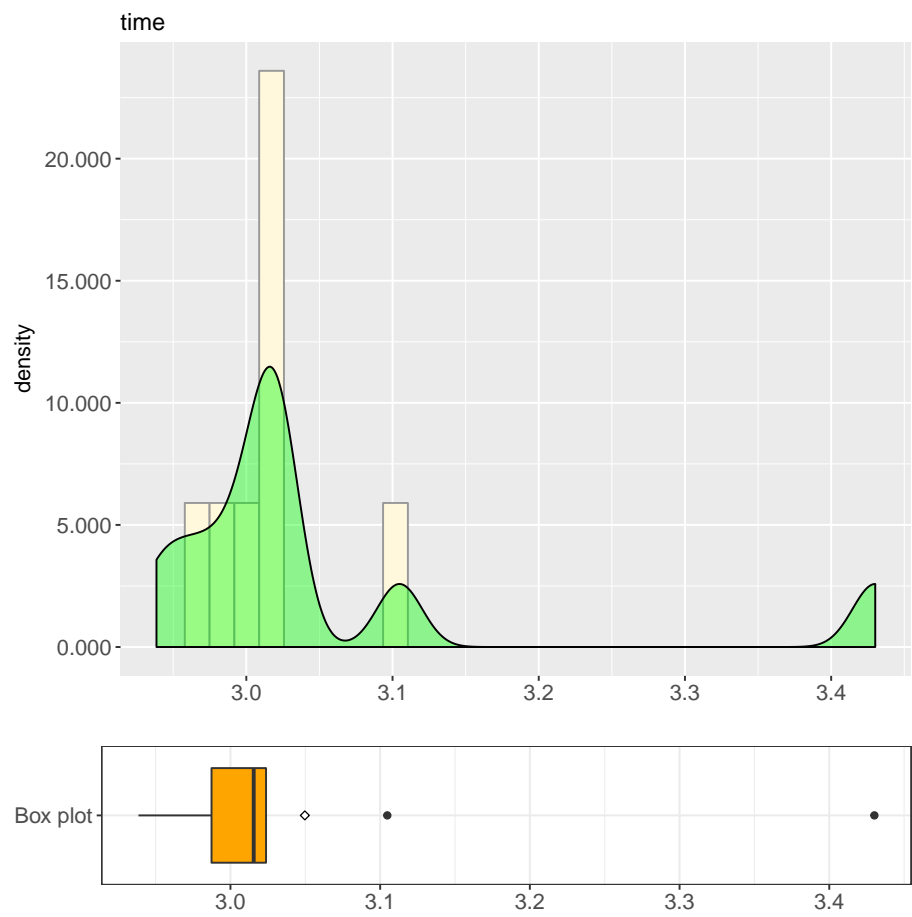
Comparison



3.1.24 RH1.24: Object 13110 steps

Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   2.939  2.987   3.016   3.050   3.024   3.430
```

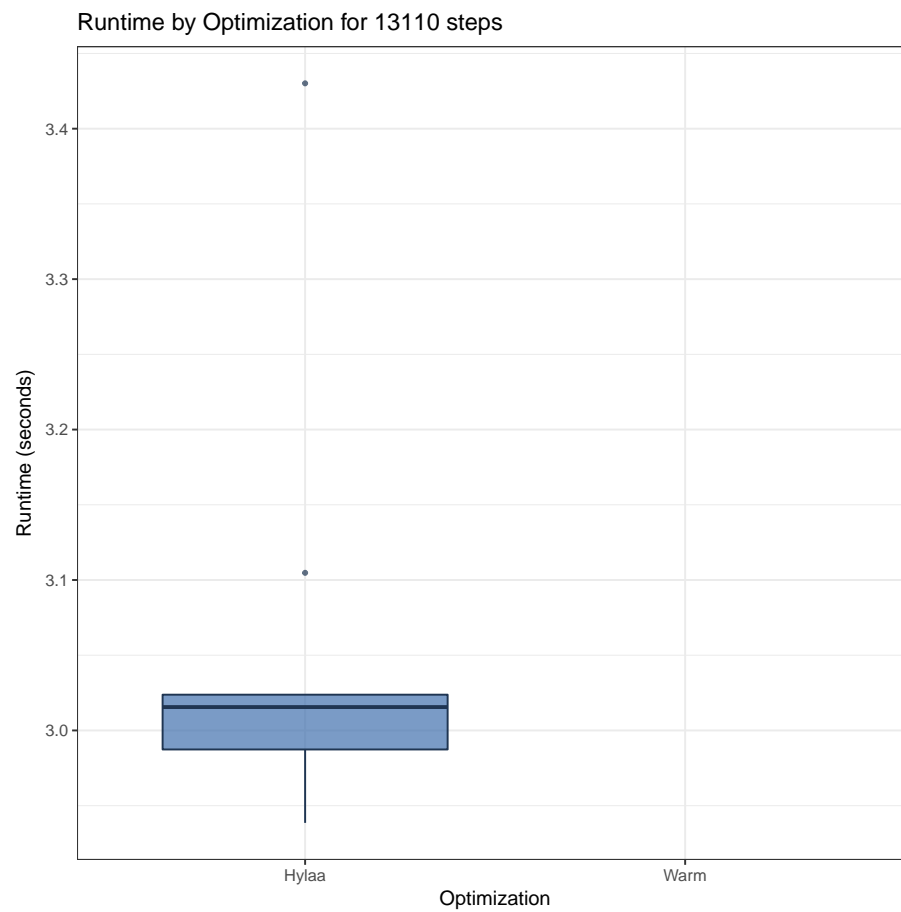


```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps13110")$time
## W = 0.65237, p-value = 0.0002343
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.000234335774565787"
```

Runtime for Warm

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA    10
```

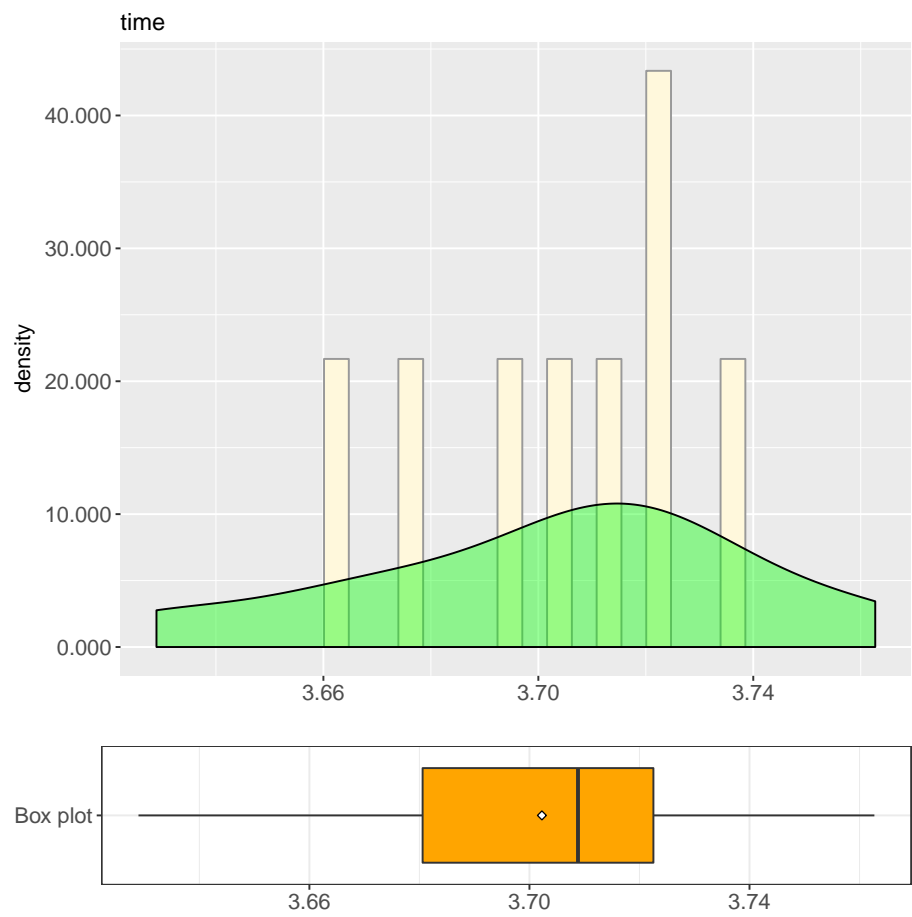
Comparison



3.1.25 RH1.25: Object 17043 steps

Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   3.629  3.681   3.709   3.702   3.723   3.763
```

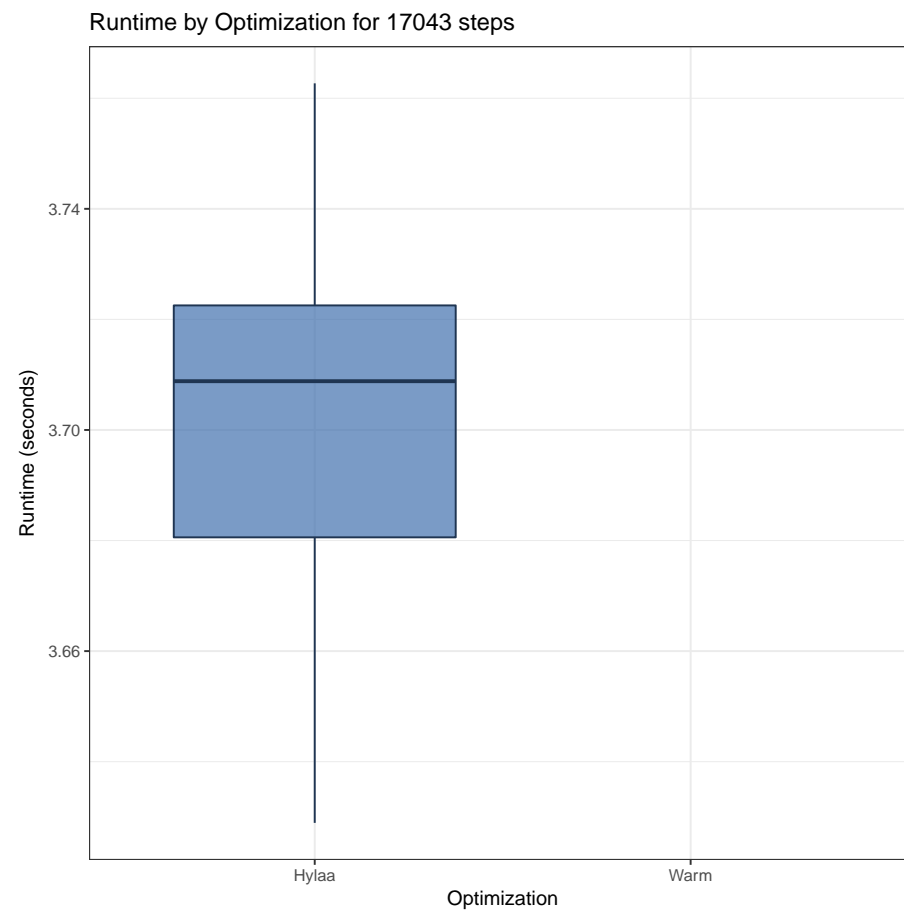


```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps17043")$time
## W = 0.97882, p-value = 0.9585
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.958546785330543"
```

Runtime for Warm

```
## [1] "Sample size:  0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    NA      NA     NA     NaN    NA      NA      10
```

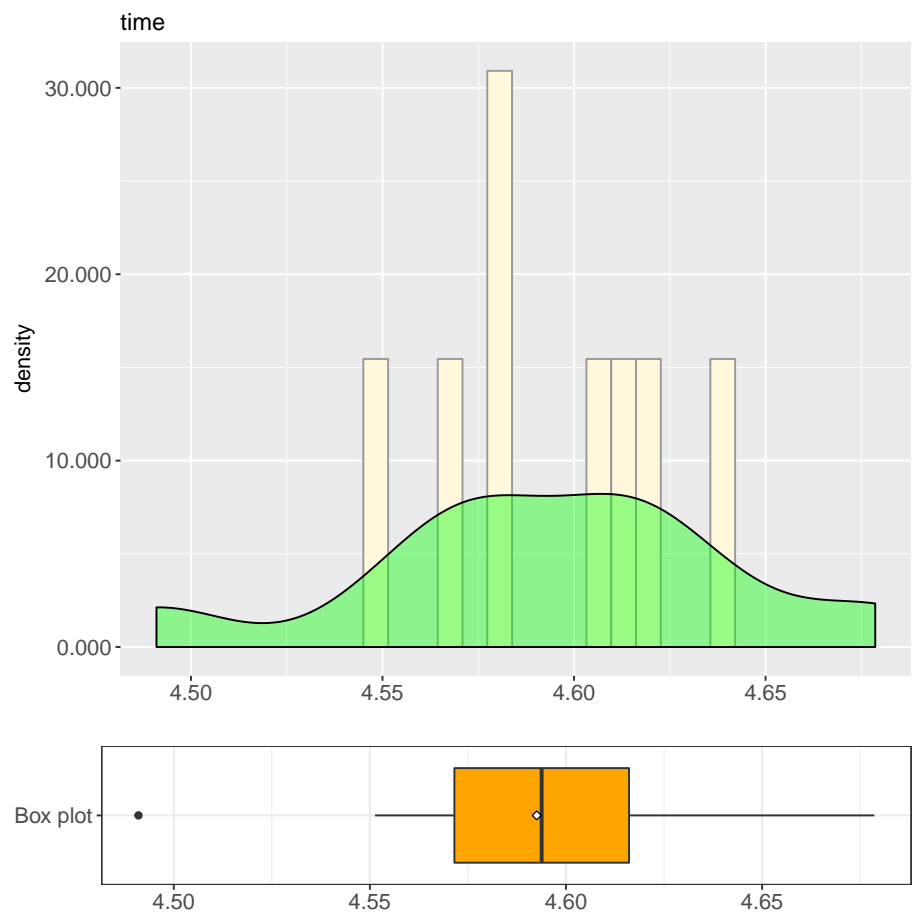
Comparison



3.1.26 RH1.26: Object 22157 steps

Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  4.491  4.572  4.594  4.593  4.616  4.679
```

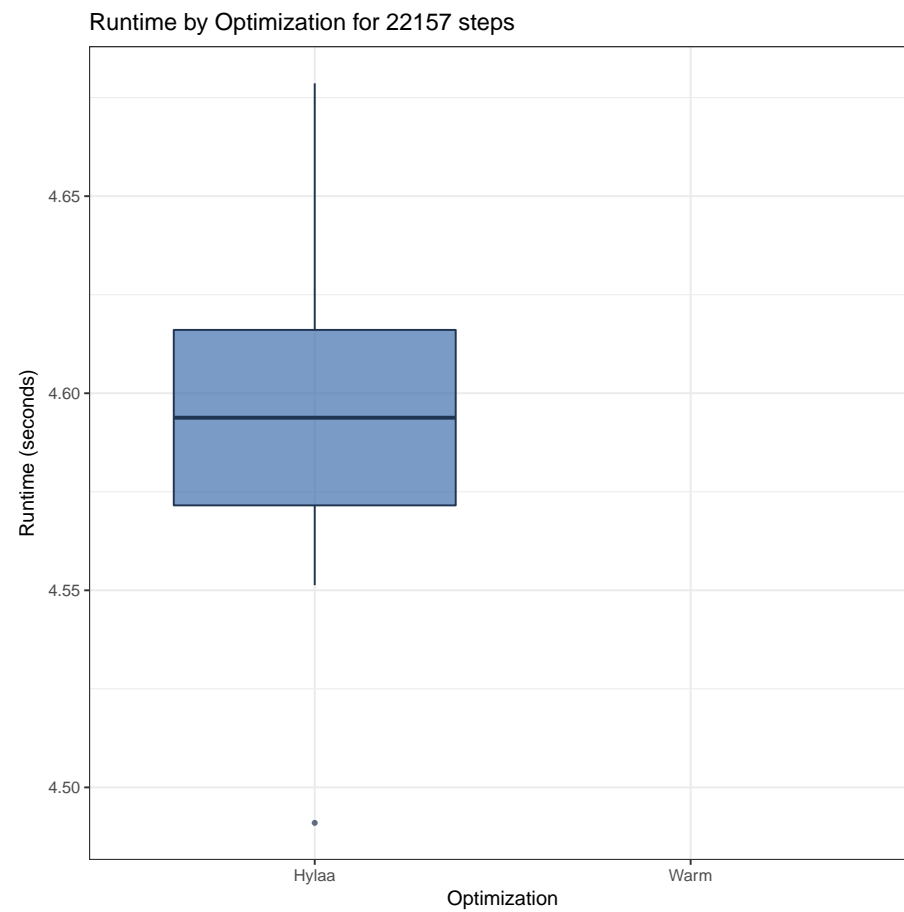


```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps22157")$time
## W = 0.97327, p-value = 0.9194
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.919388955922961"
```

Runtime for Warm

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    NA      NA      NA     NaN     NA     NA     10
```

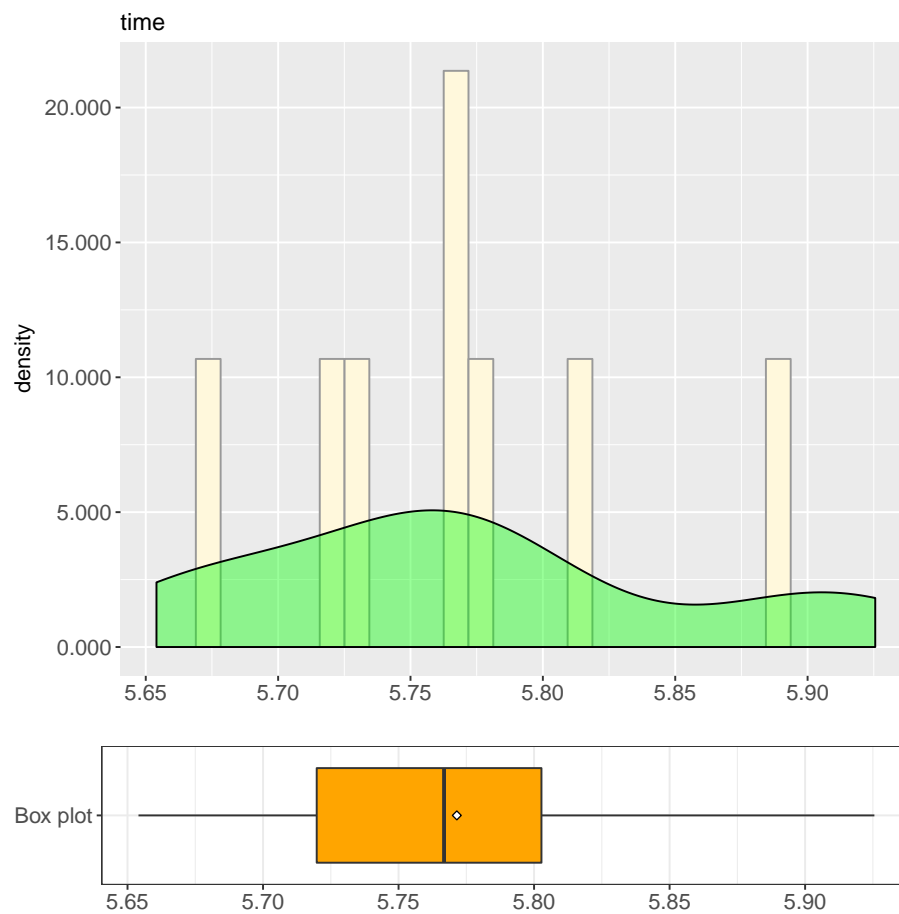
Comparison



3.1.27 RH1.27: Object 28804 steps

Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   5.654   5.720   5.767   5.771   5.803   5.926
```

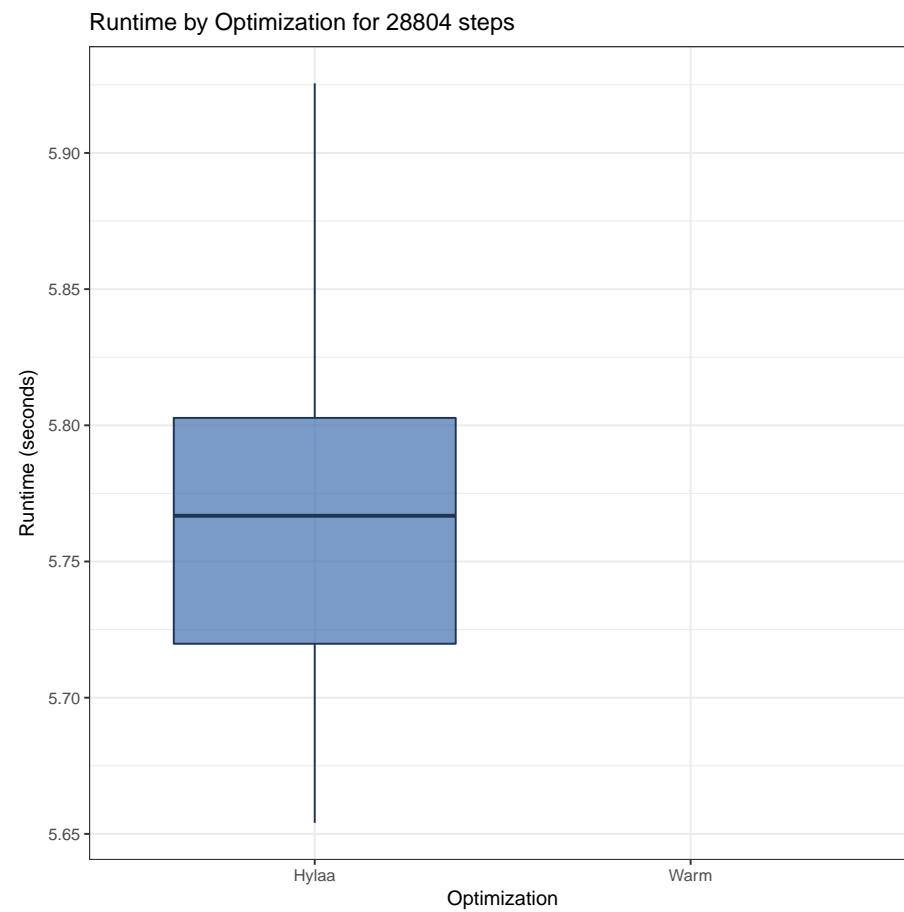


```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps28804")$time
## W = 0.94971, p-value = 0.6651
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.66510382139283"
```

Runtime for Warm

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA     10
```

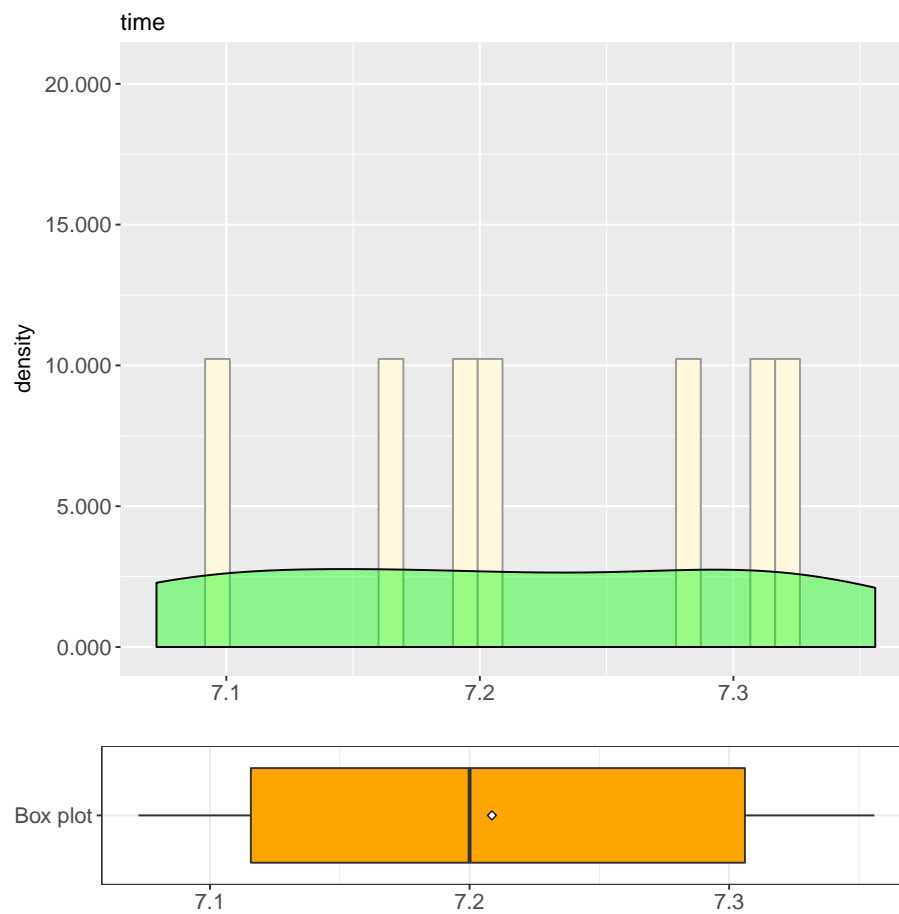
Comparison



3.1.28 RH1.28: Object 37445 steps

Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   7.072  7.116   7.200   7.209   7.306   7.356
```

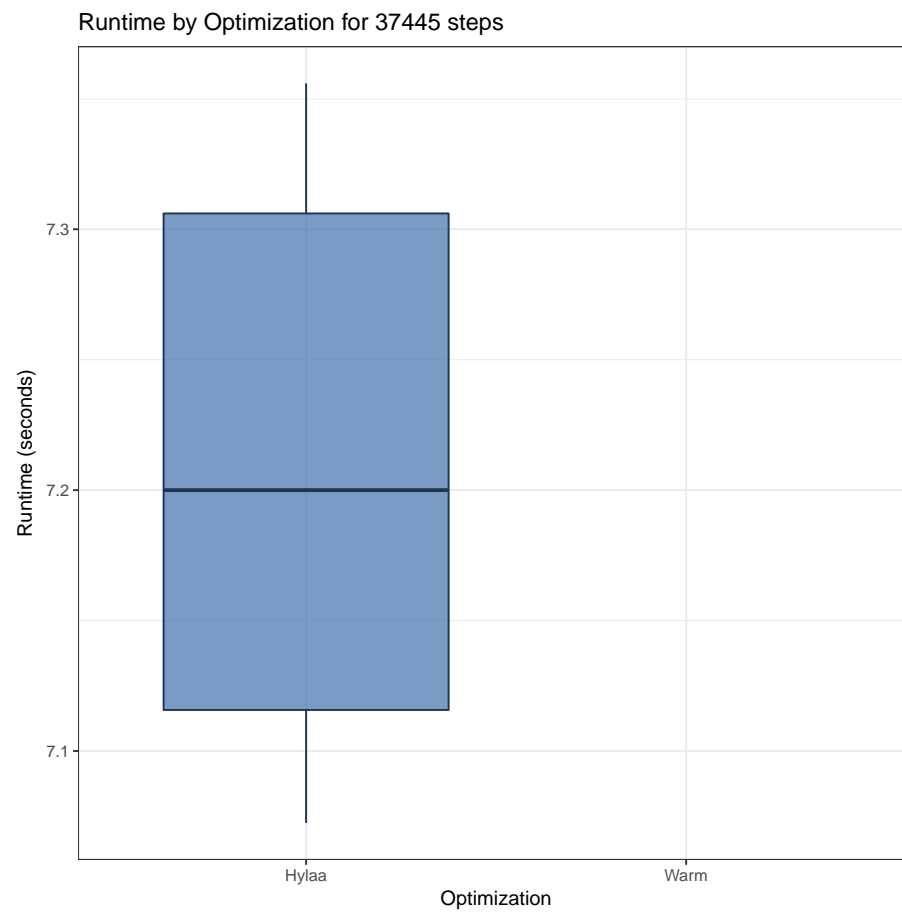


```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps37445")$time
## W = 0.91587, p-value = 0.3238
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.32377452748614"
```

Runtime for Warm

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA      NA     NaN     NA      NA     10
```

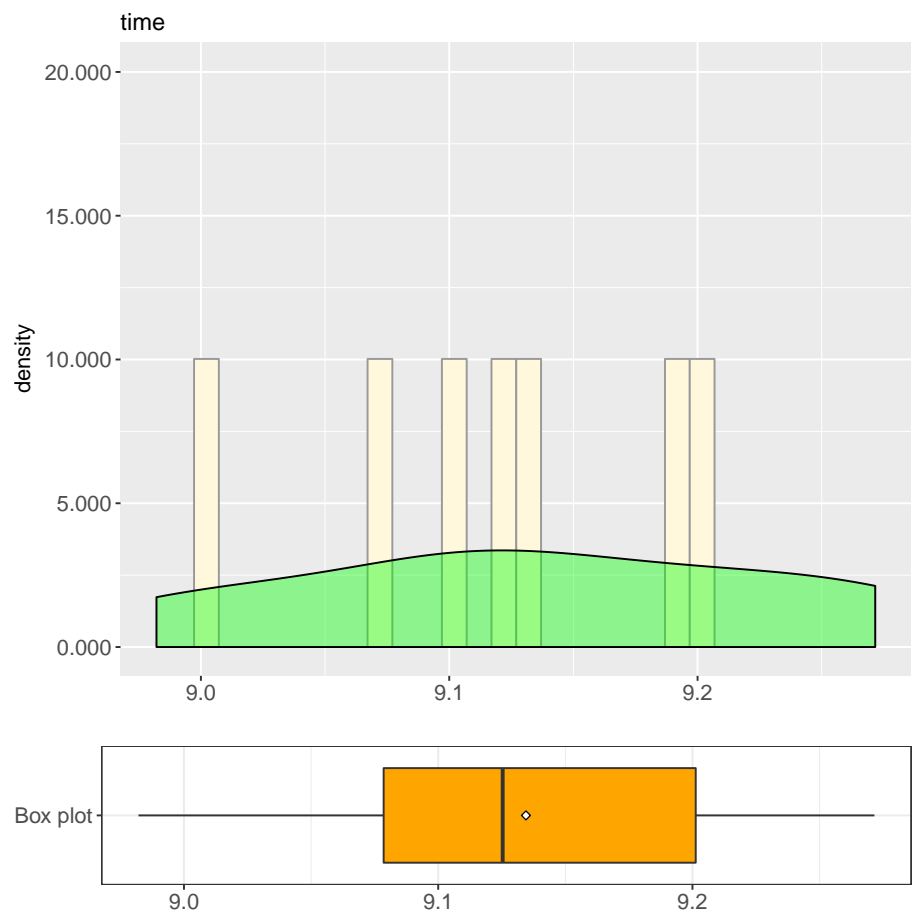
Comparison



3.1.29 RH1.29: Object 48679 steps

Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   8.982  9.079   9.125   9.135   9.201   9.272
```

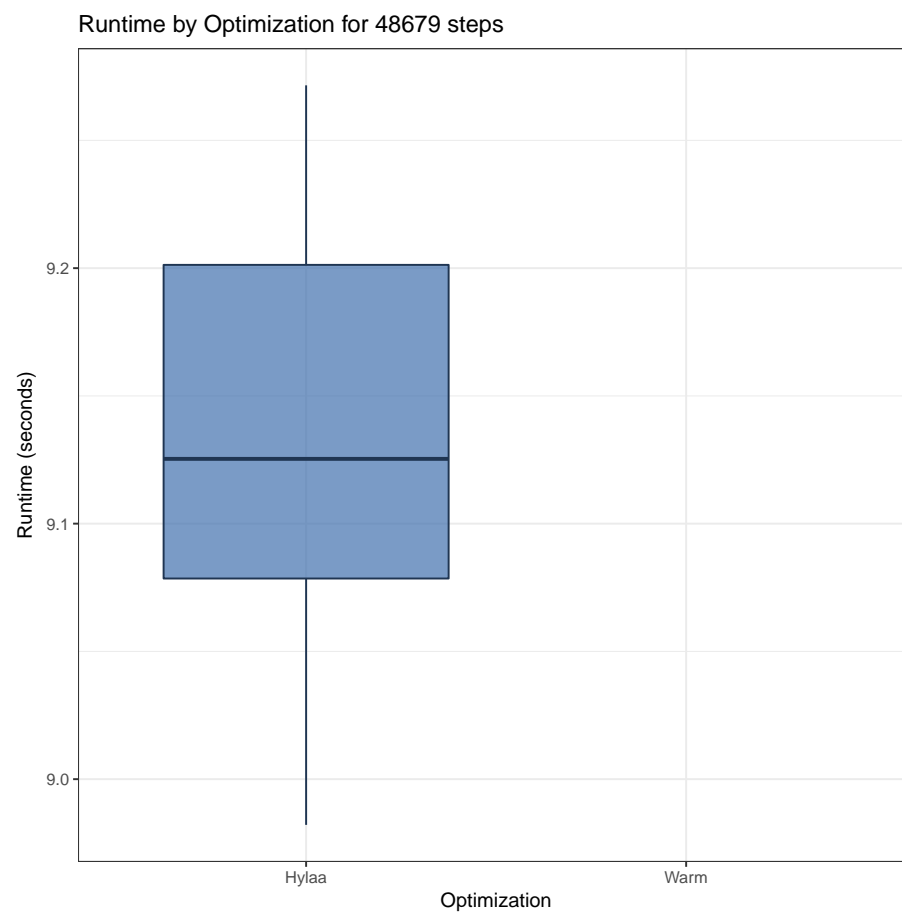


```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps48679")$time
## W = 0.95111, p-value = 0.6816
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.681647465980239"
```

Runtime for Warm

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA    10
```

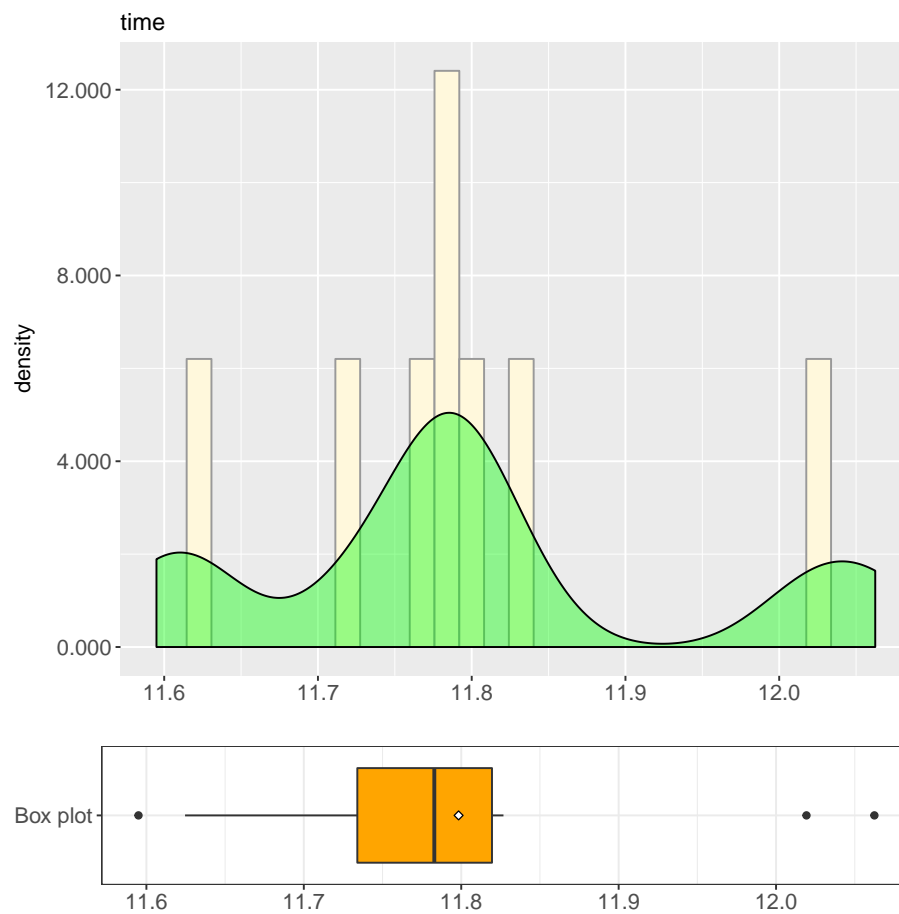
Comparison



3.1.30 RH1.30: Object 63282 steps

Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  11.59  11.73   11.78   11.80   11.82   12.06
```



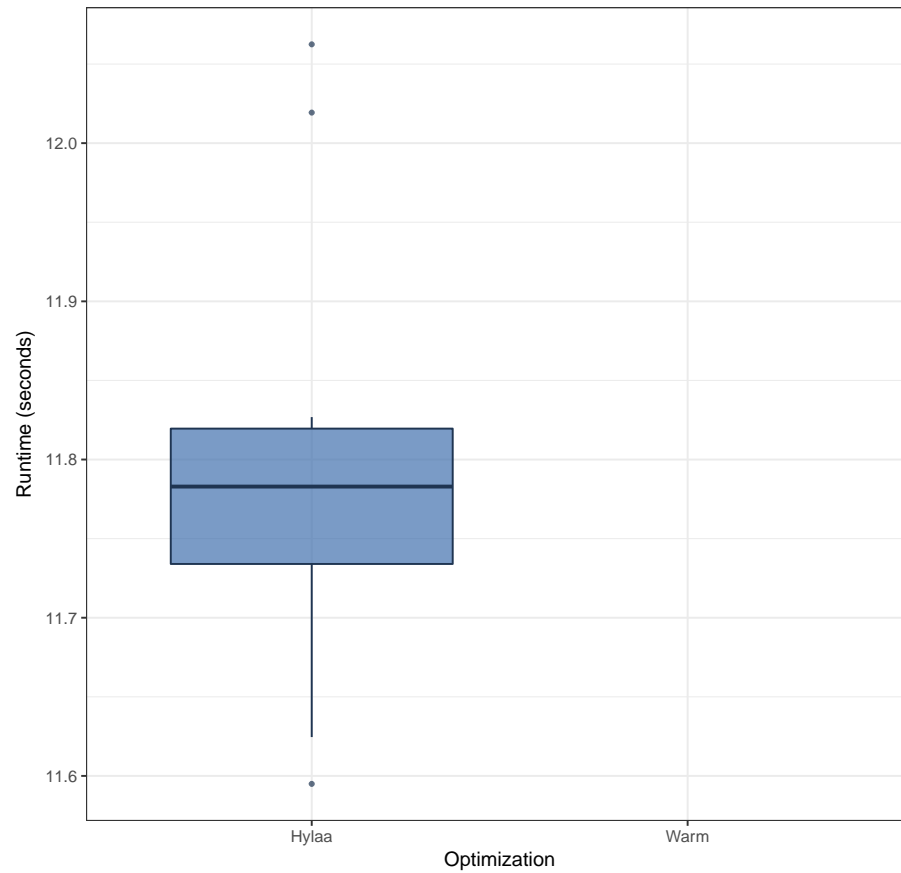
```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps63282")$time
## W = 0.90816, p-value = 0.2686
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.268588784180786"
```

Runtime for Warm

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA     10
```

Comparison

Runtime by Optimization for 63282 steps



3.1.31 RH1.31: Object 82267 steps

Runtime for Hylaa

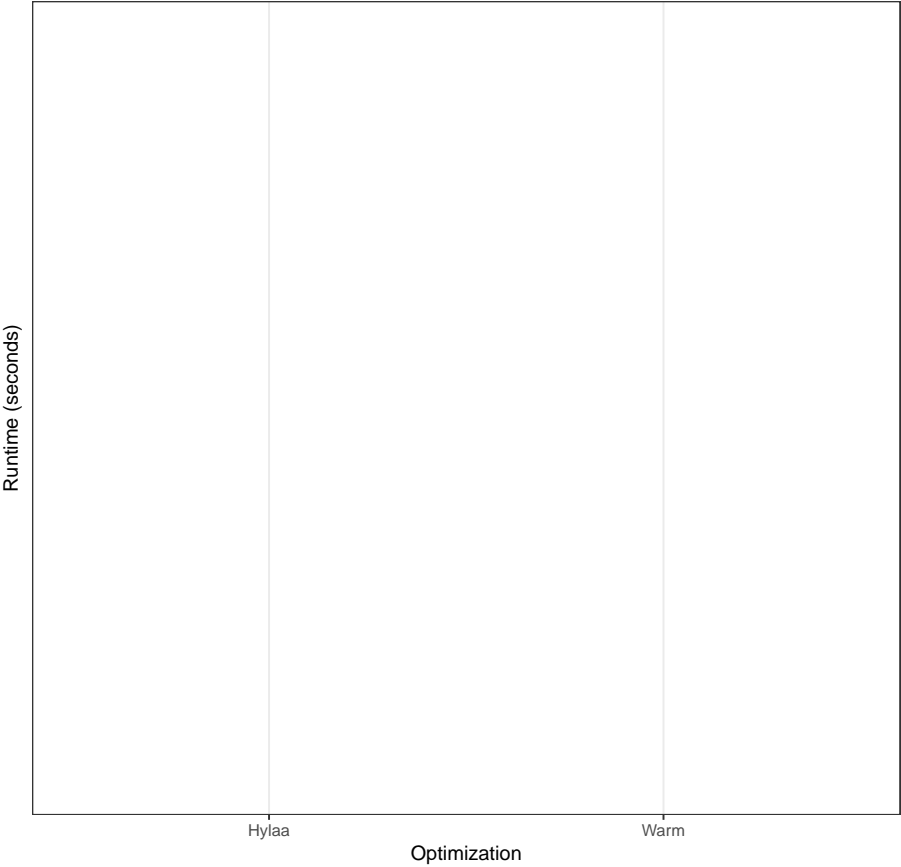
```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    NA      NA     NA     NaN    NA      NA      10
```

Runtime for Warm

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    NA      NA     NA     NaN    NA      NA      10
```

Comparison

Runtime by Optimization for 82267 steps



3.1.32 RH1.32: Object 106948 steps

Runtime for Hylaa

```
## [1] "Sample size: 0"
```

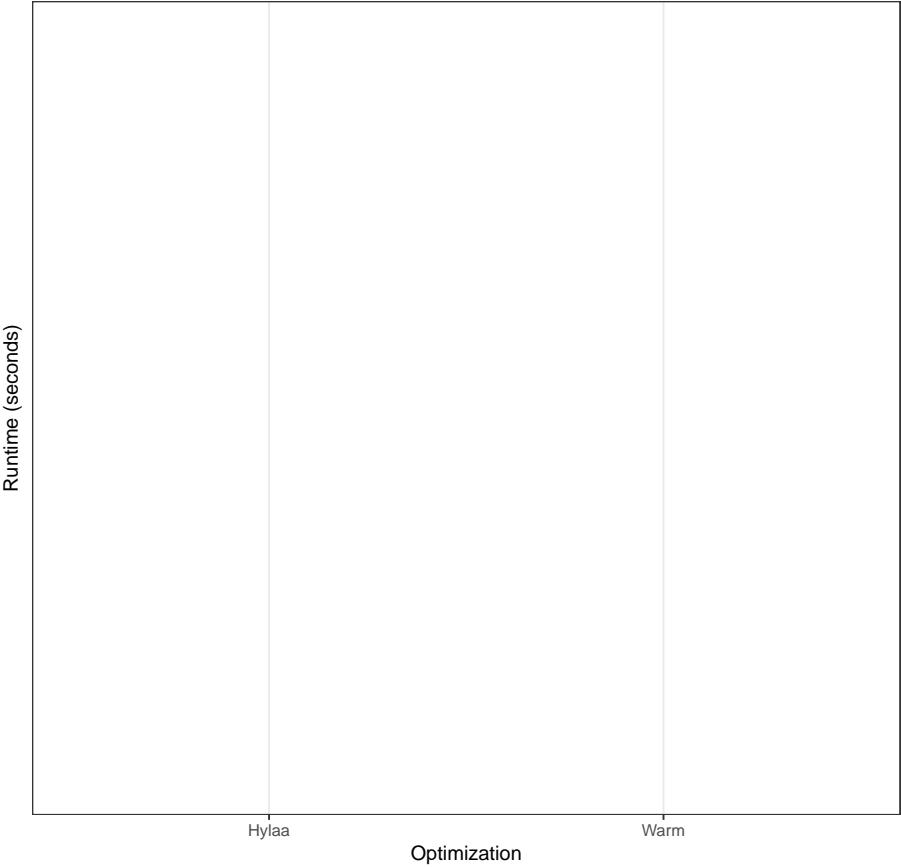
##	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	NA's
##	NA	NA	NA	NaN	NA	NA	10

Runtime for Warm

```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.     NA's
##      NA      NA      NA     NaN     NA      NA      10
```

Comparison

Runtime by Optimization for 106948 steps



3.1.33 RH1.33: Object 139032 steps

Runtime for Hylaa

```
## [1] "Sample size: 0"
```

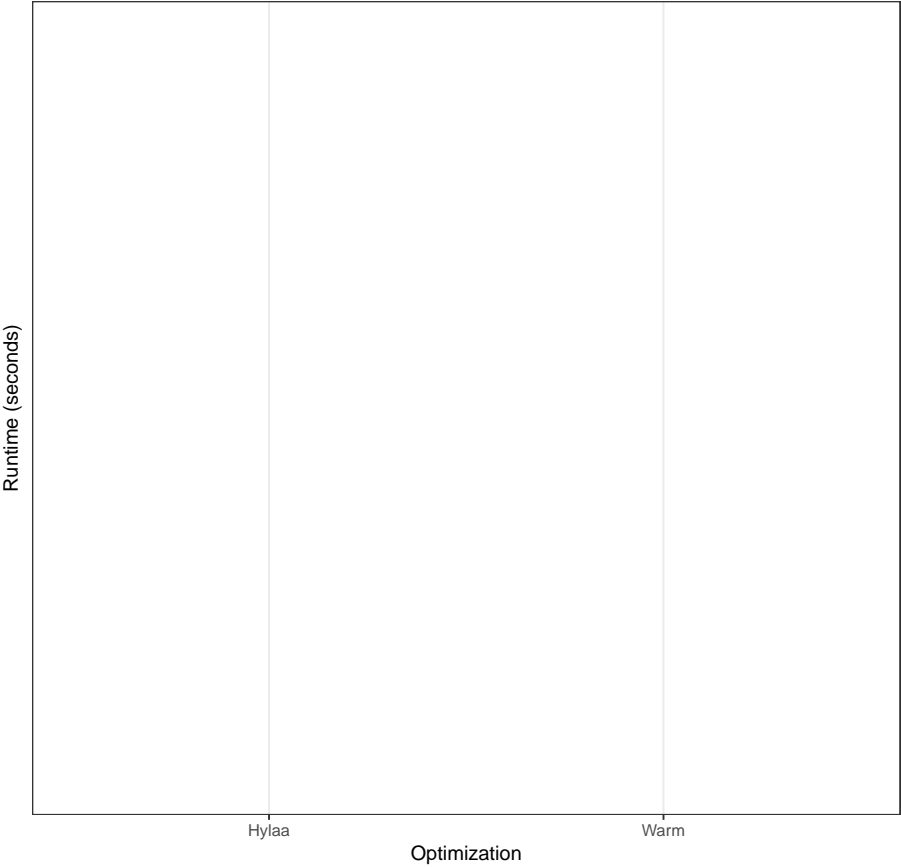
##	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	NA's
##	NA	NA	NA	NaN	NA	NA	10

Runtime for Warm

```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.     NA's
##      NA      NA      NA     NaN     NA      NA      10
```

Comparison

Runtime by Optimization for 139032 steps



3.1.34 RH1.34: Object 180742 steps

Runtime for Hylaa

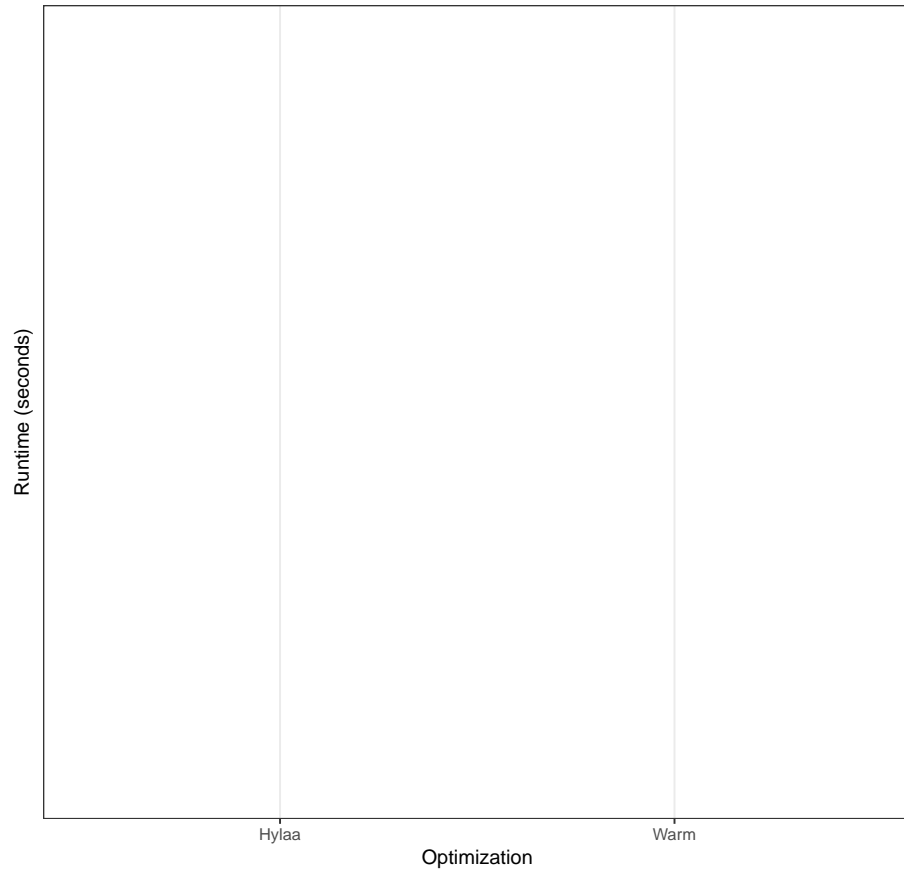
```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.     NA's
##      NA      NA      NA     NaN     NA      NA      10
```

Runtime for Warm

```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.     NA's
##      NA      NA      NA     NaN     NA      NA      10
```

Comparison

Runtime by Optimization for 180742 steps



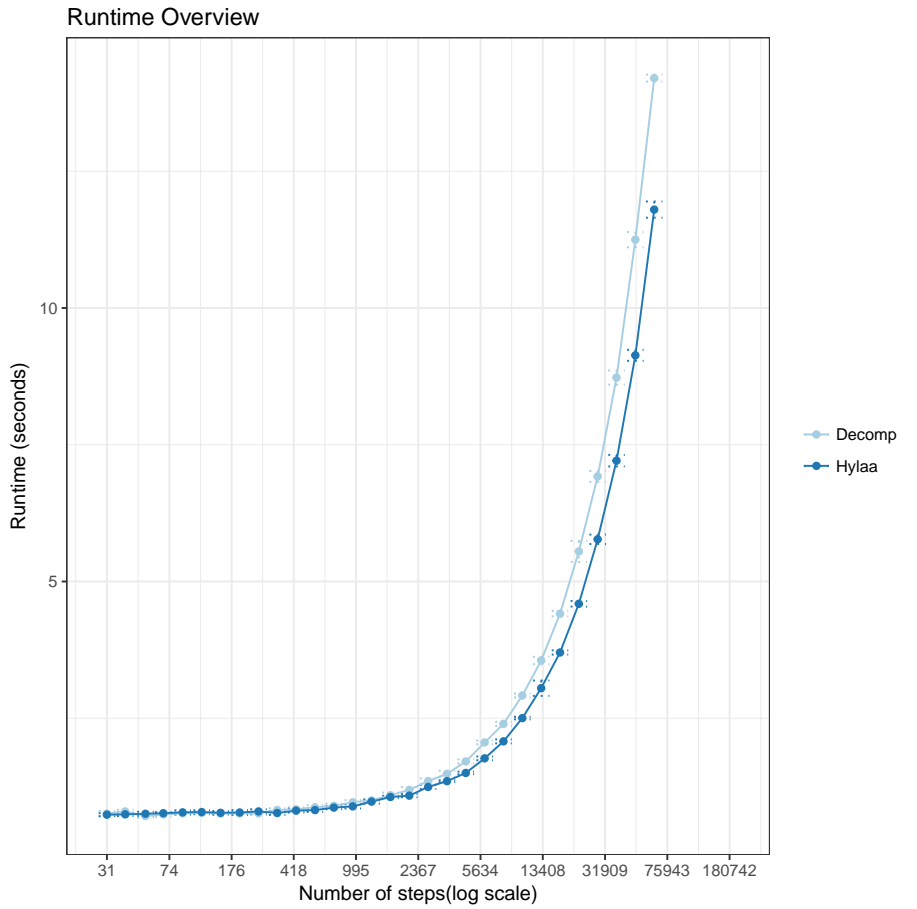
3.1.35 RH1 Results: Runtime Hylaa = Warm

Table 1: RH1 Results per Object

31 steps	Inconclusive
40 steps	Inconclusive
53 steps	Inconclusive
68 steps	Hylaa > Warm
89 steps	Inconclusive
116 steps	Hylaa > Warm
151 steps	Hylaa > Warm
197 steps	Inconclusive
256 steps	Hylaa < Warm
332 steps	Hylaa < Warm
432 steps	Hylaa < Warm
562 steps	Hylaa < Warm
731 steps	Hylaa < Warm
951 steps	Hylaa < Warm
1236 steps	Hylaa < Warm
1607 steps	Hylaa < Warm
2089 steps	Hylaa < Warm
2716 steps	Hylaa < Warm
3531 steps	Hylaa < Warm
4590 steps	Hylaa
5967 steps	Hylaa
7757 steps	Hylaa
10085 steps	Hylaa
13110 steps	Hylaa
17043 steps	Hylaa
22157 steps	Hylaa
28804 steps	Hylaa
37445 steps	Hylaa
48679 steps	Hylaa
63282 steps	Hylaa
82267 steps	None
106948 steps	None
139032 steps	None
180742 steps	None

Table 2: RH1 Results Summary	
Hylaa < Warm:	32.3529412%
Hylaa > Warm:	8.8235294%
Hylaa:	32.3529412%
Warm:	0%
None:	11.7647059%
Inconclusive:	14.7058824%

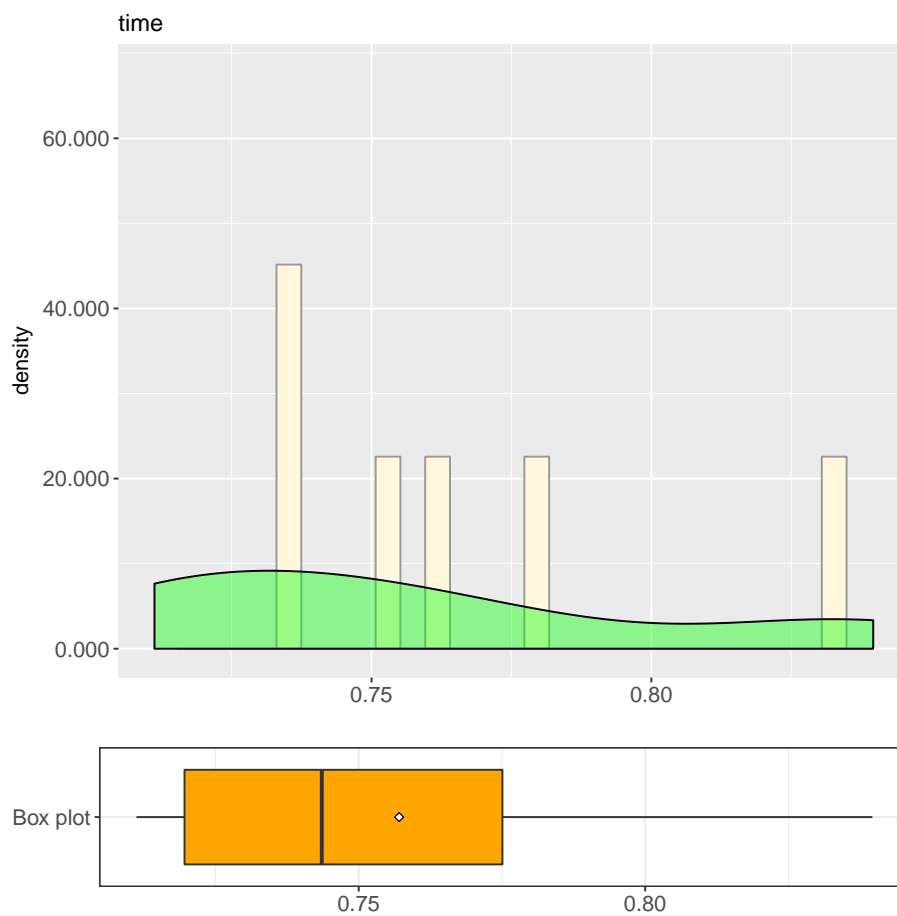
3.2 RH2: Runtime time for Hylaa is equals than runtime time for Decomp



3.2.1 RH2.1: Object 31 steps

Runtime for Decomp

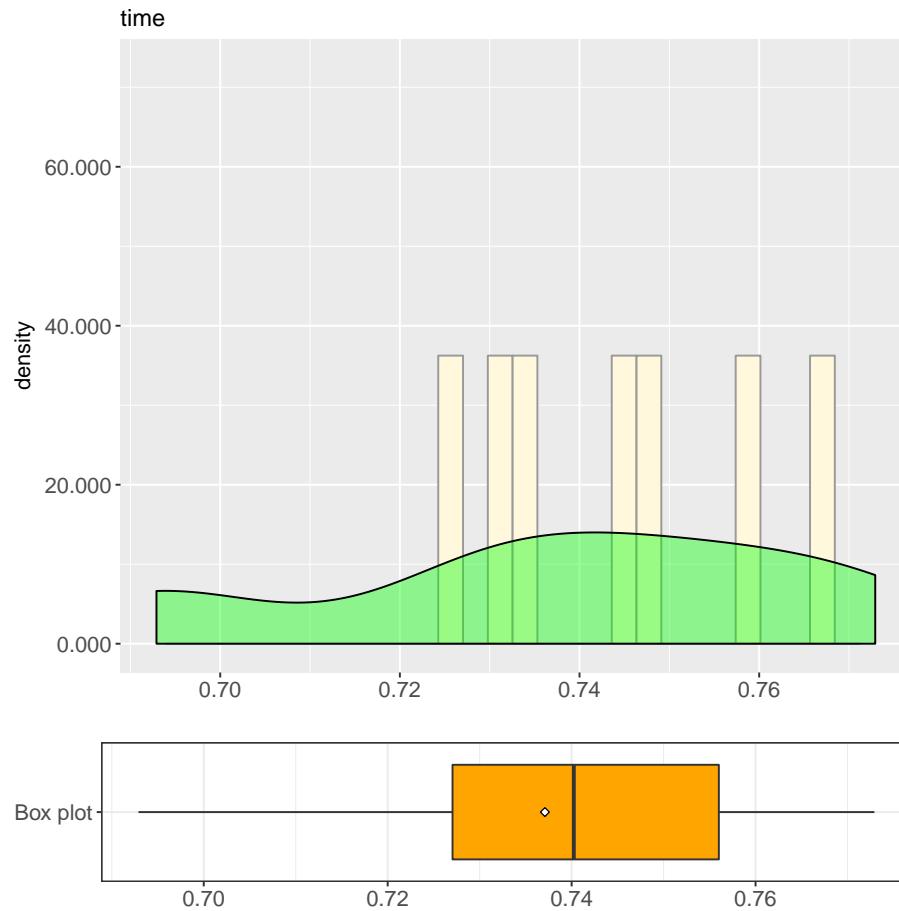
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7112 0.7196 0.7436 0.7571 0.7751 0.8397
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Decomp" & object == "steps31")$time
## W = 0.86617, p-value = 0.09017
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0901724093671922"
```

Runtime for Hylaa

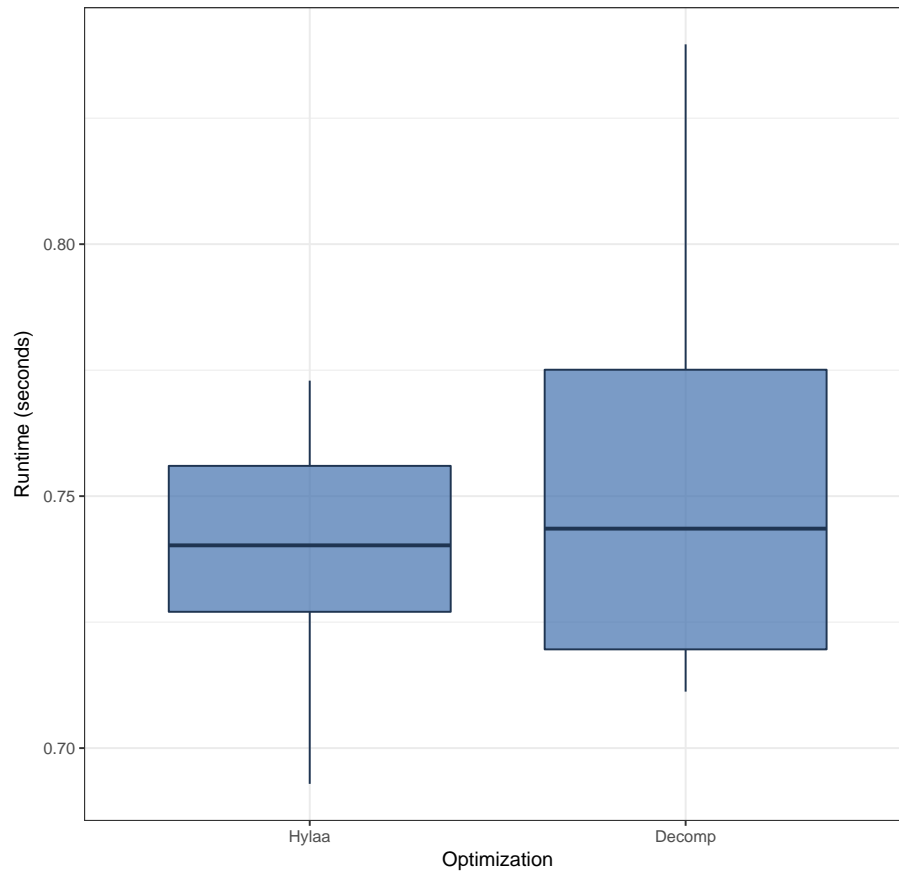

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6929  0.7270  0.7402  0.7371  0.7560  0.7729
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps31")$time
## W = 0.92348, p-value = 0.3869
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.386919454155626"
```

Comparison

Runtime by Optimization for 31 steps



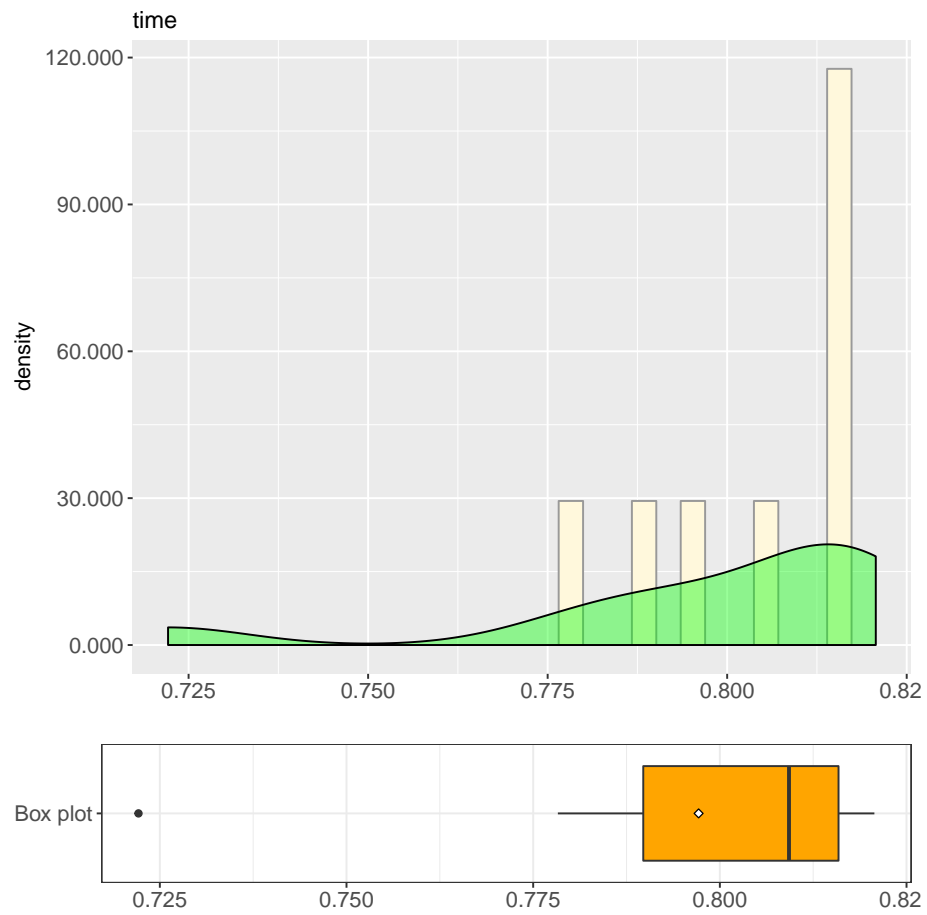
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps31")$time and subset(json_data, treatment == "Decomp" & object == "steps31")$time
## F = 0.35181, num df = 9, denom df = 9, p-value = 0.1356
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.08738372 1.41637027
## sample estimates:
## ratio of variances
##      0.3518063
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.135584119840178"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps31")$time and subset(json_data, treatment == "Decomp" & object == "steps31")$time
## t = -1.1603, df = 18, p-value = 0.2611
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.05610896 0.01618329
## sample estimates:
## mean of x mean of y
## 0.7370949 0.7570578
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.261085392293174"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7370949268343"
## [1] "Mean Runtime for Decomp: 0.7570577621459"
## [1] "Absolute difference: 0.0199628353116"
## Runtime for Decomp is 2.70831267247179 % greater than
## Runtime for Hylaa
```

3.2.2 RH2.2: Object 40 steps

Runtime for Decomp

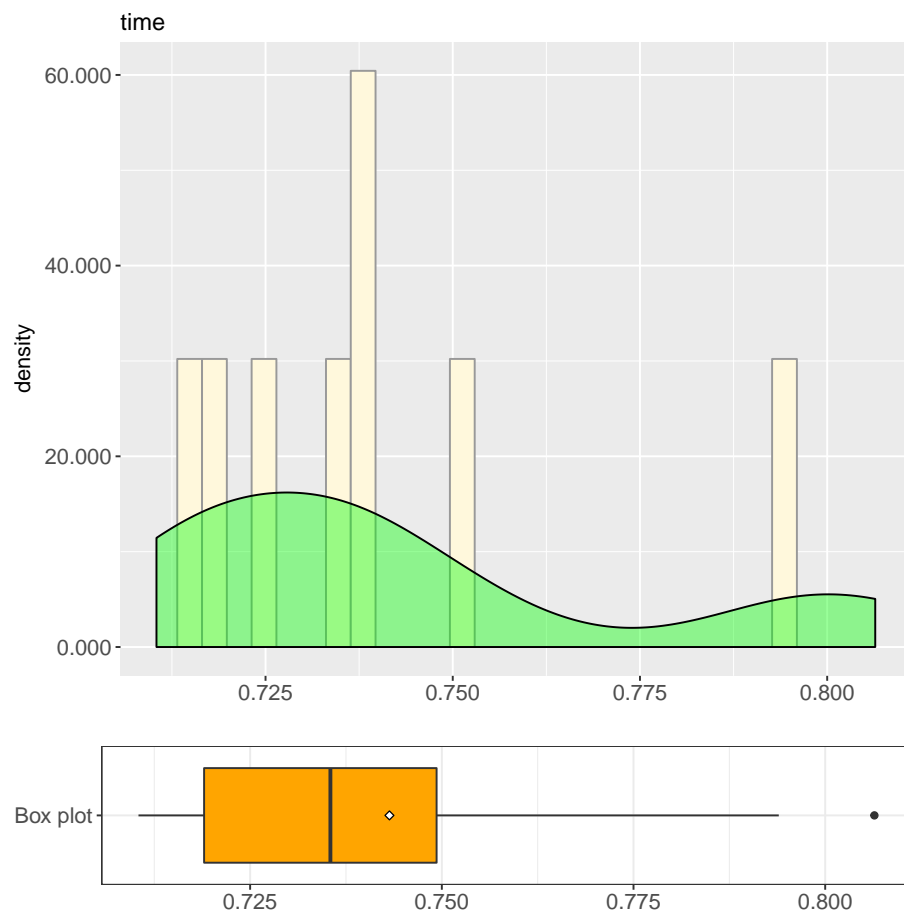
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7221 0.7897 0.8093 0.7972 0.8159 0.8207
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps40")$time
## W = 0.75921, p-value = 0.004621
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.00462065228799667"
```

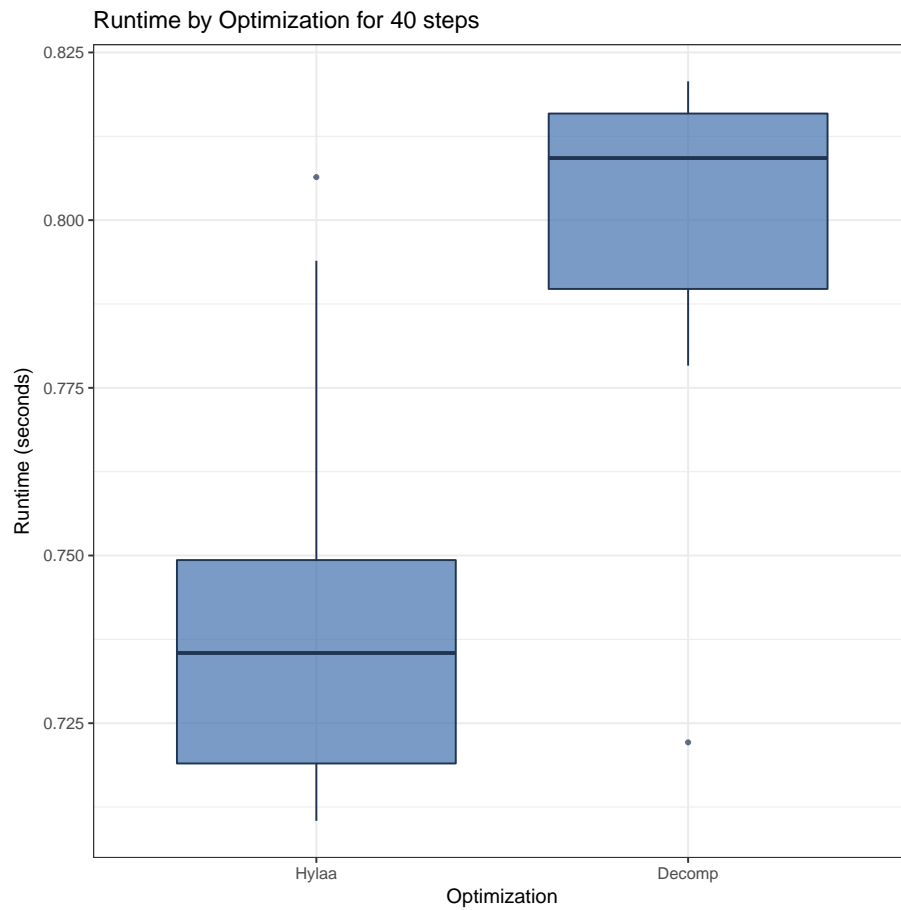
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7104 0.7190 0.7355 0.7432 0.7493 0.8064
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps40")$time
## W = 0.84556, p-value = 0.05142
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0514195741817329"
```

Comparison

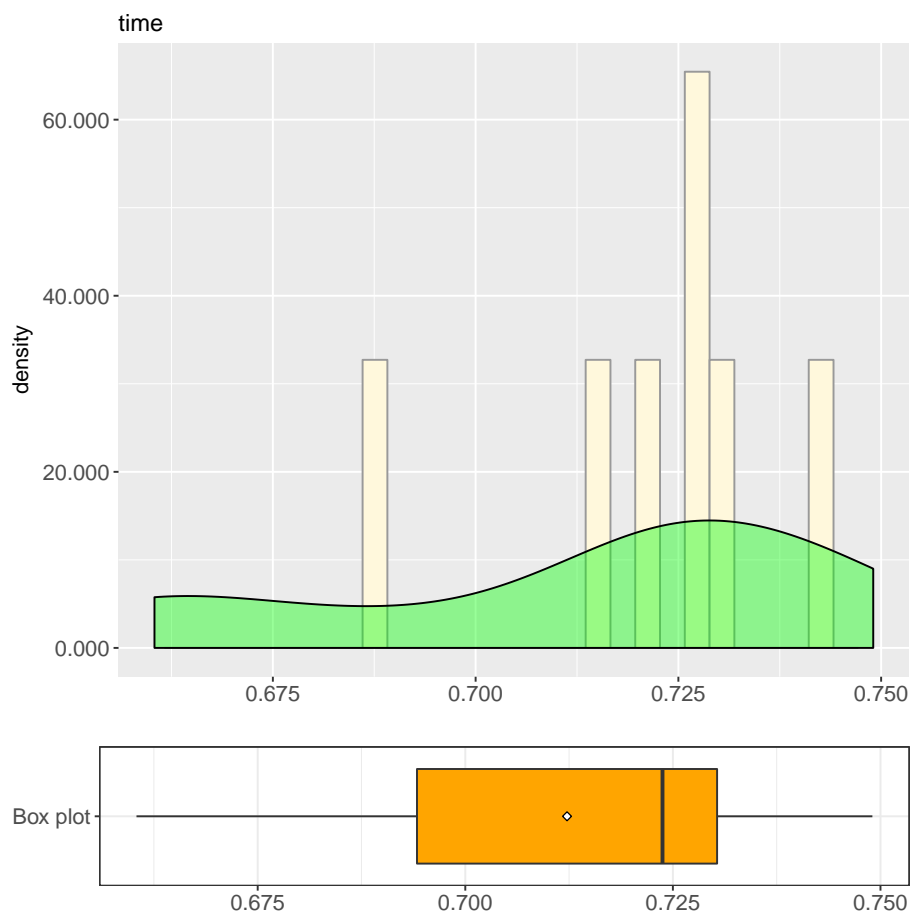


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 87, p-value = 0.003886
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 0.00388620667258438"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7431680440903"
## [1] "Mean Runtime for Decomp: 0.7971547126772"
## [1] "Absolute difference: 0.0539866685868999"
## Runtime for Decomp is 7.26439585450477 % greater than
## Runtime for Hylaa
```

3.2.3 RH2.3: Object 53 steps

Runtime for Decomp

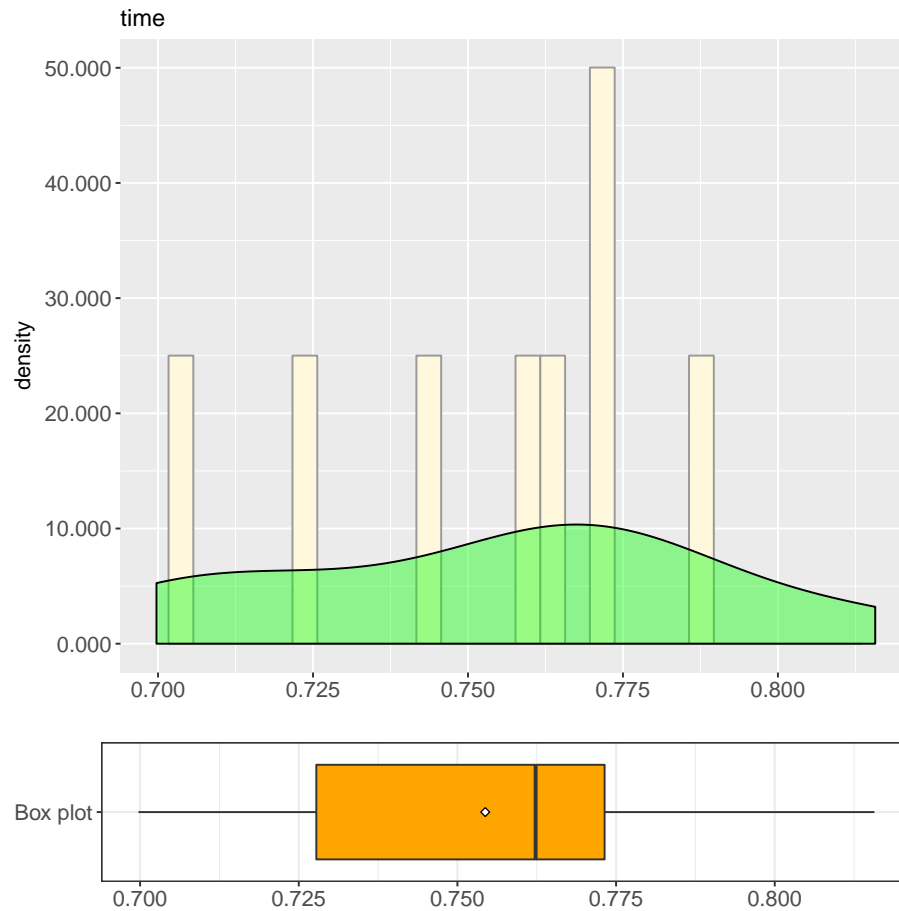
```
## [1] "Sample size: 10"  
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
## 0.6604 0.6942 0.7238 0.7123 0.7303 0.7490
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Decomp" & object == "steps53")$time  
## W = 0.86957, p-value = 0.09882  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.098823305268088"
```

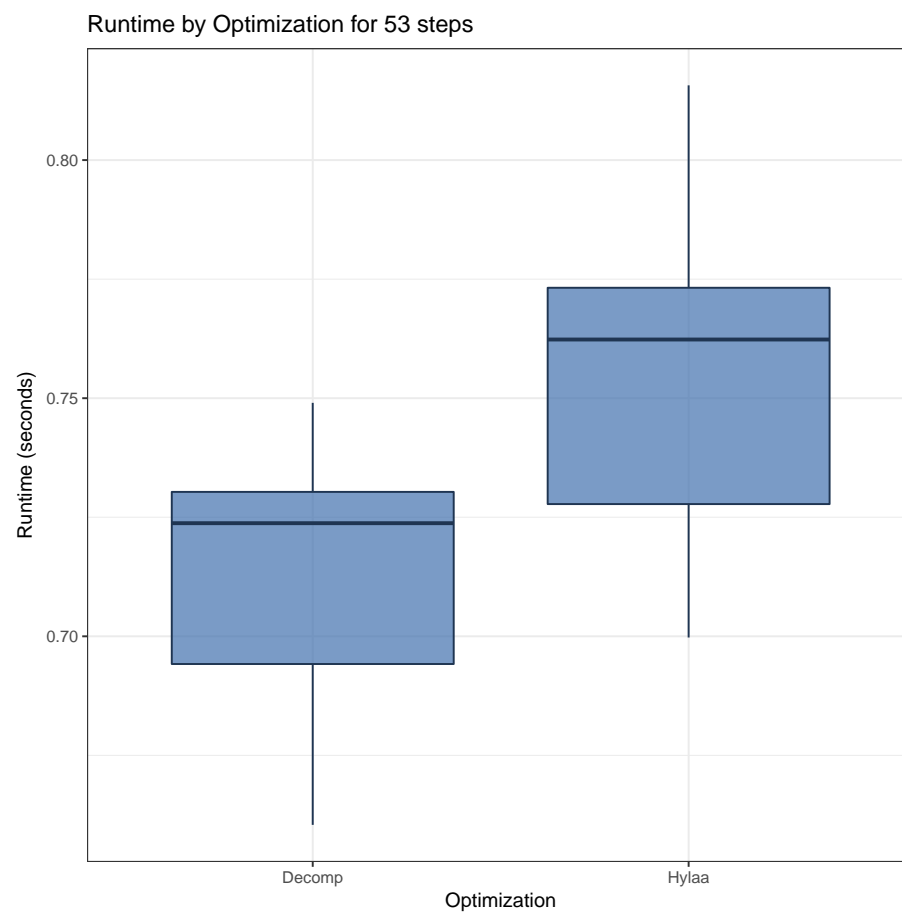
Runtime for Hylaa

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6997 0.7278 0.7623 0.7544 0.7732 0.8157
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps53")$time
## W = 0.95914, p-value = 0.776
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.776029544672673"
```

Comparison



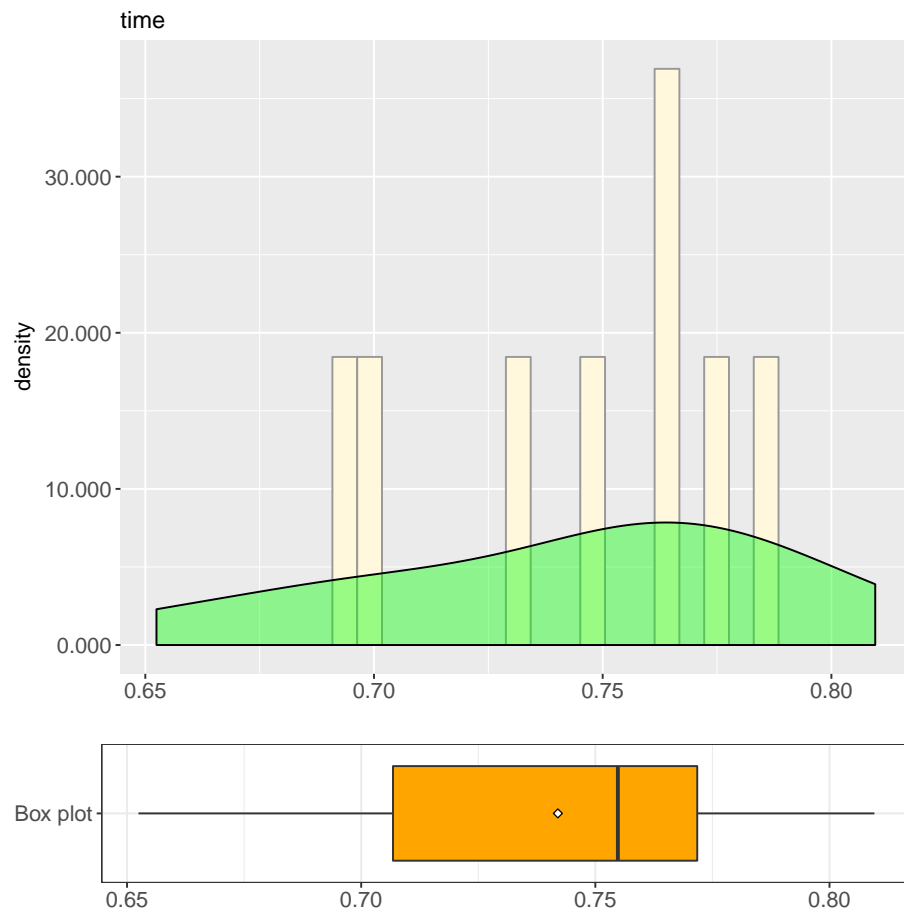
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps53")$time and subset(json_data, treatment == "Decomp" & object == "steps53")$time
## F = 1.3172, num df = 9, denom df = 9, p-value = 0.6881
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3271849 5.3032184
## sample estimates:
## ratio of variances
##      1.317244
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.688127104972335"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps53")$time and subset(json_data, treatment == "Decomp" & object == "steps53")$time
## t = 2.735, df = 18, p-value = 0.0136
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.009767075 0.074485569
## sample estimates:
## mean of x mean of y
## 0.7543800 0.7122536
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.0135990136284212"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7543799638747"
## [1] "Mean Runtime for Decomp: 0.7122536420821"
## [1] "Absolute difference: 0.0421263217926"
## Runtime for Hylaa is 5.91451125043797 % greater than
## Runtime for Decomp
```

3.2.4 RH2.4: Object 68 steps

Runtime for Decomp

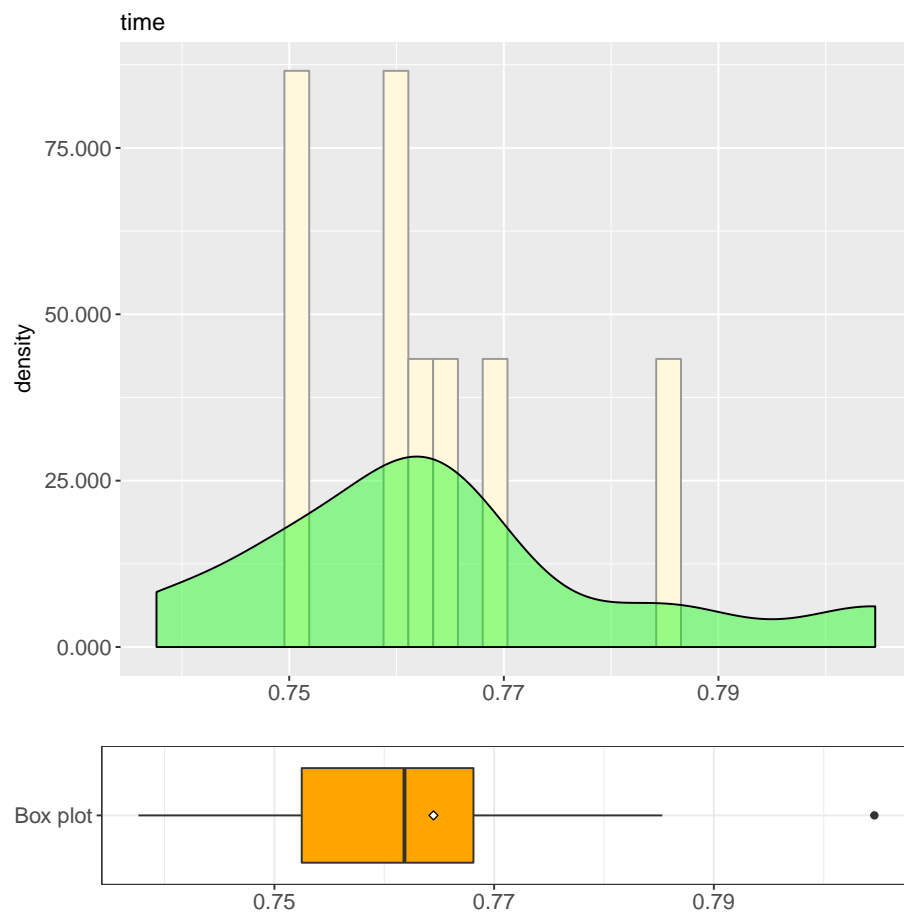
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6524  0.7068  0.7548  0.7420  0.7718  0.8096
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps68")$time
## W = 0.95688, p-value = 0.7498
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.749821903100715"
```

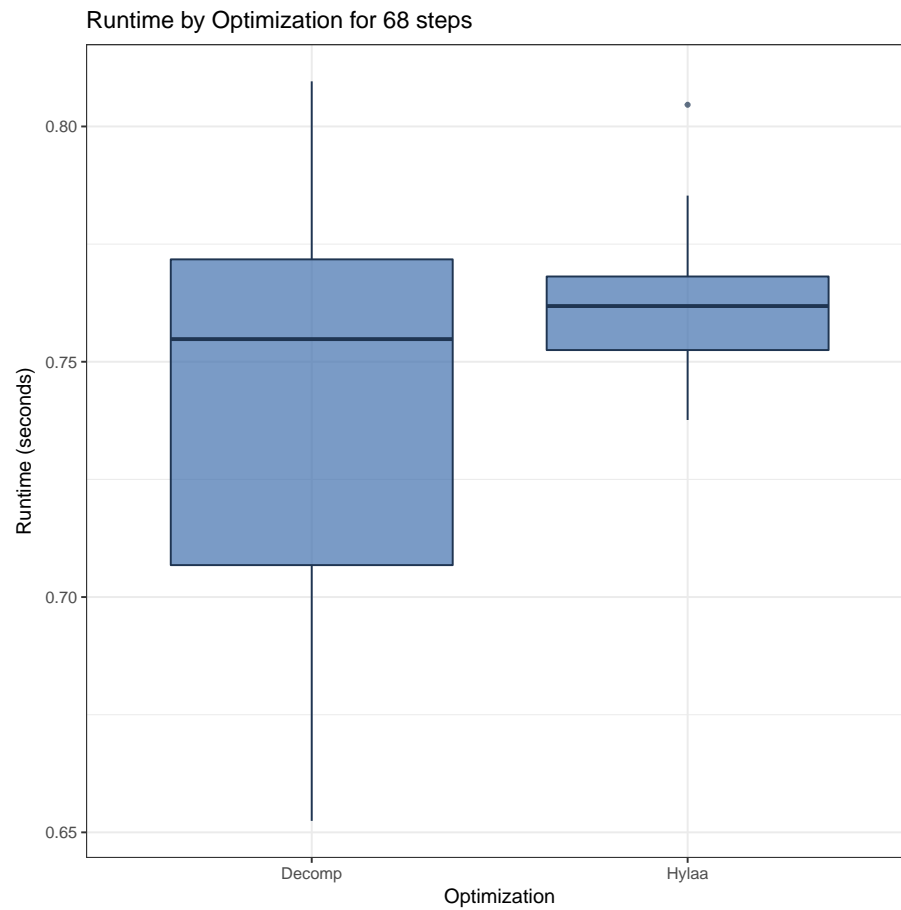
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.7376  0.7525  0.7618  0.7645  0.7681  0.8046
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps68")$time
## W = 0.92932, p-value = 0.4412
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.44123425938003"
```

Comparison



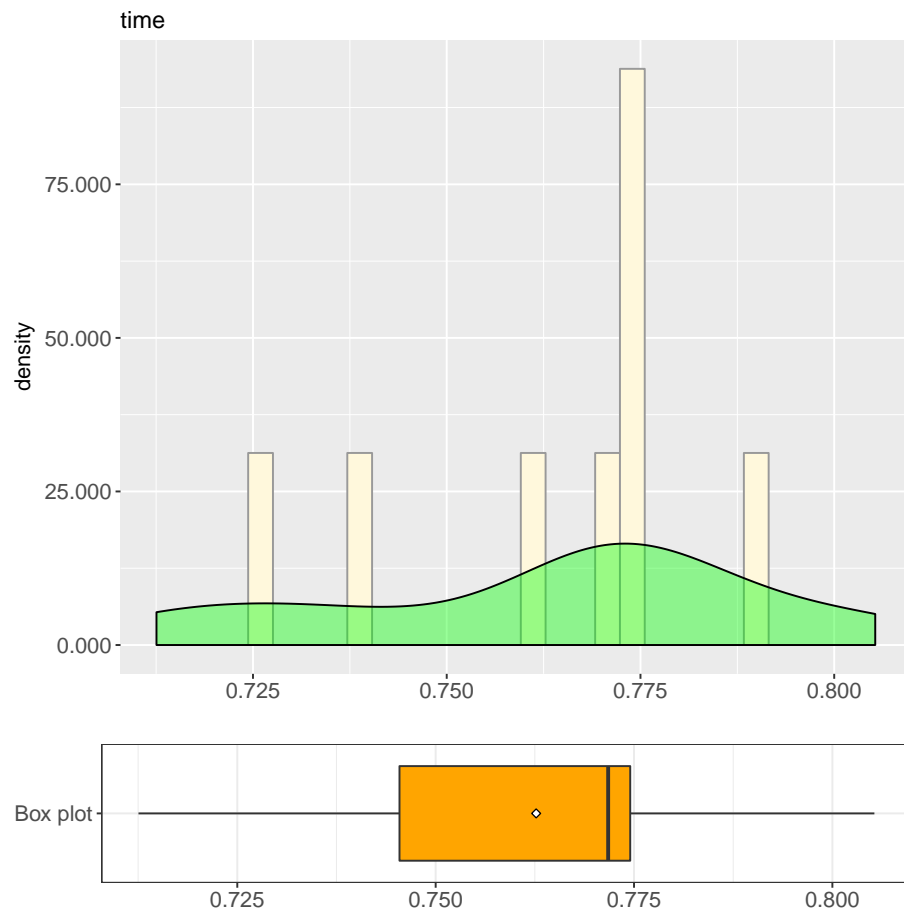
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps68")$time and subset(json_data, treatment == "Decomp" & object == "steps68")$time
## F = 0.15757, num df = 9, denom df = 9, p-value = 0.01112
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.03913742 0.63436390
## sample estimates:
## ratio of variances
##      0.157567
##
## [1] "Homogeneity of variances: FALSE. P-value: 0.0111234966136753"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Welch Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps68")$time and subset(json_data, treatment == "Decomp" & object == "steps68")$time
## t = 1.3791, df = 11.767, p-value = 0.1935
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.01311417 0.05807252
## sample estimates:
## mean of x mean of y
## 0.7644785 0.7419993
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.193522859649604"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7644784688949"
## [1] "Mean Runtime for Decomp: 0.7419992923737"
## [1] "Absolute difference: 0.0224791765212"
## Runtime for Hylaa is 3.02954150391273 % greater than
## Runtime for Decomp
```

3.2.5 RH2.5: Object 89 steps

Runtime for Decomp

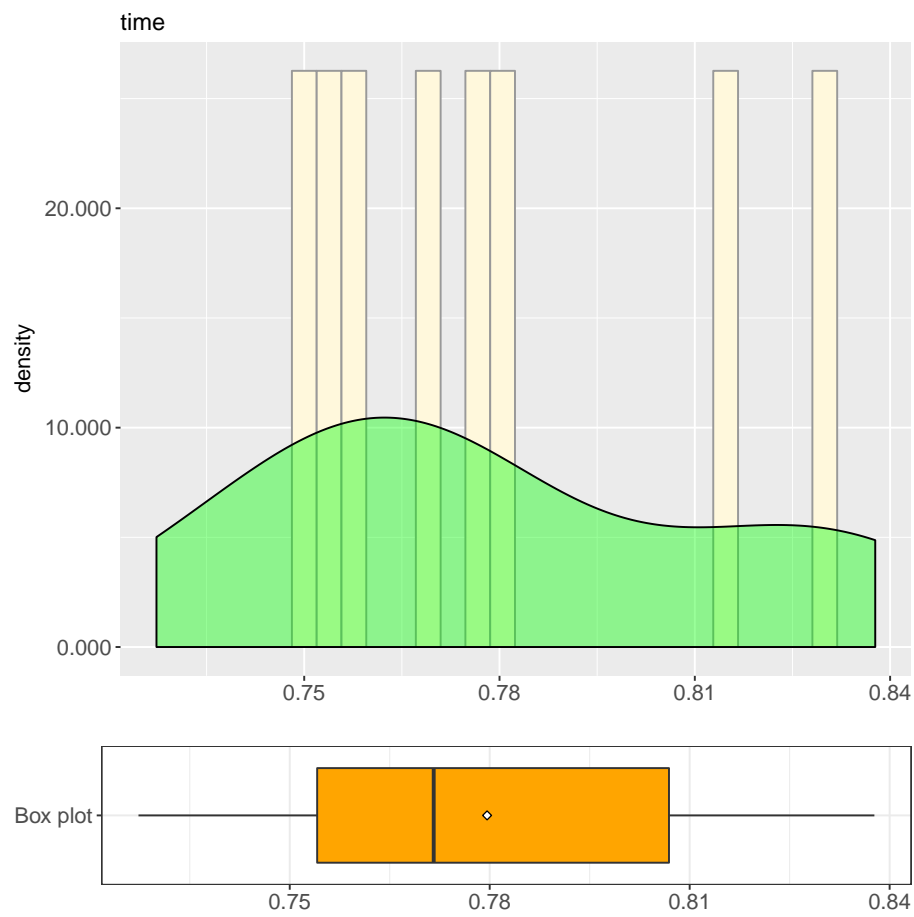
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7125  0.7454  0.7717  0.7627  0.7745  0.8053
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps89")$time
## W = 0.94031, p-value = 0.5565
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.556459664233252"
```

Runtime for Hylaa

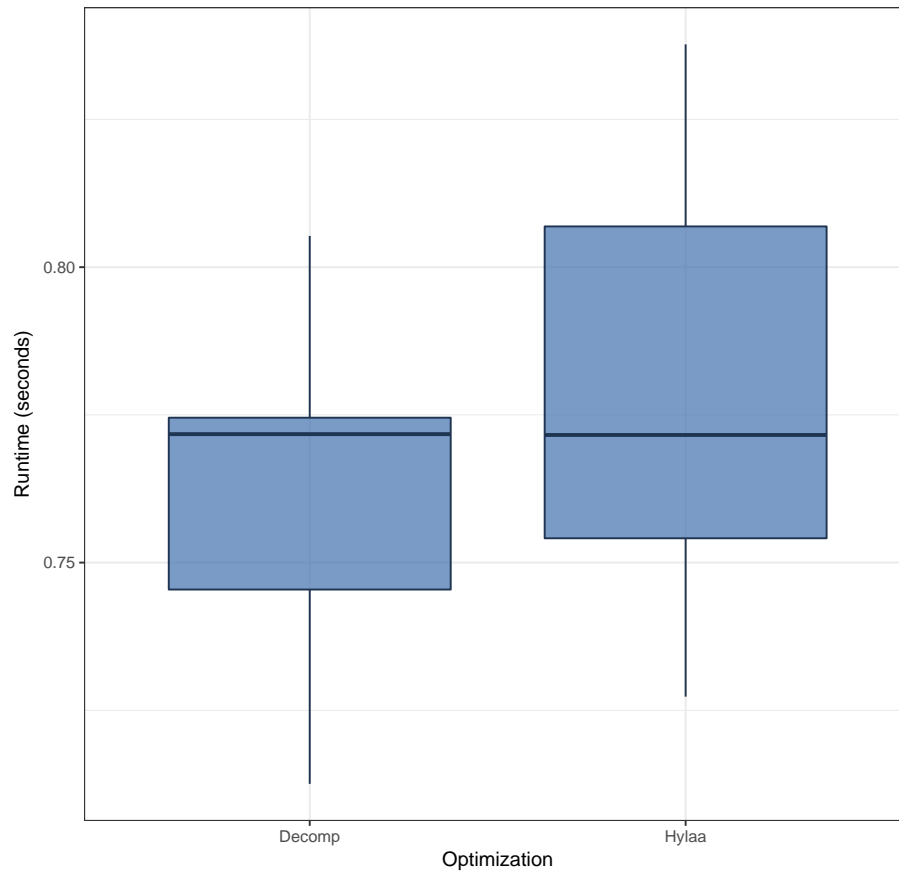
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.7273  0.7541  0.7716  0.7796  0.8069  0.8377
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps89")$time
## W = 0.92836, p-value = 0.4319
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.431928741976726"
```

Comparison

Runtime by Optimization for 89 steps



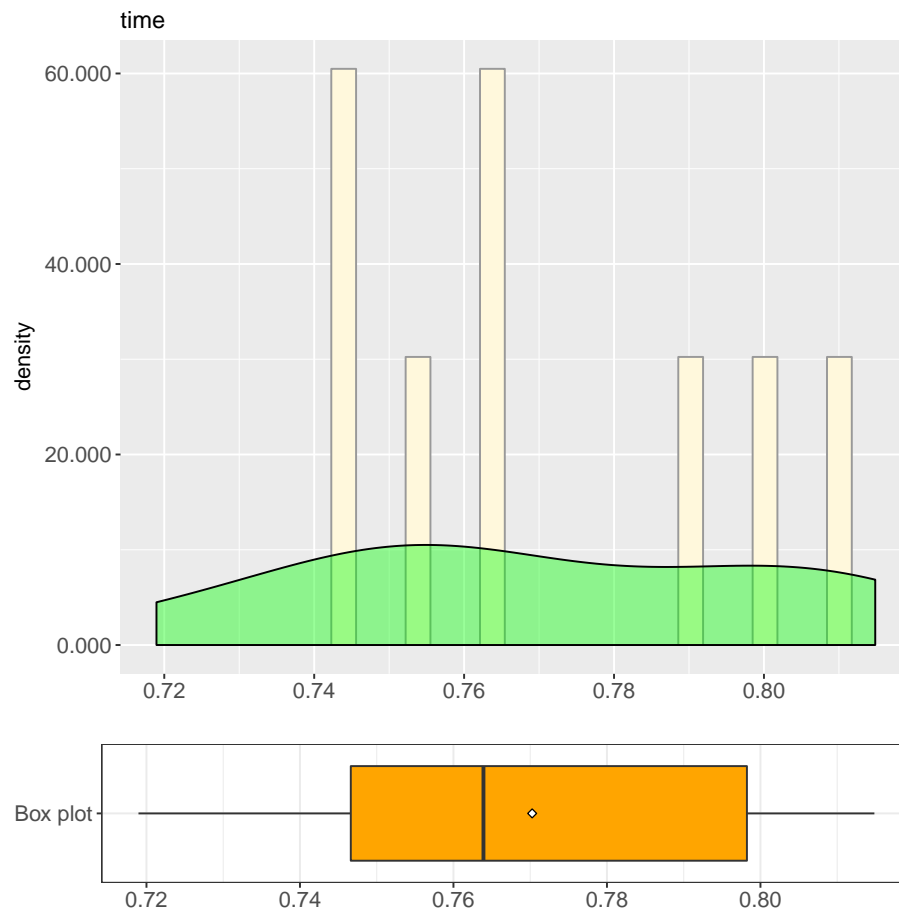
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps89")$time and subset(json_data, treatment == "Decomp" & object == "steps89")$time
## F = 1.6557, num df = 9, denom df = 9, p-value = 0.4642
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.4112493 6.6657872
## sample estimates:
## ratio of variances
##      1.655687
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.464219784270807"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps89")$time and subset(json_data, treatment == "Decomp" & object == "steps89")$time
## t = 1.1502, df = 18, p-value = 0.2651
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.01400430 0.04788649
## sample estimates:
## mean of x mean of y
## 0.7796074 0.7626663
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.265132991551365"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7796074151993"
## [1] "Mean Runtime for Decomp: 0.7626663208008"
## [1] "Absolute difference: 0.0169410943985"
## Runtime for Hylaa is 2.22129834980937 % greater than
## Runtime for Decomp
```

3.2.6 RH2.6: Object 116 steps

Runtime for Decomp

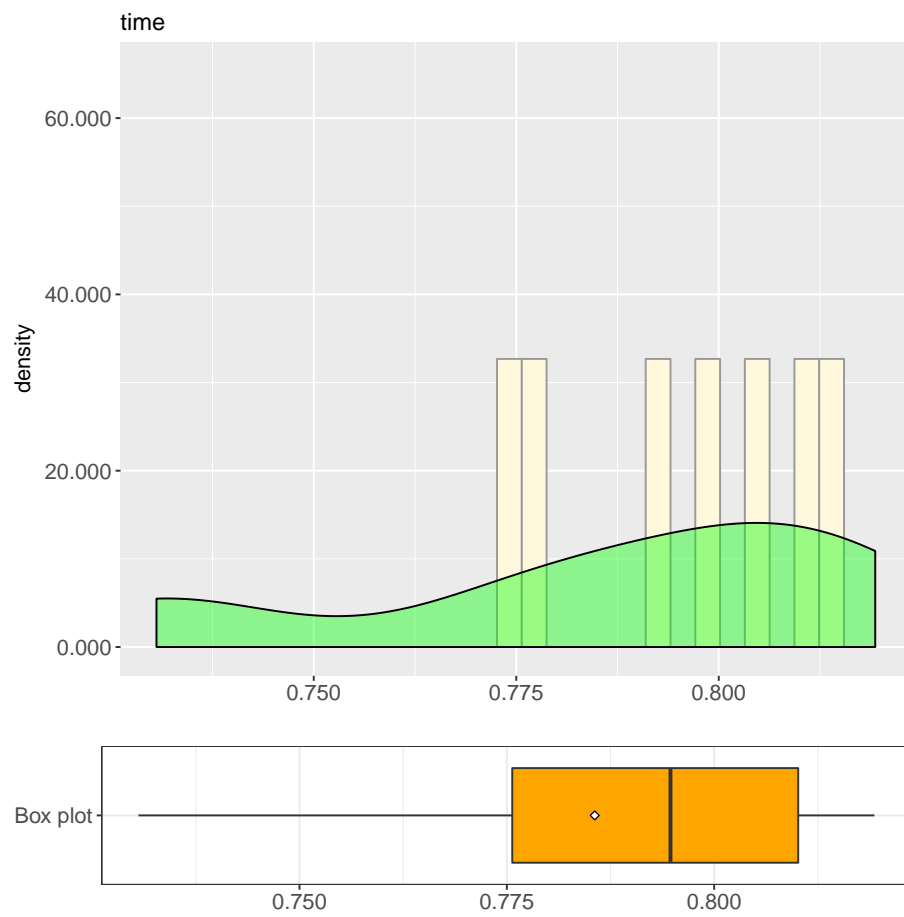
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7190  0.7466  0.7639  0.7703  0.7982  0.8148
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps116")$time
## W = 0.9452, p-value = 0.6122
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.61219716557611"
```

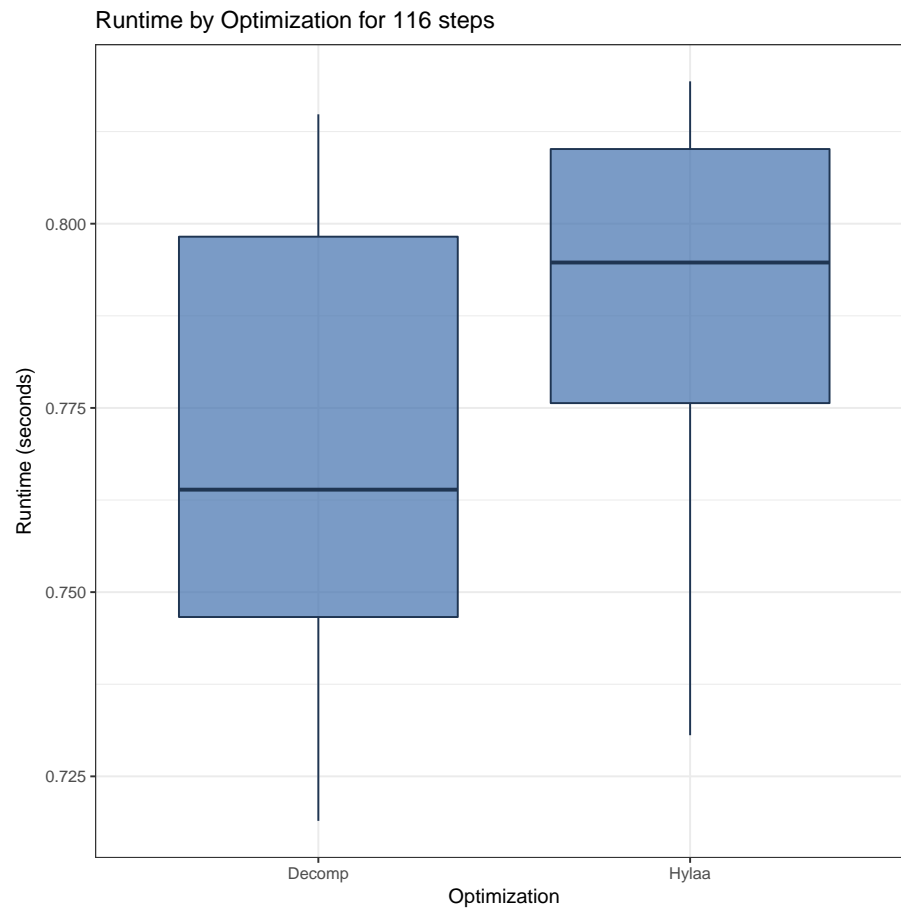
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7306 0.7757 0.7947 0.7856 0.8101 0.8193
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps116")$time
## W = 0.86307, p-value = 0.08294
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0829366496429817"
```

Comparison



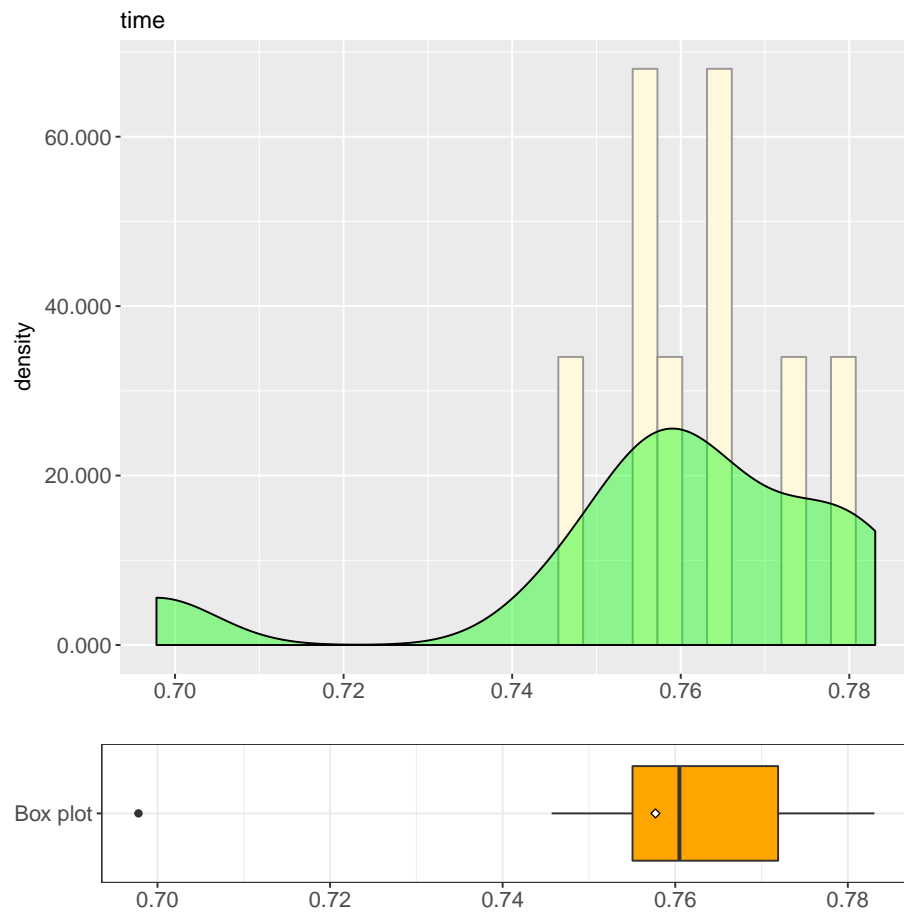
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps116")$time and subset(js
## F = 1.0126, num df = 9, denom df = 9, p-value = 0.9854
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2515272 4.0769114
## sample estimates:
## ratio of variances
##      1.012647
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.985370612134072"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps116")$time and subset(js
## t = 1.0705, df = 18, p-value = 0.2986
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.01476991 0.04545648
## sample estimates:
## mean of x mean of y
## 0.7855974 0.7702541
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.298555764186524"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7855973720549"
## [1] "Mean Runtime for Decomp: 0.7702540874481"
## [1] "Absolute difference: 0.0153432846068"
## Runtime for Hylaa is 1.99197704456633 % greater than
## Runtime for Decomp
```

3.2.7 RH2.7: Object 151 steps

Runtime for Decomp

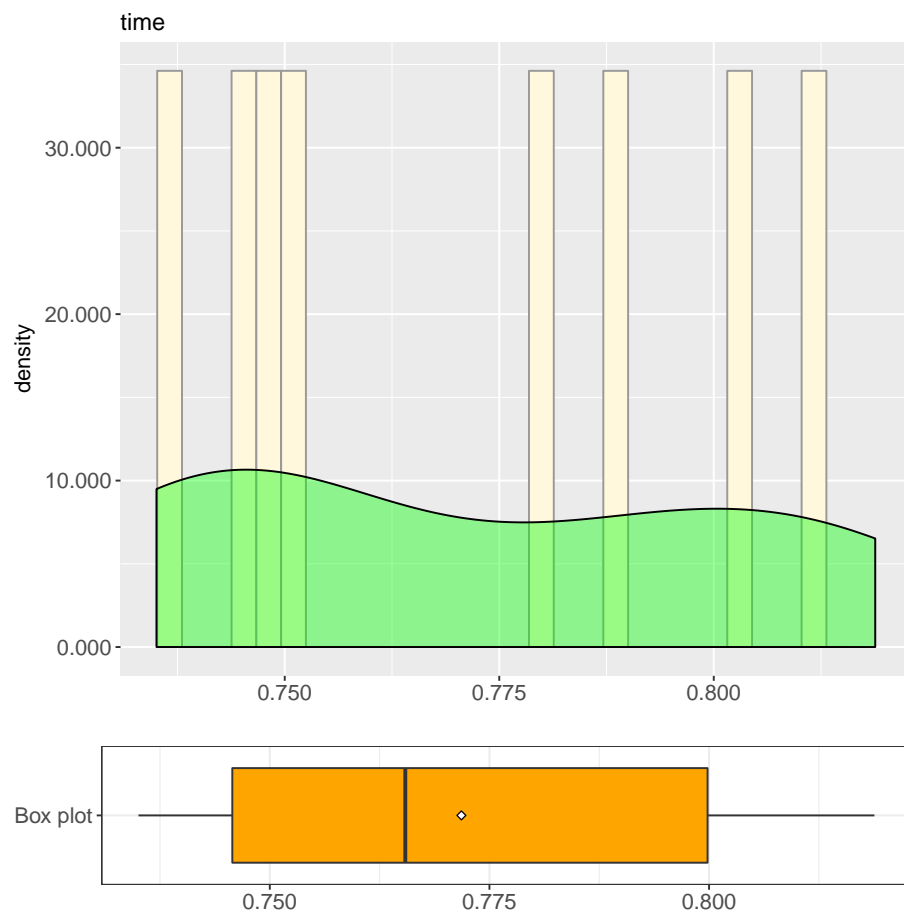
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6978 0.7550 0.7605 0.7577 0.7719 0.7831
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps151")$time
## W = 0.82216, p-value = 0.02691
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.0269114434499181"
```

Runtime for Hylaa

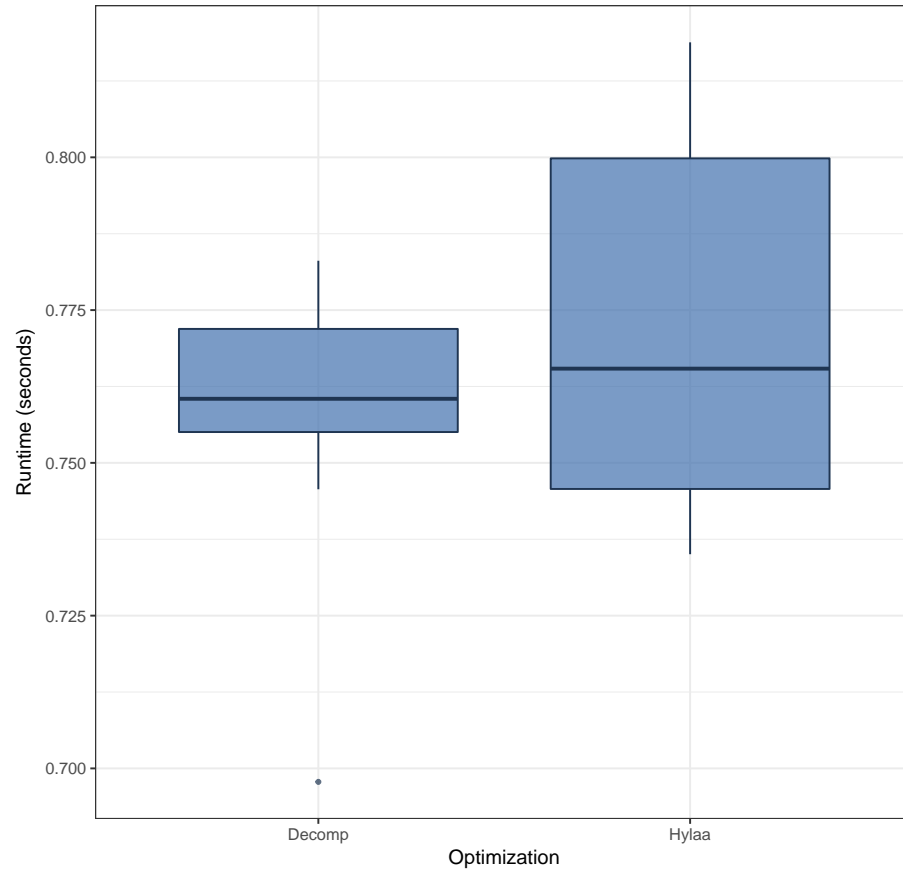
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7351 0.7457 0.7654 0.7718 0.7998 0.8188
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps151")$time
## W = 0.8855, p-value = 0.1508
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.15083040609515"
```

Comparison

Runtime by Optimization for 151 steps

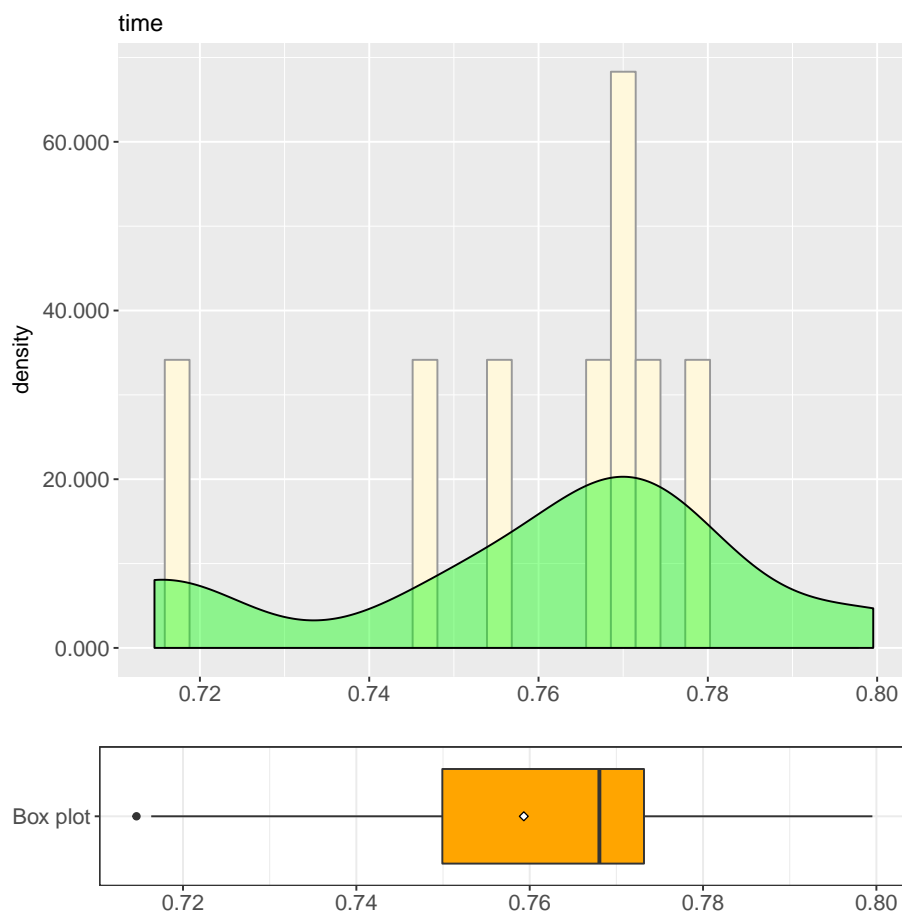


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 45, p-value = 0.7394
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis not rejected. P-value: 0.73936435081945"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7718092203141"
## [1] "Mean Runtime for Decomp: 0.7577067136765"
## [1] "Absolute difference: 0.0141025066376"
## Runtime for Hylaa is 1.8612091437296 % greater than
## Runtime for Decomp
```

3.2.8 RH2.8: Object 197 steps

Runtime for Decomp

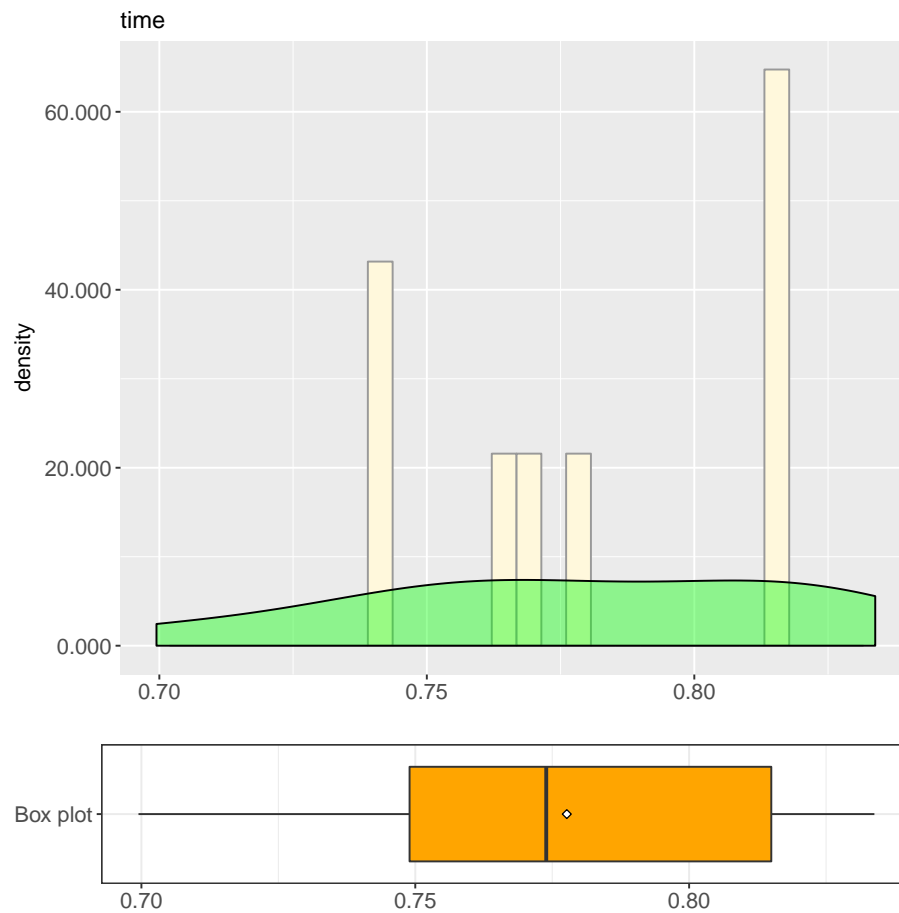
```
## [1] "Sample size: 10"  
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
## 0.7146 0.7499 0.7680 0.7593 0.7732 0.7995
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Decomp" & object == "steps197")$time  
## W = 0.90785, p-value = 0.2665  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.266542427371331"
```

Runtime for Hylaa

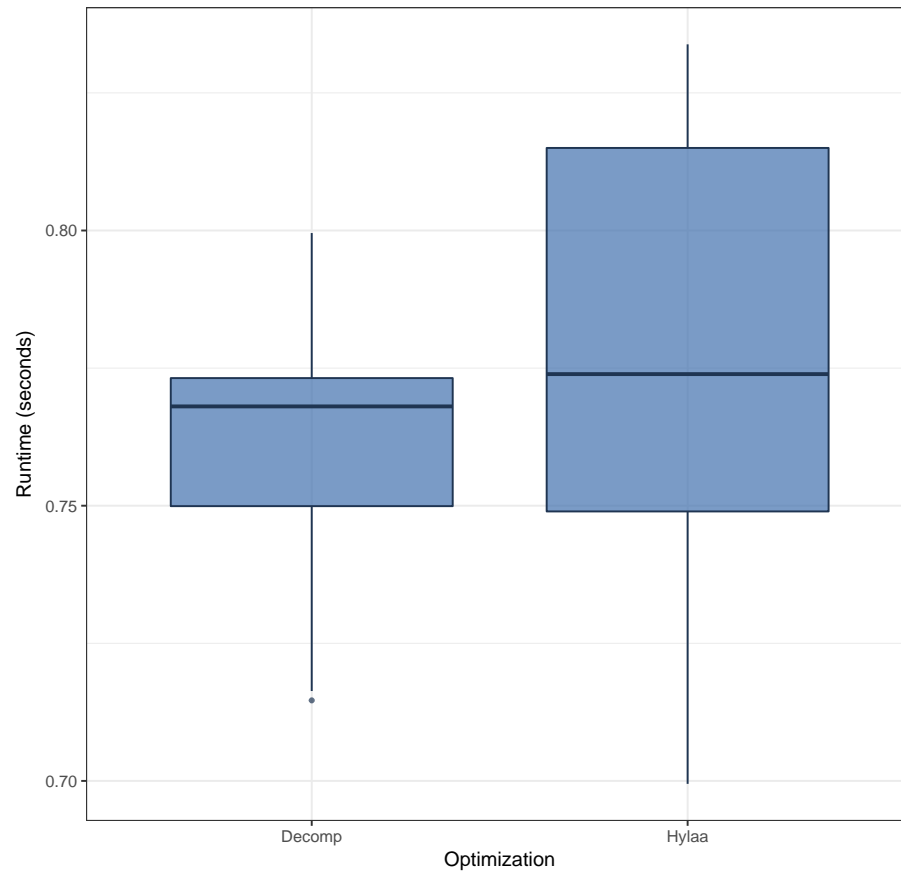
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6995  0.7490  0.7739  0.7777  0.8150  0.8338
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps197")$time
## W = 0.94142, p-value = 0.569
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.568954856828926"
```

Comparison

Runtime by Optimization for 197 steps



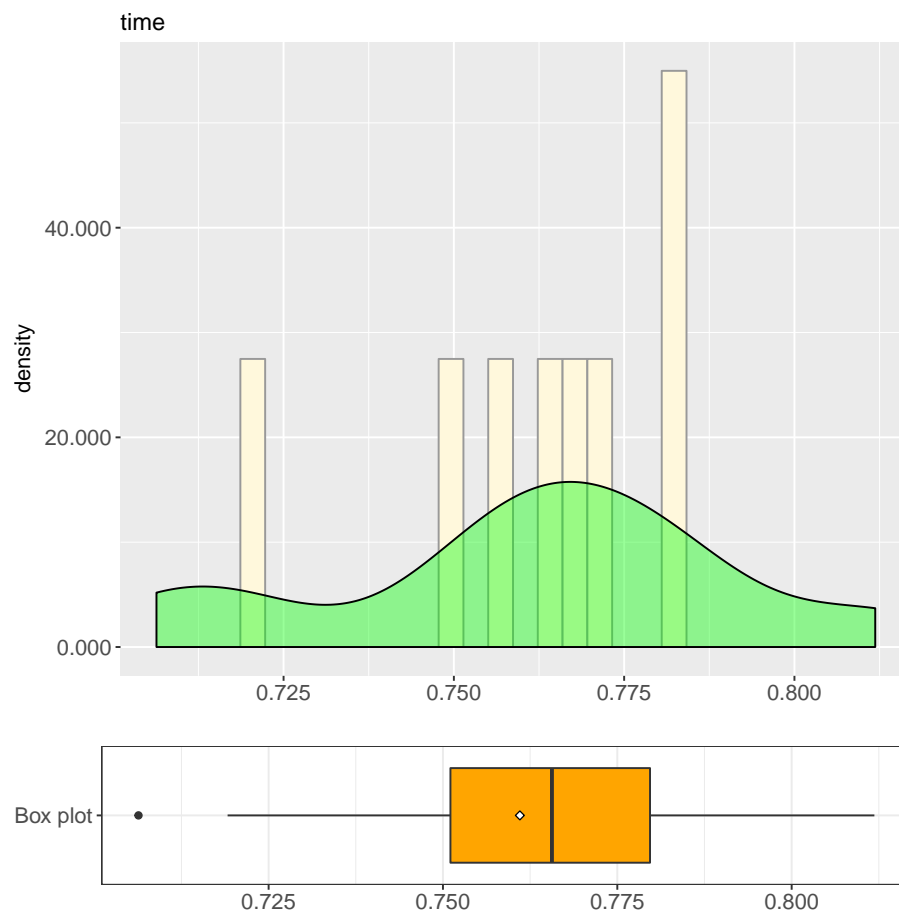
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps197")$time and subset(js
## F = 2.5361, num df = 9, denom df = 9, p-value = 0.1819
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.6299287 10.2102798
## sample estimates:
## ratio of variances
##      2.536089
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.181851926756562"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps197")$time and subset(js
## t = 1.1513, df = 18, p-value = 0.2647
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.01513052 0.05182147
## sample estimates:
## mean of x mean of y
## 0.7776674 0.7593220
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.264654985775134"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.777667427063"
## [1] "Mean Runtime for Decomp: 0.7593219518661"
## [1] "Absolute difference: 0.0183454751969"
## Runtime for Hylaa is 2.41603382489001 % greater than
## Runtime for Decomp
```

3.2.9 RH2.9: Object 256 steps

Runtime for Decomp

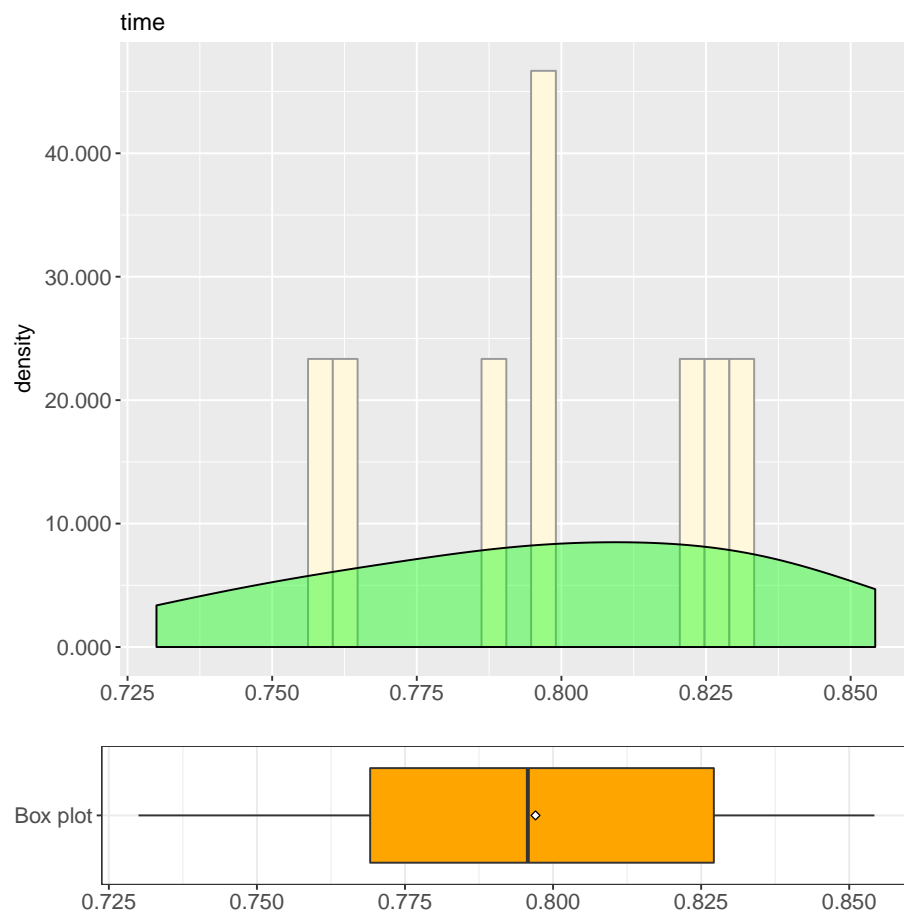
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7063  0.7511  0.7656  0.7610  0.7797  0.8119
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps256")$time
## W = 0.95667, p-value = 0.7474
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.747375944620537"
```

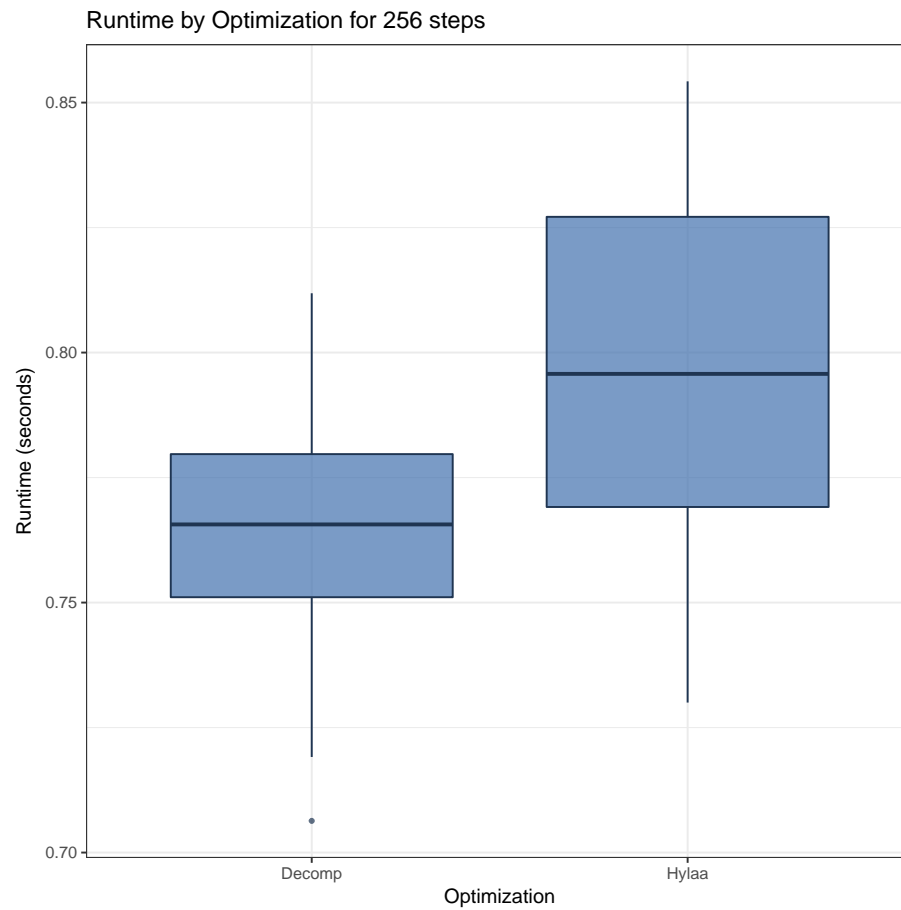
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7300 0.7691 0.7957 0.7970 0.8271 0.8542
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps256")$time
## W = 0.964, p-value = 0.8303
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.830310406698625"
```

Comparison



```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps256")$time and subset(js
## F = 1.5838, num df = 9, denom df = 9, p-value = 0.5041
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3933907 6.3763233
## sample estimates:
## ratio of variances
##      1.583789
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.504110249382027"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

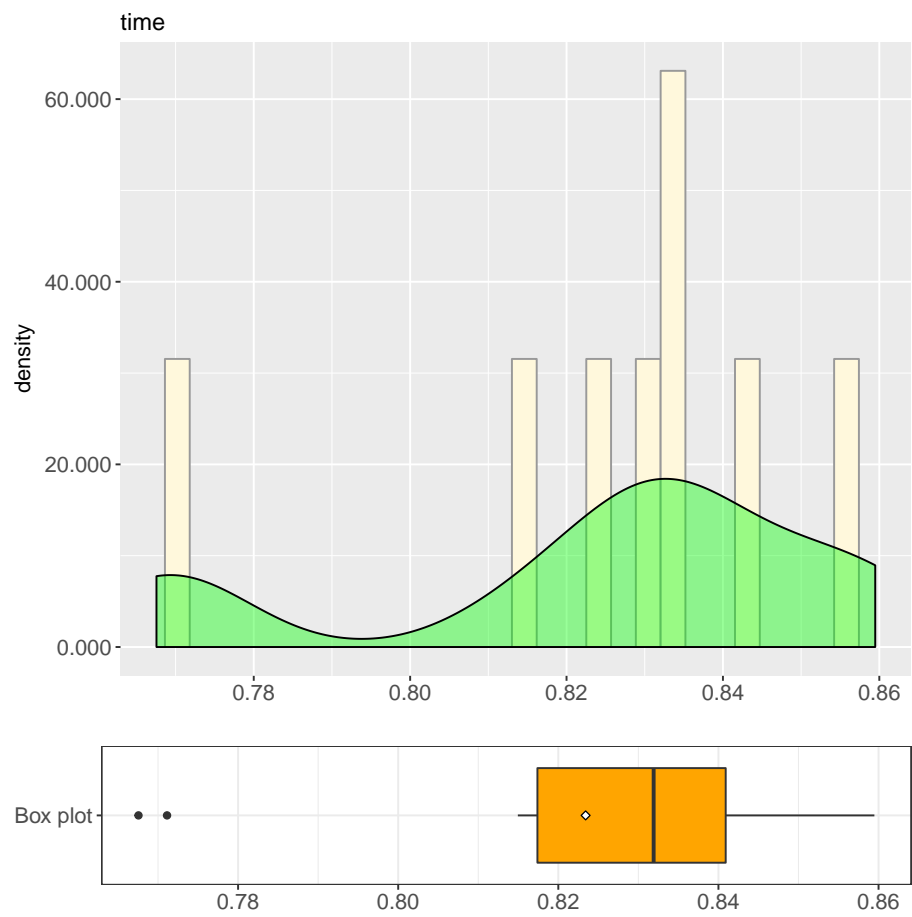


```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps256")$time and subset(js
## t = 2.2922, df = 18, p-value = 0.03416
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.003004304 0.069005641
## sample estimates:
## mean of x mean of y
## 0.797033 0.761028
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.0341639411230433"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.79703299999924"
## [1] "Mean Runtime for Decomp: 0.7610280275345"
## [1] "Absolute difference: 0.0360049724578999"
## Runtime for Hylaa is 4.73109677373448 % greater than
## Runtime for Decomp
```

3.2.10 RH2.10: Object 332 steps

Runtime for Decomp

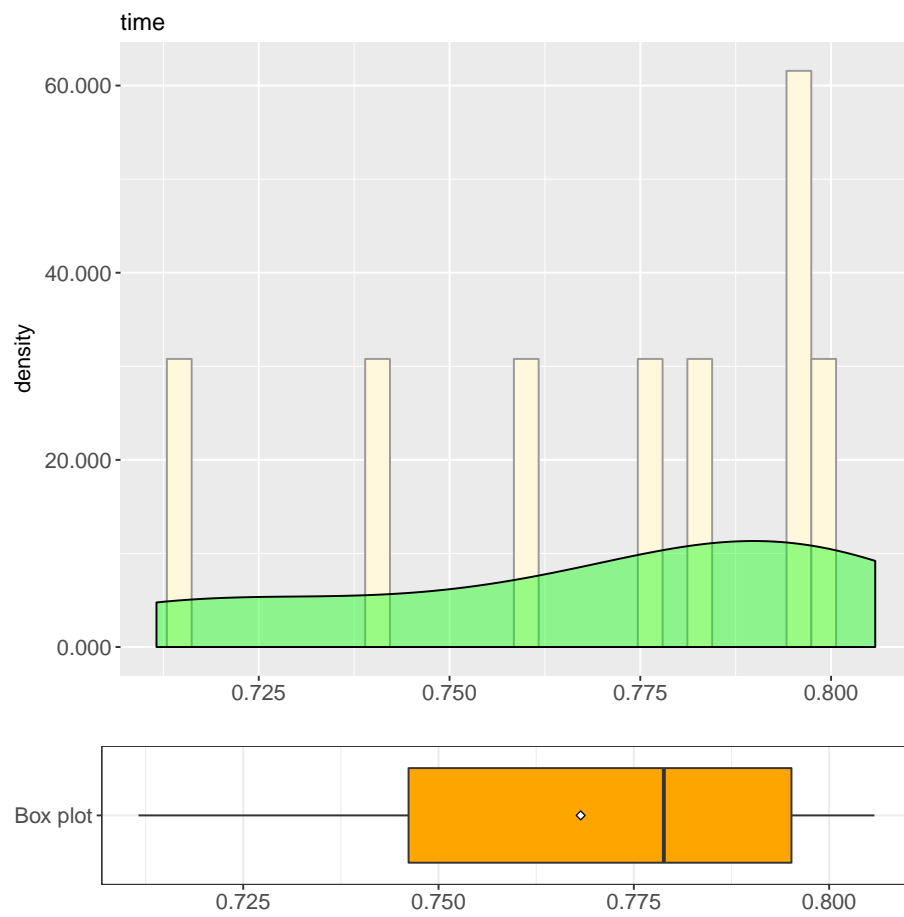
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7676 0.8174 0.8319 0.8234 0.8409 0.8595
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps332")$time
## W = 0.86459, p-value = 0.0864
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0864028845483314"
```

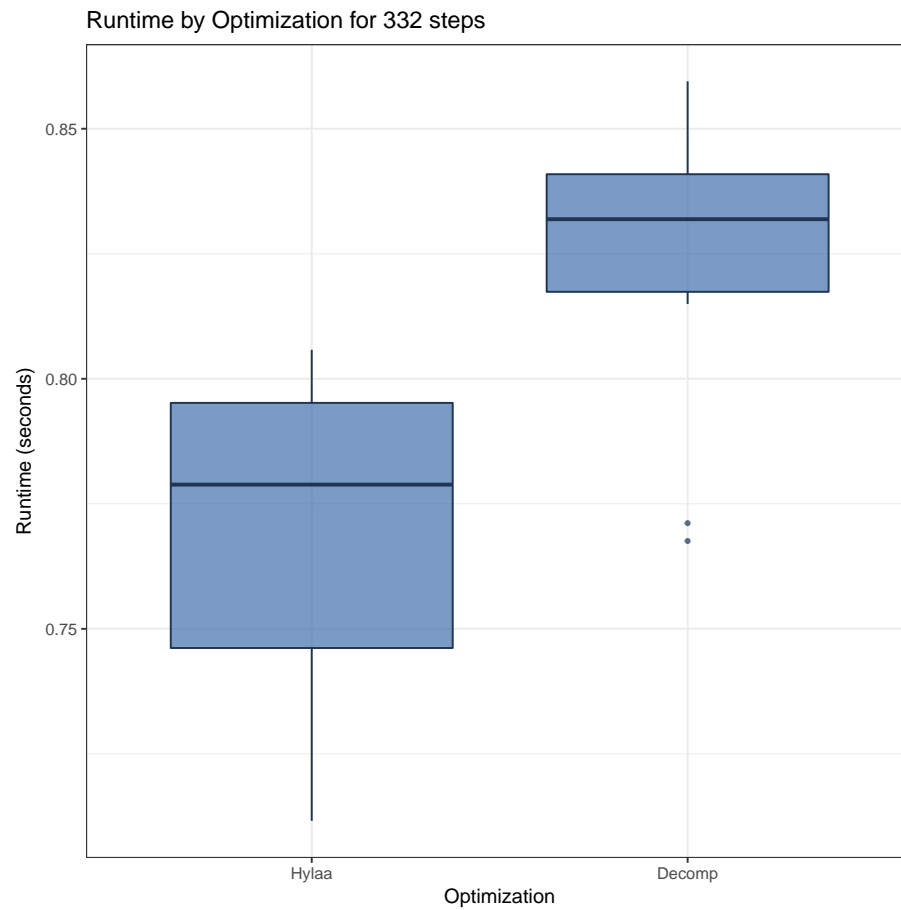
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7116 0.7462 0.7788 0.7682 0.7952 0.8058
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps332")$time
## W = 0.87995, p-value = 0.1303
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.130315495202675"
```

Comparison



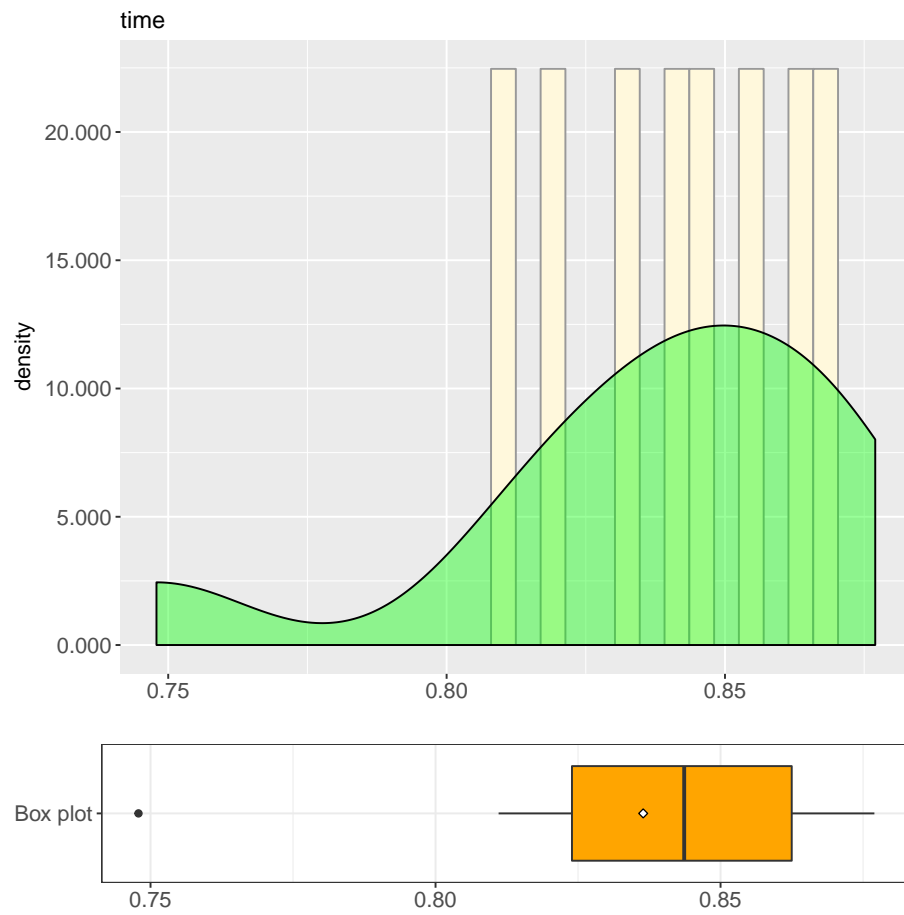
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps332")$time and subset(js
## F = 1.2297, num df = 9, denom df = 9, p-value = 0.7631
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3054445 4.9508359
## sample estimates:
## ratio of variances
##      1.229718
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.763081993650492"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps332")$time and subset(js
## t = -3.7265, df = 18, p-value = 0.001545
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.08634164 -0.02408574
## sample estimates:
## mean of x mean of y
## 0.7681974 0.8234111
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.00154458560398904"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7681974172593"
## [1] "Mean Runtime for Decomp: 0.8234111070633"
## [1] "Absolute difference: 0.055213689804"
## Runtime for Decomp is 7.18743496964439 % greater than
## Runtime for Hylaa
```

3.2.11 RH2.11: Object 432 steps

Runtime for Decomp

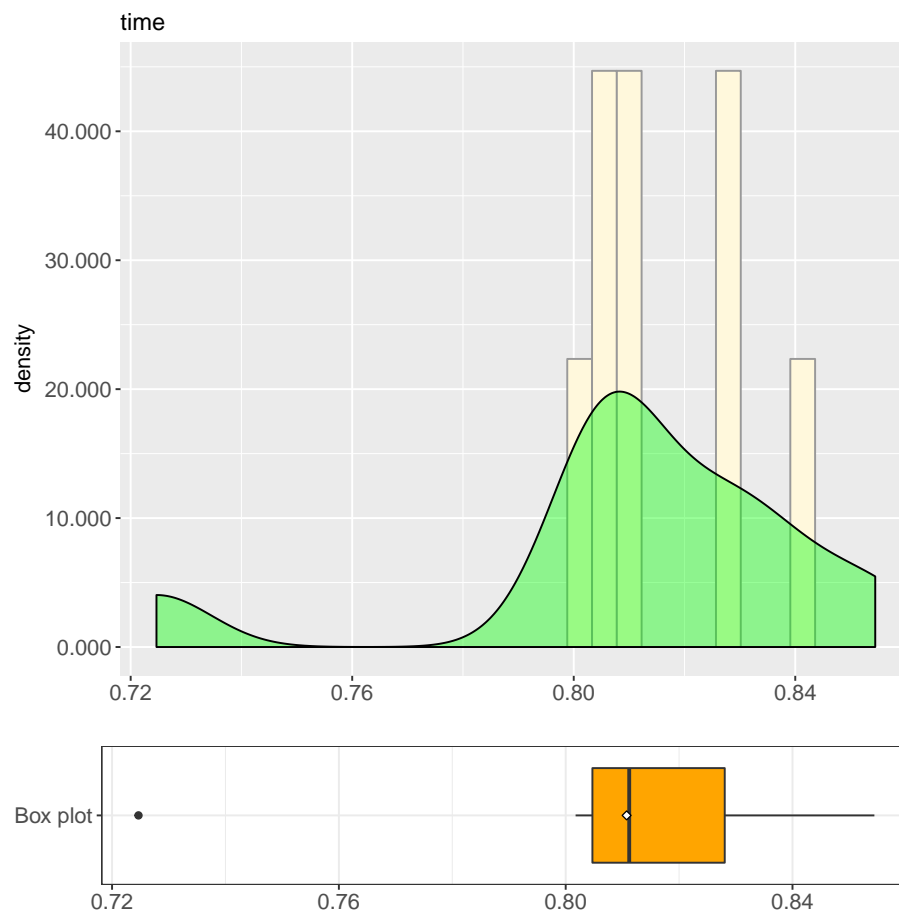
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7479  0.8239  0.8436  0.8364  0.8625  0.8770
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps432")$time
## W = 0.87325, p-value = 0.1091
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.10906821518627"
```

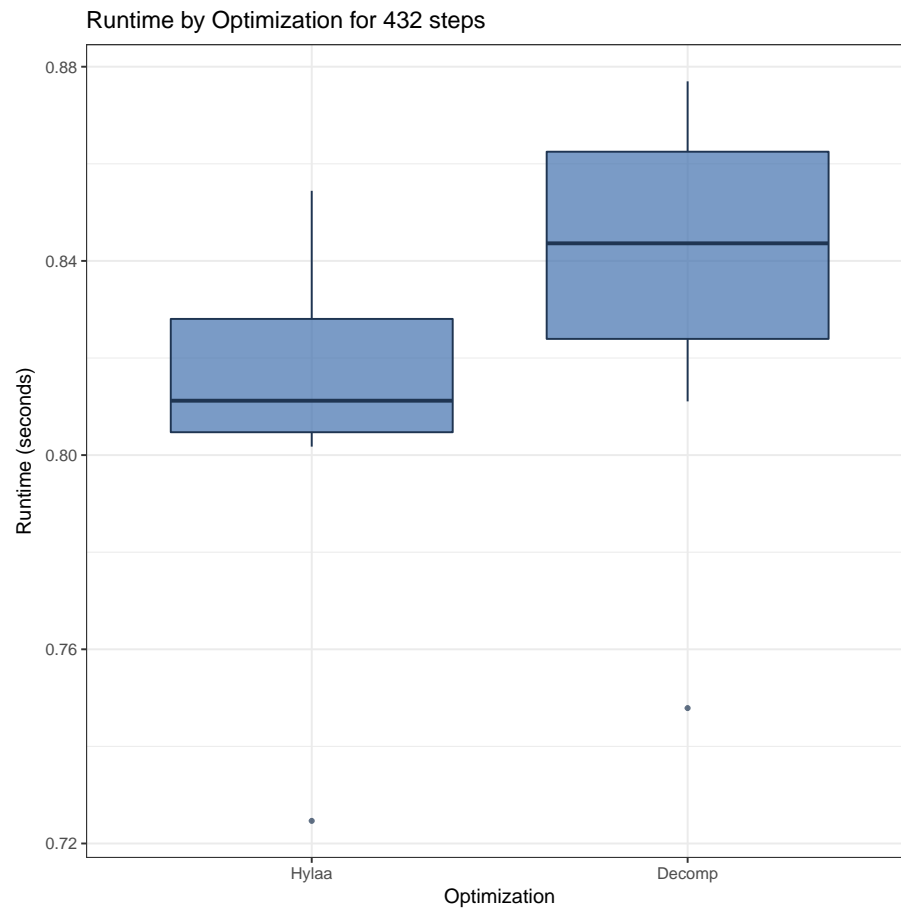
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7247 0.8047 0.8112 0.8107 0.8280 0.8544
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps432")$time
## W = 0.82468, p-value = 0.02887
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.0288658654097958"
```

Comparison

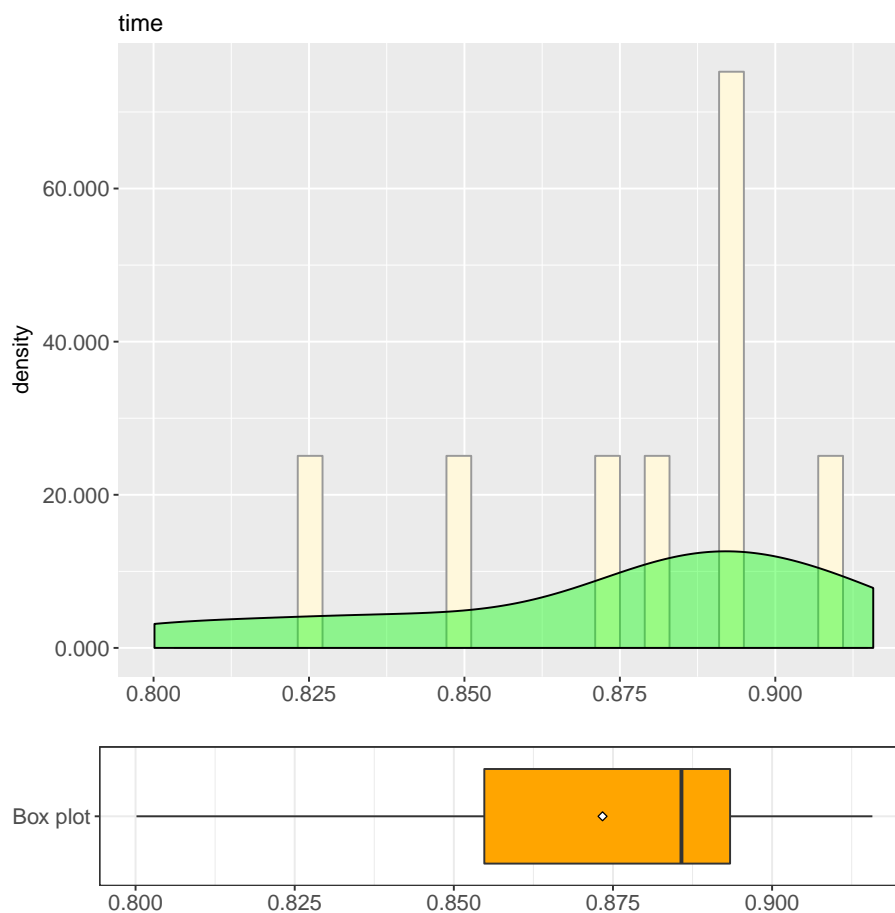


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 77, p-value = 0.04326
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 0.0432570525449782"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.8107497930526"
## [1] "Mean Runtime for Decomp: 0.8364275932313"
## [1] "Absolute difference: 0.0256778001787"
## Runtime for Decomp is 3.16716703460621 % greater than
## Runtime for Hylaa
```


3.2.12 RH2.12: Object 562 steps

Runtime for Decomp

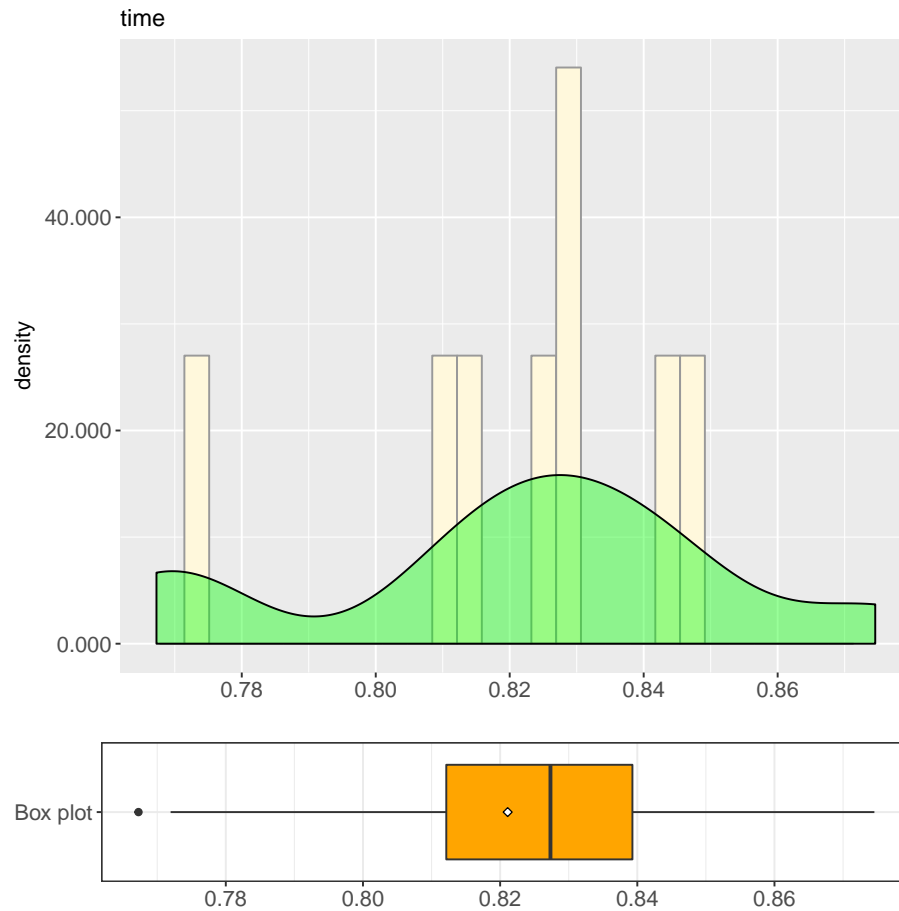
```
## [1] "Sample size: 10"  
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
## 0.8001 0.8548 0.8858 0.8734 0.8934 0.9158
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Decomp" & object == "steps562")$time  
## W = 0.90464, p-value = 0.2462  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.246164284419909"
```

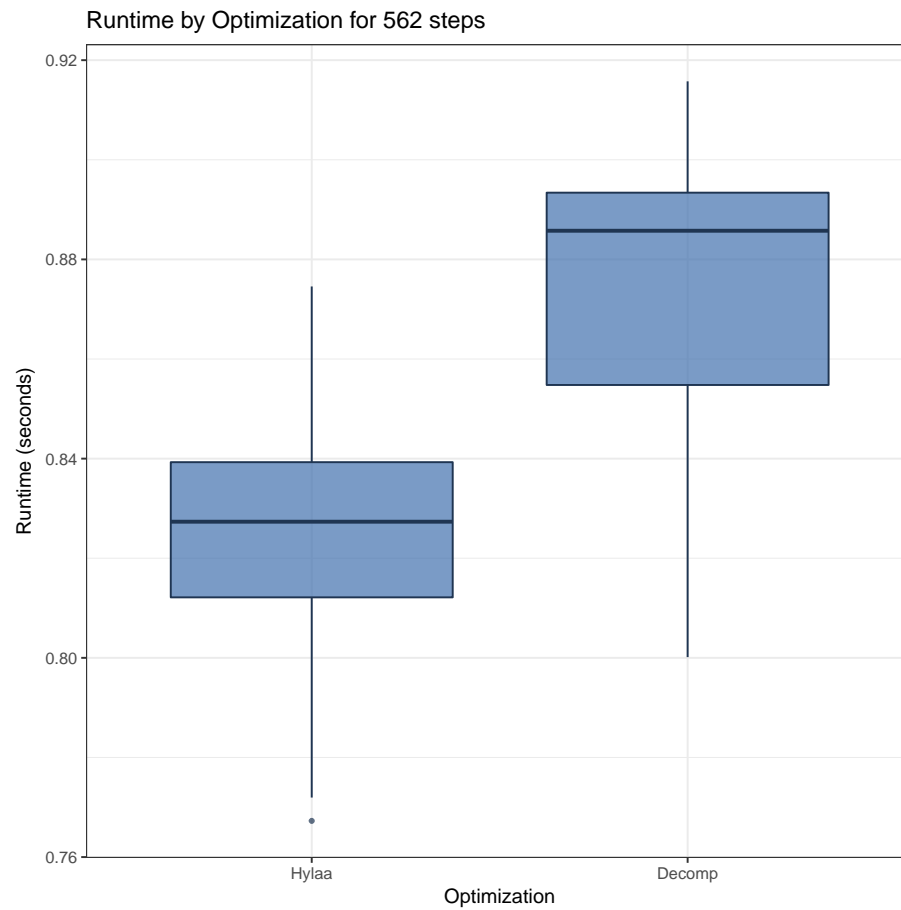
Runtime for Hylaa

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7673 0.8121 0.8273 0.8211 0.8393 0.8746
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps562")$time
## W = 0.93601, p-value = 0.5095
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.509497615860695"
```

Comparison



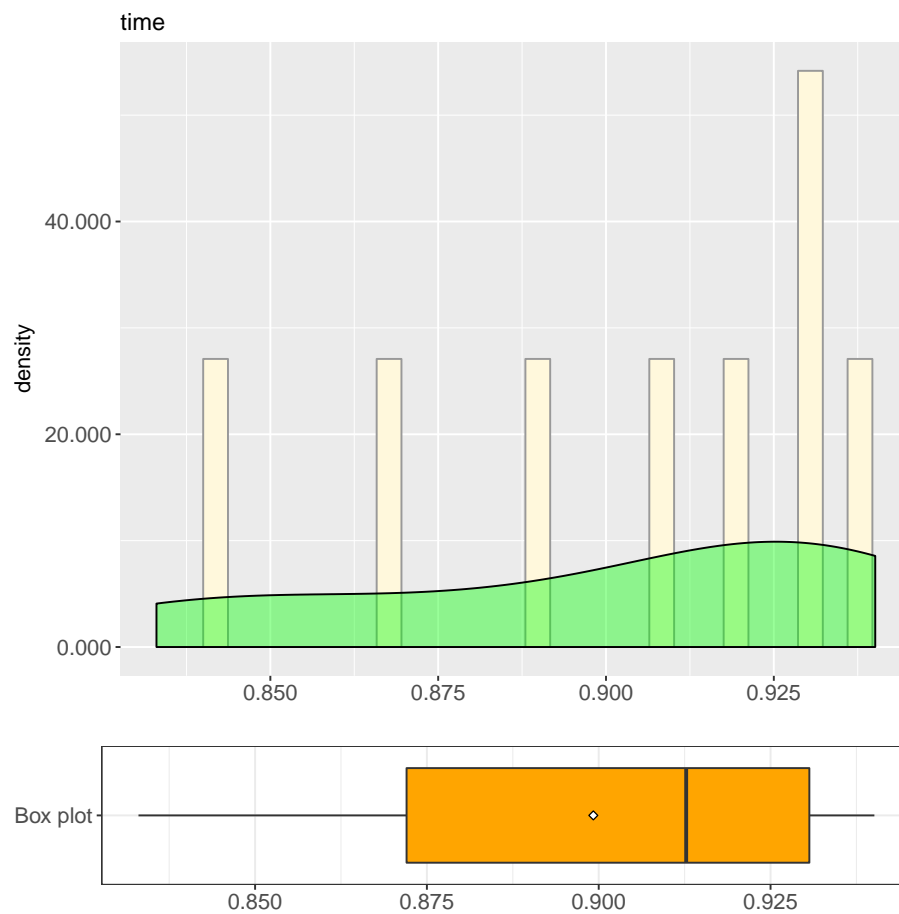
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps562")$time and subset(js
## F = 0.7585, num df = 9, denom df = 9, p-value = 0.6872
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1884004 3.0537124
## sample estimates:
## ratio of variances
##      0.758499
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.687195274057246"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps562")$time and subset(js
## t = -3.3368, df = 18, p-value = 0.003671
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.08516727 -0.01935662
## sample estimates:
## mean of x mean of y
## 0.8210984 0.8733603
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.00367054332005812"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.8210983753205"
## [1] "Mean Runtime for Decomp: 0.873360323906"
## [1] "Absolute difference: 0.0522619485854999"
## Runtime for Decomp is 6.36488271762814 % greater than
## Runtime for Hylaa
```

3.2.13 RH2.13: Object 731 steps

Runtime for Decomp

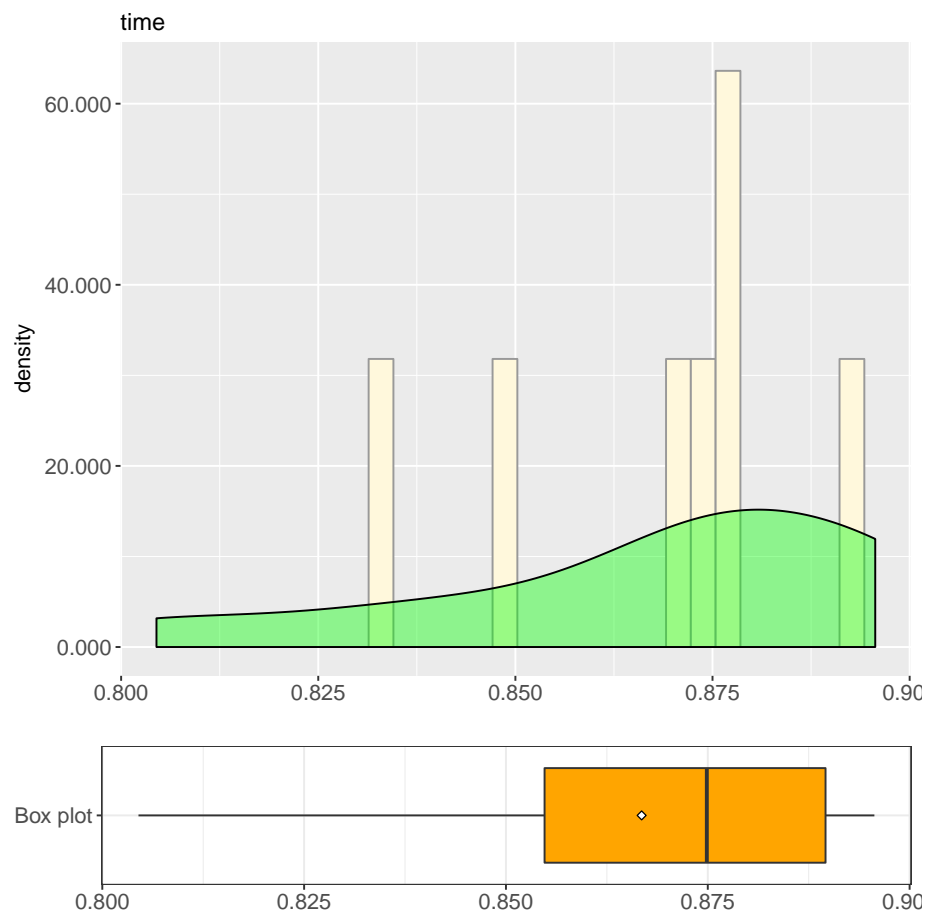
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.8330 0.8720 0.9127 0.8992 0.9306 0.9401
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps731")$time
## W = 0.87854, p-value = 0.1255
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.125538933244617"
```

Runtime for Hylaa

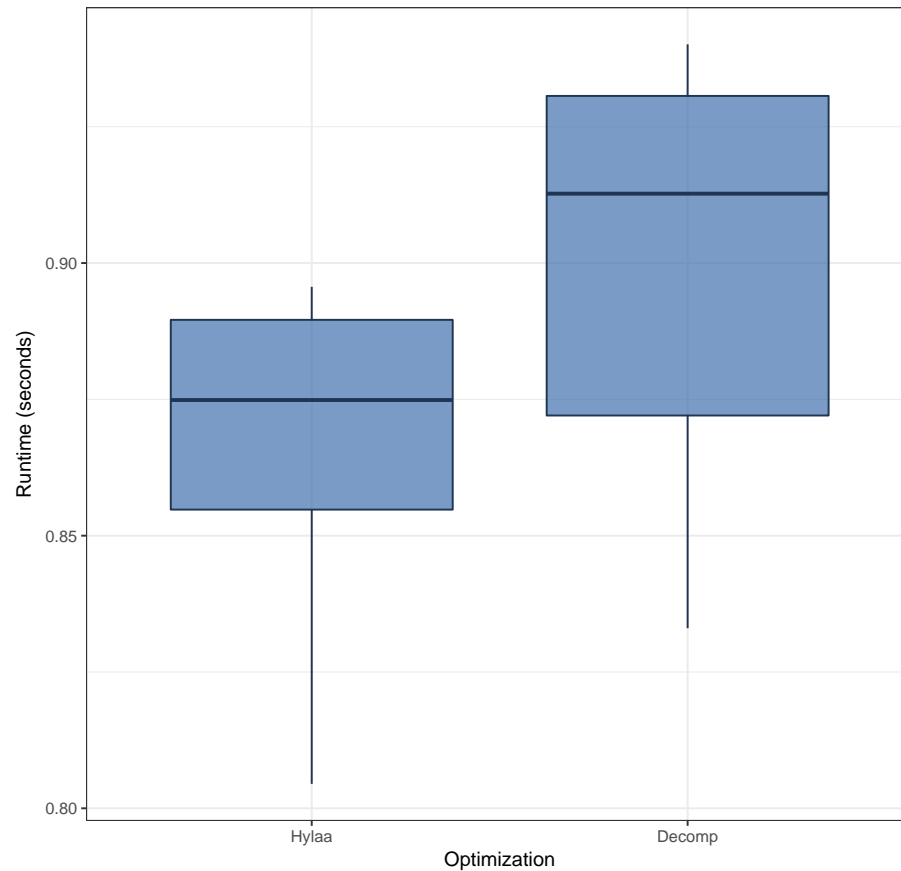
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.8045  0.8548  0.8749  0.8668  0.8896  0.8956
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps731")$time
## W = 0.86638, p-value = 0.09069
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0906925091728528"
```

Comparison

Runtime by Optimization for 731 steps



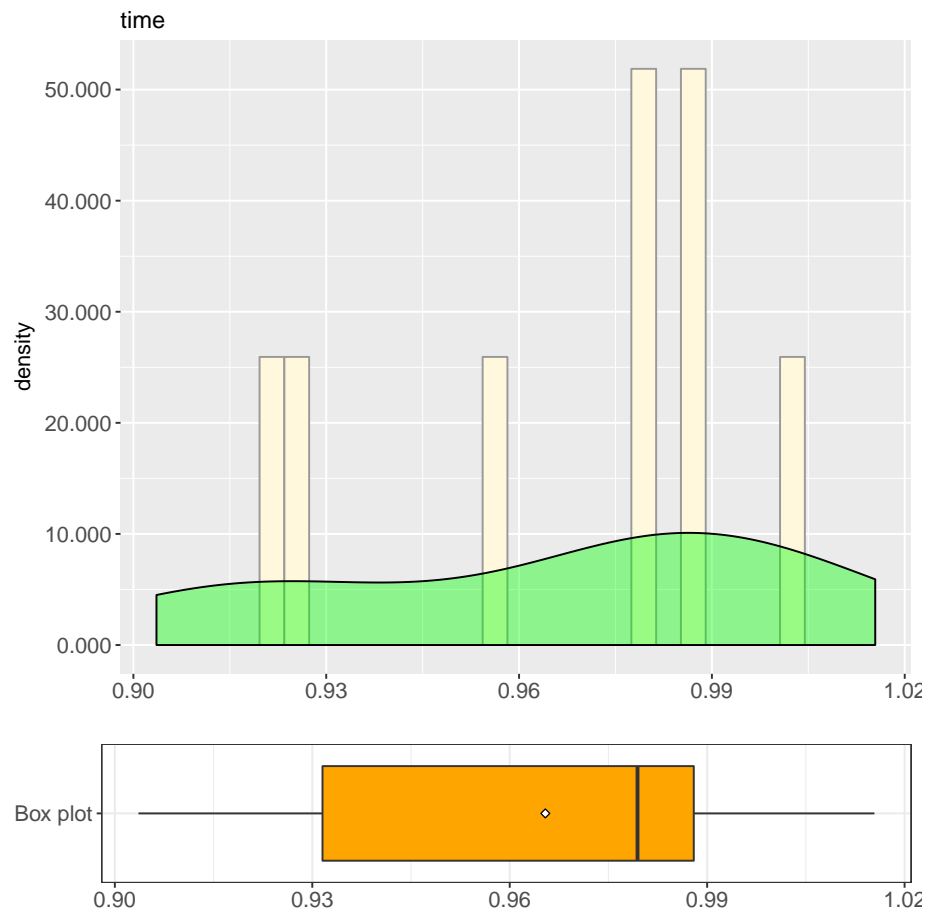
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps731")$time and subset(js
## F = 0.55885, num df = 9, denom df = 9, p-value = 0.3991
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1388096 2.2499136
## sample estimates:
## ratio of variances
##      0.5588467
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.399088259767841"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps731")$time and subset(js
## t = -2.0628, df = 18, p-value = 0.05386
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.0654144774 0.0005988131
## sample estimates:
## mean of x mean of y
## 0.8668062 0.8992141
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.0538632912080315"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.8668062448501"
## [1] "Mean Runtime for Decomp: 0.8992140769958"
## [1] "Absolute difference: 0.0324078321457001"
## Runtime for Decomp is 3.73876311323813 % greater than
## Runtime for Hylaa
```

3.2.14 RH2.14: Object 951 steps

Runtime for Decomp

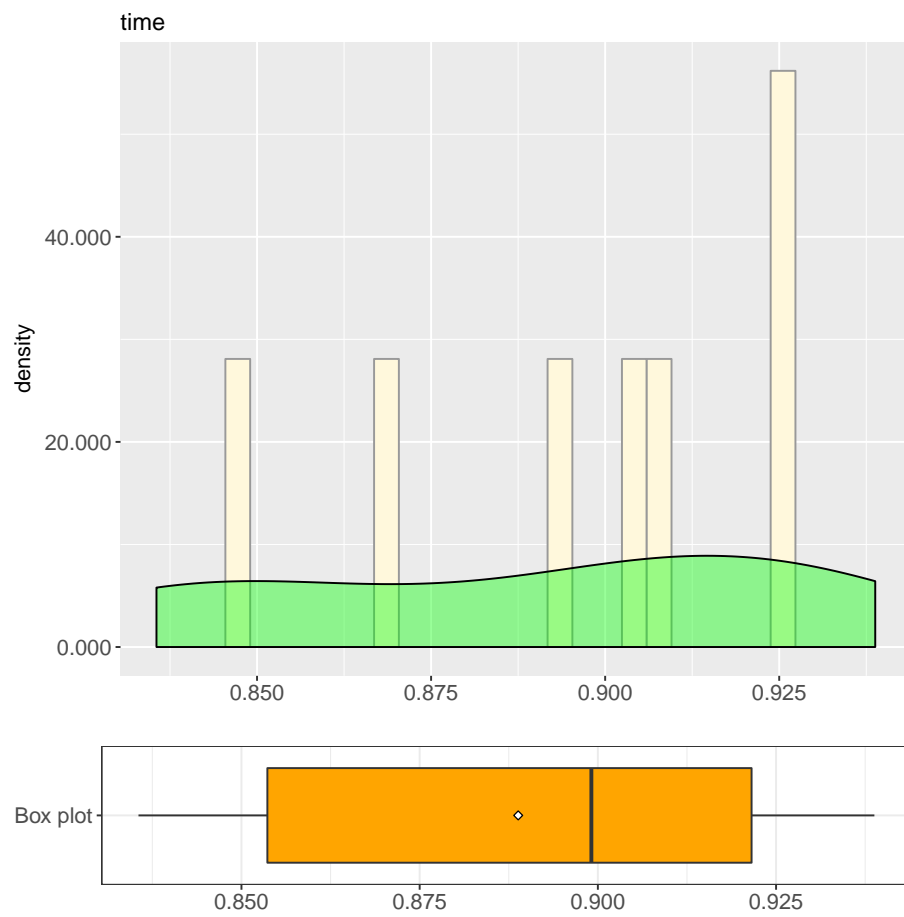
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.9036 0.9316 0.9794 0.9654 0.9880 1.0150
```

```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps951")$time
## W = 0.91893, p-value = 0.3482
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.348155264626675"
```

Runtime for Hylaa

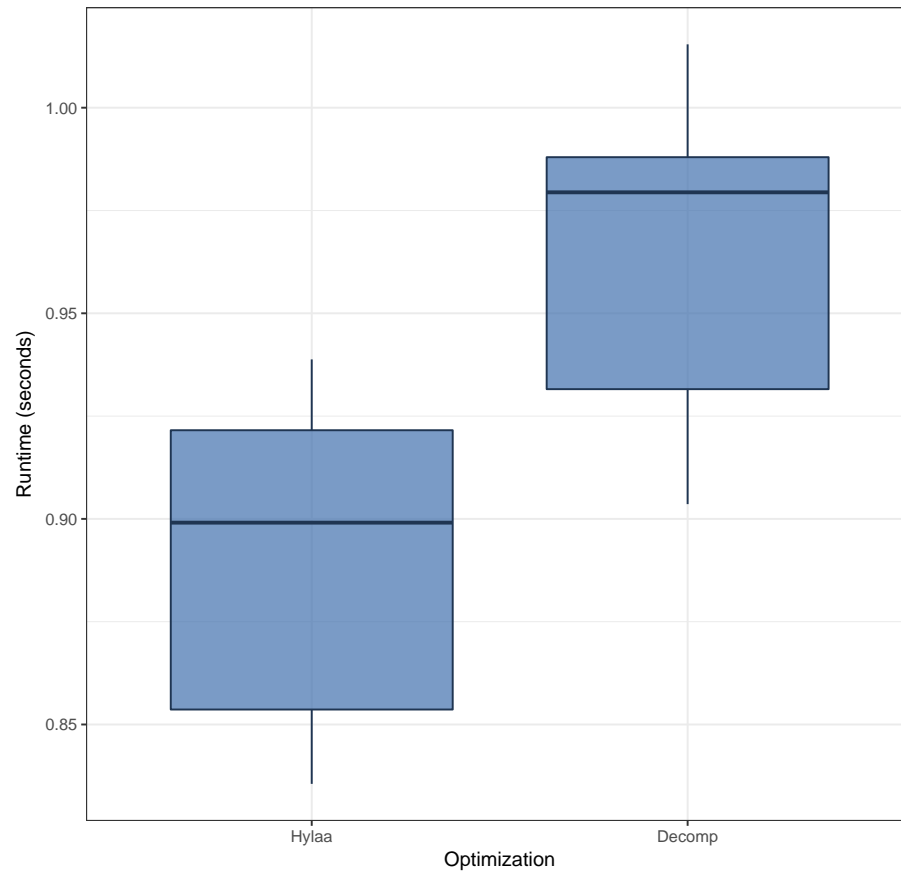
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.8356 0.8536 0.8991 0.8888 0.9216 0.9388
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps951")$time
## W = 0.90483, p-value = 0.2474
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.247358608075924"
```

Comparison

Runtime by Optimization for 951 steps



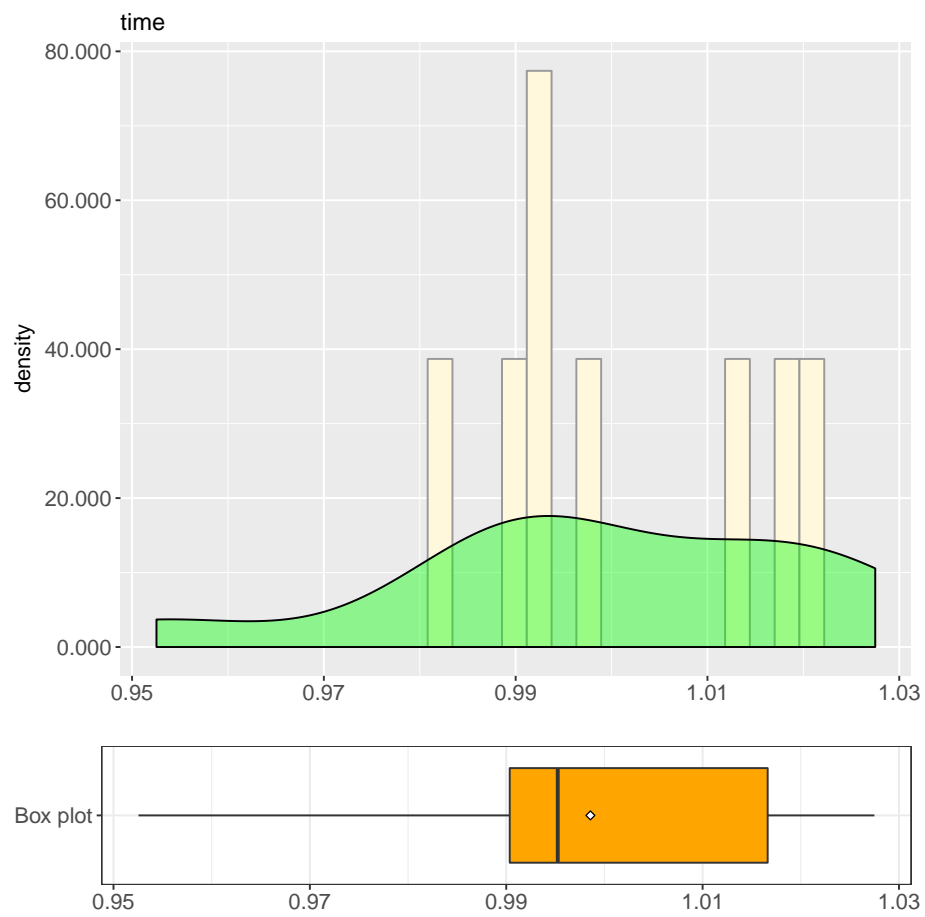
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps951")$time and subset(js
## F = 1.0625, num df = 9, denom df = 9, p-value = 0.9295
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2639217 4.2778084
## sample estimates:
## ratio of variances
##      1.062547
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.929472347516757"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps951")$time and subset(js
## t = -4.4707, df = 18, p-value = 0.0002955
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.11257849 -0.04059615
## sample estimates:
## mean of x mean of y
## 0.8888239 0.9654112
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.000295531060619764"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.8888238906861"
## [1] "Mean Runtime for Decomp: 0.9654112100603"
## [1] "Absolute difference: 0.0765873193742"
## Runtime for Decomp is 8.61670350861978 % greater than
## Runtime for Hylaa
```

3.2.15 RH2.15: Object 1236 steps

Runtime for Decomp

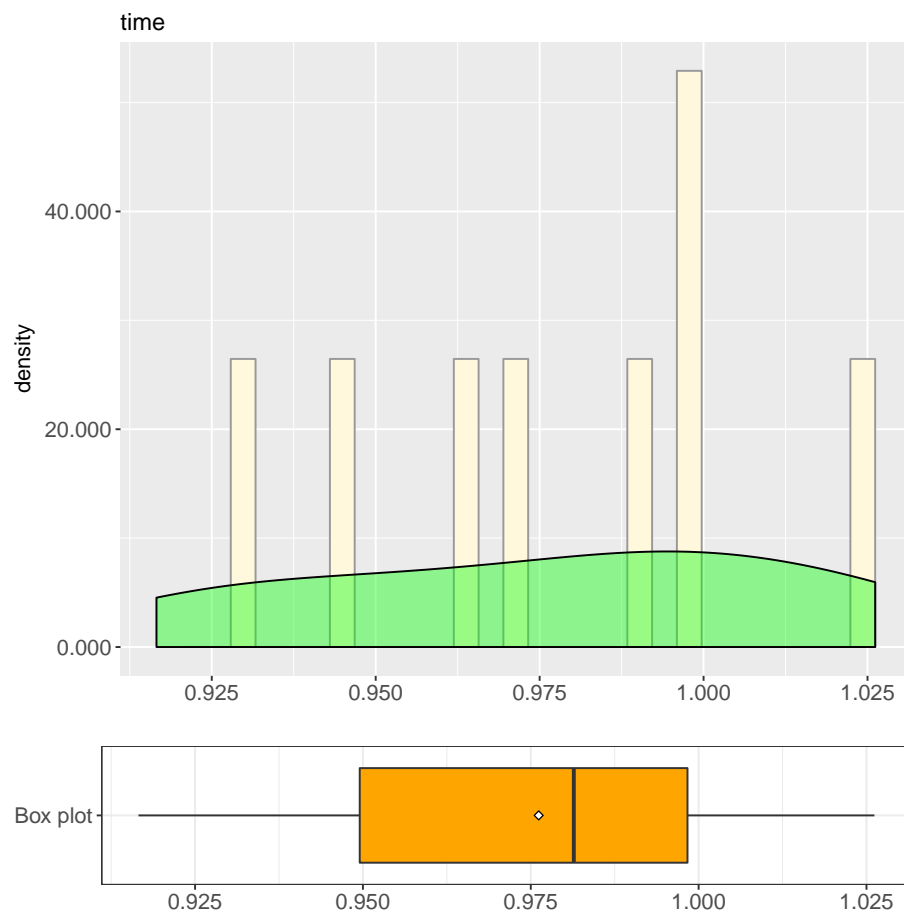
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.9525  0.9904  0.9952  0.9986  1.0170  1.0270
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps1236")$time
## W = 0.93214, p-value = 0.4693
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.46925140659137"
```

Runtime for Hylaa

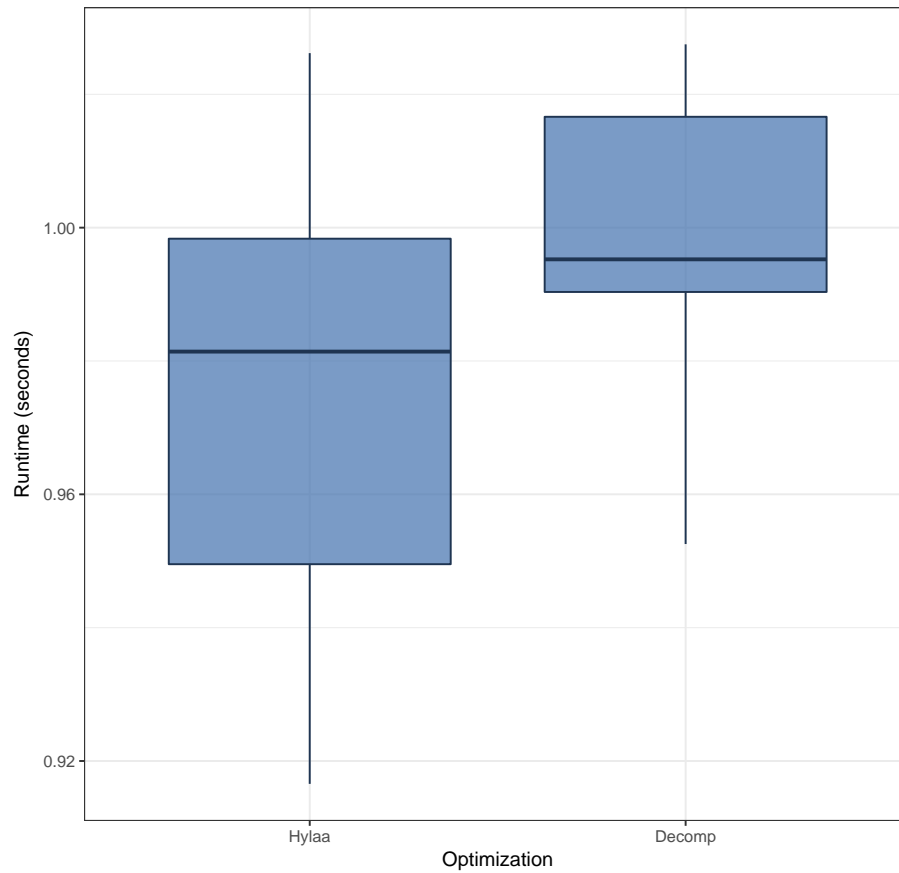
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.9166 0.9495 0.9814 0.9762 0.9983 1.0260
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps1236")$time
## W = 0.94652, p-value = 0.6275
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.627527133287823"
```

Comparison

Runtime by Optimization for 1236 steps



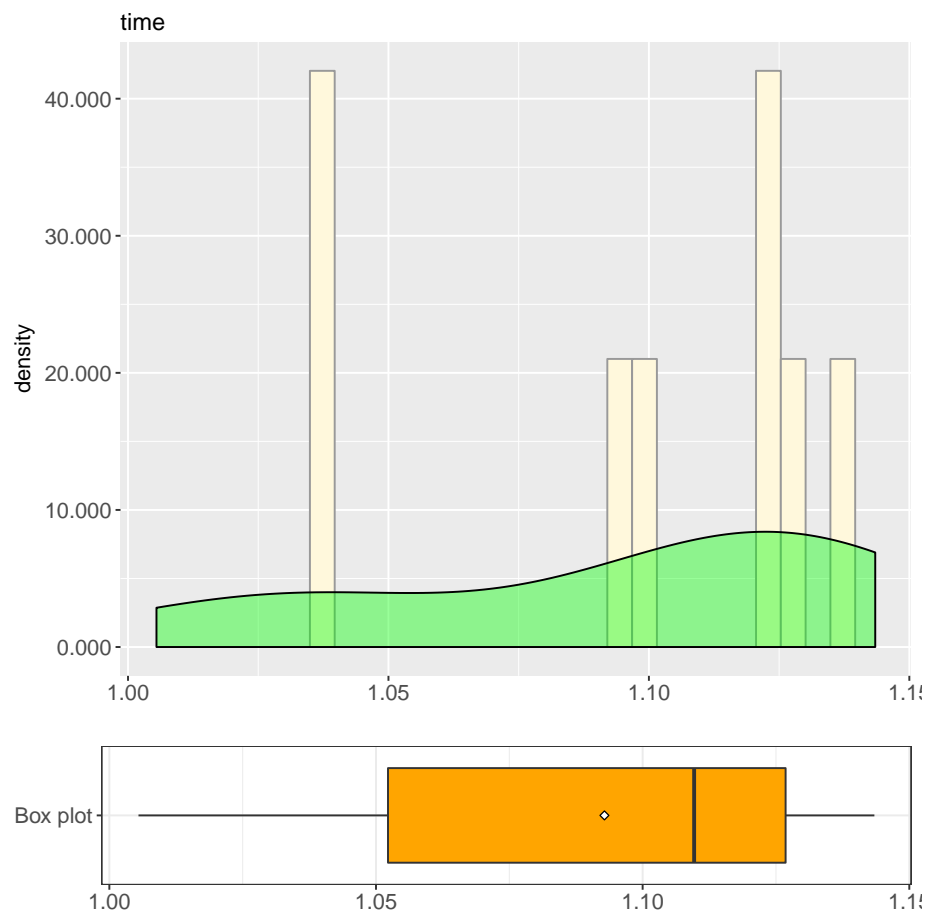
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps1236")$time and subset(j
## F = 2.9507, num df = 9, denom df = 9, p-value = 0.1227
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.7329153 11.8795520
## sample estimates:
## ratio of variances
##      2.950713
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.122690229379047"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps1236")$time and subset(j
## t = -1.6141, df = 18, p-value = 0.1239
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.051543781 0.006755086
## sample estimates:
## mean of x mean of y
## 0.9761788 0.9985732
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.123908728539939"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.9761788368224"
## [1] "Mean Runtime for Decomp: 0.9985731840122"
## [1] "Absolute difference: 0.0223943471898"
## Runtime for Decomp is 2.29408243090957 % greater than
## Runtime for Hylaa
```

3.2.16 RH2.16: Object 1607 steps

Runtime for Decomp

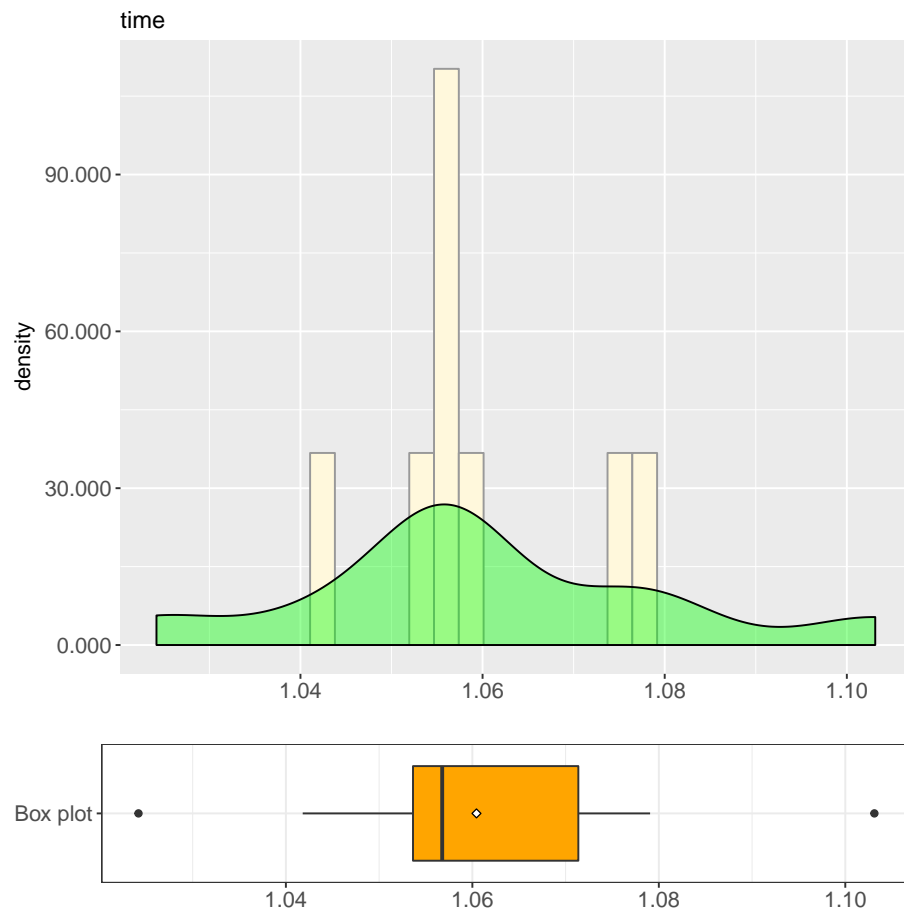
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 1.005 1.052 1.110 1.093 1.127 1.143
```

```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps1607")$time
## W = 0.87483, p-value = 0.1137
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.113742839342626"
```

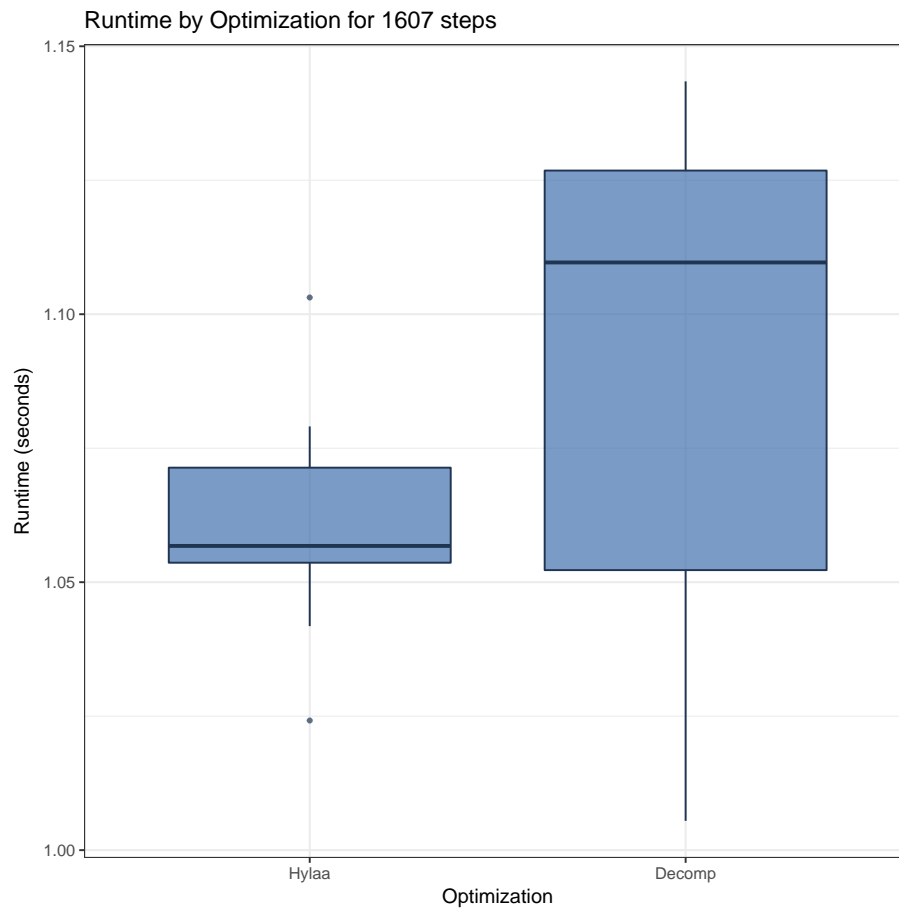
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.024  1.054   1.057   1.060   1.071   1.103
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps1607")$time
## W = 0.9449, p-value = 0.6087
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.608652897163905"
```

Comparison



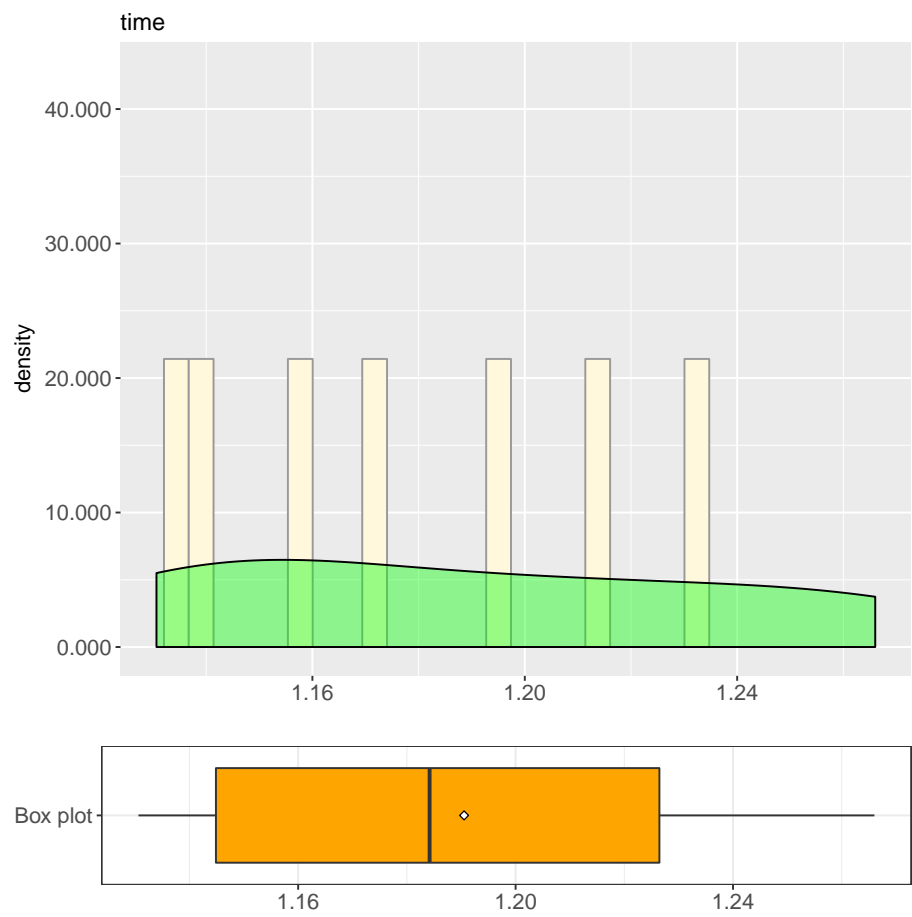
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps1607")$time and subset(j
## F = 0.1968, num df = 9, denom df = 9, p-value = 0.02377
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.0488816 0.7923037
## sample estimates:
## ratio of variances
##      0.196797
##
## [1] "Homogeneity of variances: FALSE. P-value: 0.02376838052269"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Welch Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps1607")$time and subset(j
## t = -1.9296, df = 12.41, p-value = 0.07683
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.068836110 0.004050057
## sample estimates:
## mean of x mean of y
## 1.060442 1.092835
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.0768345798131928"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.060442185402"
## [1] "Mean Runtime for Decomp: 1.092835211755"
## [1] "Absolute difference: 0.0323930263529999"
## Runtime for Decomp is 3.05467160764829 % greater than
## Runtime for Hylaa
```

3.2.17 RH2.17: Object 2089 steps

Runtime for Decomp

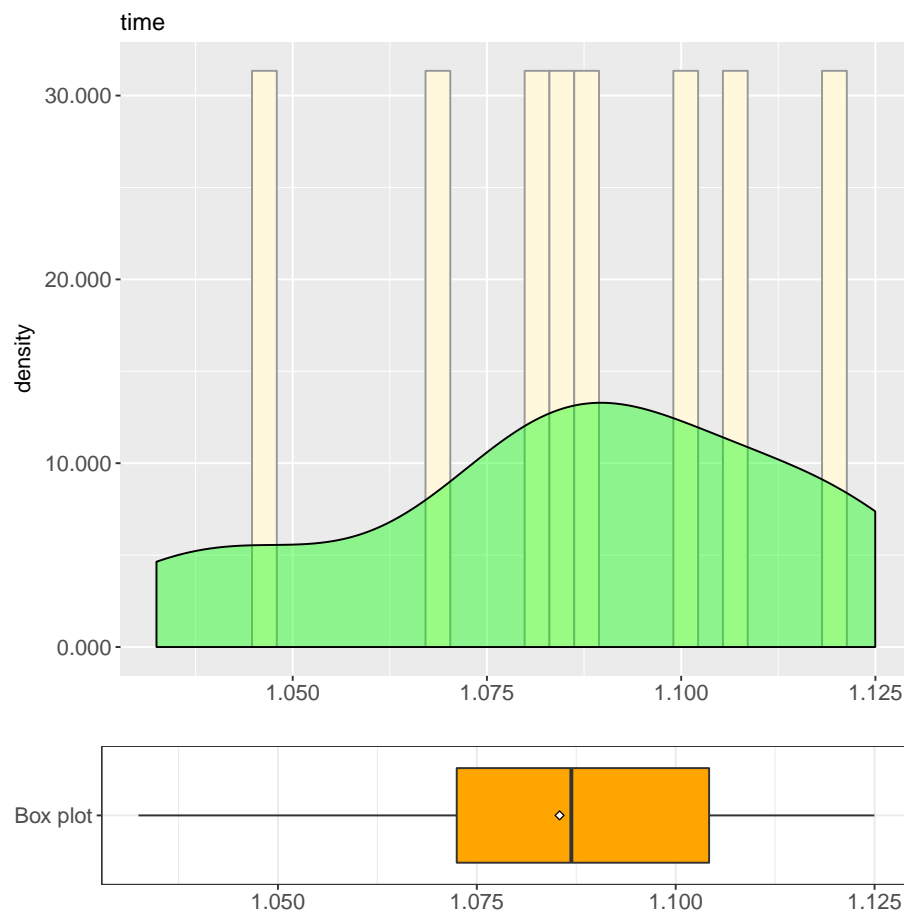
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 1.131 1.145 1.184 1.191 1.226 1.266
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps2089")$time
## W = 0.91088, p-value = 0.2871
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.287118817353588"
```

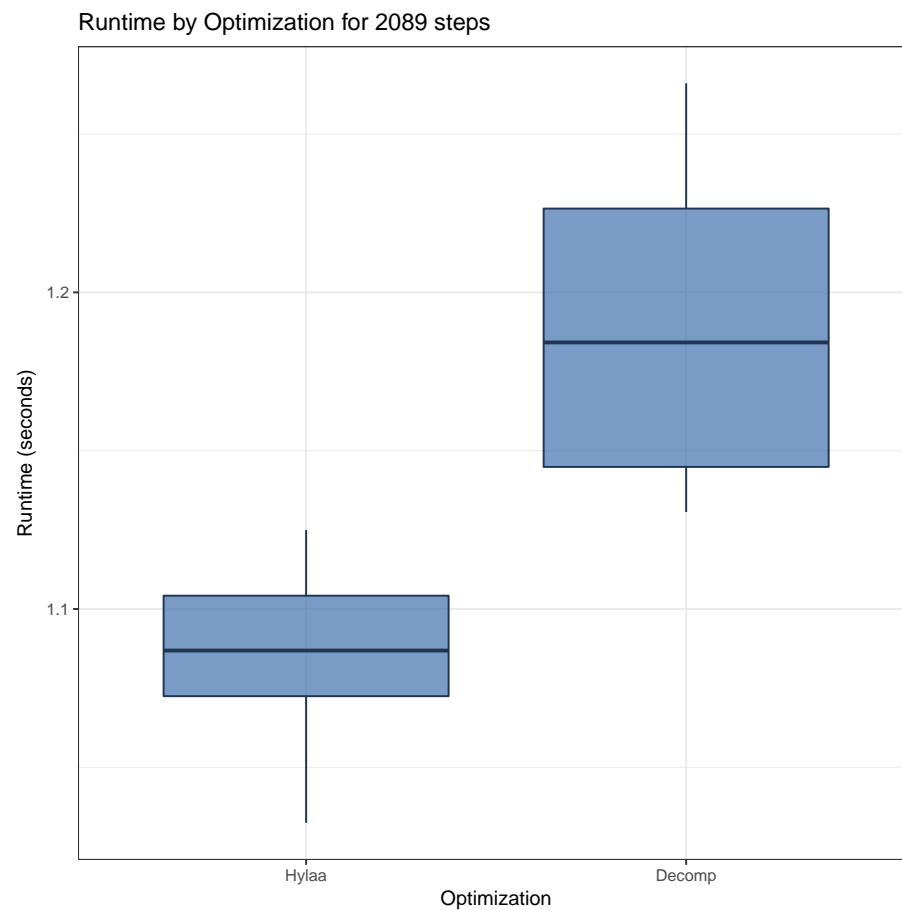
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.032  1.072   1.087   1.085   1.104   1.125
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps2089")$time
## W = 0.96099, p-value = 0.7971
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.797065263315739"
```

Comparison



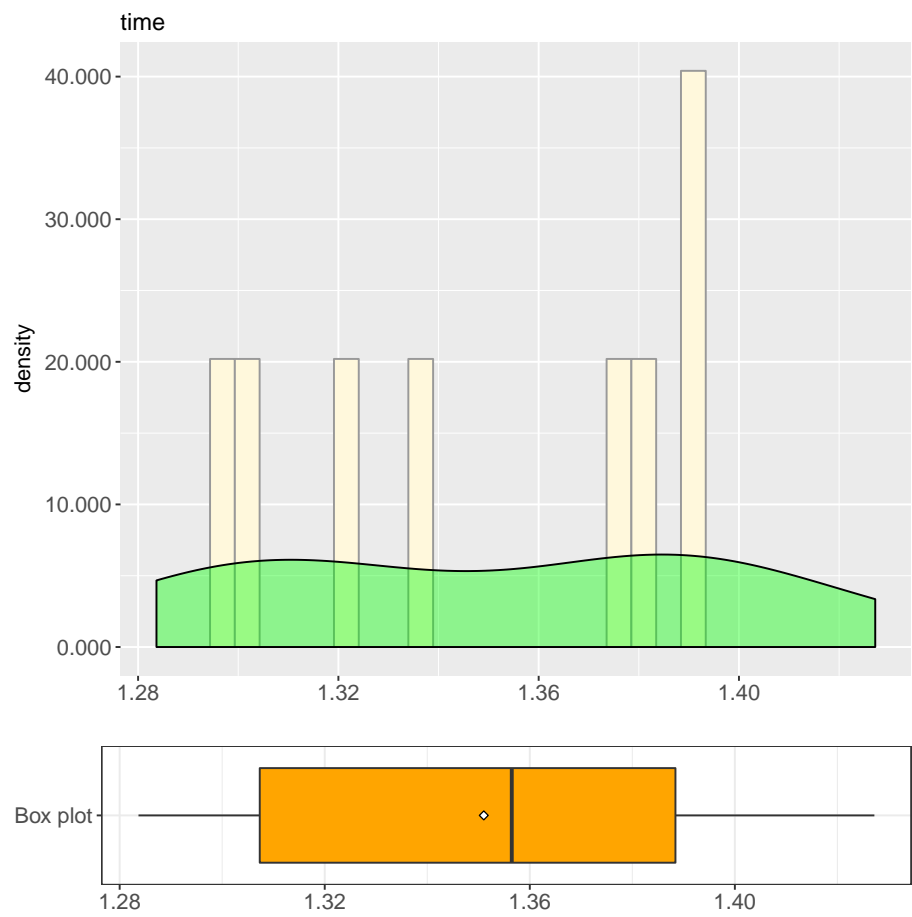
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps2089")$time and subset(j
## F = 0.33038, num df = 9, denom df = 9, p-value = 0.1145
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.08206214 1.33011483
## sample estimates:
## ratio of variances
##      0.3303817
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.114497929827874"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps2089")$time and subset(j
## t = -5.6061, df = 18, p-value = 2.55e-05
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.14451911 -0.06572812
## sample estimates:
## mean of x mean of y
## 1.085403 1.190527
##
## [1] "T-test: Null Hypothesis rejected. P-value: 2.54984312978809e-05"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.085403156281"
## [1] "Mean Runtime for Decomp: 1.190526771544"
## [1] "Absolute difference: 0.105123615263"
## Runtime for Decomp is 9.68521370650819 % greater than
## Runtime for Hylaa
```

3.2.18 RH2.18: Object 2716 steps

Runtime for Decomp

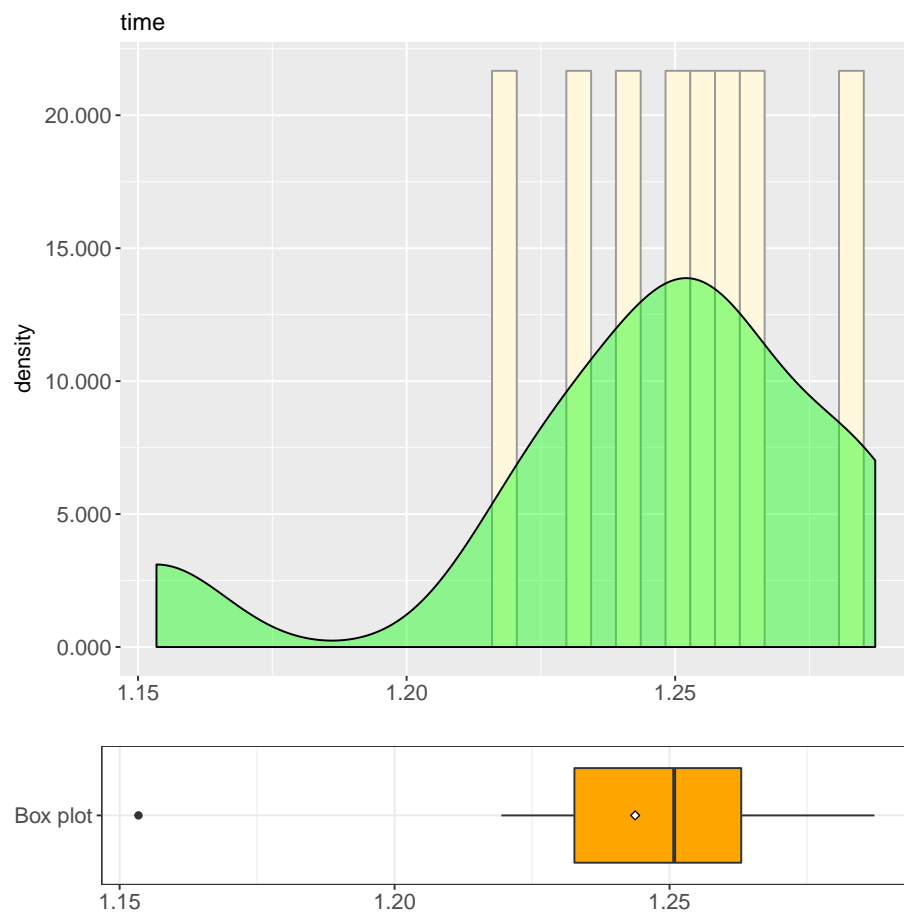
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 1.284 1.307 1.356 1.351 1.388 1.427
```

```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps2716")$time
## W = 0.92631, p-value = 0.4126
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.412585057212168"
```

Runtime for Hylaa

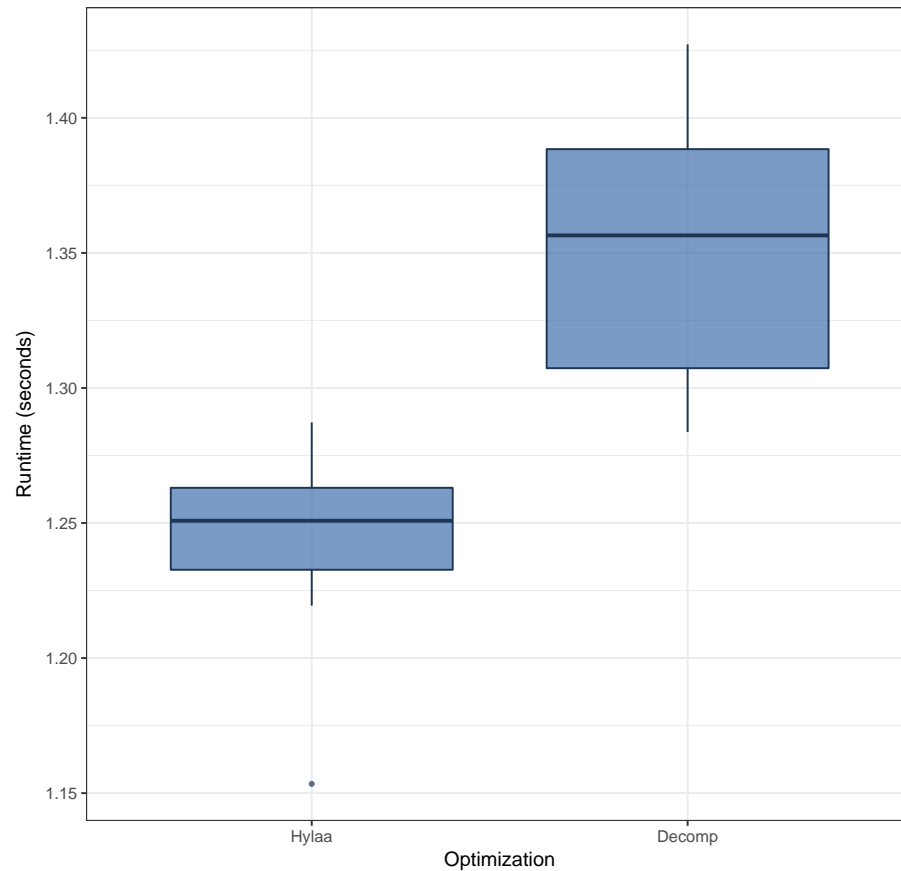
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.153  1.233   1.251   1.244   1.263   1.287
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps2716")$time
## W = 0.87909, p-value = 0.1274
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.12738118267151"
```

Comparison

Runtime by Optimization for 2716 steps



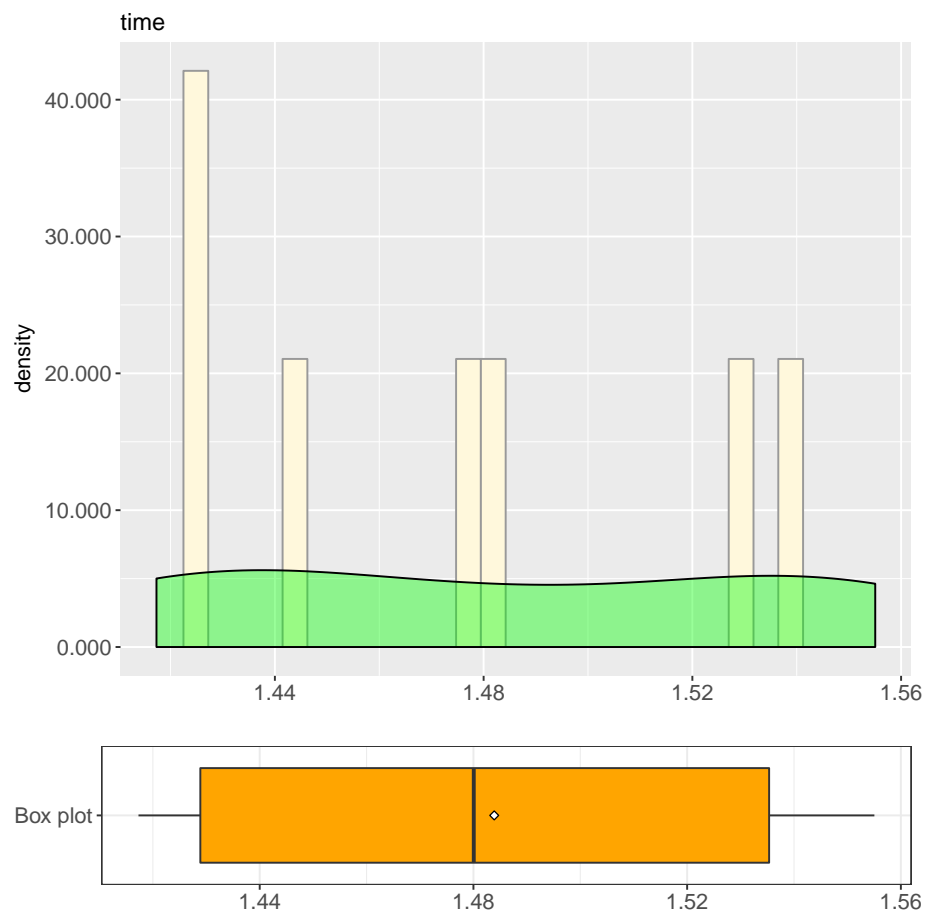
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps2716")$time and subset(json_data, treatment == "Decomp" & object == "steps2716")$time
## F = 0.61044, num df = 9, denom df = 9, p-value = 0.4736
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1516234 2.4576080
## sample estimates:
## ratio of variances
##      0.6104351
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.473601267728052"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps2716")$time and subset(j
## t = -5.4792, df = 18, p-value = 3.331e-05
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.14841207 -0.06614391
## sample estimates:
## mean of x mean of y
## 1.243749 1.351027
##
## [1] "T-test: Null Hypothesis rejected. P-value: 3.33071373512835e-05"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.243748641014"
## [1] "Mean Runtime for Decomp: 1.351026630402"
## [1] "Absolute difference: 0.107277989388"
## Runtime for Decomp is 8.62537540547893 % greater than
## Runtime for Hylaa
```

3.2.19 RH2.19: Object 3531 steps

Runtime for Decomp

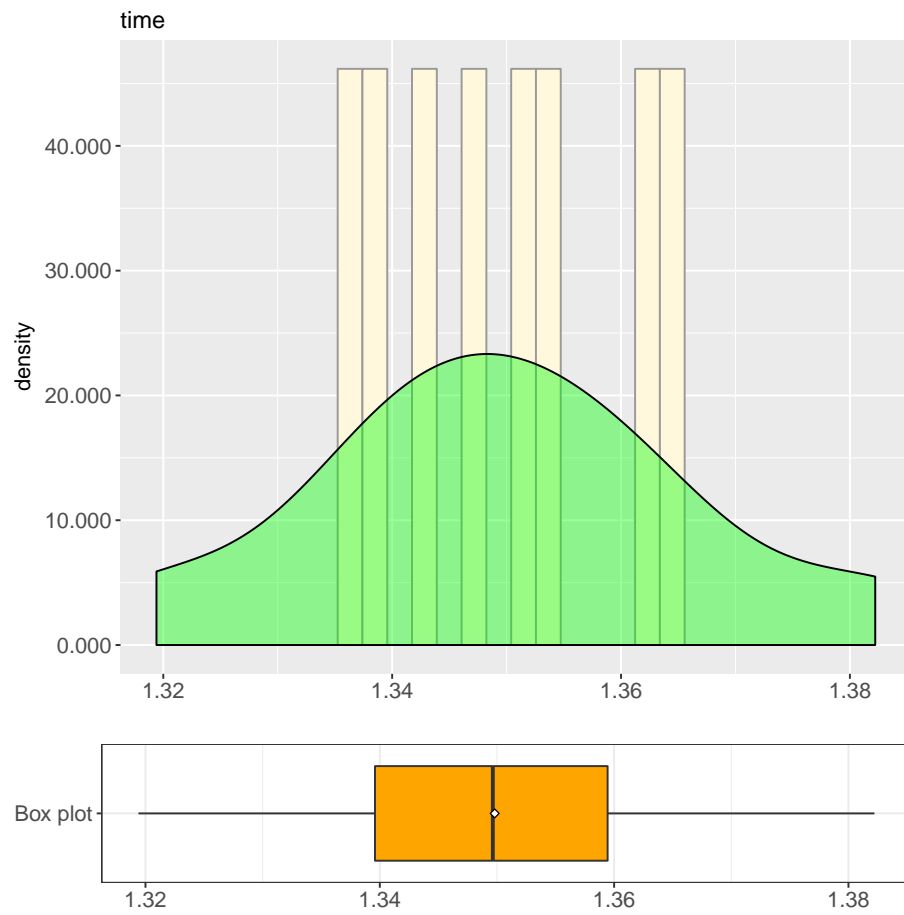
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 1.417   1.429   1.480   1.484   1.535   1.555
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Decomp" & object == "steps3531")$time
## W = 0.8751, p-value = 0.1146
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.114576744282644"
```

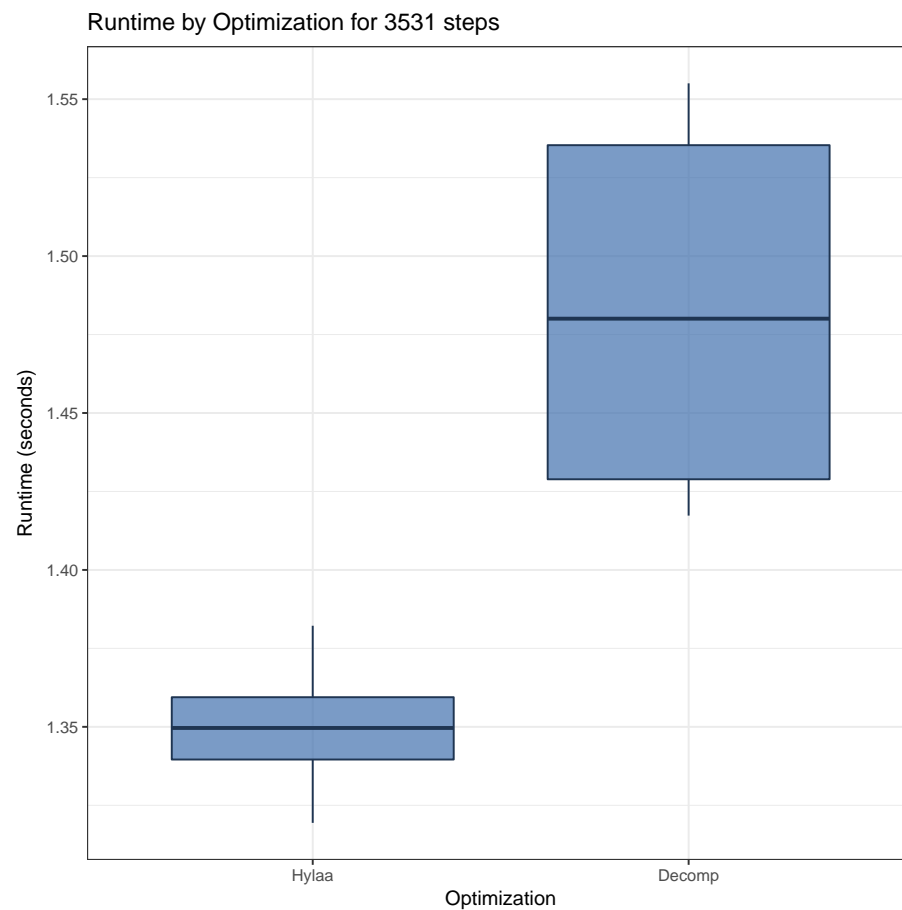
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.319  1.340   1.350   1.350   1.359   1.382
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps3531")$time
## W = 0.98776, p-value = 0.9933
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.993277943776764"
```

Comparison



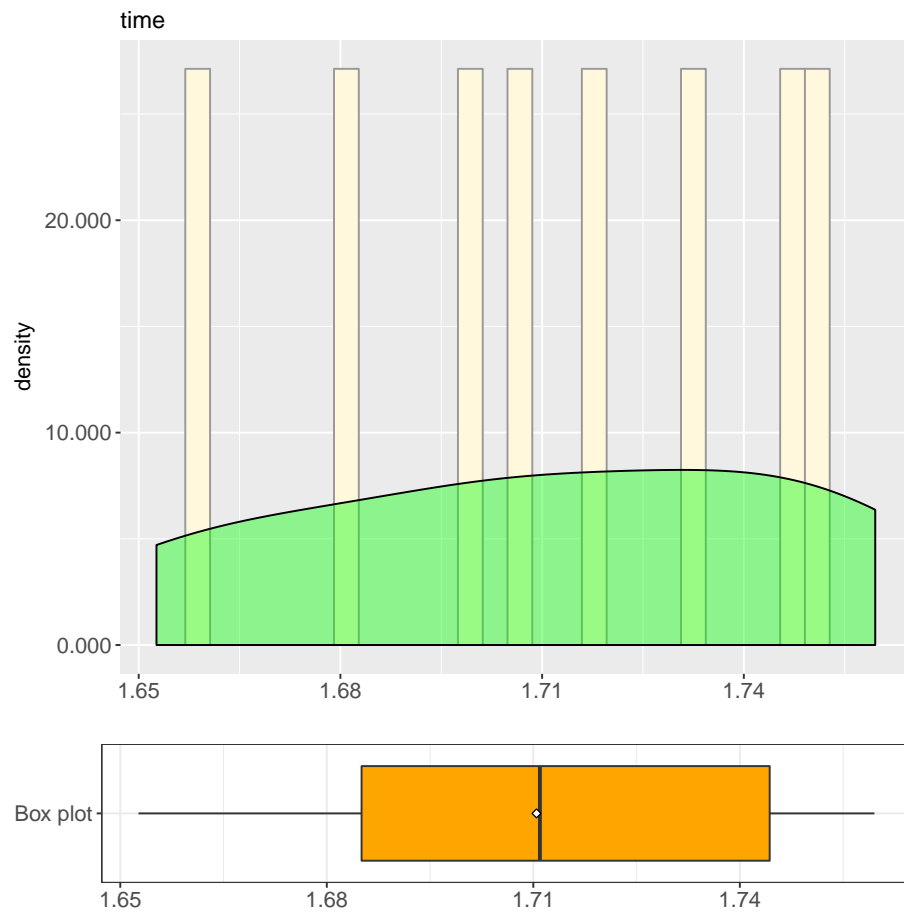
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps3531")$time and subset(j
## F = 0.096777, num df = 9, denom df = 9, p-value = 0.001836
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.02403794 0.38962206
## sample estimates:
## ratio of variances
##      0.09677661
##
## [1] "Homogeneity of variances: FALSE. P-value: 0.00183645661660574"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Welch Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps3531")$time and subset(j
## t = -7.2713, df = 10.726, p-value = 1.838e-05
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.17480019 -0.09337169
## sample estimates:
## mean of x mean of y
## 1.349807 1.483893
##
## [1] "T-test: Null Hypothesis rejected. P-value: 1.8384587625216e-05"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.349807333946"
## [1] "Mean Runtime for Decomp: 1.483893275259"
## [1] "Absolute difference: 0.134085941313"
## Runtime for Decomp is 9.93370964439909 % greater than
## Runtime for Hylaa
```

3.2.20 RH2.20: Object 4590 steps

Runtime for Decomp

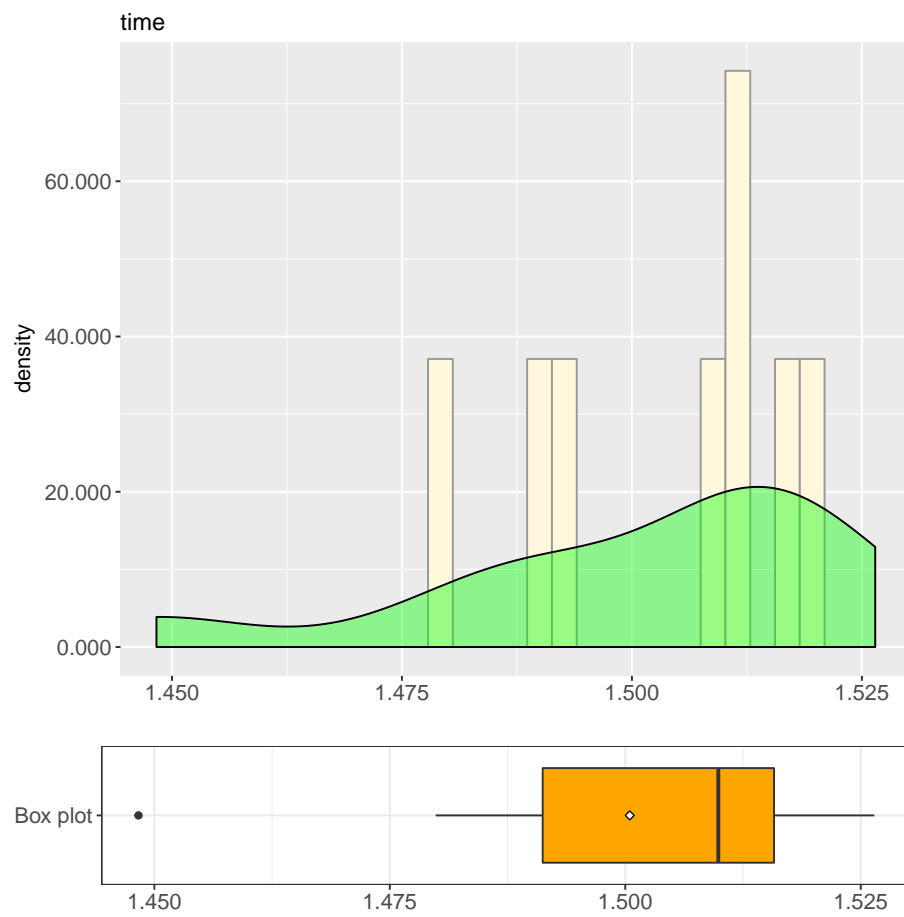
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 1.653   1.685   1.711   1.710   1.744   1.760
```

```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Decomp" & object == "steps4590")$time
## W = 0.94127, p-value = 0.5672
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.567218723150407"
```

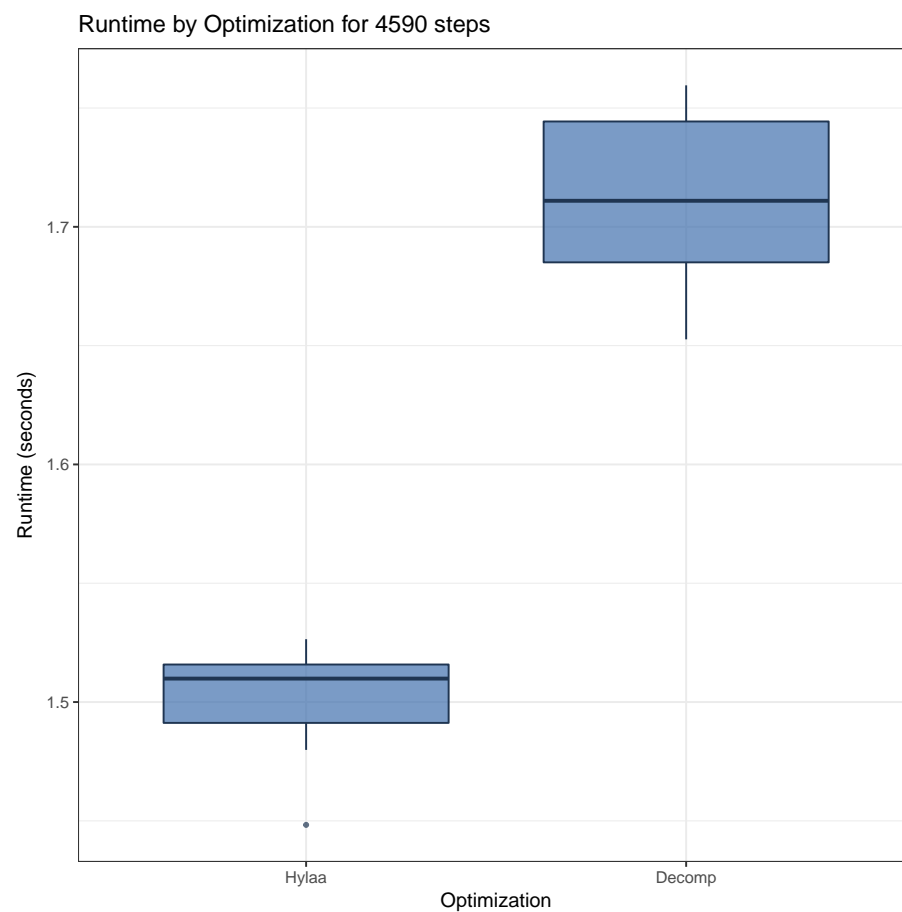
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  1.448  1.491   1.510   1.500   1.516   1.526
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps4590")$time
## W = 0.88116, p-value = 0.1346
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.134566691717643"
```

Comparison



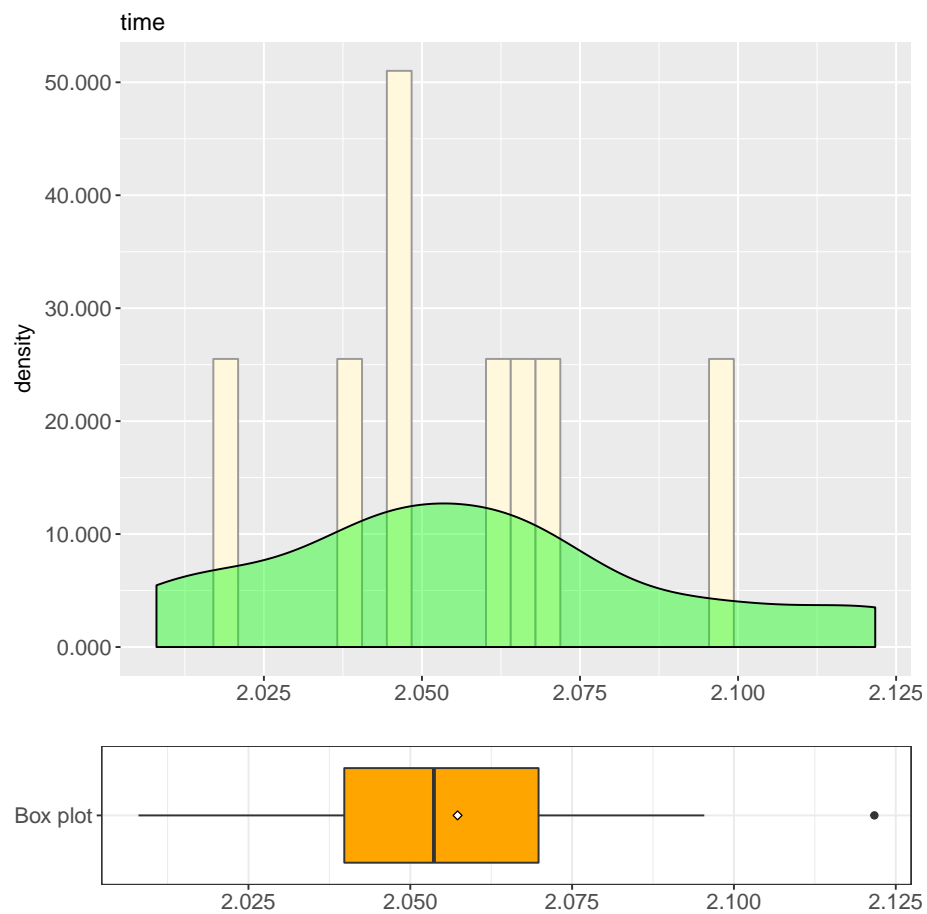
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps4590")$time and subset(json_data, treatment == "Decomp" & object == "steps4590")$time
## F = 0.37713, num df = 9, denom df = 9, p-value = 0.1625
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.09367469 1.51833828
## sample estimates:
## ratio of variances
##      0.3771338
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.162490080628519"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps4590")$time and subset(j
## t = -14.91, df = 18, p-value = 1.426e-11
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.2395715 -0.1803944
## sample estimates:
## mean of x mean of y
## 1.500478 1.710460
##
## [1] "T-test: Null Hypothesis rejected. P-value: 1.42593283273499e-11"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.500477528573"
## [1] "Mean Runtime for Decomp: 1.710460472106"
## [1] "Absolute difference: 0.209982943533"
## Runtime for Decomp is 13.9944077491584 % greater than
## Runtime for Hylaa
```

3.2.21 RH2.21: Object 5967 steps

Runtime for Decomp

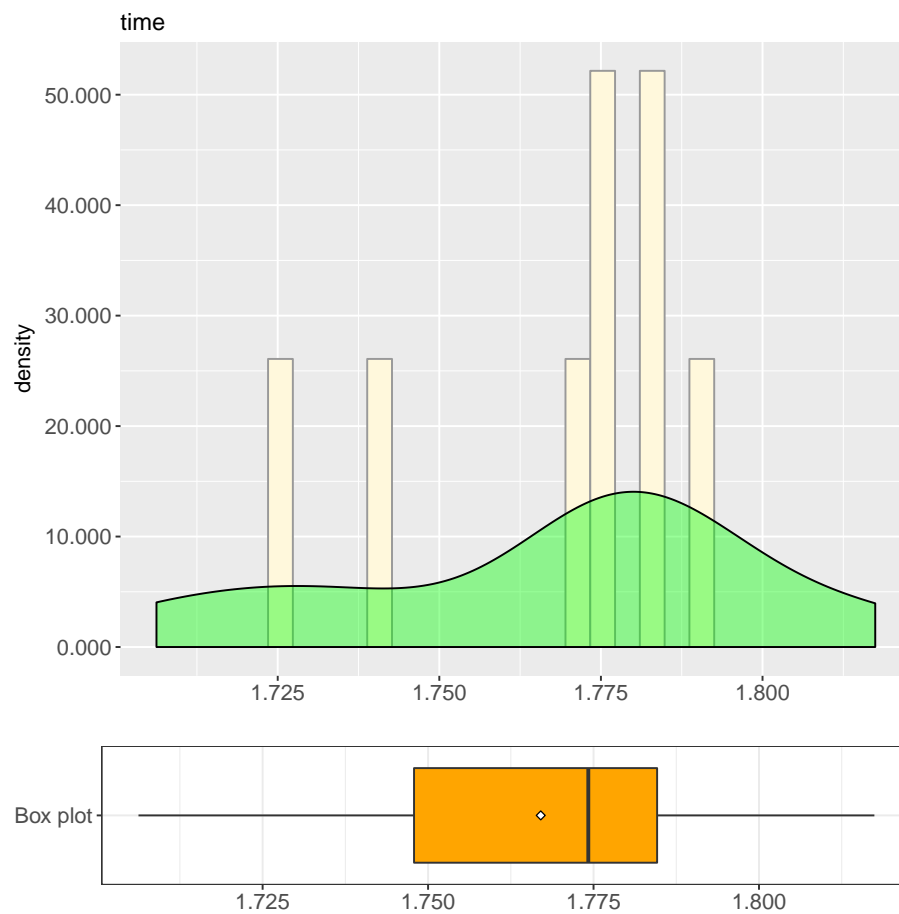
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 2.008 2.040 2.054 2.057 2.070 2.122
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Decomp" & object == "steps5967")$time
## W = 0.97291, p-value = 0.9164
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.916418823743576"
```

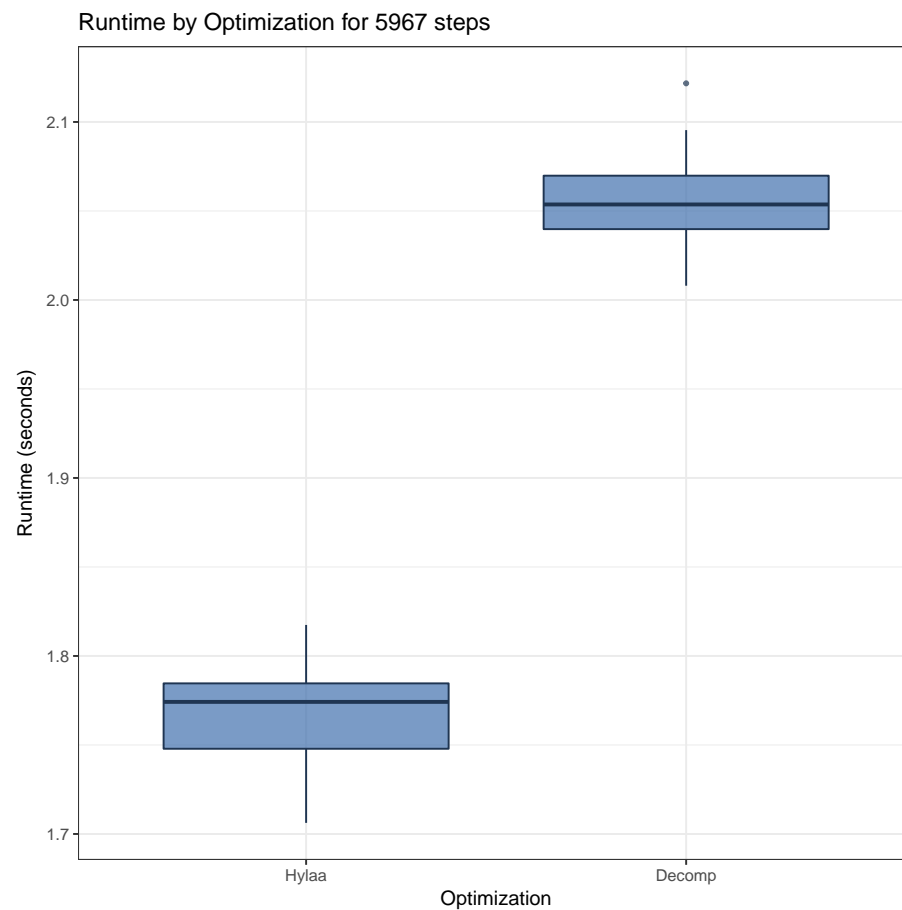
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.706  1.748   1.774   1.767   1.785   1.817
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps5967")$time
## W = 0.93205, p-value = 0.4683
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.468324949837865"
```

Comparison



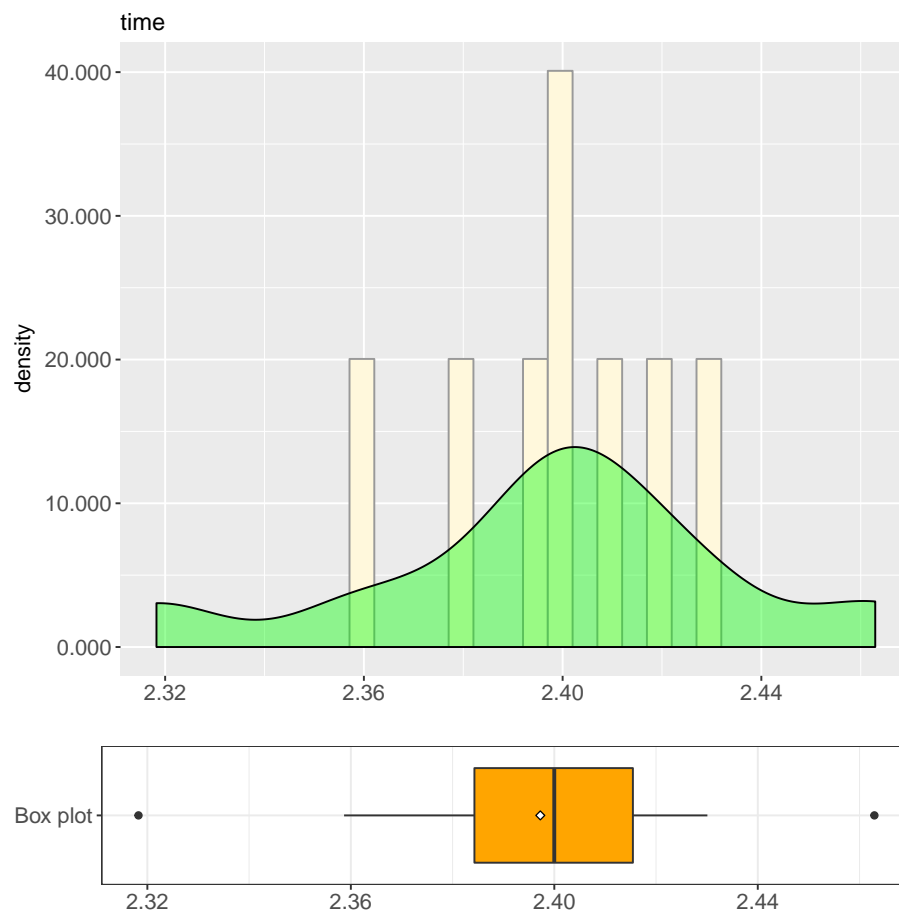
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps5967")$time and subset(json_data, treatment == "Decomp" & object == "steps5967")$time
## F = 0.9764, num df = 9, denom df = 9, p-value = 0.9722
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2425252 3.9310006
## sample estimates:
## ratio of variances
##      0.9764049
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.972209597136871"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps5967")$time and subset(j
## t = -19.258, df = 18, p-value = 1.848e-13
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.3219481 -0.2586131
## sample estimates:
## mean of x mean of y
## 1.767022 2.057303
##
## [1] "T-test: Null Hypothesis rejected. P-value: 1.84789324982661e-13"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.767022109032"
## [1] "Mean Runtime for Decomp: 2.057302689551"
## [1] "Absolute difference: 0.290280580519"
## Runtime for Decomp is 16.427671110353 % greater than
## Runtime for Hylaa
```

3.2.22 RH2.22: Object 7757 steps

Runtime for Decomp

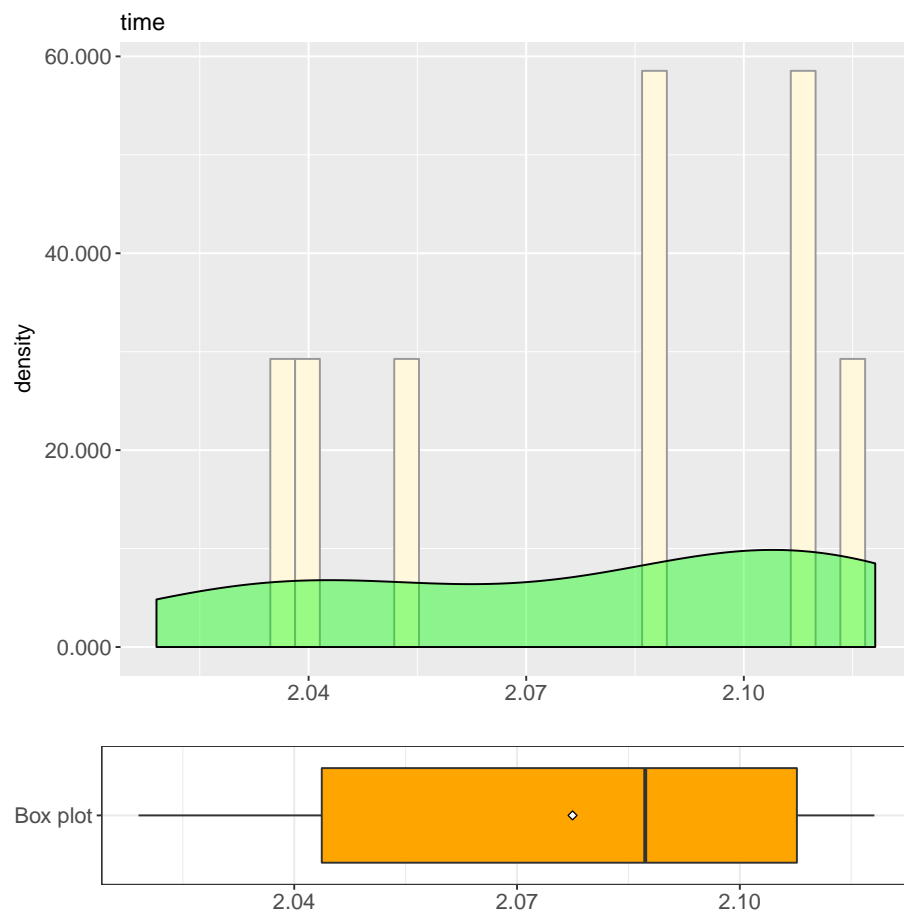
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      2.318   2.384   2.400   2.397   2.415   2.463
```

```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps7757")$time
## W = 0.96531, p-value = 0.8443
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.844301931865259"
```

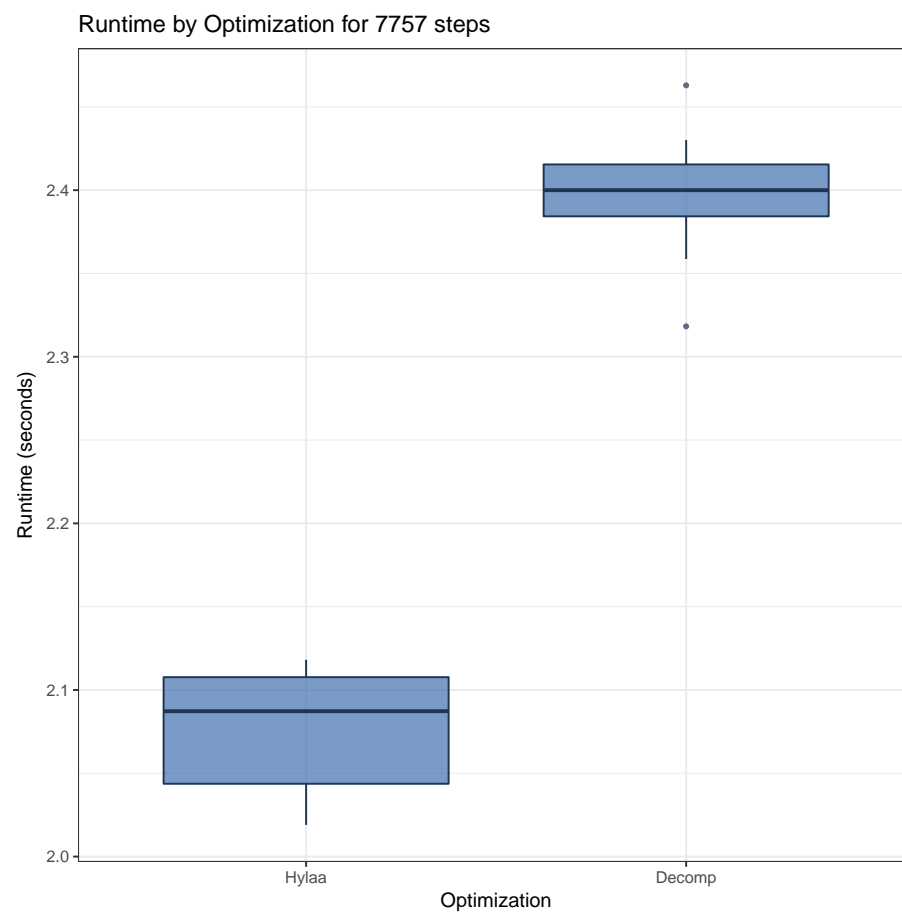
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   2.019  2.044   2.087   2.077   2.108   2.118
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps7757")$time
## W = 0.89136, p-value = 0.1756
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.175640560398436"
```

Comparison



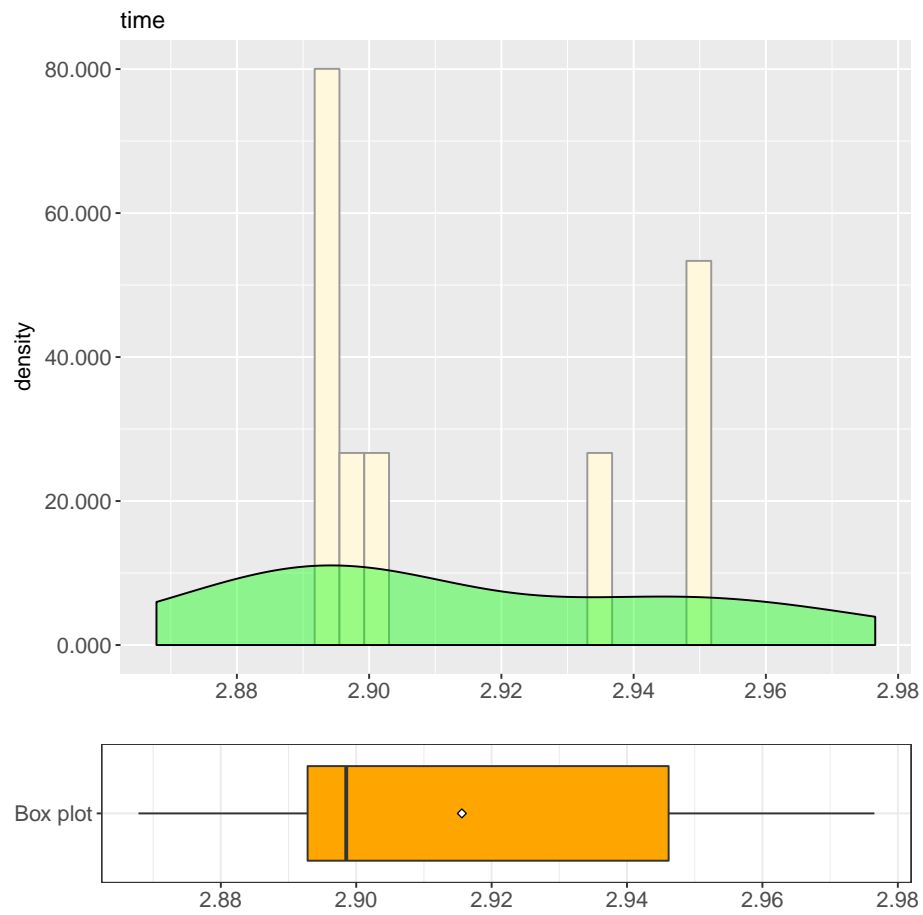
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps7757")$time and subset(j
## F = 0.86394, num df = 9, denom df = 9, p-value = 0.8311
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2145902 3.4782132
## sample estimates:
## ratio of variances
##      0.863939
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.831101128488589"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps7757")$time and subset(j
## t = -18.801, df = 18, p-value = 2.793e-13
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.3555047 -0.2840379
## sample estimates:
## mean of x mean of y
## 2.077476 2.397248
##
## [1] "T-test: Null Hypothesis rejected. P-value: 2.79334317531679e-13"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 2.077476406097"
## [1] "Mean Runtime for Decomp: 2.397247695924"
## [1] "Absolute difference: 0.319771289827"
## Runtime for Decomp is 15.3922946555991 % greater than
## Runtime for Hylaa
```

3.2.23 RH2.23: Object 10085 steps

Runtime for Decomp

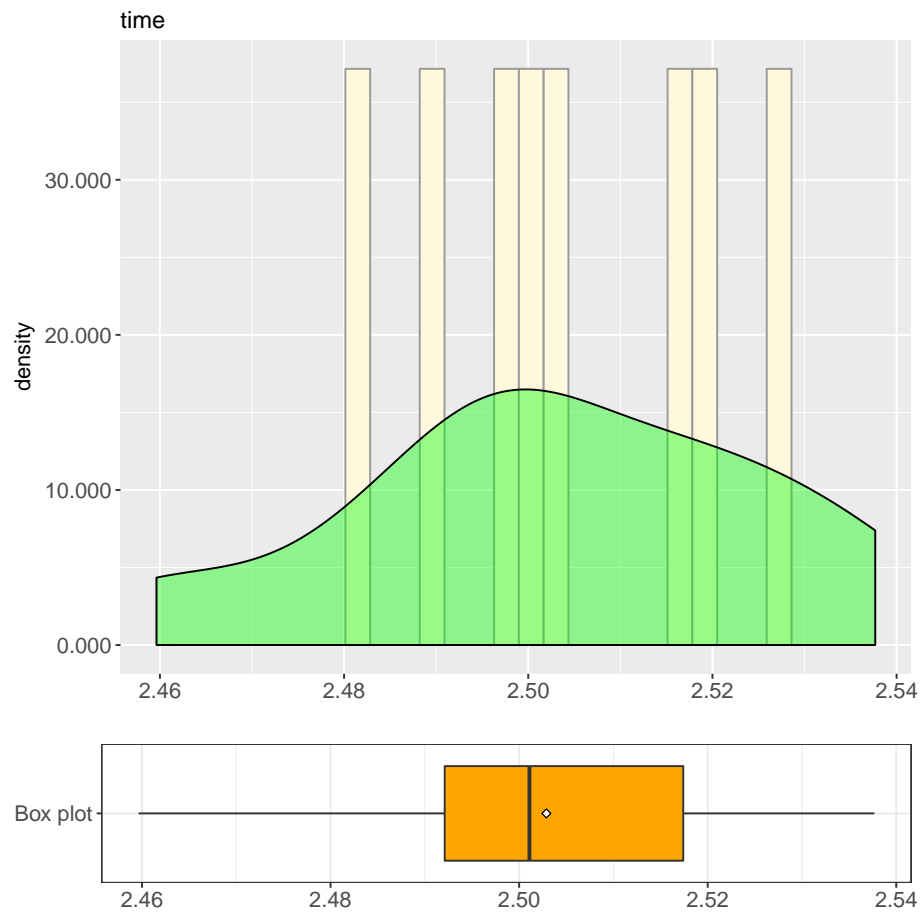
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 2.868 2.893 2.899 2.916 2.946 2.977
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps10085")$time
## W = 0.89919, p-value = 0.2147
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.21467674531661"
```

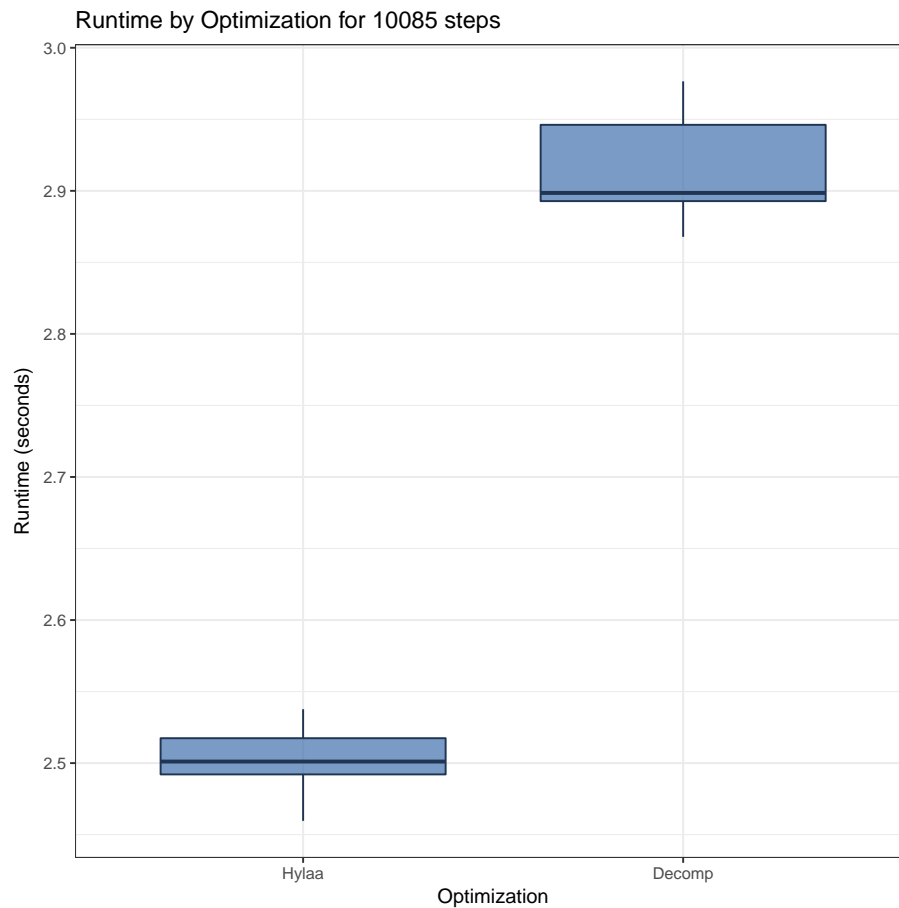
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   2.460  2.492   2.501   2.503   2.517   2.538
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps10085")$time
## W = 0.98381, p-value = 0.9823
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.982277067638566"
```

Comparison



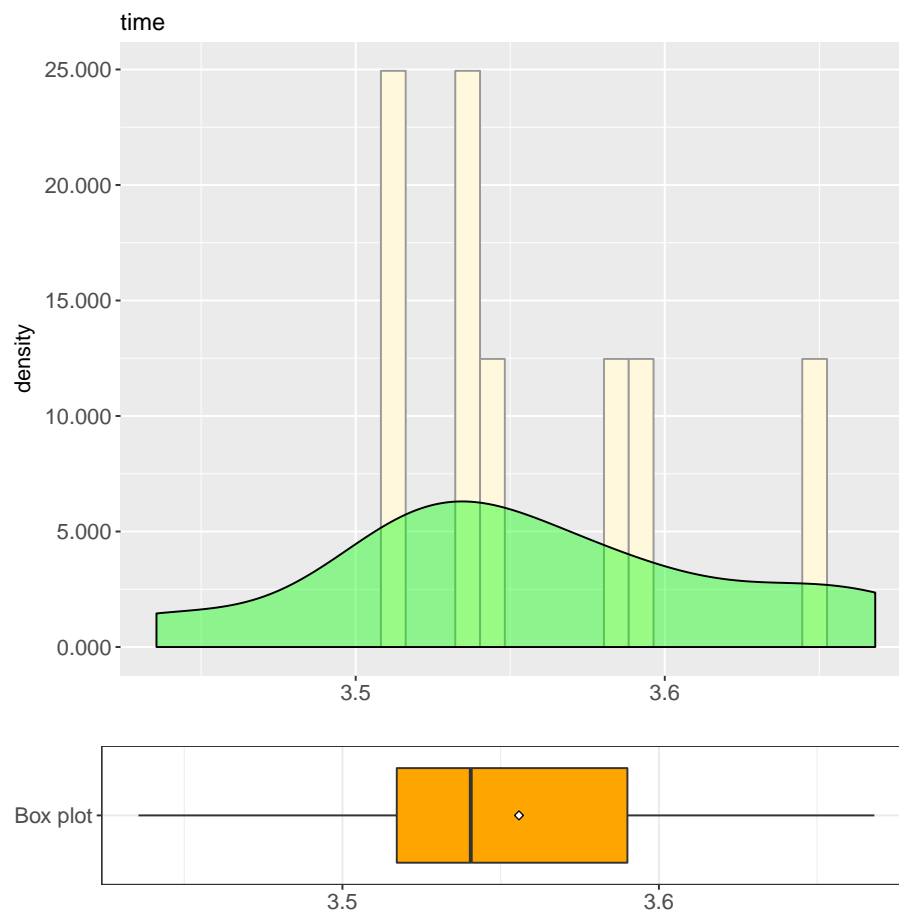
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps10085")$time and subset(
## F = 0.43934, num df = 9, denom df = 9, p-value = 0.2363
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1091262 1.7687858
## sample estimates:
## ratio of variances
##      0.4393414
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.236348361136969"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps10085")$time and subset(
## t = -31.205, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.4405036 -0.3849297
## sample estimates:
## mean of x mean of y
## 2.502889 2.915605
##
## [1] "T-test: Null Hypothesis rejected. P-value: 3.99703081291659e-17"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 2.502888703346"
## [1] "Mean Runtime for Decomp: 2.915605330468"
## [1] "Absolute difference: 0.412716627122"
## Runtime for Decomp is 16.4896116463452 % greater than
## Runtime for Hylaa
```

3.2.24 RH2.24: Object 13110 steps

Runtime for Decomp

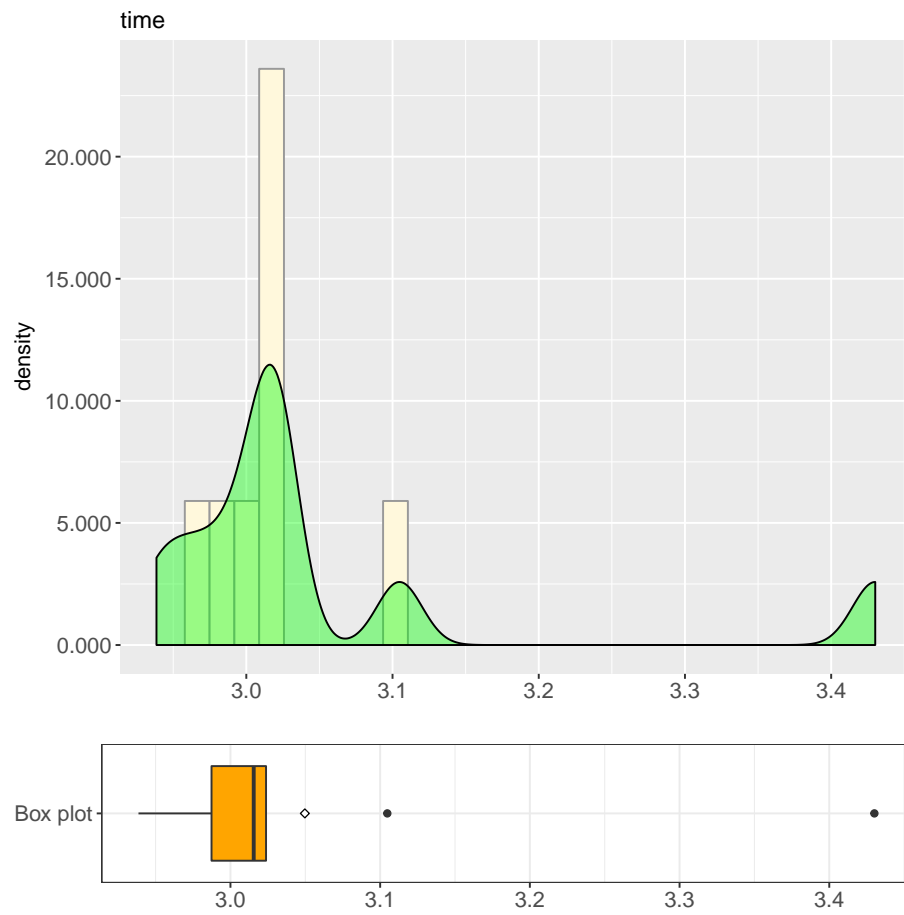
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 3.436 3.517 3.541 3.556 3.590 3.668
```

```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps13110")$time
## W = 0.96625, p-value = 0.854
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.85403316404518"
```

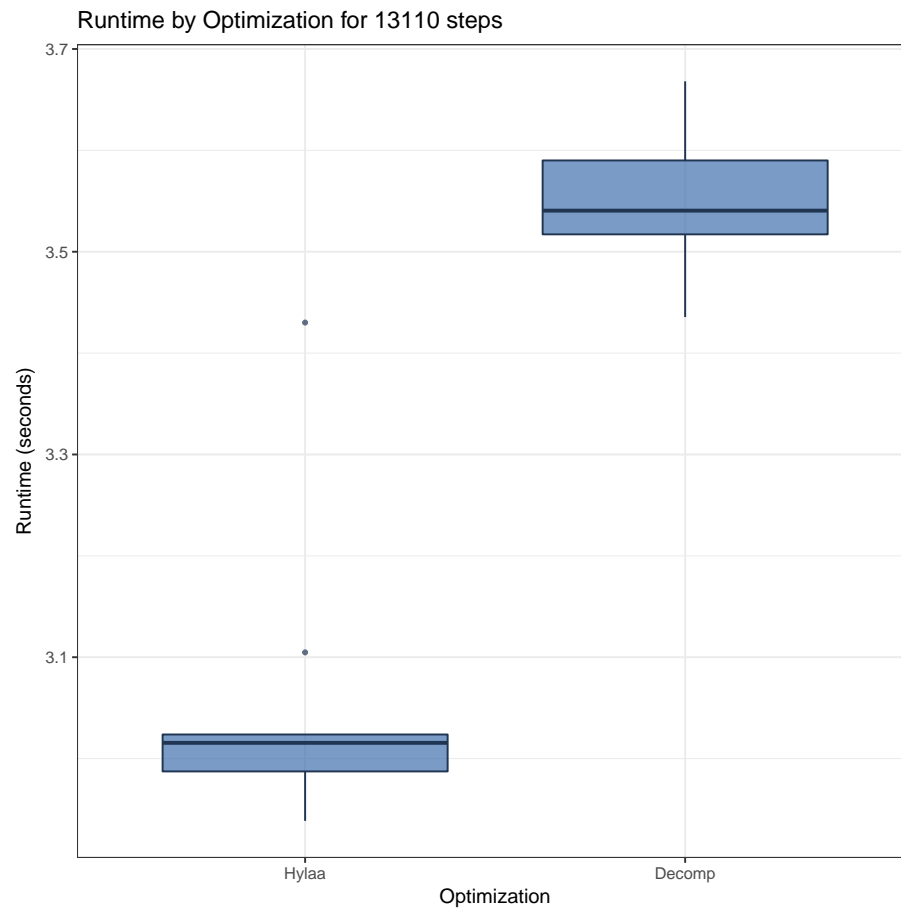
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   2.939  2.987   3.016   3.050   3.024   3.430
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps13110")$time
## W = 0.65237, p-value = 0.0002343
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.000234335774565787"
```

Comparison

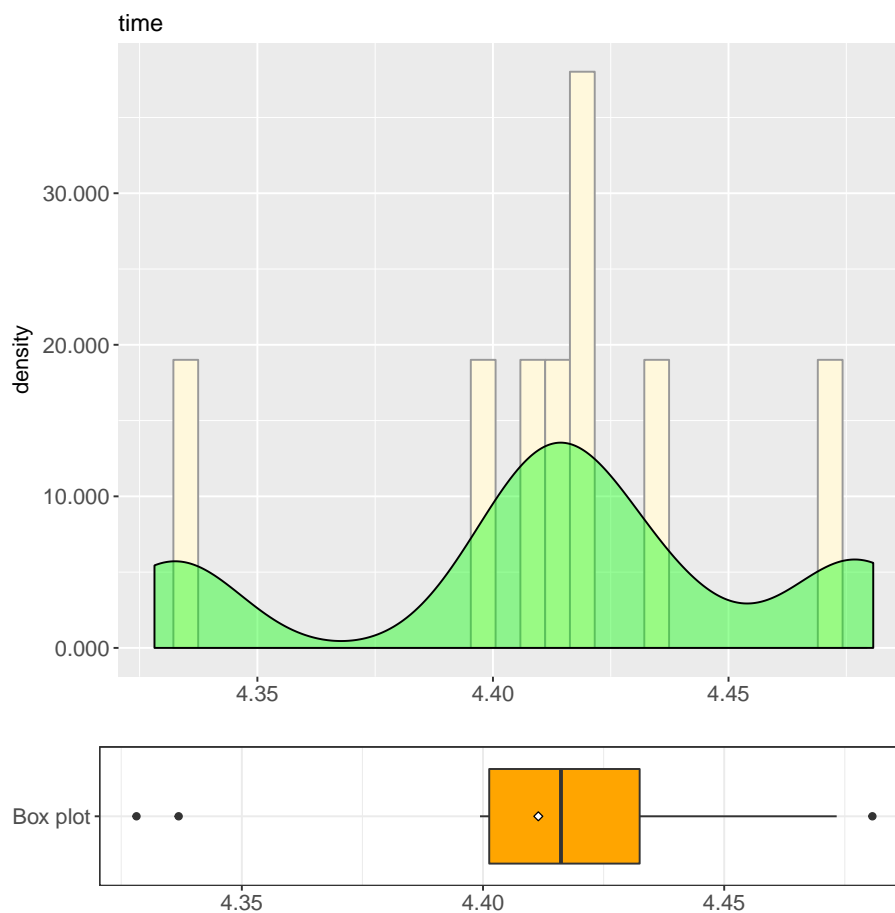


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 100, p-value = 1.083e-05
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 1.0825088224469e-05"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 3.049691486358"
## [1] "Mean Runtime for Decomp: 3.555790042876"
## [1] "Absolute difference: 0.506098556518"
## Runtime for Decomp is 16.5950739208179 % greater than
## Runtime for Hylaa
```

3.2.25 RH2.25: Object 17043 steps

Runtime for Decomp

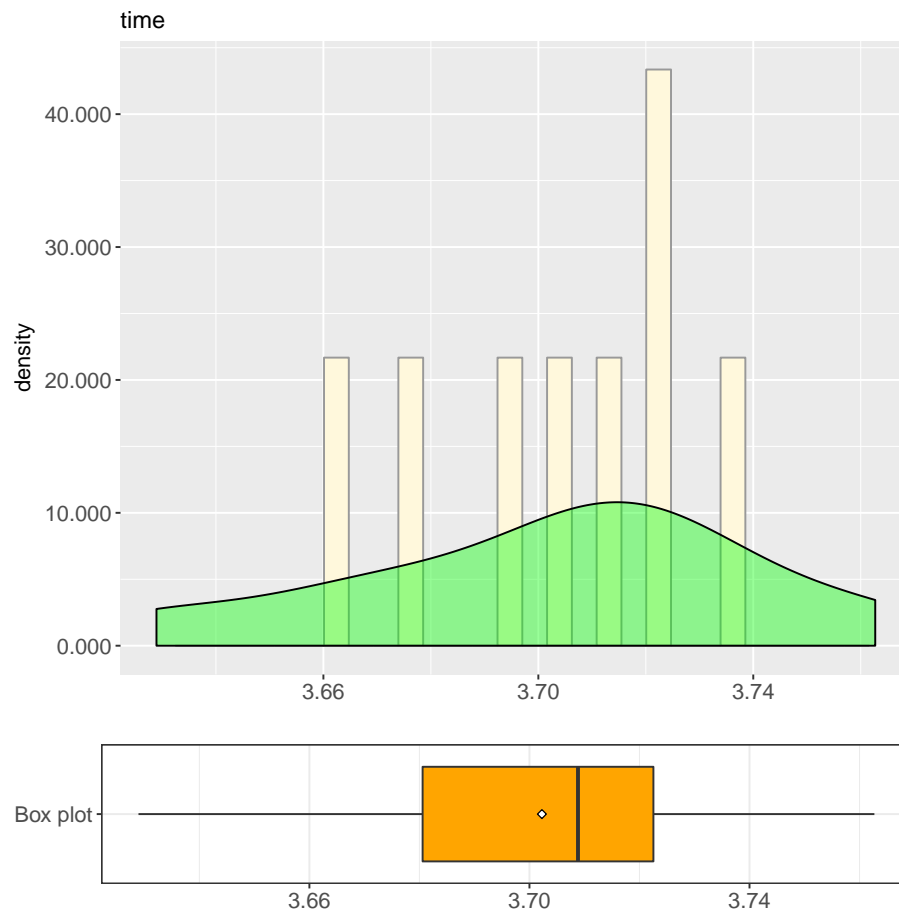
```
## [1] "Sample size: 10"  
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
## 4.328  4.401  4.416  4.411  4.432  4.481
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Decomp" & object == "steps17043")$time  
## W = 0.91683, p-value = 0.3312  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.331240406678634"
```

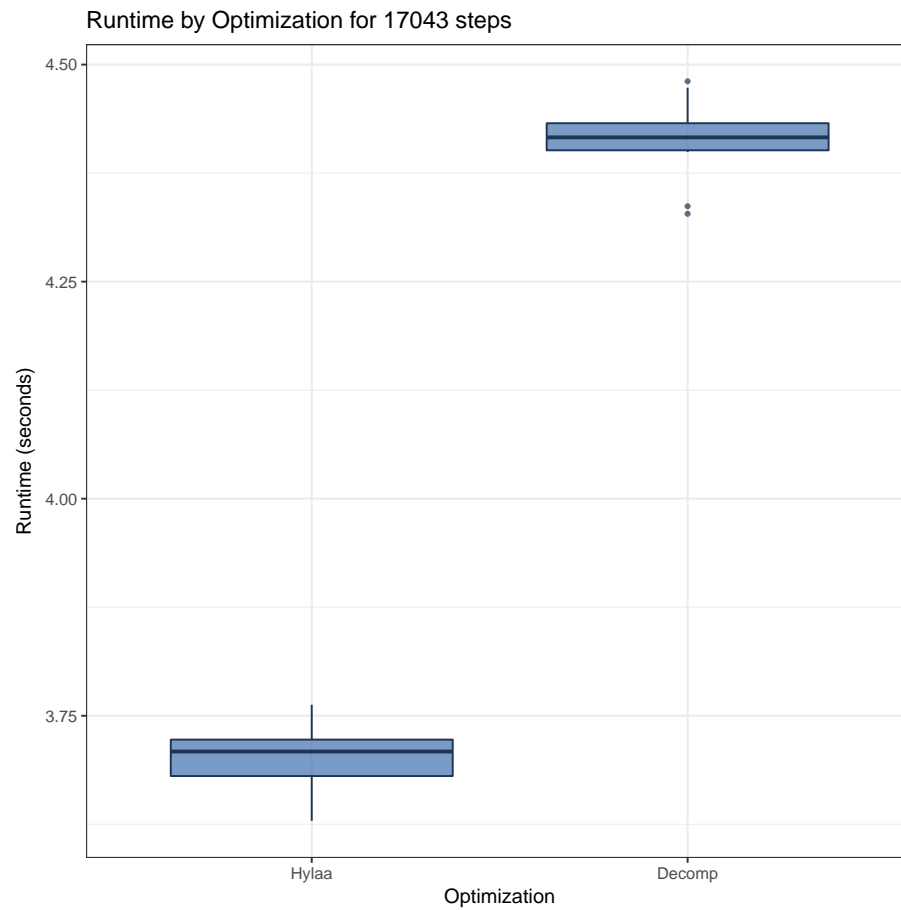
Runtime for Hylaa

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 3.629  3.681  3.709  3.702  3.723  3.763
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps17043")$time
## W = 0.97882, p-value = 0.9585
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.958546785330543"
```

Comparison



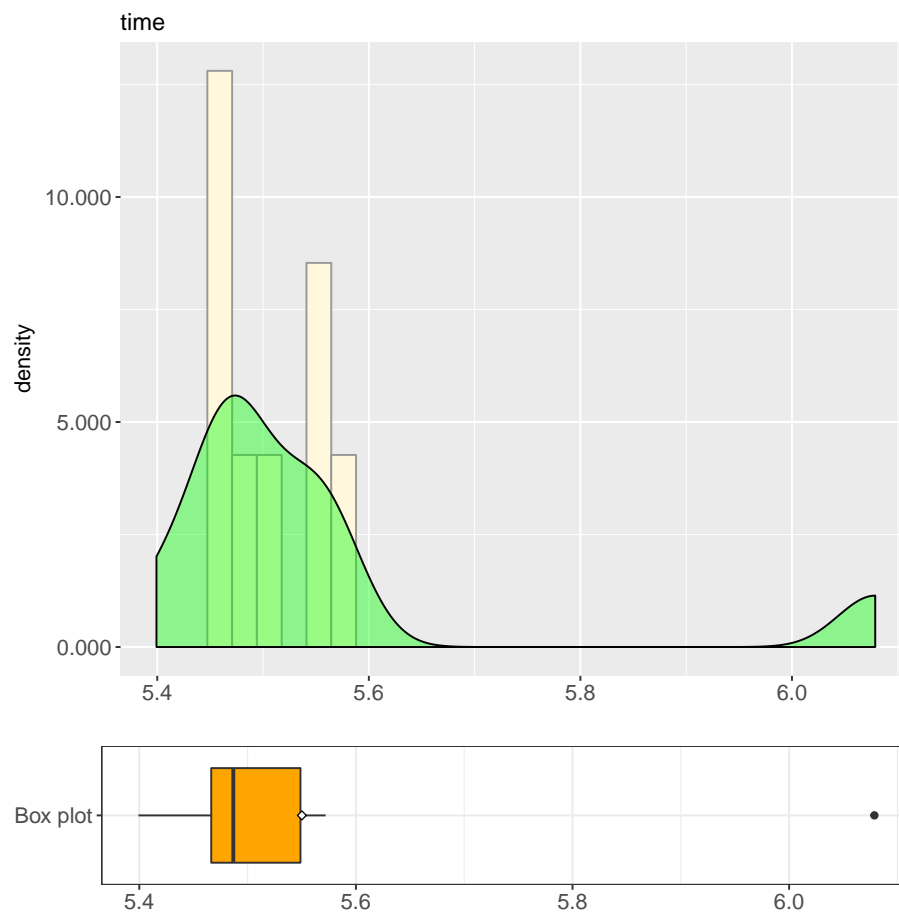
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps17043")$time and subset(
## F = 0.61802, num df = 9, denom df = 9, p-value = 0.4846
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1535077 2.4881492
## sample estimates:
## ratio of variances
##      0.6180211
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.484635381036366"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps17043")$time and subset(
## t = -35.621, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.7510252 -0.6673681
## sample estimates:
## mean of x mean of y
## 3.702265 4.411462
##
## [1] "T-test: Null Hypothesis rejected. P-value: 3.82603164961423e-18"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 3.70226535797"
## [1] "Mean Runtime for Decom: 4.411462020874"
## [1] "Absolute difference: 0.709196662904"
## Runtime for Decom is 19.1557490977054 % greater than
## Runtime for Hylaa
```

3.2.26 RH2.26: Object 22157 steps

Runtime for Decom

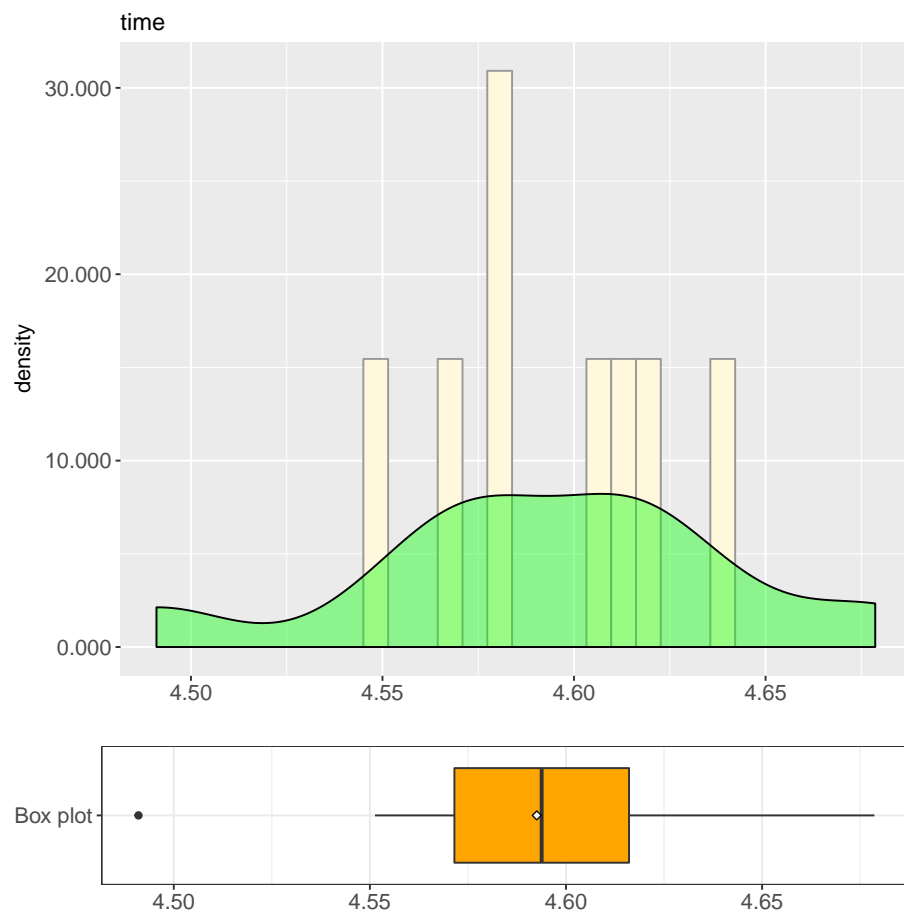
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 5.399  5.466  5.487  5.550  5.549  6.079
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps22157")$time
## W = 0.6269, p-value = 0.0001159
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.000115908827023797"
```

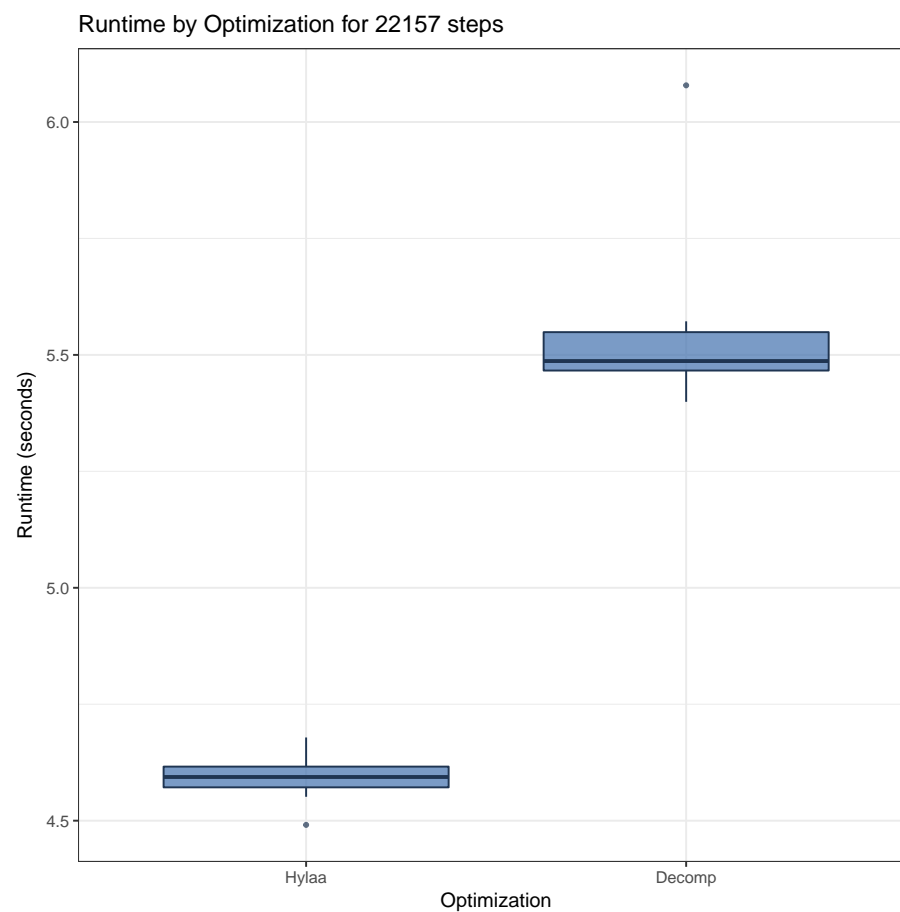
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  4.491  4.572   4.594   4.593   4.616   4.679
```

```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps22157")$time
## W = 0.97327, p-value = 0.9194
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.919388955922961"
```

Comparison

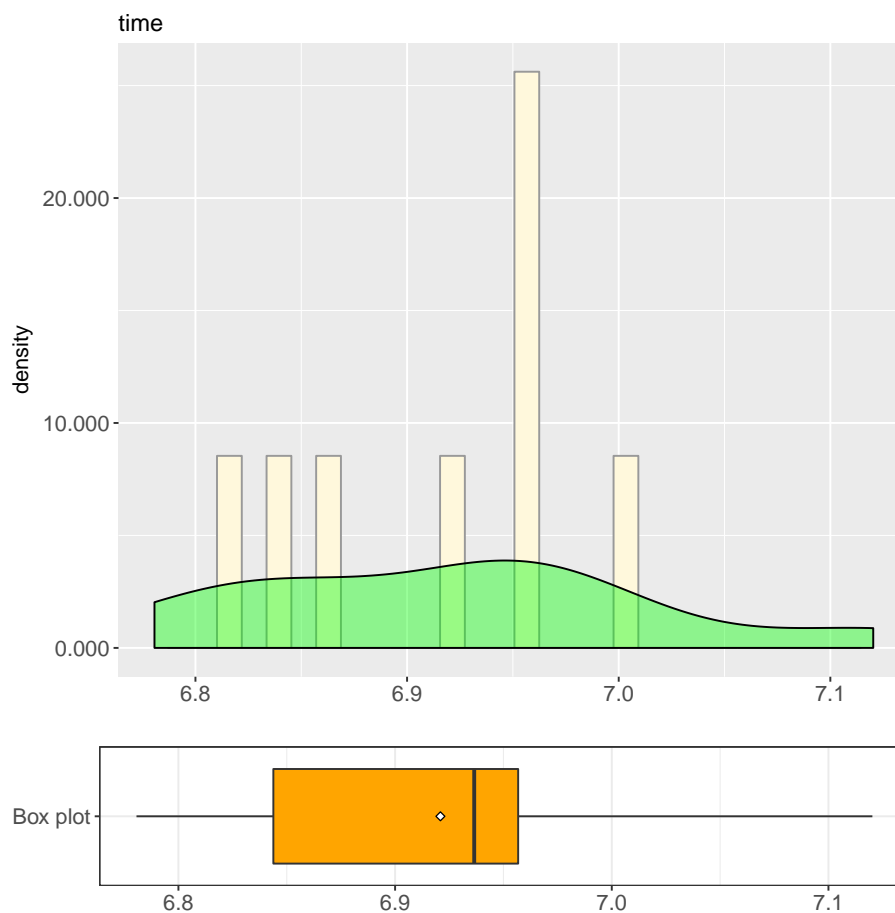


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 100, p-value = 1.083e-05
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 1.0825088224469e-05"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 4.592543911932"
## [1] "Mean Runtime for Decomp: 5.550147604941"
## [1] "Absolute difference: 0.957603693008999"
## Runtime for Decomp is 20.8512691739545 % greater than
## Runtime for Hylaa
```

3.2.27 RH2.27: Object 28804 steps

Runtime for Decomp

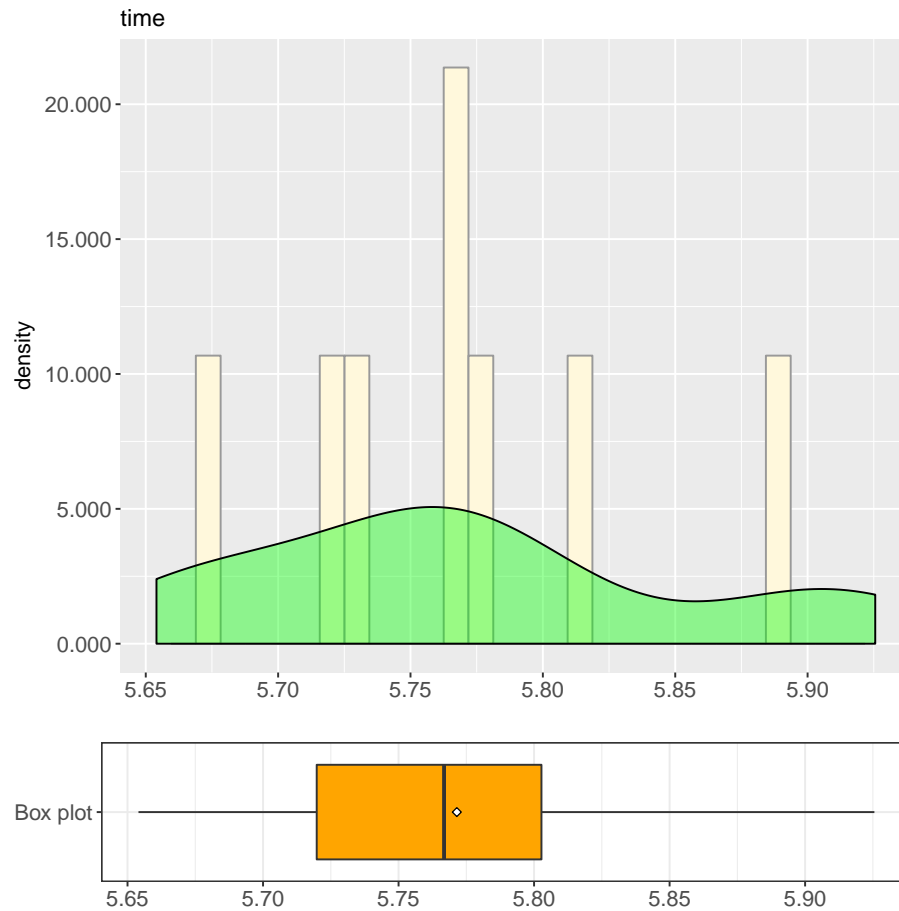
```
## [1] "Sample size: 10"  
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
## 6.781  6.844  6.937  6.921  6.957  7.120
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Decomp" & object == "steps28804")$time  
## W = 0.95404, p-value = 0.7163  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.71632763195629"
```

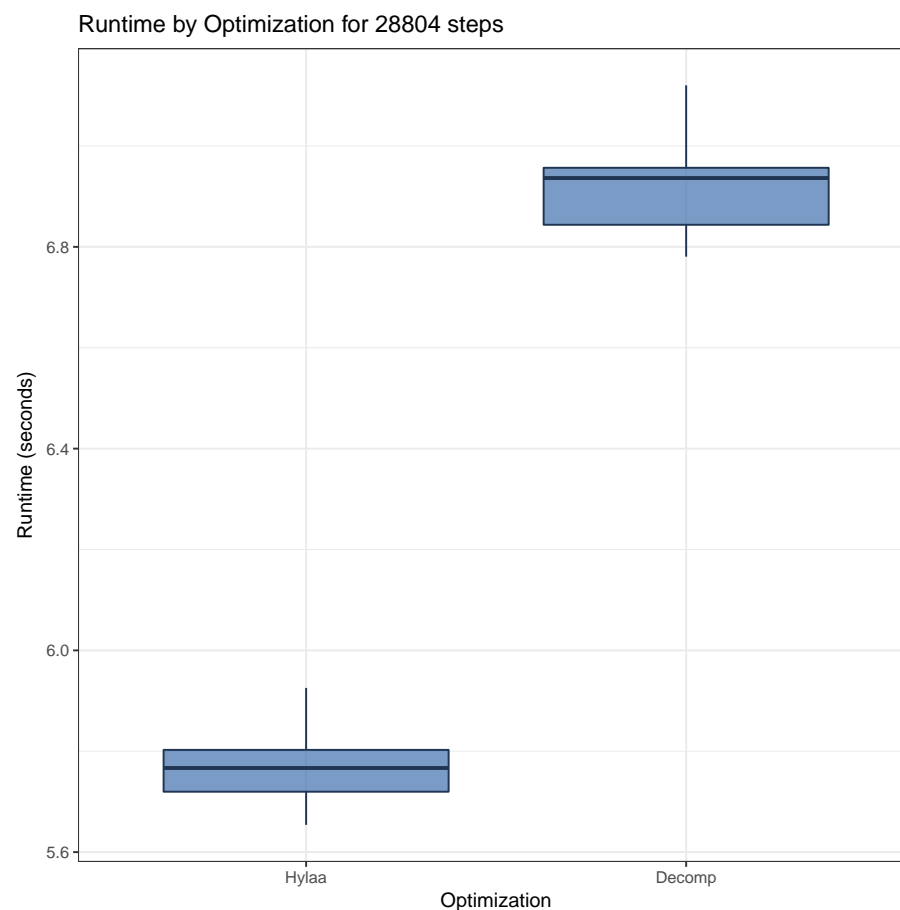
Runtime for Hylaa

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 5.654   5.720   5.767   5.771   5.803   5.926
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps28804")$time
## W = 0.94971, p-value = 0.6651
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.66510382139283"
```

Comparison



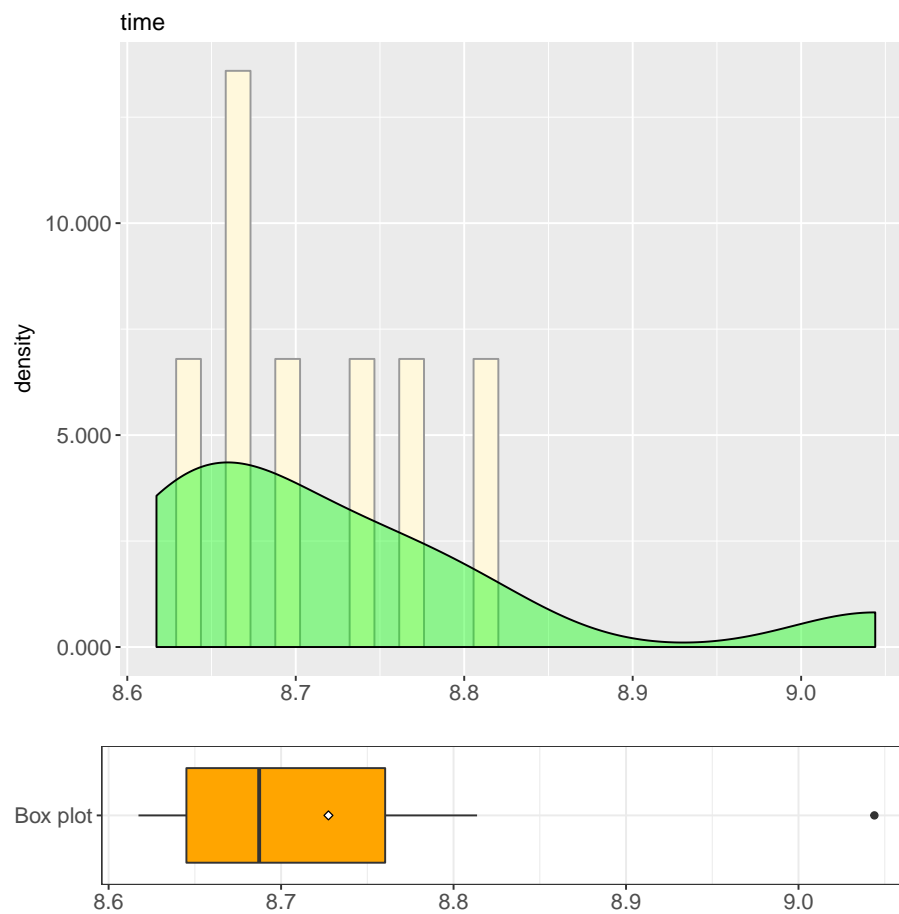
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps28804")$time and subset(
## F = 0.74432, num df = 9, denom df = 9, p-value = 0.6671
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1848779 2.9966170
## sample estimates:
## ratio of variances
##      0.7443173
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.667147859923453"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps28804")$time and subset(
## t = -27.582, df = 18, p-value = 3.529e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -1.236967 -1.061864
## sample estimates:
## mean of x mean of y
## 5.771499 6.920914
##
## [1] "T-test: Null Hypothesis rejected. P-value: 3.52893771802666e-16"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 5.771498990059"
## [1] "Mean Runtime for Decom: 6.920914435387"
## [1] "Absolute difference: 1.149415445328"
## Runtime for Decom is 19.9153711593433 % greater than
## Runtime for Hylaa
```

3.2.28 RH2.28: Object 37445 steps

Runtime for Decom

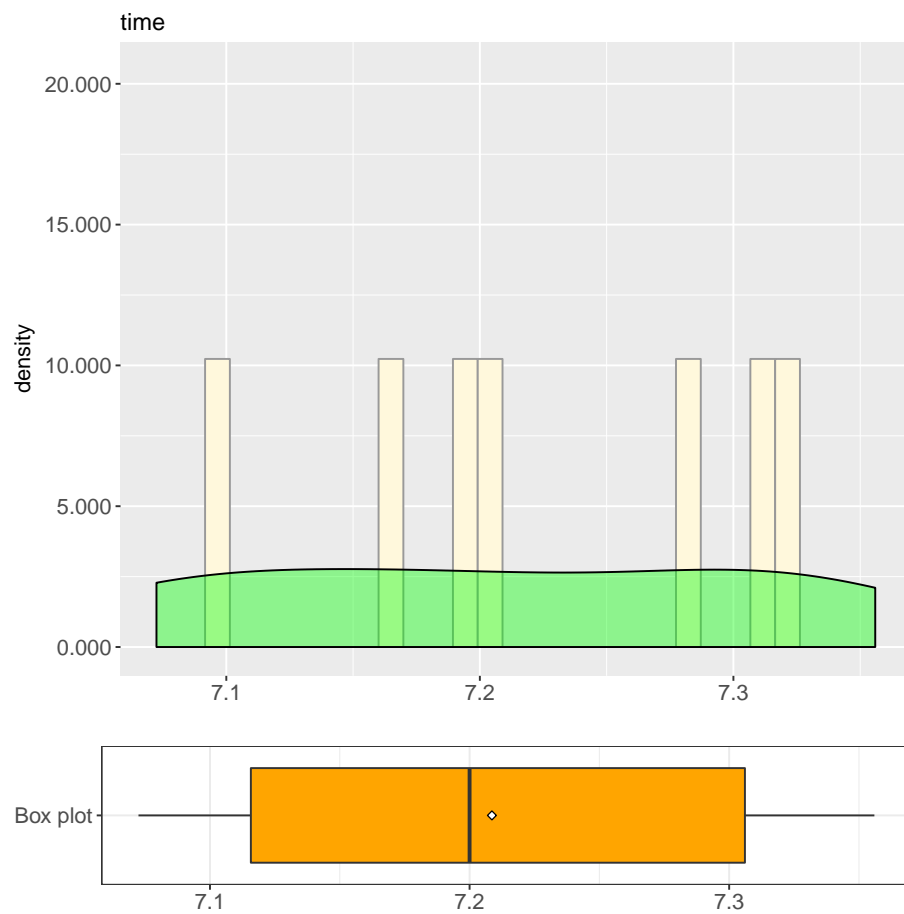
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      8.617   8.645   8.687   8.727   8.760   9.044
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Decomp" & object == "steps37445")$time
## W = 0.8078, p-value = 0.01803
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.0180344892026632"
```

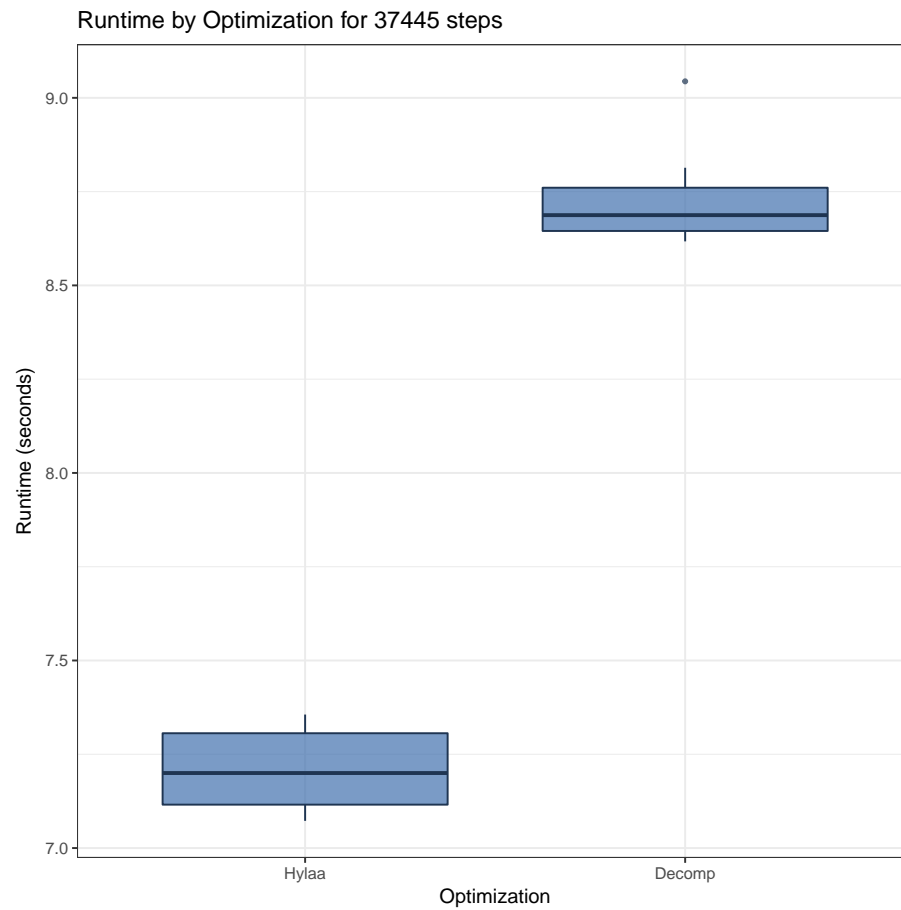
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   7.072  7.116   7.200   7.209  7.306   7.356
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps37445")$time
## W = 0.91587, p-value = 0.3238
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.32377452748614"
```

Comparison

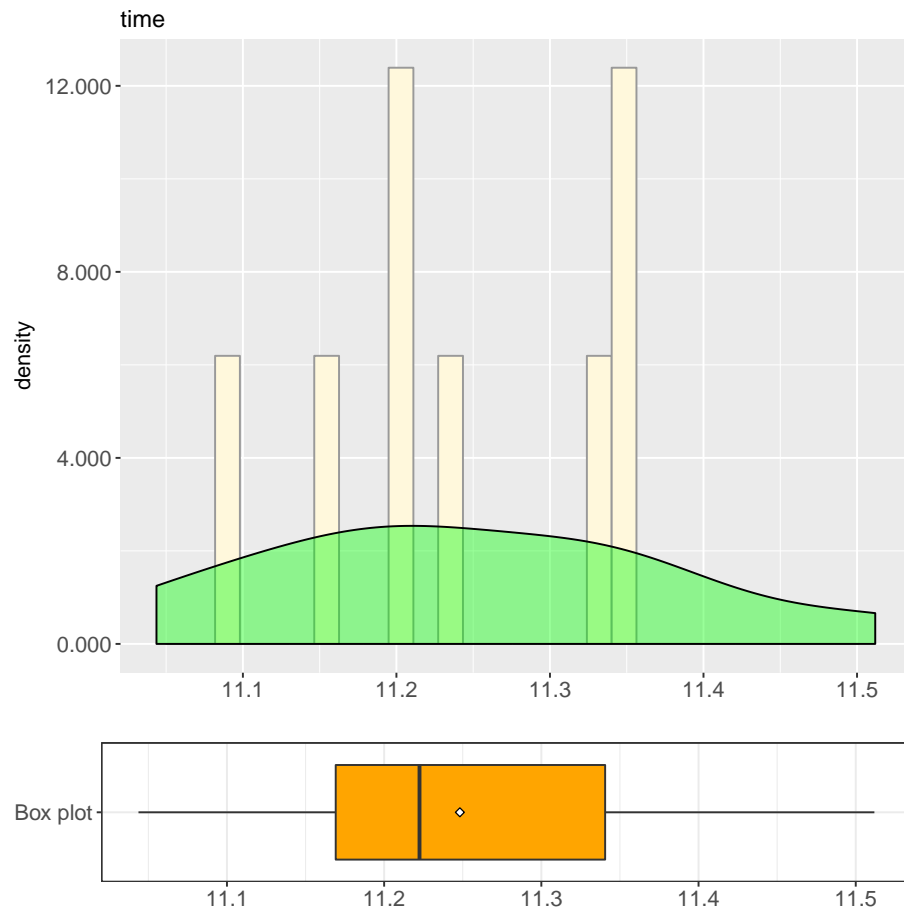


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 100, p-value = 1.083e-05
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 1.0825088224469e-05"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 7.208603620529"
## [1] "Mean Runtime for Decomp: 8.727449989318"
## [1] "Absolute difference: 1.518846368789"
## Runtime for Decomp is 21.0699110222063 % greater than
## Runtime for Hylaa
```

3.2.29 RH2.29: Object 48679 steps

Runtime for Decomp

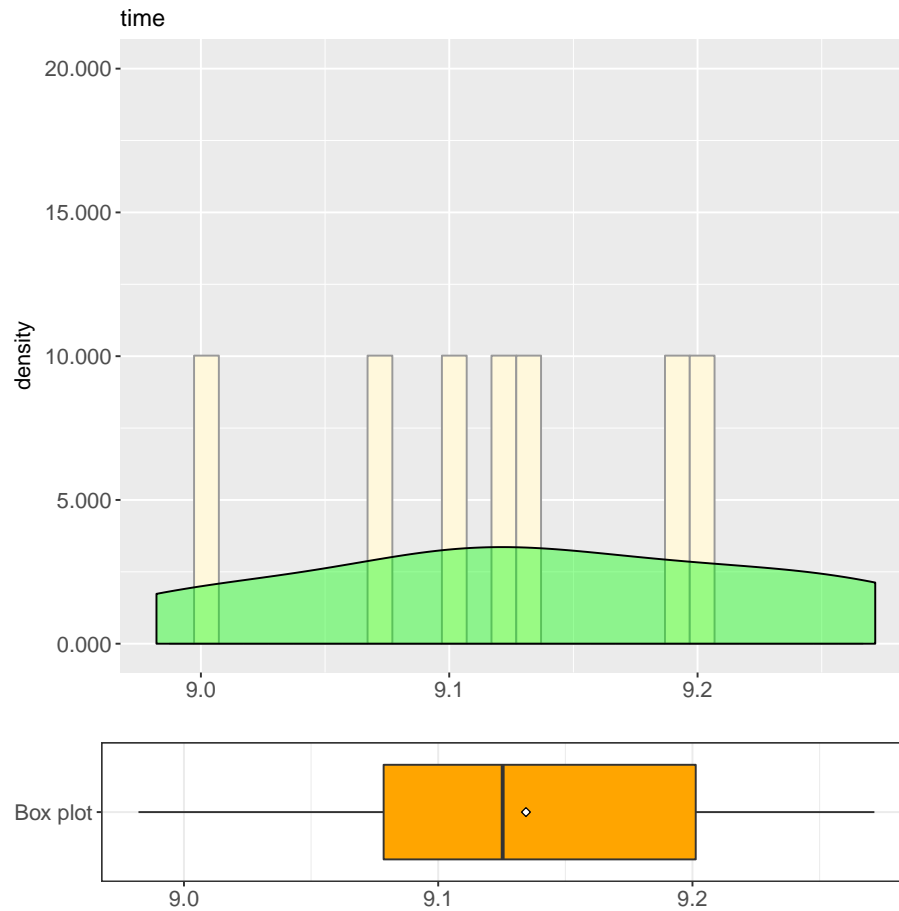
```
## [1] "Sample size: 10"  
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
##  11.04   11.17   11.22   11.25   11.34   11.51
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Decomp" & object == "steps48679")$time  
## W = 0.96649, p-value = 0.8565  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.856515226056453"
```

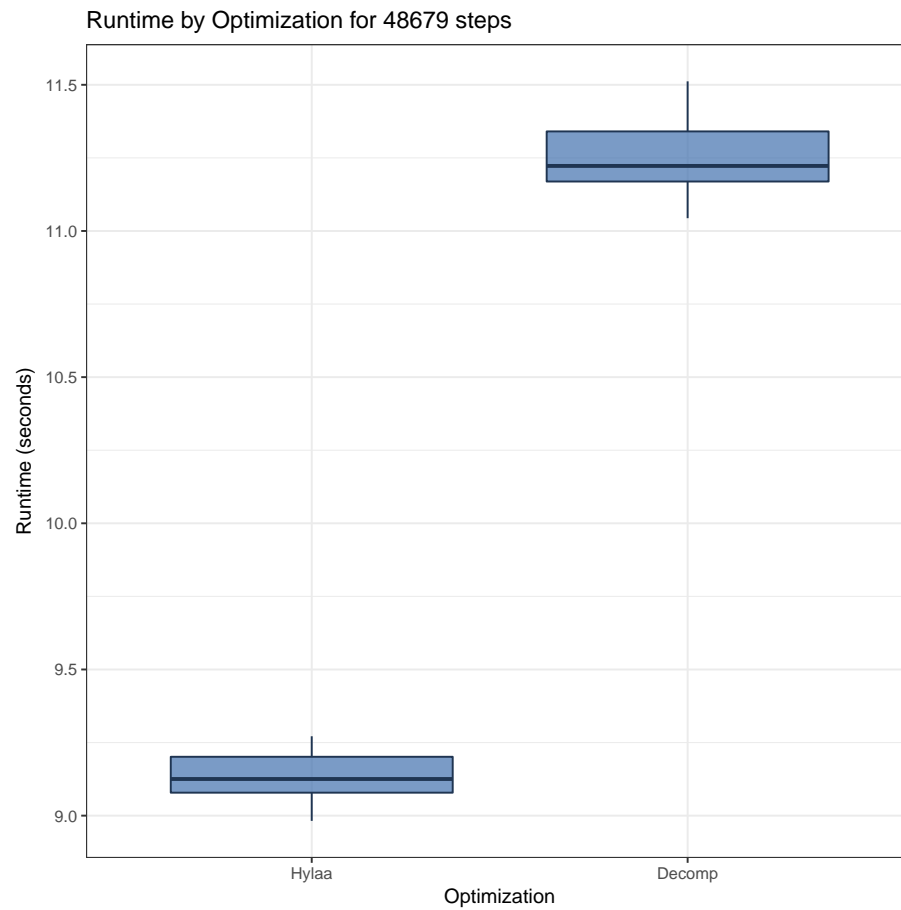
Runtime for Hylaa

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      8.982   9.079   9.125   9.135   9.201   9.272
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps48679")$time
## W = 0.95111, p-value = 0.6816
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.681647465980239"
```

Comparison



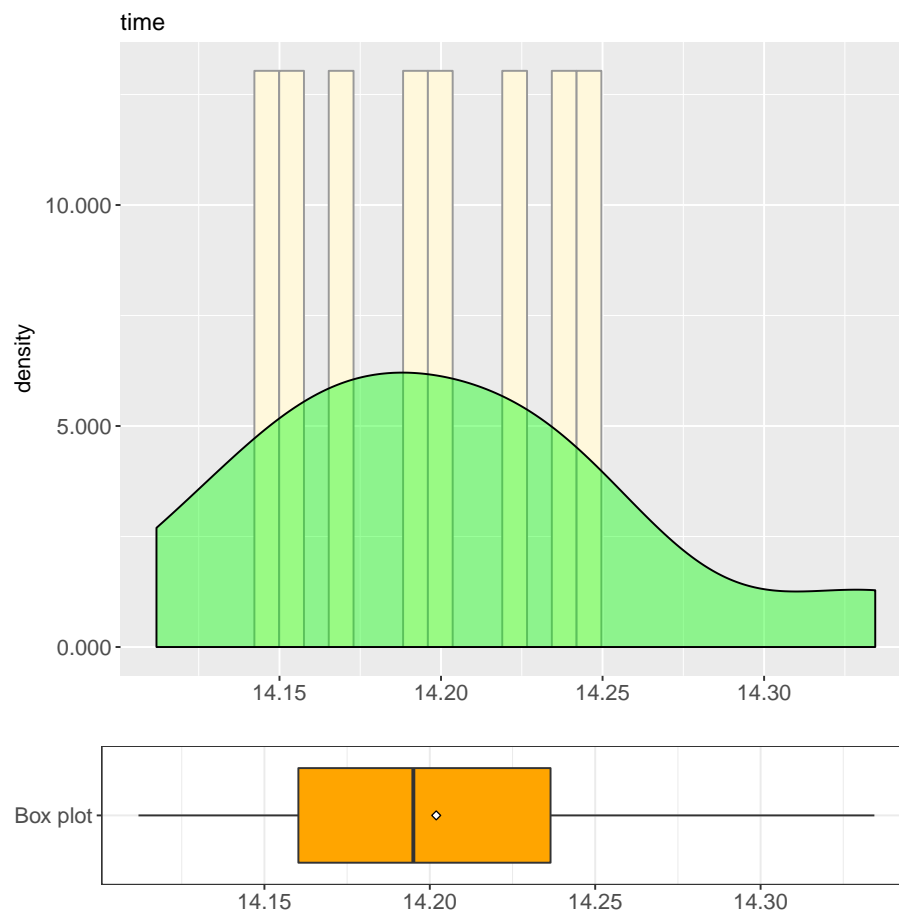
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps48679")$time and subset(
## F = 0.52027, num df = 9, denom df = 9, p-value = 0.3445
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1292274 2.0945997
## sample estimates:
## ratio of variances
##      0.5202689
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.344517807575589"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps48679")$time and subset(
## t = -39.006, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -2.227509 -1.999818
## sample estimates:
## mean of x mean of y
## 9.134509 11.248173
##
## [1] "T-test: Null Hypothesis rejected. P-value: 7.61557391530083e-19"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 9.134509158134"
## [1] "Mean Runtime for Decomp: 11.24817292691"
## [1] "Absolute difference: 2.113663768776"
## Runtime for Decomp is 23.1393250823318 % greater than
## Runtime for Hylaa
```

3.2.30 RH2.30: Object 63282 steps

Runtime for Decomp

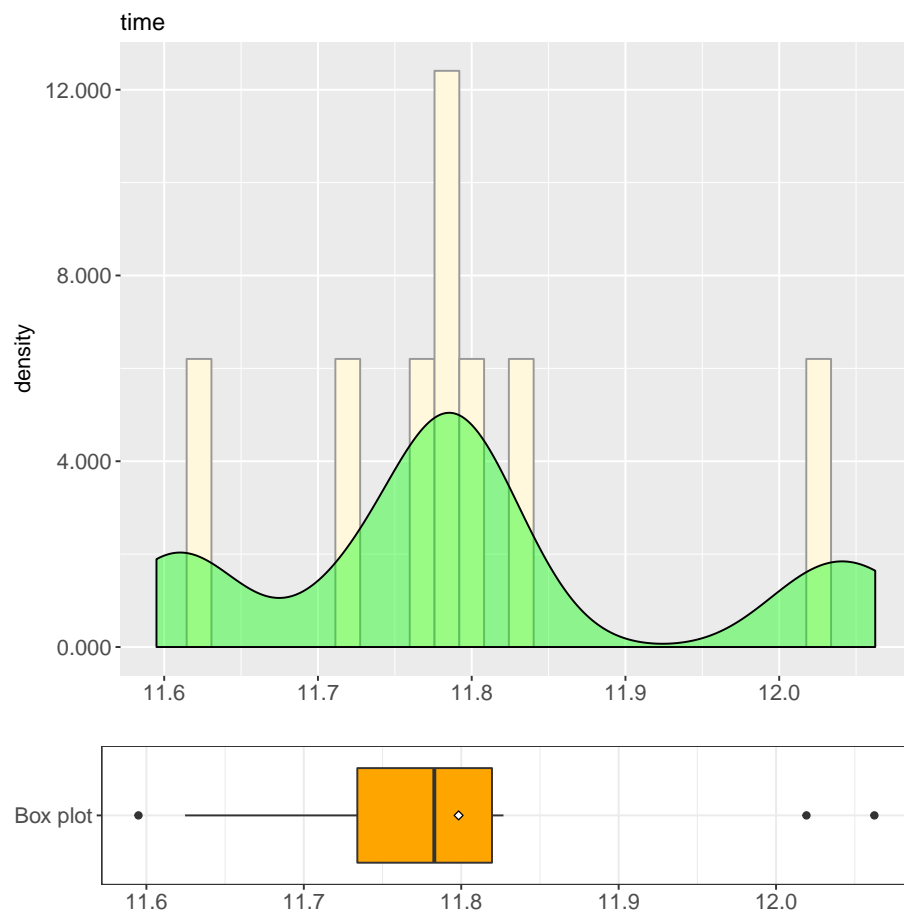
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    14.11   14.16   14.20   14.20   14.24   14.33
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Decomp" & object == "steps63282")$time
## W = 0.95494, p-value = 0.727
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.726954482156963"
```

Runtime for Hylaa

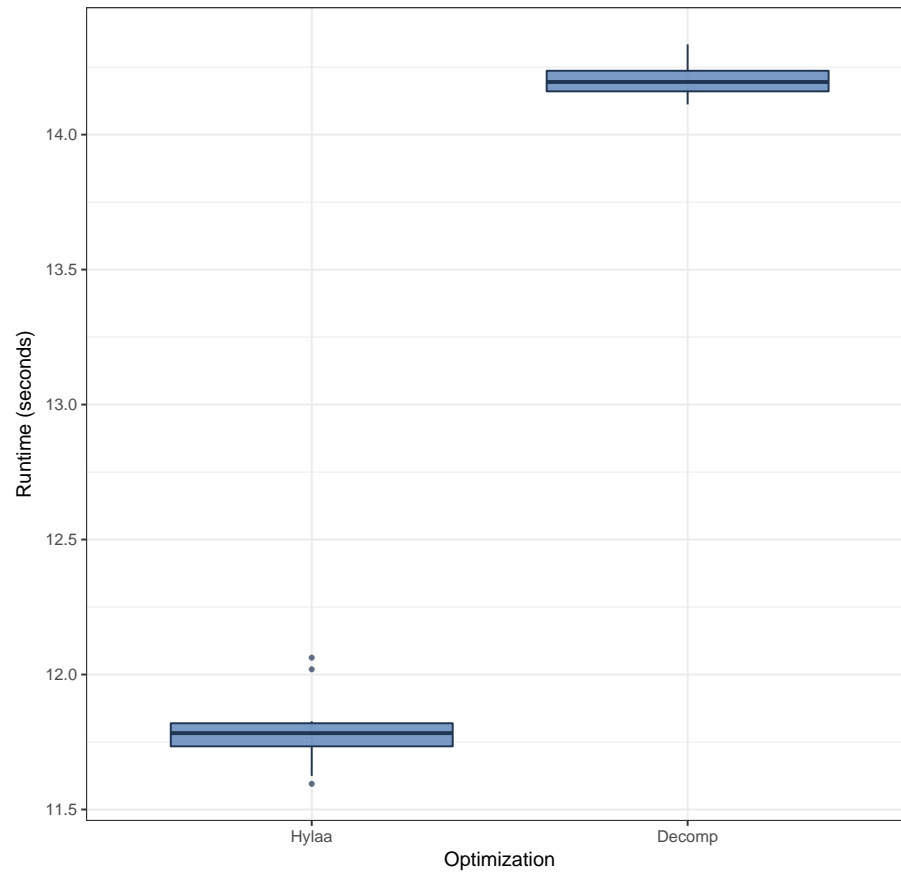
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  11.59  11.73   11.78   11.80   11.82   12.06
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps63282")$time
## W = 0.90816, p-value = 0.2686
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.268588784180786"
```

Comparison

Runtime by Optimization for 63282 steps



```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps63282")$time and subset(
## F = 5.5905, num df = 9, denom df = 9, p-value = 0.01725
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  1.388611 22.507477
## sample estimates:
## ratio of variances
##      5.590539
##
## [1] "Homogeneity of variances: FALSE. P-value: 0.0172480781080933"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```



```
## Welch Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps63282")$time and subset(
## t = -47.188, df = 12.12, p-value = 4.142e-15
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -2.514476 -2.292756
## sample estimates:
## mean of x mean of y
## 11.79832 14.20194
##
## [1] "T-test: Null Hypothesis rejected. P-value: 4.14197458288919e-15"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 11.79832429887"
## [1] "Mean Runtime for Decomp: 14.20194046496"
## [1] "Absolute difference: 2.40361616609"
## Runtime for Decomp is 20.3725215988529 % greater than
## Runtime for Hylaa
```

3.2.31 RH2.31: Object 82267 steps

Runtime for Decomp

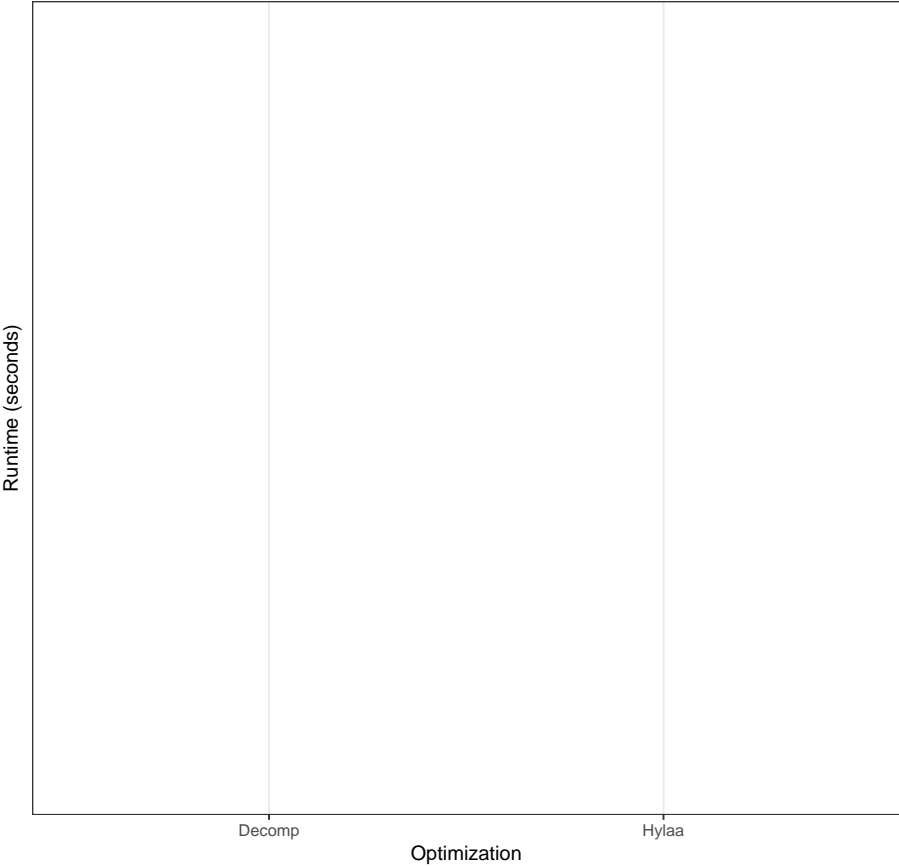
```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median      Mean 3rd Qu.      Max.      NA's
##      NA      NA      NA      NaN      NA      NA      10
```

Runtime for Hylaa

```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median      Mean 3rd Qu.      Max.      NA's
##      NA      NA      NA      NaN      NA      NA      10
```

Comparison

Runtime by Optimization for 82267 steps



3.2.32 RH2.32: Object 106948 steps

Runtime for Decomp

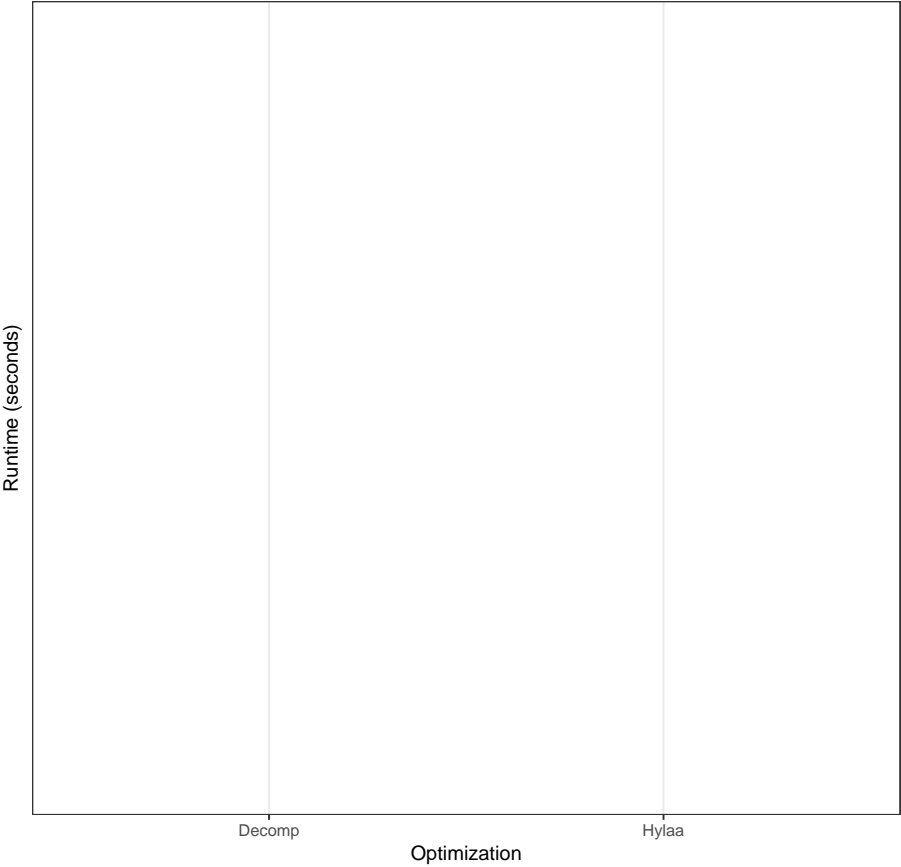
```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median      Mean 3rd Qu.      Max.      NA's
##      NA      NA      NA      NaN      NA      NA      10
```

Runtime for Hylaa

```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median      Mean 3rd Qu.      Max.      NA's
##      NA      NA      NA      NaN      NA      NA      10
```

Comparison

Runtime by Optimization for 106948 steps



3.2.33 RH2.33: Object 139032 steps

Runtime for Decomp

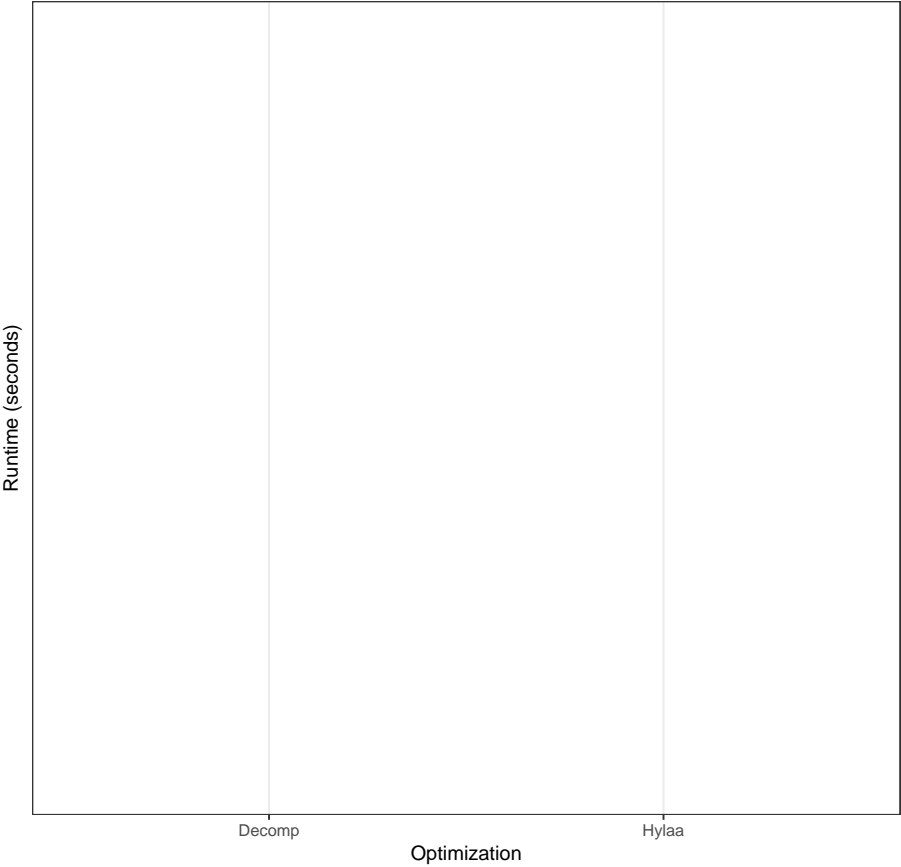
```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median      Mean 3rd Qu.      Max.      NA's
##      NA      NA      NA      NaN      NA      NA      10
```

Runtime for Hylaa

```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median      Mean 3rd Qu.      Max.      NA's
##      NA      NA      NA      NaN      NA      NA      10
```

Comparison

Runtime by Optimization for 139032 steps



3.2.34 RH2.34: Object 180742 steps

Runtime for Decomp

```
## [1] "Sample size: 0"
```

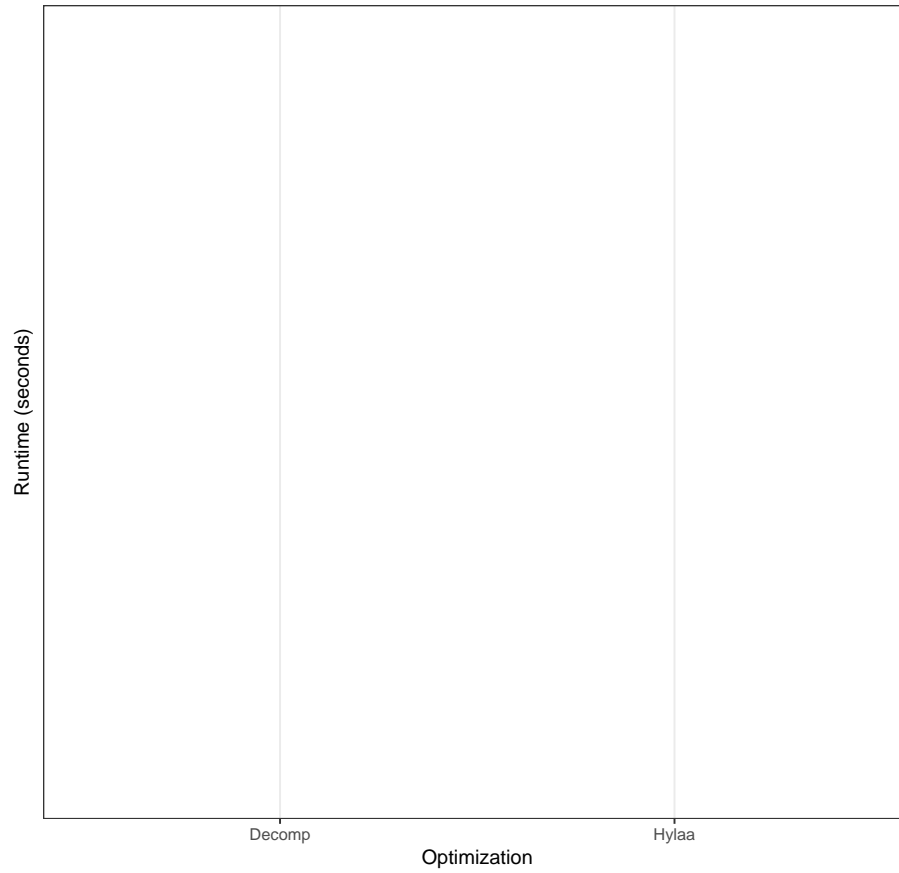
##	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	NA's
##	NA	NA	NA	NaN	NA	NA	10

Runtime for Hylaa

```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median      Mean 3rd Qu.      Max.      NA's
##      NA      NA      NA      NaN      NA      NA      10
```

Comparison

Runtime by Optimization for 180742 steps



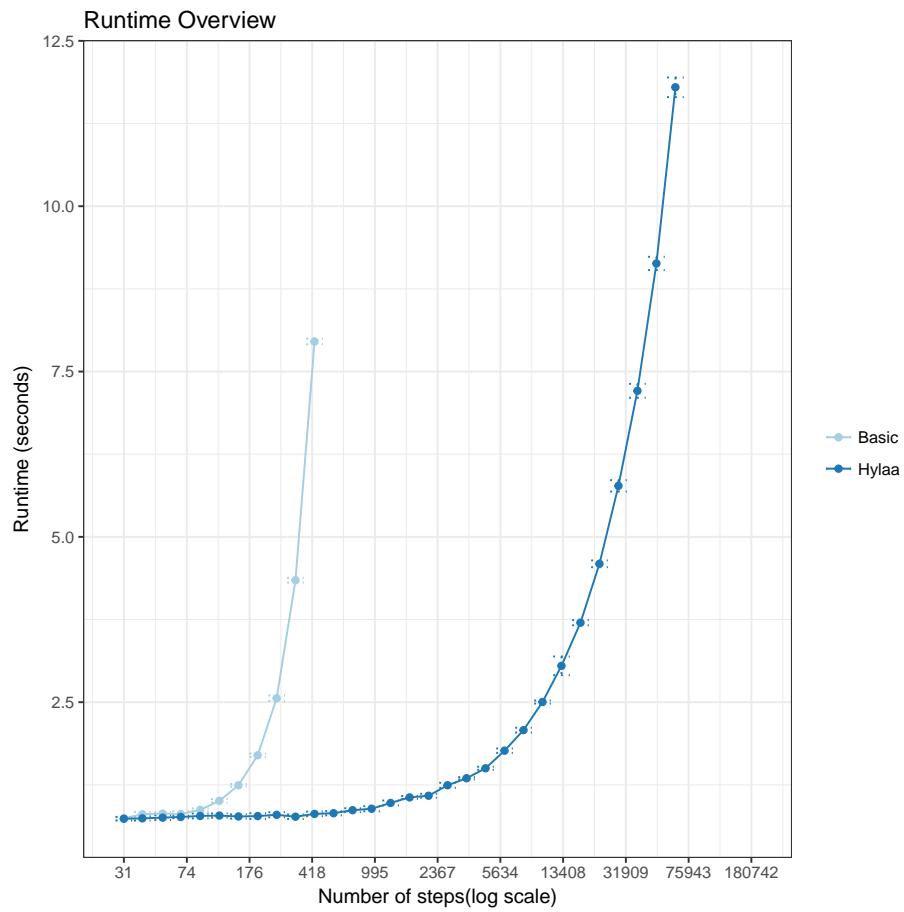
3.2.35 RH2 Results: Runtime Hylaa = Decomp

Table 3: RH2 Results per Object

31 steps	Inconclusive
40 steps	Hylaa < Decomp
53 steps	Hylaa > Decomp
68 steps	Inconclusive
89 steps	Inconclusive
116 steps	Inconclusive
151 steps	Inconclusive
197 steps	Inconclusive
256 steps	Hylaa > Decomp
332 steps	Hylaa < Decomp
432 steps	Hylaa < Decomp
562 steps	Hylaa < Decomp
731 steps	Inconclusive
951 steps	Hylaa < Decomp
1236 steps	Inconclusive
1607 steps	Inconclusive
2089 steps	Hylaa < Decomp
2716 steps	Hylaa < Decomp
3531 steps	Hylaa < Decomp
4590 steps	Hylaa < Decomp
5967 steps	Hylaa < Decomp
7757 steps	Hylaa < Decomp
10085 steps	Hylaa < Decomp
13110 steps	Hylaa < Decomp
17043 steps	Hylaa < Decomp
22157 steps	Hylaa < Decomp
28804 steps	Hylaa < Decomp
37445 steps	Hylaa < Decomp
48679 steps	Hylaa < Decomp
63282 steps	Hylaa < Decomp
82267 steps	None
106948 steps	None
139032 steps	None
180742 steps	None

Table 4: RH2 Results Summary	
Hylaa < Decomp:	55.8823529%
Hylaa > Decomp:	5.8823529%
Hylaa:	0%
Decomp:	0%
None:	11.7647059%
Inconclusive:	26.4705882%

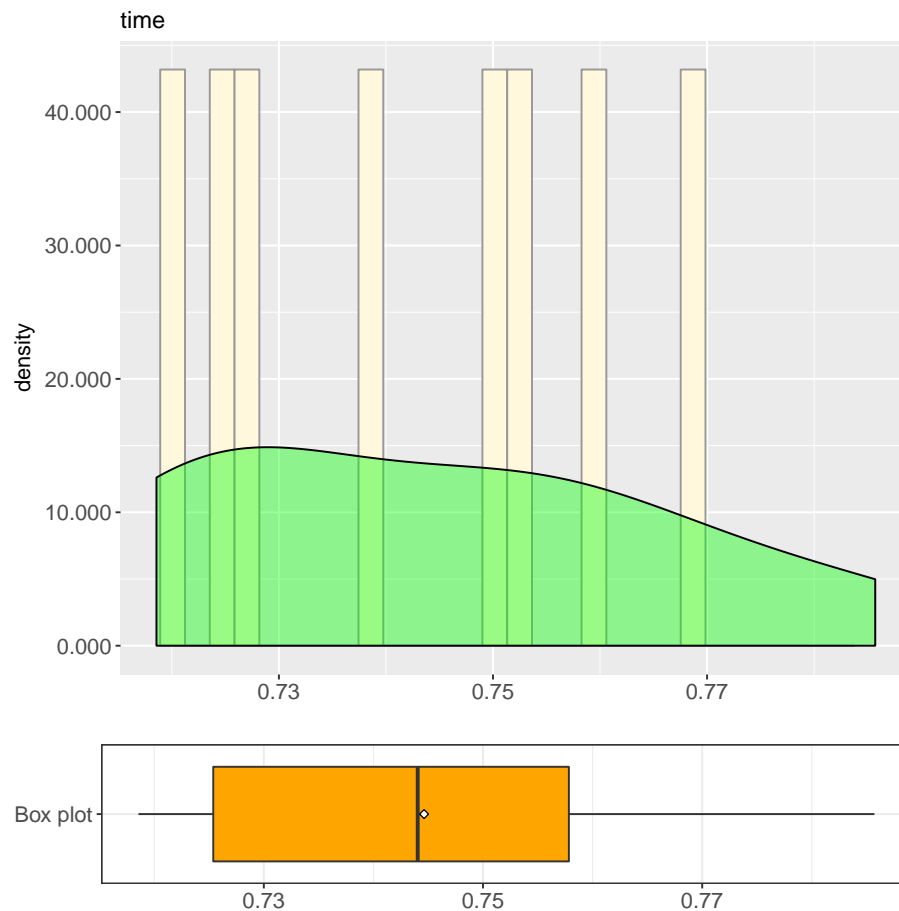
3.3 RH3: Runtime time for Hylaa is equals than runtime time for Basic



3.3.1 RH3.1: Object 31 steps

Runtime for Basic

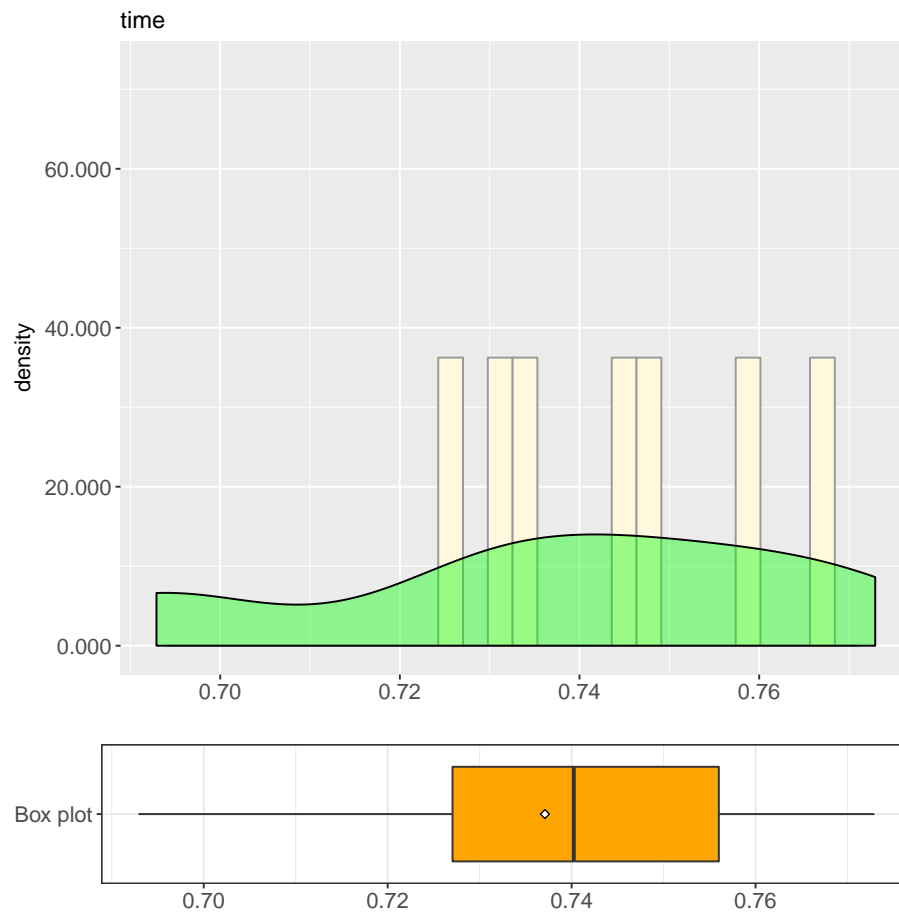
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7186 0.7254 0.7440 0.7446 0.7578 0.7857
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Basic" & object == "steps31")$time
## W = 0.93659, p-value = 0.5157
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.515716063680102"
```

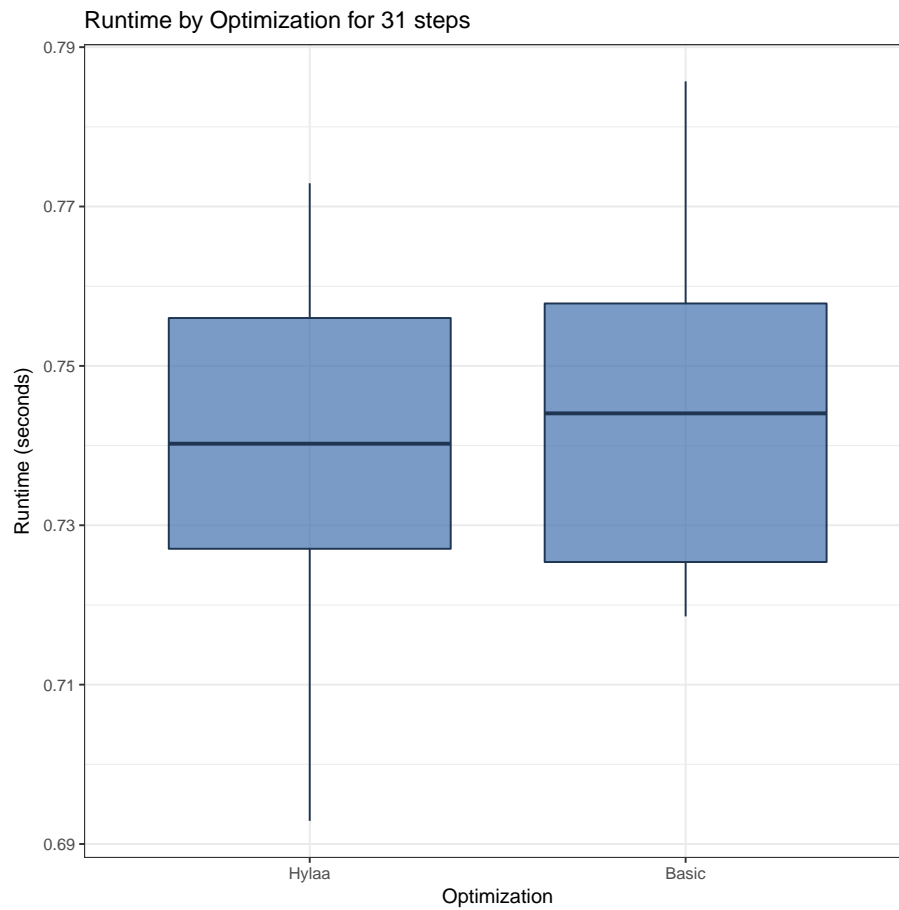
Runtime for Hylaa


```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6929  0.7270  0.7402  0.7371  0.7560  0.7729
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps31")$time
## W = 0.92348, p-value = 0.3869
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.386919454155626"
```

Comparison



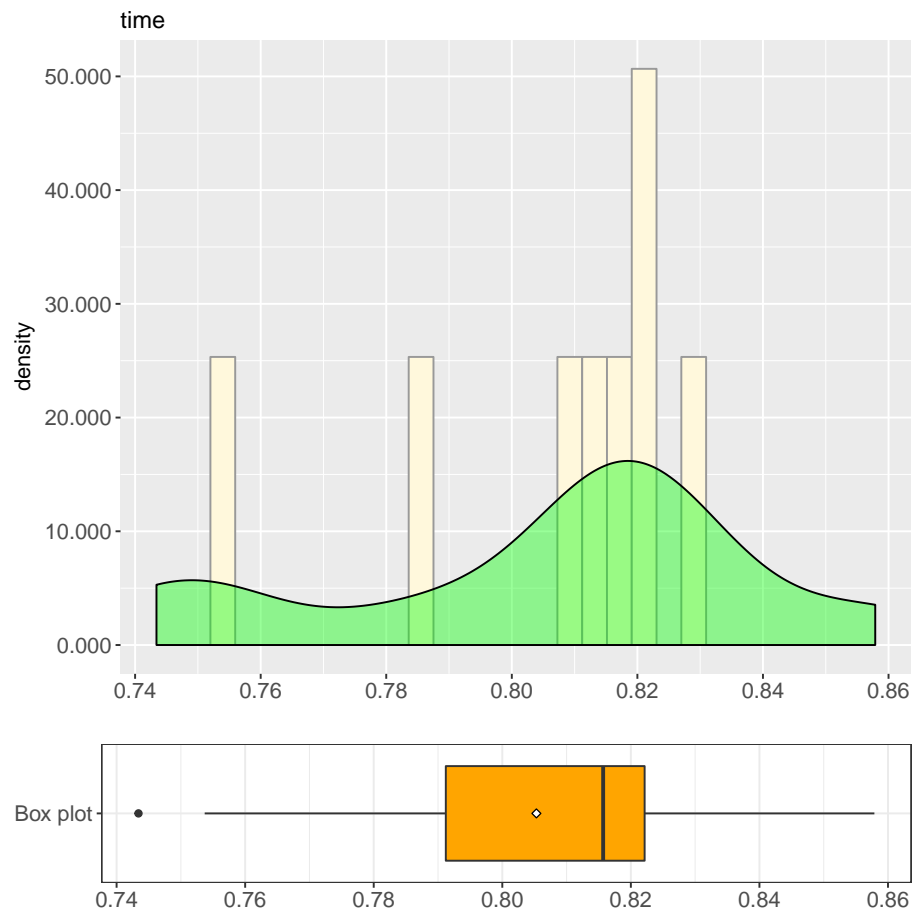
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps31")$time and subset(json_data, treatment == "Basic" & object == "steps31")$time
## F = 1.5257, num df = 9, denom df = 9, p-value = 0.5391
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3789737 6.1426437
## sample estimates:
## ratio of variances
##      1.525746
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.539086303842604"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps31")$time and subset(json_data, treatment == "Basic" & object == "steps31")$time
## t = -0.66662, df = 18, p-value = 0.5135
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.03125318 0.01619724
## sample estimates:
## mean of x mean of y
## 0.7370949 0.7446229
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.513470139172935"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7370949268343"
## [1] "Mean Runtime for Basic: 0.7446228981017"
## [1] "Absolute difference: 0.00752797126740001"
## Runtime for Basic is 1.02130281912689 % greater than
## Runtime for Hylaa
```

3.3.2 RH3.2: Object 40 steps

Runtime for Basic

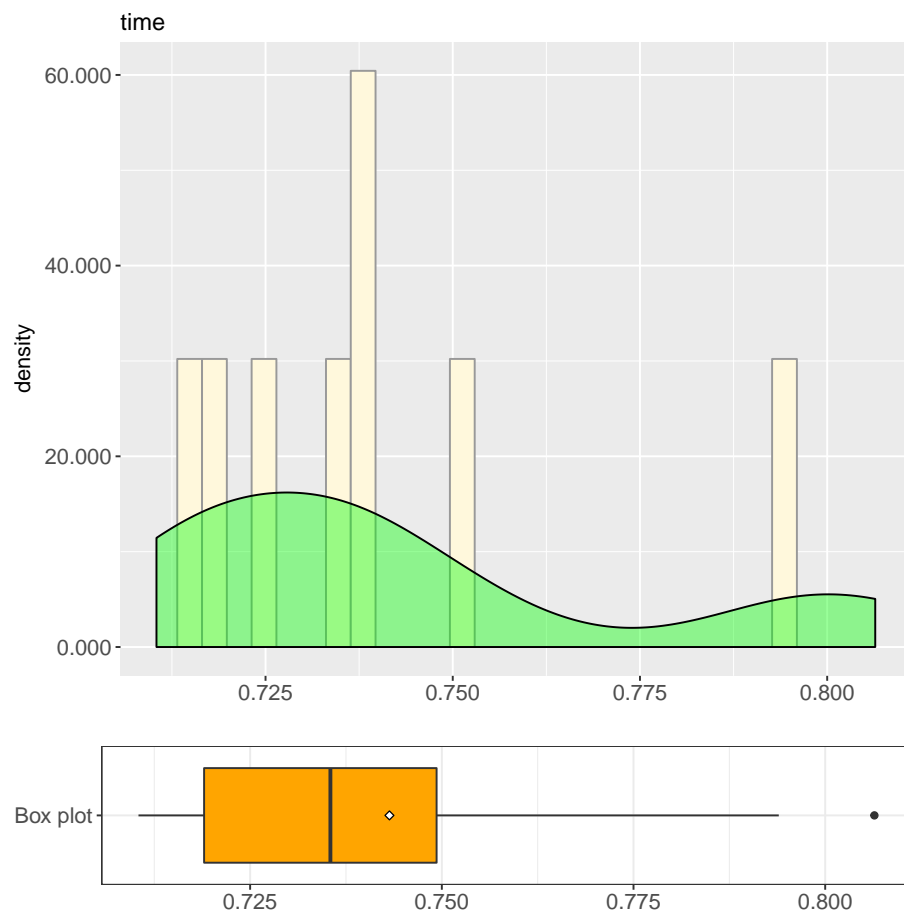
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7434 0.7912 0.8157 0.8053 0.8221 0.8579
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Basic" & object == "steps40")$time
## W = 0.91538, p-value = 0.32
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.319991403565201"
```

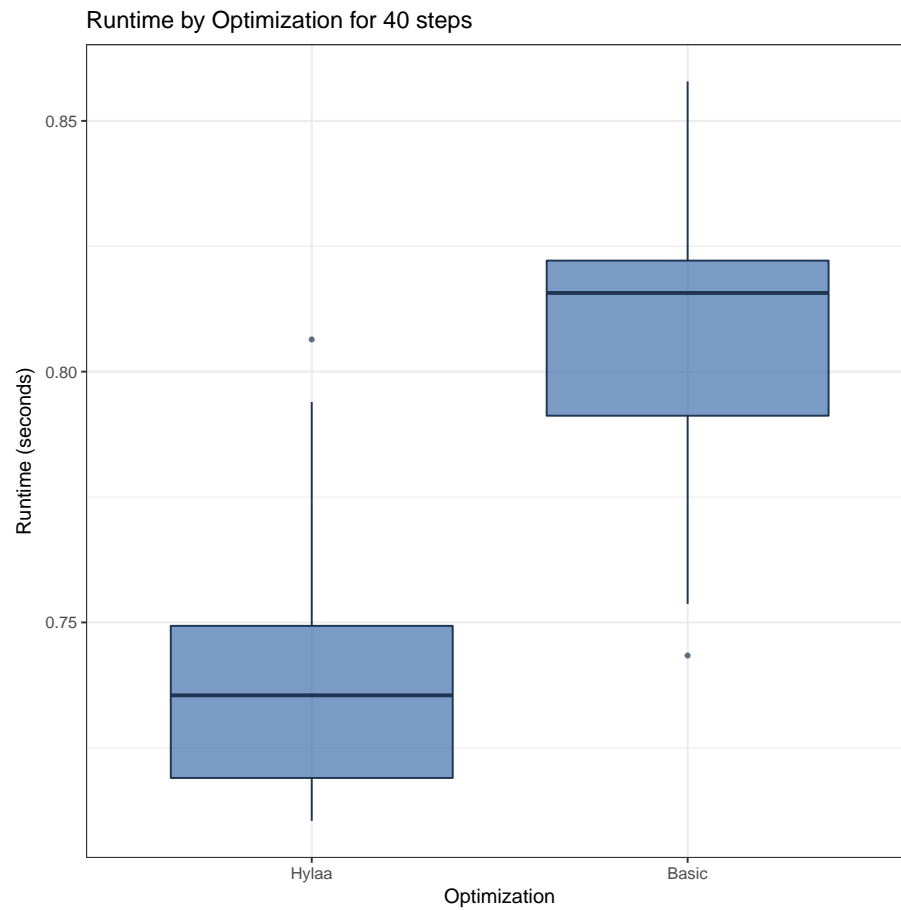
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7104 0.7190 0.7355 0.7432 0.7493 0.8064
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps40")$time
## W = 0.84556, p-value = 0.05142
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0514195741817329"
```

Comparison



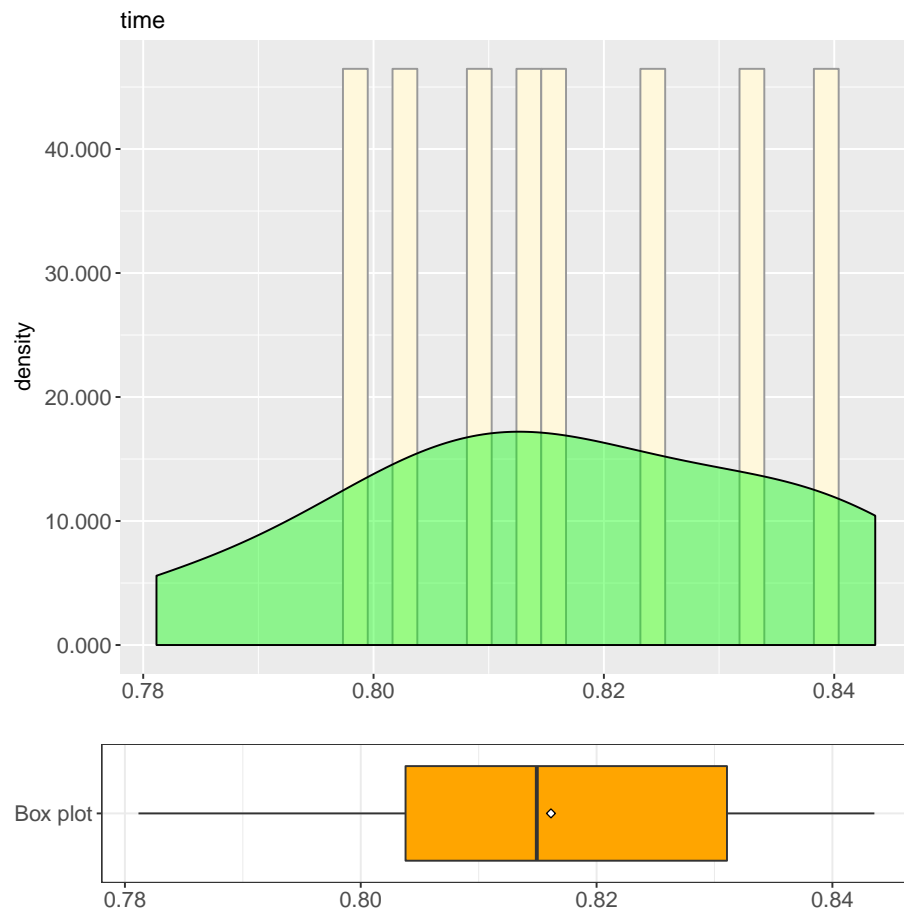
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps40")$time and subset(json_data, treatment == "Basic" & object == "steps40")$time
## F = 0.87484, num df = 9, denom df = 9, p-value = 0.8454
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2172986 3.5221124
## sample estimates:
## ratio of variances
##      0.8748429
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.845383286267737"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps40")$time and subset(json
## t = -4.1003, df = 18, p-value = 0.0006718
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.09397537 -0.03029879
## sample estimates:
## mean of x mean of y
## 0.7431680 0.8053051
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.000671837245387798"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7431680440903"
## [1] "Mean Runtime for Basic: 0.8053051233291"
## [1] "Absolute difference: 0.0621370792388"
## Runtime for Basic is 8.36110752243942 % greater than
## Runtime for Hylaa
```

3.3.3 RH3.3: Object 53 steps

Runtime for Basic

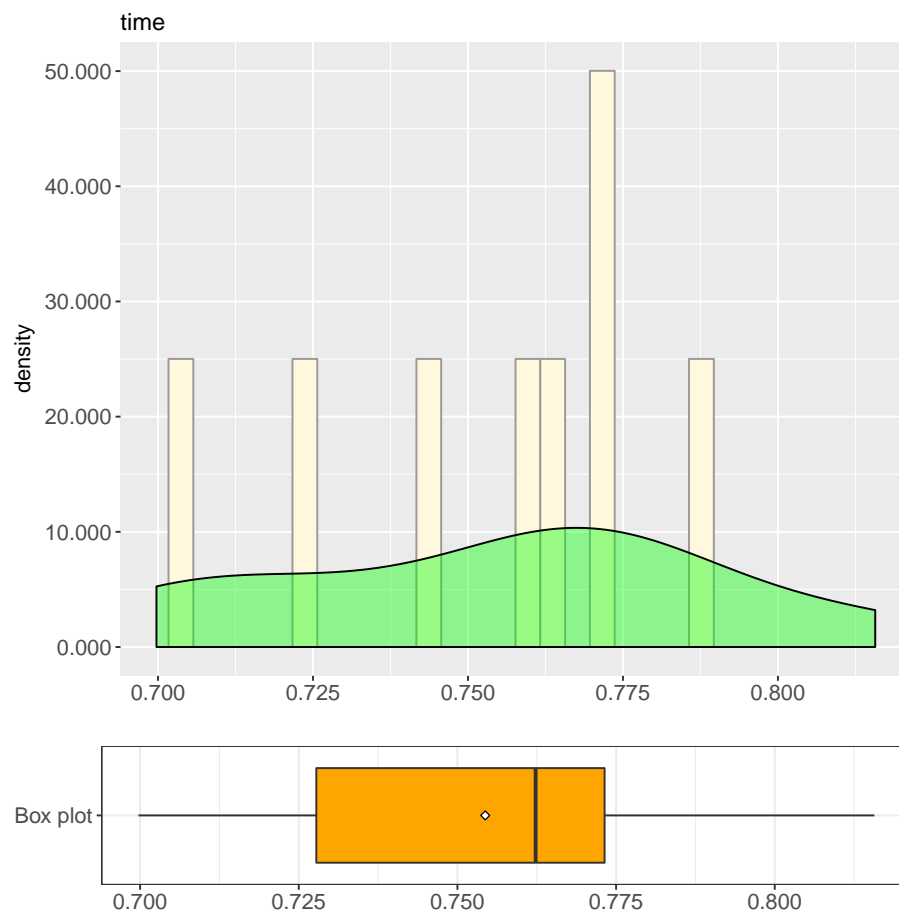
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7812 0.8038 0.8149 0.8161 0.8311 0.8436
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Basic" & object == "steps53")$time
## W = 0.97306, p-value = 0.9177
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.917690328563095"
```

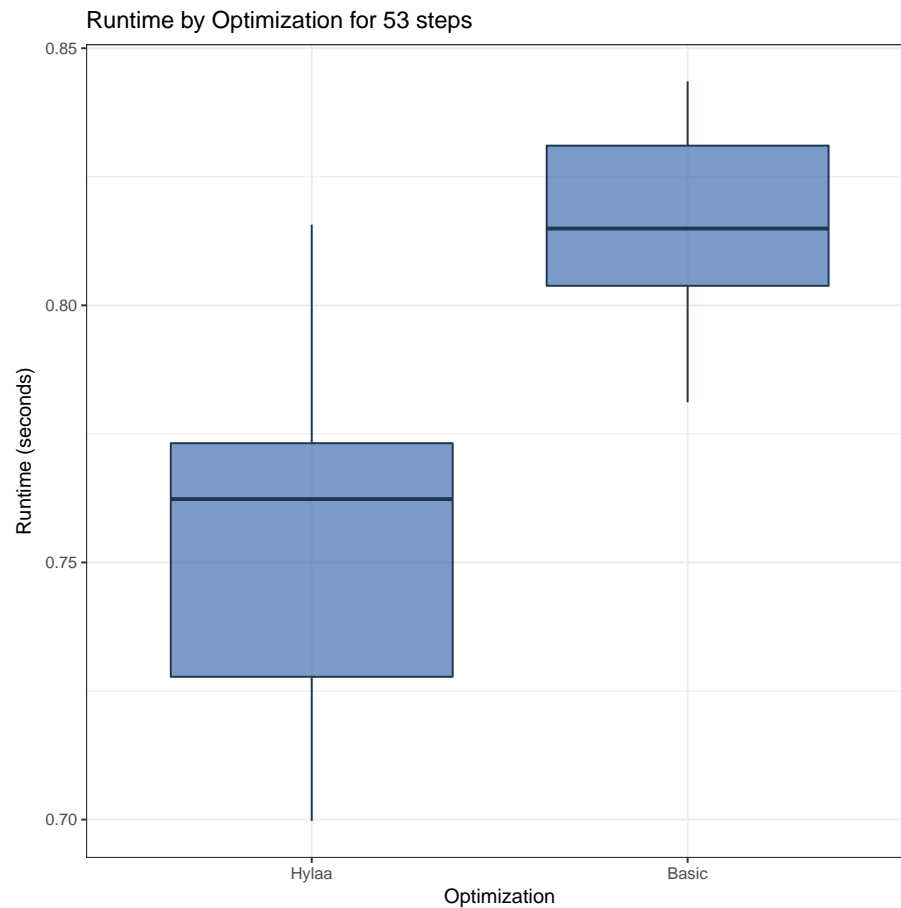
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6997 0.7278 0.7623 0.7544 0.7732 0.8157
```

```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps53")$time
## W = 0.95914, p-value = 0.776
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.776029544672673"
```

Comparison



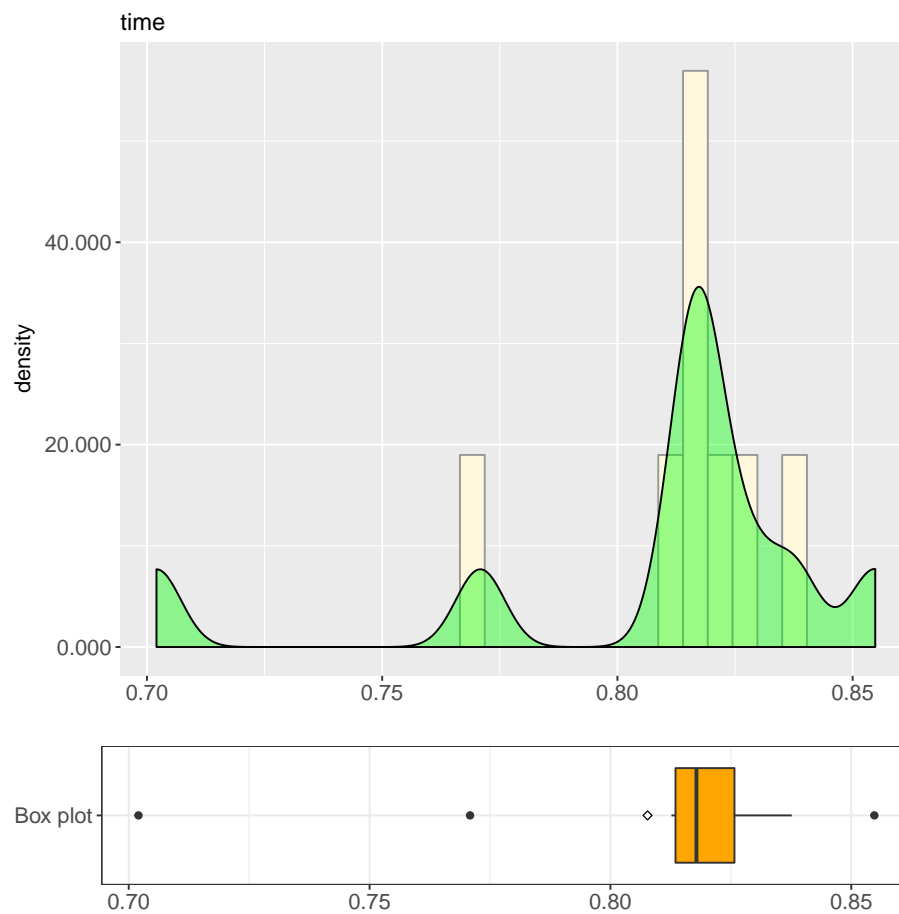
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps53")$time and subset(json_data, treatment == "Basic" & object == "steps53")$time
## F = 3.4683, num df = 9, denom df = 9, p-value = 0.07804
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.8614821 13.9634439
## sample estimates:
## ratio of variances
##      3.468322
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.0780378748014869"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps53")$time and subset(json
## t = -4.685, df = 18, p-value = 0.0001844
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.08944492 -0.03406043
## sample estimates:
## mean of x mean of y
## 0.7543800 0.8161326
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.000184423208671564"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7543799638747"
## [1] "Mean Runtime for Basic: 0.8161326408387"
## [1] "Absolute difference: 0.061752676964"
## Runtime for Basic is 8.18588508724722 % greater than
## Runtime for Hylaa
```

3.3.4 RH3.4: Object 68 steps

Runtime for Basic

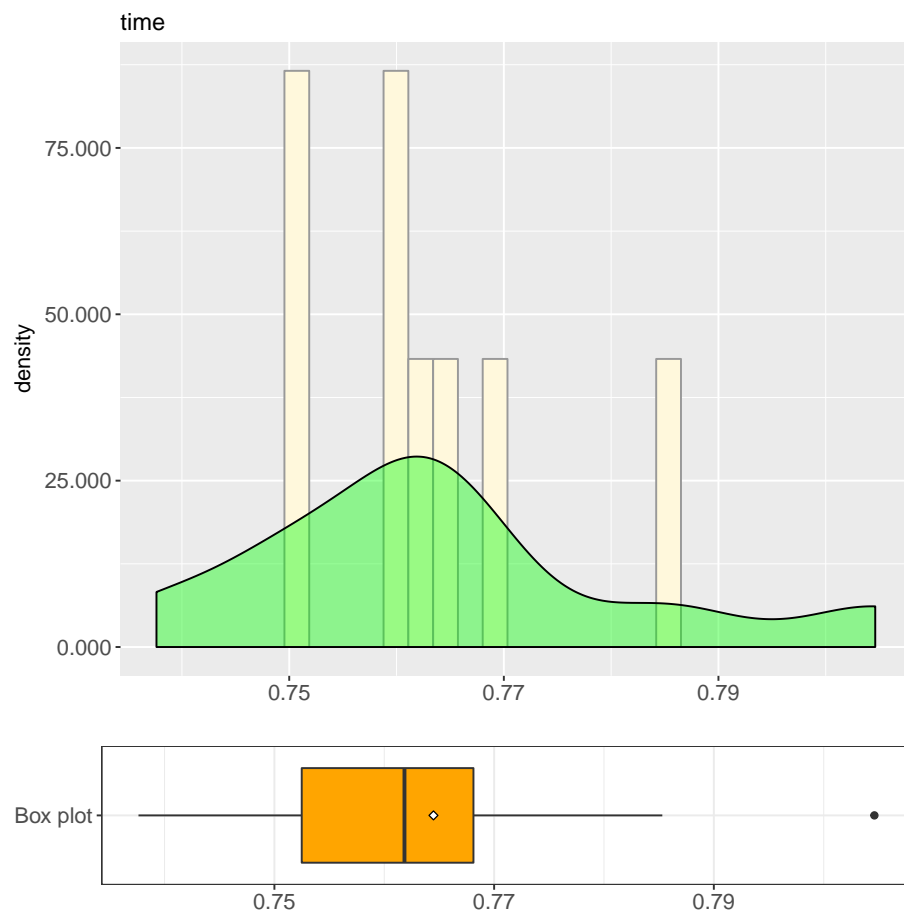
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7020  0.8135  0.8179  0.8077  0.8258  0.8548
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Basic" & object == "steps68")$time
## W = 0.77971, p-value = 0.008211
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.00821098716754948"
```

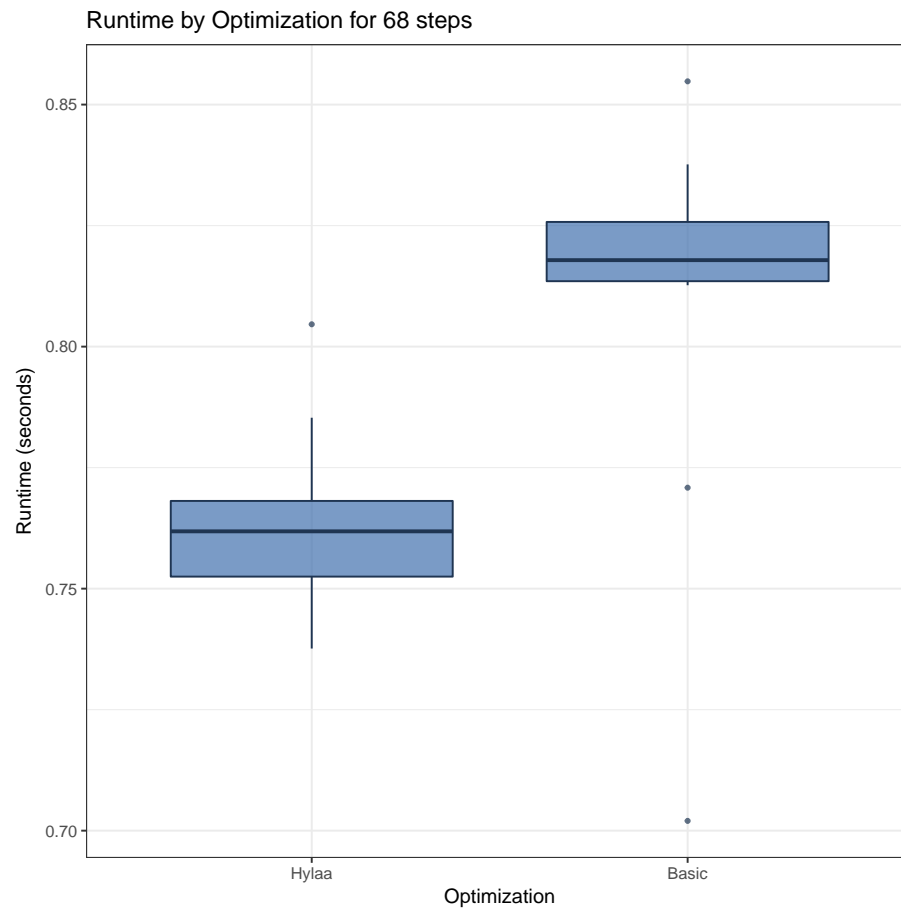
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7376 0.7525 0.7618 0.7645 0.7681 0.8046
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps68")$time
## W = 0.92932, p-value = 0.4412
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.44123425938003"
```

Comparison

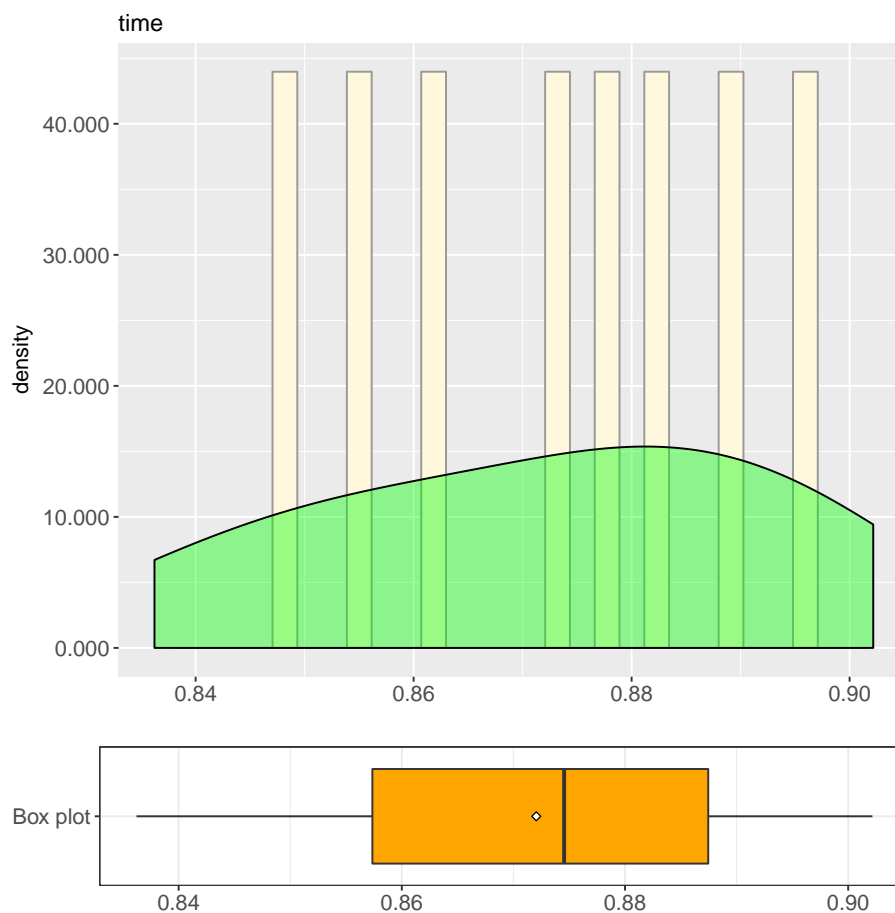


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 88, p-value = 0.002879
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 0.00287947346770876"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7644784688949"
## [1] "Mean Runtime for Basic: 0.8077137708664"
## [1] "Absolute difference: 0.0432353019714999"
## Runtime for Basic is 5.65552906074637 % greater than
## Runtime for Hylaa
```

3.3.5 RH3.5: Object 89 steps

Runtime for Basic

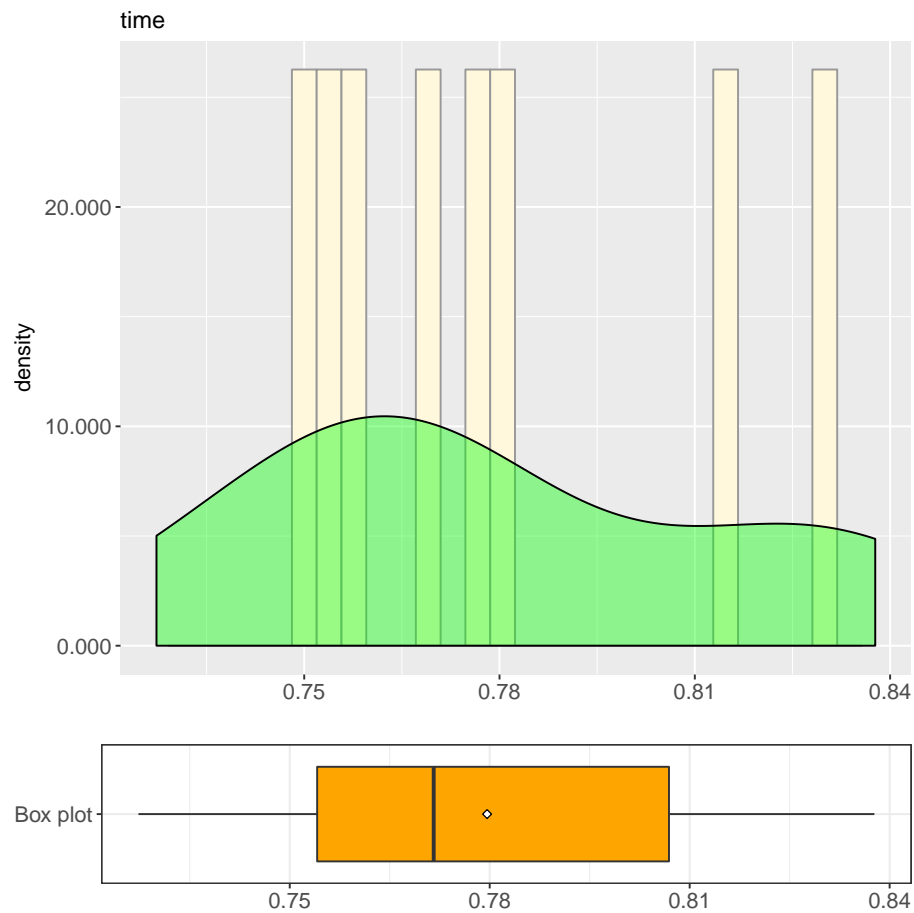
```
## [1] "Sample size: 10"  
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
## 0.8362 0.8574 0.8745 0.8720 0.8875 0.9022
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Basic" & object == "steps89")$time  
## W = 0.97464, p-value = 0.9302  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.930240033091894"
```

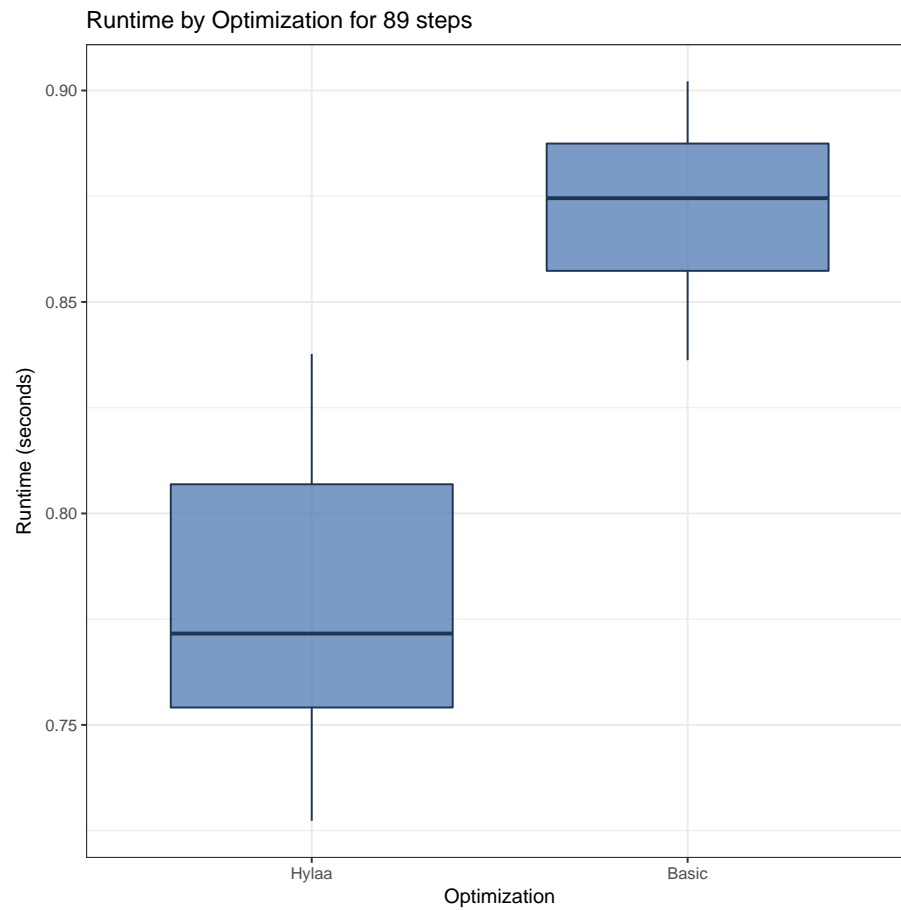
Runtime for Hylaa

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7273 0.7541 0.7716 0.7796 0.8069 0.8377
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps89")$time
## W = 0.92836, p-value = 0.4319
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.431928741976726"
```

Comparison



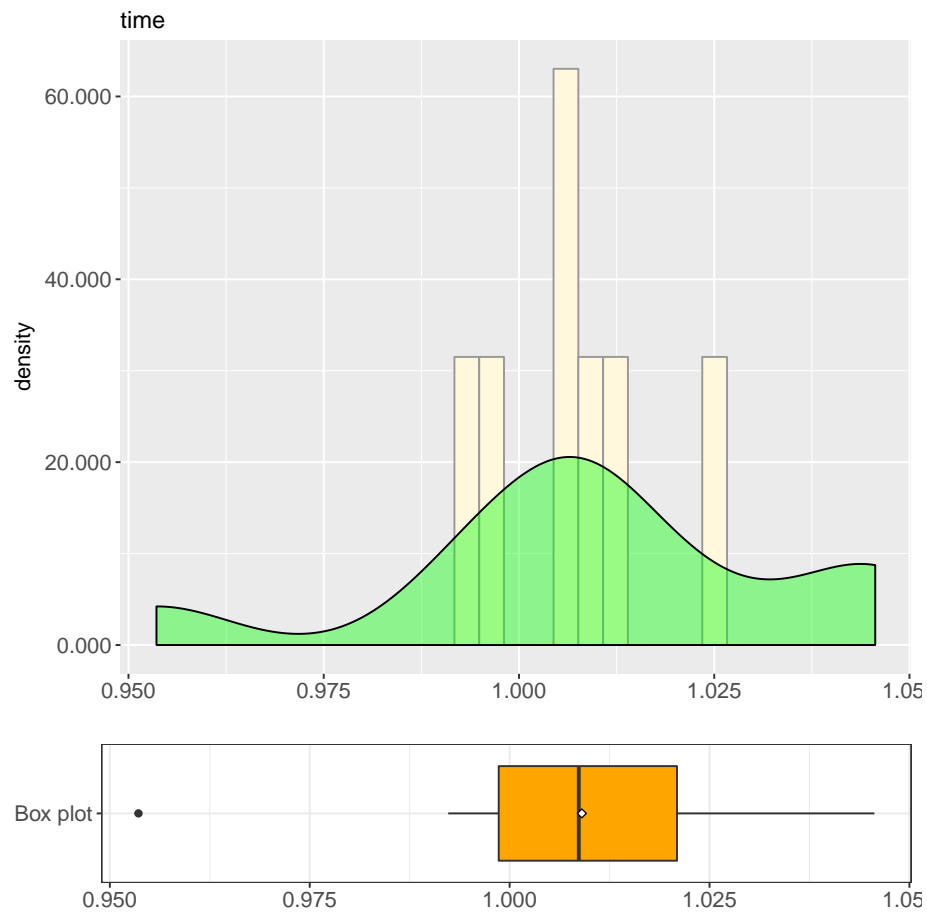
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps89")$time and subset(json_data, treatment == "Basic" & object == "steps89")$time
## F = 2.9502, num df = 9, denom df = 9, p-value = 0.1227
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.7327954 11.8776092
## sample estimates:
## ratio of variances
##      2.95023
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.122744378870267"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps89")$time and subset(json
## t = -6.8691, df = 18, p-value = 1.998e-06
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.12071520 -0.06416816
## sample estimates:
## mean of x mean of y
## 0.7796074 0.8720491
##
## [1] "T-test: Null Hypothesis rejected. P-value: 1.99833886298784e-06"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7796074151993"
## [1] "Mean Runtime for Basic: 0.8720490932466"
## [1] "Absolute difference: 0.0924416780473"
## Runtime for Basic is 11.8574652119834 % greater than
## Runtime for Hylaa
```

3.3.6 RH3.6: Object 116 steps

Runtime for Basic

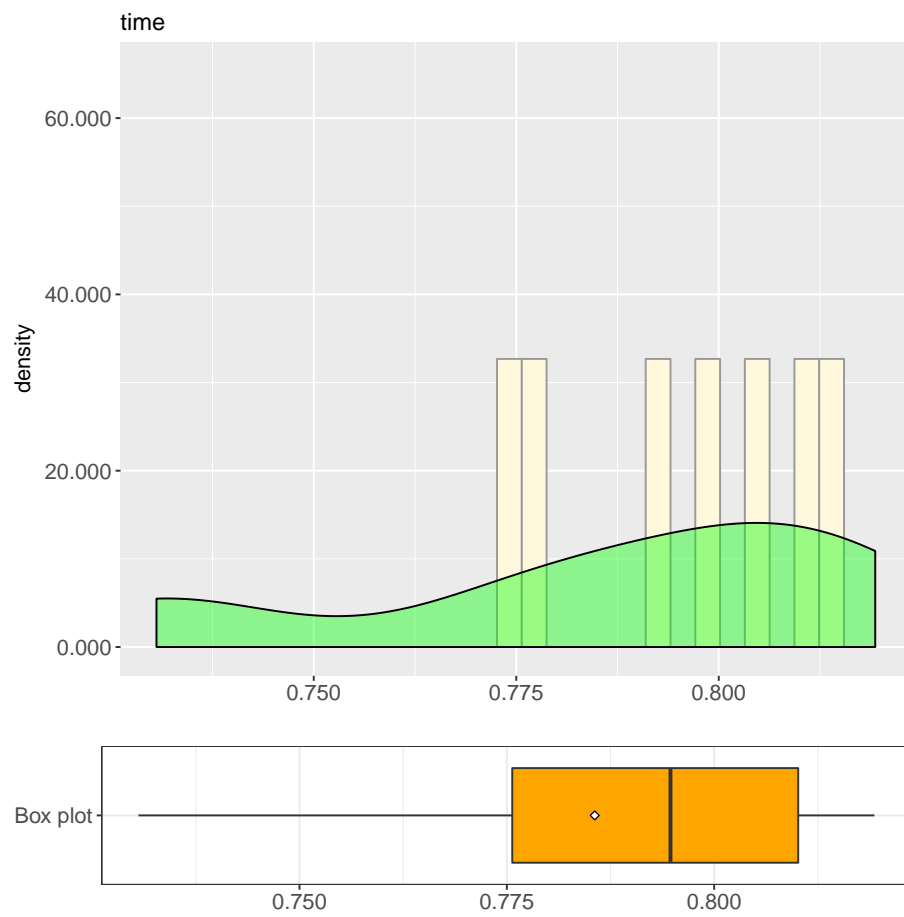
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.9536 0.9986 1.0090 1.0090 1.0210 1.0460
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Basic" & object == "steps116")$time
## W = 0.9263, p-value = 0.4125
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.412546529034677"
```

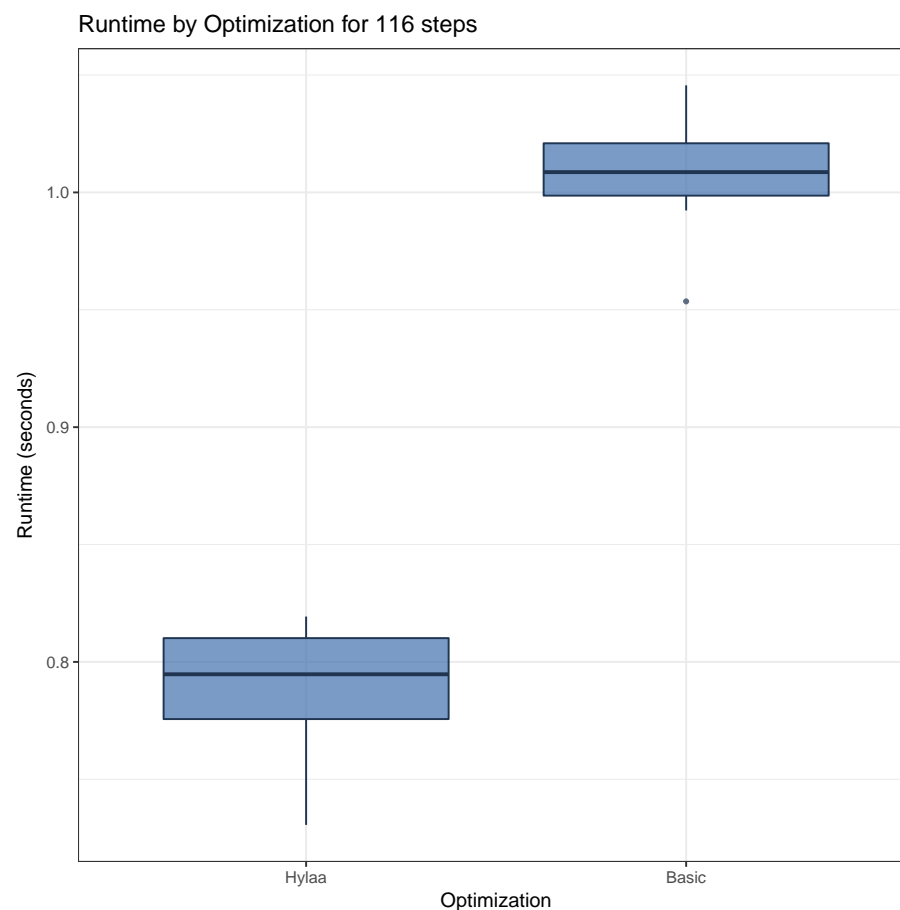
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7306 0.7757 0.7947 0.7856 0.8101 0.8193
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps116")$time
## W = 0.86307, p-value = 0.08294
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0829366496429817"
```

Comparison



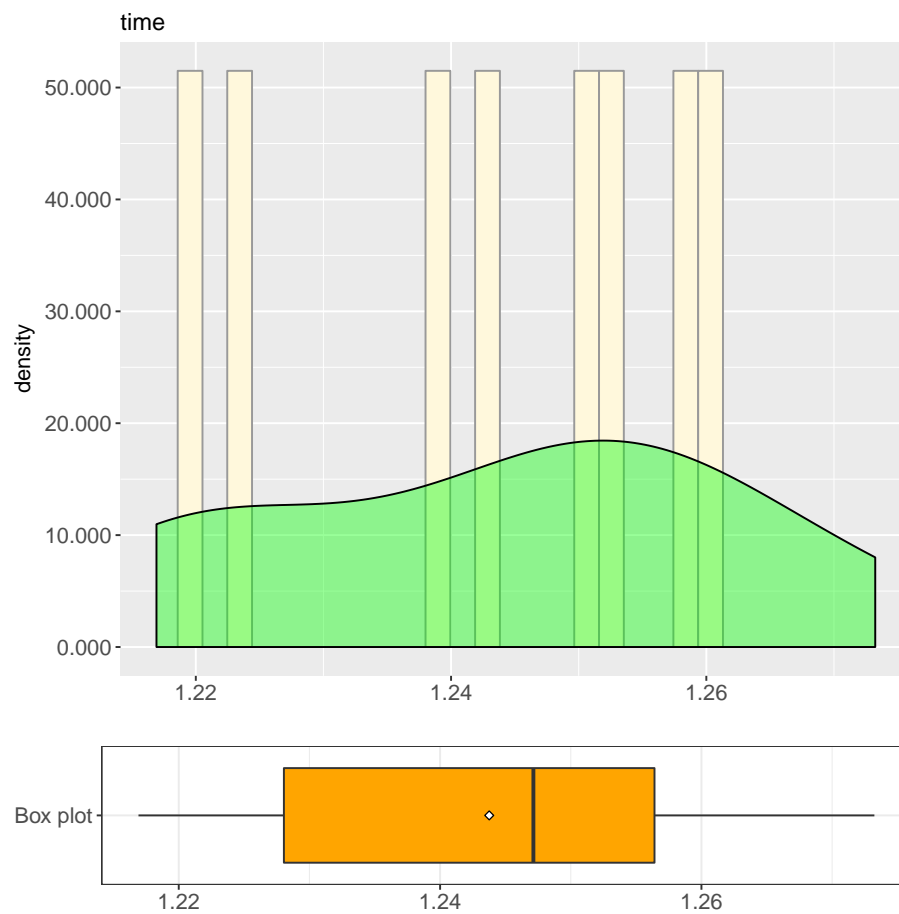
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps116")$time and subset(js
## F = 1.4652, num df = 9, denom df = 9, p-value = 0.5784
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3639293 5.8987958
## sample estimates:
## ratio of variances
##      1.465177
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.578437849677497"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps116")$time and subset(js
## t = -16.943, df = 18, p-value = 1.652e-12
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.2511444 -0.1957315
## sample estimates:
## mean of x mean of y
## 0.7855974 1.0090353
##
## [1] "T-test: Null Hypothesis rejected. P-value: 1.65242796426971e-12"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7855973720549"
## [1] "Mean Runtime for Basic: 1.0090353250514"
## [1] "Absolute difference: 0.2234379529965"
## Runtime for Basic is 28.4417897697455 % greater than
## Runtime for Hylaa
```

3.3.7 RH3.7: Object 151 steps

Runtime for Basic

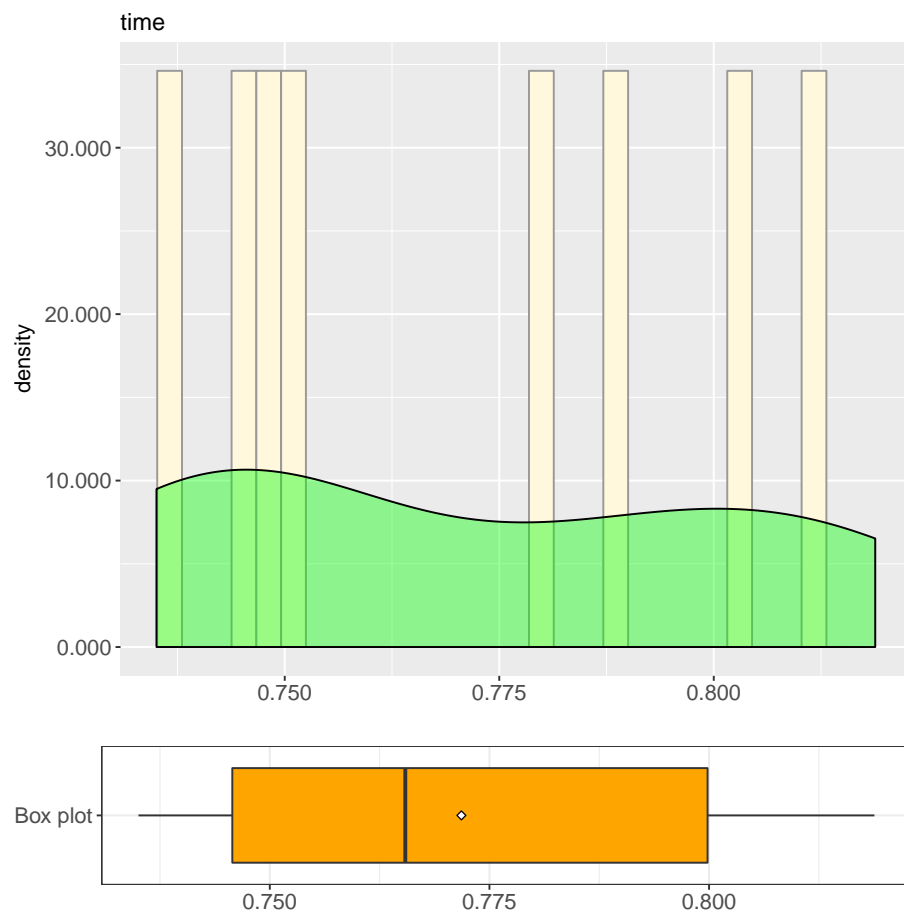
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1.217   1.228   1.247   1.244   1.256   1.273
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Basic" & object == "steps151")$time
## W = 0.94617, p-value = 0.6234
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.623430069380077"
```

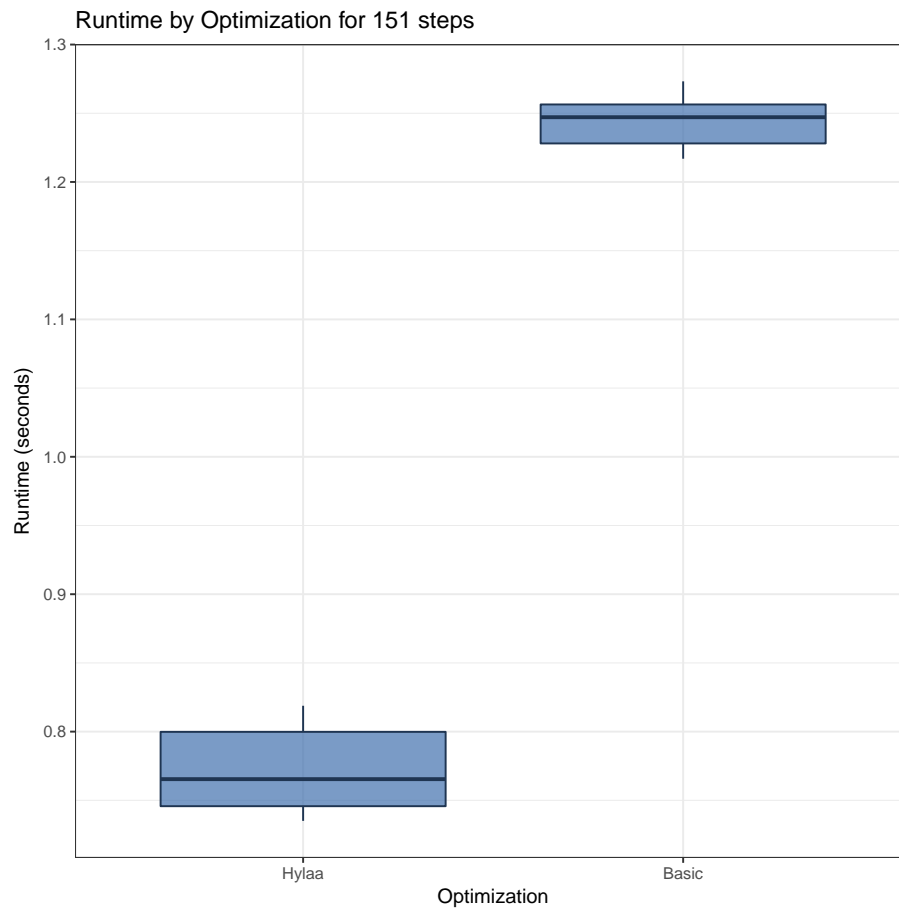
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7351 0.7457 0.7654 0.7718 0.7998 0.8188
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps151")$time
## W = 0.8855, p-value = 0.1508
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.15083040609515"
```

Comparison



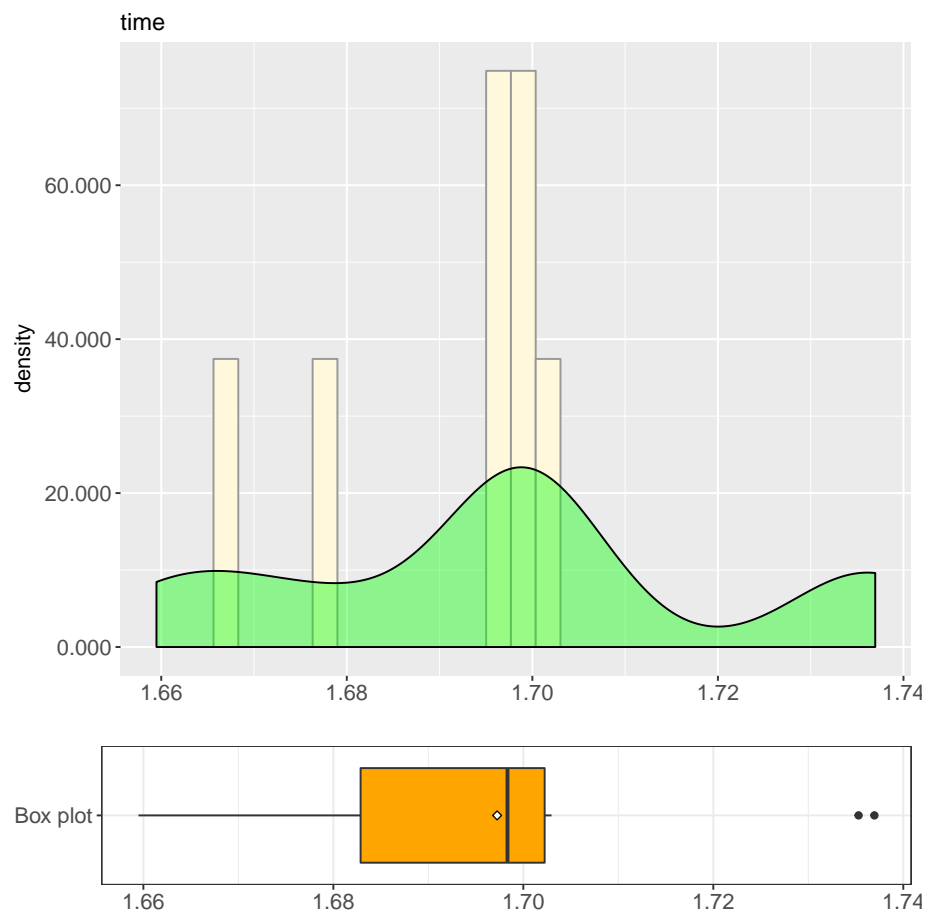
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps151")$time and subset(js
## F = 2.9605, num df = 9, denom df = 9, p-value = 0.1216
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.7353467 11.9189620
## sample estimates:
## ratio of variances
##      2.960502
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.121597927974591"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps151")$time and subset(js
## t = -39.75, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.4968950 -0.4470062
## sample estimates:
## mean of x mean of y
## 0.7718092 1.2437598
##
## [1] "T-test: Null Hypothesis rejected. P-value: 5.440874983464e-19"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7718092203141"
## [1] "Mean Runtime for Basic: 1.243759799003"
## [1] "Absolute difference: 0.4719505786889"
## Runtime for Basic is 61.1486059335793 % greater than
## Runtime for Hylaa
```

3.3.8 RH3.8: Object 197 steps

Runtime for Basic

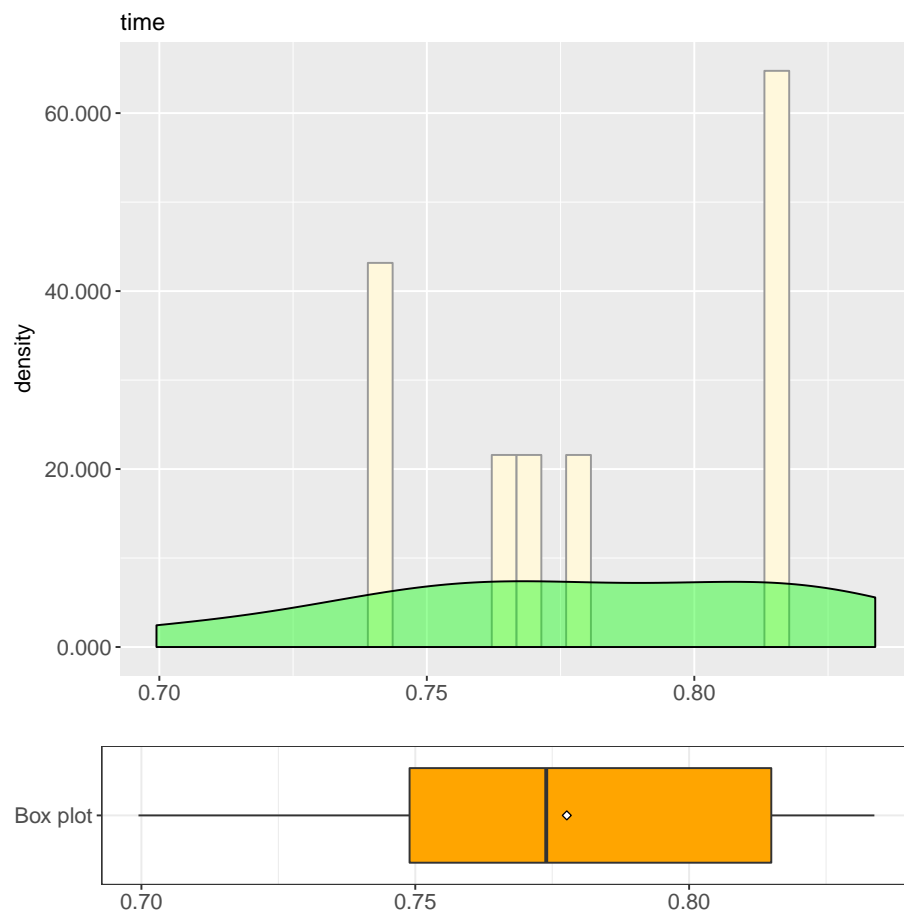
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1.659   1.683   1.698   1.697   1.702   1.737
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Basic" & object == "steps197")$time
## W = 0.9196, p-value = 0.3537
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.353670156215988"
```

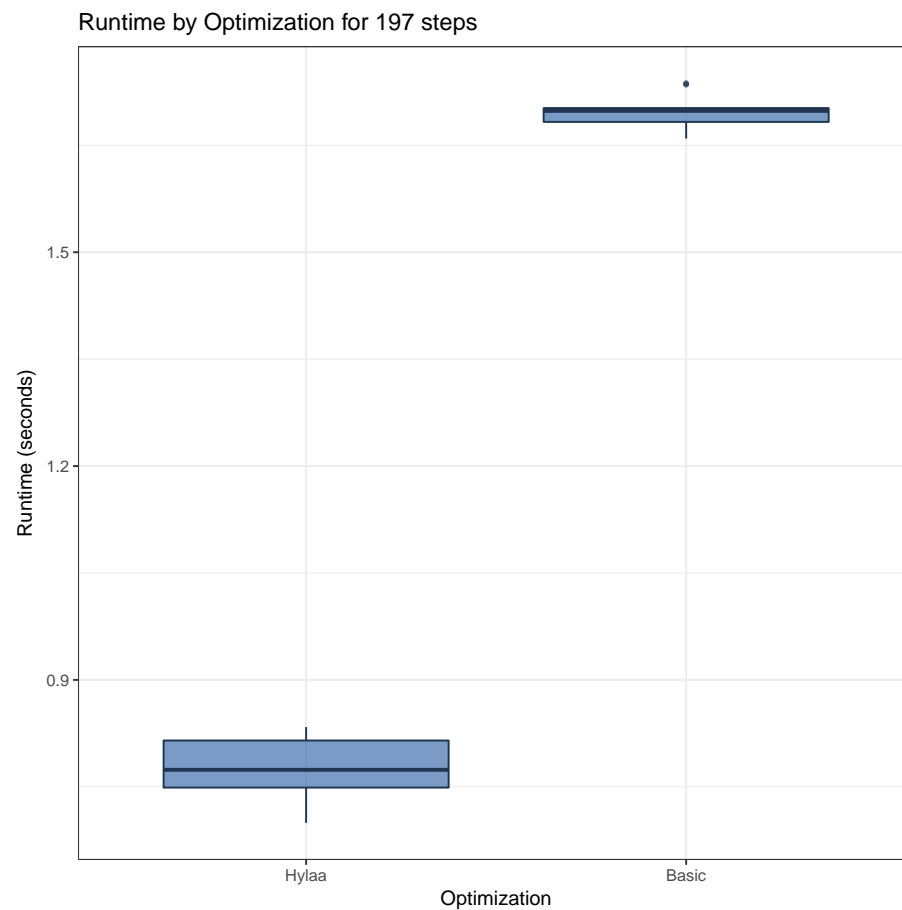
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6995 0.7490 0.7739 0.7777 0.8150 0.8338
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps197")$time
## W = 0.94142, p-value = 0.569
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.568954856828926"
```

Comparison



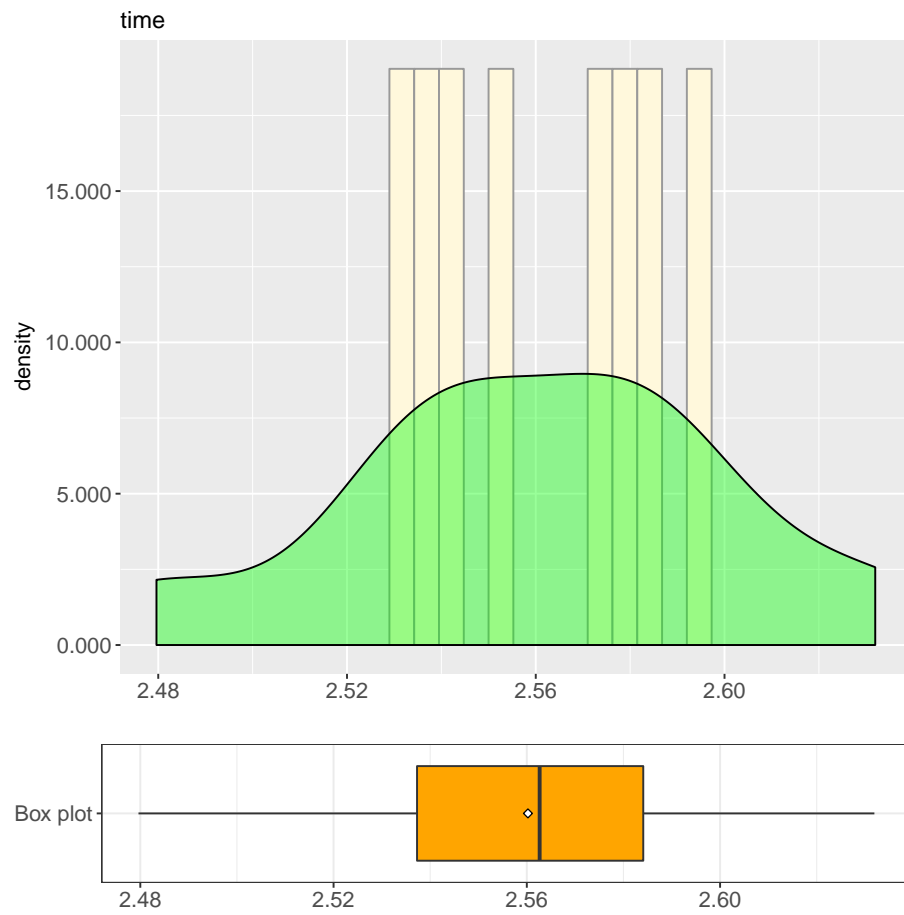
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps197")$time and subset(json_data, treatment == "Basic" & object == "steps197")$time
## F = 2.8381, num df = 9, denom df = 9, p-value = 0.1361
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.7049407 11.4261218
## sample estimates:
## ratio of variances
##      2.838087
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.13613979560032"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps197")$time and subset(js
## t = -58.6, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.9525410 -0.8866041
## sample estimates:
## mean of x mean of y
## 0.7776674 1.6972400
##
## [1] "T-test: Null Hypothesis rejected. P-value: 5.29863503198605e-22"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.777667427063"
## [1] "Mean Runtime for Basic: 1.697239995003"
## [1] "Absolute difference: 0.91957256794"
## Runtime for Basic is 118.247535635243 % greater than
## Runtime for Hylaa
```

3.3.9 RH3.9: Object 256 steps

Runtime for Basic

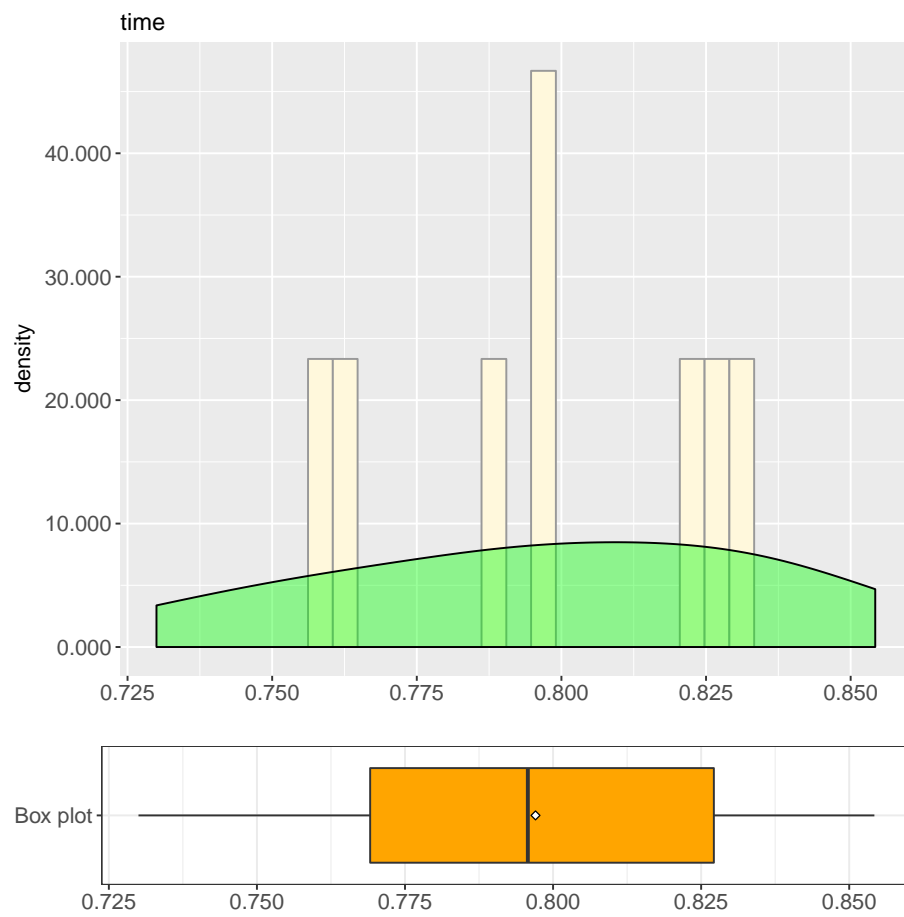
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 2.480 2.537 2.563 2.560 2.584 2.632
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Basic" & object == "steps256")$time
## W = 0.97902, p-value = 0.9597
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.959716352289663"
```

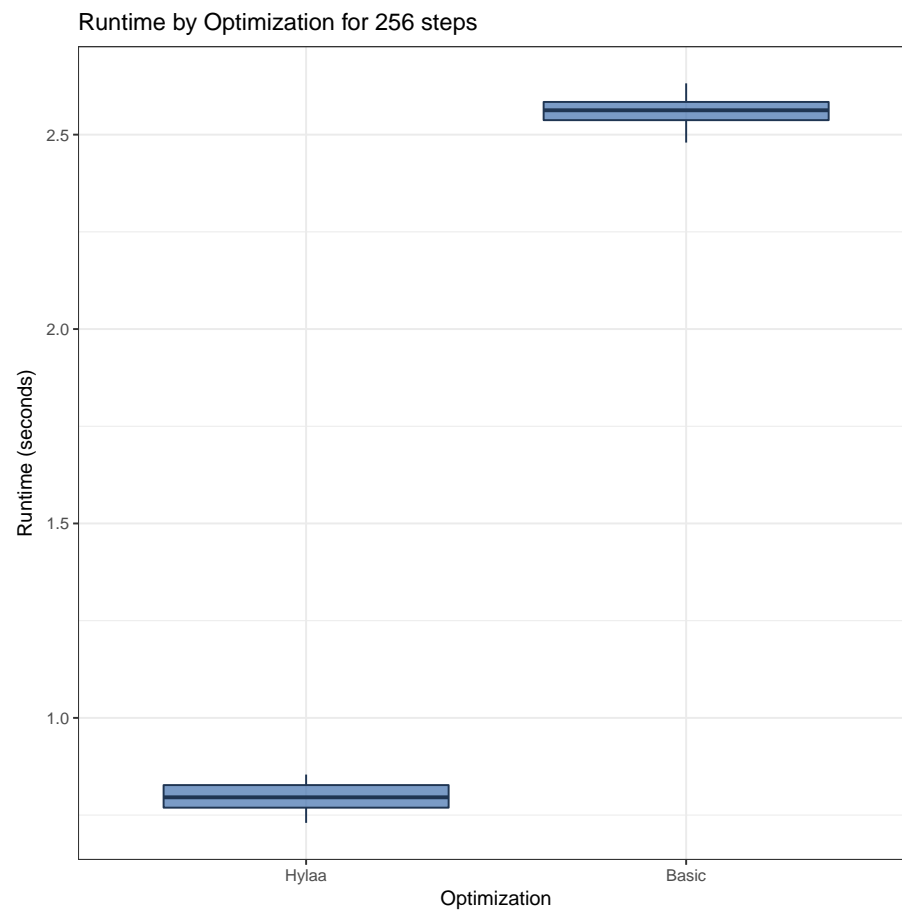
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.7300  0.7691  0.7957  0.7970  0.8271  0.8542
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps256")$time
## W = 0.964, p-value = 0.8303
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.830310406698625"
```

Comparison



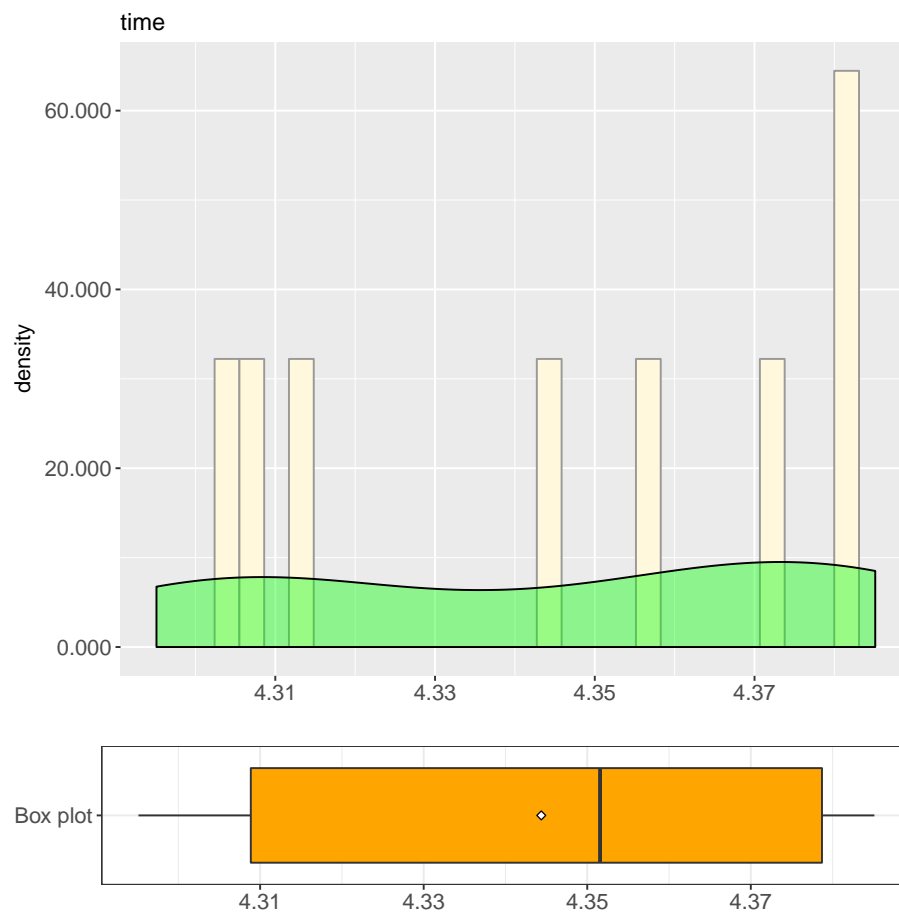
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps256")$time and subset(js
## F = 0.852, num df = 9, denom df = 9, p-value = 0.8153
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.211625 3.430151
## sample estimates:
## ratio of variances
##      0.852001
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.815325324168849"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps256")$time and subset(js
## t = -97.245, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -1.801292 -1.725106
## sample estimates:
## mean of x mean of y
## 0.797033 2.560232
##
## [1] "T-test: Null Hypothesis rejected. P-value: 5.98473083037681e-26"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.79703299999924"
## [1] "Mean Runtime for Basic: 2.560232043267"
## [1] "Absolute difference: 1.7631990432746"
## Runtime for Basic is 221.220331315192 % greater than
## Runtime for Hylaa
```

3.3.10 RH3.10: Object 332 steps

Runtime for Basic

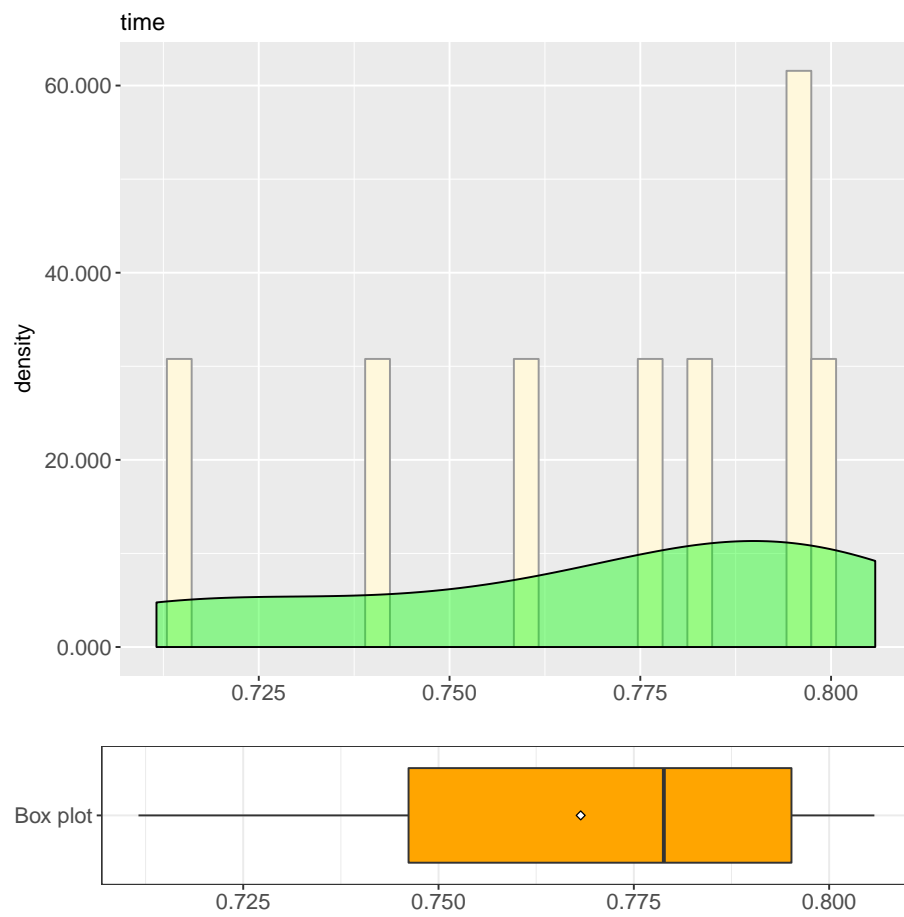
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 4.295 4.309 4.352 4.344 4.379 4.385
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Basic" & object == "steps332")$time
## W = 0.86376, p-value = 0.0845
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0845037588040598"
```

Runtime for Hylaa

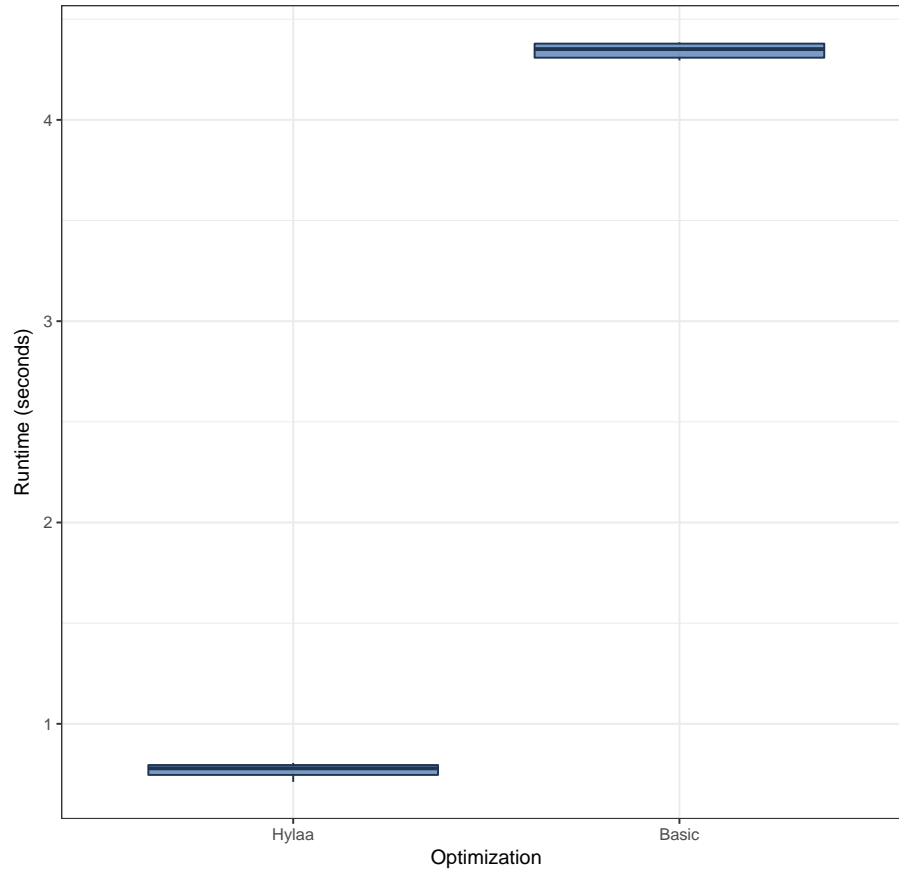
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.7116 0.7462  0.7788  0.7682  0.7952  0.8058
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps332")$time
## W = 0.87995, p-value = 0.1303
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.130315495202675"
```

Comparison

Runtime by Optimization for 332 steps



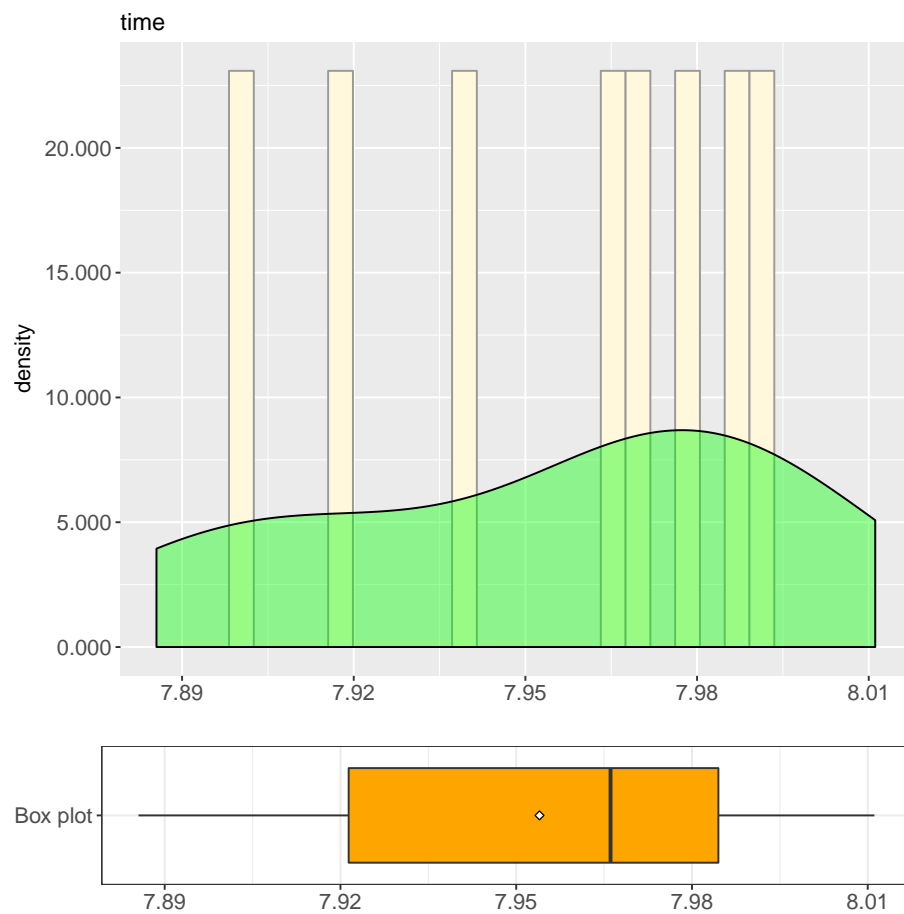
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps332")$time and subset(js
## F = 0.93169, num df = 9, denom df = 9, p-value = 0.9178
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2314186 3.7509786
## sample estimates:
## ratio of variances
##          0.93169
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.917787981425155"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps332")$time and subset(js
## t = -225.72, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -3.609468 -3.542896
## sample estimates:
## mean of x mean of y
## 0.7681974 4.3443795
##
## [1] "T-test: Null Hypothesis rejected. P-value: 1.58557518923748e-32"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7681974172593"
## [1] "Mean Runtime for Basic: 4.344379544259"
## [1] "Absolute difference: 3.5761821269997"
## Runtime for Basic is 465.529048477988 % greater than
## Runtime for Hylaa
```

3.3.11 RH3.11: Object 432 steps

Runtime for Basic

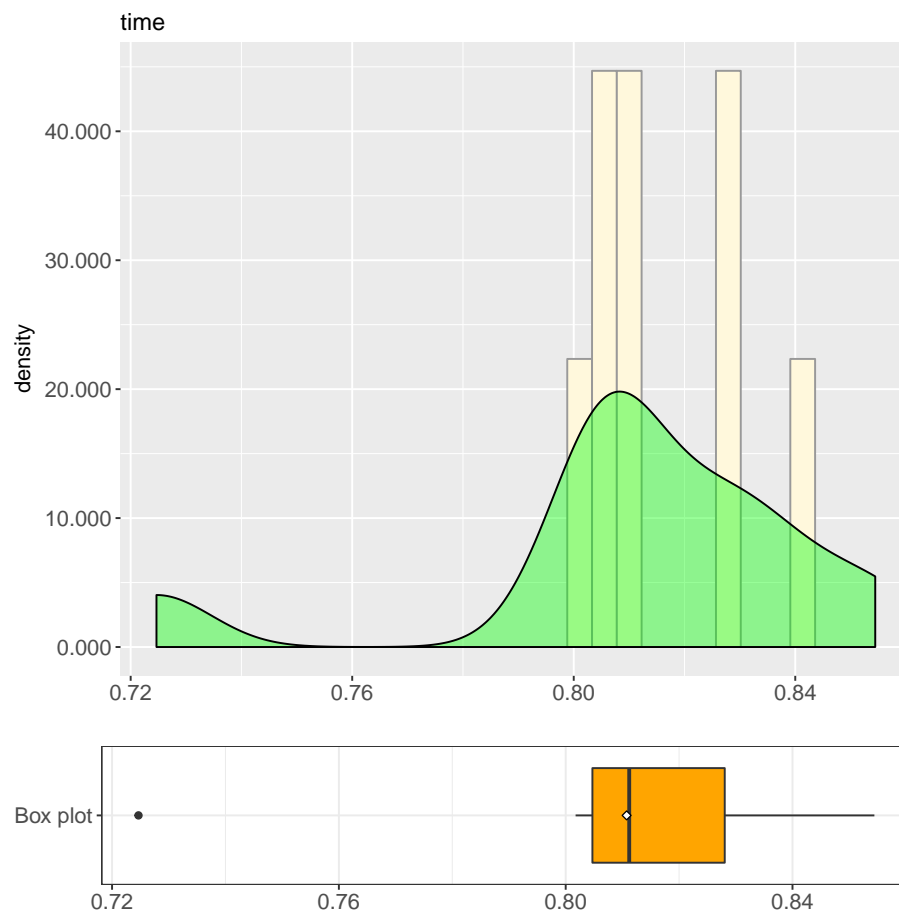
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      7.886   7.921   7.966   7.954   7.985   8.011
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Basic" & object == "steps432")$time
## W = 0.94309, p-value = 0.5879
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.587894017375594"
```

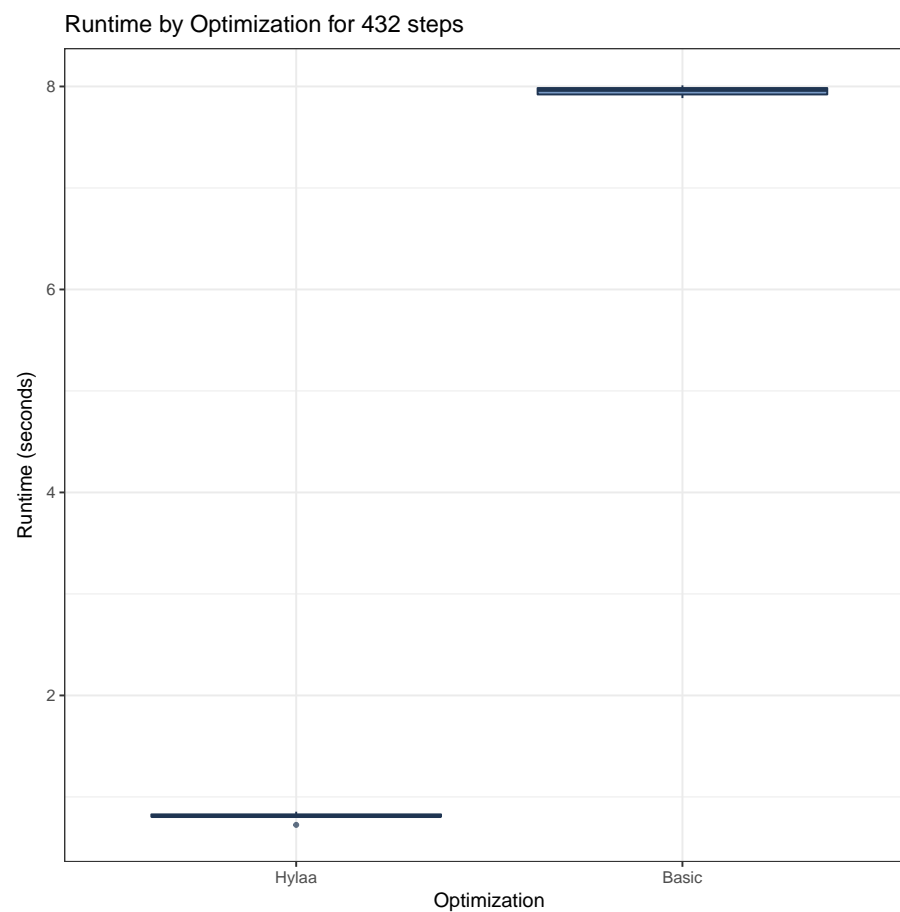
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7247 0.8047 0.8112 0.8107 0.8280 0.8544
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps432")$time
## W = 0.82468, p-value = 0.02887
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.0288658654097958"
```

Comparison



```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 100, p-value = 1.083e-05
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 1.0825088224469e-05"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.8107497930526"
## [1] "Mean Runtime for Basic: 7.953976011278"
## [1] "Absolute difference: 7.1432262182254"
## Runtime for Basic is 881.064204941704 % greater than
## Runtime for Hylaa
```

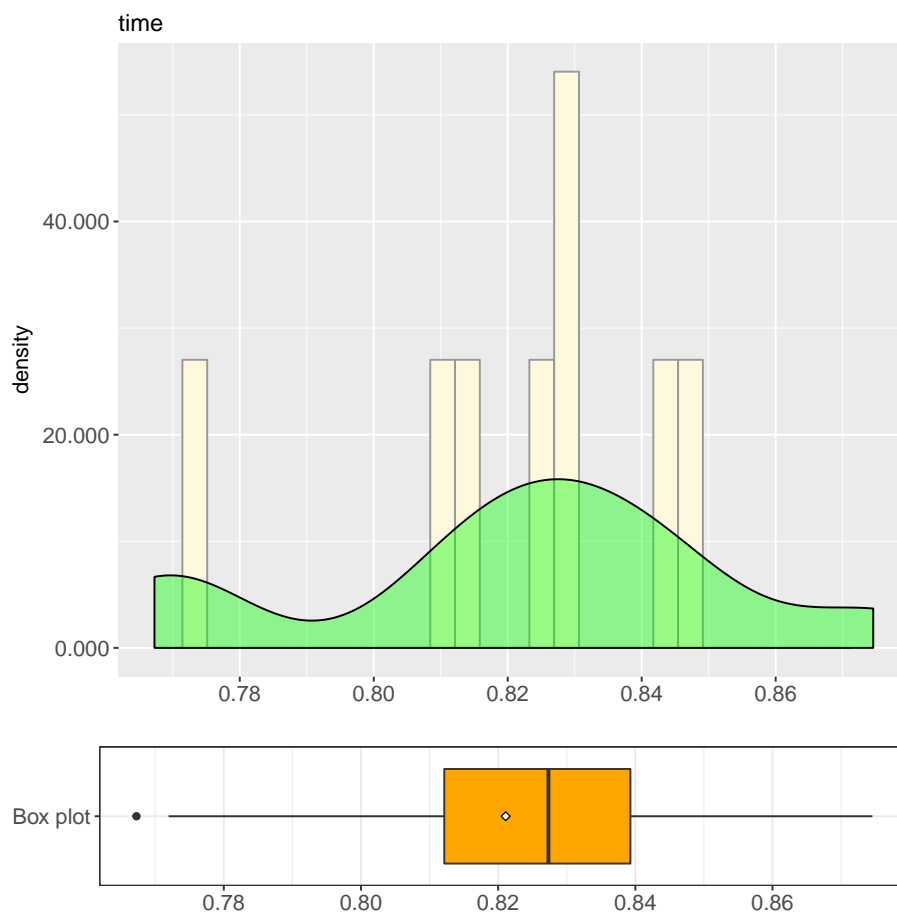
3.3.12 RH3.12: Object 562 steps

Runtime for Basic

```
## [1] "Sample size: 0"  
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's  
##      NA      NA      NA     NaN    NA     NA     10
```

Runtime for Hylaa

```
## [1] "Sample size: 10"  
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
## 0.7673 0.8121 0.8273 0.8211 0.8393 0.8746
```

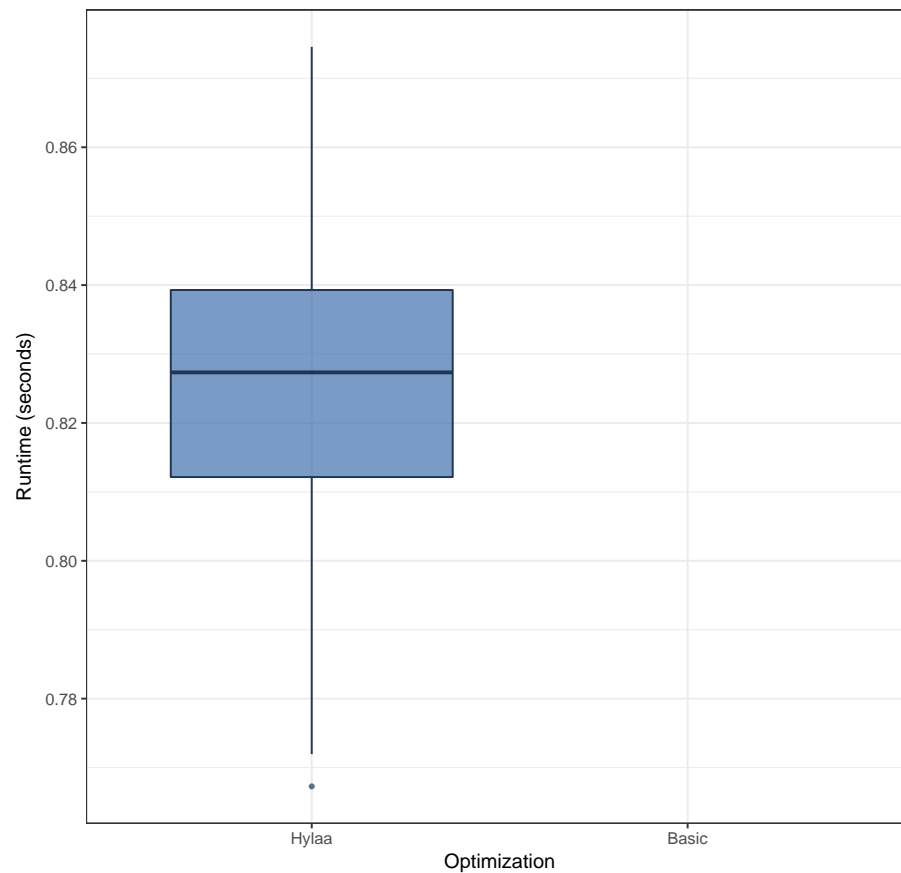


```
##  
## Shapiro-Wilk normality test  
##
```

```
## data: subset(json_data, treatment == "Hylaa" & object == "steps562")$time
## W = 0.93601, p-value = 0.5095
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.509497615860695"
```

Comparison

Runtime by Optimization for 562 steps



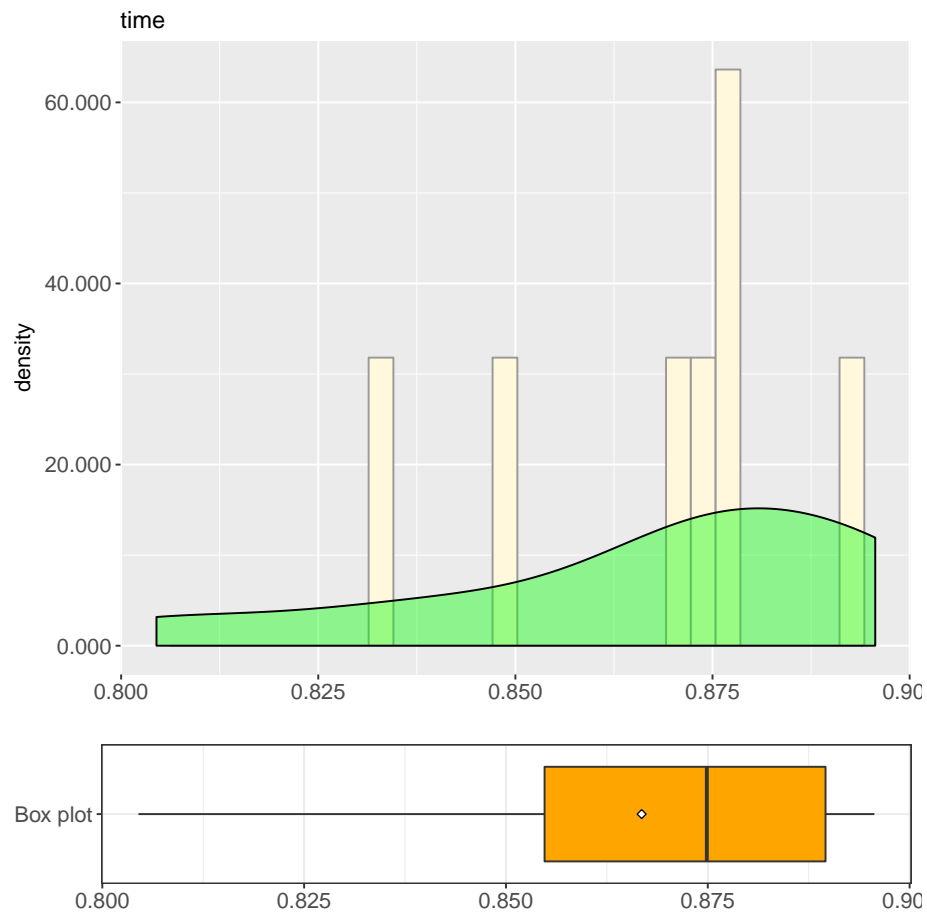
3.3.13 RH3.13: Object 731 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   NA      NA     NA     NaN    NA     NA     10
```

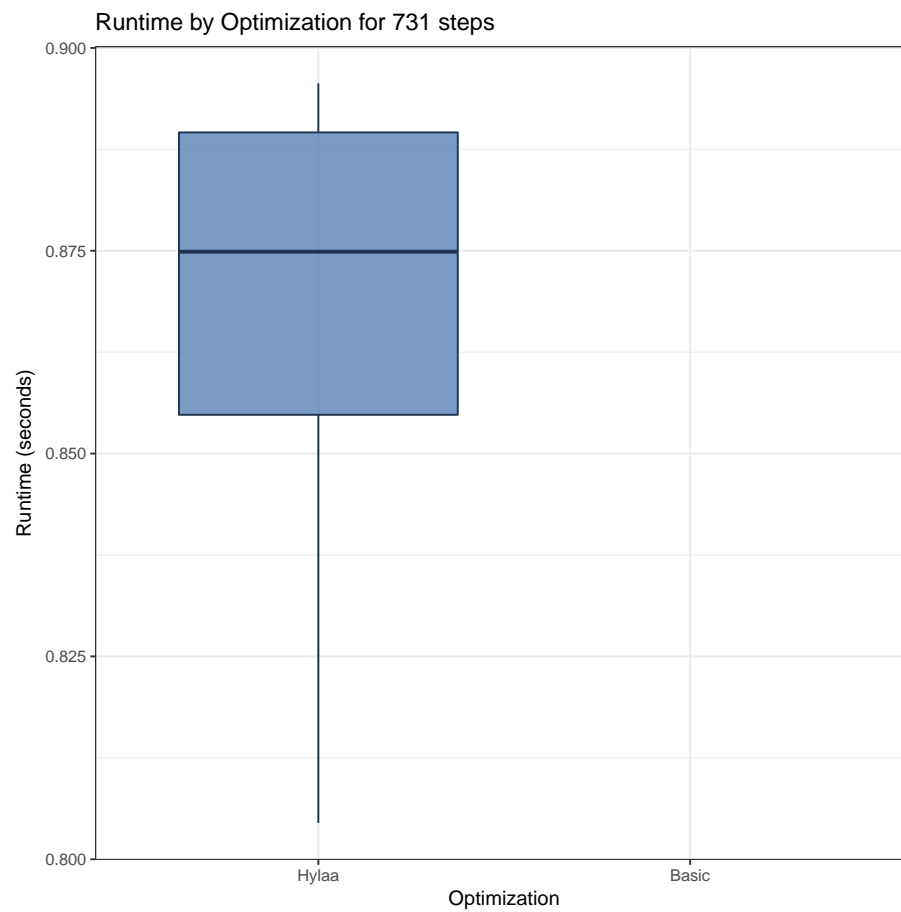
Runtime for Hylaa

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.8045  0.8548  0.8749  0.8668  0.8896  0.8956
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps731")$time
## W = 0.86638, p-value = 0.09069
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0906925091728528"
```

Comparison



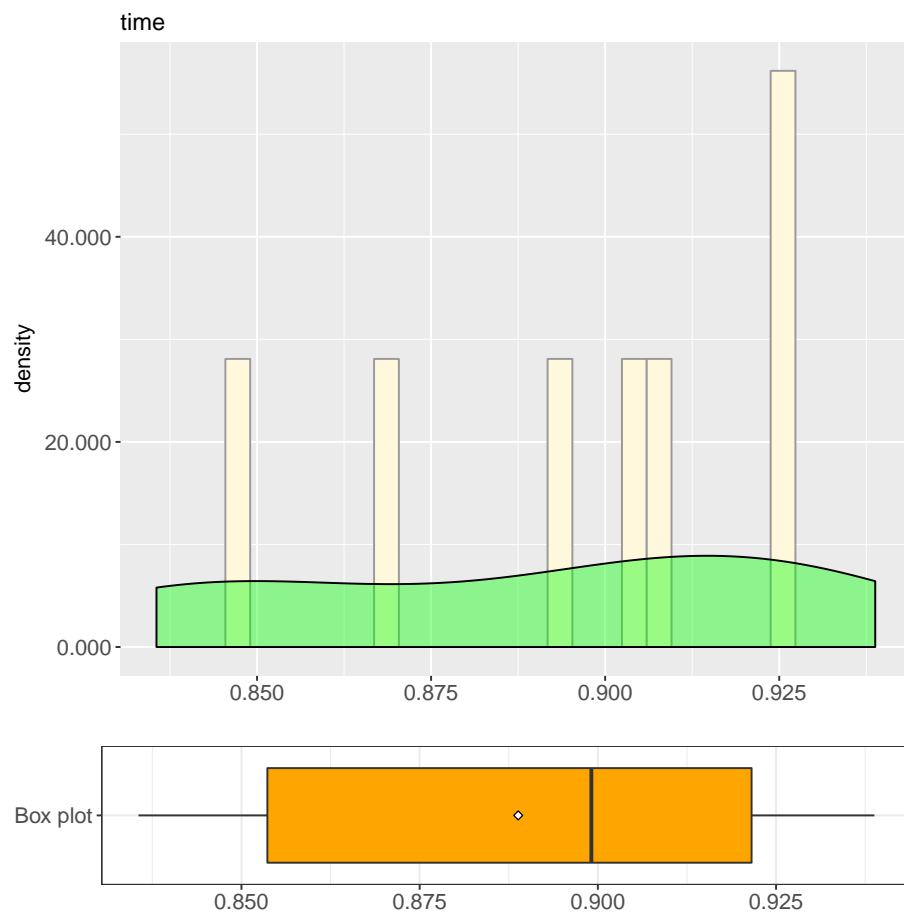
3.3.14 RH3.14: Object 951 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA    10
```

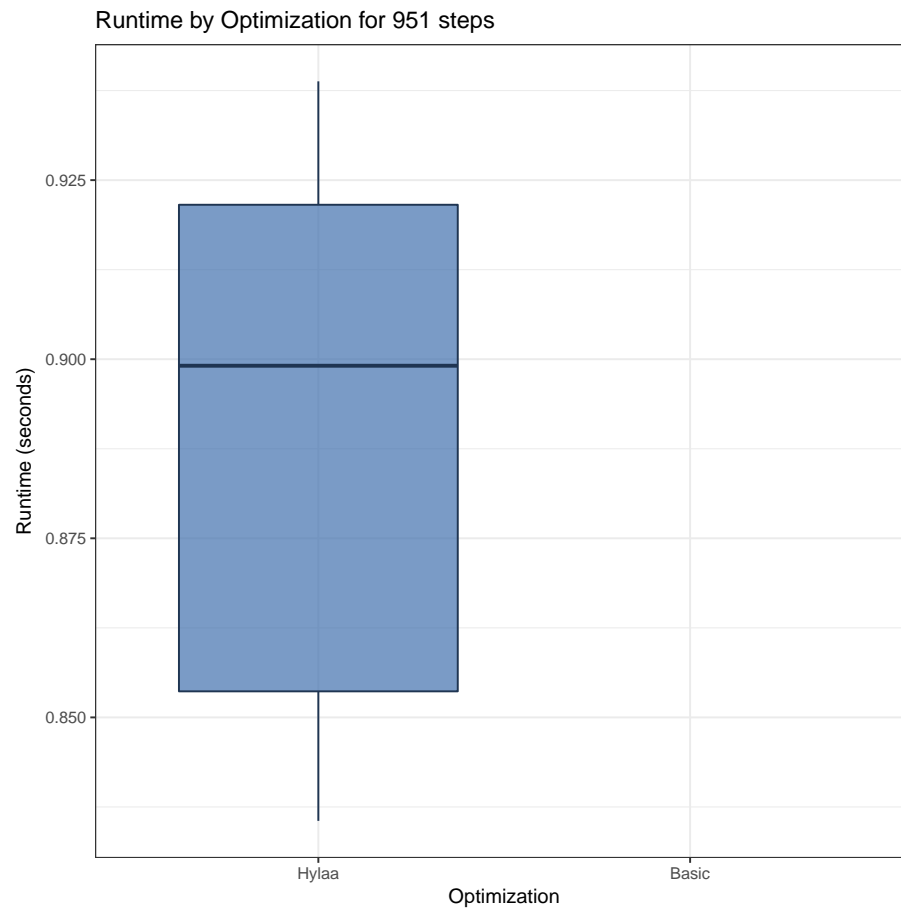
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.8356 0.8536 0.8991 0.8888 0.9216 0.9388
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps951")$time
## W = 0.90483, p-value = 0.2474
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.247358608075924"
```

Comparison



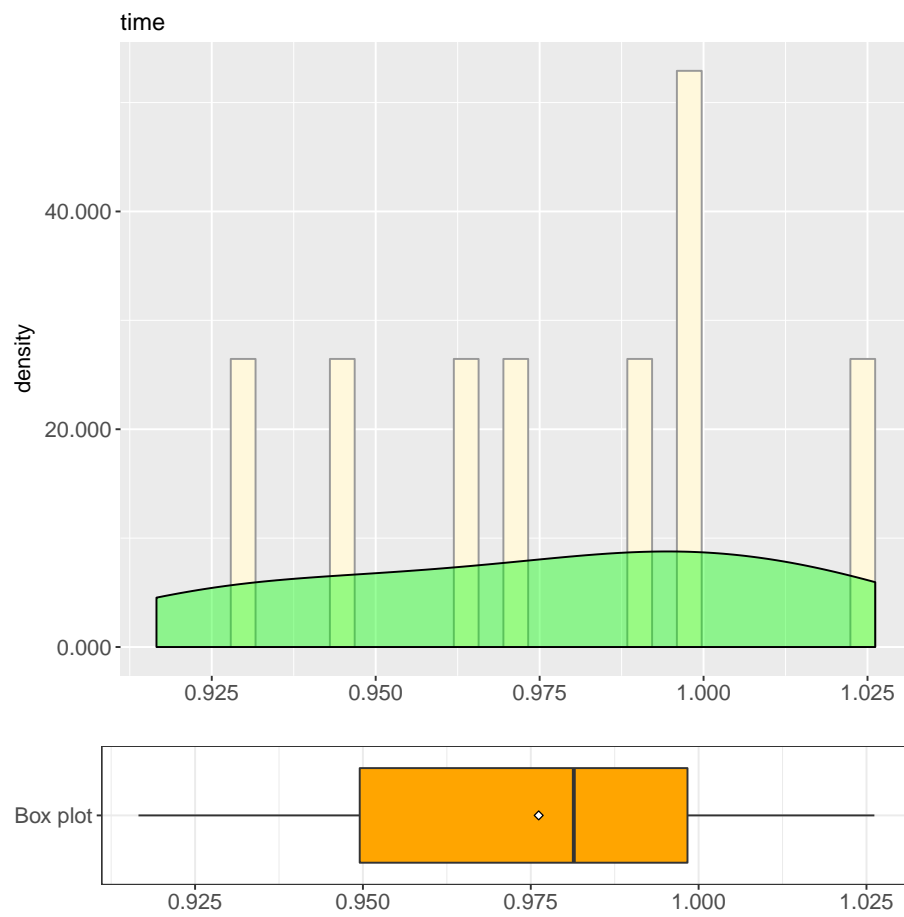
3.3.15 RH3.15: Object 1236 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA    10
```

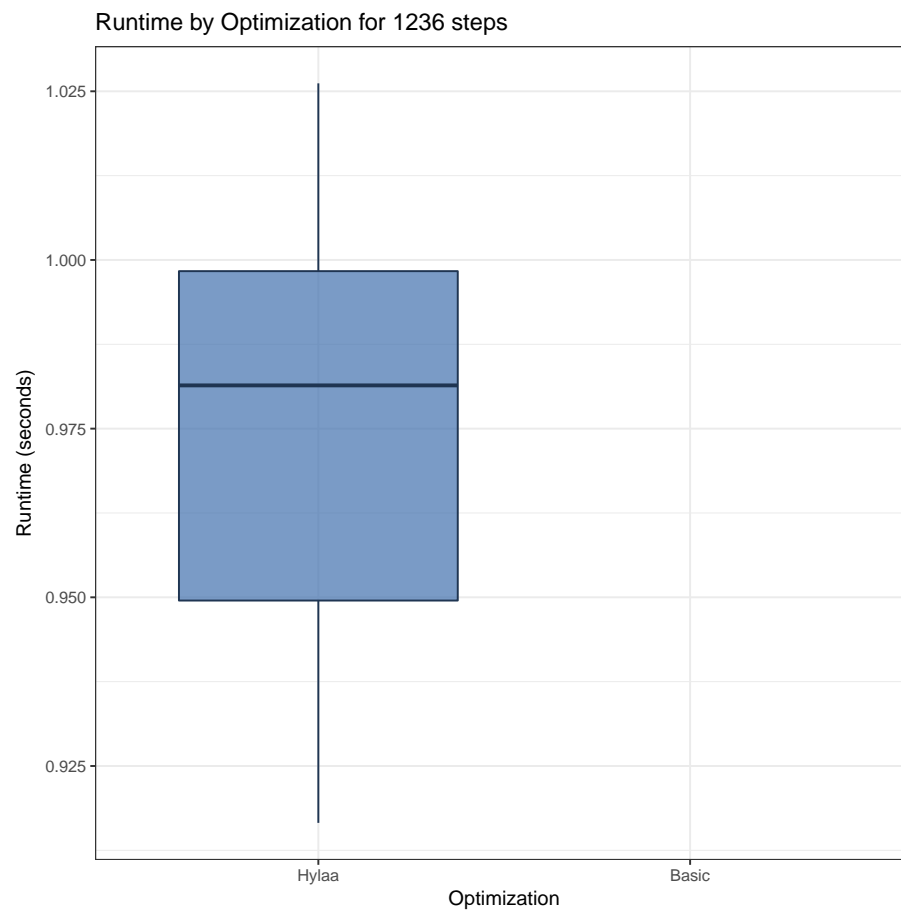
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.9166 0.9495 0.9814 0.9762 0.9983 1.0260
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps1236")$time
## W = 0.94652, p-value = 0.6275
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.627527133287823"
```

Comparison



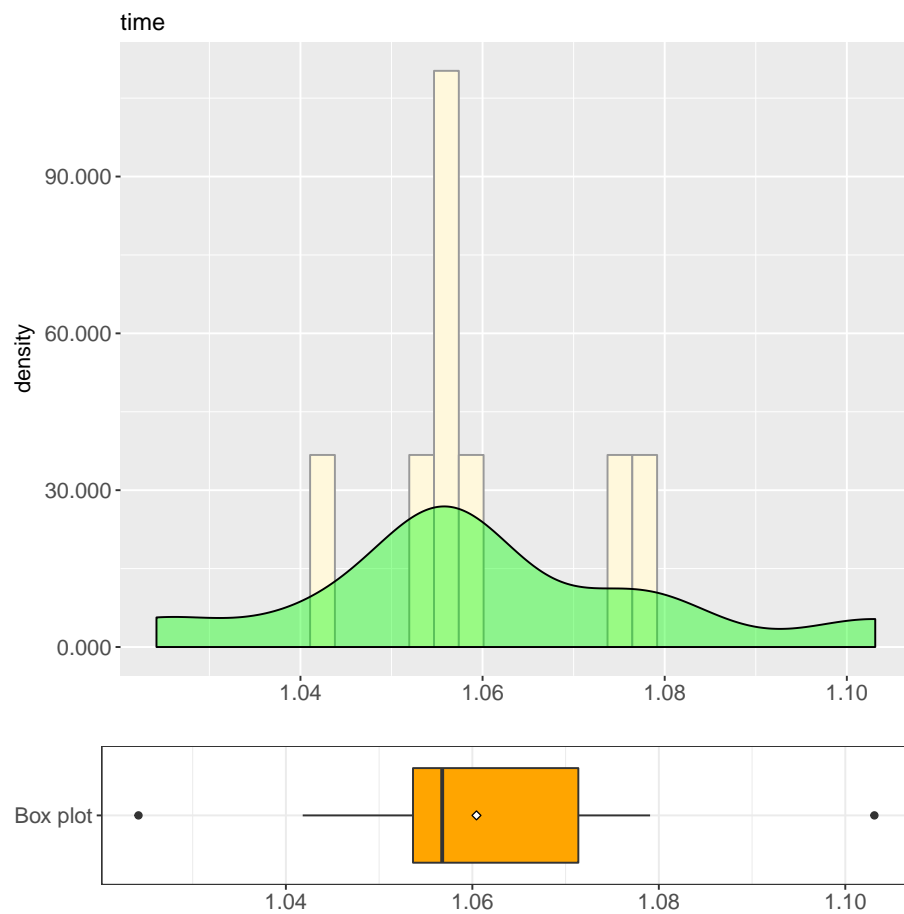
3.3.16 RH3.16: Object 1607 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA     NA    10
```

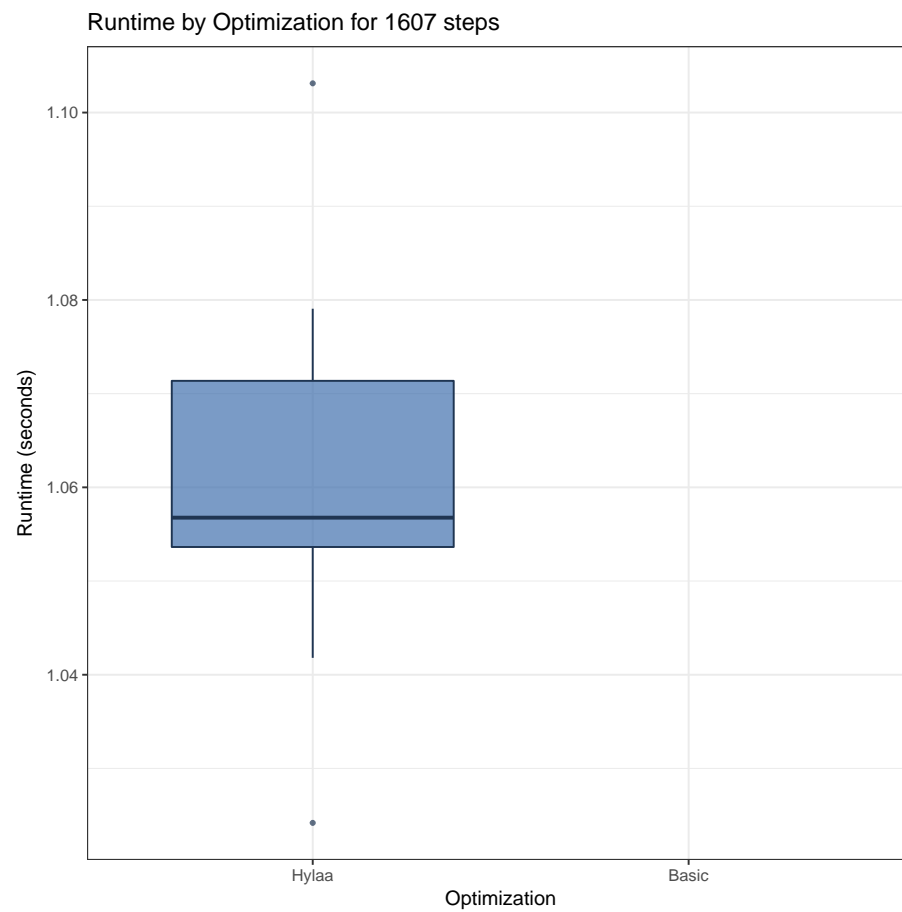
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  1.024  1.054  1.057  1.060  1.071  1.103
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps1607")$time
## W = 0.9449, p-value = 0.6087
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.608652897163905"
```

Comparison



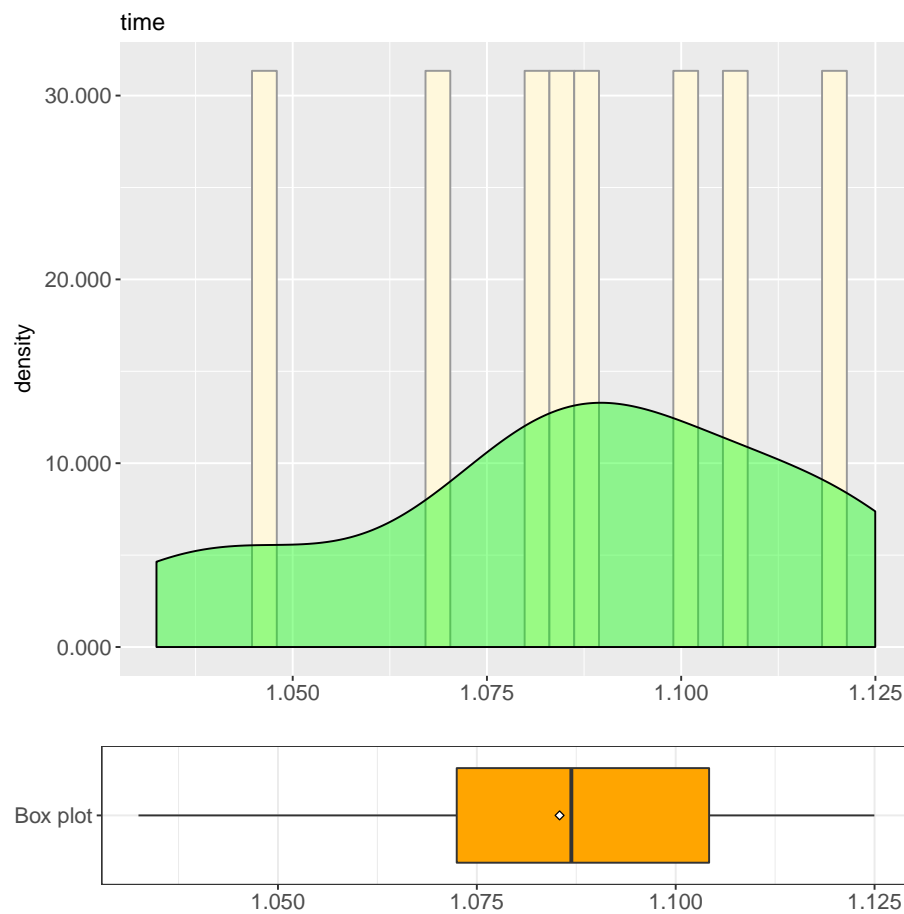
3.3.17 RH3.17: Object 2089 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA     10
```

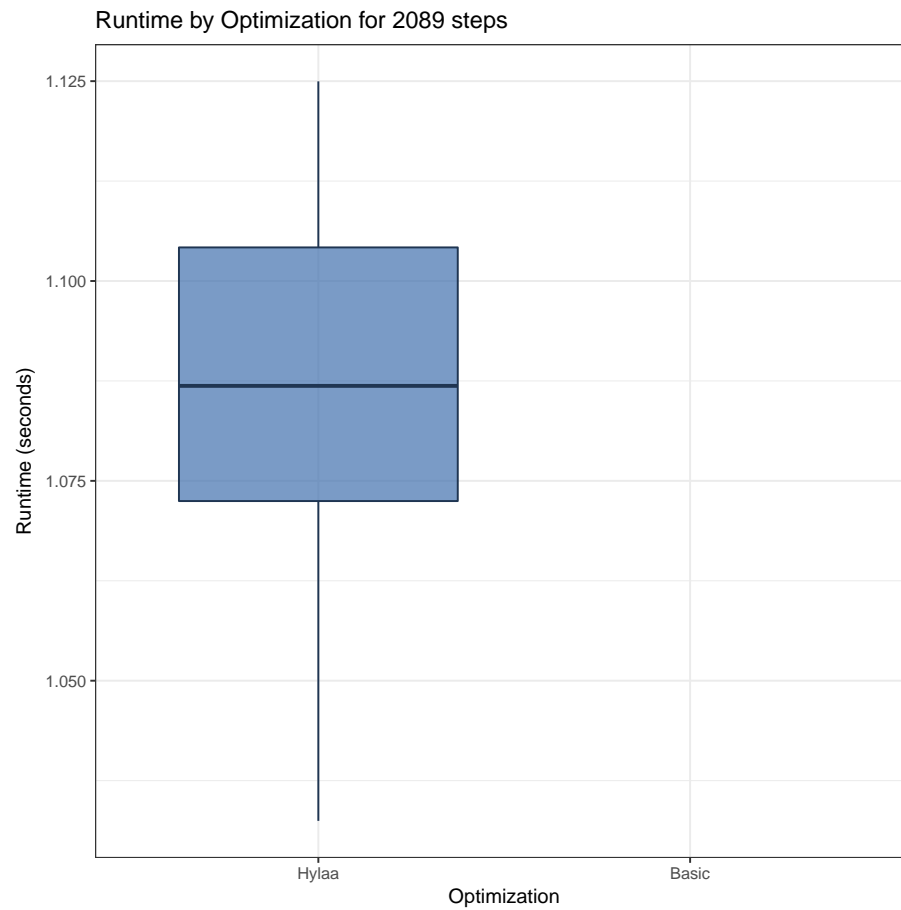
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  1.032  1.072  1.087  1.085  1.104  1.125
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps2089")$time
## W = 0.96099, p-value = 0.7971
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.797065263315739"
```

Comparison



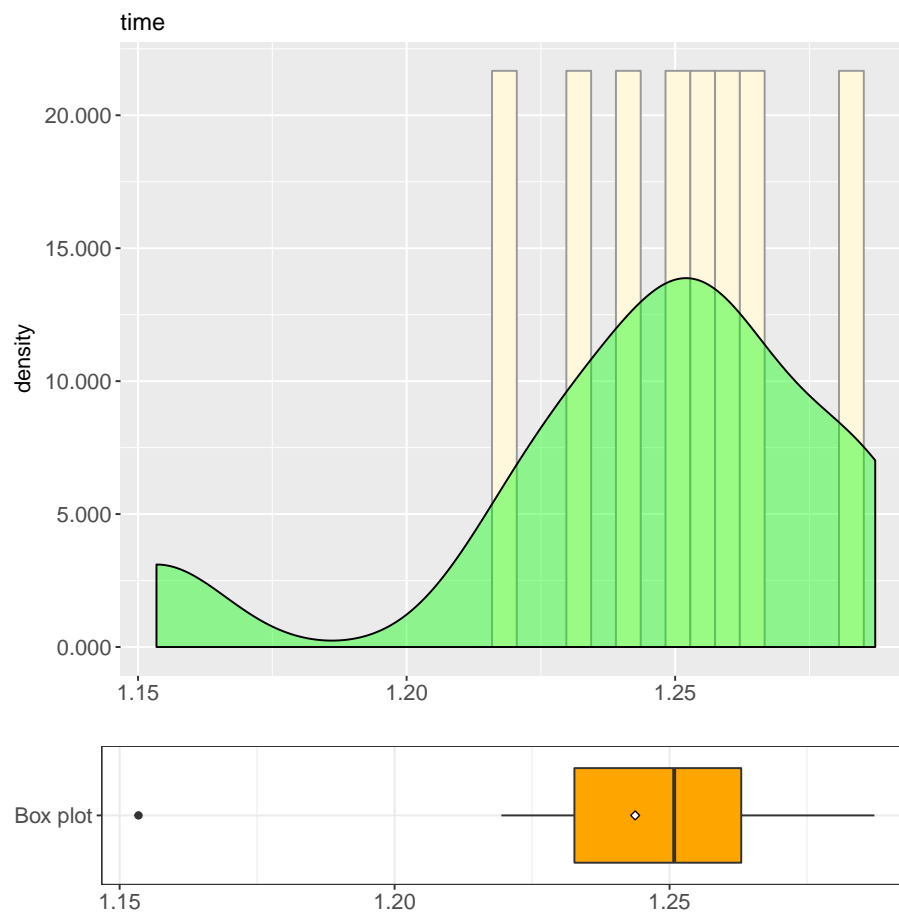
3.3.18 RH3.18: Object 2716 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.  Max.   NA's
##    NA      NA     NA     NaN    NA     NA    10
```

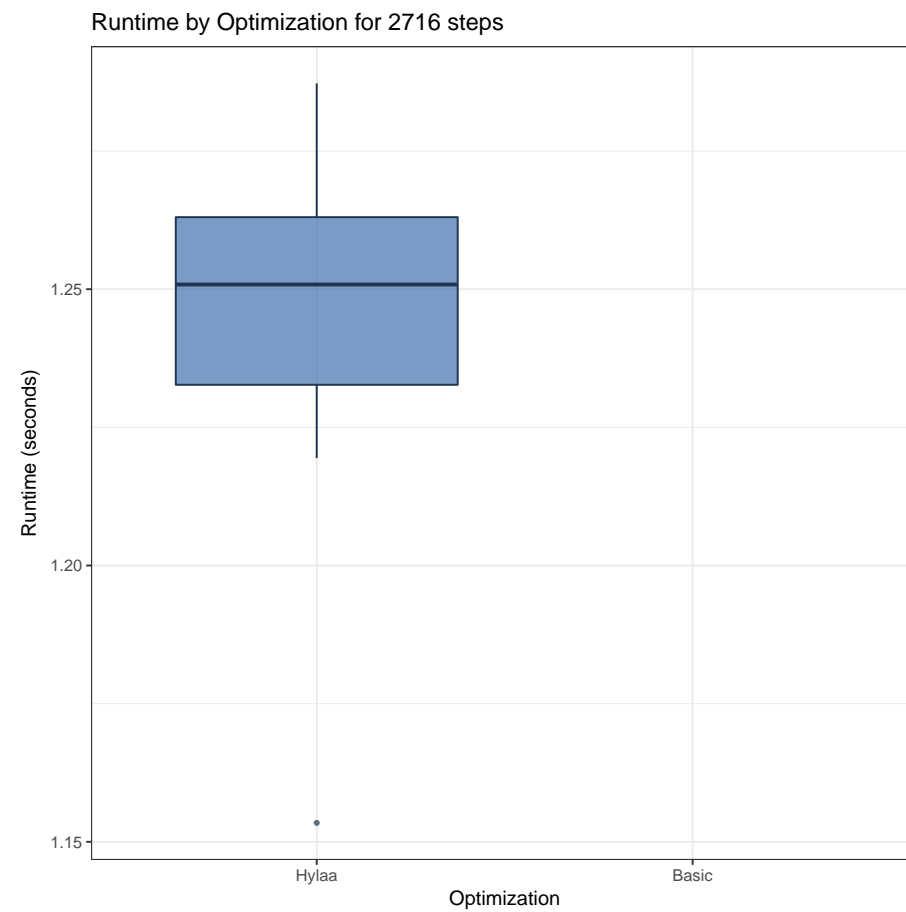
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.  Max.
##  1.153  1.233  1.251  1.244  1.263  1.287
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps2716")$time
## W = 0.87909, p-value = 0.1274
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.12738118267151"
```

Comparison



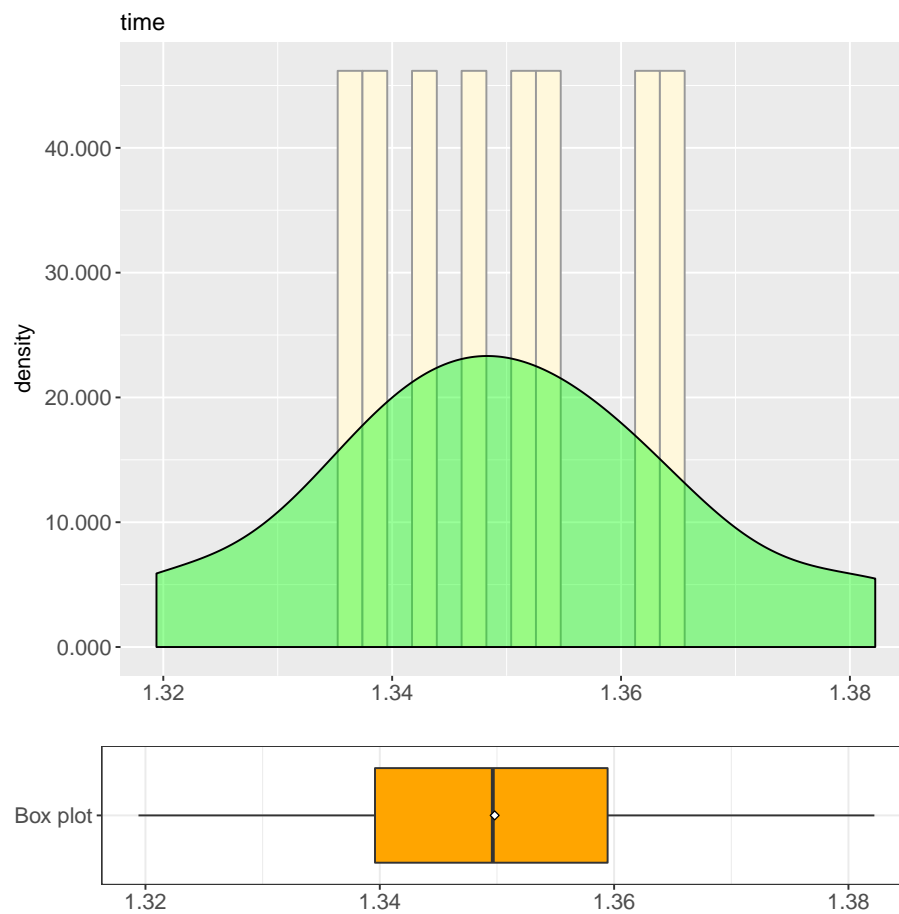
3.3.19 RH3.19: Object 3531 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA    10
```

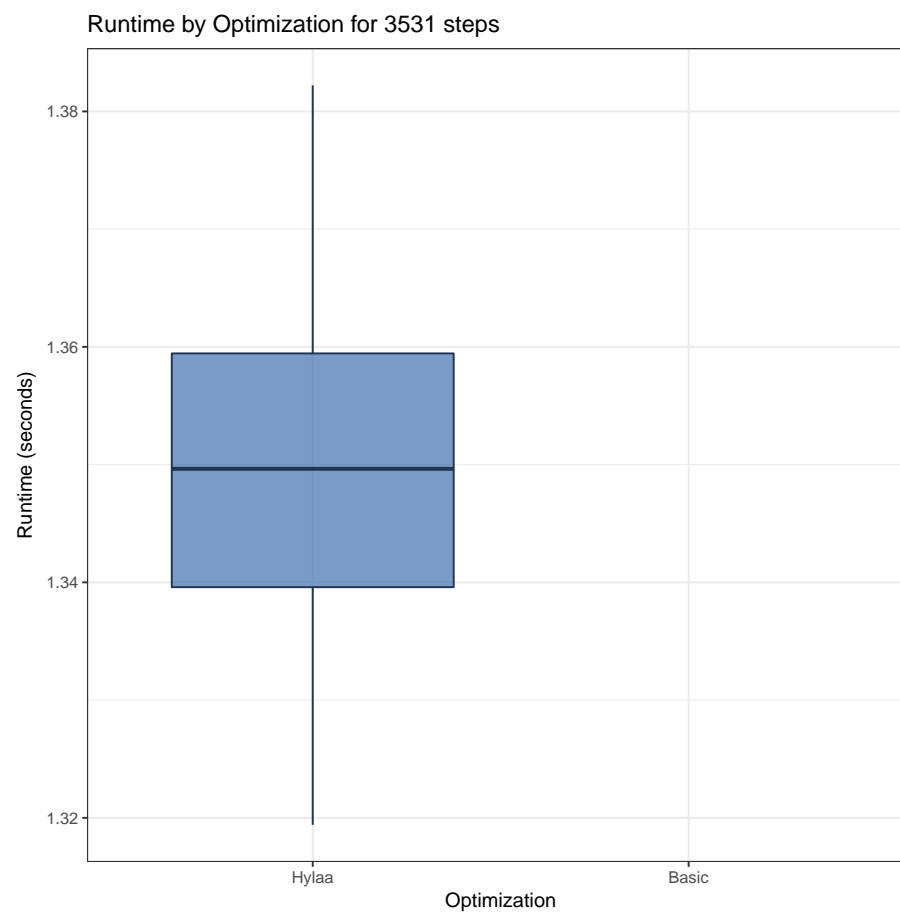
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  1.319  1.340  1.350  1.350  1.359  1.382
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps3531")$time
## W = 0.98776, p-value = 0.9933
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.993277943776764"
```

Comparison



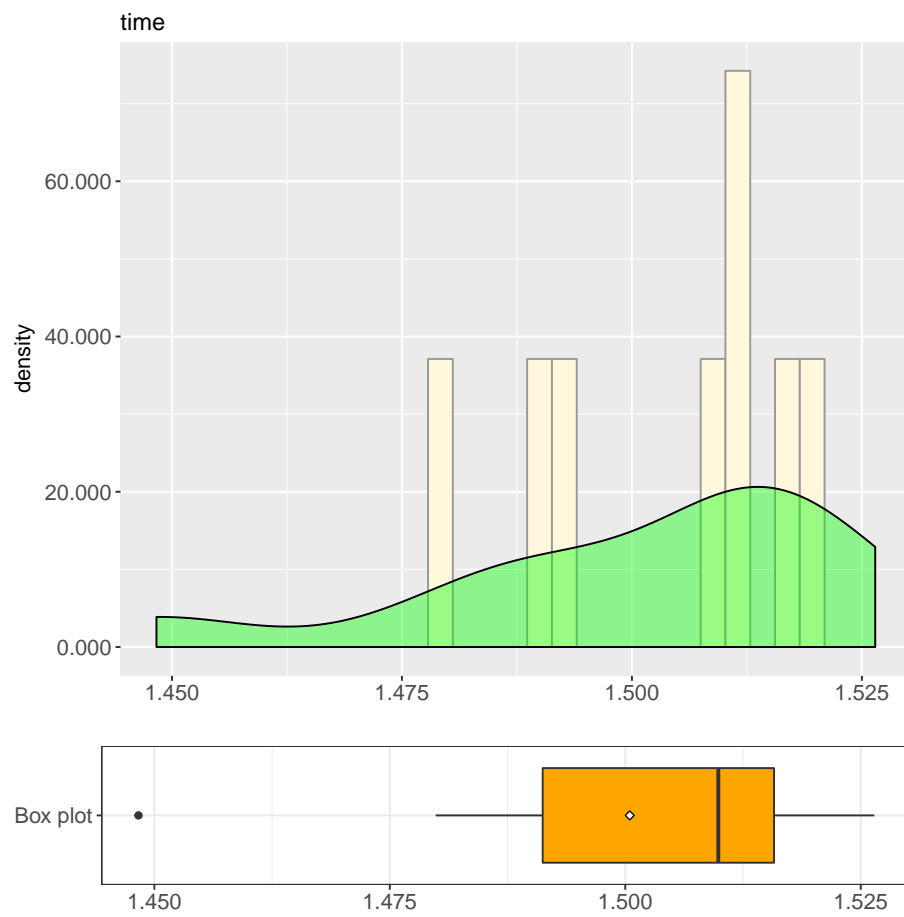
3.3.20 RH3.20: Object 4590 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA    10
```

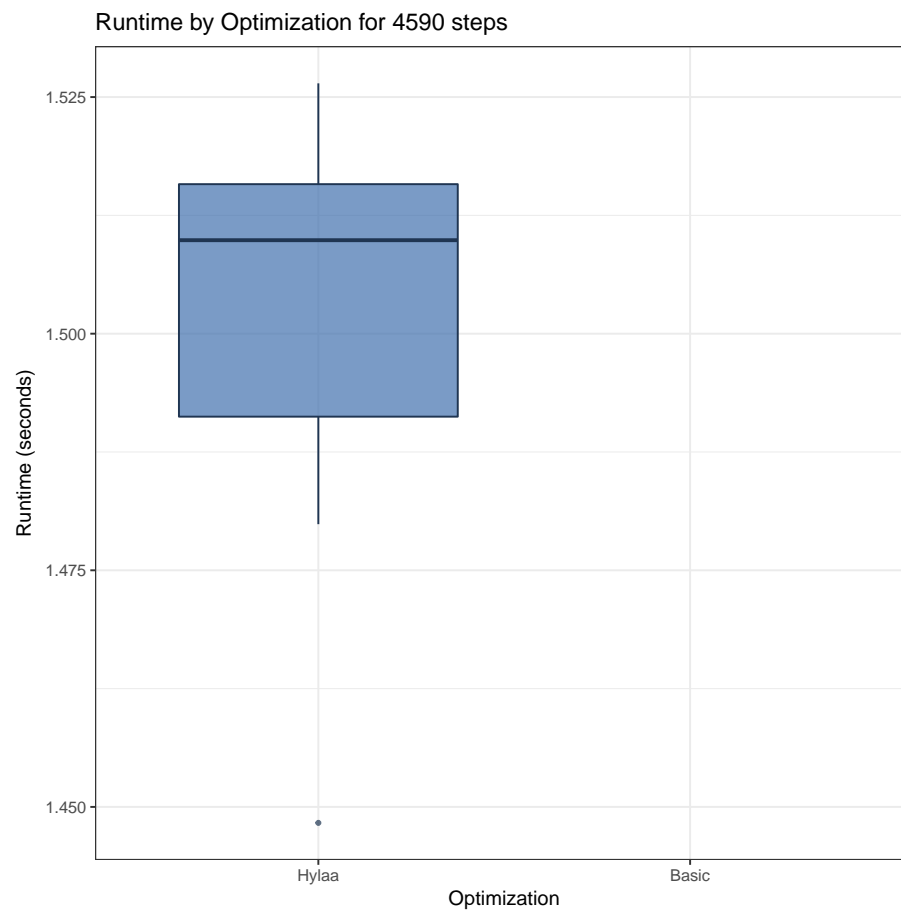
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  1.448  1.491  1.510  1.500  1.516  1.526
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps4590")$time
## W = 0.88116, p-value = 0.1346
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.134566691717643"
```

Comparison



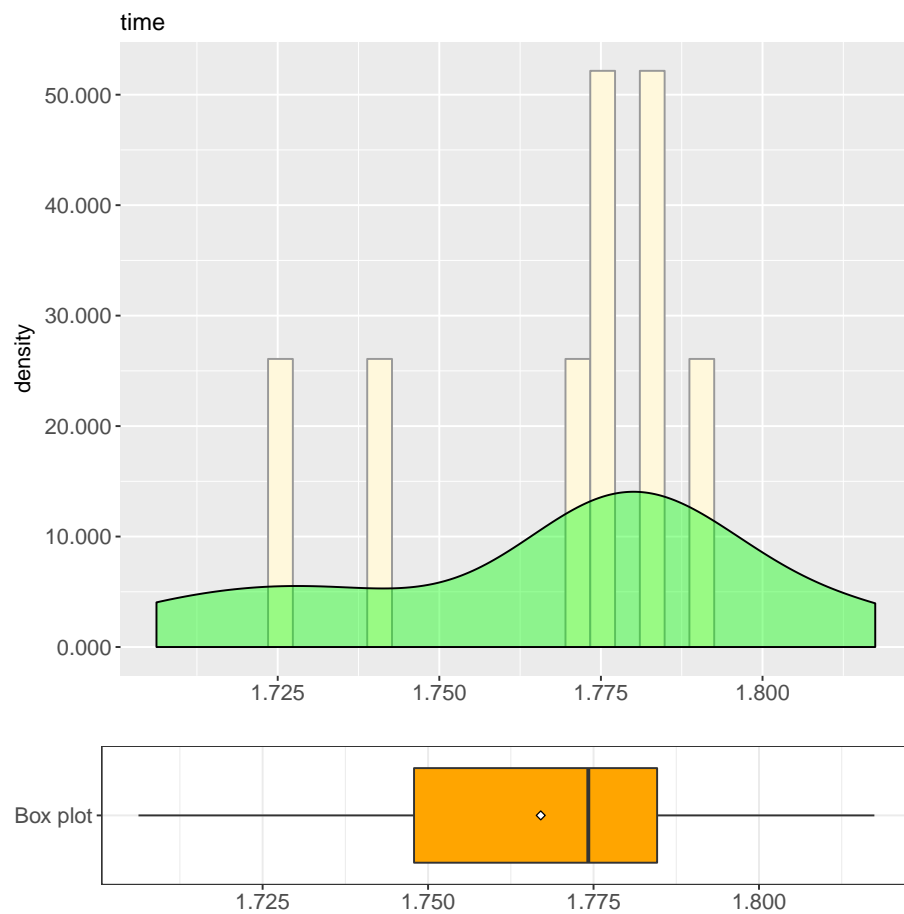
3.3.21 RH3.21: Object 5967 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA    10
```

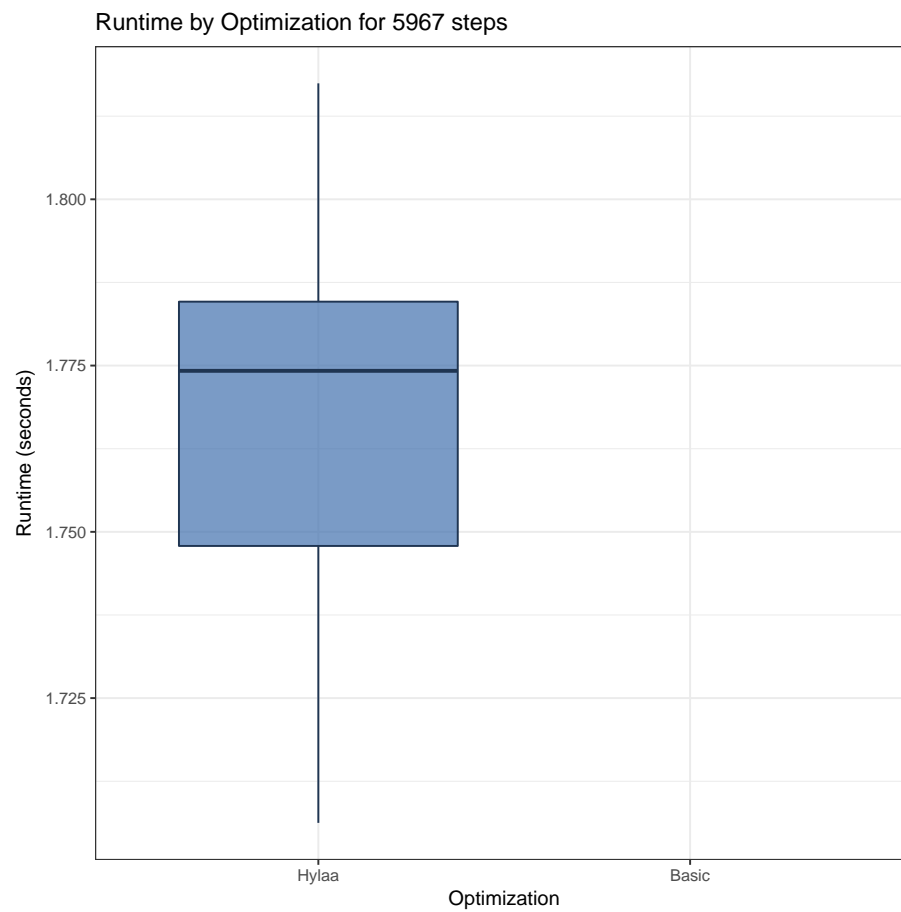
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  1.706  1.748  1.774  1.767  1.785  1.817
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps5967")$time
## W = 0.93205, p-value = 0.4683
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.468324949837865"
```

Comparison



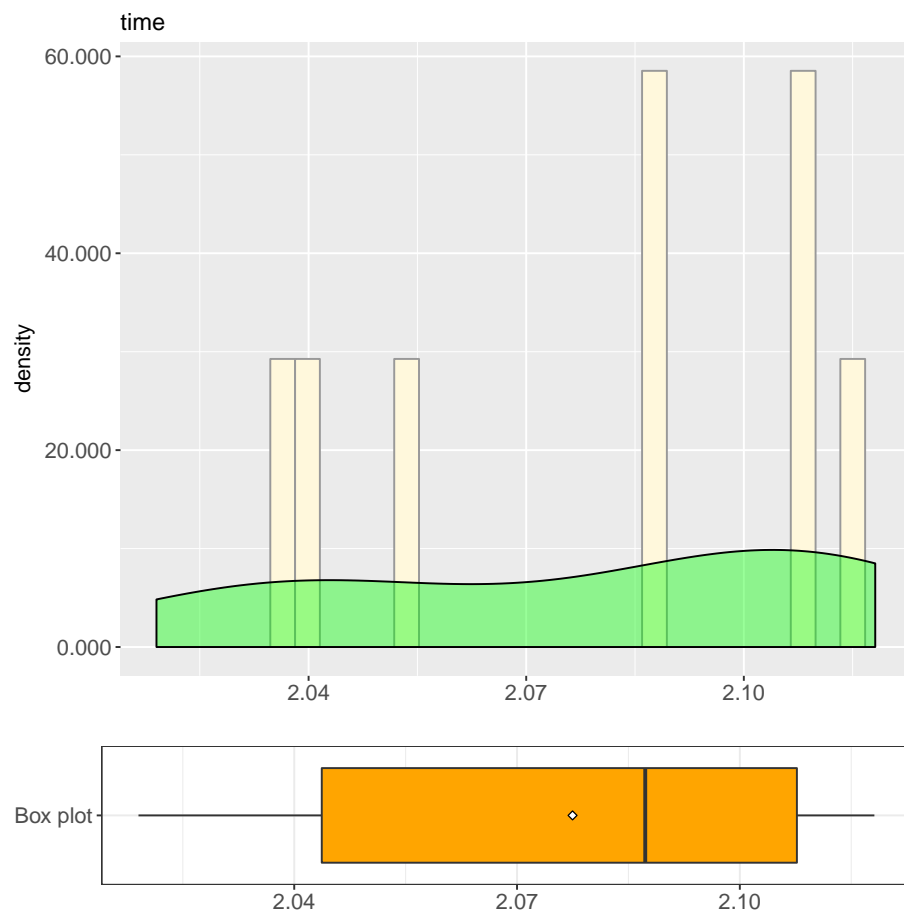
3.3.22 RH3.22: Object 7757 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA    10
```

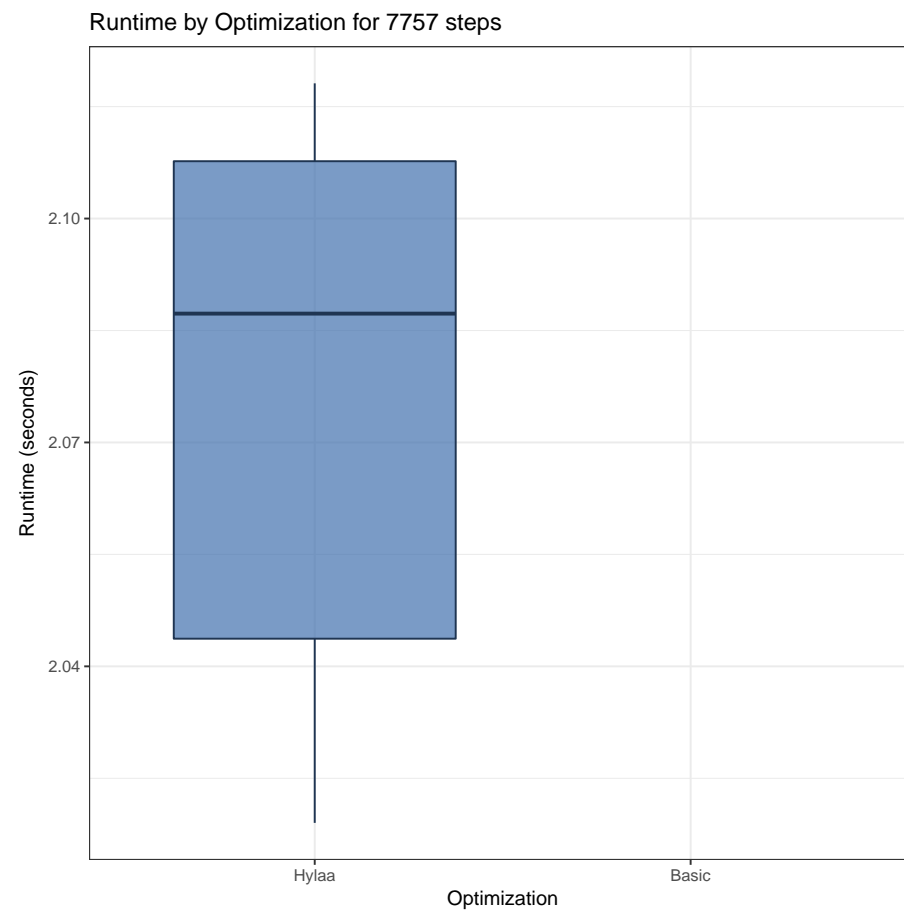
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  2.019  2.044  2.087  2.077  2.108  2.118
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps7757")$time
## W = 0.89136, p-value = 0.1756
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.175640560398436"
```

Comparison



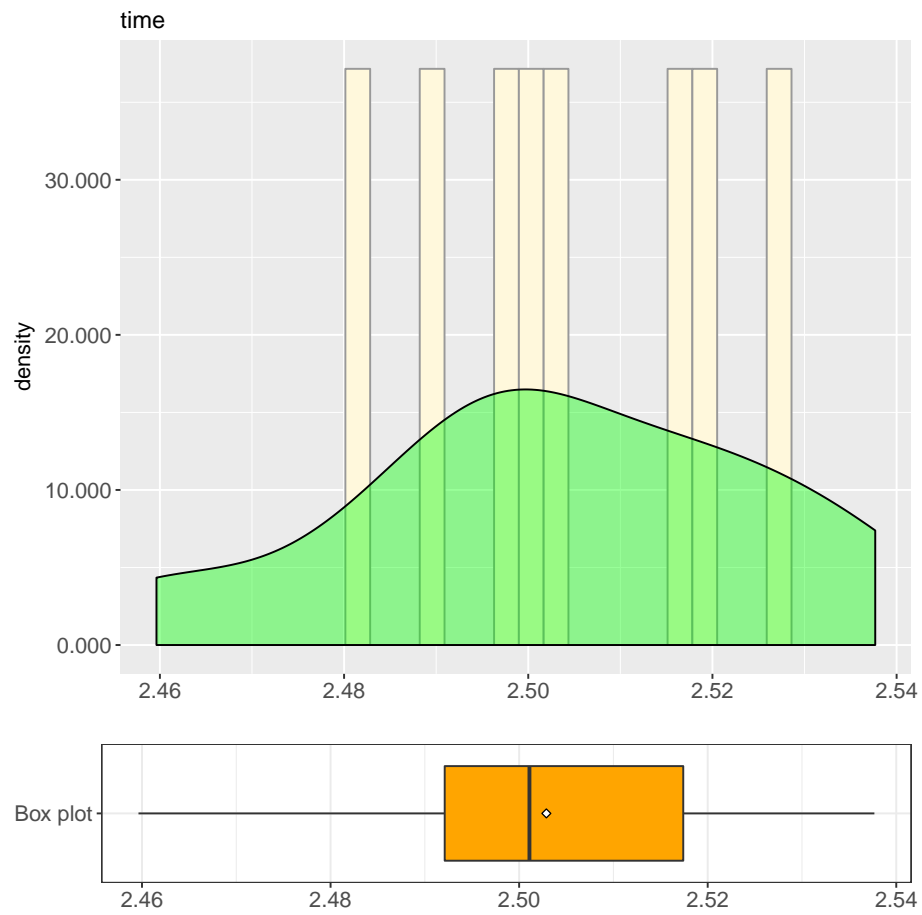
3.3.23 RH3.23: Object 10085 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    NA      NA     NA     NaN    NA      NA     10
```

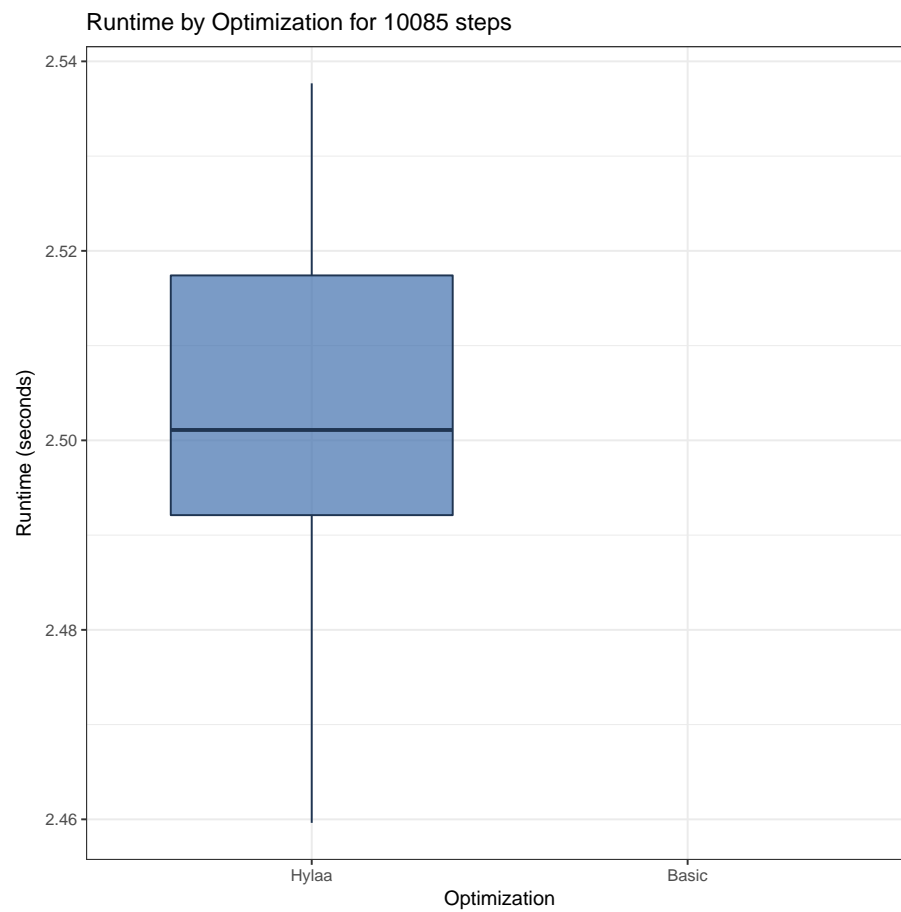
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  2.460  2.492  2.501  2.503  2.517  2.538
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps10085")$time
## W = 0.98381, p-value = 0.9823
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.982277067638566"
```

Comparison



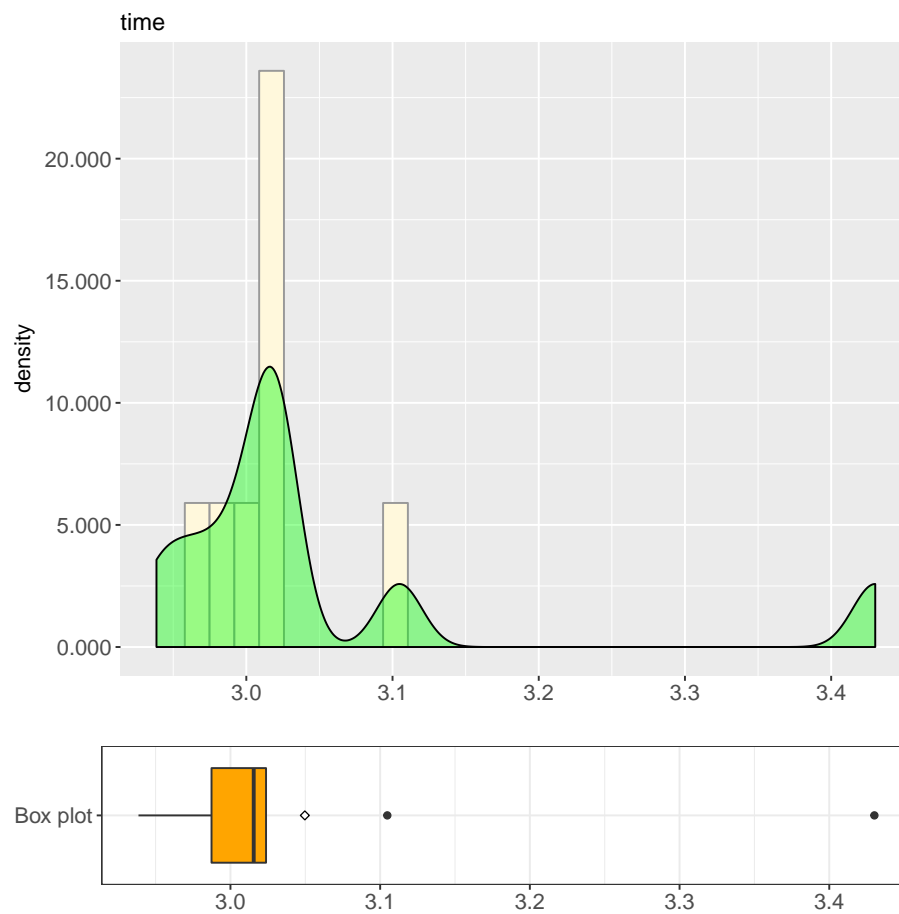
3.3.24 RH3.24: Object 13110 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    NA      NA     NA     NaN    NA      NA      10
```

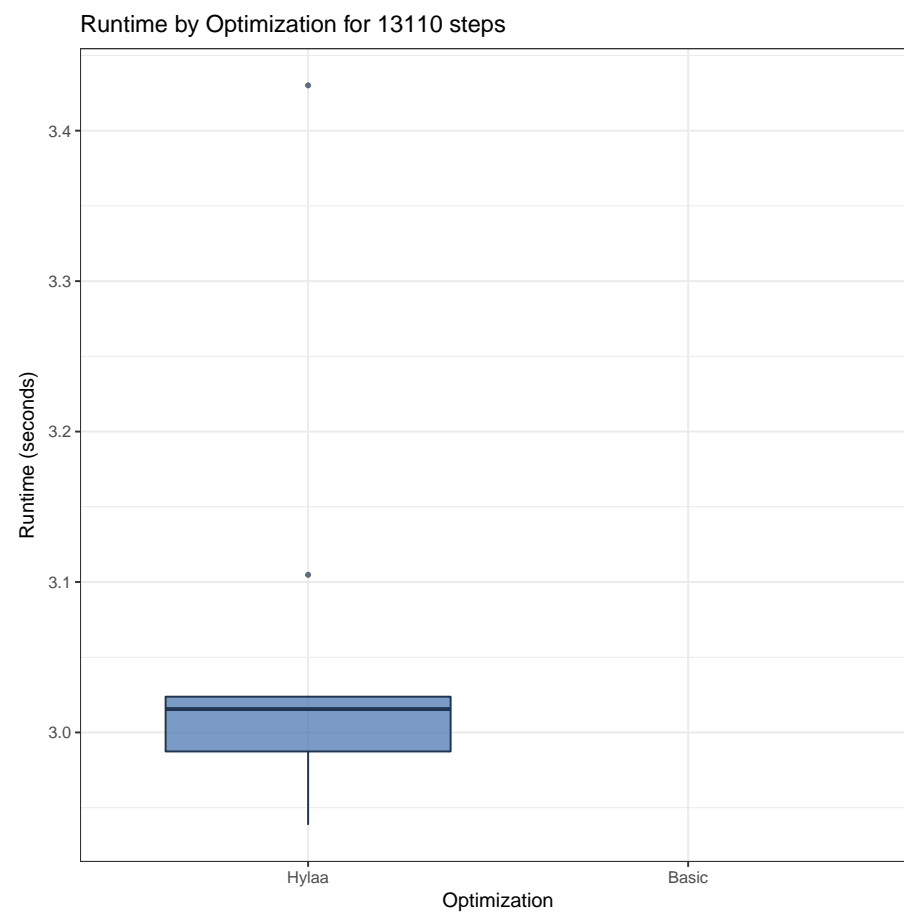
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  2.939  2.987  3.016  3.050  3.024  3.430
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps13110")$time
## W = 0.65237, p-value = 0.0002343
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.000234335774565787"
```

Comparison



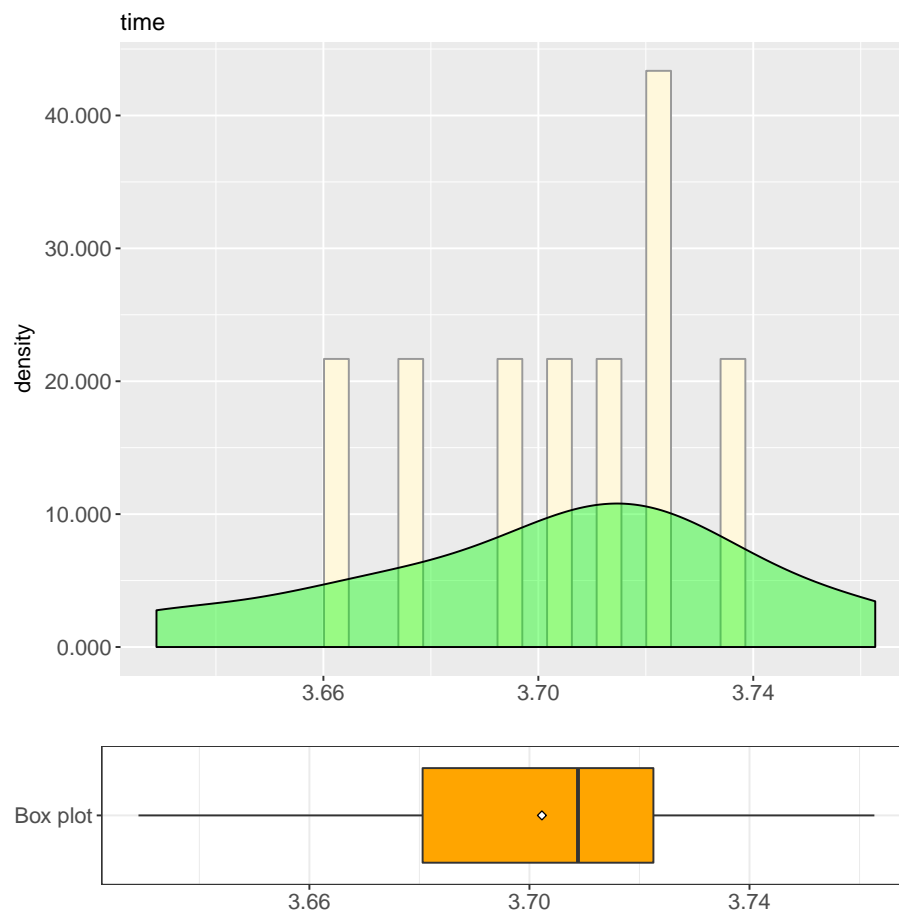
3.3.25 RH3.25: Object 17043 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.  Max.    NA's
##    NA      NA     NA     NaN    NA     NA     10
```

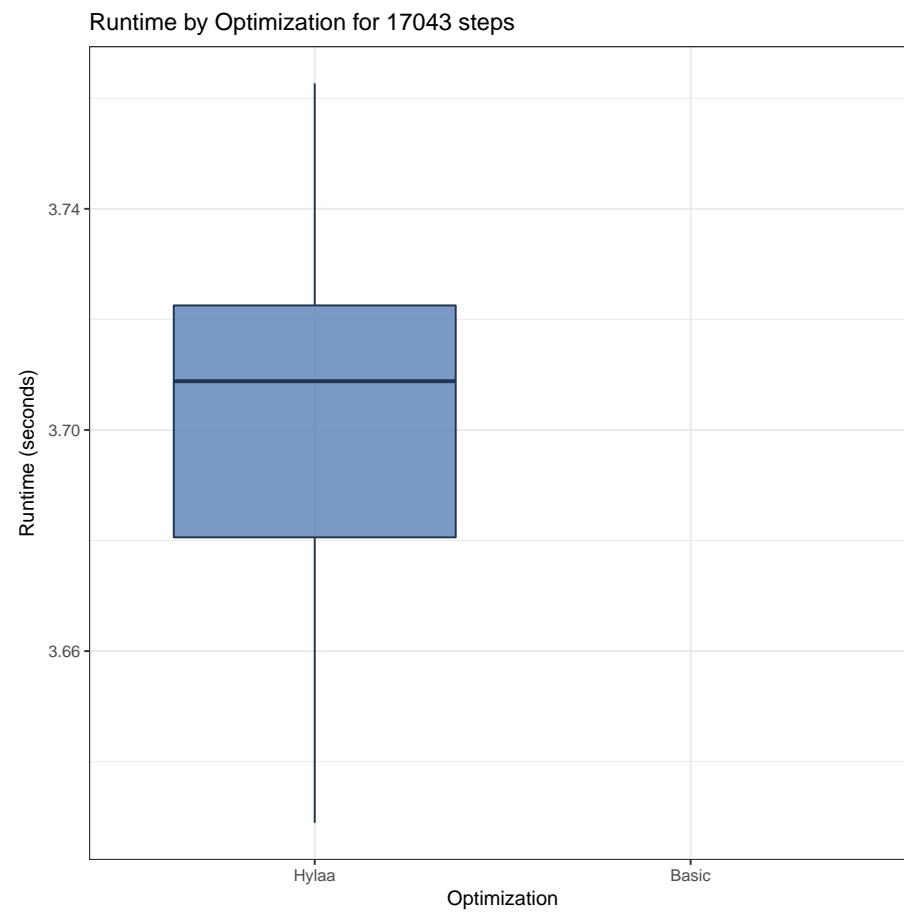
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.  Max.
##  3.629  3.681  3.709  3.702  3.723  3.763
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps17043")$time
## W = 0.97882, p-value = 0.9585
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.958546785330543"
```

Comparison



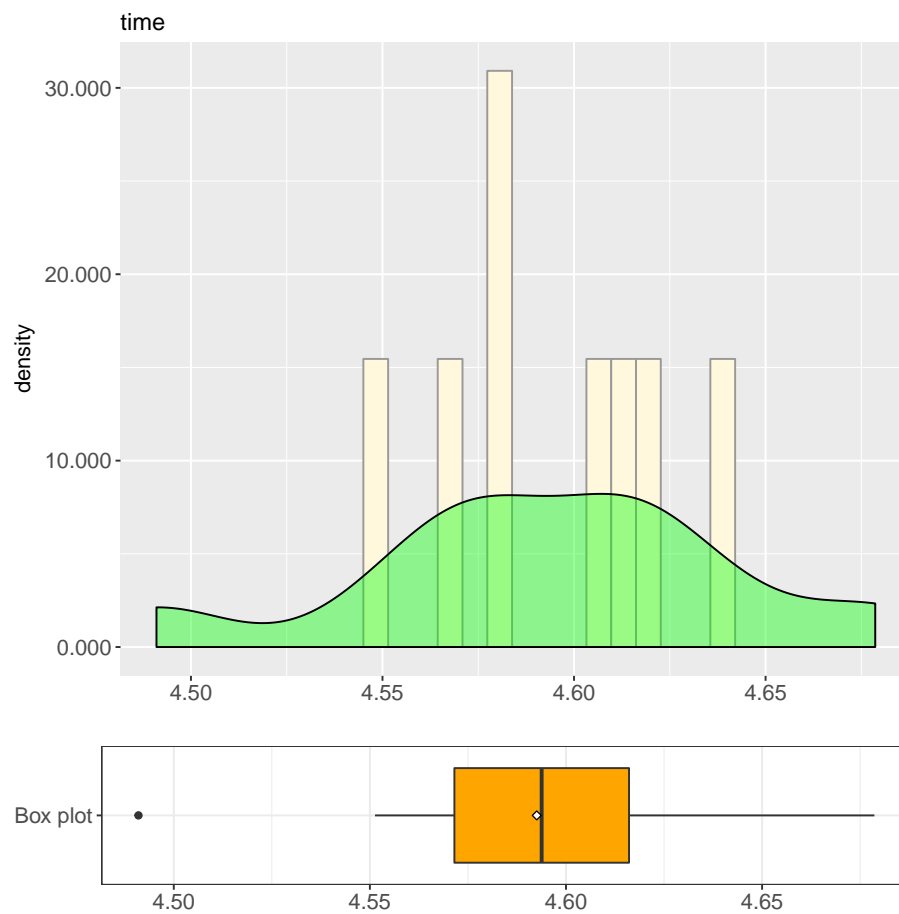
3.3.26 RH3.26: Object 22157 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA     NA    10
```

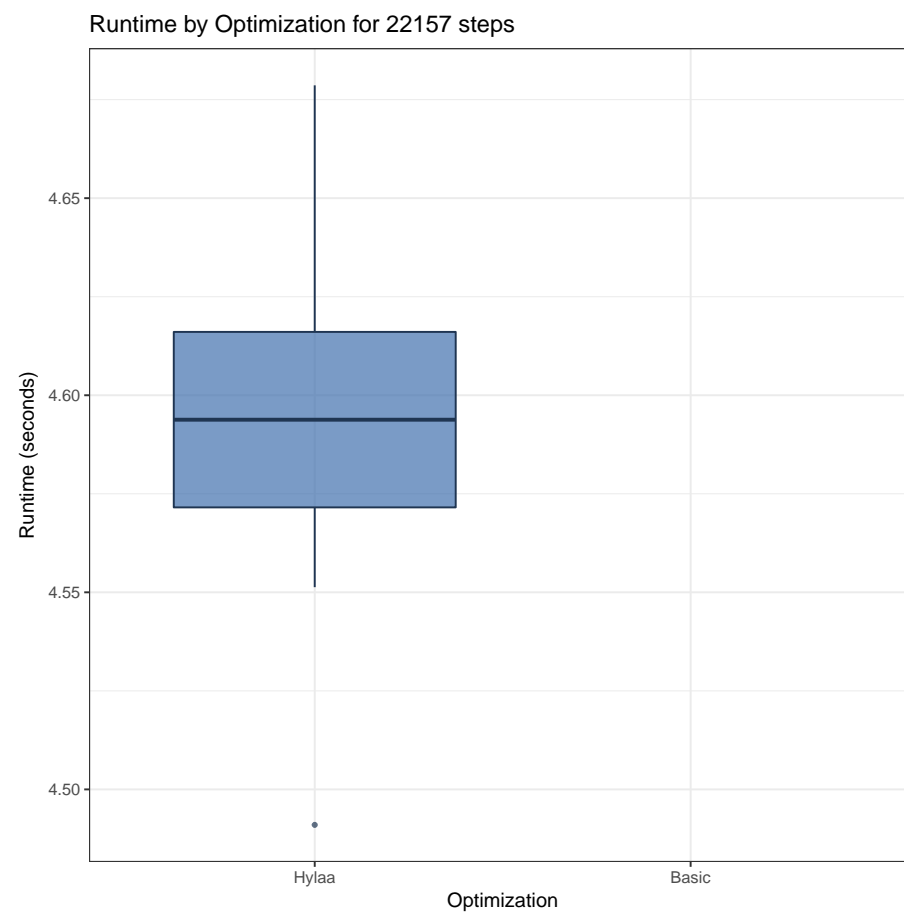
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  4.491  4.572  4.594  4.593  4.616  4.679
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps22157")$time
## W = 0.97327, p-value = 0.9194
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.919388955922961"
```

Comparison



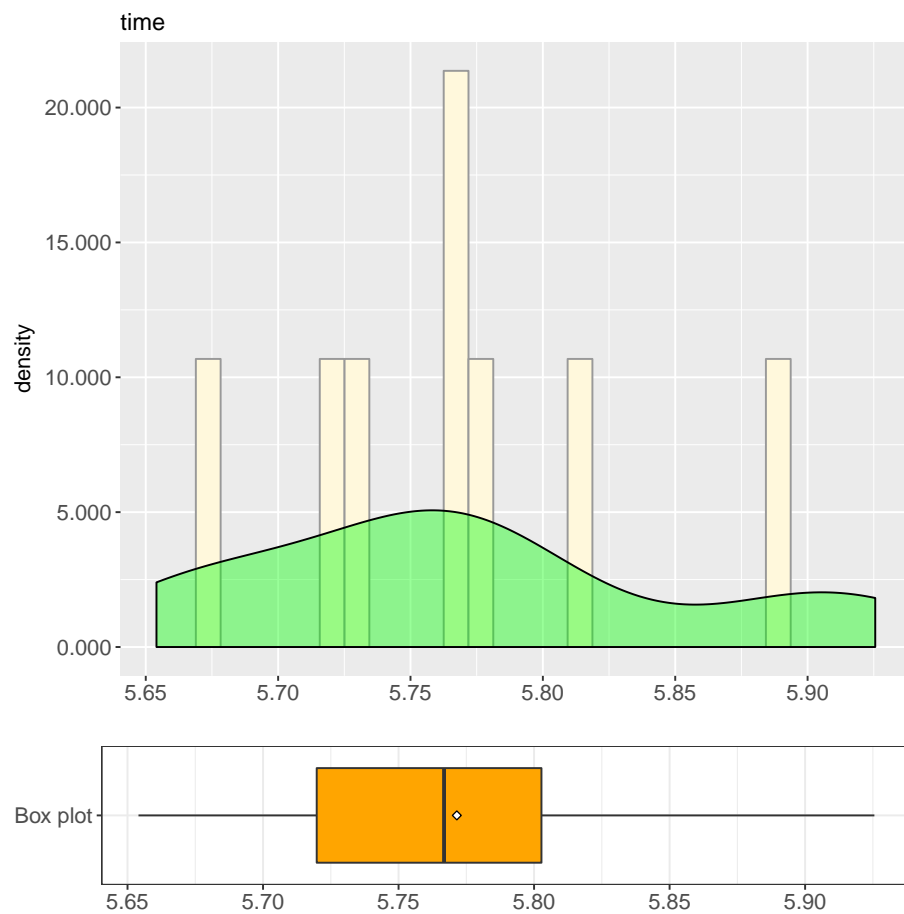
3.3.27 RH3.27: Object 28804 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.  Max.    NA's
##    NA      NA     NA     NaN    NA     NA     10
```

Runtime for Hylaa

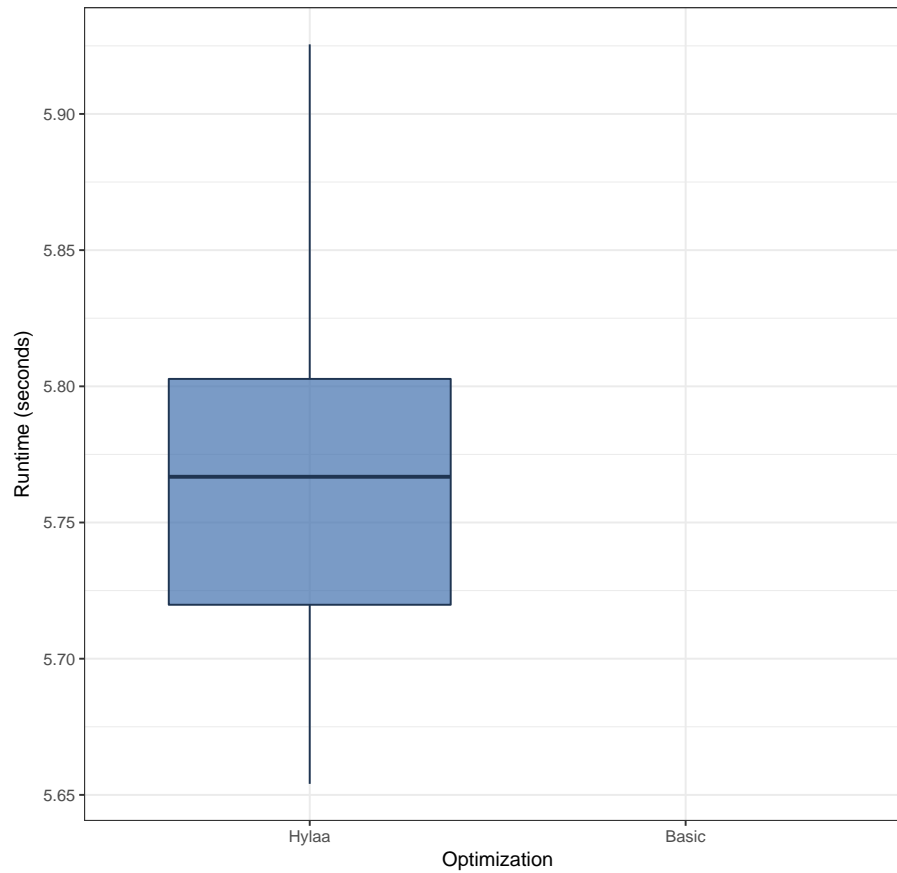
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.  Max.
##  5.654  5.720  5.767  5.771  5.803  5.926
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps28804")$time
## W = 0.94971, p-value = 0.6651
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.66510382139283"
```

Comparison

Runtime by Optimization for 28804 steps



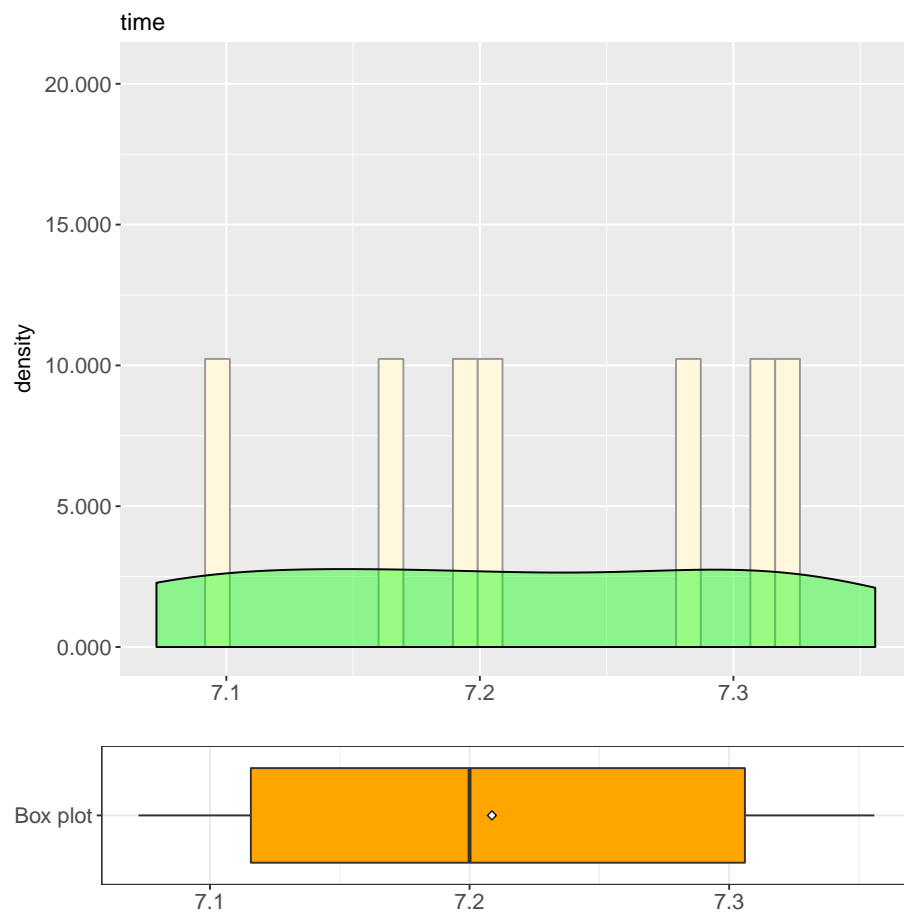
3.3.28 RH3.28: Object 37445 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA     NA    10
```

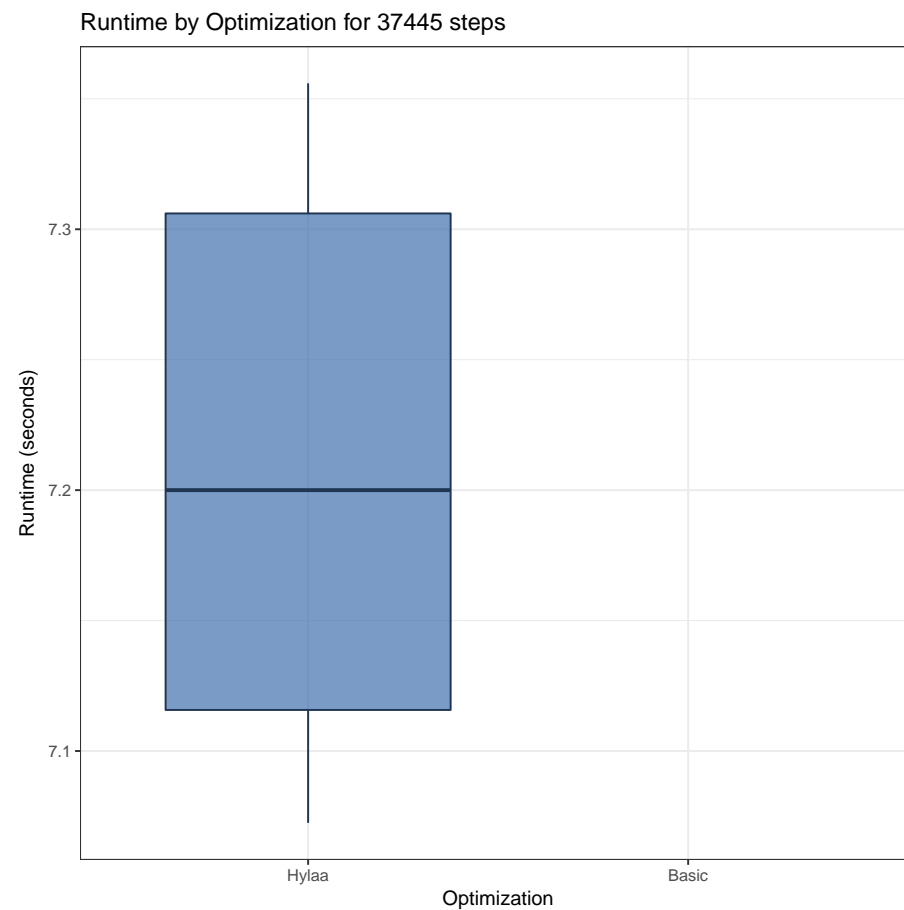
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  7.072  7.116  7.200  7.209  7.306  7.356
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps37445")$time
## W = 0.91587, p-value = 0.3238
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.32377452748614"
```

Comparison



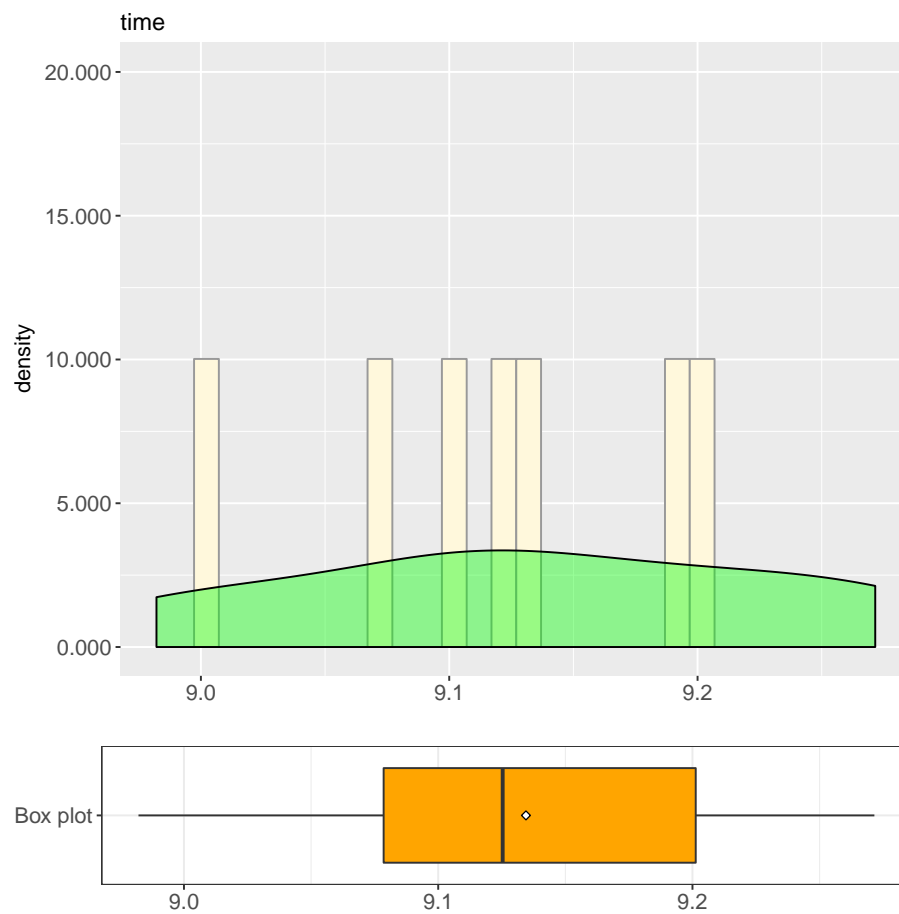
3.3.29 RH3.29: Object 48679 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA    10
```

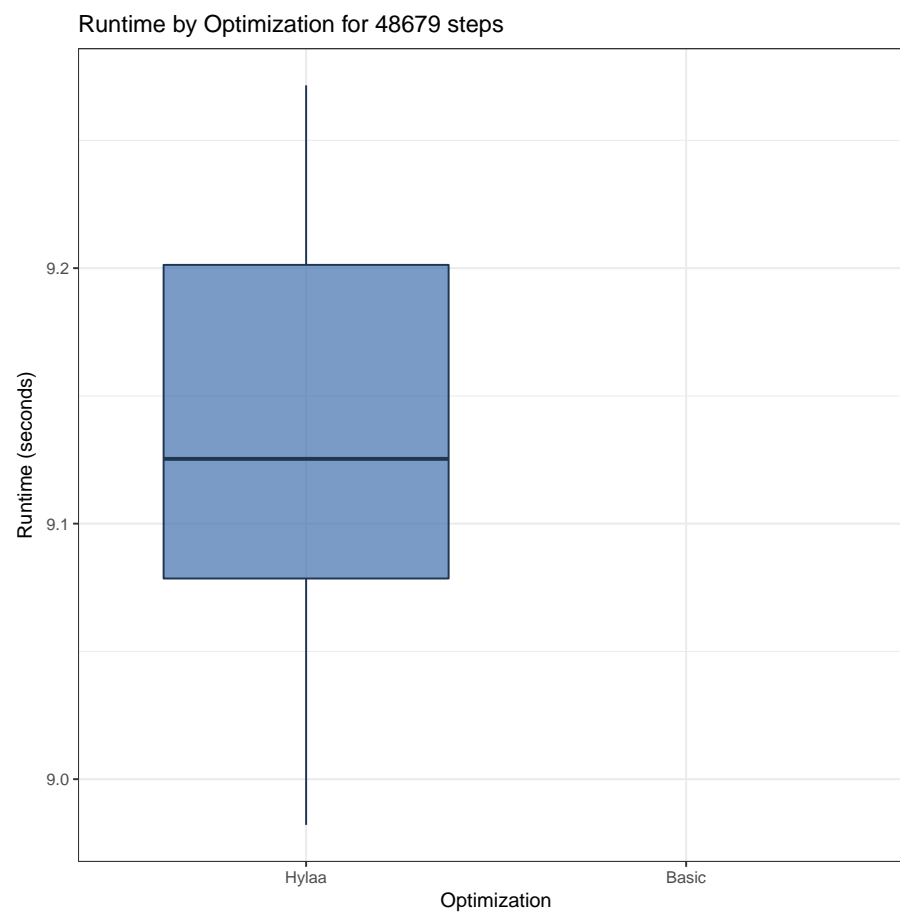
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  8.982  9.079  9.125  9.135  9.201  9.272
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps48679")$time
## W = 0.95111, p-value = 0.6816
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.681647465980239"
```

Comparison



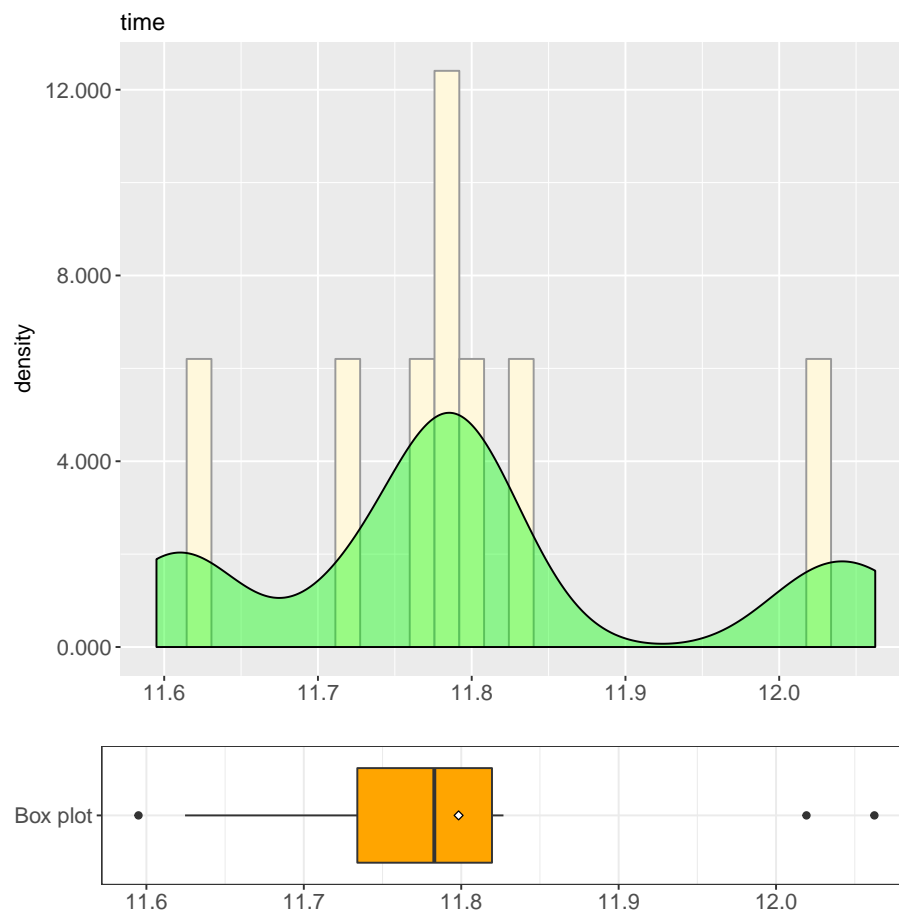
3.3.30 RH3.30: Object 63282 steps

Runtime for Basic

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA    10
```

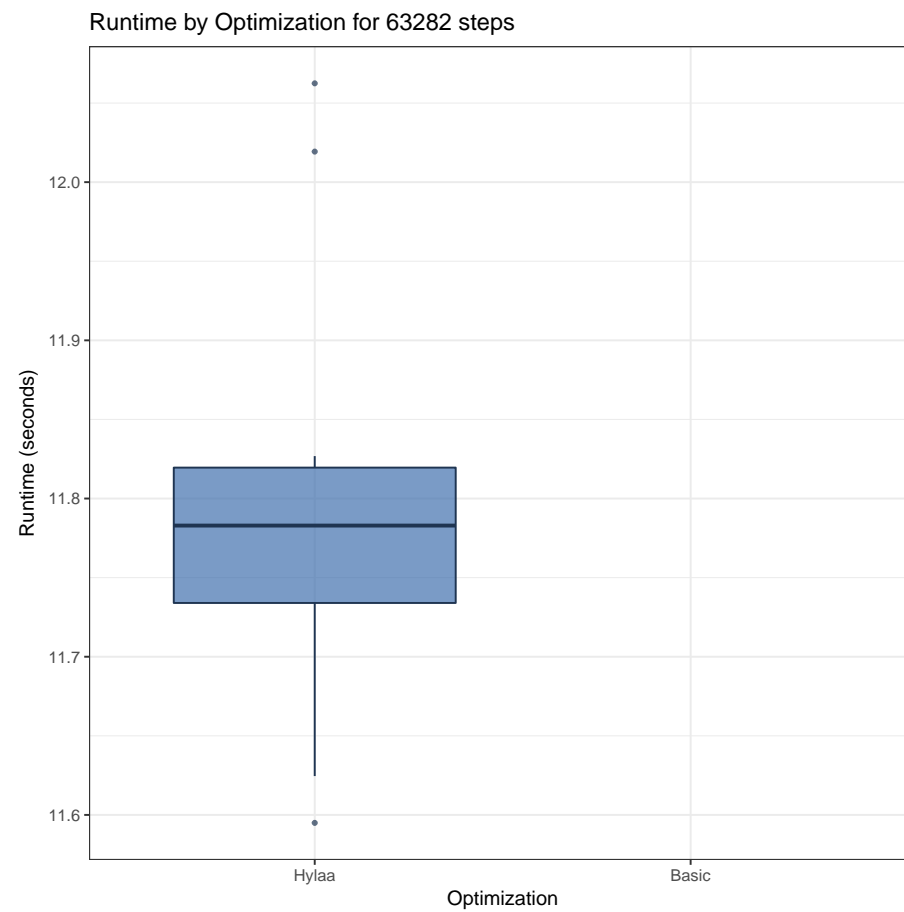
Runtime for Hylaa

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  11.59  11.73   11.78   11.80  11.82   12.06
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps63282")$time
## W = 0.90816, p-value = 0.2686
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.268588784180786"
```

Comparison



3.3.31 RH3.31: Object 82267 steps

Runtime for Basic

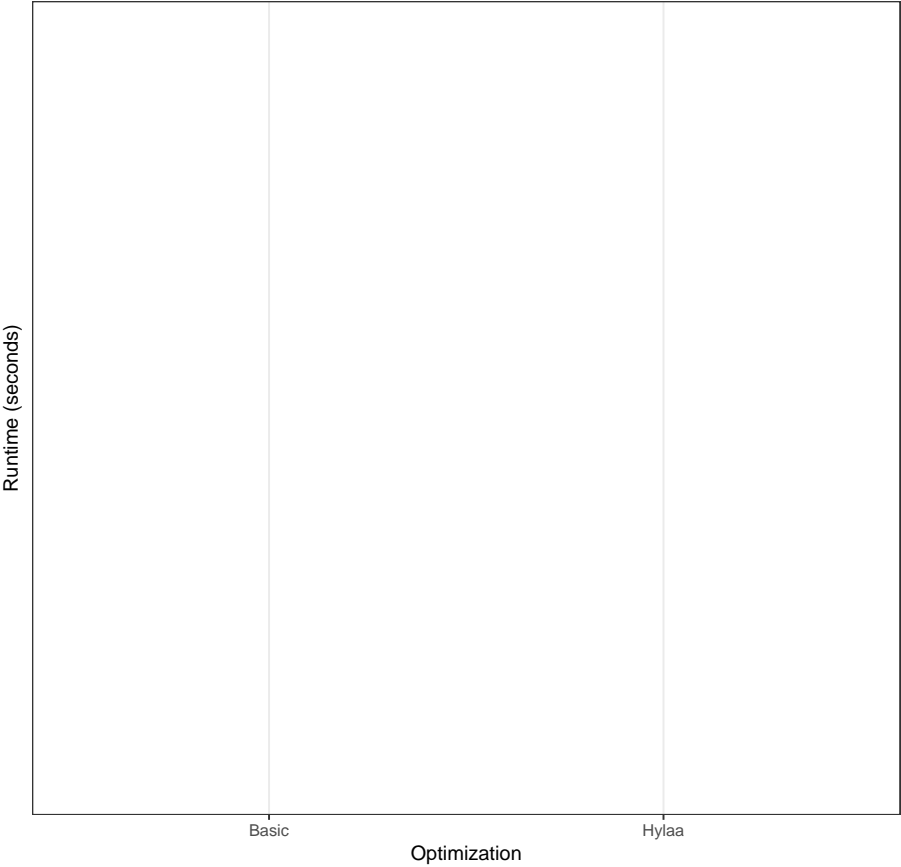
```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.  Max.    NA's
##    NA      NA     NA     NaN    NA     NA     10
```

Runtime for Hylaa

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.  Max.    NA's
##    NA      NA     NA     NaN    NA     NA     10
```

Comparison

Runtime by Optimization for 82267 steps



3.3.32 RH3.32: Object 106948 steps

Runtime for Basic

```
## [1] "Sample size: 0"
```

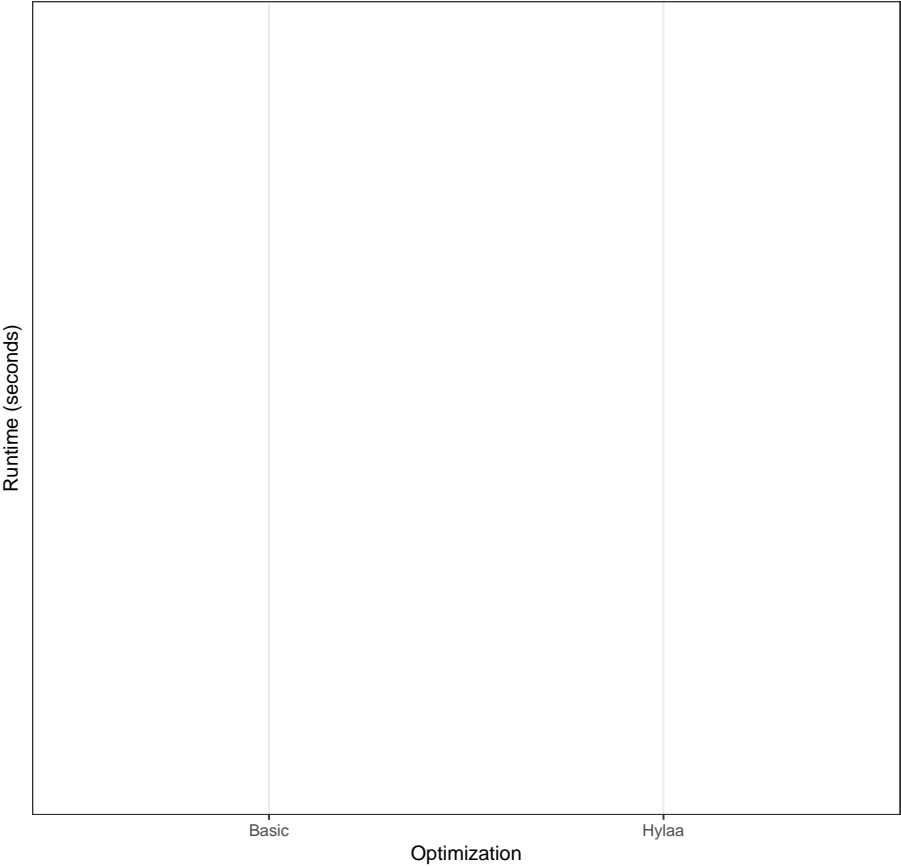
##	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	NA's
##	NA	NA	NA	NaN	NA	NA	10

Runtime for Hylaa

```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median      Mean 3rd Qu.      Max.      NA's
##      NA      NA      NA      NaN      NA      NA      10
```

Comparison

Runtime by Optimization for 106948 steps



3.3.33 RH3.33: Object 139032 steps

Runtime for Basic

```
## [1] "Sample size: 0"
```

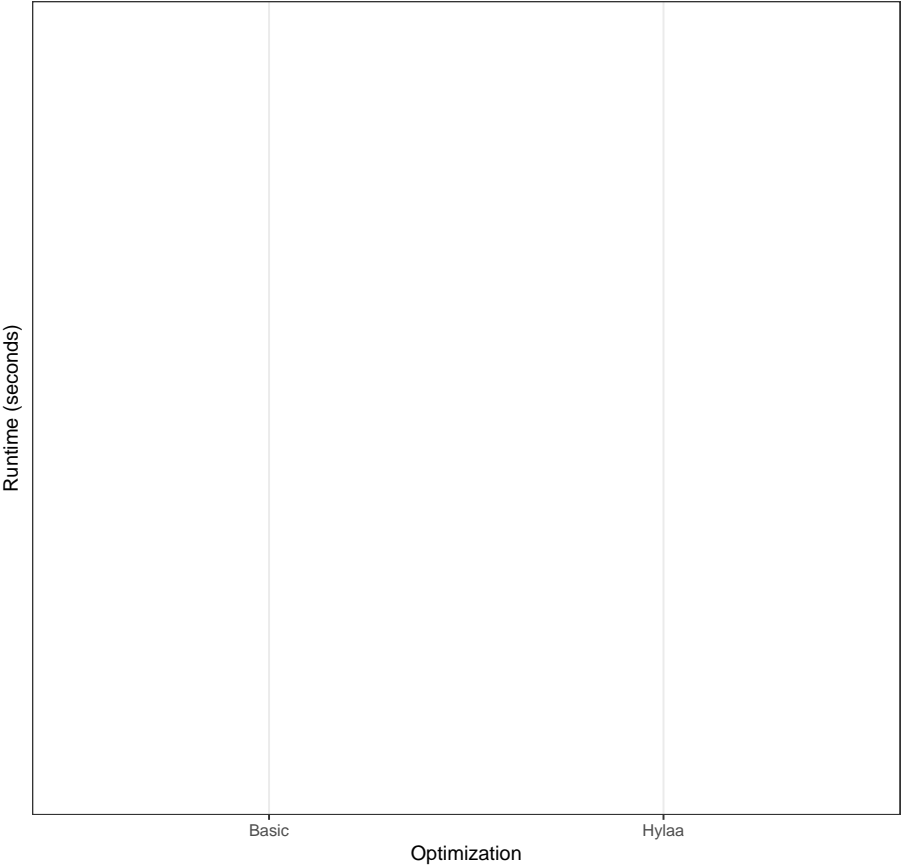
##	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	NA's
##	NA	NA	NA	NaN	NA	NA	10

Runtime for Hylaa

```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median      Mean 3rd Qu.      Max.      NA's
##      NA      NA      NA      NaN      NA      NA      10
```

Comparison

Runtime by Optimization for 139032 steps



3.3.34 RH3.34: Object 180742 steps

Runtime for Basic

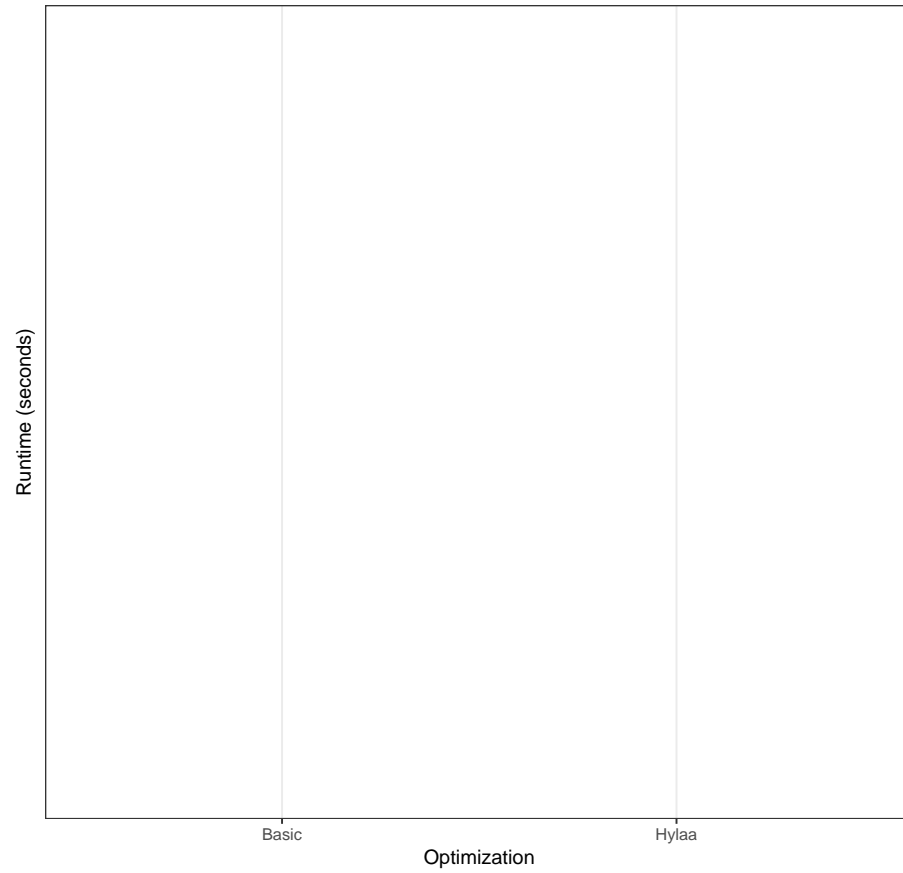
##	[1]	"Sample size: 0"					
##	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	NA's
##	NA	NA	NA	NaN	NA	NA	10

Runtime for Hylaa

##	[1]	"Sample size: 0"					
##	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	NA's
##	NA	NA	NA	NaN	NA	NA	10

Comparison

Runtime by Optimization for 180742 steps



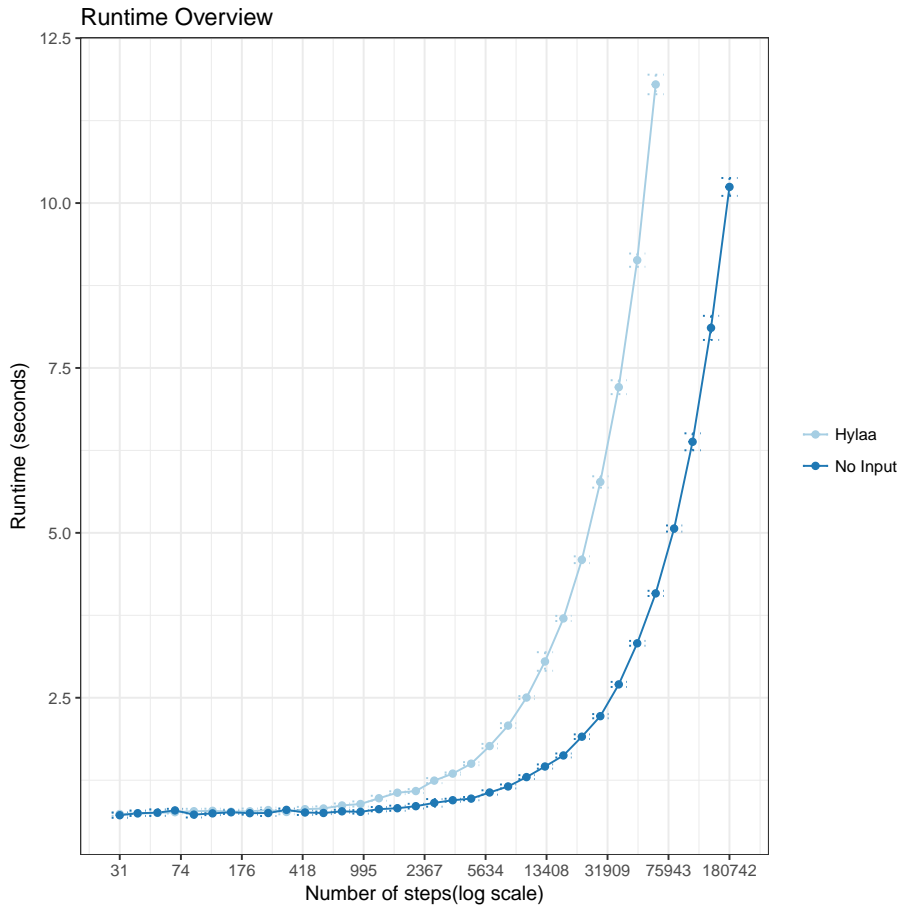
3.3.35 RH3 Results: Runtime Hylaa = Basic

Table 5: RH3 Results per Object

31 steps	Inconclusive
40 steps	Hylaa < Basic
53 steps	Hylaa < Basic
68 steps	Hylaa < Basic
89 steps	Hylaa < Basic
116 steps	Hylaa < Basic
151 steps	Hylaa < Basic
197 steps	Hylaa < Basic
256 steps	Hylaa < Basic
332 steps	Hylaa < Basic
432 steps	Hylaa < Basic
562 steps	Hylaa
731 steps	Hylaa
951 steps	Hylaa
1236 steps	Hylaa
1607 steps	Hylaa
2089 steps	Hylaa
2716 steps	Hylaa
3531 steps	Hylaa
4590 steps	Hylaa
5967 steps	Hylaa
7757 steps	Hylaa
10085 steps	Hylaa
13110 steps	Hylaa
17043 steps	Hylaa
22157 steps	Hylaa
28804 steps	Hylaa
37445 steps	Hylaa
48679 steps	Hylaa
63282 steps	Hylaa
82267 steps	None
106948 steps	None
139032 steps	None
180742 steps	None

Table 6: RH3 Results Summary	
Hylaa < Basic:	29.4117647%
Hylaa > Basic:	0%
Hylaa:	55.8823529%
Basic:	0%
None:	11.7647059%
Inconclusive:	2.9411765%

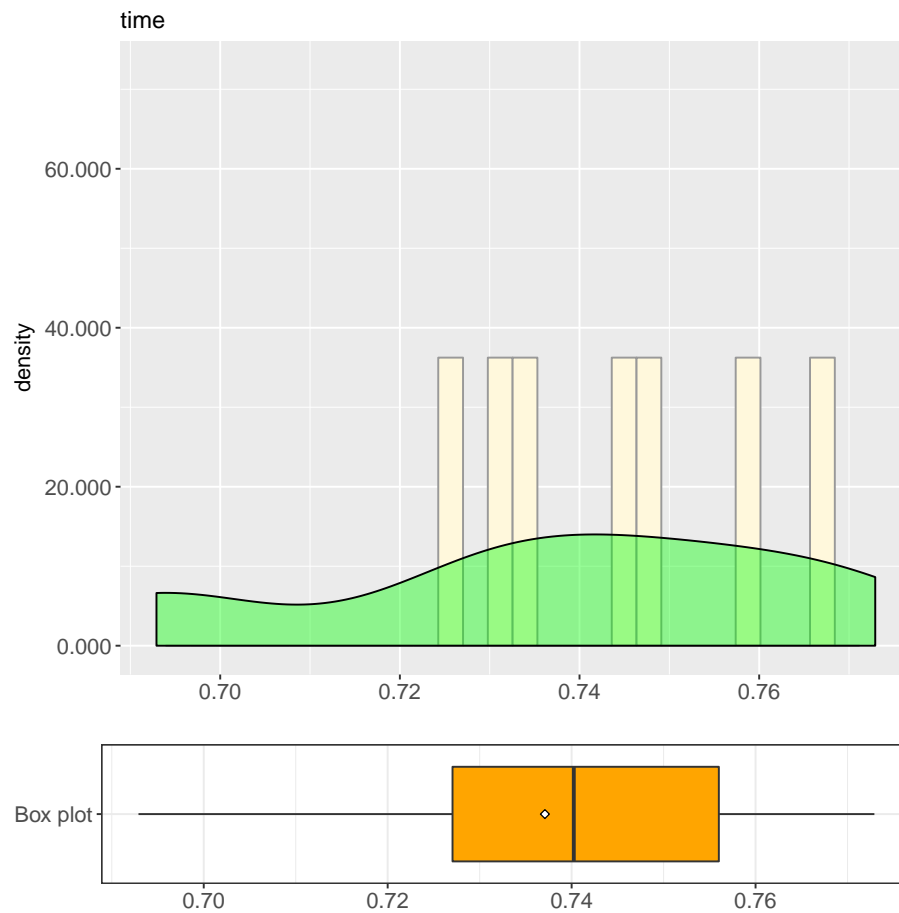
3.4 RH4: Runtime time for Hylaa is equals than runtime time for NoInput



3.4.1 RH4.1: Object 31 steps

Runtime for Hylaa

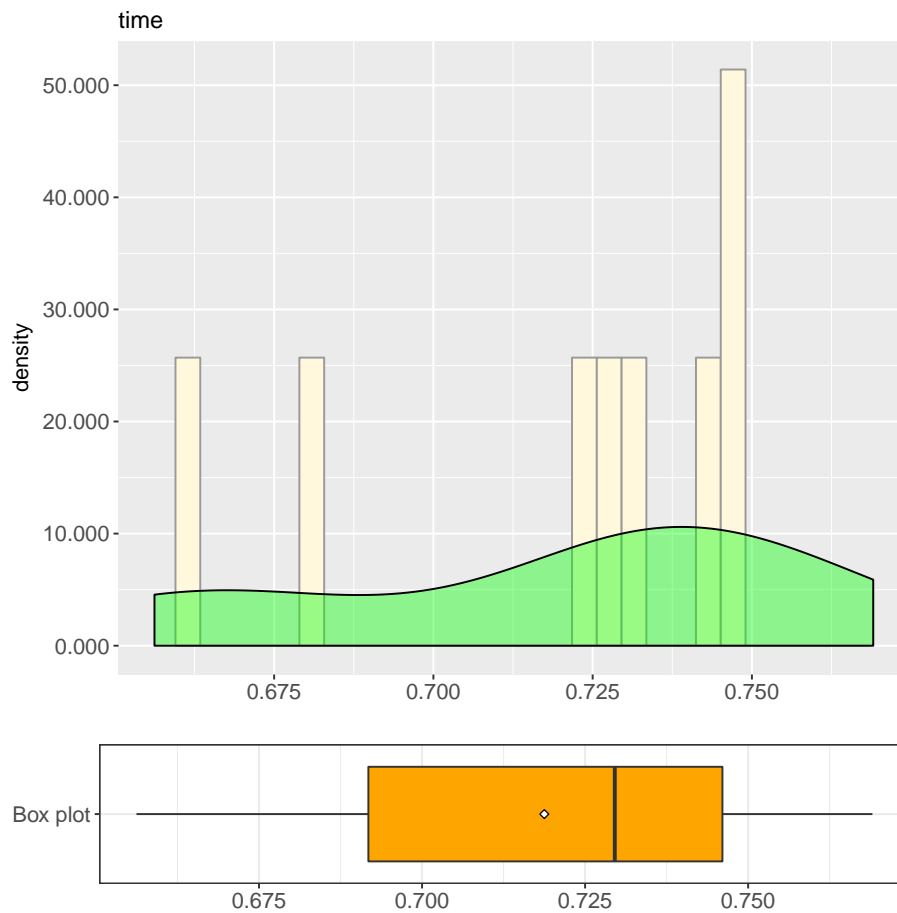
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6929  0.7270  0.7402  0.7371  0.7560  0.7729
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps31")$time
## W = 0.92348, p-value = 0.3869
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.386919454155626"
```

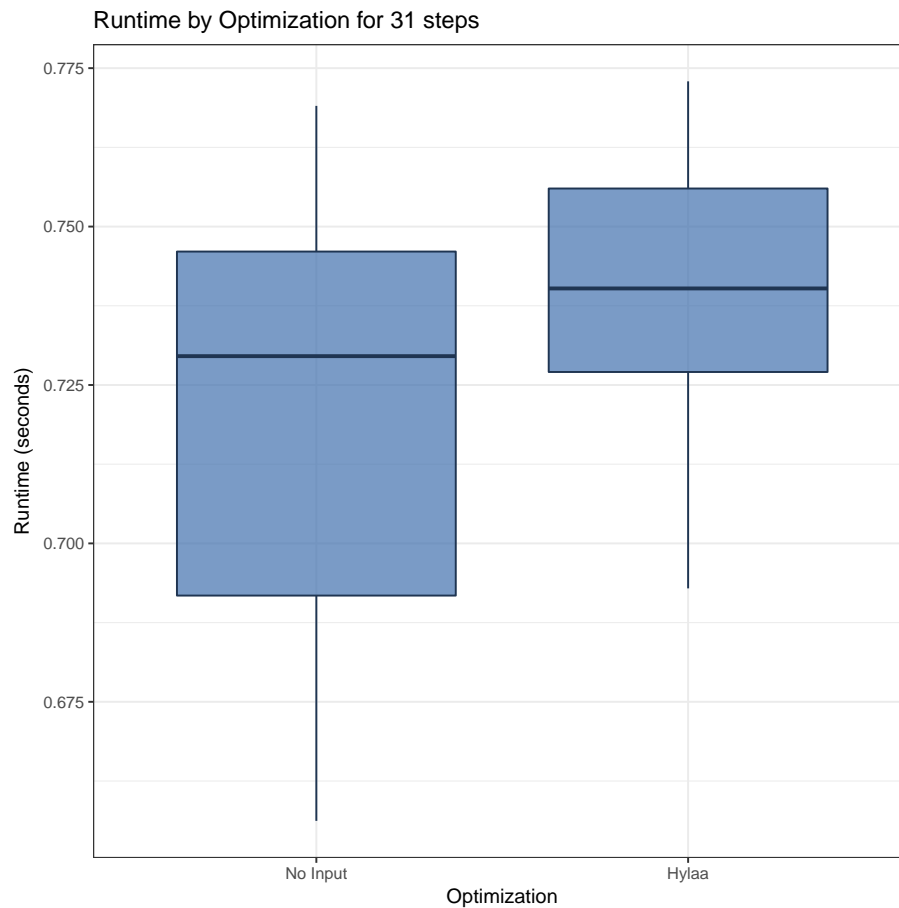
Runtime for No Input

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6562 0.6918 0.7296 0.7187 0.7461 0.7690
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "NoInput" & object == "steps31")$time
## W = 0.8834, p-value = 0.1427
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.142718895747195"
```

Comparison



```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps31")$time and subset(json_data, treatment == "No Input" & object == "steps31")$time
## F = 0.50593, num df = 9, denom df = 9, p-value = 0.3246
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1256662 2.0368761
## sample estimates:
## ratio of variances
##      0.5059312
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.324628978494896"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

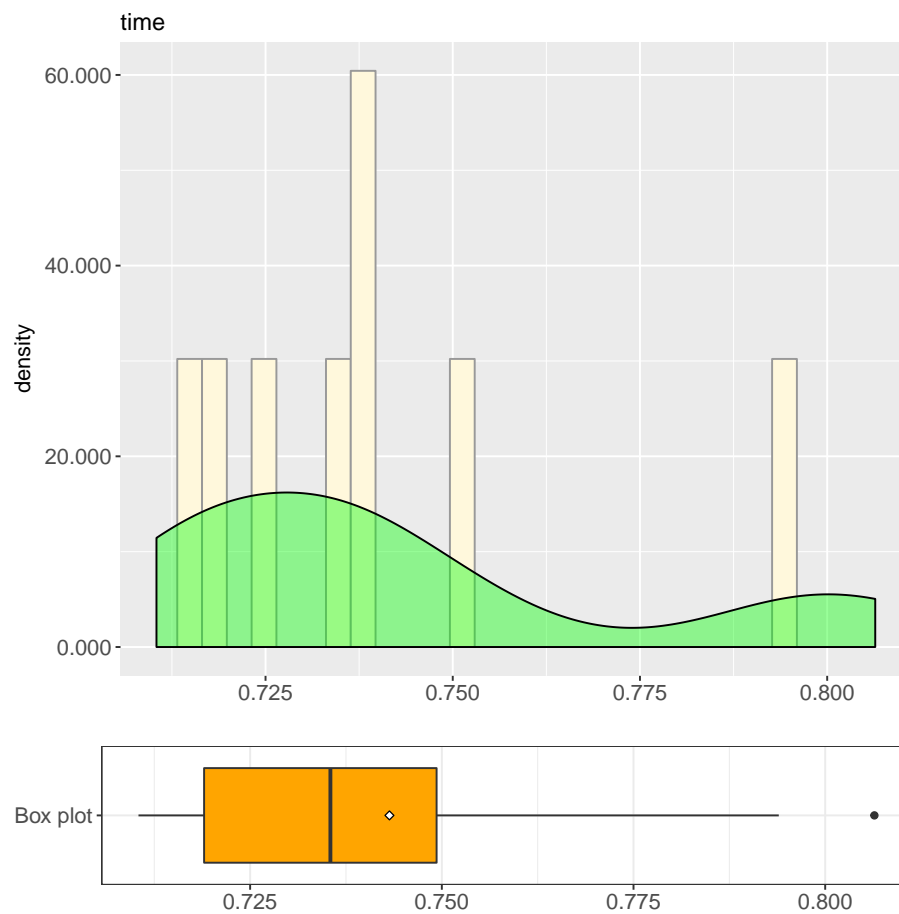


```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps31")$time and subset(json
## t = 1.2118, df = 18, p-value = 0.2413
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.01346439 0.05016287
## sample estimates:
## mean of x mean of y
## 0.7370949 0.7187457
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.241273850751091"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7370949268343"
## [1] "Mean Runtime for No Input: 0.7187456846236"
## [1] "Absolute difference: 0.0183492422107"
## Runtime for Hylaa is 2.55295337464312 % greater than
## Runtime for No Input
```

3.4.2 RH4.2: Object 40 steps

Runtime for Hylaa

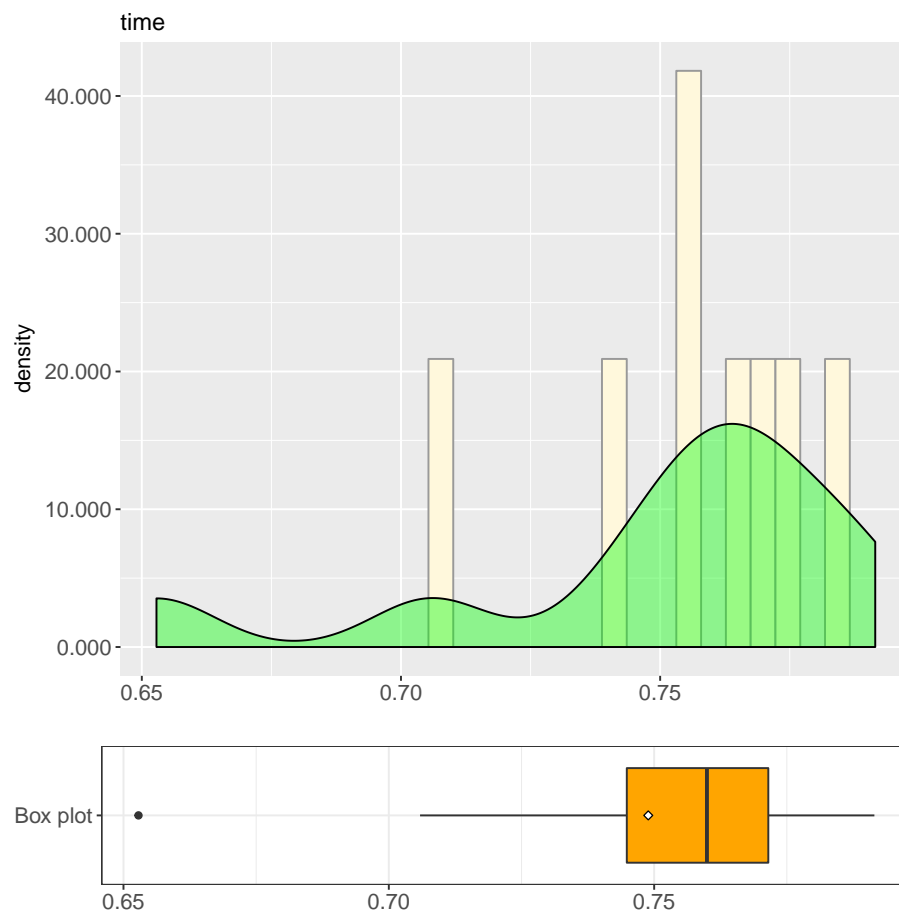
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7104 0.7190 0.7355 0.7432 0.7493 0.8064
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps40")$time
## W = 0.84556, p-value = 0.05142
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0514195741817329"
```

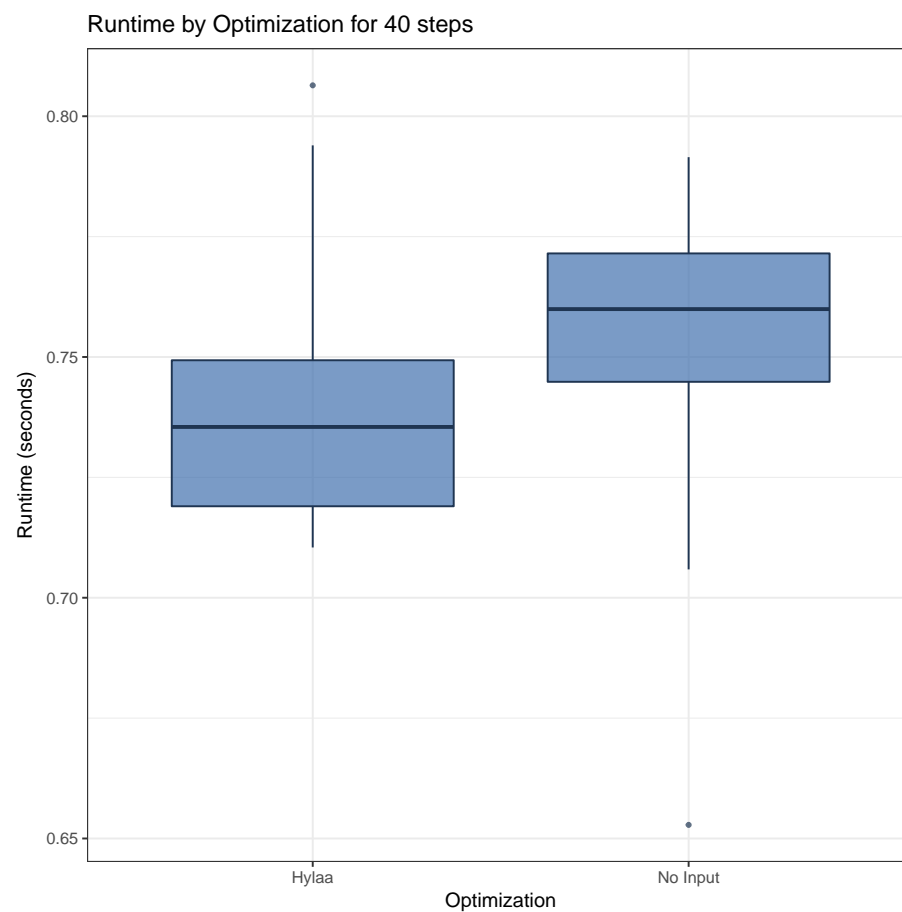
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6528 0.7448 0.7599 0.7489 0.7715 0.7915
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps40")$time
## W = 0.84097, p-value = 0.04533
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.04532567083103"
```

Comparison

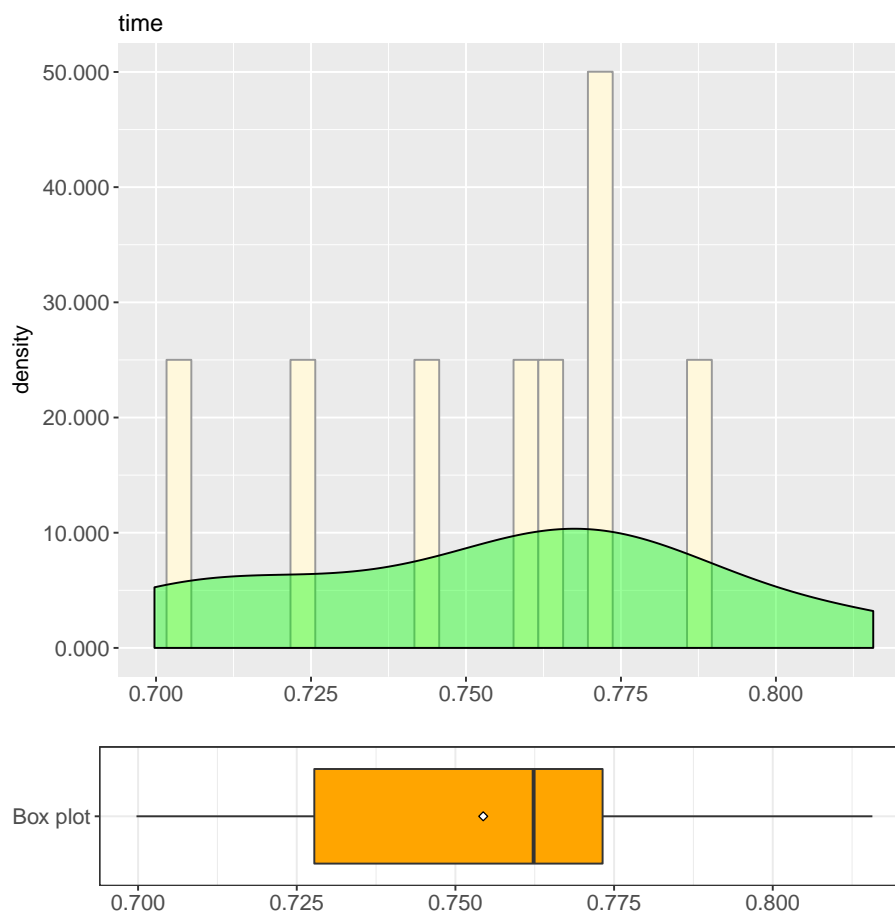


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 37, p-value = 0.3527
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis not rejected. P-value: 0.35268137435320"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7431680440903"
## [1] "Mean Runtime for No Input: 0.748886680603"
## [1] "Absolute difference: 0.00571863651269999"
## Runtime for No Input is 0.76949440414921 % greater than
## Runtime for Hylaa
```

3.4.3 RH4.3: Object 53 steps

Runtime for Hylaa

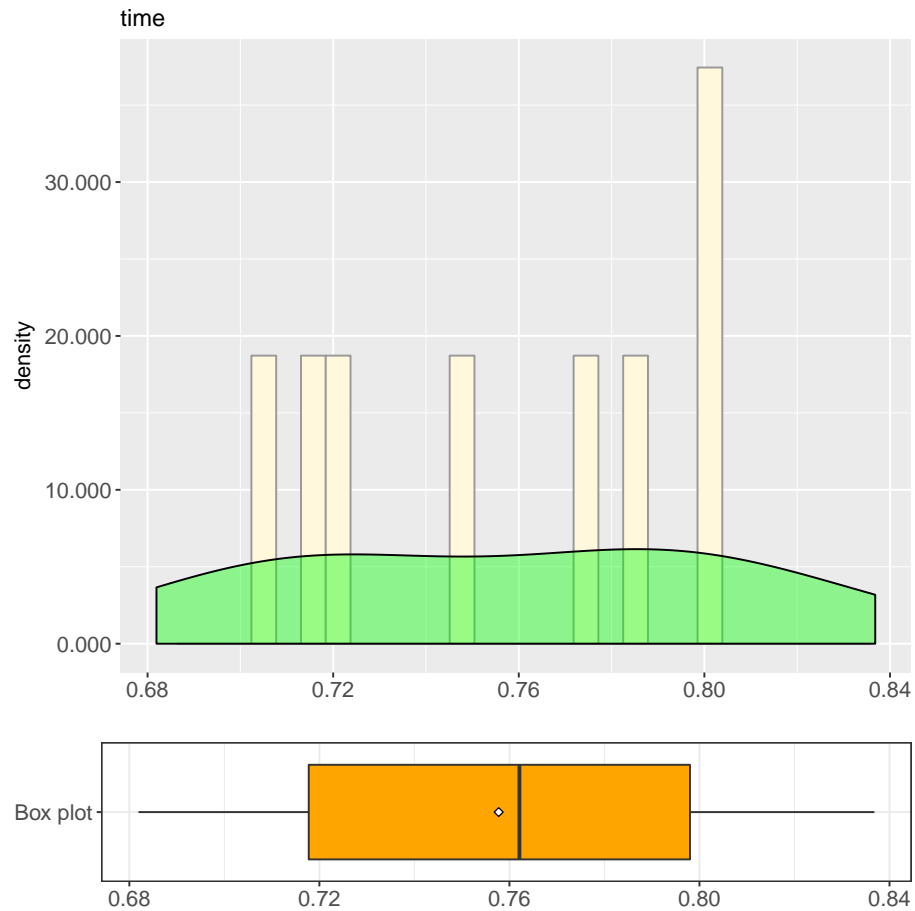
```
## [1] "Sample size: 10"  
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
## 0.6997 0.7278 0.7623 0.7544 0.7732 0.8157
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Hylaa" & object == "steps53")$time  
## W = 0.95914, p-value = 0.776  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.776029544672673"
```

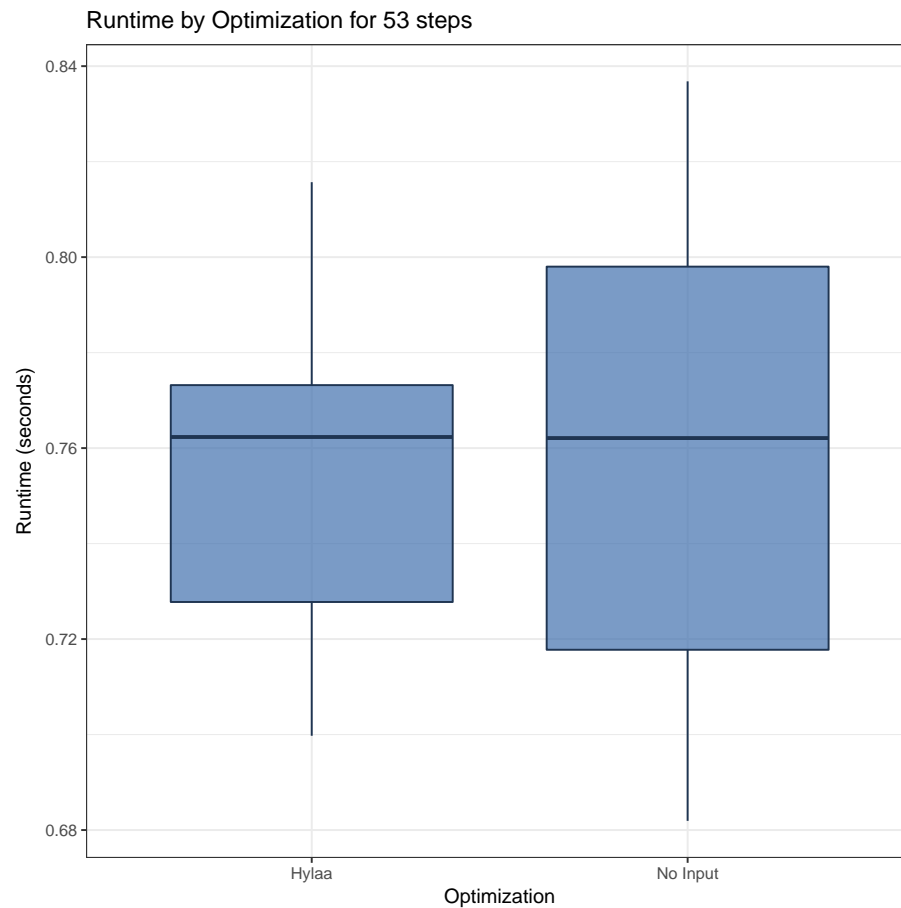
Runtime for No Input

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6819  0.7178  0.7621  0.7577  0.7980  0.8368
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "NoInput" & object == "steps53")$time
## W = 0.96185, p-value = 0.8068
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.80676233136489"
```

Comparison



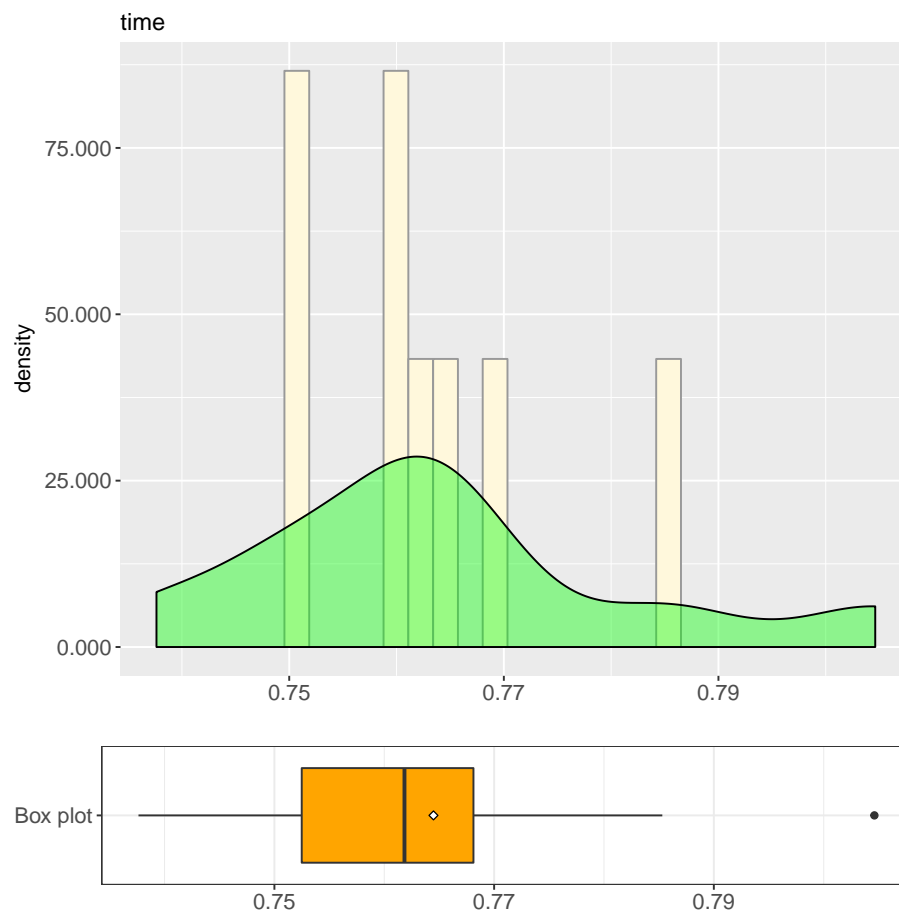
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps53")$time and subset(json_data, treatment == "No Input" & object == "steps53")$time
## F = 0.53269, num df = 9, denom df = 9, p-value = 0.3619
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1323131 2.1446142
## sample estimates:
## ratio of variances
##      0.5326918
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.361939006189545"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps53")$time and subset(json
## t = -0.17054, df = 18, p-value = 0.8665
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.0447435 0.0380250
## sample estimates:
## mean of x mean of y
## 0.7543800 0.7577392
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.866490680679862"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7543799638747"
## [1] "Mean Runtime for No Input: 0.7577392101288"
## [1] "Absolute difference: 0.0033592462541"
## Runtime for No Input is 0.445298975975714 % greater than
## Runtime for Hylaa
```

3.4.4 RH4.4: Object 68 steps

Runtime for Hylaa

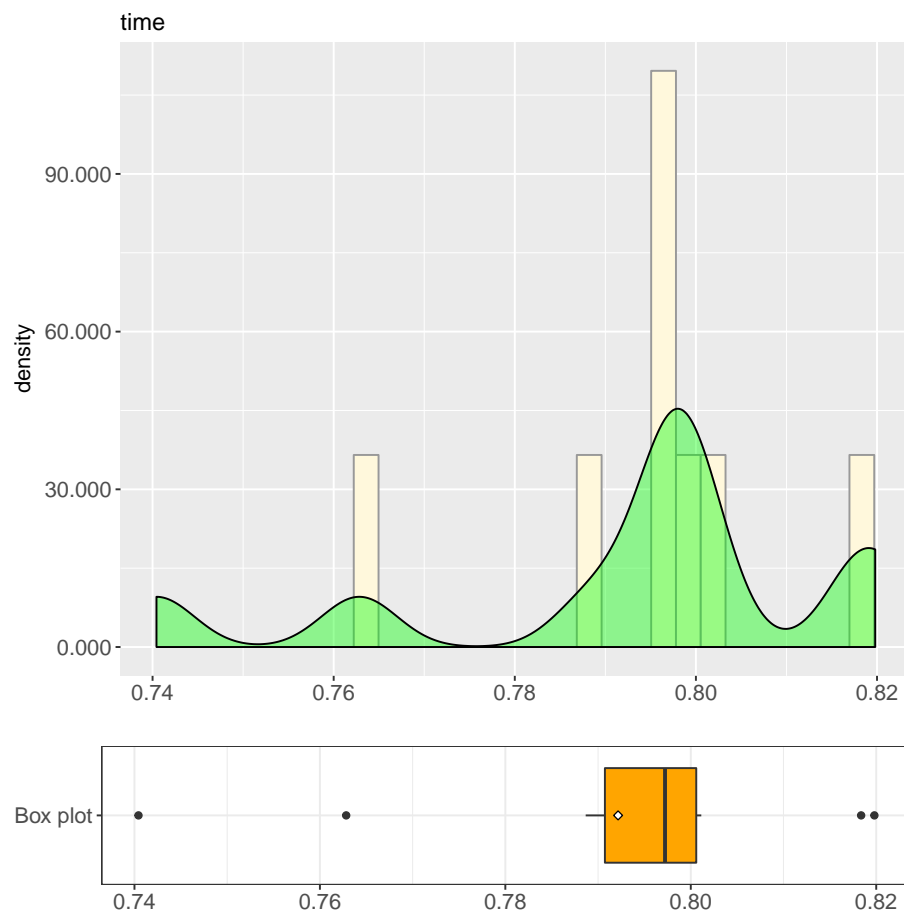
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7376 0.7525 0.7618 0.7645 0.7681 0.8046
```

```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps68")$time
## W = 0.92932, p-value = 0.4412
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.44123425938003"
```

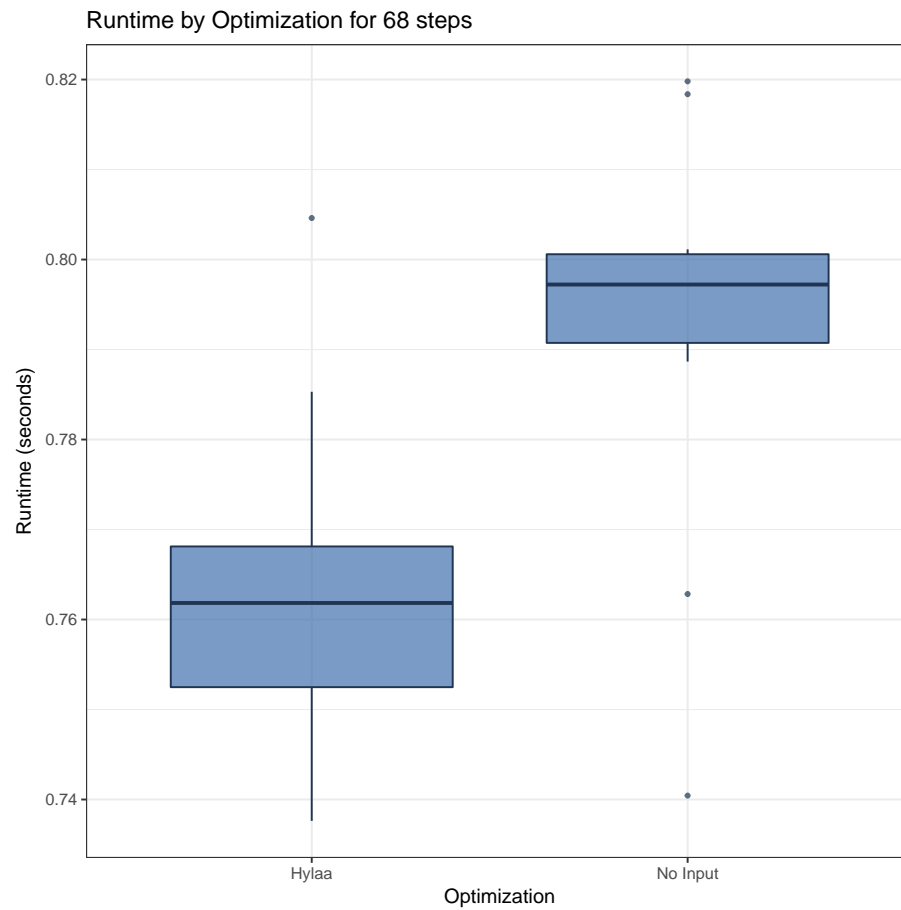
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7404 0.7907 0.7972 0.7922 0.8006 0.8198
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps68")$time
## W = 0.85646, p-value = 0.0693
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0693005139271127"
```

Comparison



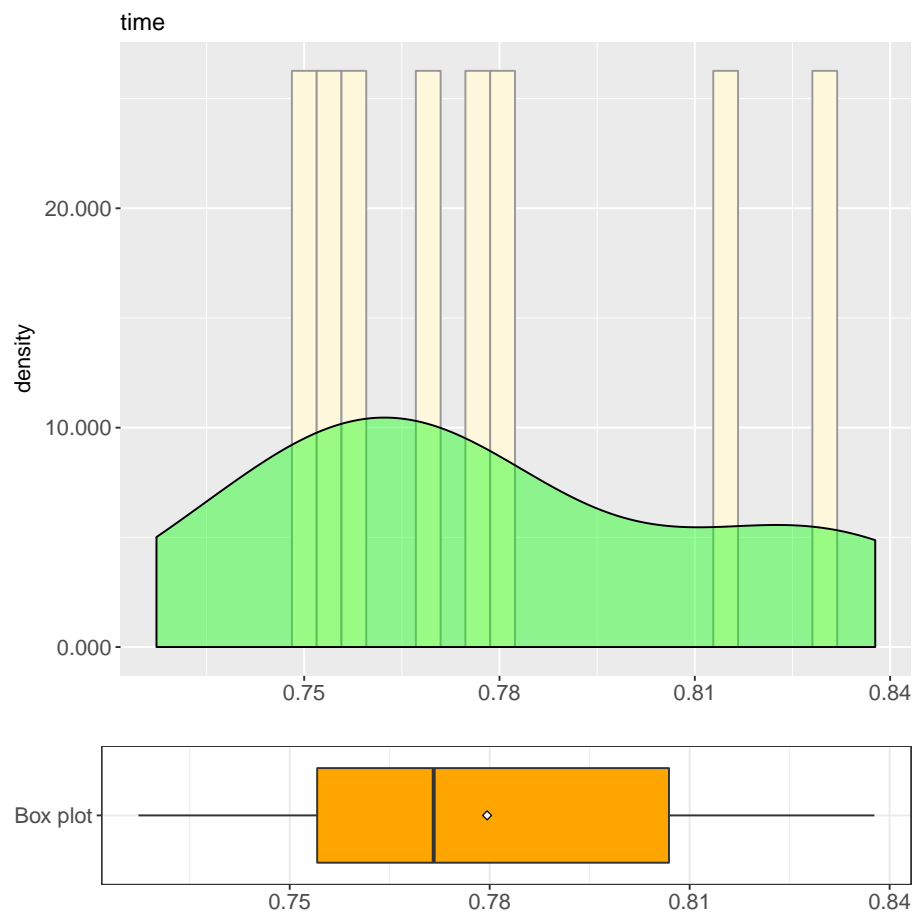
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps68")$time and subset(json_data, treatment == "No Input" & object == "steps68")$time
## F = 0.62593, num df = 9, denom df = 9, p-value = 0.4961
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1554714 2.5199784
## sample estimates:
## ratio of variances
##      0.625927
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.496143841238467"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps68")$time and subset(json
## t = -2.856, df = 18, p-value = 0.0105
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.048045855 -0.007318659
## sample estimates:
## mean of x mean of y
## 0.7644785 0.7921607
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.0104955376652981"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7644784688949"
## [1] "Mean Runtime for No Input: 0.7921607255935"
## [1] "Absolute difference: 0.0276822566986"
## Runtime for No Input is 3.62106427125625 % greater than
## Runtime for Hylaa
```

3.4.5 RH4.5: Object 89 steps

Runtime for Hylaa

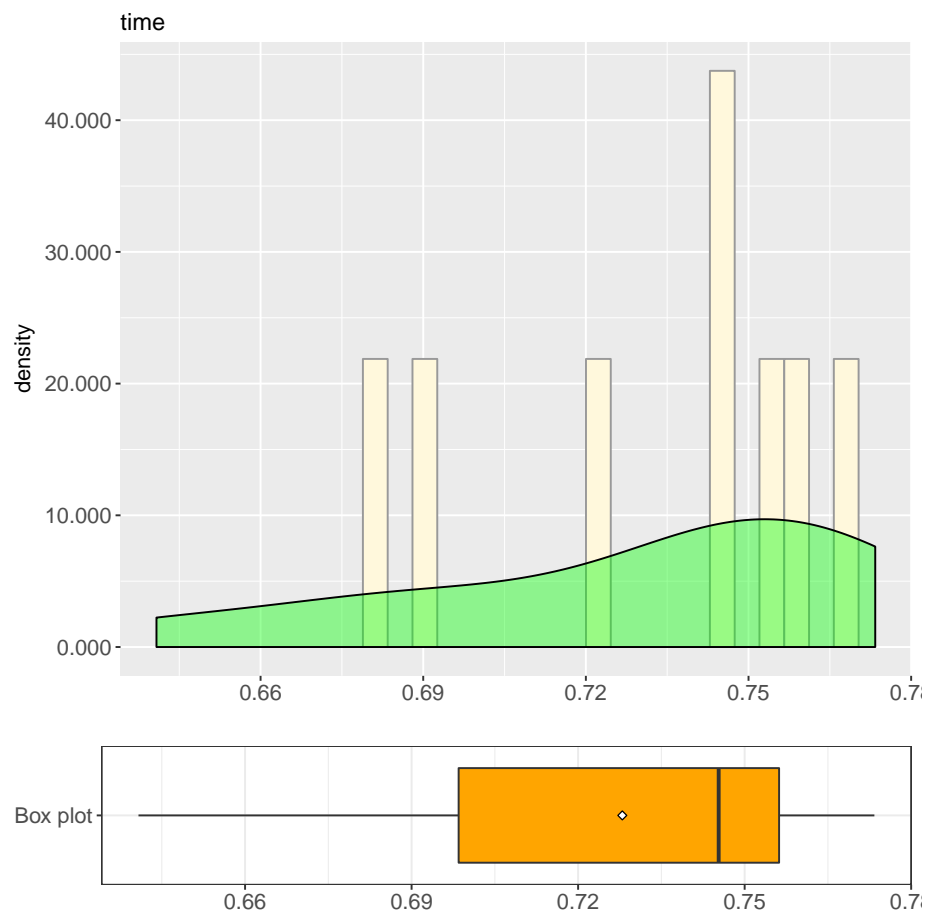
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7273  0.7541  0.7716  0.7796  0.8069  0.8377
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps89")$time
## W = 0.92836, p-value = 0.4319
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.431928741976726"
```

Runtime for No Input

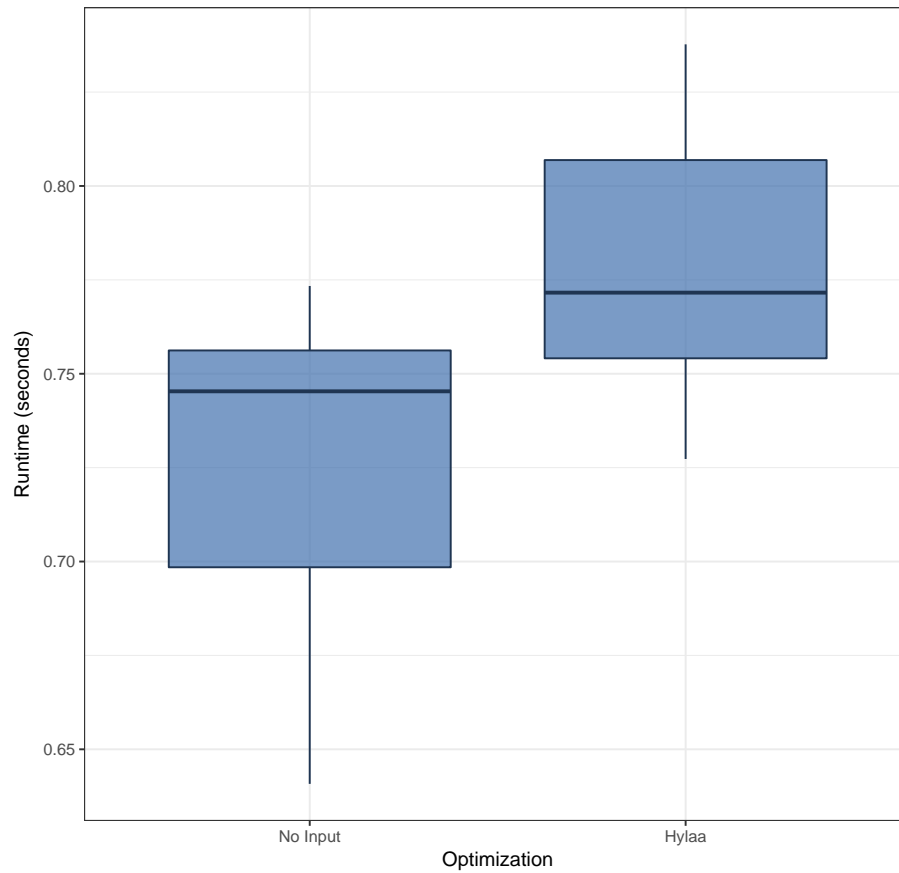
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.6408  0.6985  0.7453  0.7280  0.7562  0.7734
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps89")$time
## W = 0.88532, p-value = 0.1501
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.150100160582422"
```

Comparison

Runtime by Optimization for 89 steps



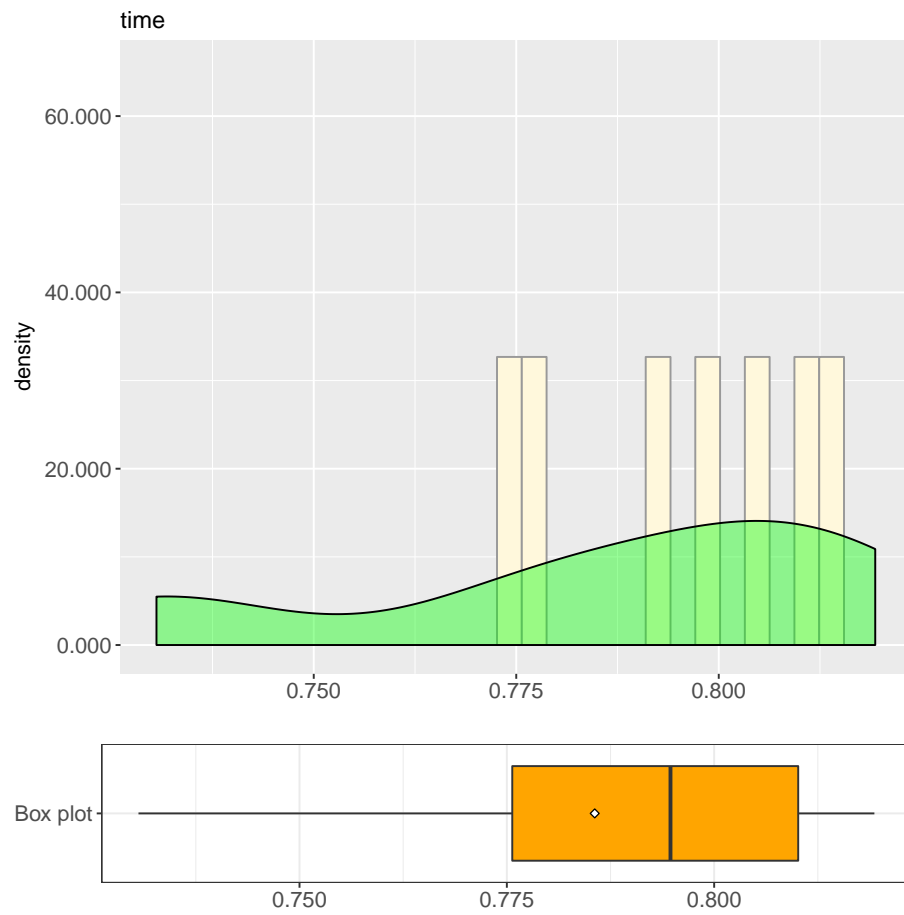
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps89")$time and subset(json_data, treatment == "No Input" & object == "steps89")$time
## F = 0.71928, num df = 9, denom df = 9, p-value = 0.6314
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1786585 2.8958100
## sample estimates:
## ratio of variances
##      0.7192782
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.6314423386319"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps89")$time and subset(json
## t = 2.8722, df = 18, p-value = 0.01014
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.01386770 0.08942062
## sample estimates:
## mean of x mean of y
## 0.7796074 0.7279633
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.0101361380580459"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7796074151993"
## [1] "Mean Runtime for No Input: 0.727963256836"
## [1] "Absolute difference: 0.0516441583632999"
## Runtime for Hylaa is 7.09433585807129 % greater than
## Runtime for No Input
```

3.4.6 RH4.6: Object 116 steps

Runtime for Hylaa

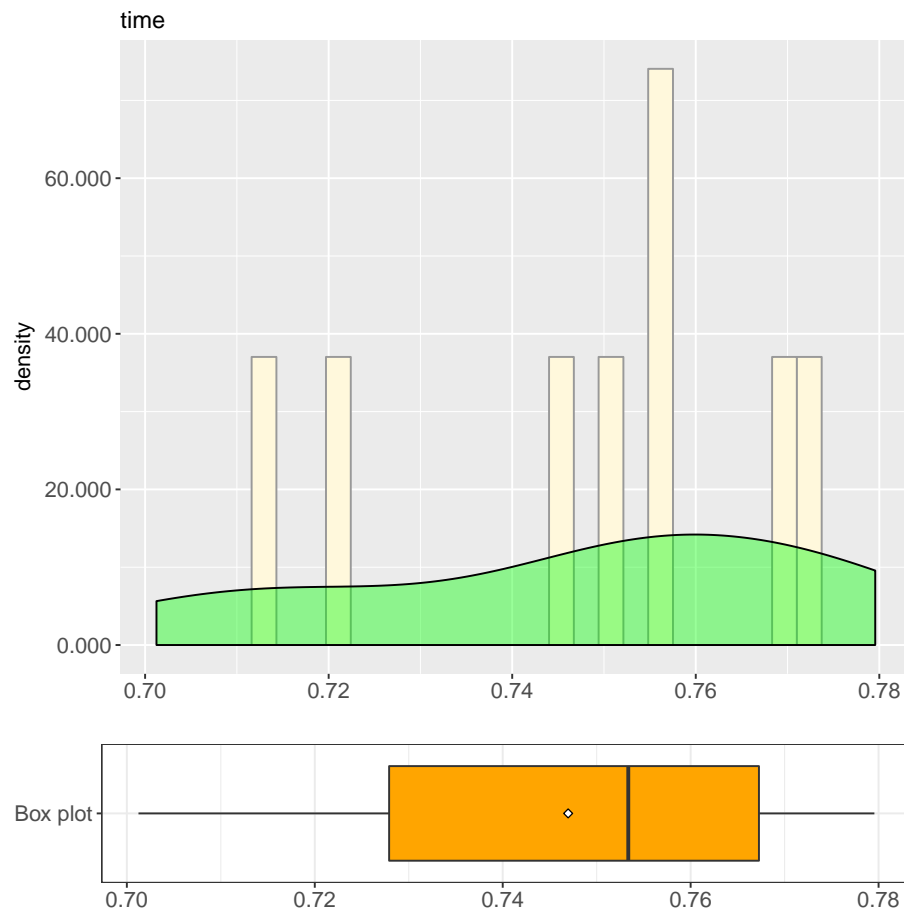
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7306 0.7757 0.7947 0.7856 0.8101 0.8193
```

```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps116")$time
## W = 0.86307, p-value = 0.08294
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0829366496429817"
```

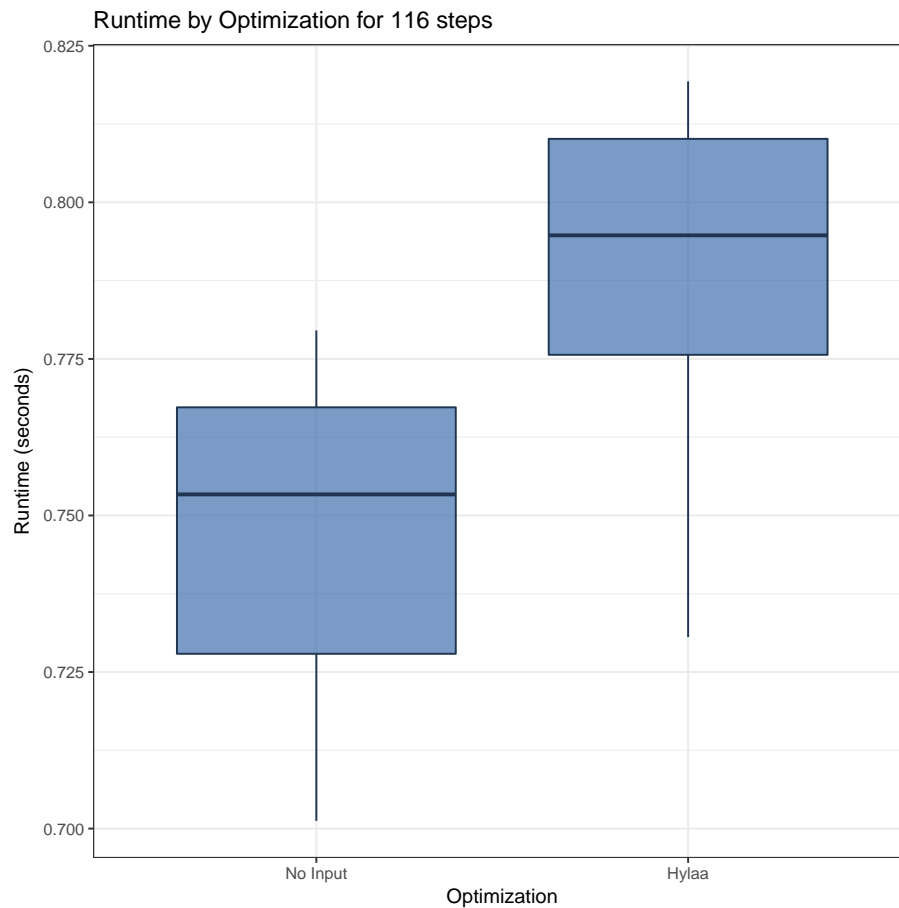
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7012 0.7279 0.7534 0.7470 0.7673 0.7796
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "NoInput" & object == "steps116")$time
## W = 0.92302, p-value = 0.3828
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.382818747956388"
```

Comparison



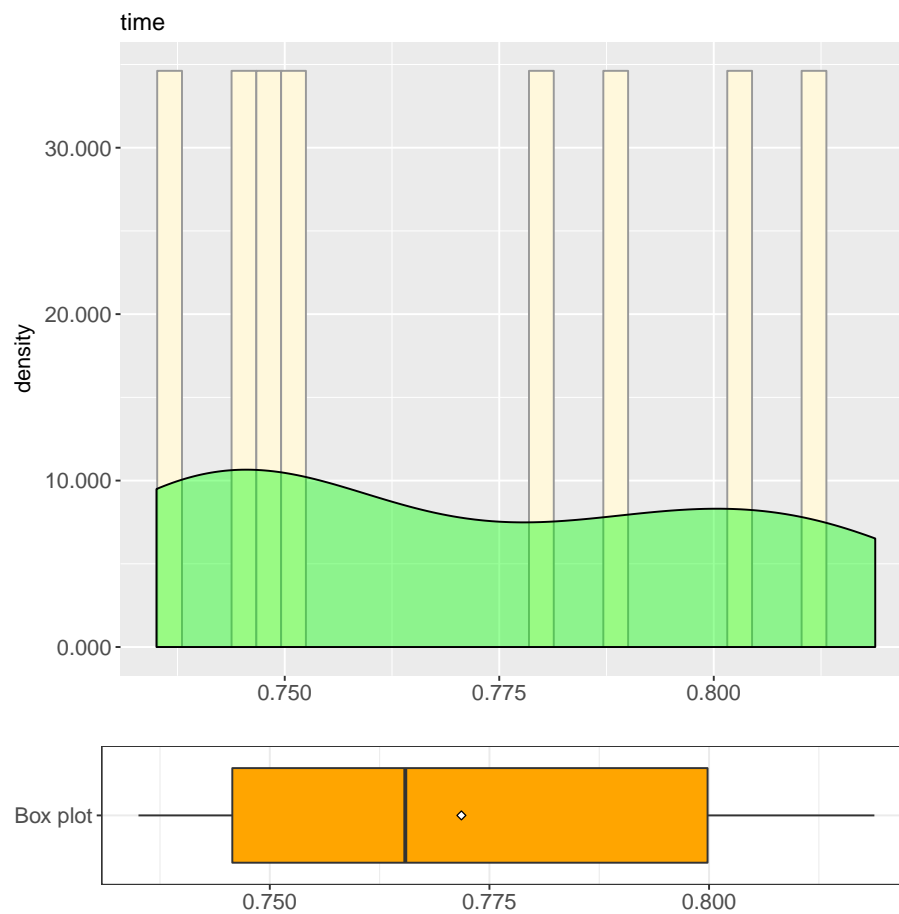
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps116")$time and subset(json_data, treatment == "No Input" & object == "steps116")$time
## F = 1.4652, num df = 9, denom df = 9, p-value = 0.5784
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3639261 5.8987430
## sample estimates:
## ratio of variances
##      1.465164
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.578446694193737"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps116")$time and subset(js
## t = 2.9294, df = 18, p-value = 0.008957
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.01092605 0.06633907
## sample estimates:
## mean of x mean of y
## 0.7855974 0.7469648
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.00895714298884188"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7855973720549"
## [1] "Mean Runtime for No Input: 0.7469648122788"
## [1] "Absolute difference: 0.0386325597761"
## Runtime for Hylaa is 5.17193837528195 % greater than
## Runtime for No Input
```

3.4.7 RH4.7: Object 151 steps

Runtime for Hylaa

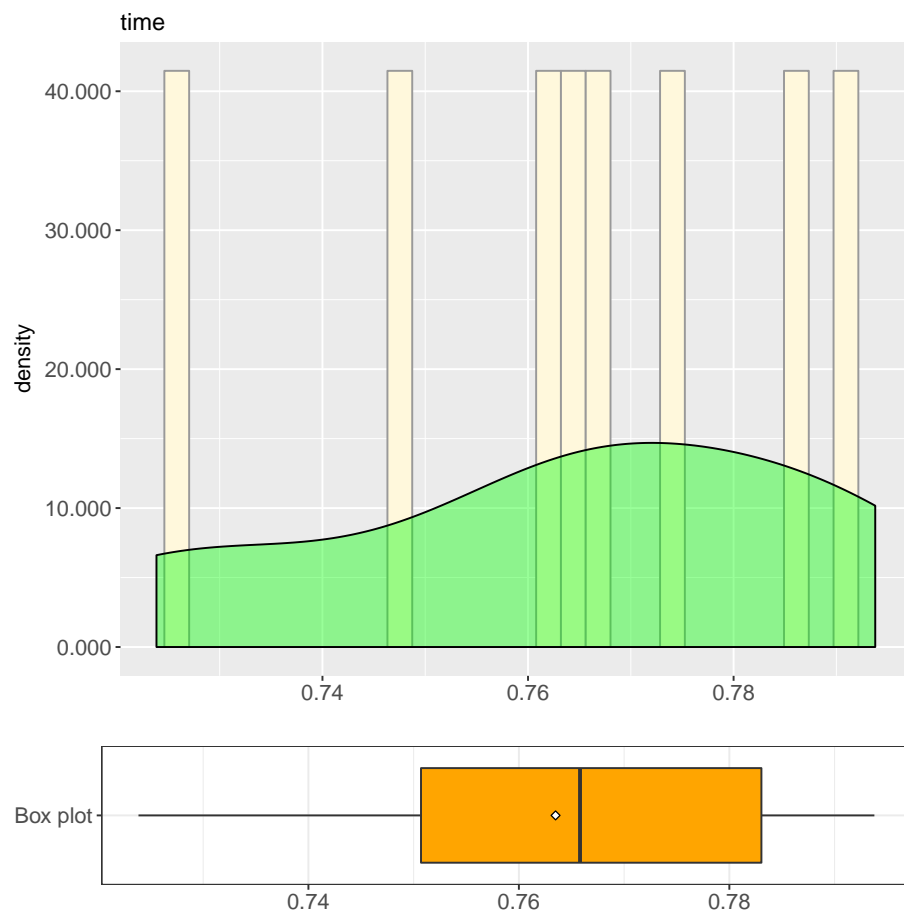
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7351  0.7457  0.7654  0.7718  0.7998  0.8188
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps151")$time
## W = 0.8855, p-value = 0.1508
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.15083040609515"
```

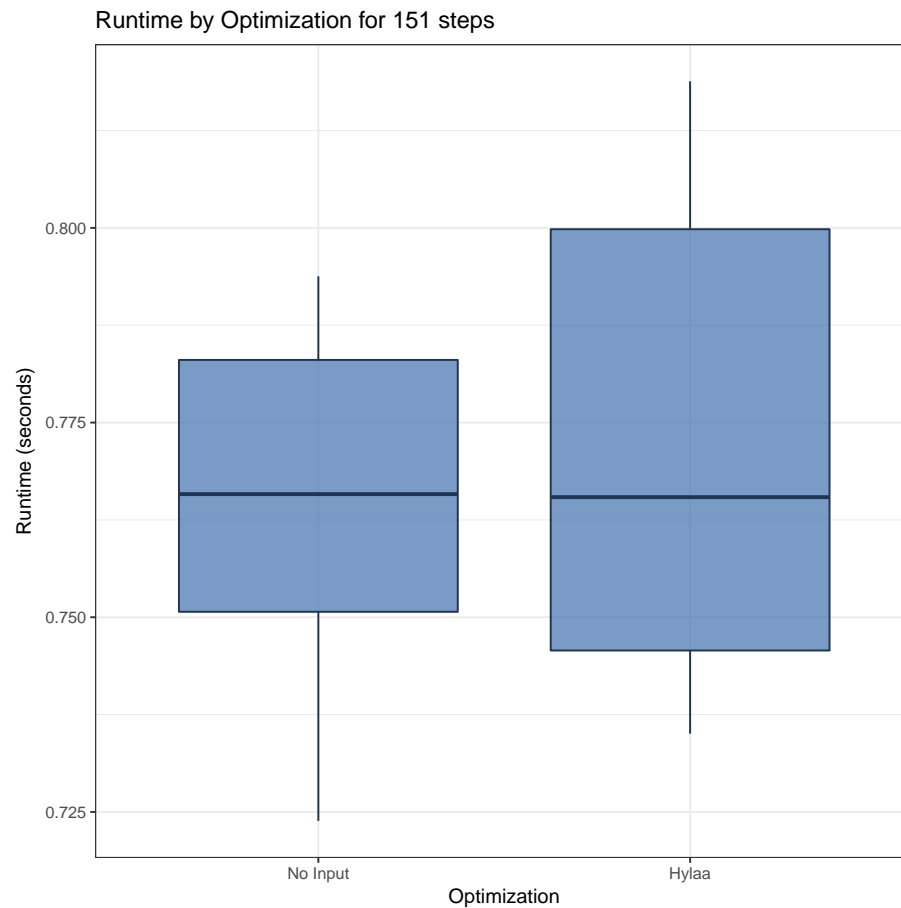
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7239 0.7507 0.7658 0.7635 0.7830 0.7938
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "NoInput" & object == "steps151")$time
## W = 0.91862, p-value = 0.3456
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.345609193423644"
```

Comparison



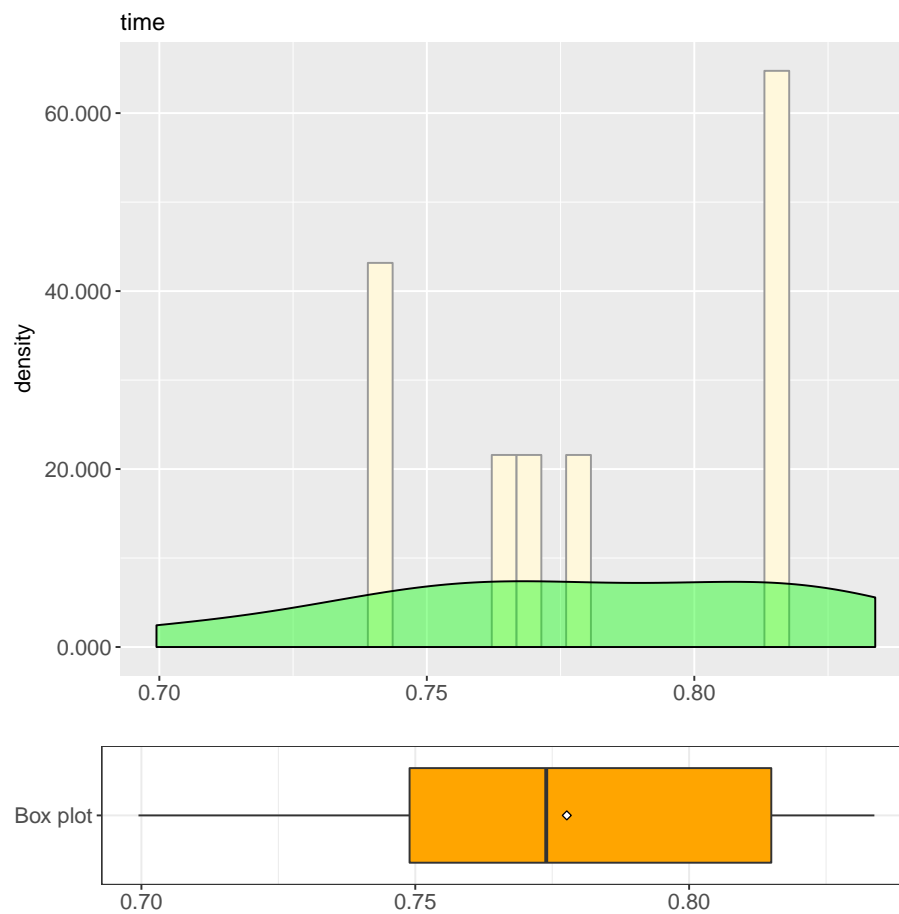
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps151")$time and subset(js
## F = 1.7239, num df = 9, denom df = 9, p-value = 0.4296
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.428197 6.940486
## sample estimates:
## ratio of variances
##      1.723918
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.429599917380244"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps151")$time and subset(js
## t = 0.64503, df = 18, p-value = 0.527
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.01878614 0.03543262
## sample estimates:
## mean of x mean of y
## 0.7718092 0.7634860
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.527041763031356"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7718092203141"
## [1] "Mean Runtime for No Input: 0.7634859800338"
## [1] "Absolute difference: 0.00832324028030007"
## Runtime for Hylaa is 1.09016281869794 % greater than
## Runtime for No Input
```

3.4.8 RH4.8: Object 197 steps

Runtime for Hylaa

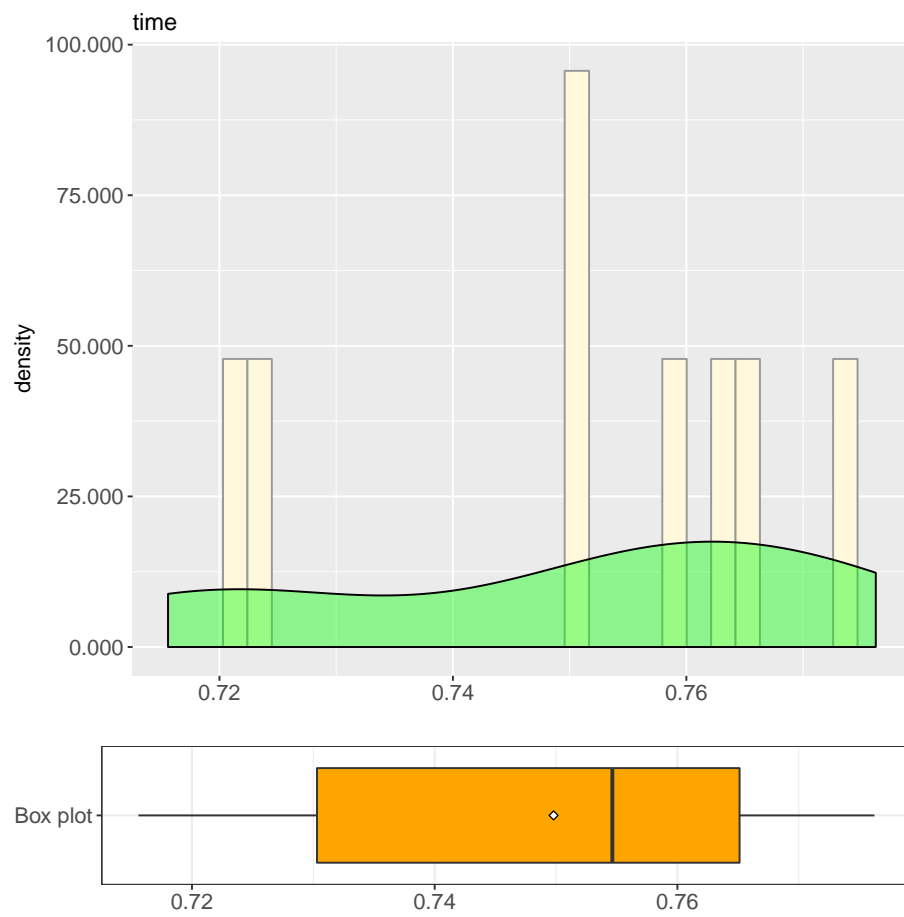
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.6995 0.7490 0.7739 0.7777 0.8150 0.8338
```

```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps197")$time
## W = 0.94142, p-value = 0.569
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.568954856828926"
```

Runtime for No Input

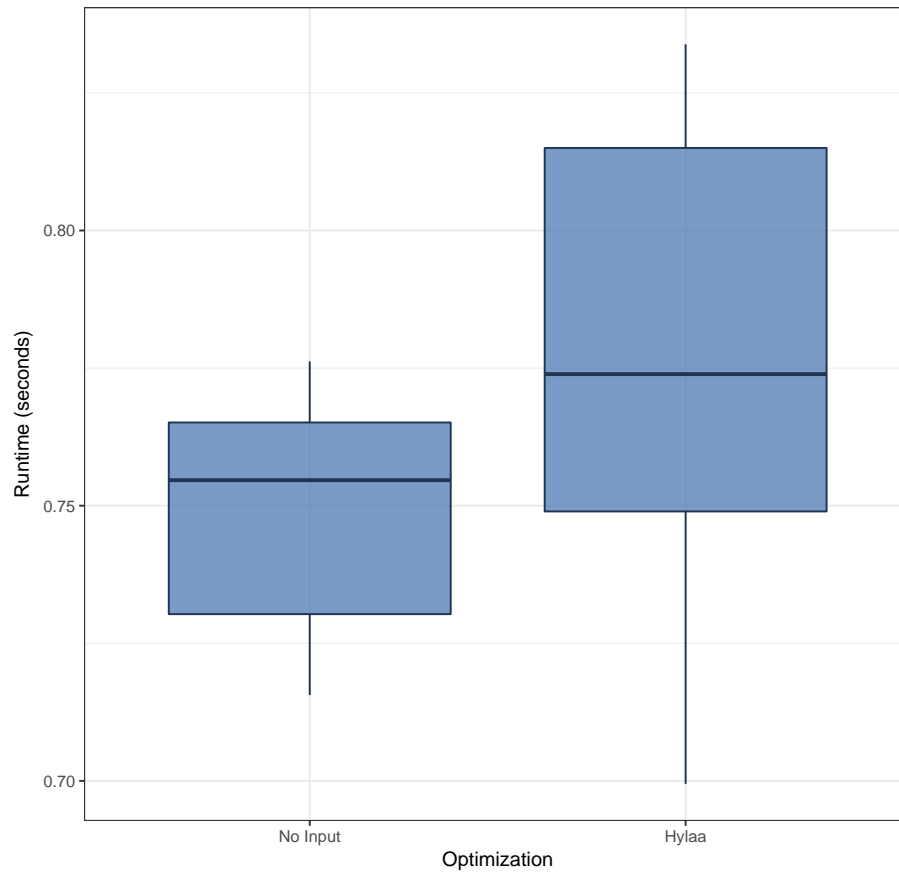
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7156 0.7303 0.7546 0.7498 0.7651 0.7762
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps197")$time
## W = 0.8855, p-value = 0.1508
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.150818781399032"
```

Comparison

Runtime by Optimization for 197 steps



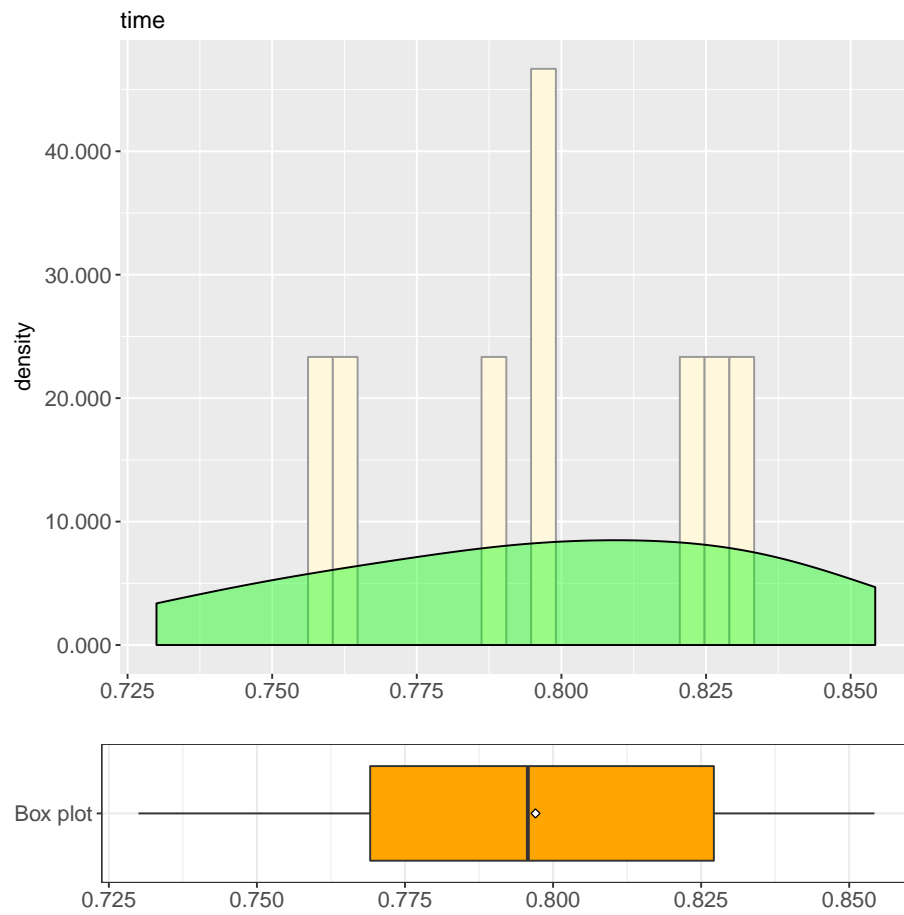
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps197")$time and subset(js
## F = 3.6873, num df = 9, denom df = 9, p-value = 0.0652
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.9158757 14.8450893
## sample estimates:
## ratio of variances
##      3.68731
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.0652026687424552"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps197")$time and subset(js
## t = 1.832, df = 18, p-value = 0.08356
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.004092036 0.059835969
## sample estimates:
## mean of x mean of y
## 0.7776674 0.7497955
##
## [1] "T-test: Null Hypothesis not rejected. P-value: 0.0835570018368799"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.777667427063"
## [1] "Mean Runtime for No Input: 0.7497954607011"
## [1] "Absolute difference: 0.0278719663618999"
## Runtime for Hylaa is 3.71727595360981 % greater than
## Runtime for No Input
```

3.4.9 RH4.9: Object 256 steps

Runtime for Hylaa

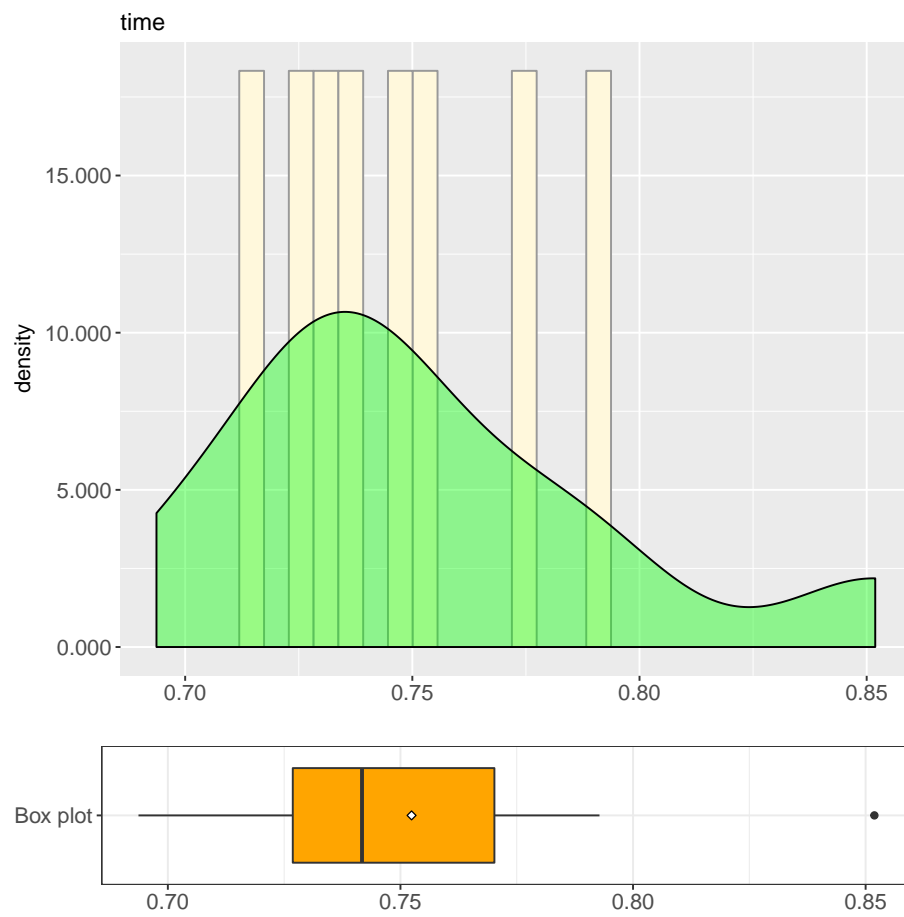
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7300 0.7691 0.7957 0.7970 0.8271 0.8542
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps256")$time
## W = 0.964, p-value = 0.8303
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.830310406698625"
```

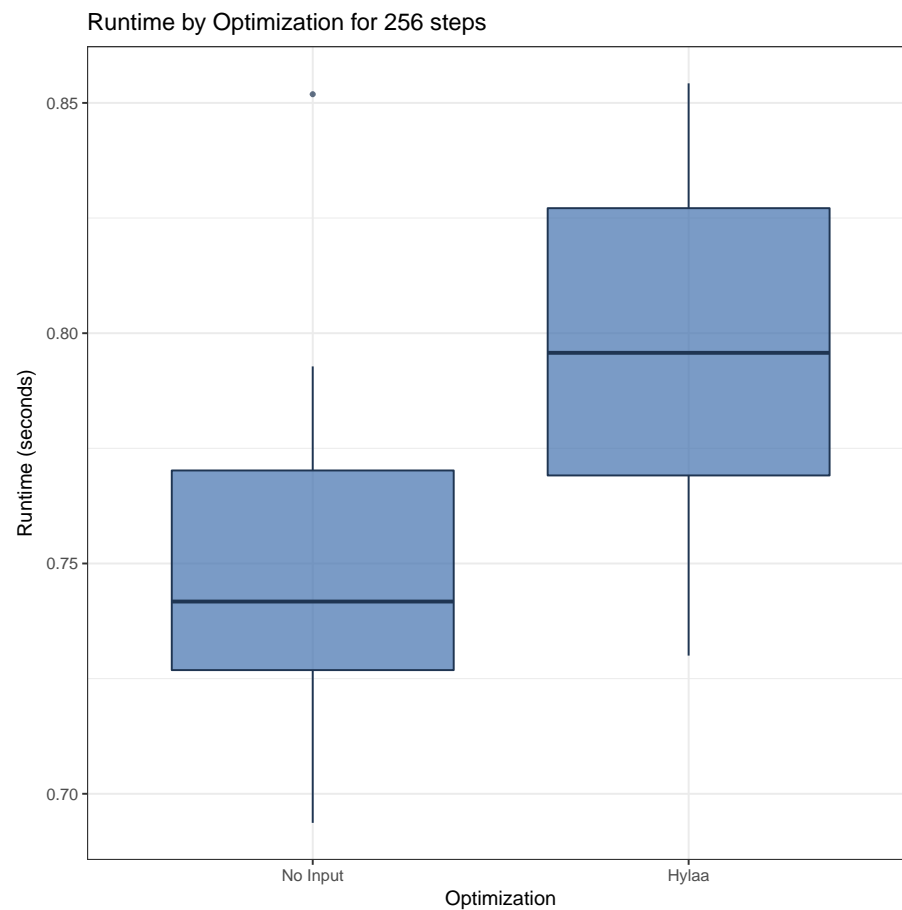
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.6937 0.7269 0.7417 0.7524 0.7702 0.8519
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps256")$time
## W = 0.9265, p-value = 0.4144
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.414374996139315"
```

Comparison



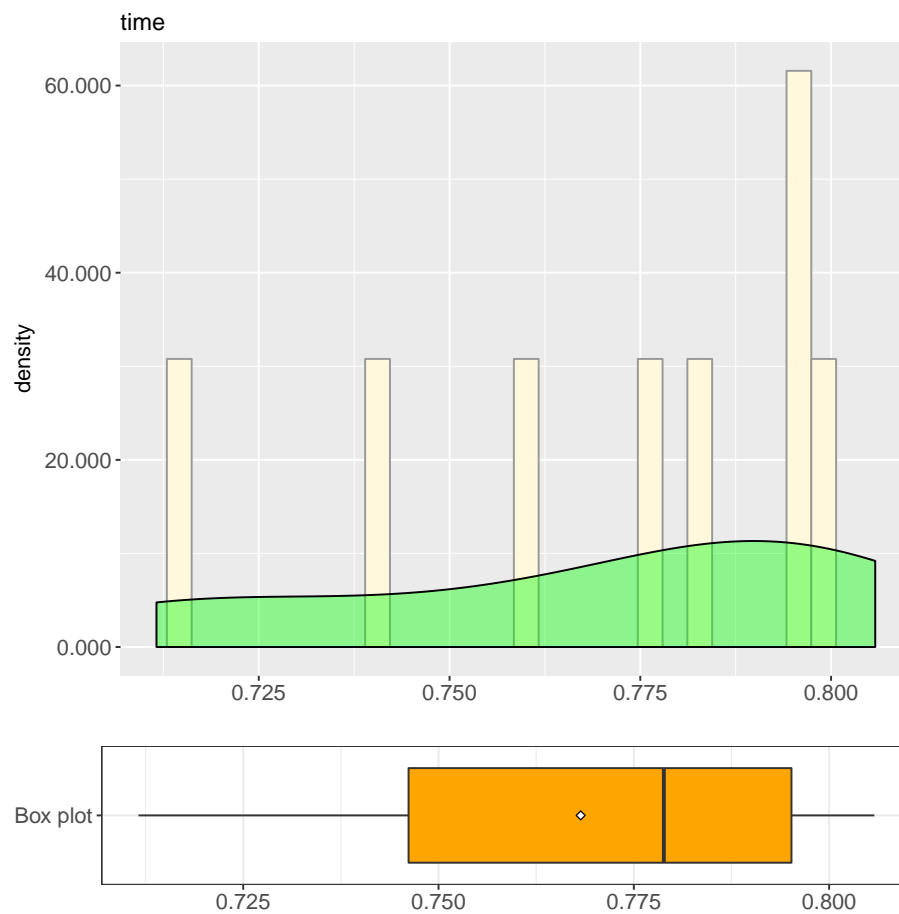
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps256")$time and subset(js
## F = 0.73996, num df = 9, denom df = 9, p-value = 0.661
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1837968 2.9790937
## sample estimates:
## ratio of variances
##      0.7399647
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.660968338544875"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps256")$time and subset(js
## t = 2.3674, df = 18, p-value = 0.02932
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.005024534 0.084263272
## sample estimates:
## mean of x mean of y
## 0.7970330 0.7523891
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.0293228451357061"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.79703299999924"
## [1] "Mean Runtime for No Input: 0.7523890972139"
## [1] "Absolute difference: 0.0446439027784999"
## Runtime for Hylaa is 5.93361904682252 % greater than
## Runtime for No Input
```

3.4.10 RH4.10: Object 332 steps

Runtime for Hylaa

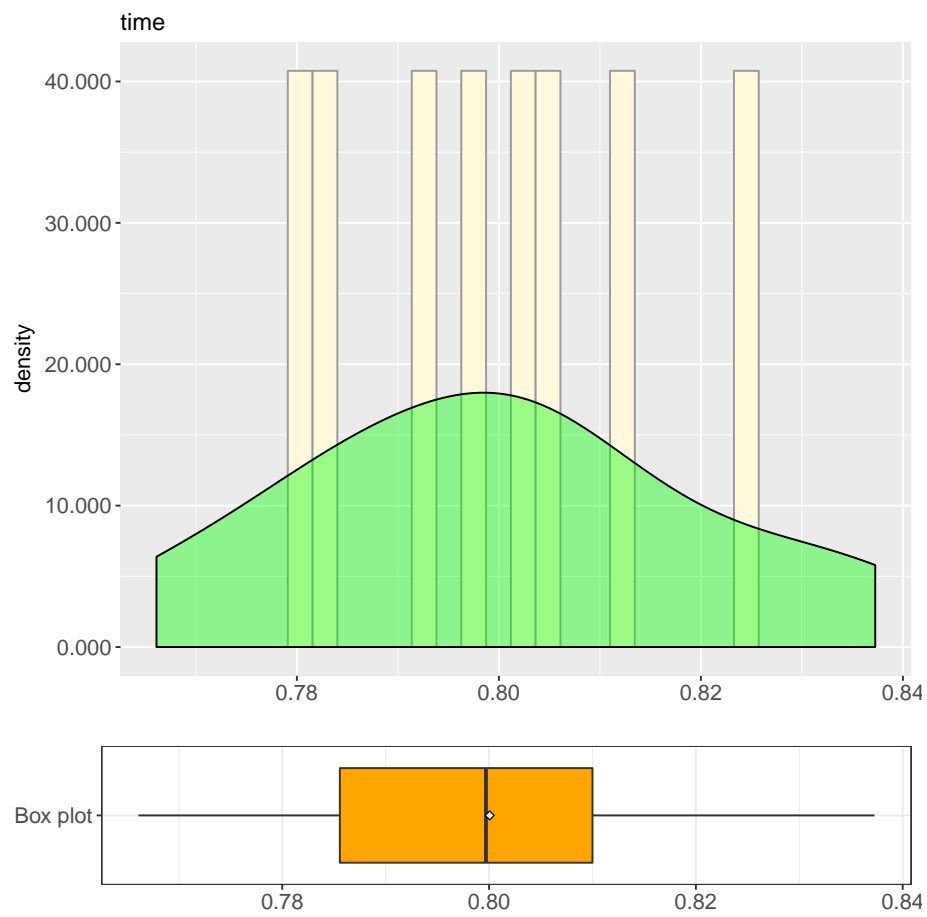
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7116 0.7462 0.7788 0.7682 0.7952 0.8058
```

```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps332")$time
## W = 0.87995, p-value = 0.1303
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.130315495202675"
```

Runtime for No Input

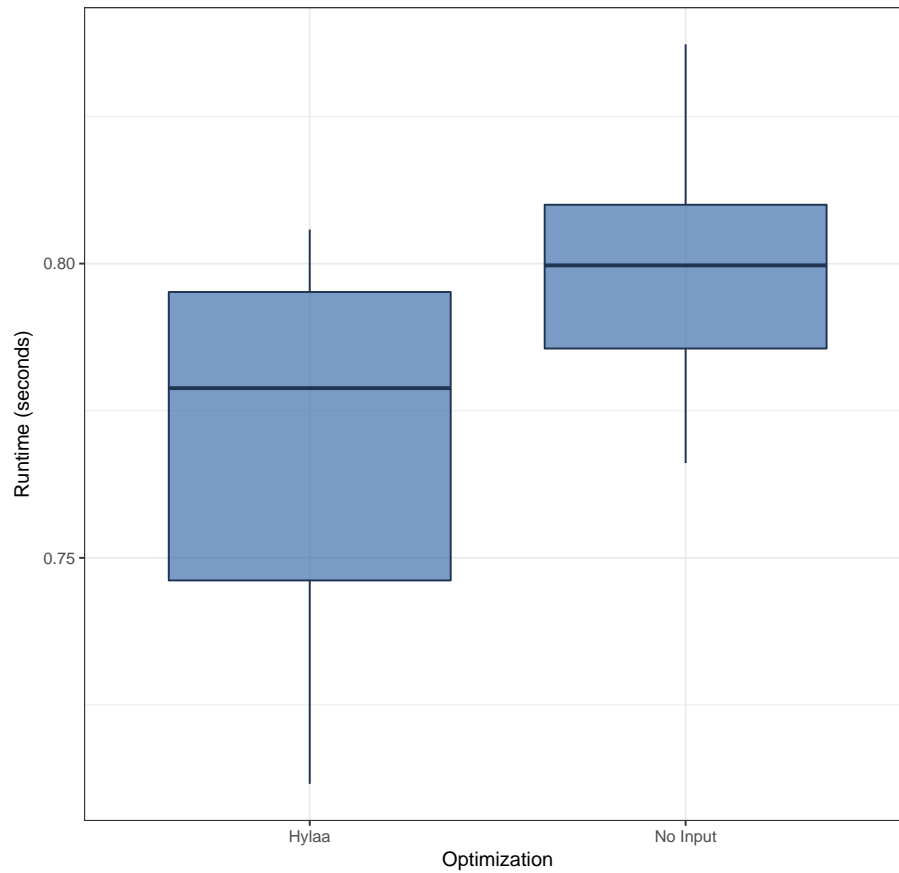
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.7661  0.7856  0.7997  0.8001  0.8100  0.8373
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps332")$time
## W = 0.98924, p-value = 0.9958
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.99580819770823"
```

Comparison

Runtime by Optimization for 332 steps



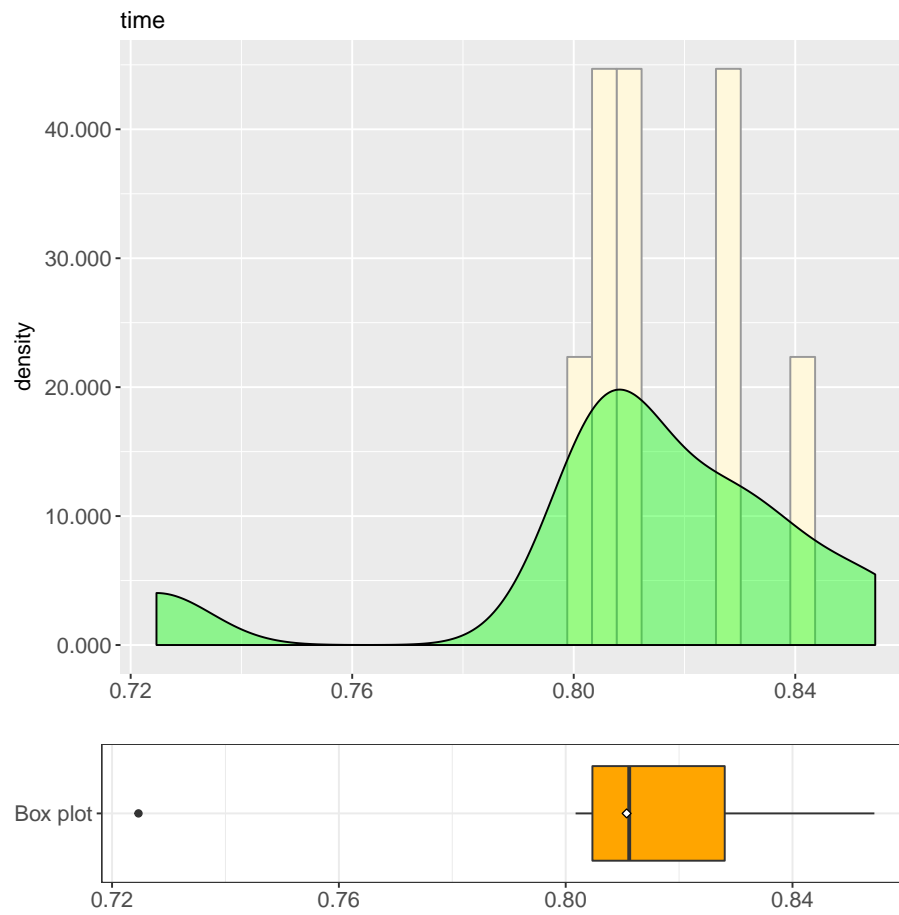
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps332")$time and subset(js
## F = 2.7335, num df = 9, denom df = 9, p-value = 0.1502
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.6789736 11.0052313
## sample estimates:
## ratio of variances
##      2.733544
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.150224237981617"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps332")$time and subset(js
## t = -2.4776, df = 18, p-value = 0.02337
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.05887615 -0.00484355
## sample estimates:
## mean of x mean of y
## 0.7681974 0.8000573
##
## [1] "T-test: Null Hypothesis rejected. P-value: 0.0233707432692102"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.7681974172593"
## [1] "Mean Runtime for No Input: 0.8000572681428"
## [1] "Absolute difference: 0.0318598508835"
## Runtime for No Input is 4.14735199151885 % greater than
## Runtime for Hylaa
```

3.4.11 RH4.11: Object 432 steps

Runtime for Hylaa

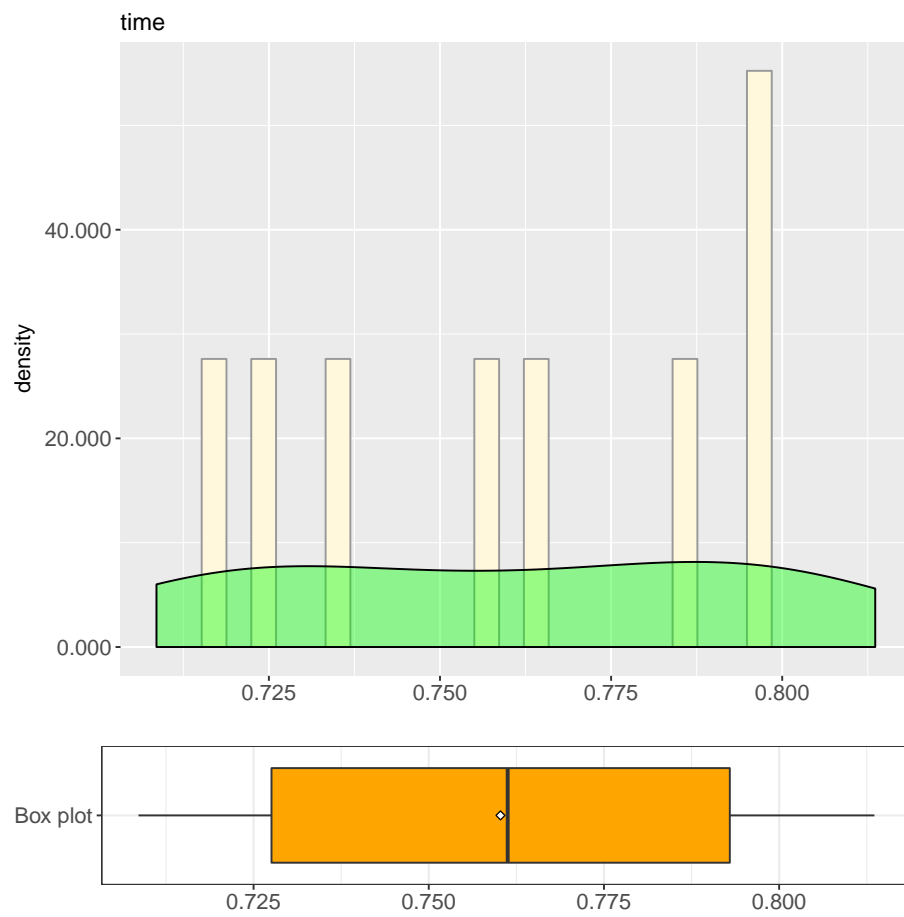
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7247 0.8047 0.8112 0.8107 0.8280 0.8544
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps432")$time
## W = 0.82468, p-value = 0.02887
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.0288658654097958"
```

Runtime for No Input

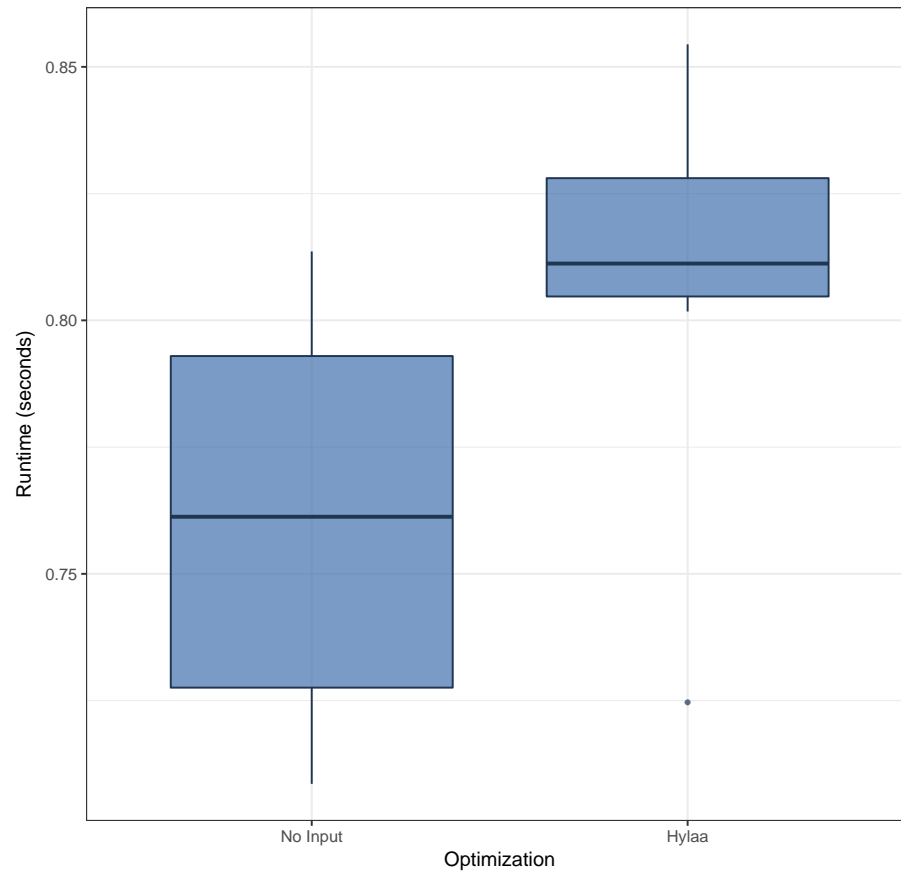
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7086 0.7276 0.7613 0.7602 0.7930 0.8136
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "NoInput" & object == "steps432")$time
## W = 0.93381, p-value = 0.4863
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.486345623942788"
```

Comparison

Runtime by Optimization for 432 steps

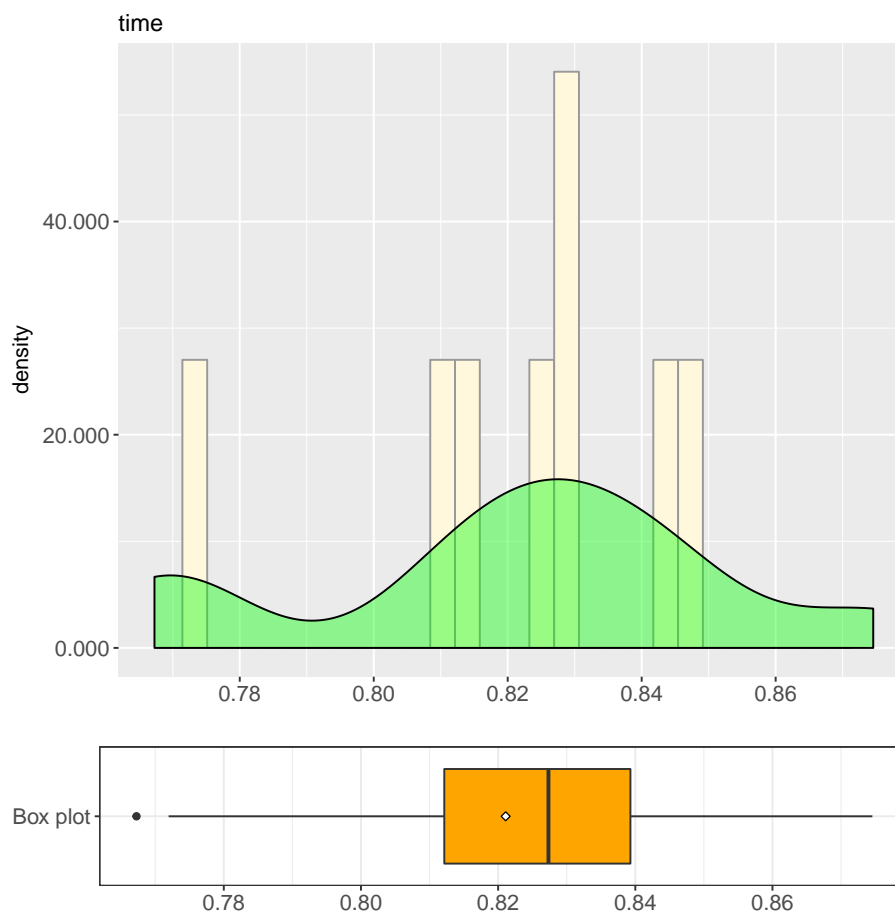


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 87, p-value = 0.003886
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 0.00388620667258438"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.8107497930526"
## [1] "Mean Runtime for No Input: 0.760235786438"
## [1] "Absolute difference: 0.0505140066145999"
## Runtime for Hylaa is 6.64451838702275 % greater than
## Runtime for No Input
```

3.4.12 RH4.12: Object 562 steps

Runtime for Hylaa

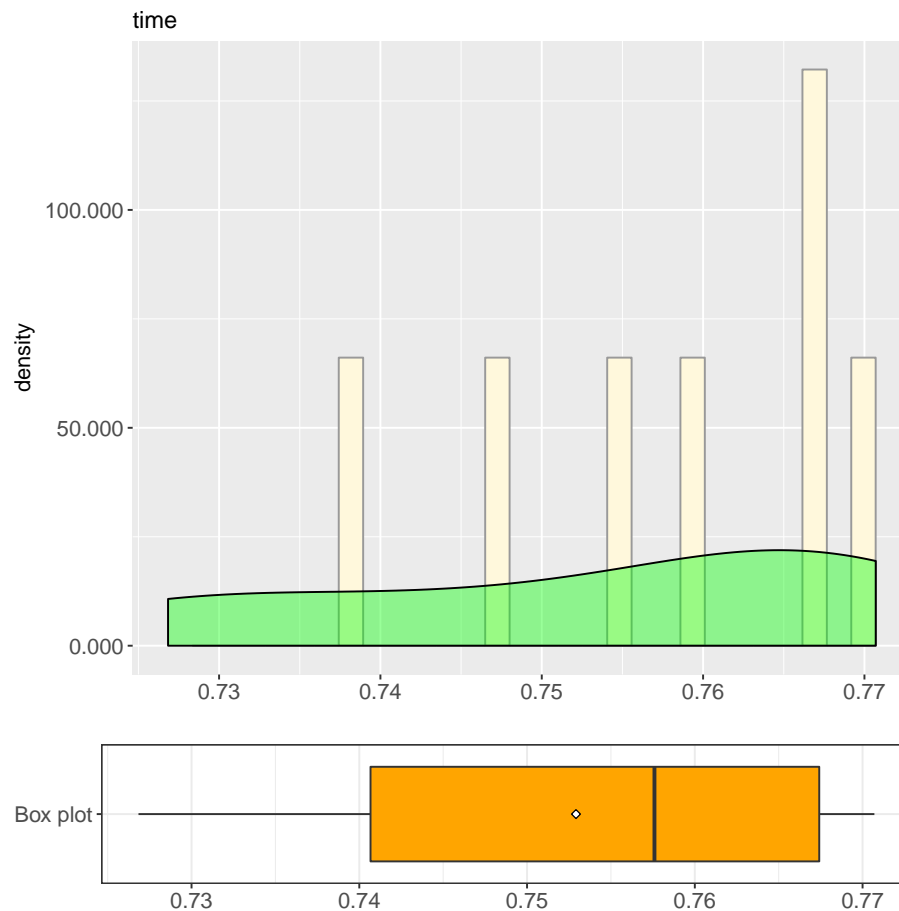
```
## [1] "Sample size: 10"  
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
## 0.7673  0.8121  0.8273  0.8211  0.8393  0.8746
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Hylaa" & object == "steps562")$time  
## W = 0.93601, p-value = 0.5095  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.509497615860695"
```

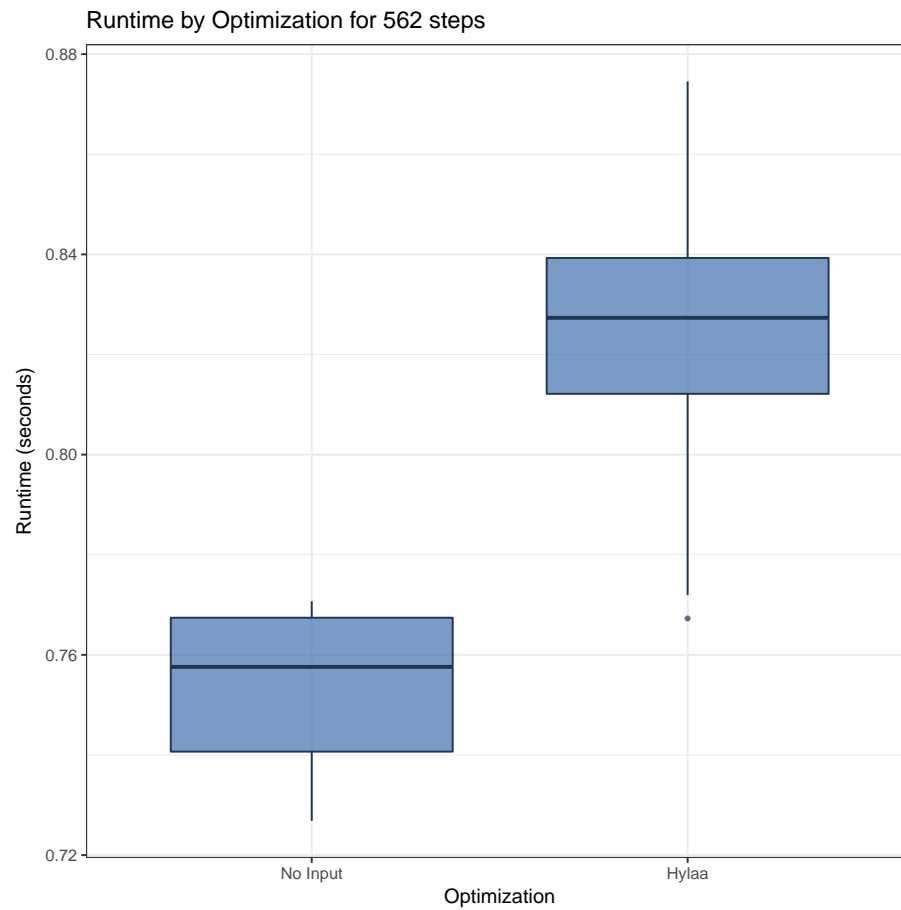
Runtime for No Input


```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7268 0.7407 0.7576 0.7529 0.7674 0.7707
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "NoInput" & object == "steps562")$time
## W = 0.86863, p-value = 0.09636
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0963607011743788"
```

Comparison



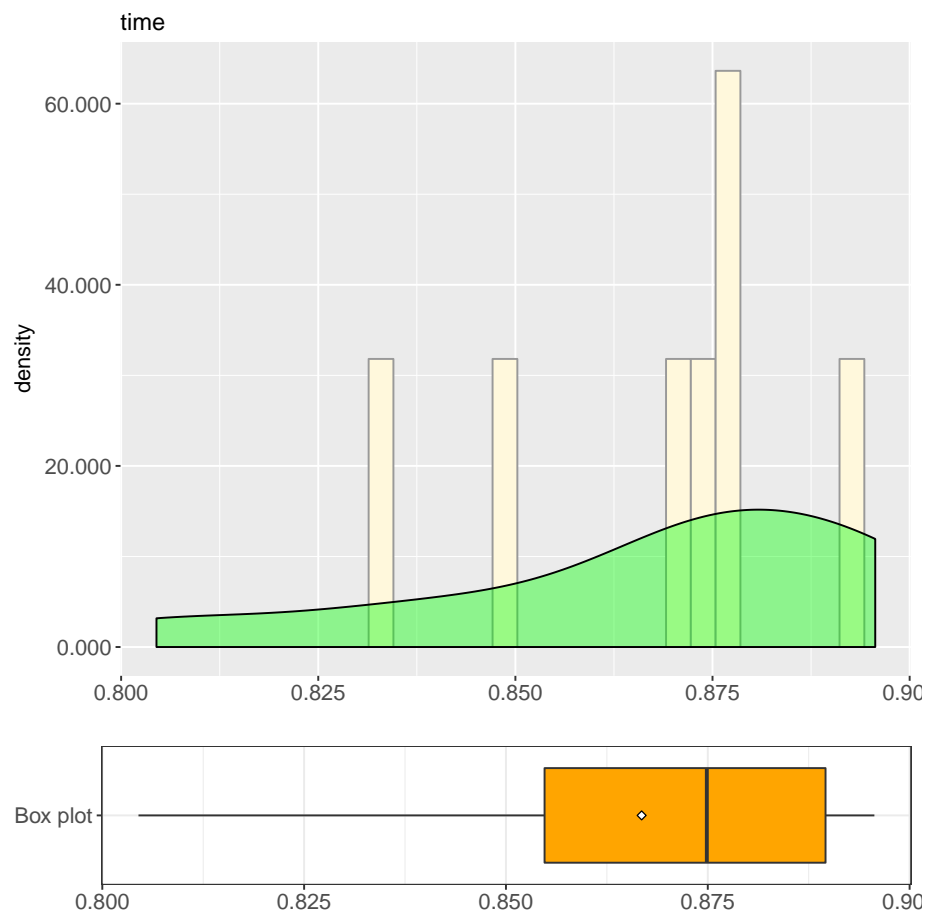
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps562")$time and subset(js
## F = 3.5746, num df = 9, denom df = 9, p-value = 0.07146
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.887879 14.391301
## sample estimates:
## ratio of variances
##      3.574595
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.07146213762243"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps562")$time and subset(js
## t = 5.8593, df = 18, p-value = 1.505e-05
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.04373455 0.09262967
## sample estimates:
## mean of x mean of y
## 0.8210984 0.7529163
##
## [1] "T-test: Null Hypothesis rejected. P-value: 1.5053271323417e-05"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.8210983753205"
## [1] "Mean Runtime for No Input: 0.752916264534"
## [1] "Absolute difference: 0.0681821107865"
## Runtime for Hylaa is 9.0557362084215 % greater than
## Runtime for No Input
```

3.4.13 RH4.13: Object 731 steps

Runtime for Hylaa

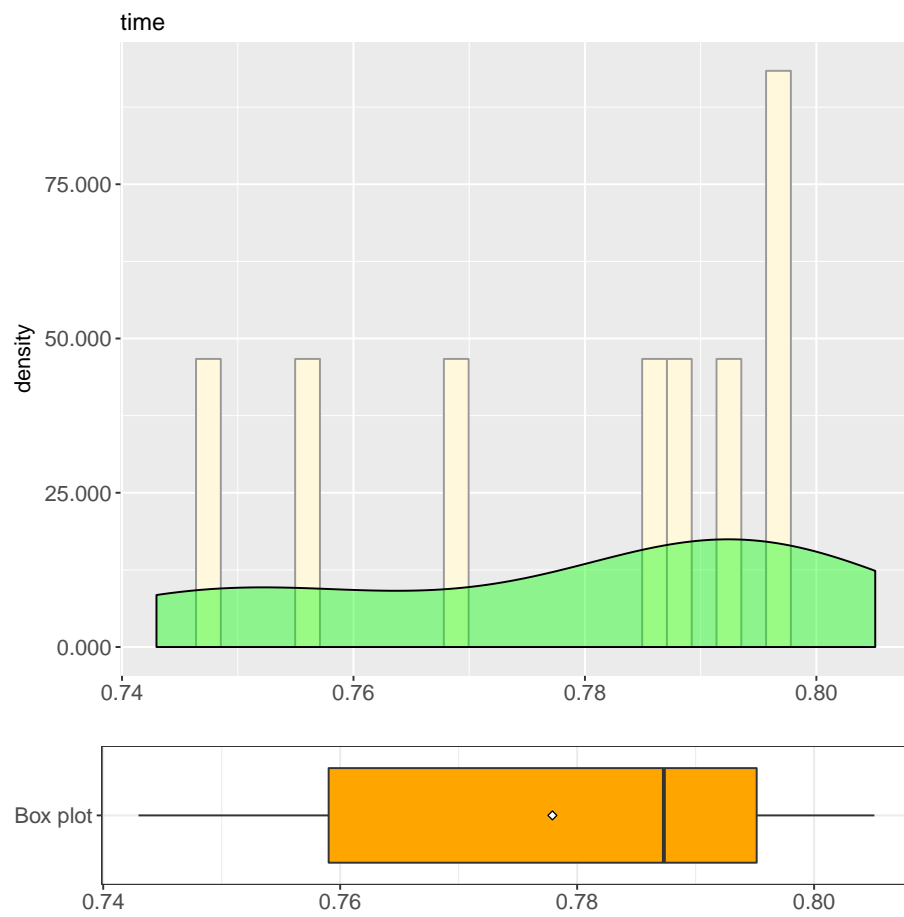
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.8045 0.8548 0.8749 0.8668 0.8896 0.8956
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps731")$time
## W = 0.86638, p-value = 0.09069
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0906925091728528"
```

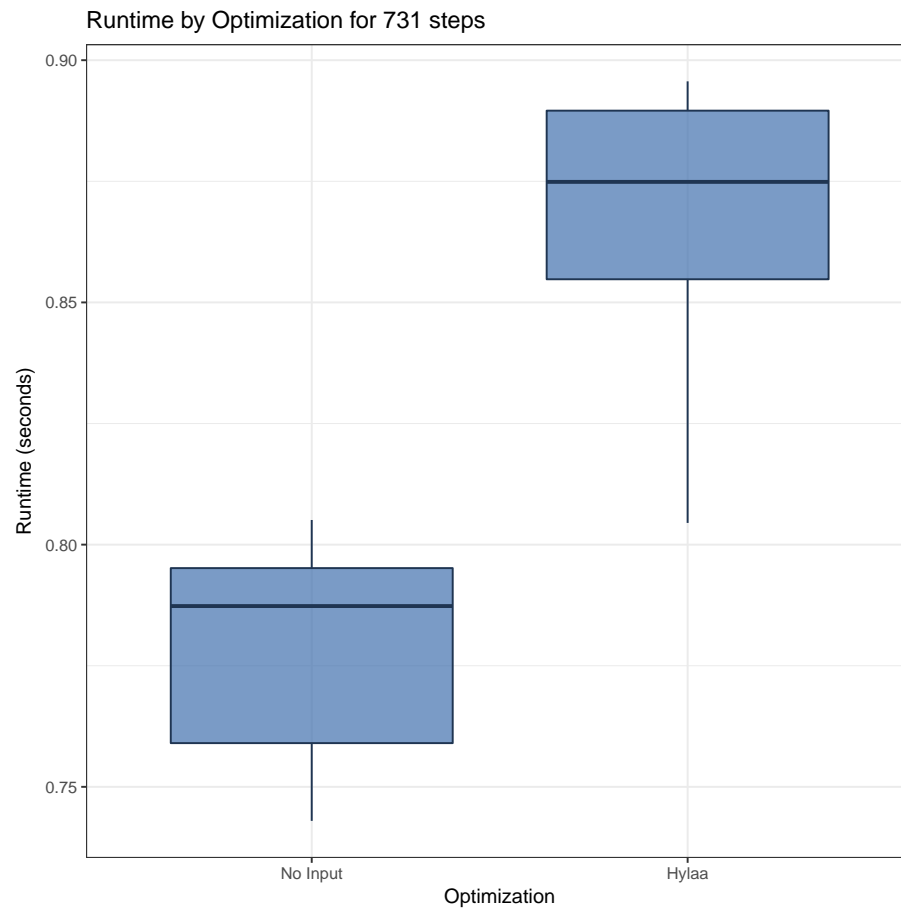
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.7430  0.7590  0.7873  0.7779  0.7952  0.8051
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps731")$time
## W = 0.88414, p-value = 0.1455
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.145537181070326"
```

Comparison



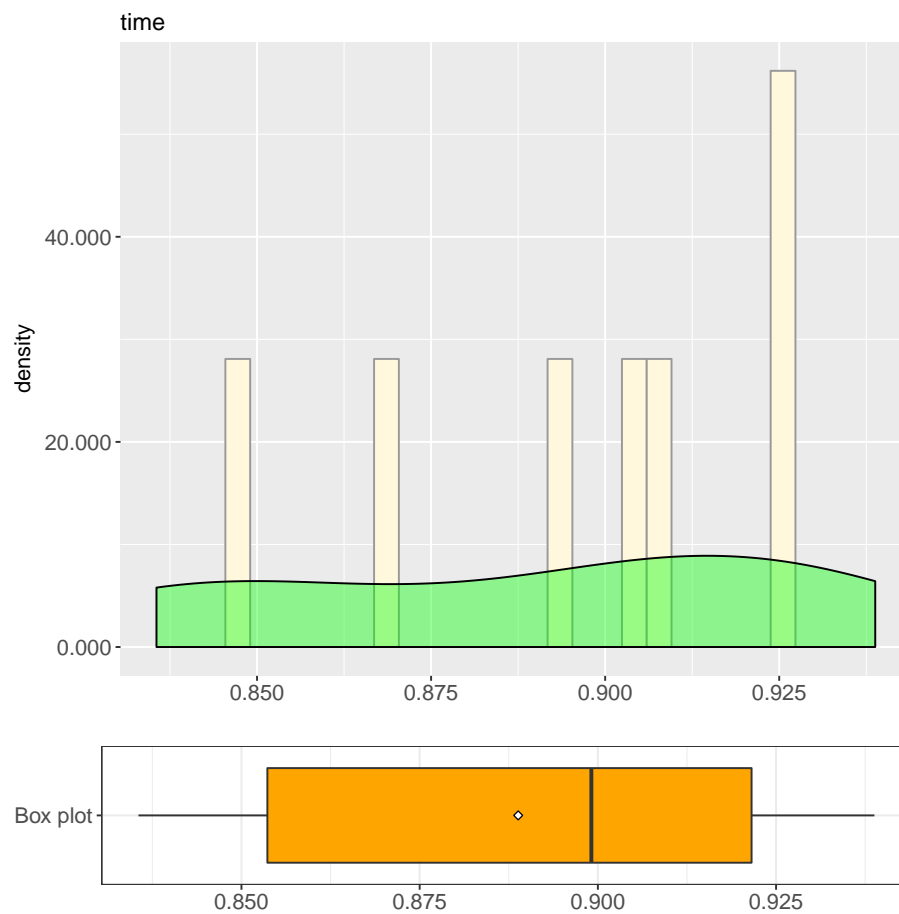
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps731")$time and subset(js
## F = 1.7458, num df = 9, denom df = 9, p-value = 0.4191
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.4336332 7.0286001
## sample estimates:
## ratio of variances
##      1.745805
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.419117538249995"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps731")$time and subset(js
## t = 7.5356, df = 18, p-value = 5.683e-07
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.06411268 0.11368201
## sample estimates:
## mean of x mean of y
## 0.8668062 0.7779089
##
## [1] "T-test: Null Hypothesis rejected. P-value: 5.68261341534836e-07"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.8668062448501"
## [1] "Mean Runtime for No Input: 0.7779088973998"
## [1] "Absolute difference: 0.0888973474503"
## Runtime for Hylaa is 11.4277324436632 % greater than
## Runtime for No Input
```

3.4.14 RH4.14: Object 951 steps

Runtime for Hylaa

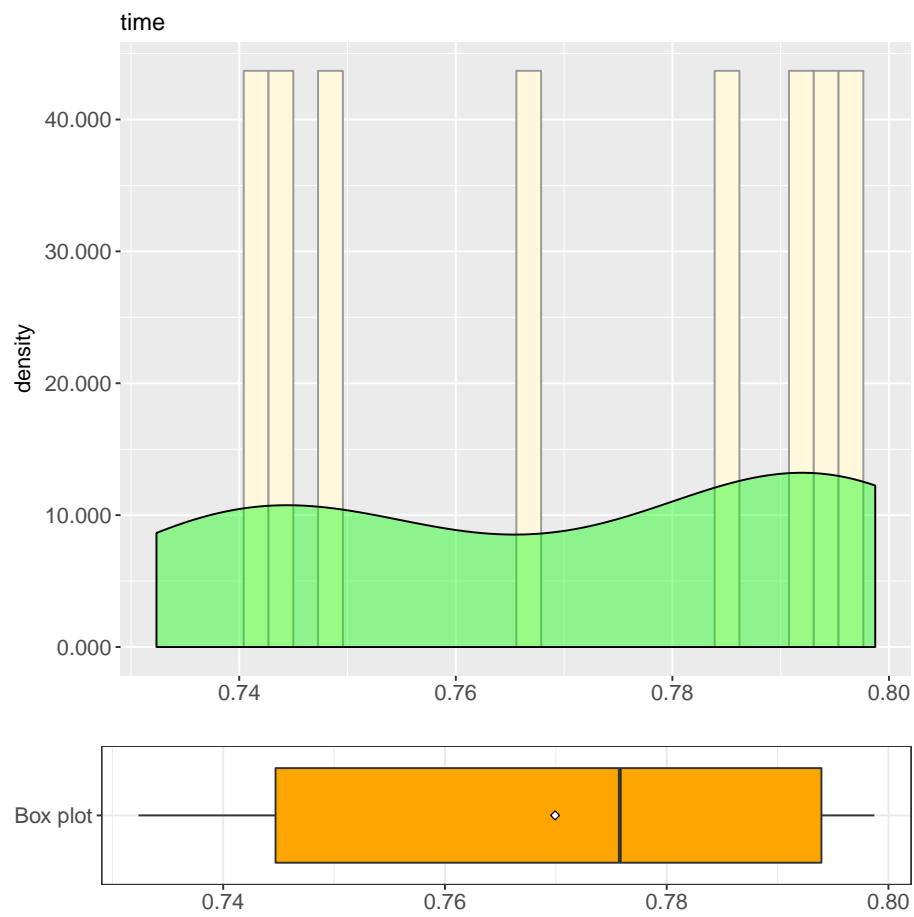
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.8356 0.8536 0.8991 0.8888 0.9216 0.9388
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps951")$time
## W = 0.90483, p-value = 0.2474
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.247358608075924"
```

Runtime for No Input

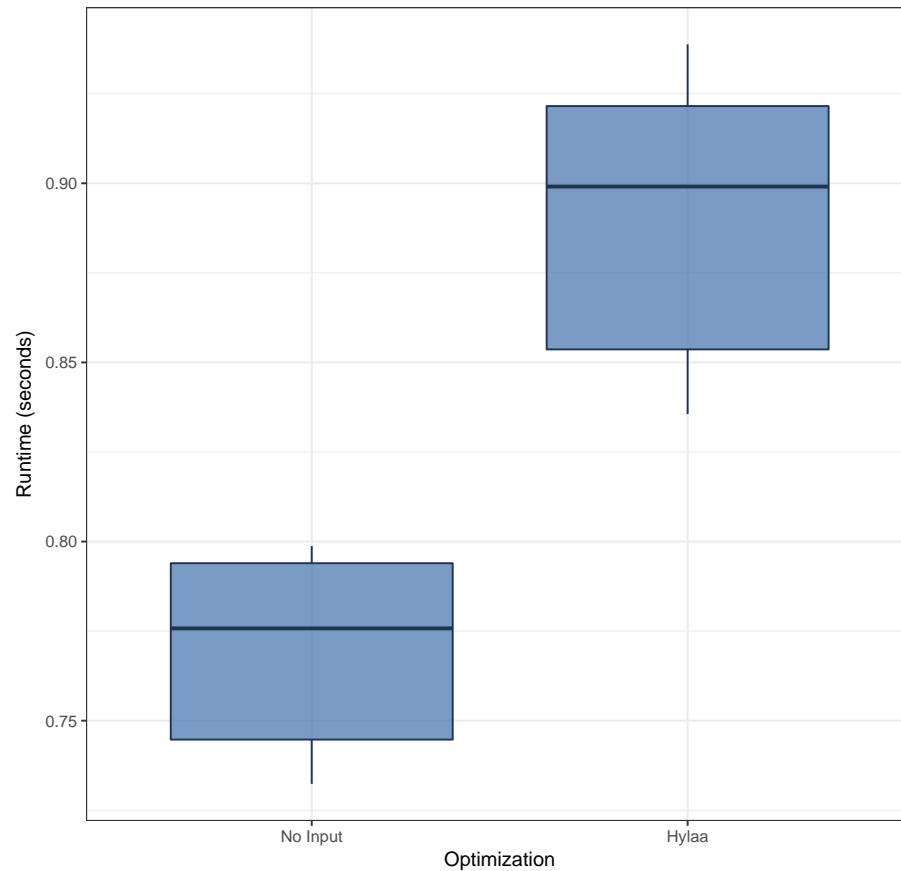
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.7324 0.7447  0.7758  0.7699  0.7940  0.7987
```

```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps951")$time
## W = 0.85749, p-value = 0.07127
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0712711860843741"
```

Comparison

Runtime by Optimization for 951 steps



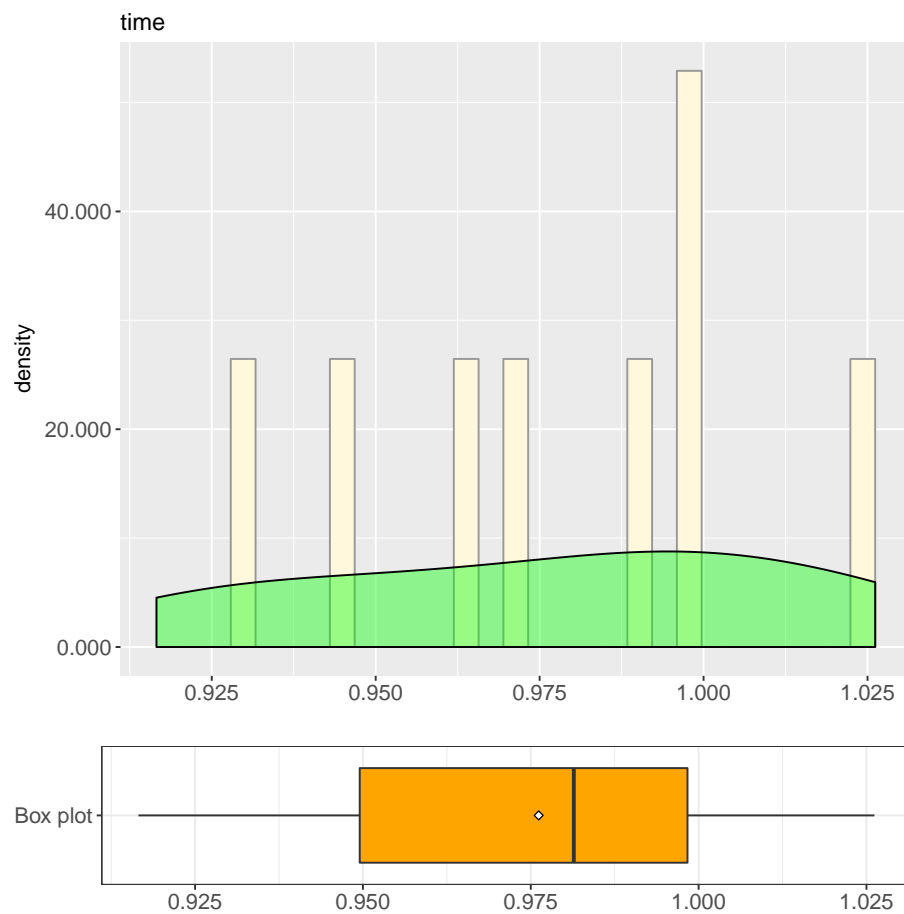
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps951")$time and subset(js
## F = 2.1532, num df = 9, denom df = 9, p-value = 0.2687
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.5348345 8.6689338
## sample estimates:
## ratio of variances
##      2.153241
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.268676900656385"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps951")$time and subset(js
## t = 7.9904, df = 18, p-value = 2.493e-07
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.08763256 0.15015421
## sample estimates:
## mean of x mean of y
## 0.8888239 0.7699305
##
## [1] "T-test: Null Hypothesis rejected. P-value: 2.49308726221035e-07"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.8888238906861"
## [1] "Mean Runtime for No Input: 0.7699305057524"
## [1] "Absolute difference: 0.1188933849337"
## Runtime for Hylaa is 15.4420930259821 % greater than
## Runtime for No Input
```

3.4.15 RH4.15: Object 1236 steps

Runtime for Hylaa

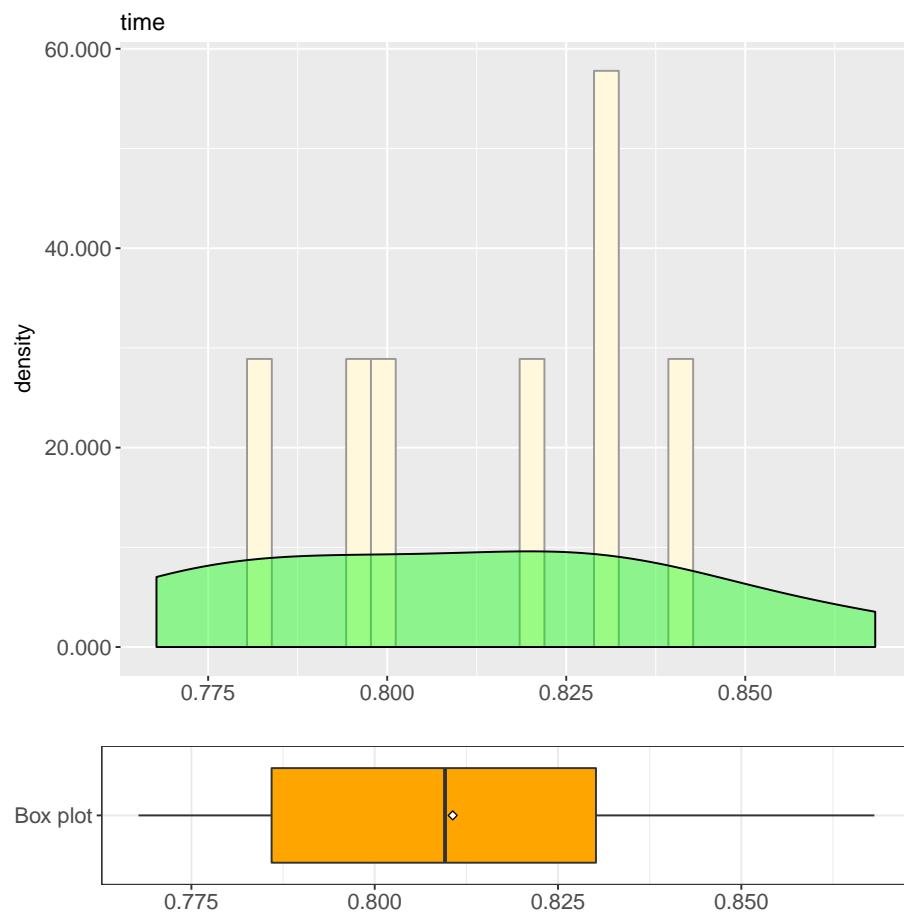
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.9166  0.9495  0.9814  0.9762  0.9983  1.0260
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps1236")$time
## W = 0.94652, p-value = 0.6275
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.627527133287823"
```

Runtime for No Input

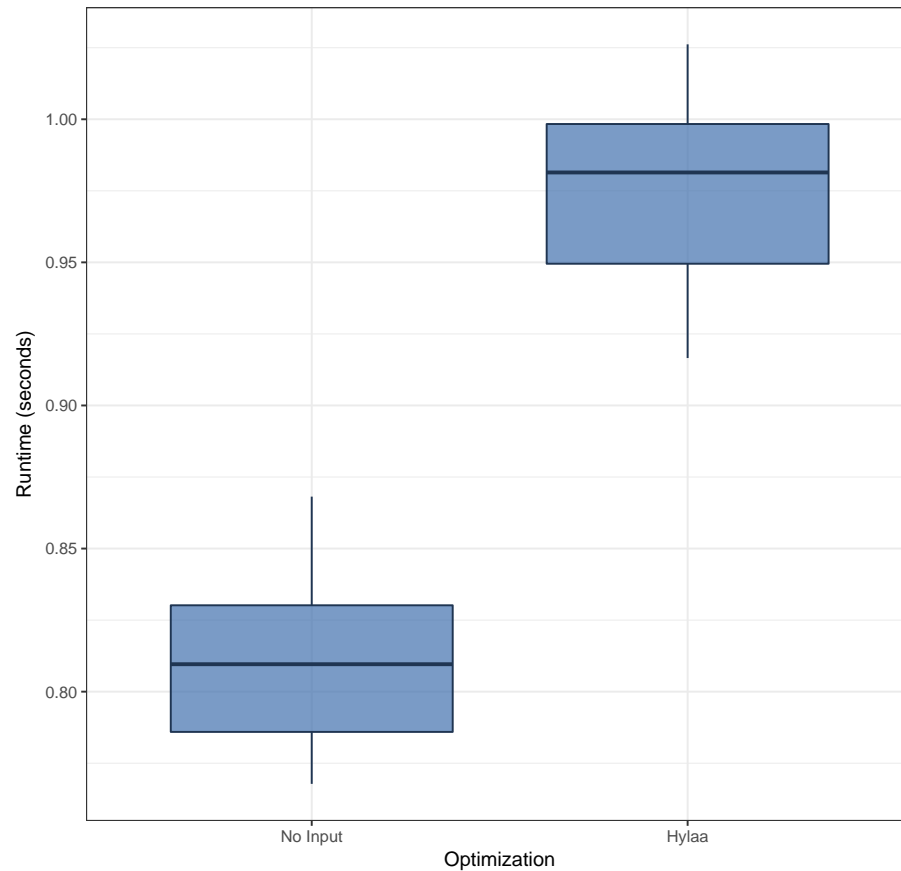
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7678 0.7859 0.8096 0.8106 0.8302 0.8681
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "NoInput" & object == "steps1236")$time
## W = 0.95641, p-value = 0.7443
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.744348182960949"
```

Comparison

Runtime by Optimization for 1236 steps



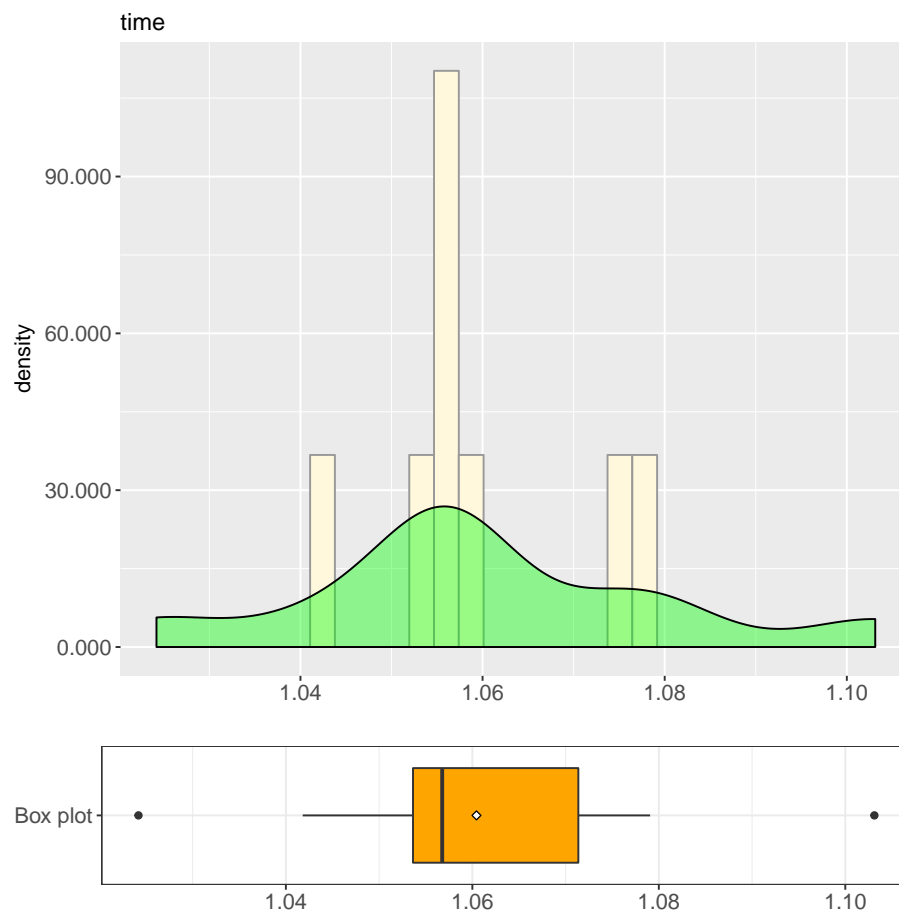
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps1236")$time and subset(j
## F = 1.3347, num df = 9, denom df = 9, p-value = 0.6741
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3315161 5.3734217
## sample estimates:
## ratio of variances
##      1.334682
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.67412518590098"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps1236")$time and subset(j
## t = 10.438, df = 18, p-value = 4.596e-09
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.1322239 0.1988602
## sample estimates:
## mean of x mean of y
## 0.9761788 0.8106368
##
## [1] "T-test: Null Hypothesis rejected. P-value: 4.59559913683751e-09"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 0.9761788368224"
## [1] "Mean Runtime for No Input: 0.810636806488"
## [1] "Absolute difference: 0.1655420303344"
## Runtime for Hylaa is 20.4212329133677 % greater than
## Runtime for No Input
```

3.4.16 RH4.16: Object 1607 steps

Runtime for Hylaa

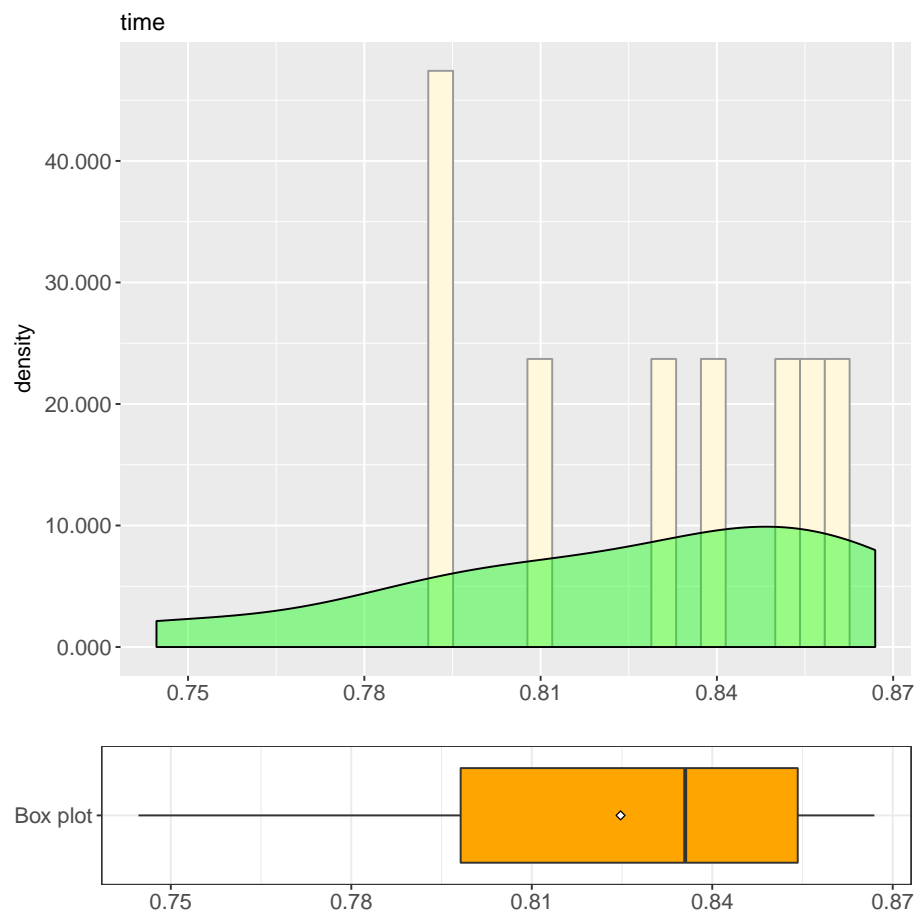
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 1.024 1.054 1.057 1.060 1.071 1.103
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps1607")$time
## W = 0.9449, p-value = 0.6087
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.608652897163905"
```

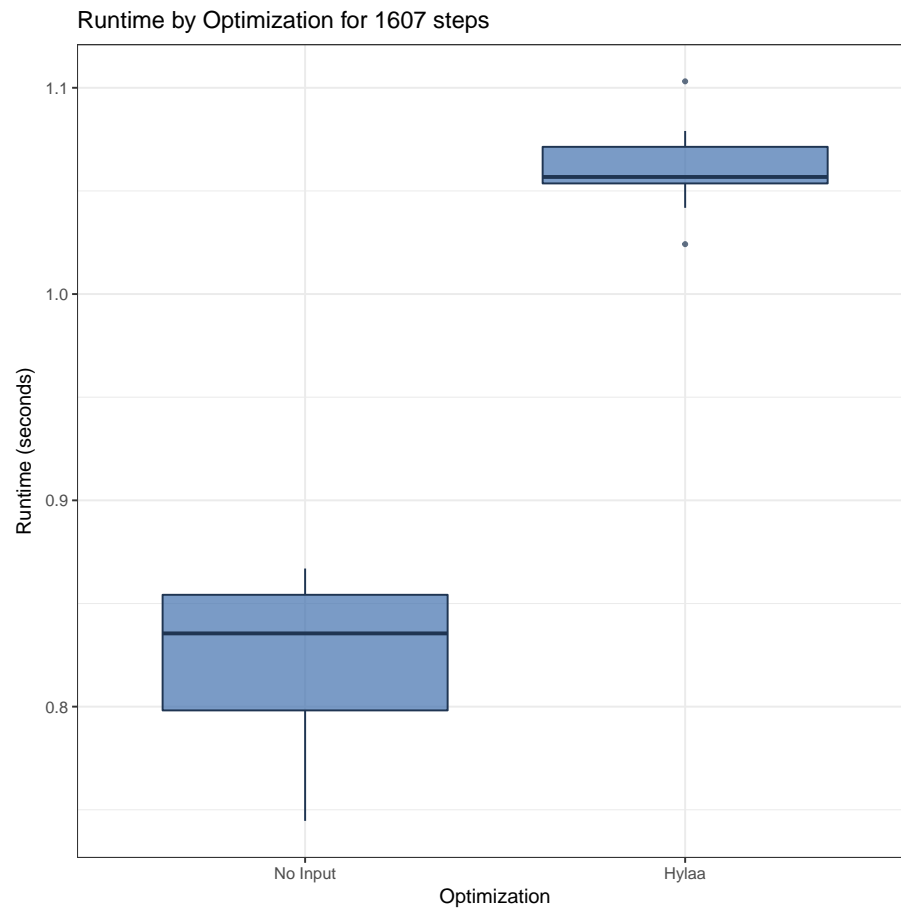
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.7446  0.7982  0.8355  0.8248  0.8542  0.8669
```

```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps1607")$time
## W = 0.90583, p-value = 0.2536
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.253552020700596"
```

Comparison



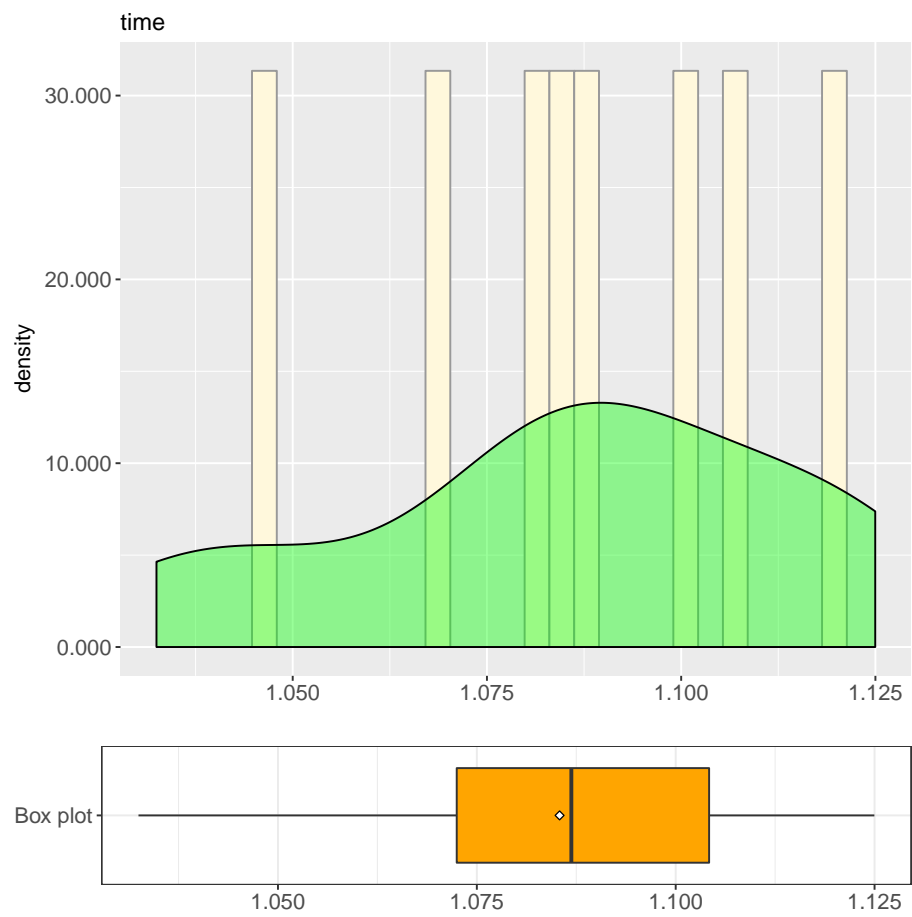
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps1607")$time and subset(json_data, treatment == "No Input" & object == "steps1607")$time
## F = 0.30735, num df = 9, denom df = 9, p-value = 0.09368
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.0763402 1.2373699
## sample estimates:
## ratio of variances
##      0.3073452
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.0936826730152032"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps1607")$time and subset(j
## t = 16.787, df = 18, p-value = 1.934e-12
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.2061853 0.2651791
## sample estimates:
## mean of x mean of y
## 1.060442 0.824760
##
## [1] "T-test: Null Hypothesis rejected. P-value: 1.93409446860168e-12"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.060442185402"
## [1] "Mean Runtime for No Input: 0.8247600078583"
## [1] "Absolute difference: 0.2356821775437"
## Runtime for Hylaa is 28.575849374136 % greater than
## Runtime for No Input
```

3.4.17 RH4.17: Object 2089 steps

Runtime for Hylaa

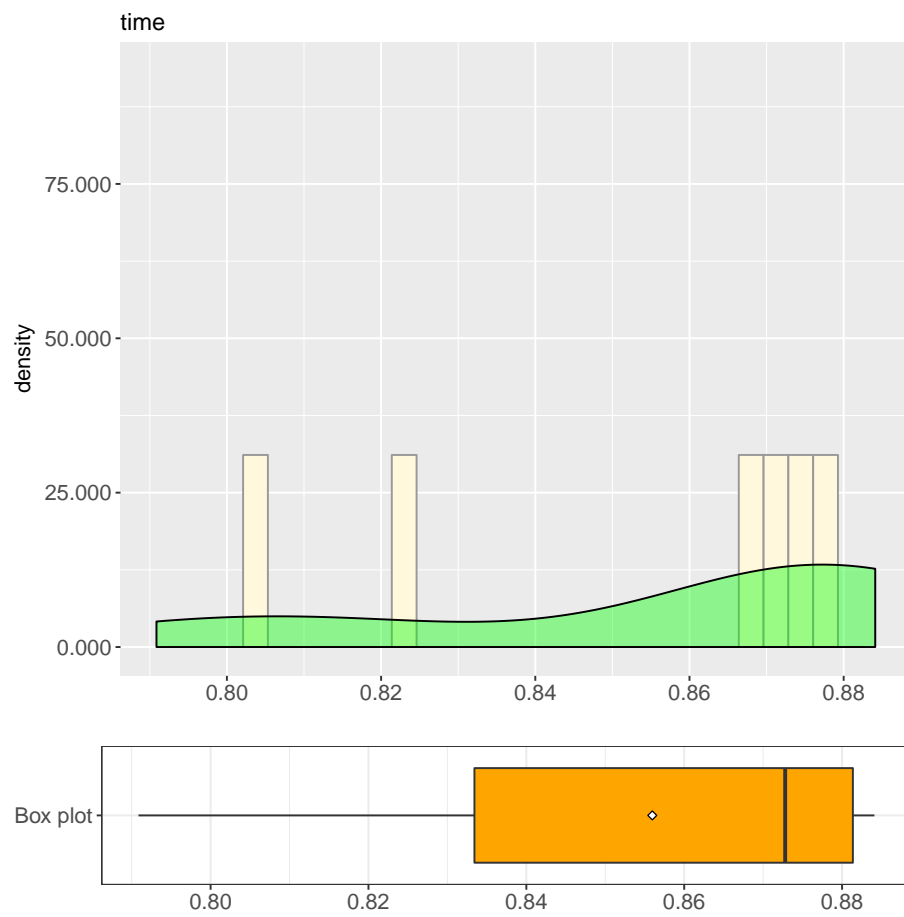
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 1.032   1.072   1.087   1.085   1.104   1.125
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps2089")$time
## W = 0.96099, p-value = 0.7971
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.797065263315739"
```

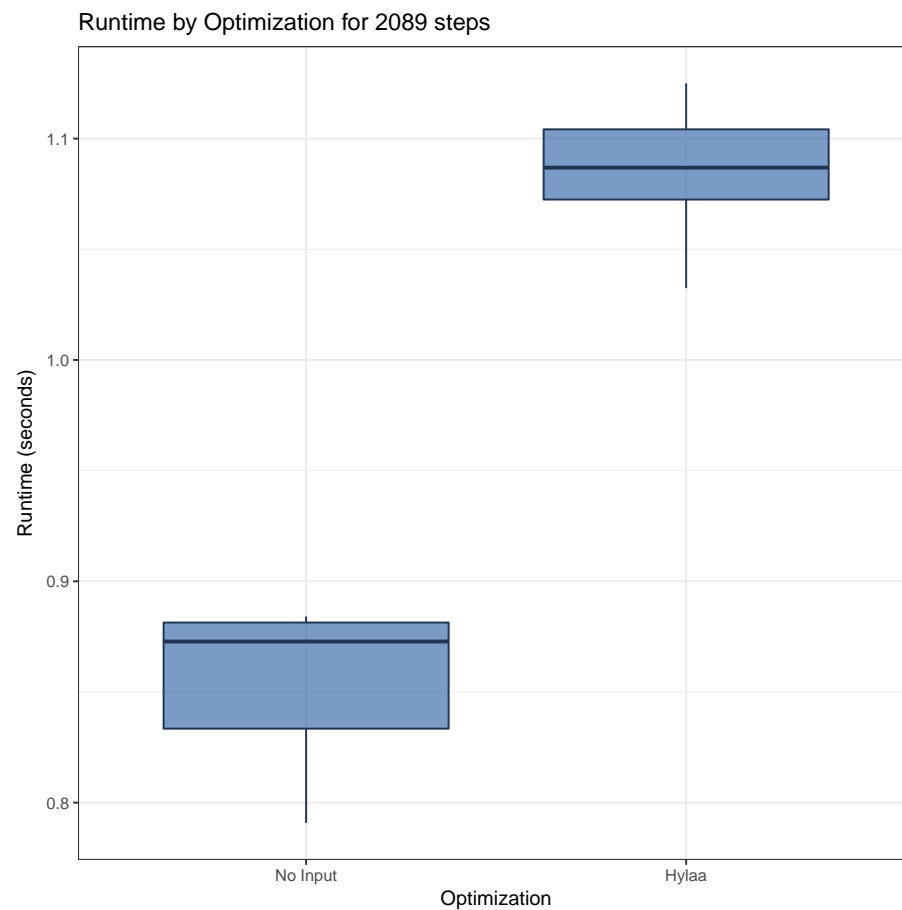
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7909 0.8334 0.8728 0.8560 0.8814 0.8841
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps2089")$time
## W = 0.76002, p-value = 0.004726
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.00472634954483069"
```

Comparison

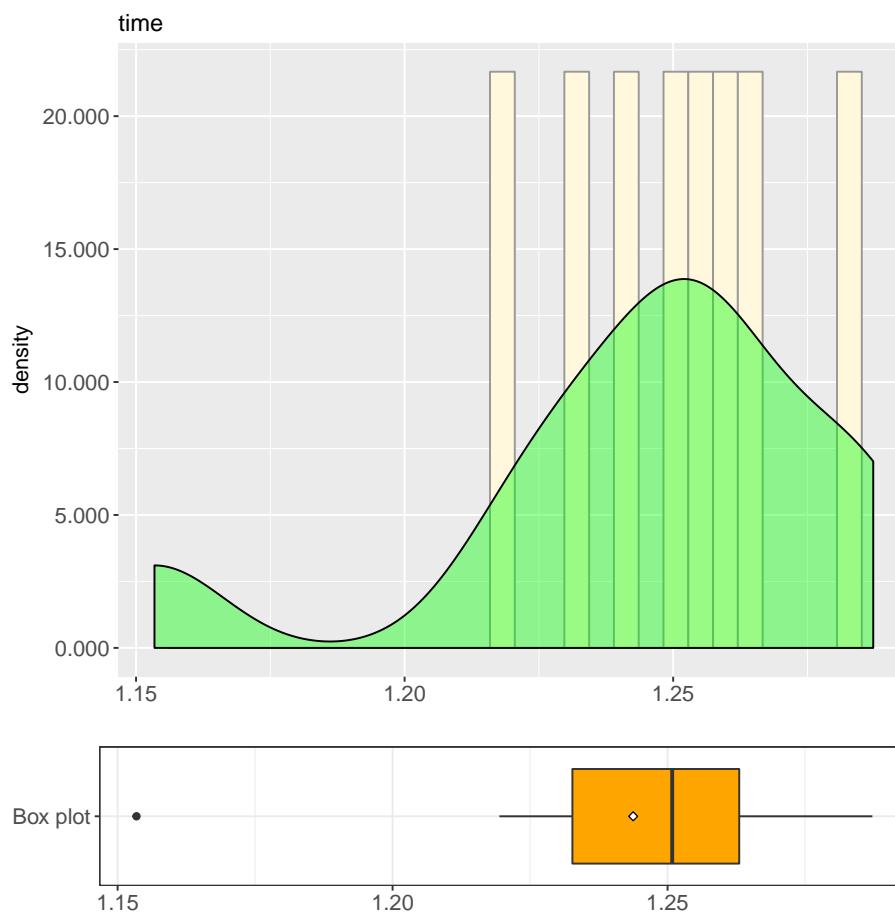


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 100, p-value = 1.083e-05
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 1.0825088224469e-05"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.085403156281"
## [1] "Mean Runtime for No Input: 0.8559572935105"
## [1] "Absolute difference: 0.2294458627705"
## Runtime for Hylaa is 26.8057605805874 % greater than
## Runtime for No Input
```

3.4.18 RH4.18: Object 2716 steps

Runtime for Hylaa

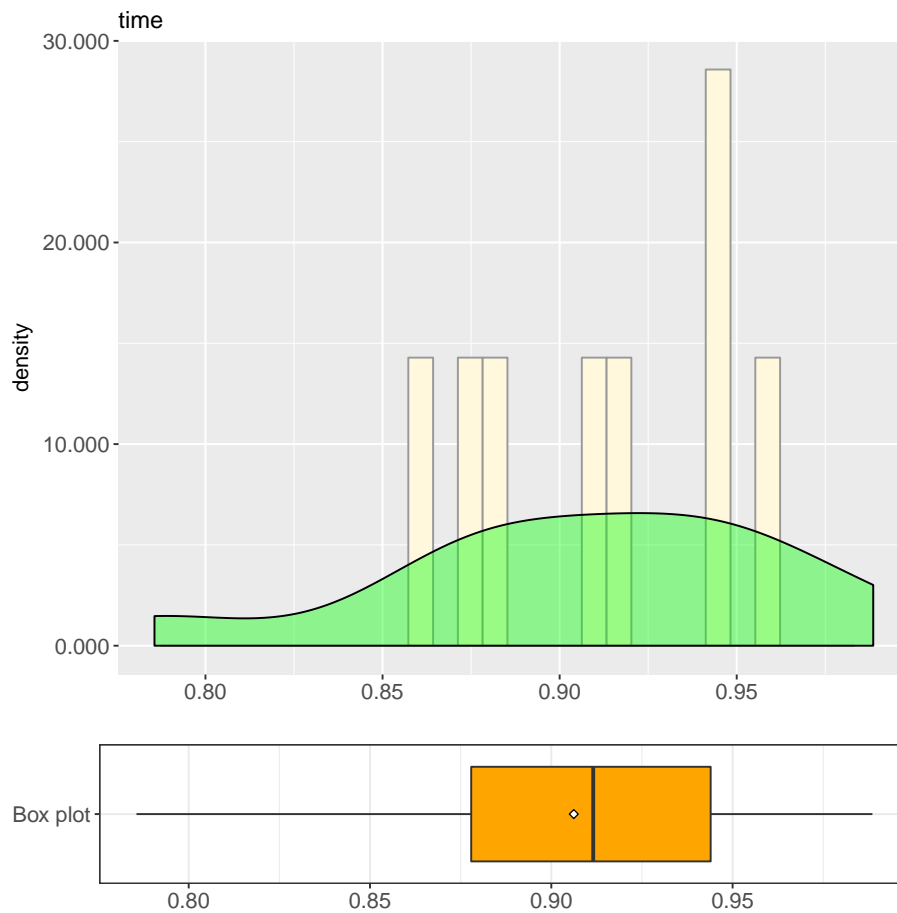
```
## [1] "Sample size: 10"  
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
##  1.153   1.233   1.251   1.244   1.263   1.287
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Hylaa" & object == "steps2716")$time  
## W = 0.87909, p-value = 0.1274  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.12738118267151"
```

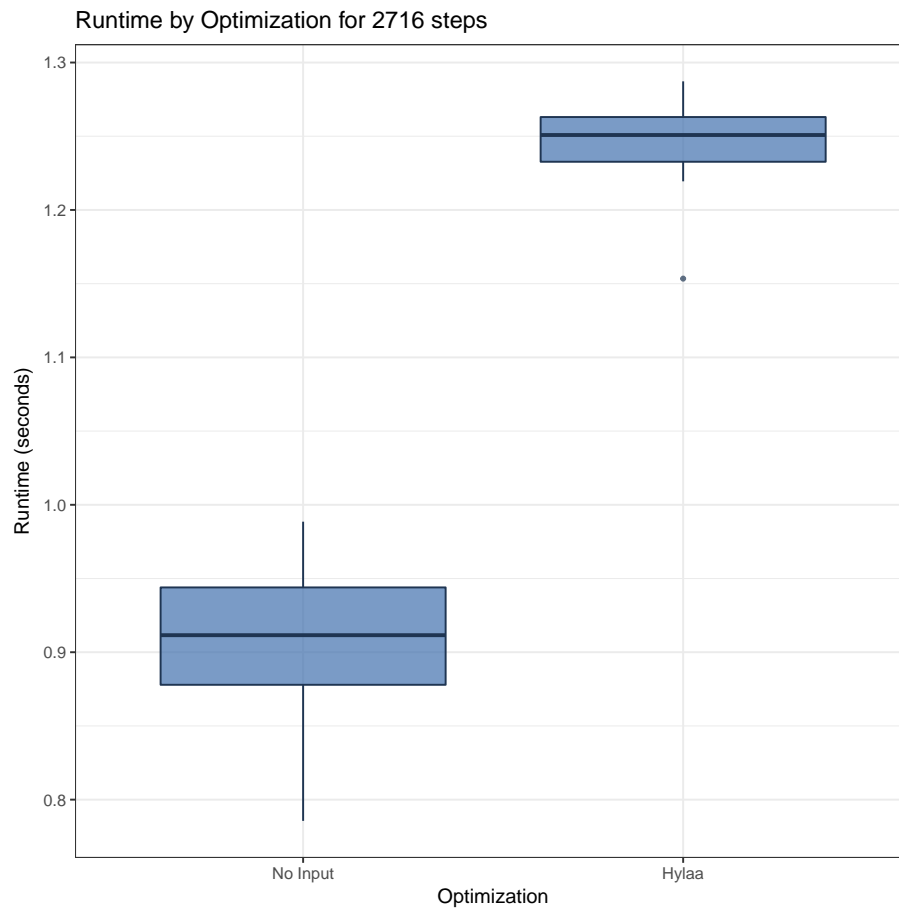
Runtime for No Input

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.7856 0.8779 0.9116 0.9062 0.9439 0.9885
```



```
##
## Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps2716")$time
## W = 0.95502, p-value = 0.7279
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.727898562403801"
```

Comparison



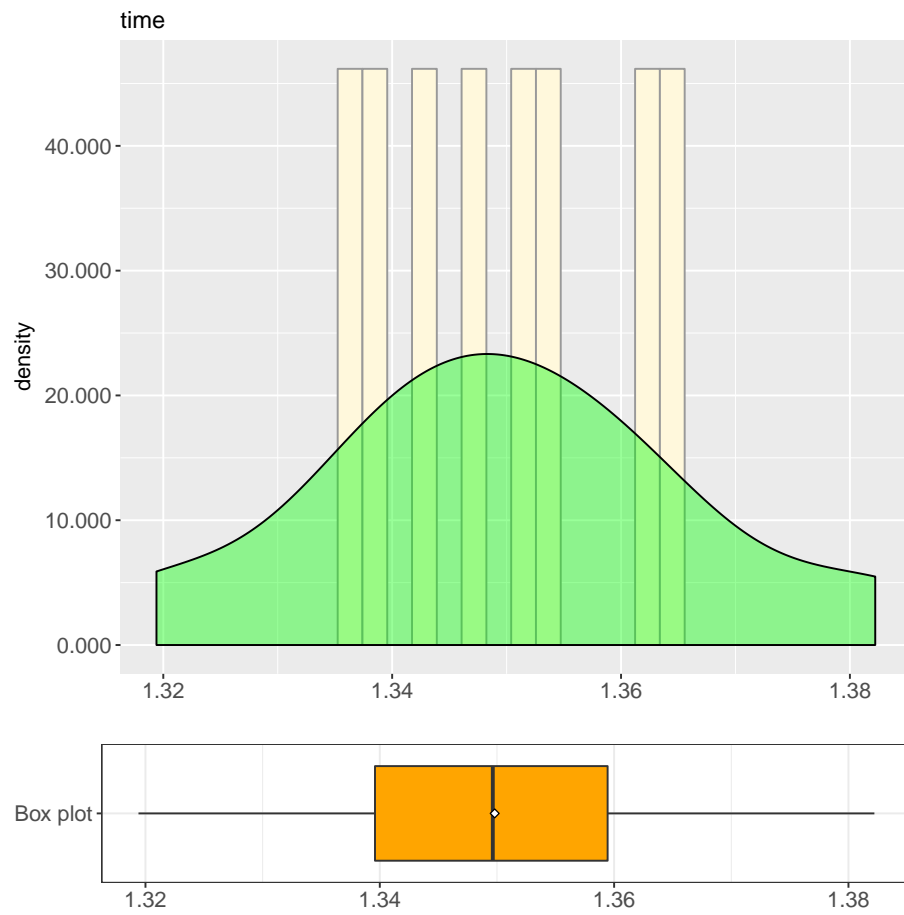
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps2716")$time and subset(json_data, treatment == "No Input" & object == "steps2716")$time
## F = 0.4354, num df = 9, denom df = 9, p-value = 0.2314
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.108147 1.752915
## sample estimates:
## ratio of variances
##      0.4353993
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.231384270826966"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps2716")$time and subset(j
## t = 15.422, df = 18, p-value = 8.091e-12
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.2915663 0.3835313
## sample estimates:
## mean of x mean of y
## 1.2437486 0.9061998
##
## [1] "T-test: Null Hypothesis rejected. P-value: 8.09148923563213e-12"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.243748641014"
## [1] "Mean Runtime for No Input: 0.906199836731"
## [1] "Absolute difference: 0.337548804283"
## Runtime for Hylaa is 37.2488264289104 % greater than
## Runtime for No Input
```

3.4.19 RH4.19: Object 3531 steps

Runtime for Hylaa

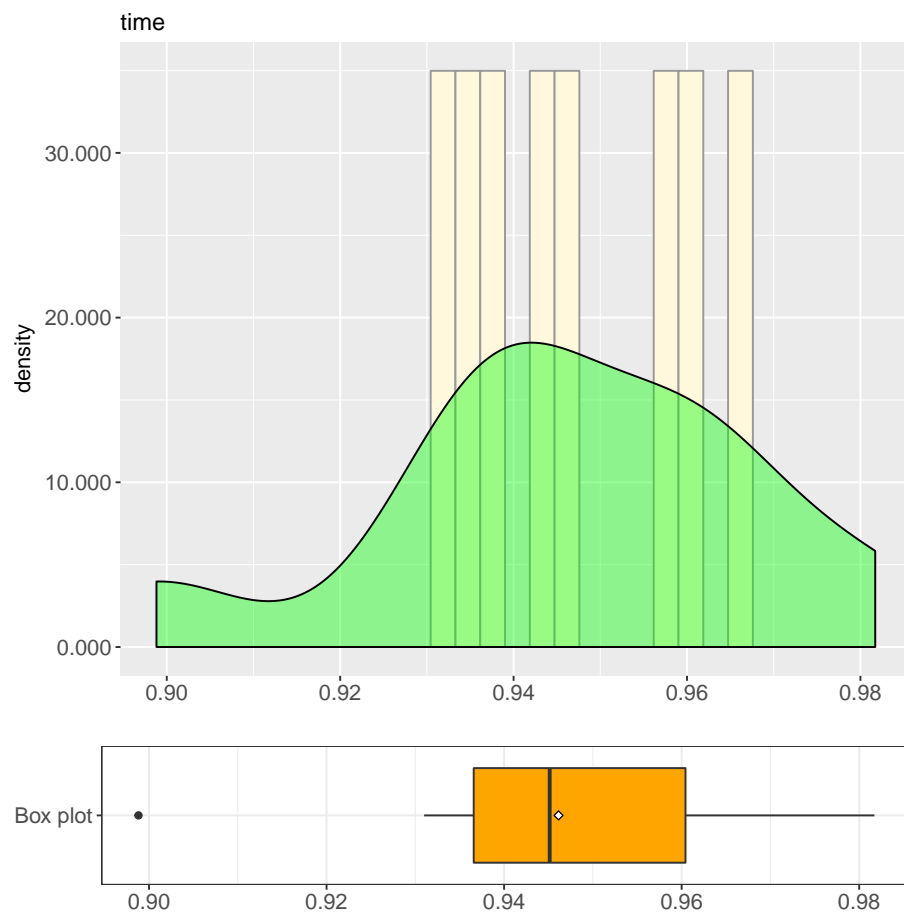
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 1.319   1.340   1.350   1.350   1.359   1.382
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps3531")$time
## W = 0.98776, p-value = 0.9933
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.993277943776764"
```

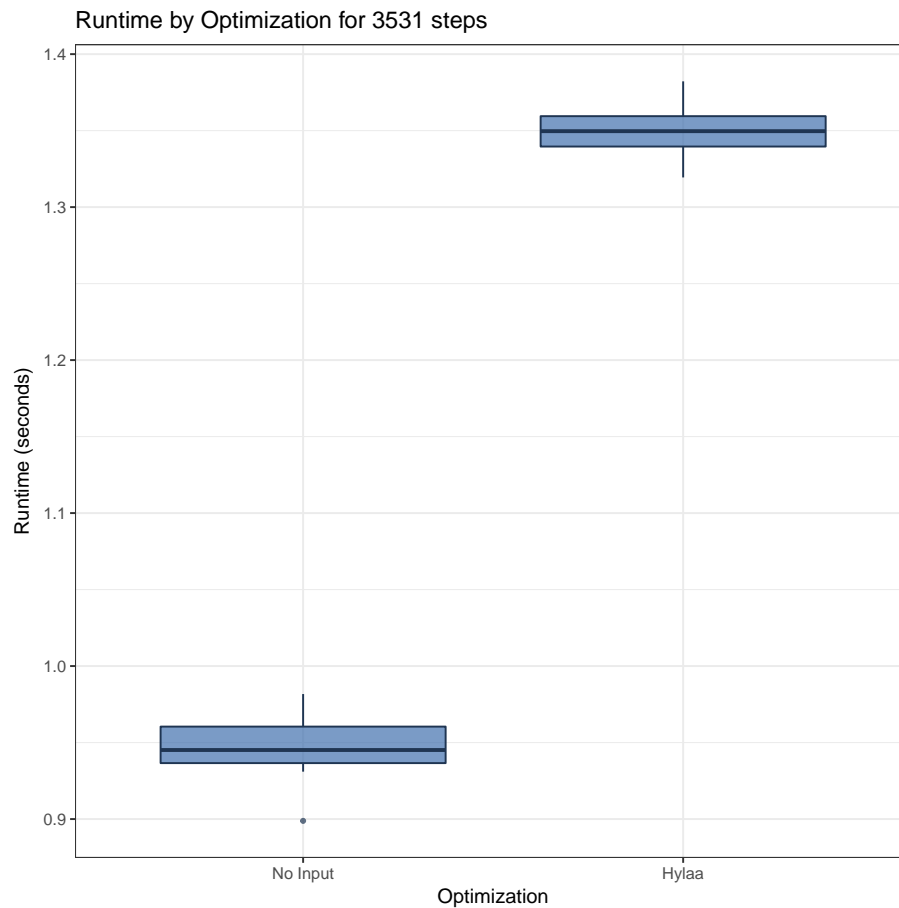
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.8988  0.9366  0.9451  0.9461  0.9604  0.9817
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "NoInput" & object == "steps3531")$time
## W = 0.96107, p-value = 0.798
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.7980086428003"
```

Comparison



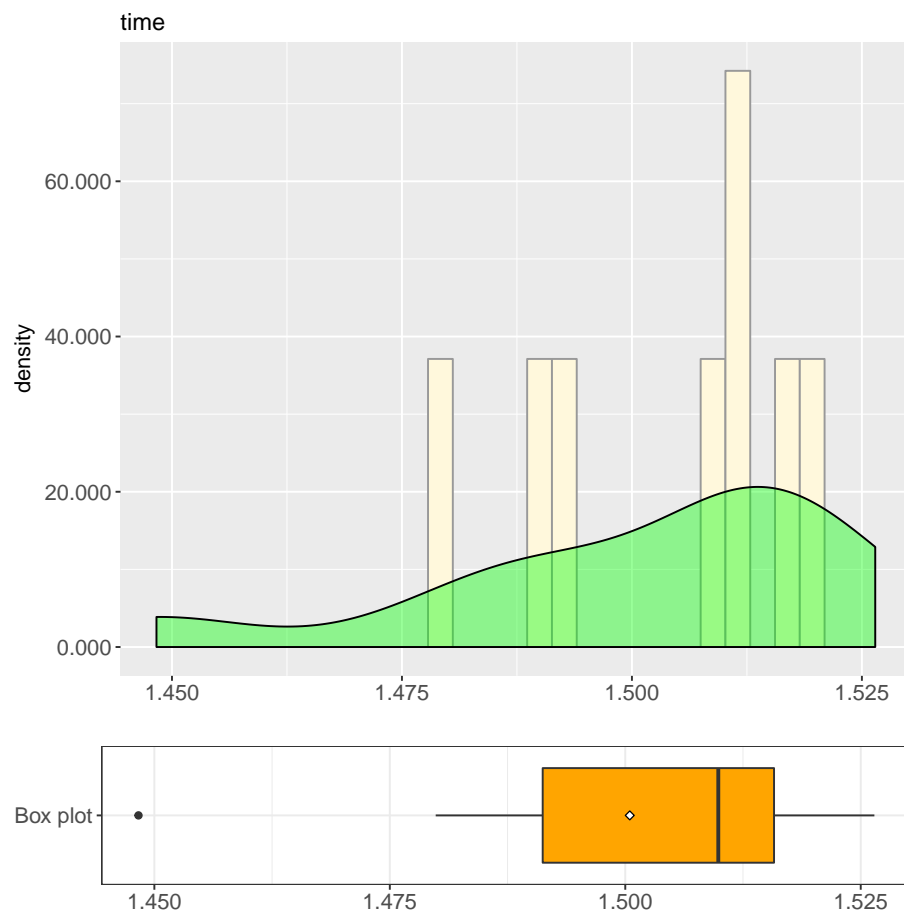
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps3531")$time and subset(j
## F = 0.57897, num df = 9, denom df = 9, p-value = 0.428
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.143809 2.330947
## sample estimates:
## ratio of variances
##      0.5789742
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.428013079532773"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps3531")$time and subset(j
## t = 44.625, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.3846720 0.4226819
## sample estimates:
## mean of x mean of y
## 1.3498073 0.9461304
##
## [1] "T-test: Null Hypothesis rejected. P-value: 6.91721605910582e-20"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.349807333946"
## [1] "Mean Runtime for No Input: 0.9461303710936"
## [1] "Absolute difference: 0.4036769628524"
## Runtime for Hylaa is 42.6661034446874 % greater than
## Runtime for No Input
```

3.4.20 RH4.20: Object 4590 steps

Runtime for Hylaa

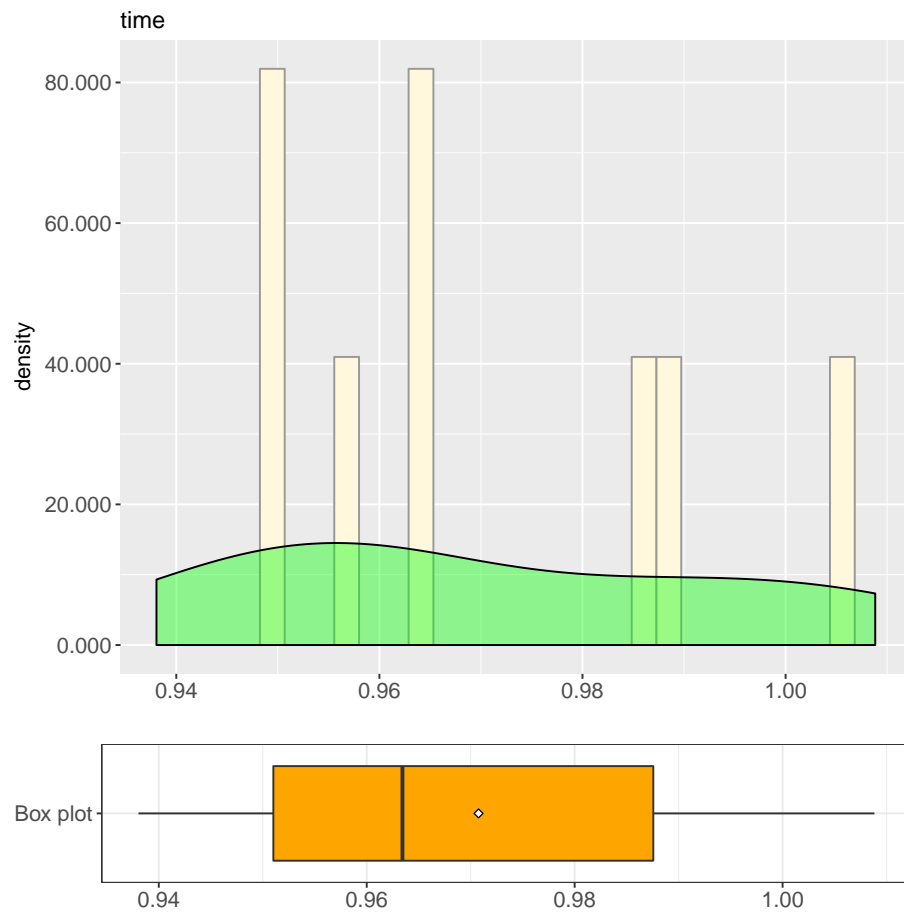
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 1.448 1.491 1.510 1.500 1.516 1.526
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps4590")$time
## W = 0.88116, p-value = 0.1346
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.134566691717643"
```

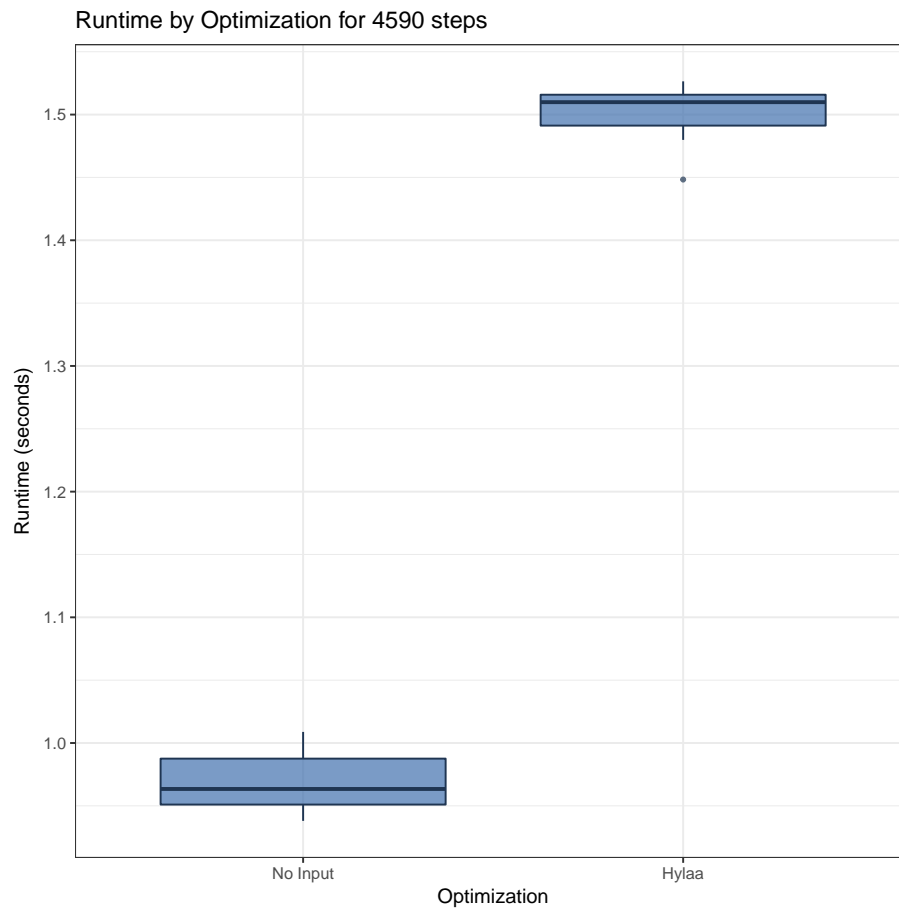
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  0.9380  0.9510  0.9634  0.9708  0.9876  1.0090
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps4590")$time
## W = 0.92396, p-value = 0.3912
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.391211123458605"
```

Comparison



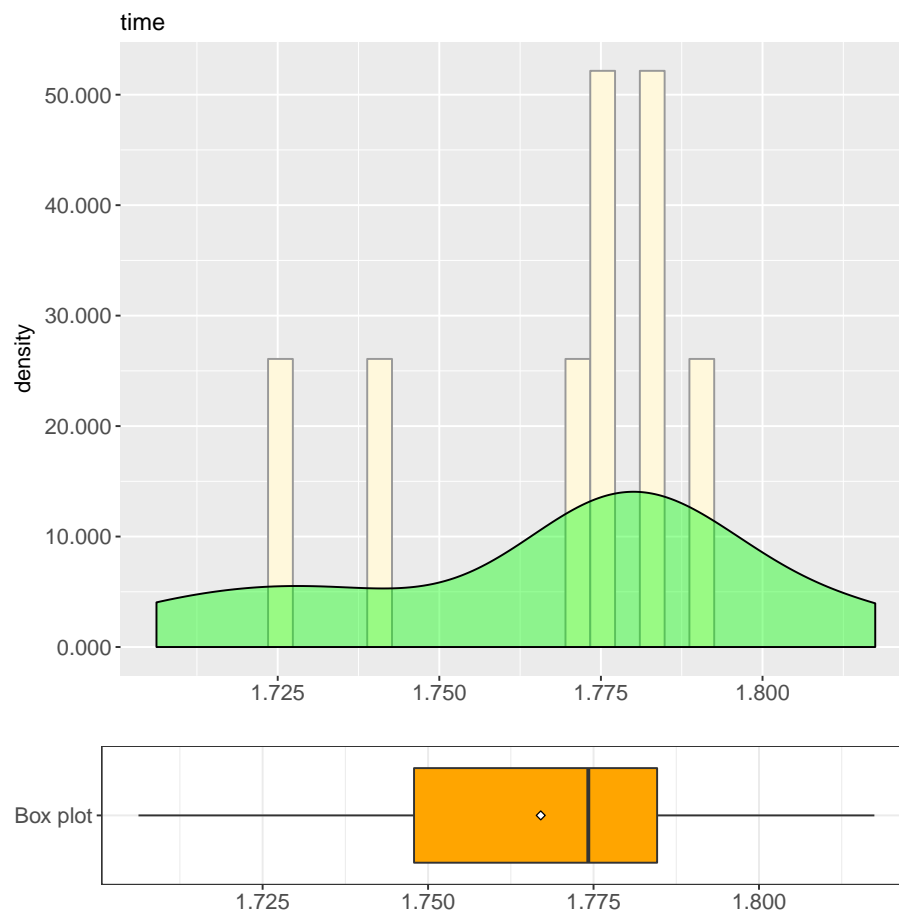
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps4590")$time and subset(j
## F = 0.89729, num df = 9, denom df = 9, p-value = 0.8744
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2228746 3.6124918
## sample estimates:
## ratio of variances
##      0.8972919
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.874394493560052"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps4590")$time and subset(j
## t = 49.428, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.5072048 0.5522360
## sample estimates:
## mean of x mean of y
## 1.5004775 0.9707572
##
## [1] "T-test: Null Hypothesis rejected. P-value: 1.11417737126626e-20"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.500477528573"
## [1] "Mean Runtime for No Input: 0.9707571506506"
## [1] "Absolute difference: 0.5297203779224"
## Runtime for Hylaa is 54.5677544139008 % greater than
## Runtime for No Input
```

3.4.21 RH4.21: Object 5967 steps

Runtime for Hylaa

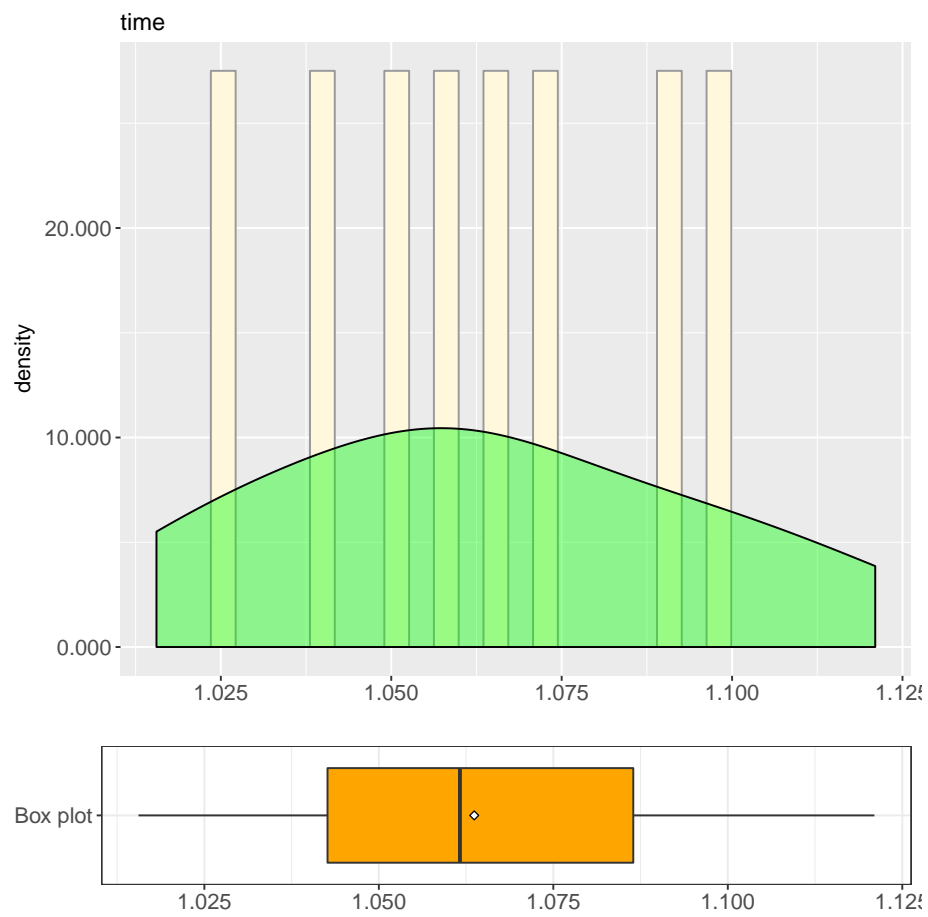
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 1.706   1.748   1.774   1.767   1.785   1.817
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps5967")$time
## W = 0.93205, p-value = 0.4683
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.468324949837865"
```

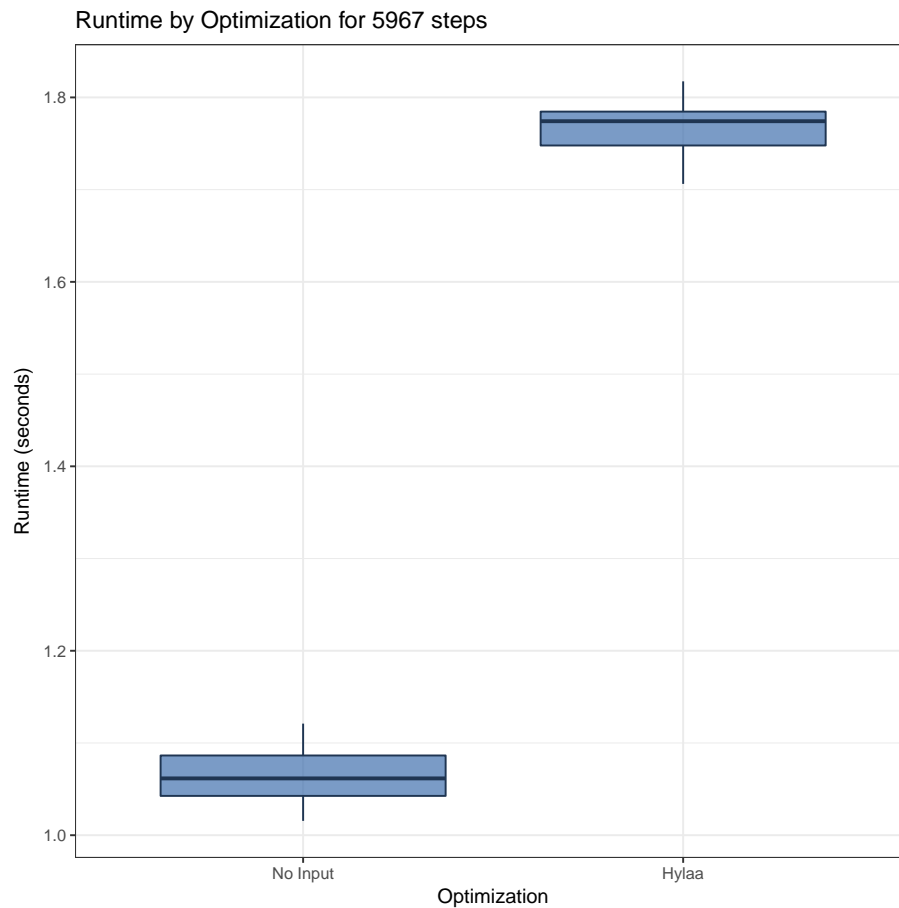
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.016  1.043   1.062   1.064   1.086   1.121
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps5967")$time
## W = 0.98004, p-value = 0.9654
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.965368194560415"
```

Comparison



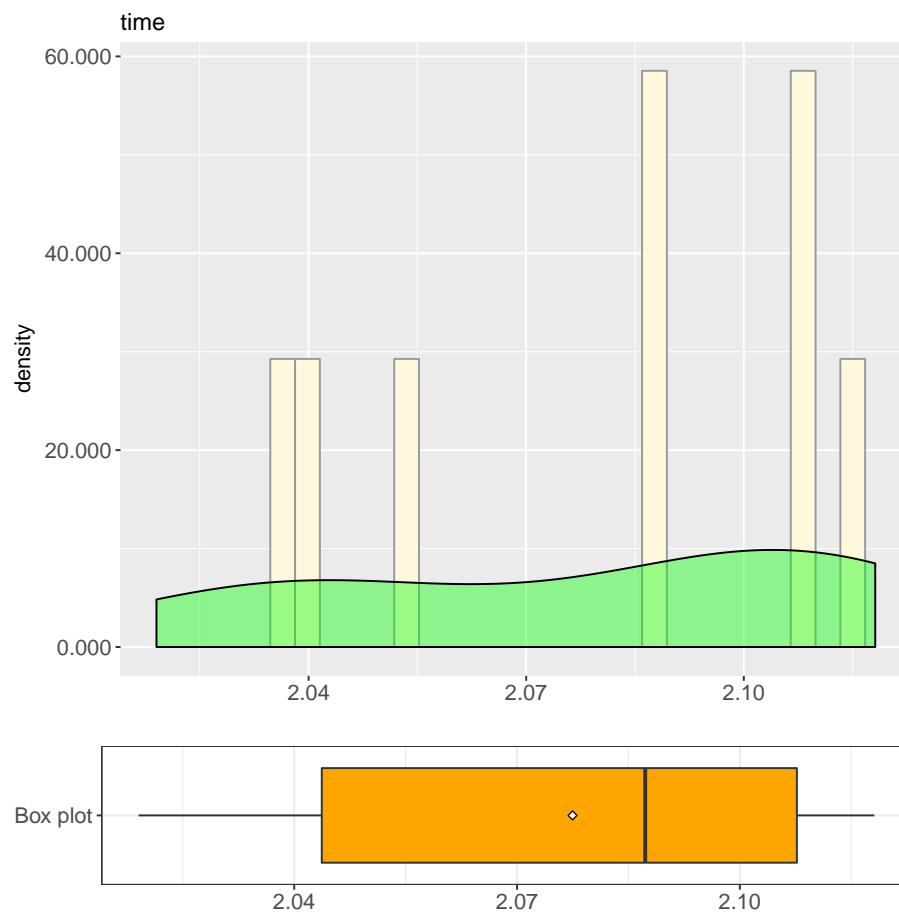
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps5967")$time and subset(json_data, treatment == "No Input" & object == "steps5967")$time
## F = 1.0281, num df = 9, denom df = 9, p-value = 0.9677
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2553723 4.1392346
## sample estimates:
## ratio of variances
##      1.028127
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.967718192462343"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps5967")$time and subset(j
## t = 47.268, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.6720940 0.7346178
## sample estimates:
## mean of x mean of y
## 1.767022 1.063666
##
## [1] "T-test: Null Hypothesis rejected. P-value: 2.47555893133987e-20"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 1.767022109032"
## [1] "Mean Runtime for No Input: 1.06366622448"
## [1] "Absolute difference: 0.703355884552"
## Runtime for Hylaa is 66.1256198950807 % greater than
## Runtime for No Input
```

3.4.22 RH4.22: Object 7757 steps

Runtime for Hylaa

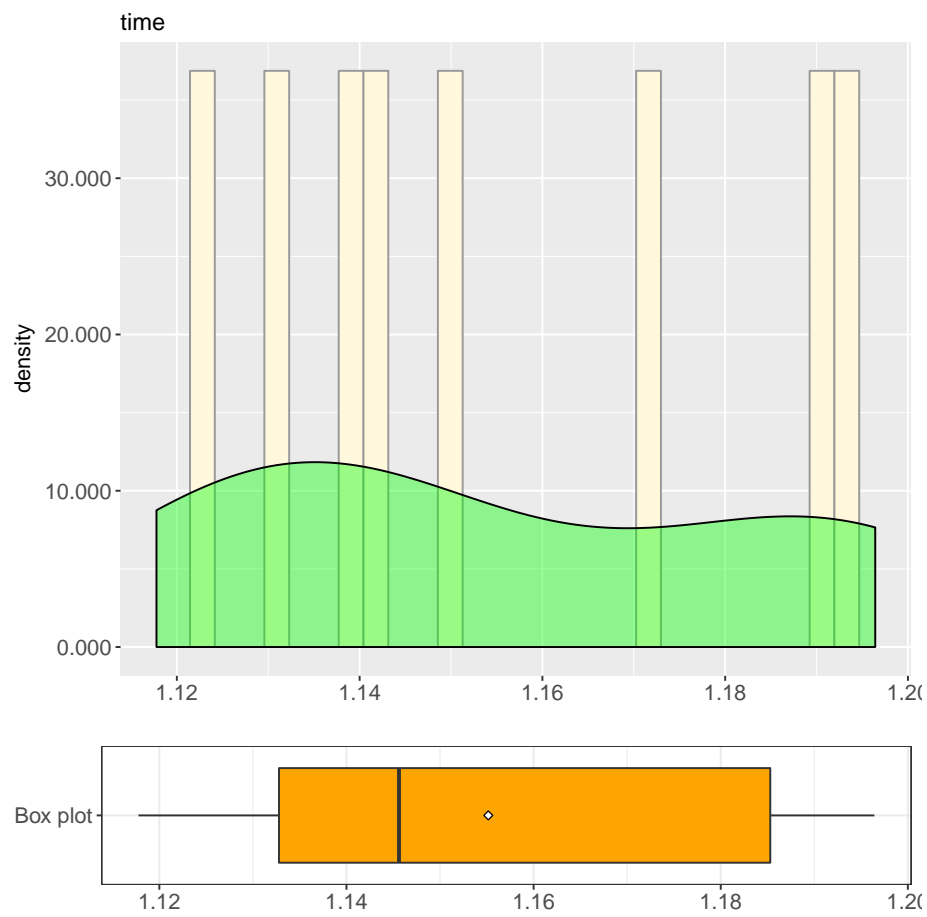
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      2.019   2.044   2.087   2.077   2.108   2.118
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps7757")$time
## W = 0.89136, p-value = 0.1756
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.175640560398436"
```

Runtime for No Input

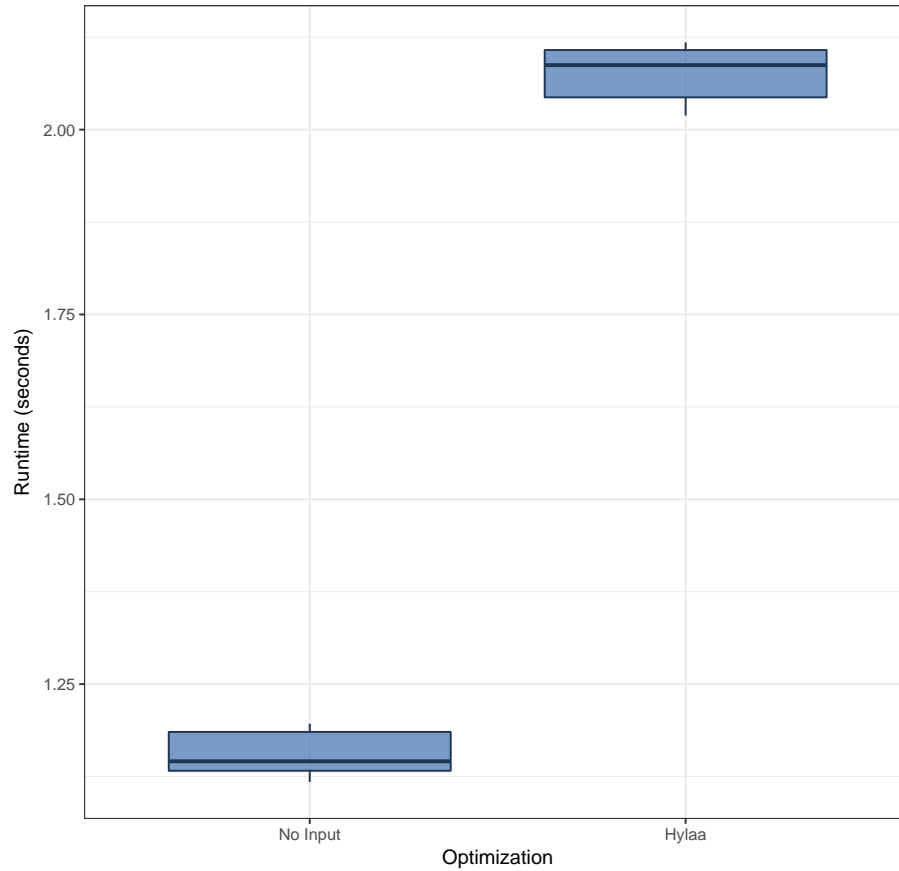
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.118  1.133   1.146   1.155   1.185   1.196
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps7757")$time
## W = 0.89365, p-value = 0.1864
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.186350385137733"
```

Comparison

Runtime by Optimization for 7757 steps



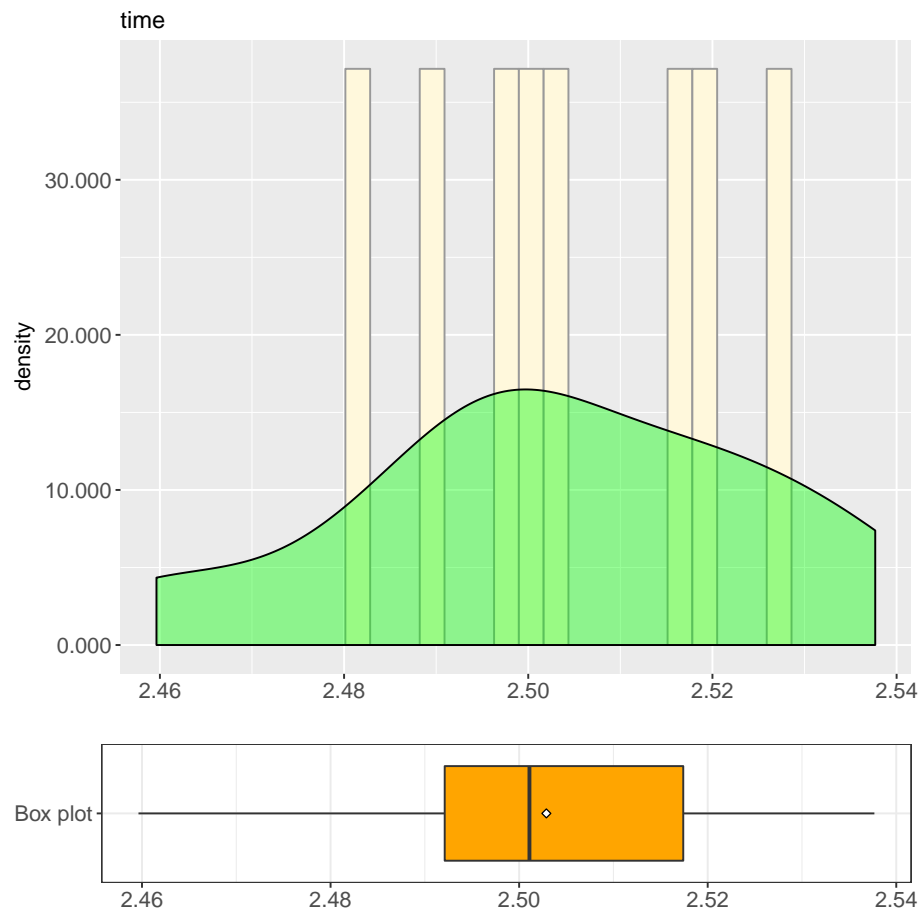
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps7757")$time and subset(json_data, treatment == "No Input" & object == "steps7757")$time
## F = 1.4884, num df = 9, denom df = 9, p-value = 0.563
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3696983 5.9923028
## sample estimates:
## ratio of variances
##      1.488403
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.562990289177772"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian distribution"
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps7757")$time and subset(j
## t = 61.601, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 0.8908627 0.9537742
## sample estimates:
## mean of x mean of y
## 2.077476 1.155158
##
## [1] "T-test: Null Hypothesis rejected. P-value: 2.16534144650849e-22"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 2.077476406097"
## [1] "Mean Runtime for No Input: 1.155157971382"
## [1] "Absolute difference: 0.922318434715"
## Runtime for Hylaa is 79.8434895974931 % greater than
## Runtime for No Input
```

3.4.23 RH4.23: Object 10085 steps

Runtime for Hylaa

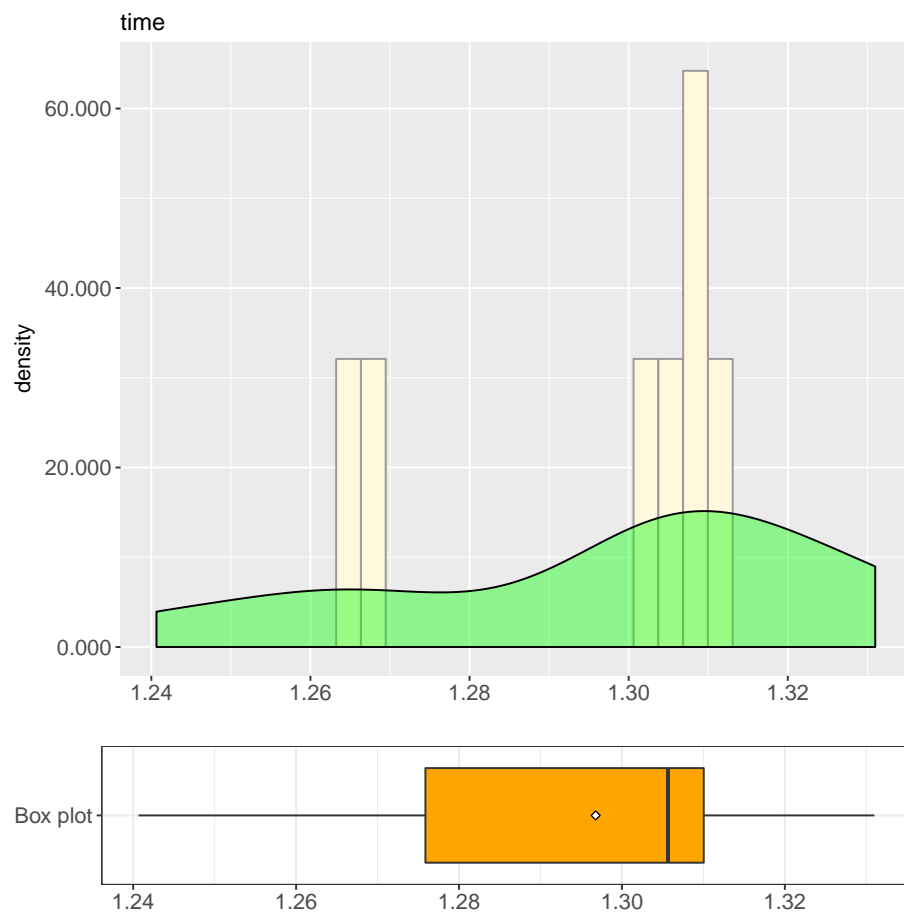
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 2.460 2.492 2.501 2.503 2.517 2.538
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps10085")$time
## W = 0.98381, p-value = 0.9823
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.982277067638566"
```

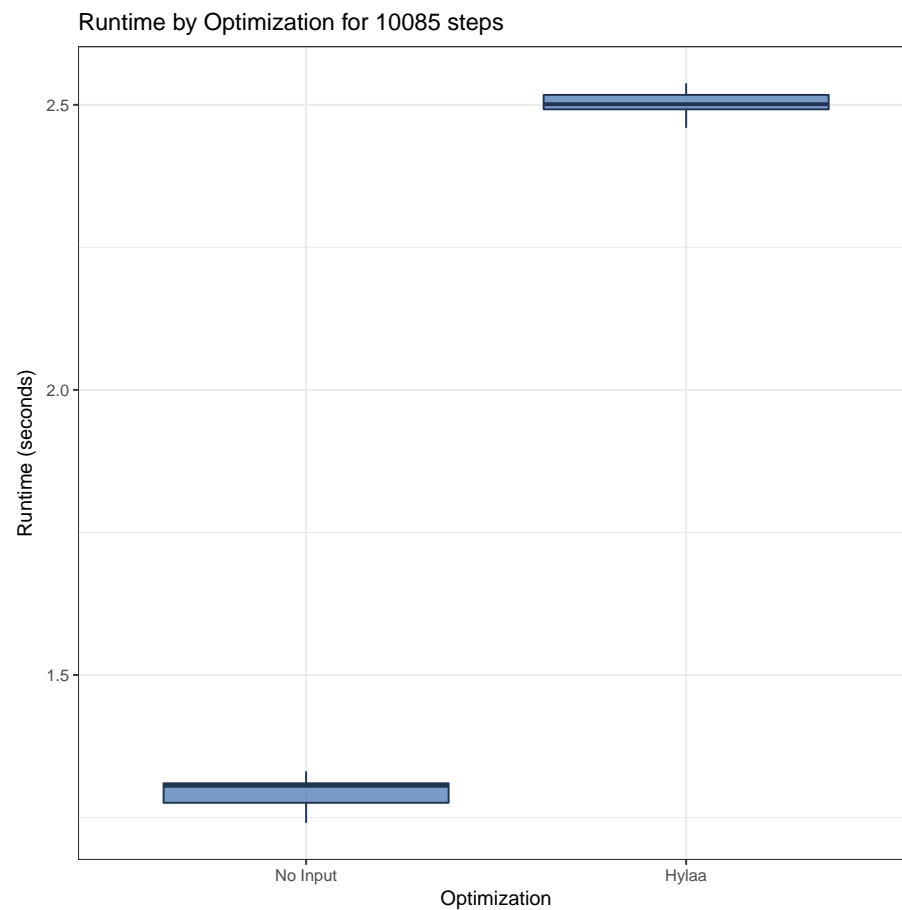
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  1.241  1.276   1.306   1.297   1.310   1.331
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps10085")$time
## W = 0.88608, p-value = 0.1531
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.153105569907757"
```

Comparison



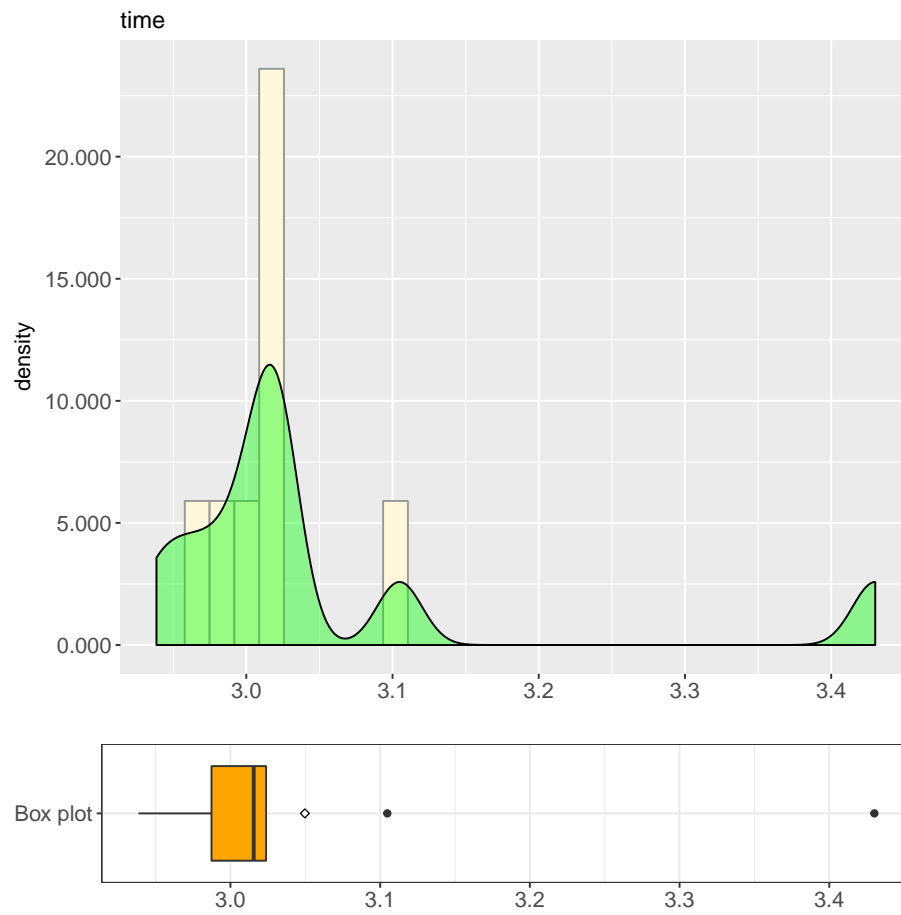
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps10085")$time and subset(
## F = 0.6083, num df = 9, denom df = 9, p-value = 0.4705
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1510926 2.4490033
## sample estimates:
## ratio of variances
##      0.6082978
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.470494508377598"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps10085")$time and subset(
## t = 101.51, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 1.181155 1.231079
## sample estimates:
## mean of x mean of y
## 2.502889 1.296772
##
## [1] "T-test: Null Hypothesis rejected. P-value: 2.766920937322e-26"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 2.502888703346"
## [1] "Mean Runtime for No Input: 1.296771836281"
## [1] "Absolute difference: 1.206116867065"
## Runtime for Hylaa is 93.0091812083158 % greater than
## Runtime for No Input
```

3.4.24 RH4.24: Object 13110 steps

Runtime for Hylaa

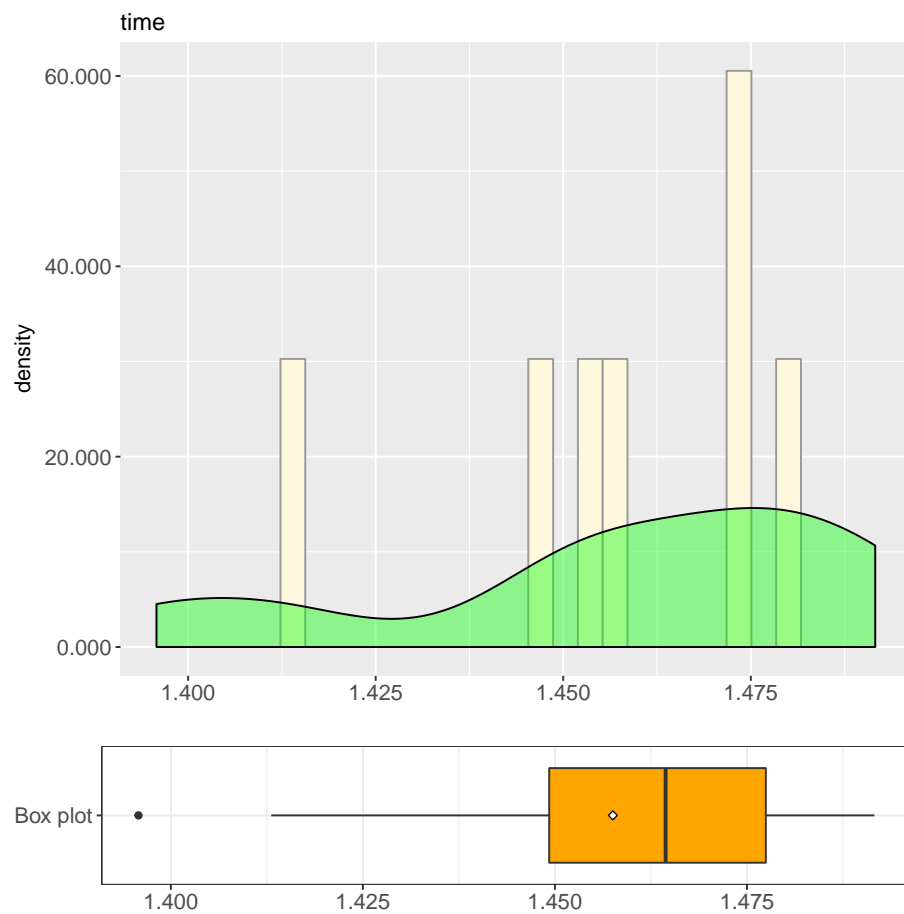
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      2.939   2.987   3.016   3.050   3.024   3.430
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps13110")$time
## W = 0.65237, p-value = 0.0002343
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.000234335774565787"
```

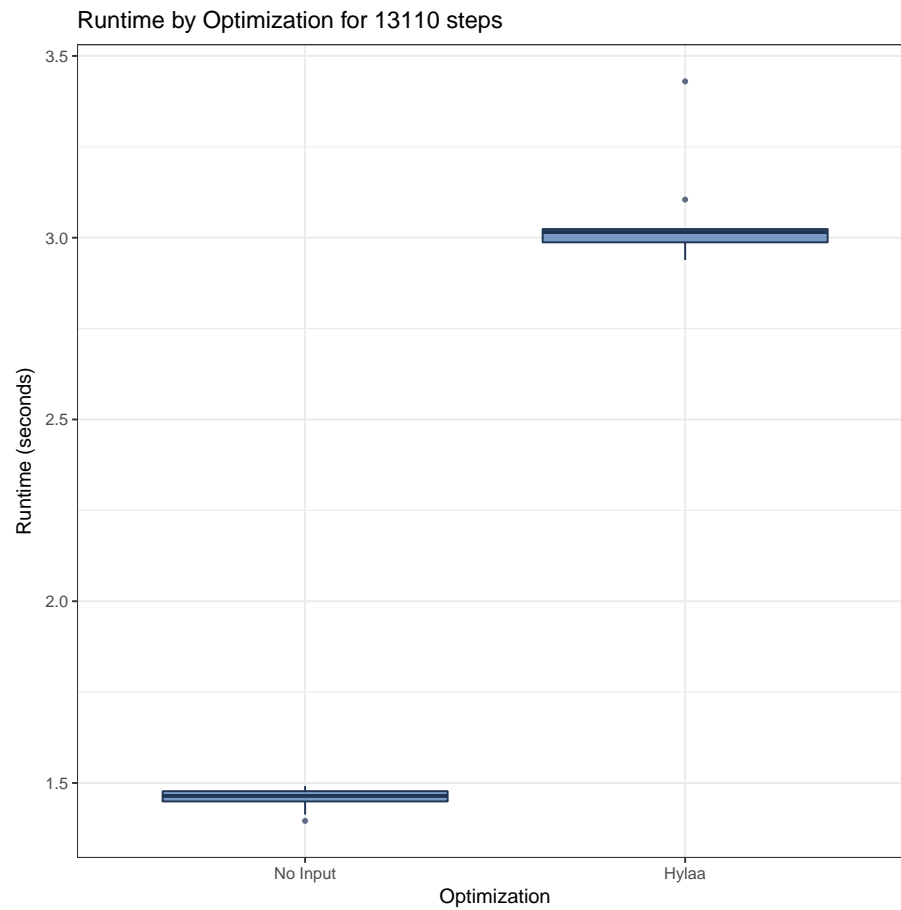
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  1.396  1.449   1.464   1.458  1.477   1.492
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps13110")$time
## W = 0.89368, p-value = 0.1865
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.186482276702233"
```

Comparison

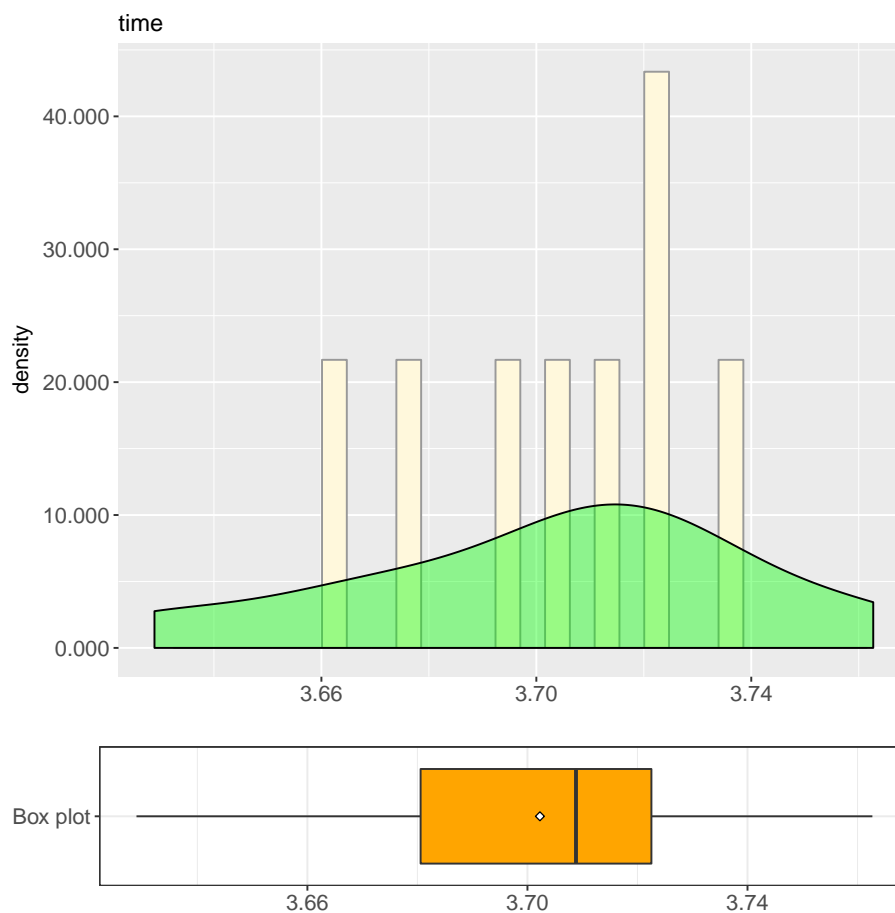


```
##
## Wilcoxon rank sum test
##
## data: time by treatment
## W = 100, p-value = 1.083e-05
## alternative hypothesis: true location shift is not equal to 0
##
## [1] "Wilcoxon-Mann-Whitney test: Null Hypothesis rejected. P-value: 1.0825088224469e-05"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 3.049691486358"
## [1] "Mean Runtime for No Input: 1.457536697387"
## [1] "Absolute difference: 1.592154788971"
## Runtime for Hylaa is 109.236000151855 % greater than
## Runtime for No Input
```

3.4.25 RH4.25: Object 17043 steps

Runtime for Hylaa

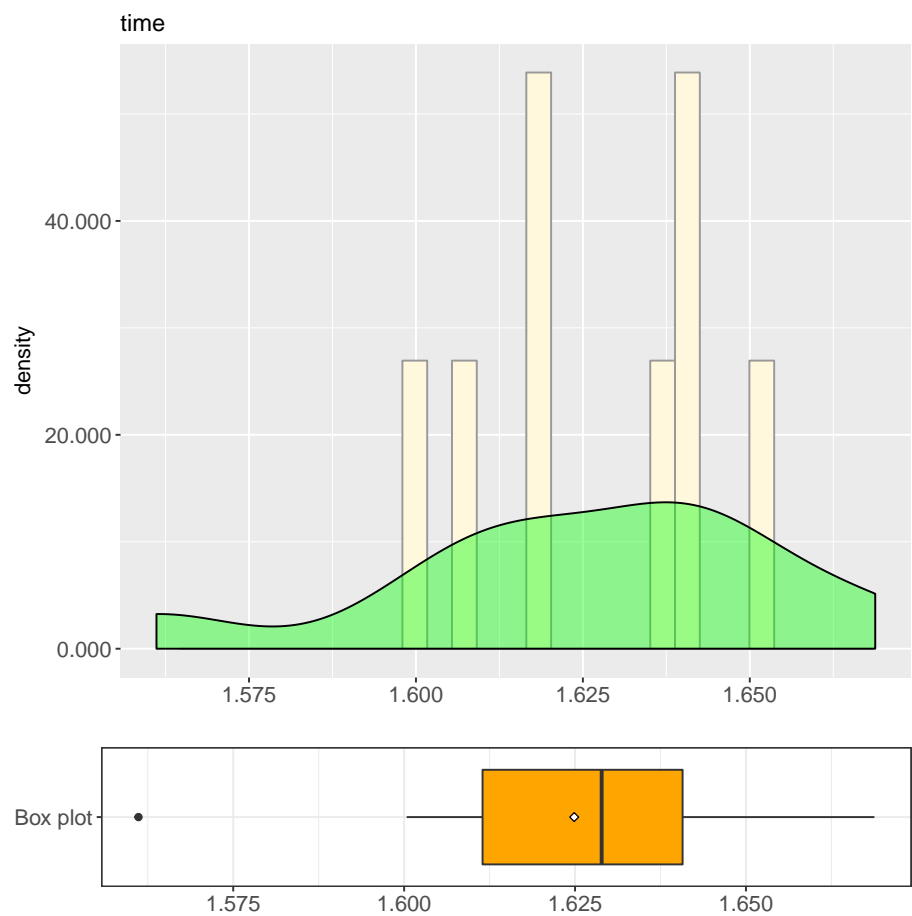
```
## [1] "Sample size: 10"  
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.  
##   3.629  3.681  3.709   3.702  3.723   3.763
```



```
##  
## Shapiro-Wilk normality test  
##  
## data: subset(json_data, treatment == "Hylaa" & object == "steps17043")$time  
## W = 0.97882, p-value = 0.9585  
##  
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.958546785330543"
```

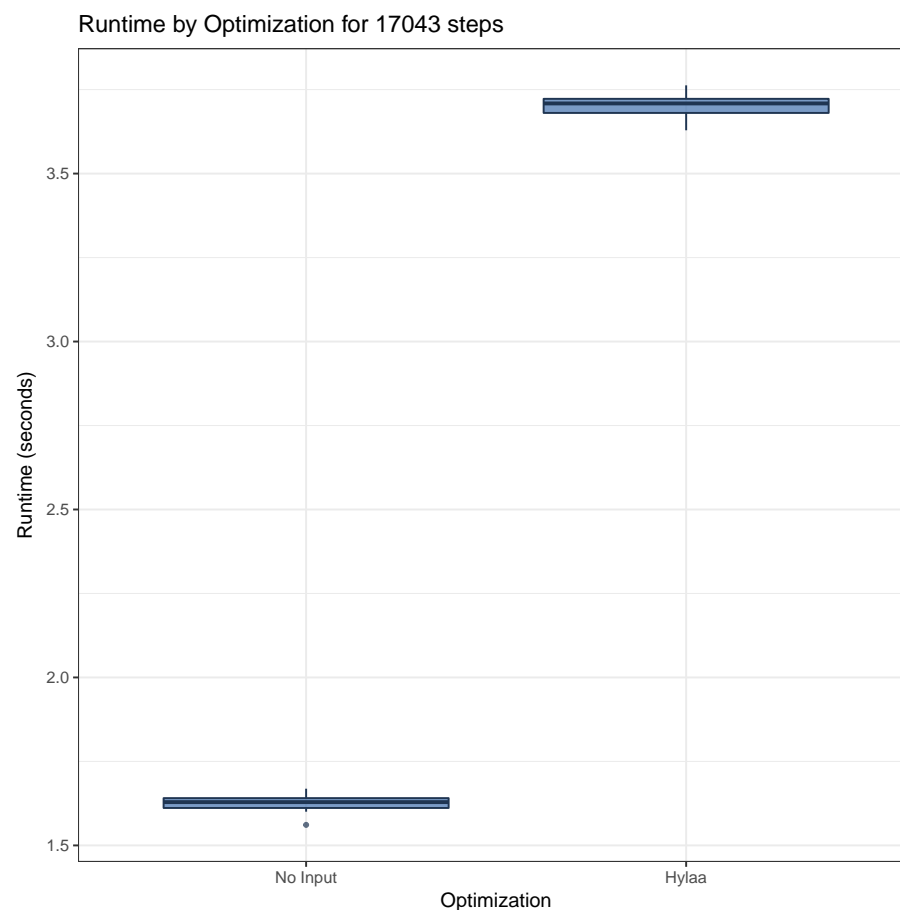
Runtime for No Input

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      1.561   1.611   1.629   1.625   1.641   1.669
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps17043")$time
## W = 0.9524, p-value = 0.697
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.696984752188095"
```

Comparison



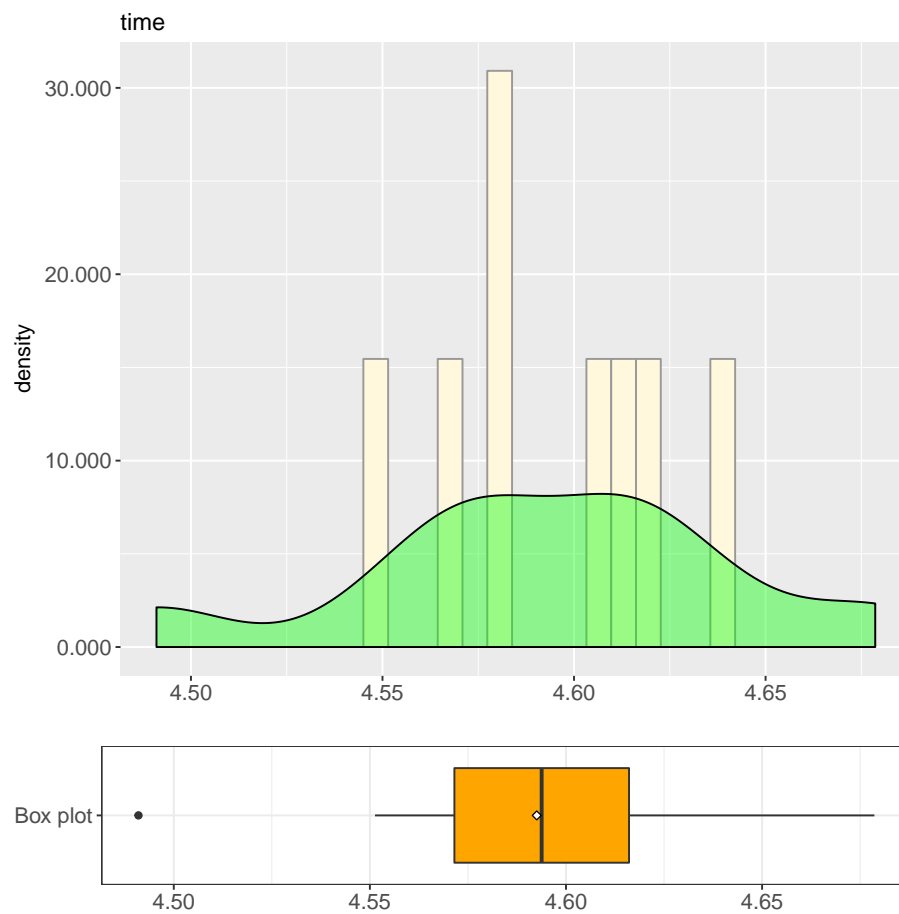
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps17043")$time and subset(
## F = 1.6416, num df = 9, denom df = 9, p-value = 0.4718
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.4077409 6.6089212
## sample estimates:
## ratio of variances
##      1.641563
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.471770520509052"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps17043")$time and subset(
## t = 133.09, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 2.044596 2.110182
## sample estimates:
## mean of x mean of y
## 3.702265 1.624876
##
## [1] "T-test: Null Hypothesis rejected. P-value: 2.12504242932078e-28"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 3.70226535797"
## [1] "Mean Runtime for No Input: 1.624876427651"
## [1] "Absolute difference: 2.077388930319"
## Runtime for Hylaa is 127.849041008132 % greater than
## Runtime for No Input
```

3.4.26 RH4.26: Object 22157 steps

Runtime for Hylaa

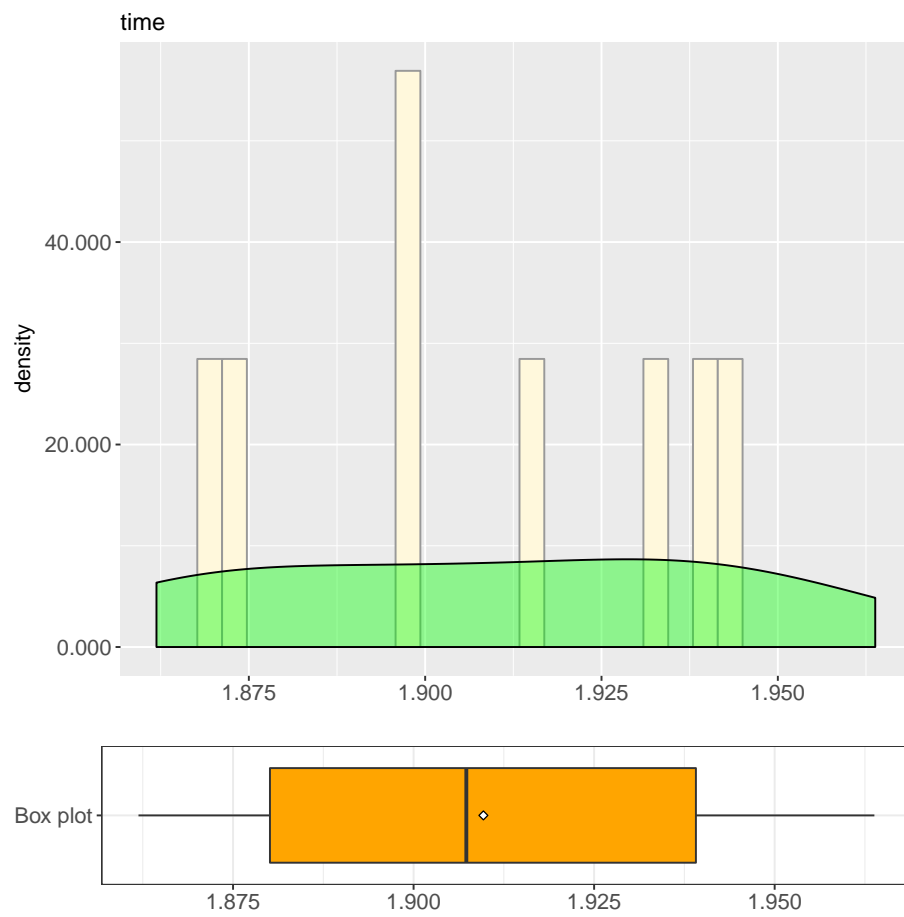
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 4.491 4.572 4.594 4.593 4.616 4.679
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps22157")$time
## W = 0.97327, p-value = 0.9194
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.919388955922961"
```

Runtime for No Input

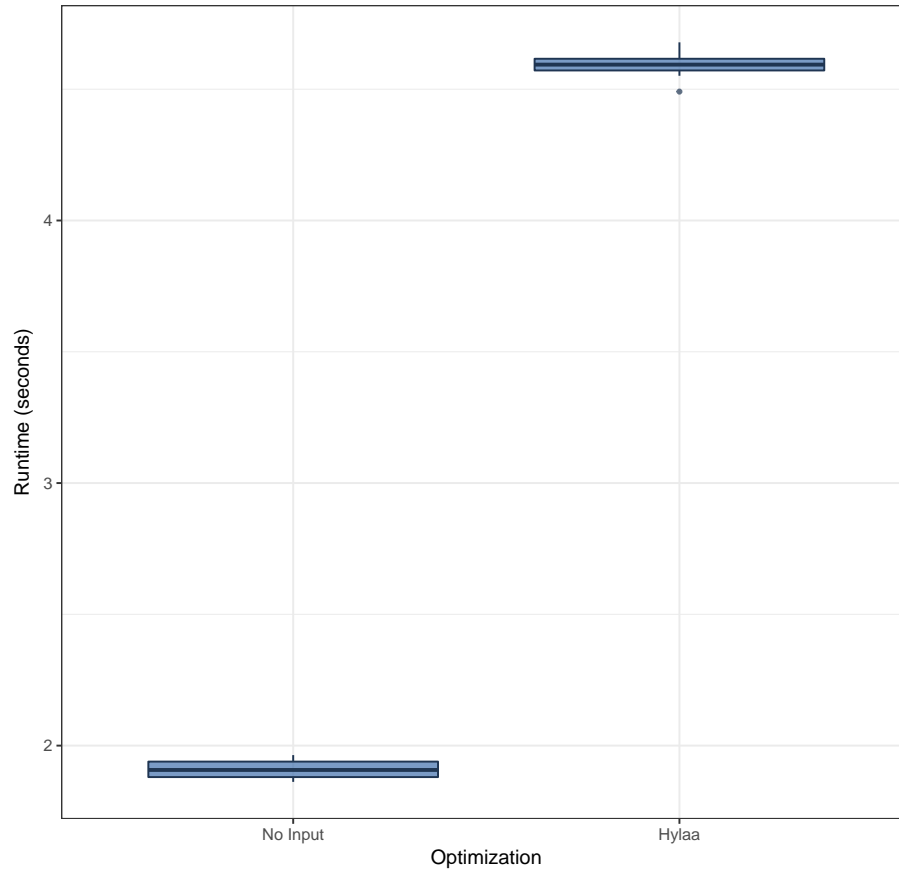
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  1.862  1.880   1.907   1.910   1.939   1.964
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps22157")$time
## W = 0.94043, p-value = 0.5578
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.557830173384547"
```

Comparison

Runtime by Optimization for 22157 steps



```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps22157")$time and subset(
## F = 2.1406, num df = 9, denom df = 9, p-value = 0.2723
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.5316836 8.6178616
## sample estimates:
## ratio of variances
##      2.140555
##
## [1] "Homogeneity of variances: TRUE. P-value: 0.272299113035468"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

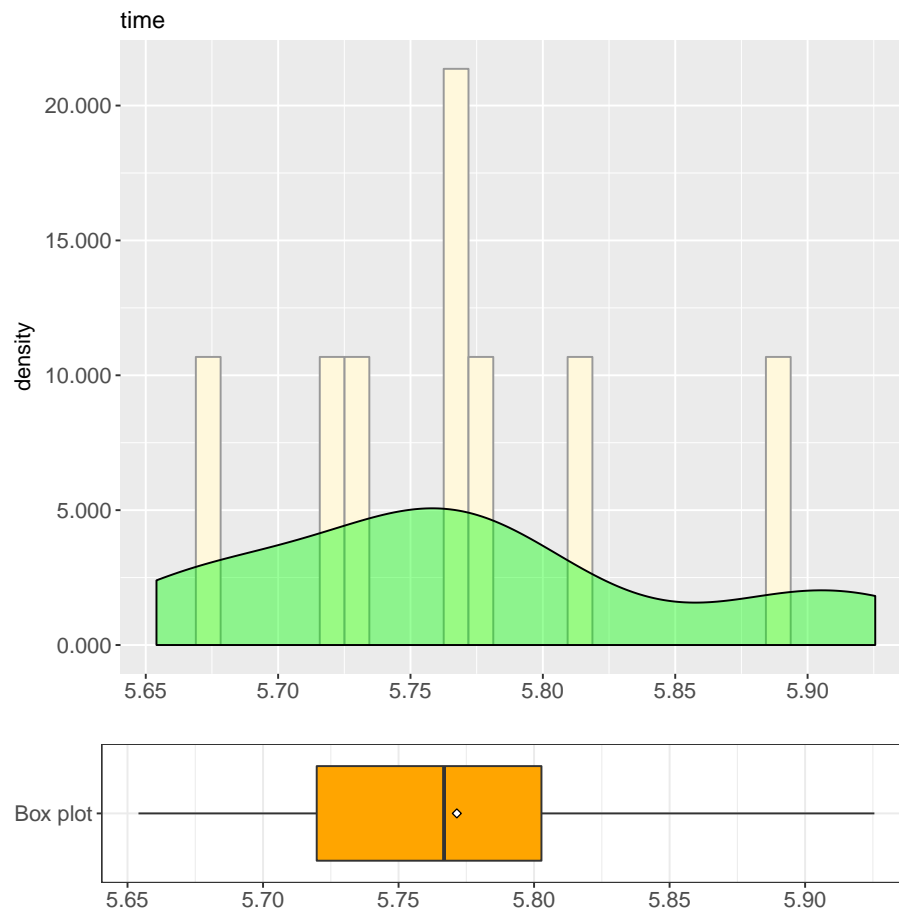


```
## Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps22157")$time and subset(
## t = 136.56, df = 18, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 2.641605 2.724152
## sample estimates:
## mean of x mean of y
## 4.592544 1.909665
##
## [1] "T-test: Null Hypothesis rejected. P-value: 1.33694227055956e-28"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 4.592543911932"
## [1] "Mean Runtime for No Input: 1.909665369987"
## [1] "Absolute difference: 2.682878541945"
## Runtime for Hylaa is 140.489458735028 % greater than
## Runtime for No Input
```

3.4.27 RH4.27: Object 28804 steps

Runtime for Hylaa

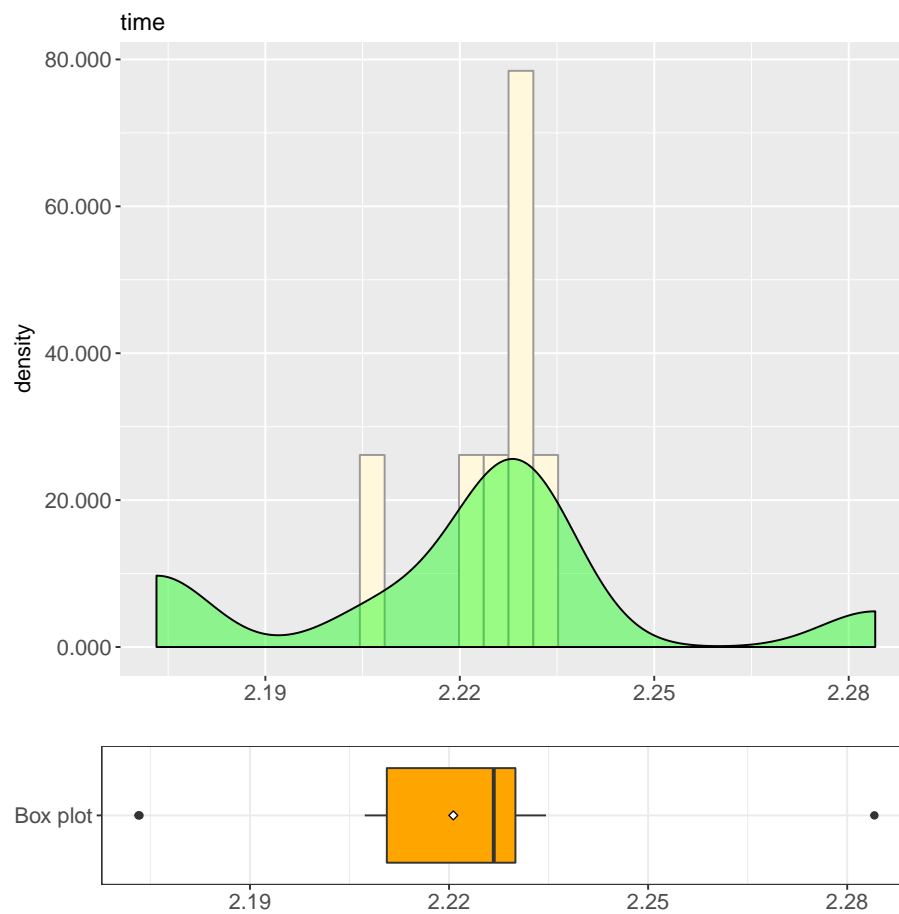
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 5.654   5.720   5.767   5.771   5.803   5.926
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps28804")$time
## W = 0.94971, p-value = 0.6651
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.66510382139283"
```

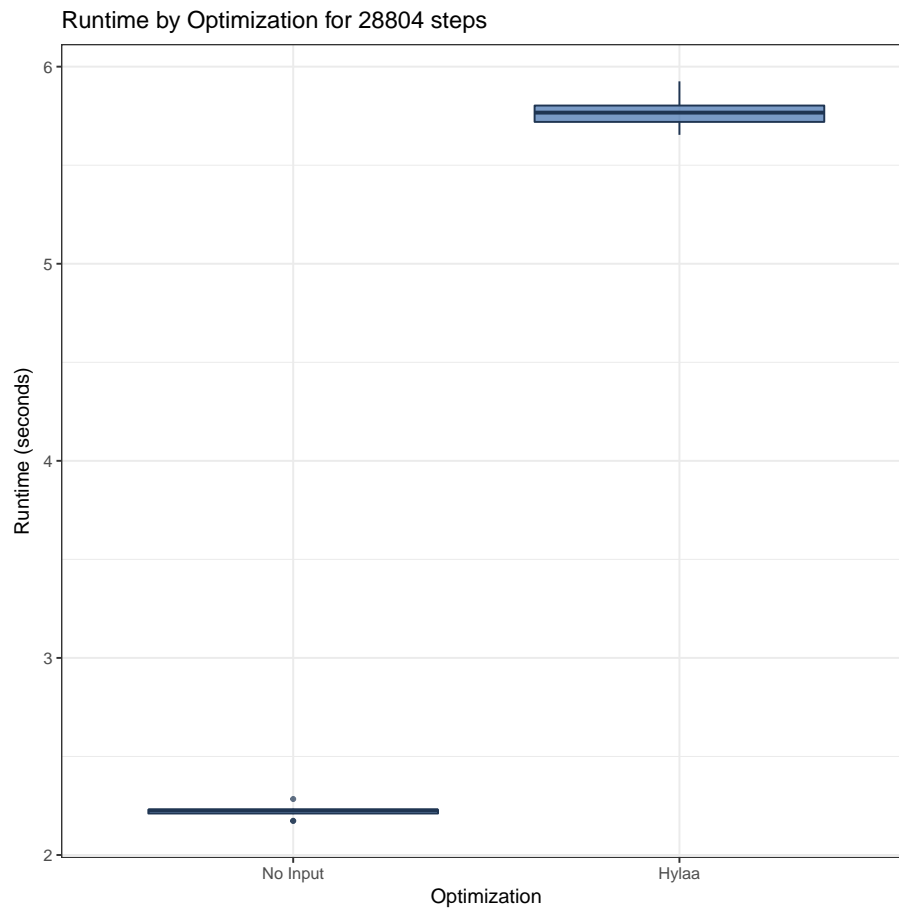
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  2.173  2.211   2.227   2.221   2.230   2.284
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps28804")$time
## W = 0.88532, p-value = 0.1501
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.150114726557424"
```

Comparison



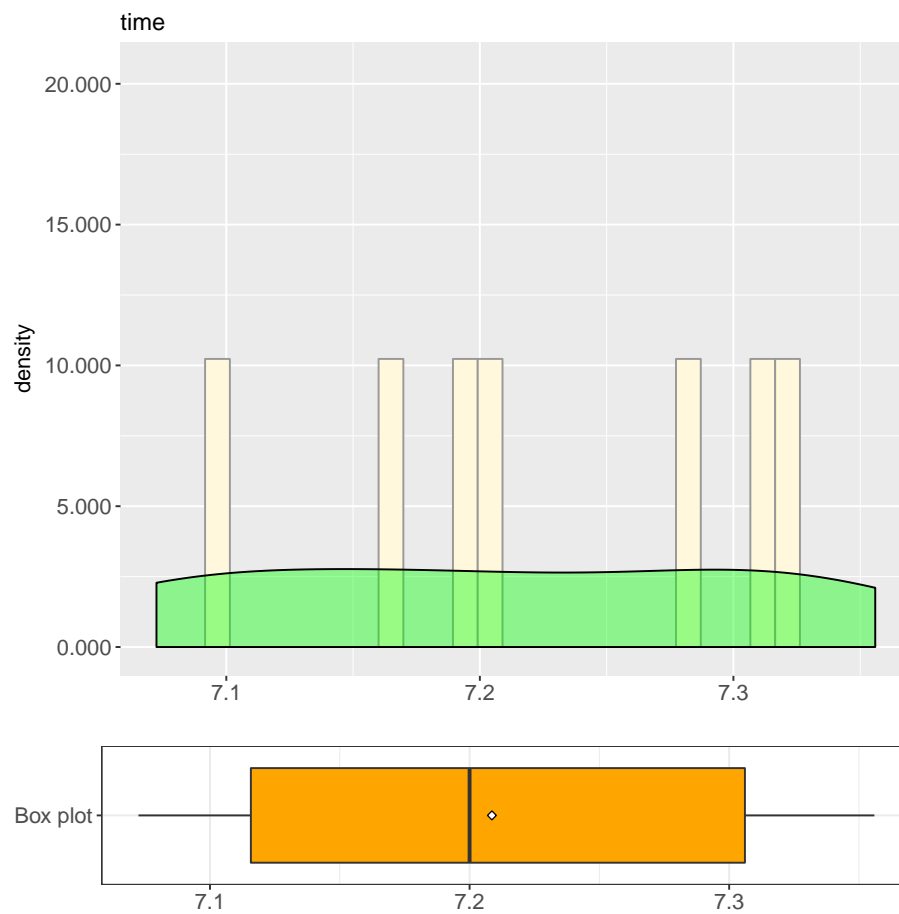
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps28804")$time and subset(
## F = 7.2933, num df = 9, denom df = 9, p-value = 0.006771
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  1.811552 29.362770
## sample estimates:
## ratio of variances
##      7.293297
##
## [1] "Homogeneity of variances: FALSE. P-value: 0.00677143661976665"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Welch Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps28804")$time and subset(
## t = 122.32, df = 11.422, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 3.487255 3.614462
## sample estimates:
## mean of x mean of y
## 5.771499 2.220641
##
## [1] "T-test: Null Hypothesis rejected. P-value: 3.61713413299378e-19"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 5.771498990059"
## [1] "Mean Runtime for No Input: 2.22064051628"
## [1] "Absolute difference: 3.550858473779"
## Runtime for Hylaa is 159.902444711194 % greater than
## Runtime for No Input
```

3.4.28 RH4.28: Object 37445 steps

Runtime for Hylaa

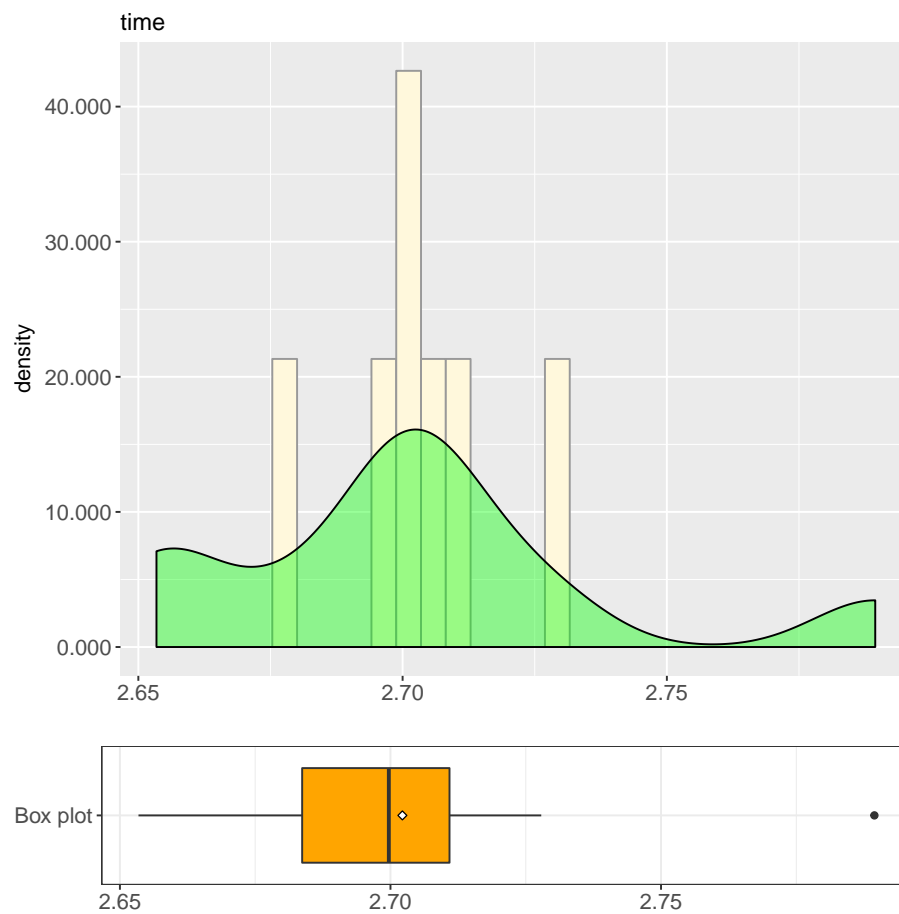
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      7.072   7.116   7.200   7.209   7.306   7.356
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps37445")$time
## W = 0.91587, p-value = 0.3238
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.32377452748614"
```

Runtime for No Input

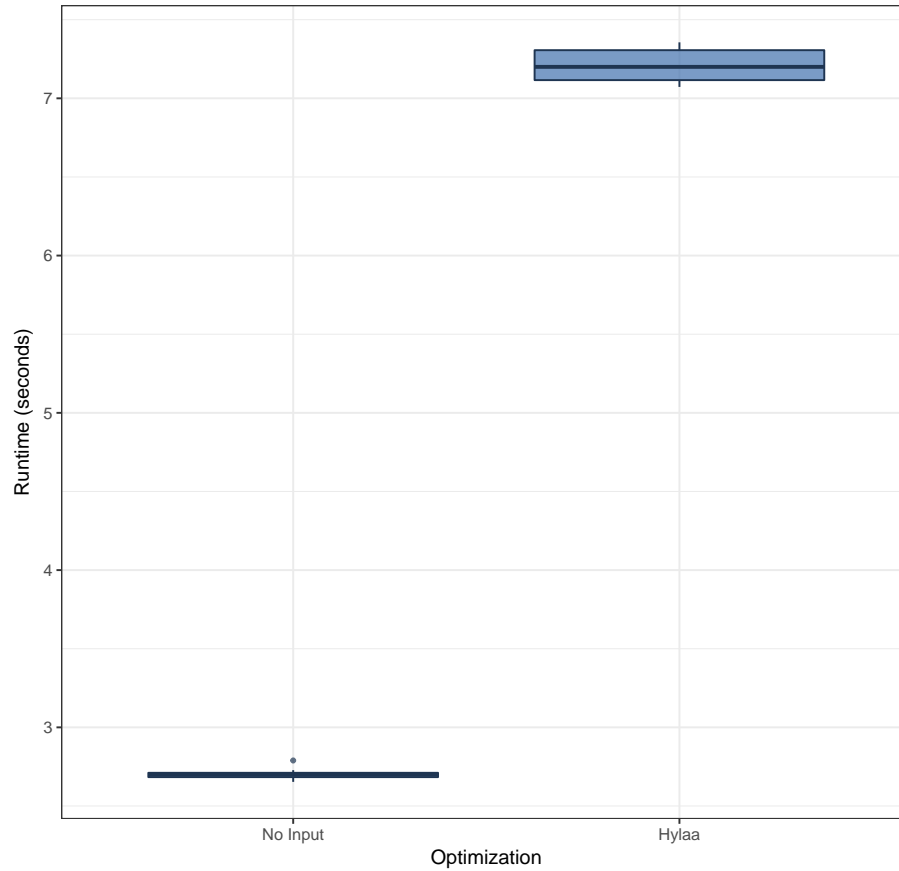
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   2.653  2.684   2.700   2.702   2.711   2.789
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps37445")$time
## W = 0.89978, p-value = 0.2179
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.217881101045638"
```

Comparison

Runtime by Optimization for 37445 steps



```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps37445")$time and subset(
## F = 7.4248, num df = 9, denom df = 9, p-value = 0.006346
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  1.844204 29.892018
## sample estimates:
## ratio of variances
##      7.424755
##
## [1] "Homogeneity of variances: FALSE. P-value: 0.00634617982406205"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

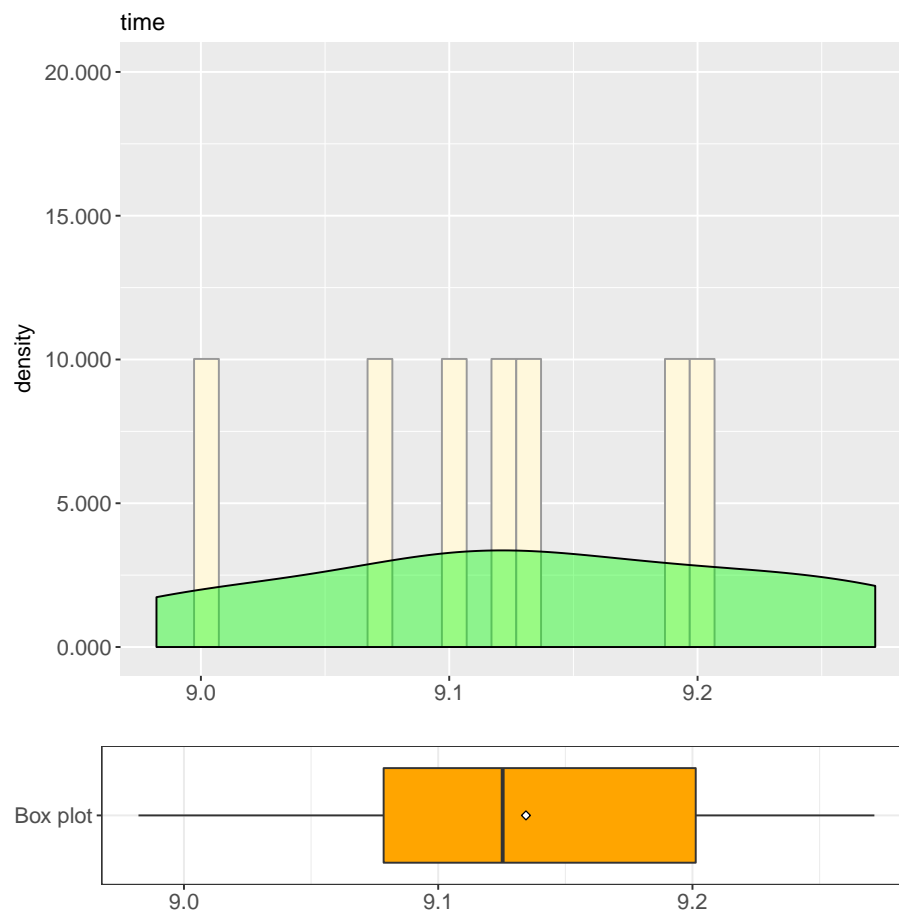


```
## Welch Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps37445")$time and subset(
## t = 127.05, df = 11.381, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 4.428653 4.584152
## sample estimates:
## mean of x mean of y
## 7.208604 2.702201
##
## [1] "T-test: Null Hypothesis rejected. P-value: 2.67505096703544e-19"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 7.208603620529"
## [1] "Mean Runtime for No Input: 2.702201032637"
## [1] "Absolute difference: 4.506402587892"
## Runtime for Hylaa is 166.767850854321 % greater than
## Runtime for No Input
```

3.4.29 RH4.29: Object 48679 steps

Runtime for Hylaa

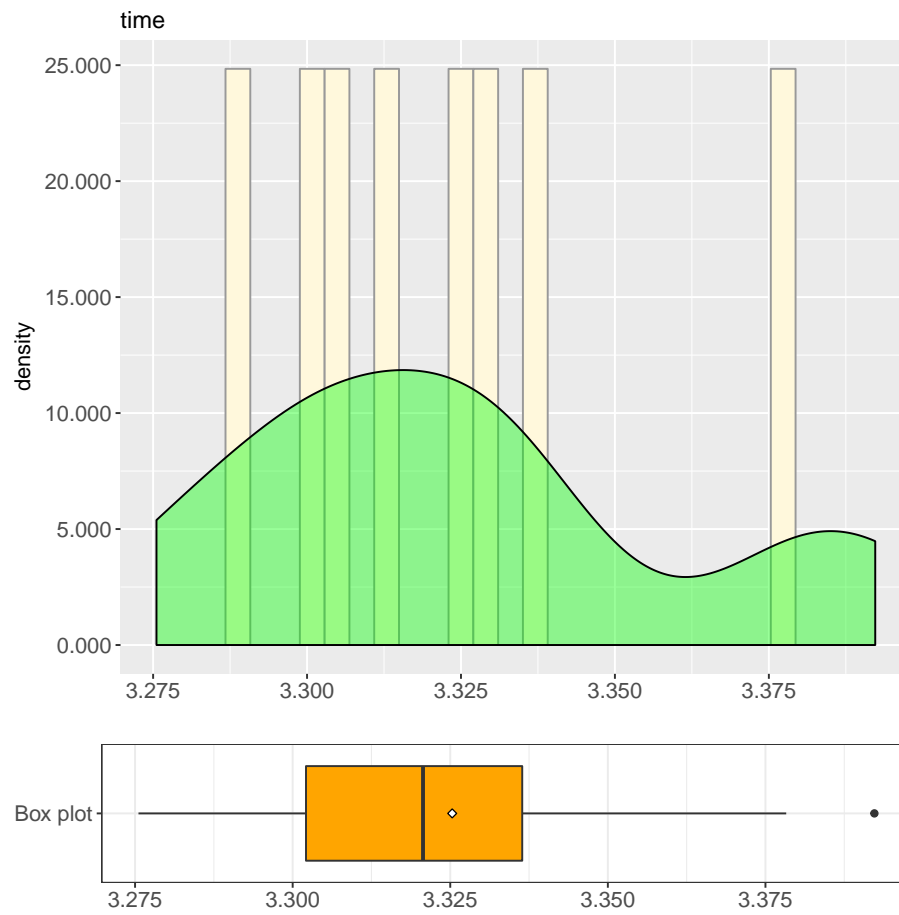
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      8.982   9.079   9.125   9.135   9.201   9.272
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps48679")$time
## W = 0.95111, p-value = 0.6816
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.681647465980239"
```

Runtime for No Input

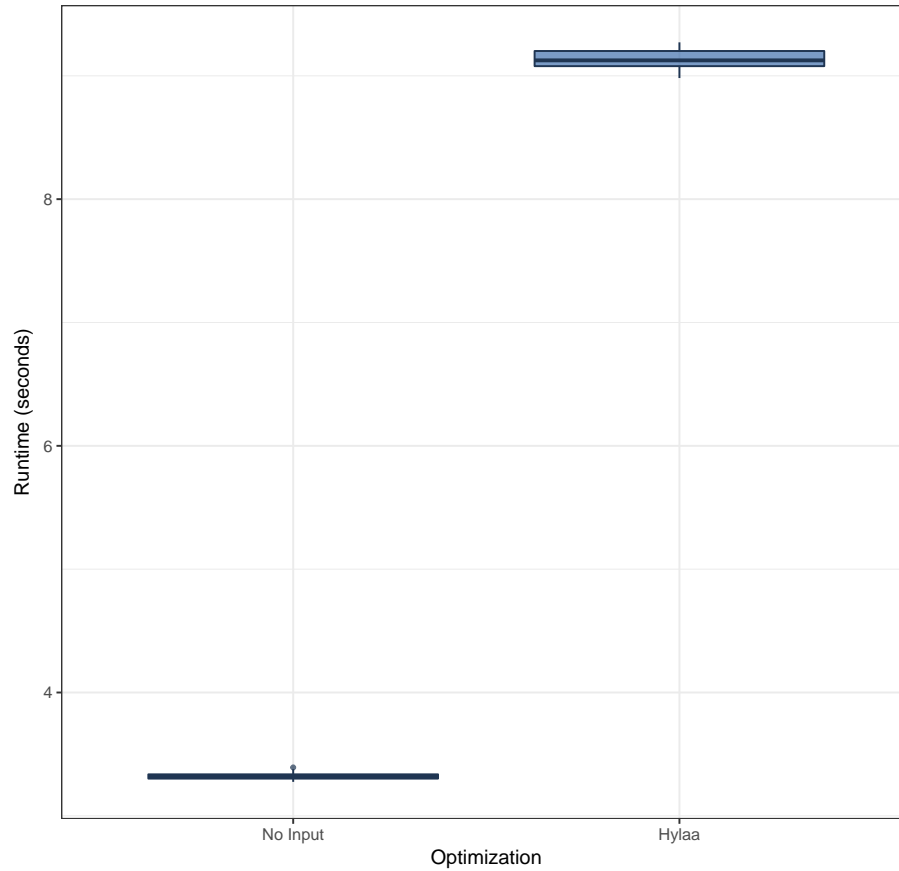
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  3.276  3.302   3.321   3.325   3.336   3.392
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "NoInput" & object == "steps48679")$time
## W = 0.93993, p-value = 0.5522
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.55219319911"
```

Comparison

Runtime by Optimization for 48679 steps



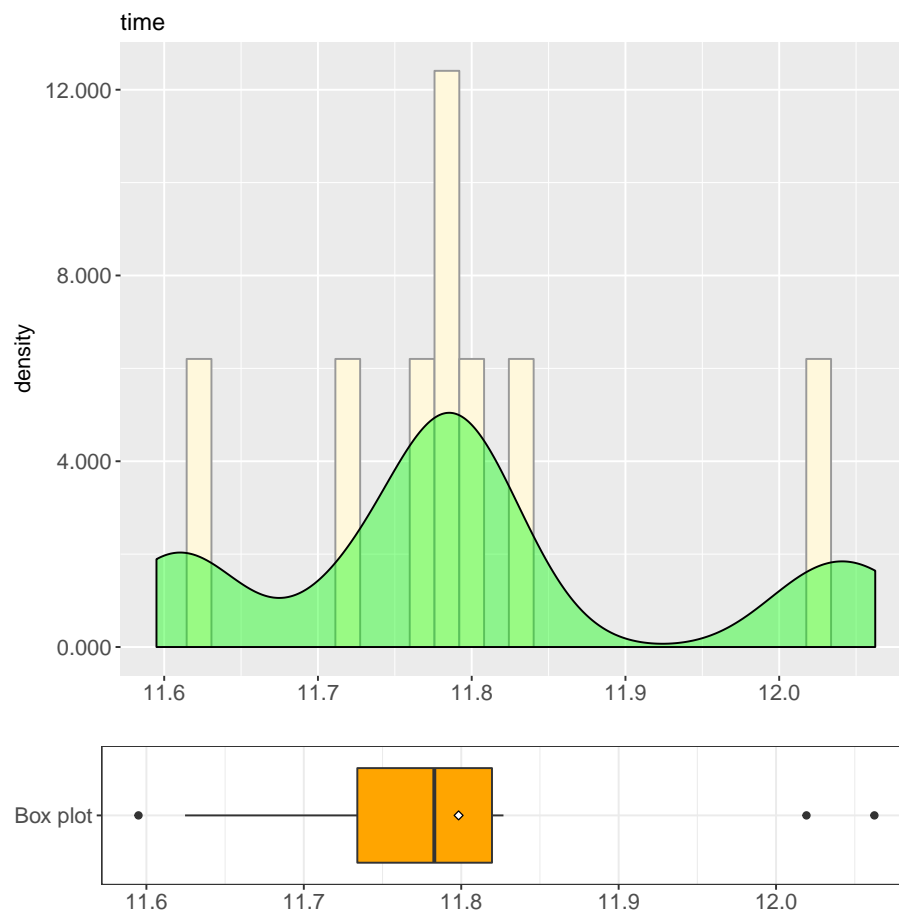
```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps48679")$time and subset(
## F = 7.3661, num df = 9, denom df = 9, p-value = 0.006532
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  1.829639 29.655944
## sample estimates:
## ratio of variances
##      7.366117
##
## [1] "Homogeneity of variances: FALSE. P-value: 0.00653172440529959"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```

```
## Welch Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps48679")$time and subset(
## t = 171.95, df = 11.399, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 5.735162 5.883242
## sample estimates:
## mean of x mean of y
## 9.134509 3.325307
##
## [1] "T-test: Null Hypothesis rejected. P-value: 8.02833760575554e-21"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 9.134509158134"
## [1] "Mean Runtime for No Input: 3.325307297707"
## [1] "Absolute difference: 5.809201860427"
## Runtime for Hylaa is 174.696692375853 % greater than
## Runtime for No Input
```

3.4.30 RH4.30: Object 63282 steps

Runtime for Hylaa

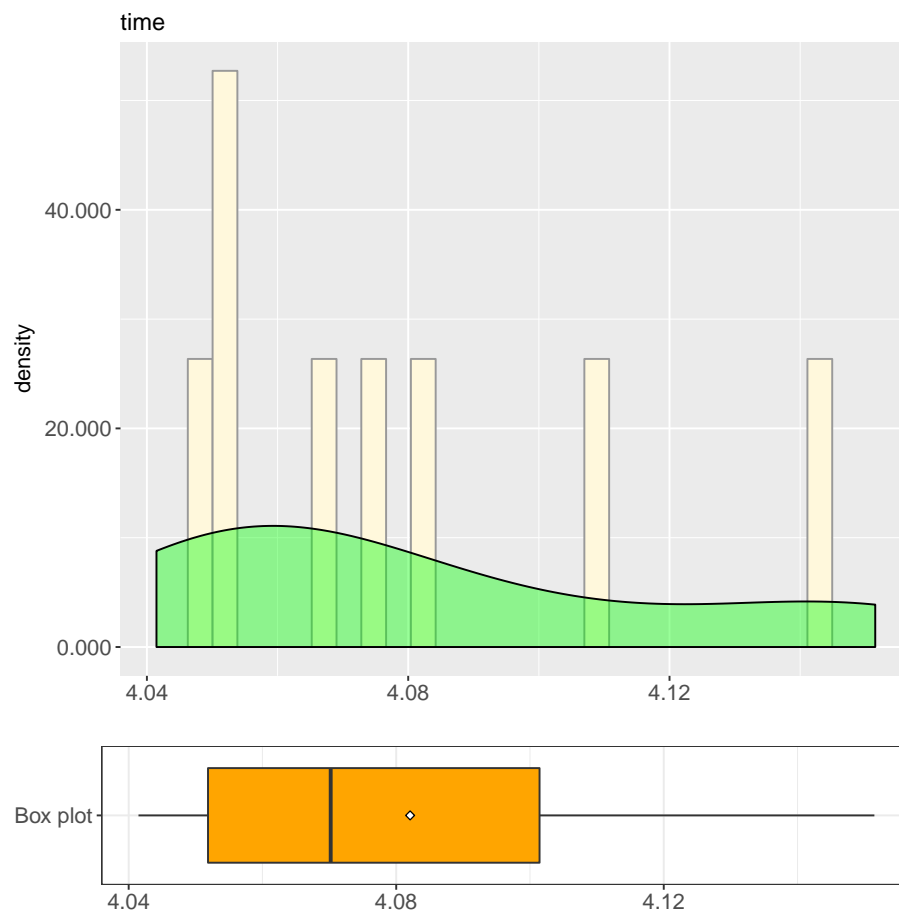
```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    11.59   11.73   11.78   11.80   11.82   12.06
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps63282")$time
## W = 0.90816, p-value = 0.2686
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.268588784180786"
```

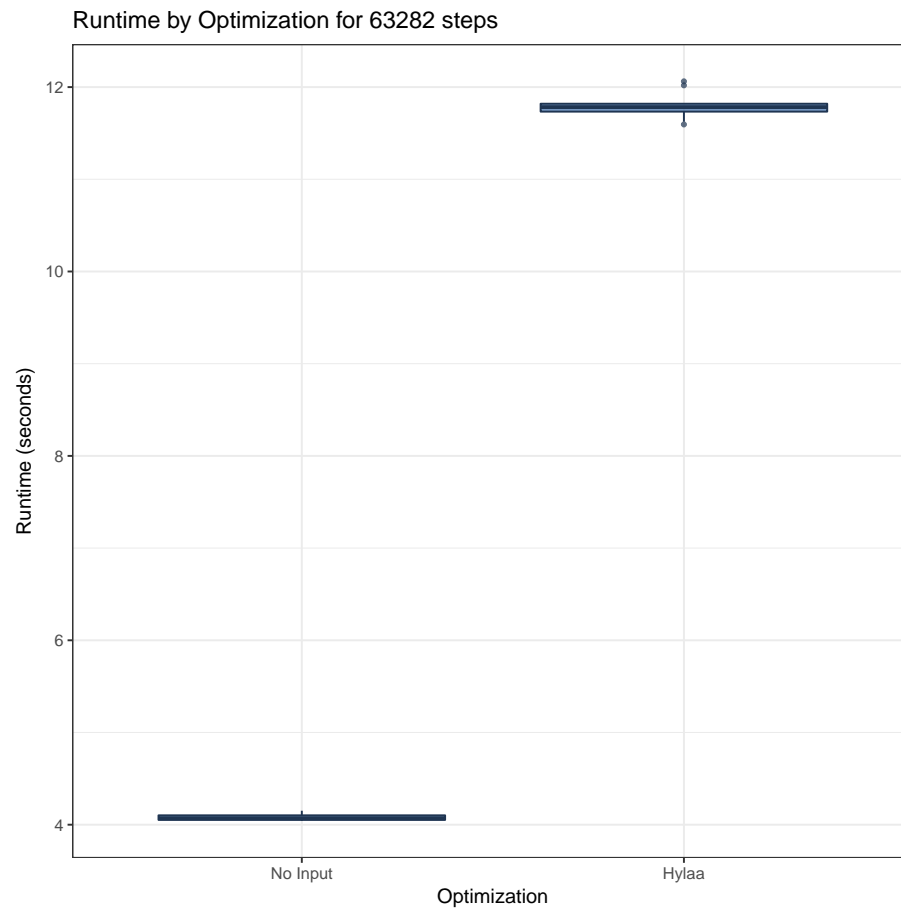
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   4.041  4.052  4.070  4.082  4.101  4.151
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "NoInput" & object == "steps63282")$time
## W = 0.86196, p-value = 0.08048
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.0804772059614514"
```

Comparison



```
## [1] "Fisher's F-test to verify the homoskedasticity (homogeneity of variances)"
##
## F test to compare two variances
##
## data:  subset(json_data, treatment == "Hylaa" & object == "steps63282")$time and subset(
## F = 14.182, num df = 9, denom df = 9, p-value = 0.0005273
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  3.522657 57.097439
## sample estimates:
## ratio of variances
##      14.1822
##
## [1] "Homogeneity of variances: FALSE. P-value: 0.000527290657418078"
## [1] "Assuming that the two samples are taken from populations that follow a Gaussian dist
##
```



```
## Welch Two Sample t-test
##
## data: subset(json_data, treatment == "Hylaa" & object == "steps63282")$time and subset(
## t = 158.97, df = 10.263, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## 7.608470 7.824025
## sample estimates:
## mean of x mean of y
## 11.798324 4.082077
##
## [1] "T-test: Null Hypothesis rejected. P-value: 9.60070696768075e-19"
## [1] ""
## [1] "Means comparison"
## [1] "Mean Runtime for Hylaa: 11.79832429887"
## [1] "Mean Runtime for No Input: 4.082077097894"
## [1] "Absolute difference: 7.716247200976"
## Runtime for Hylaa is 189.027473414378 % greater than
## Runtime for No Input
```

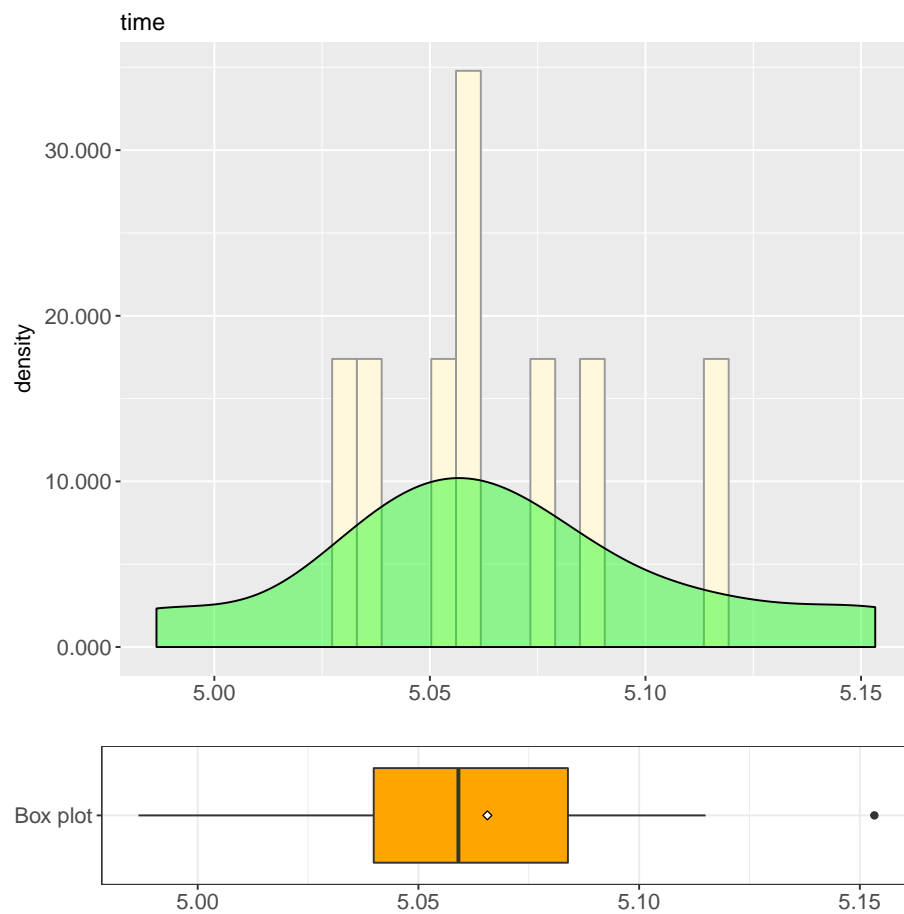
3.4.31 RH4.31: Object 82267 steps

Runtime for Hylaa

```
## [1] "Sample size: 0"
##      Min. 1st Qu.  Median      Mean 3rd Qu.      Max.      NA's
##      NA      NA      NA      NaN      NA      NA      10
```

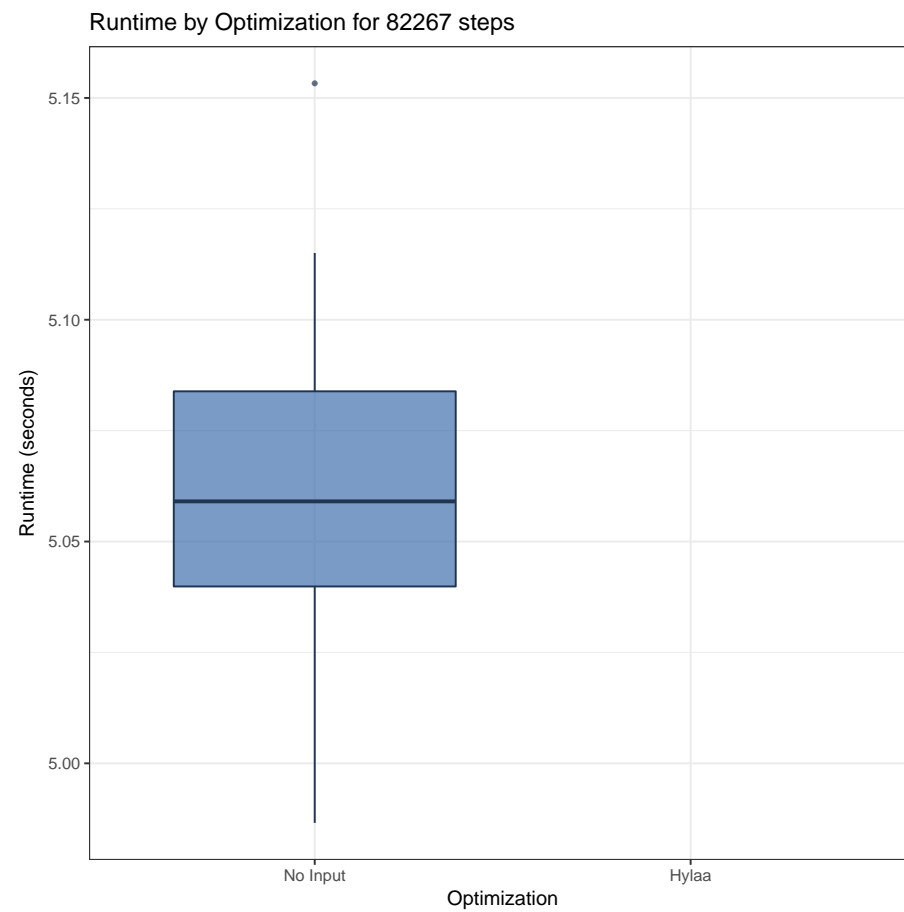
Runtime for No Input

```
## [1] "Sample size: 10"
##      Min. 1st Qu.  Median      Mean 3rd Qu.      Max.
##      4.987    5.040    5.059    5.066    5.084    5.153
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "NoInput" & object == "steps82267")$time
## W = 0.975, p-value = 0.933
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.932976077741412"
```

Comparison



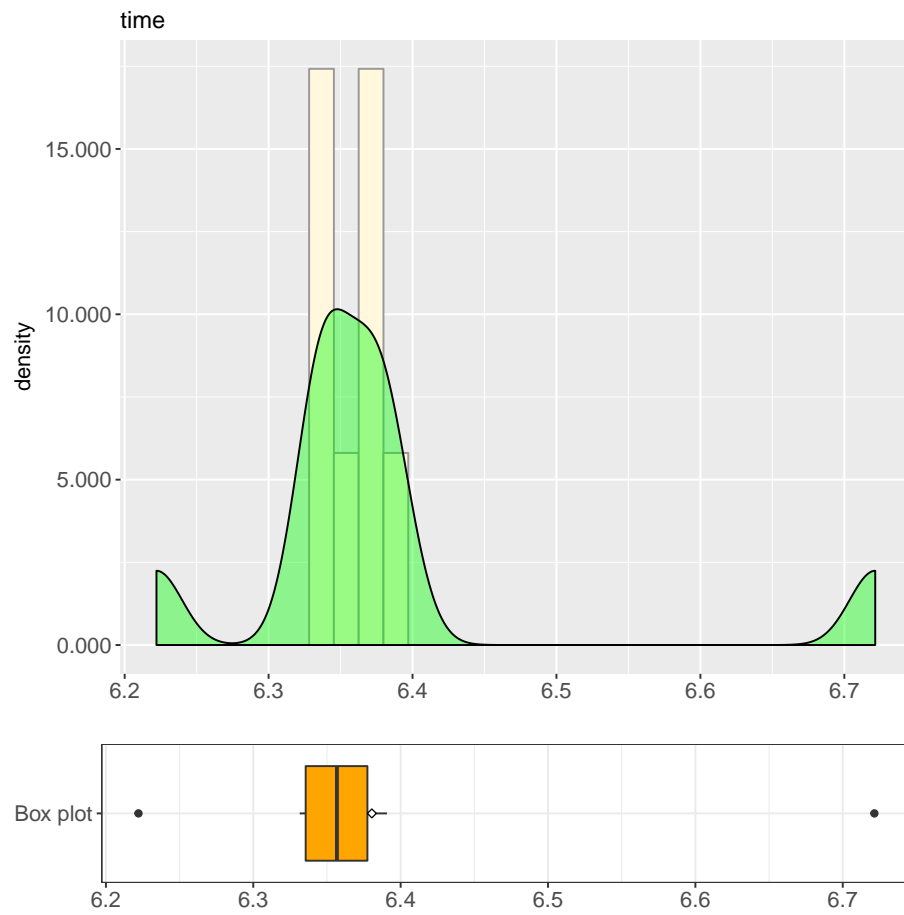
3.4.32 RH4.32: Object 106948 steps

Runtime for Hylaa

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA     10
```

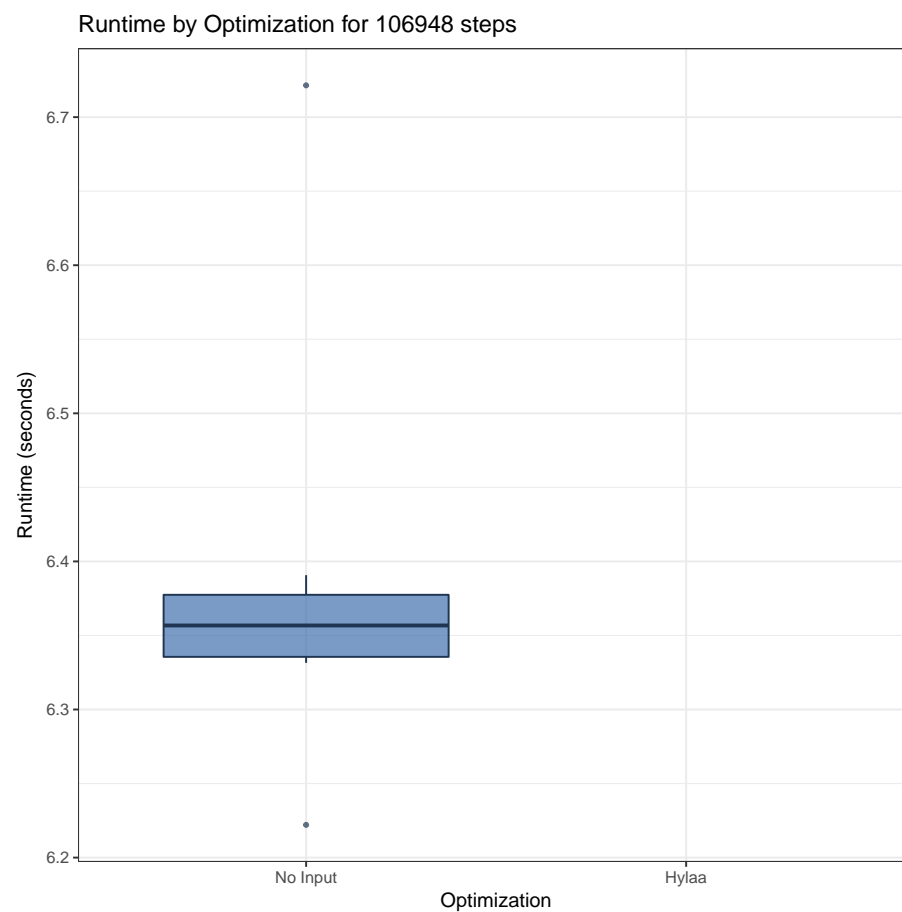
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  6.222  6.336  6.357  6.380  6.377  6.721
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps106948")$time
## W = 0.6887, p-value = 0.0006429
##
## [1] "Shapiro test: Null Hypothesis (normality) rejected. P-value: 0.000642945631112053"
```

Comparison



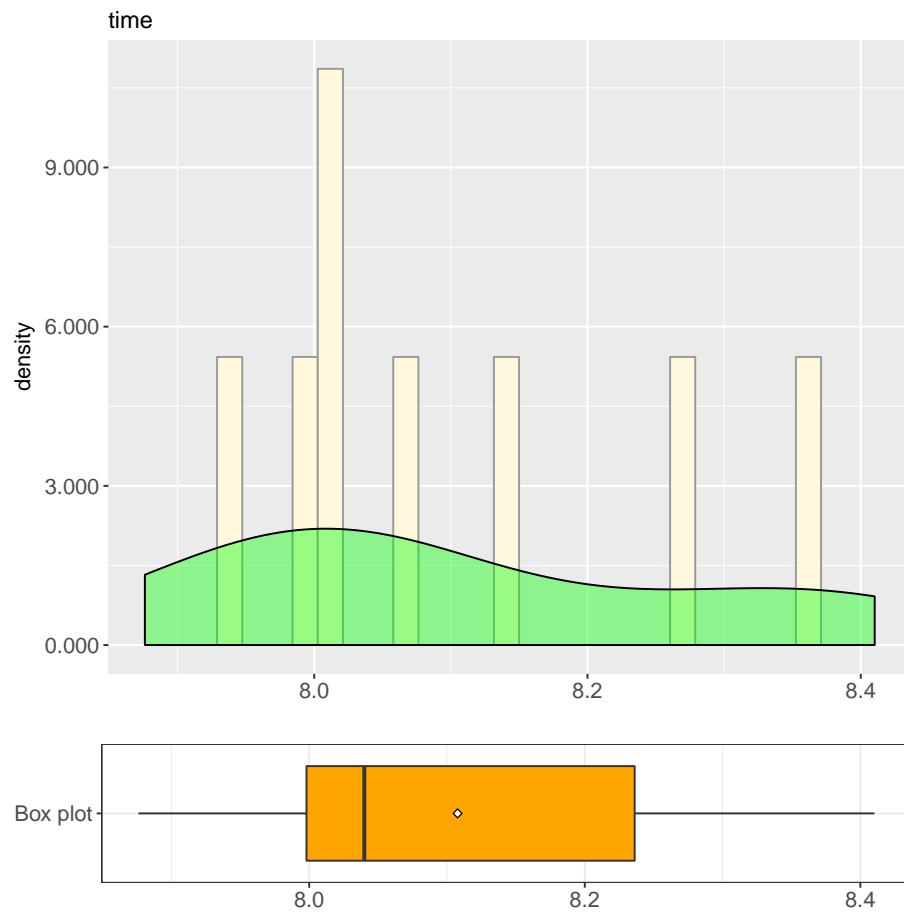
3.4.33 RH4.33: Object 139032 steps

Runtime for Hylaa

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    NA      NA     NA     NaN    NA      NA      10
```

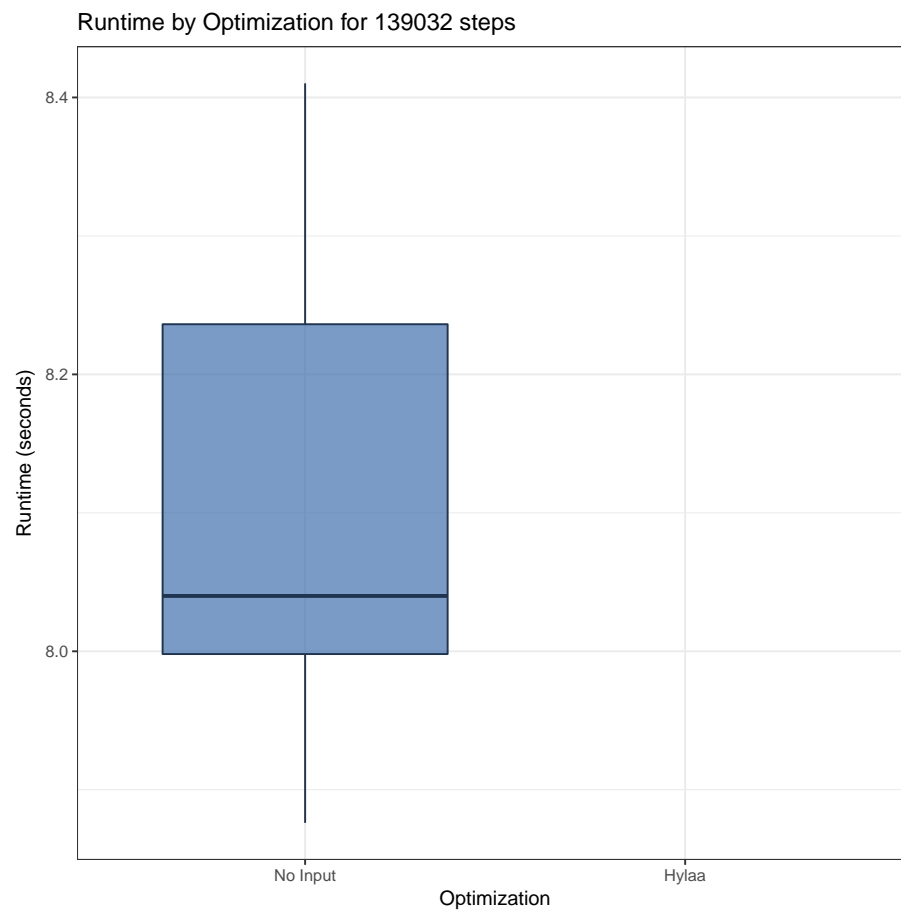
Runtime for No Input

```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  7.876  7.998  8.040  8.108  8.236  8.410
```



```
##
## Shapiro-Wilk normality test
##
## data: subset(json_data, treatment == "NoInput" & object == "steps139032")$time
## W = 0.91266, p-value = 0.2998
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.299757121190149"
```

Comparison



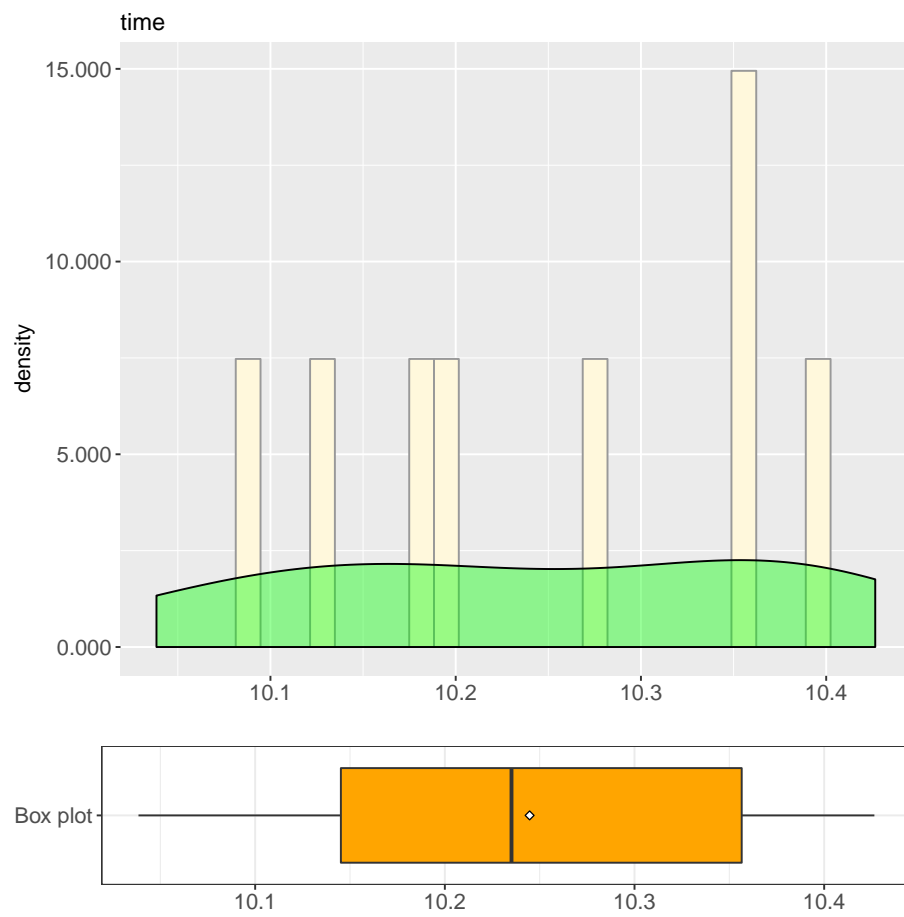
3.4.34 RH4.34: Object 180742 steps

Runtime for Hylaa

```
## [1] "Sample size: 0"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.   NA's
##    NA      NA     NA     NaN    NA      NA     10
```

Runtime for No Input

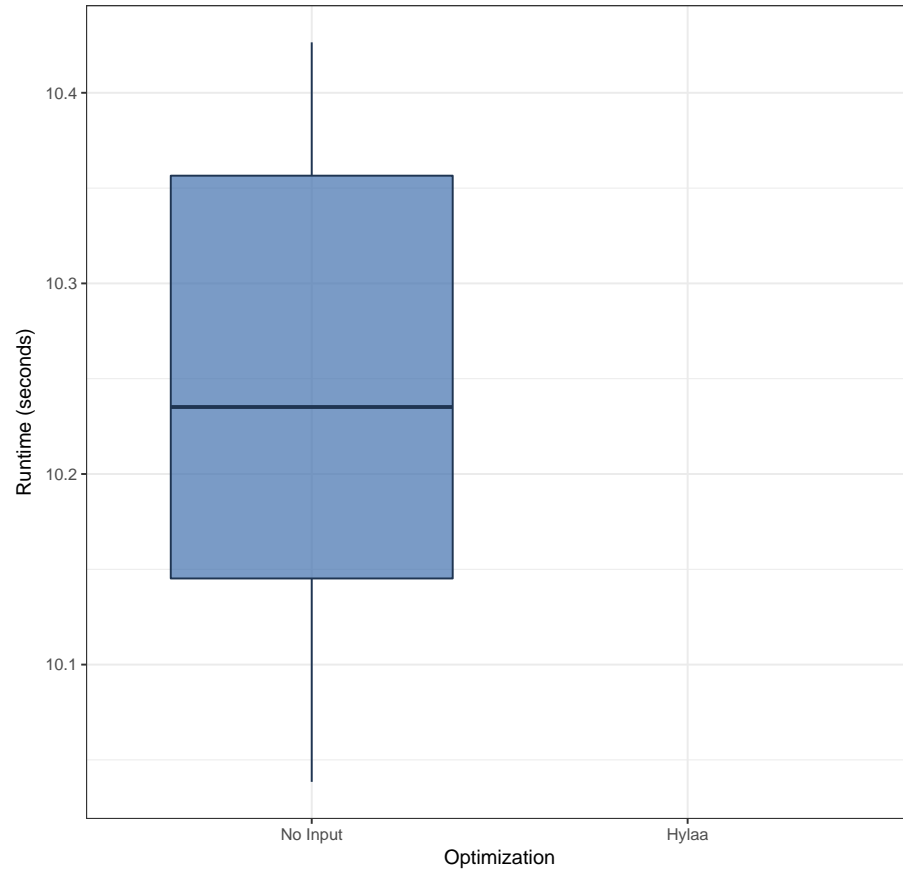
```
## [1] "Sample size: 10"
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  10.04  10.15   10.24   10.24  10.36   10.43
```



```
##
##  Shapiro-Wilk normality test
##
## data:  subset(json_data, treatment == "NoInput" & object == "steps180742")$time
## W = 0.93806, p-value = 0.5317
##
## [1] "Shapiro test: Null Hypothesis (normality) not rejected. P-value: 0.531671950075446"
```

Comparison

Runtime by Optimization for 180742 steps



3.4.35 RH4 Results: Runtime Hylaa = No Input

Table 7: RH4 Results per Object

31 steps	Inconclusive
40 steps	Inconclusive
53 steps	Inconclusive
68 steps	Hylaa < No Input
89 steps	Hylaa > No Input
116 steps	Hylaa > No Input
151 steps	Inconclusive
197 steps	Inconclusive
256 steps	Hylaa > No Input
332 steps	Hylaa < No Input
432 steps	Hylaa > No Input
562 steps	Hylaa > No Input
731 steps	Hylaa > No Input
951 steps	Hylaa > No Input
1236 steps	Hylaa > No Input
1607 steps	Hylaa > No Input
2089 steps	Hylaa > No Input
2716 steps	Hylaa > No Input
3531 steps	Hylaa > No Input
4590 steps	Hylaa > No Input
5967 steps	Hylaa > No Input
7757 steps	Hylaa > No Input
10085 steps	Hylaa > No Input
13110 steps	Hylaa > No Input
17043 steps	Hylaa > No Input
22157 steps	Hylaa > No Input
28804 steps	Hylaa > No Input
37445 steps	Hylaa > No Input
48679 steps	Hylaa > No Input
63282 steps	Hylaa > No Input
82267 steps	No Input
106948 steps	No Input
139032 steps	No Input
180742 steps	No Input

Table 8: RH4 Results Summary	
Hylaa < No Input:	5.8823529%
Hylaa > No Input:	67.6470588%
Hylaa:	0%
No Input:	11.7647059%
None:	0%
Inconclusive:	14.7058824%

4 Result Summary

4.1 Research Hypotheses

4.1.1 RH1 Results: Runtime Hylaa = Warm

Table 9: RH1 Results per Object

31 steps	Inconclusive
40 steps	Inconclusive
53 steps	Inconclusive
68 steps	Hylaa > Warm
89 steps	Inconclusive
116 steps	Hylaa > Warm
151 steps	Hylaa > Warm
197 steps	Inconclusive
256 steps	Hylaa < Warm
332 steps	Hylaa < Warm
432 steps	Hylaa < Warm
562 steps	Hylaa < Warm
731 steps	Hylaa < Warm
951 steps	Hylaa < Warm
1236 steps	Hylaa < Warm
1607 steps	Hylaa < Warm
2089 steps	Hylaa < Warm
2716 steps	Hylaa < Warm
3531 steps	Hylaa < Warm
4590 steps	Hylaa
5967 steps	Hylaa
7757 steps	Hylaa
10085 steps	Hylaa
13110 steps	Hylaa
17043 steps	Hylaa
22157 steps	Hylaa
28804 steps	Hylaa
37445 steps	Hylaa
48679 steps	Hylaa
63282 steps	Hylaa
82267 steps	None
106948 steps	None
139032 steps	None
180742 steps	None

Table 10: RH1 Results Summary

Hylaa < Warm:	32.3529412%
Hylaa > Warm:	8.8235294%
Hylaa:	32.3529412%
Warm:	0%
None:	11.7647059%
Inconclusive:	14.7058824%

4.1.2 RH2 Results: Runtime Hylaa = Decomp

Table 11: RH2 Results per Object

31 steps	Inconclusive
40 steps	Hylaa < Decomp
53 steps	Hylaa > Decomp
68 steps	Inconclusive
89 steps	Inconclusive
116 steps	Inconclusive
151 steps	Inconclusive
197 steps	Inconclusive
256 steps	Hylaa > Decomp
332 steps	Hylaa < Decomp
432 steps	Hylaa < Decomp
562 steps	Hylaa < Decomp
731 steps	Inconclusive
951 steps	Hylaa < Decomp
1236 steps	Inconclusive
1607 steps	Inconclusive
2089 steps	Hylaa < Decomp
2716 steps	Hylaa < Decomp
3531 steps	Hylaa < Decomp
4590 steps	Hylaa < Decomp
5967 steps	Hylaa < Decomp
7757 steps	Hylaa < Decomp
10085 steps	Hylaa < Decomp
13110 steps	Hylaa < Decomp
17043 steps	Hylaa < Decomp
22157 steps	Hylaa < Decomp
28804 steps	Hylaa < Decomp
37445 steps	Hylaa < Decomp
48679 steps	Hylaa < Decomp
63282 steps	Hylaa < Decomp
82267 steps	None
106948 steps	None
139032 steps	None
180742 steps	None

Table 12: RH2 Results Summary

Hylaa < Decomp:	55.8823529%
Hylaa > Decomp:	5.8823529%
Hylaa:	0%
Decomp:	0%
None:	11.7647059%
Inconclusive:	26.4705882%

4.1.3 RH3 Results: Runtime Hylaa = Basic

Table 13: RH3 Results per Object

31 steps	Inconclusive
40 steps	Hylaa < Basic
53 steps	Hylaa < Basic
68 steps	Hylaa < Basic
89 steps	Hylaa < Basic
116 steps	Hylaa < Basic
151 steps	Hylaa < Basic
197 steps	Hylaa < Basic
256 steps	Hylaa < Basic
332 steps	Hylaa < Basic
432 steps	Hylaa < Basic
562 steps	Hylaa
731 steps	Hylaa
951 steps	Hylaa
1236 steps	Hylaa
1607 steps	Hylaa
2089 steps	Hylaa
2716 steps	Hylaa
3531 steps	Hylaa
4590 steps	Hylaa
5967 steps	Hylaa
7757 steps	Hylaa
10085 steps	Hylaa
13110 steps	Hylaa
17043 steps	Hylaa
22157 steps	Hylaa
28804 steps	Hylaa
37445 steps	Hylaa
48679 steps	Hylaa
63282 steps	Hylaa
82267 steps	None
106948 steps	None
139032 steps	None
180742 steps	None

Table 14: RH3 Results Summary

Hylaa < Basic:	29.4117647%
Hylaa > Basic:	0%
Hylaa:	55.8823529%
Basic:	0%
None:	11.7647059%
Inconclusive:	2.9411765%

4.1.4 RH4 Results: Runtime Hylaa = No Input

Table 15: RH4 Results per Object

31 steps	Inconclusive
40 steps	Inconclusive
53 steps	Inconclusive
68 steps	Hylaa < No Input
89 steps	Hylaa > No Input
116 steps	Hylaa > No Input
151 steps	Inconclusive
197 steps	Inconclusive
256 steps	Hylaa > No Input
332 steps	Hylaa < No Input
432 steps	Hylaa > No Input
562 steps	Hylaa > No Input
731 steps	Hylaa > No Input
951 steps	Hylaa > No Input
1236 steps	Hylaa > No Input
1607 steps	Hylaa > No Input
2089 steps	Hylaa > No Input
2716 steps	Hylaa > No Input
3531 steps	Hylaa > No Input
4590 steps	Hylaa > No Input
5967 steps	Hylaa > No Input
7757 steps	Hylaa > No Input
10085 steps	Hylaa > No Input
13110 steps	Hylaa > No Input
17043 steps	Hylaa > No Input
22157 steps	Hylaa > No Input
28804 steps	Hylaa > No Input
37445 steps	Hylaa > No Input
48679 steps	Hylaa > No Input
63282 steps	Hylaa > No Input
82267 steps	No Input
106948 steps	No Input
139032 steps	No Input
180742 steps	No Input

Table 16: RH4 Results Summary

Hylaa < No Input:	5.8823529%
Hylaa > No Input:	67.6470588%
Hylaa:	0%
No Input:	11.7647059%
None:	0%
Inconclusive:	14.7058824%

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
```