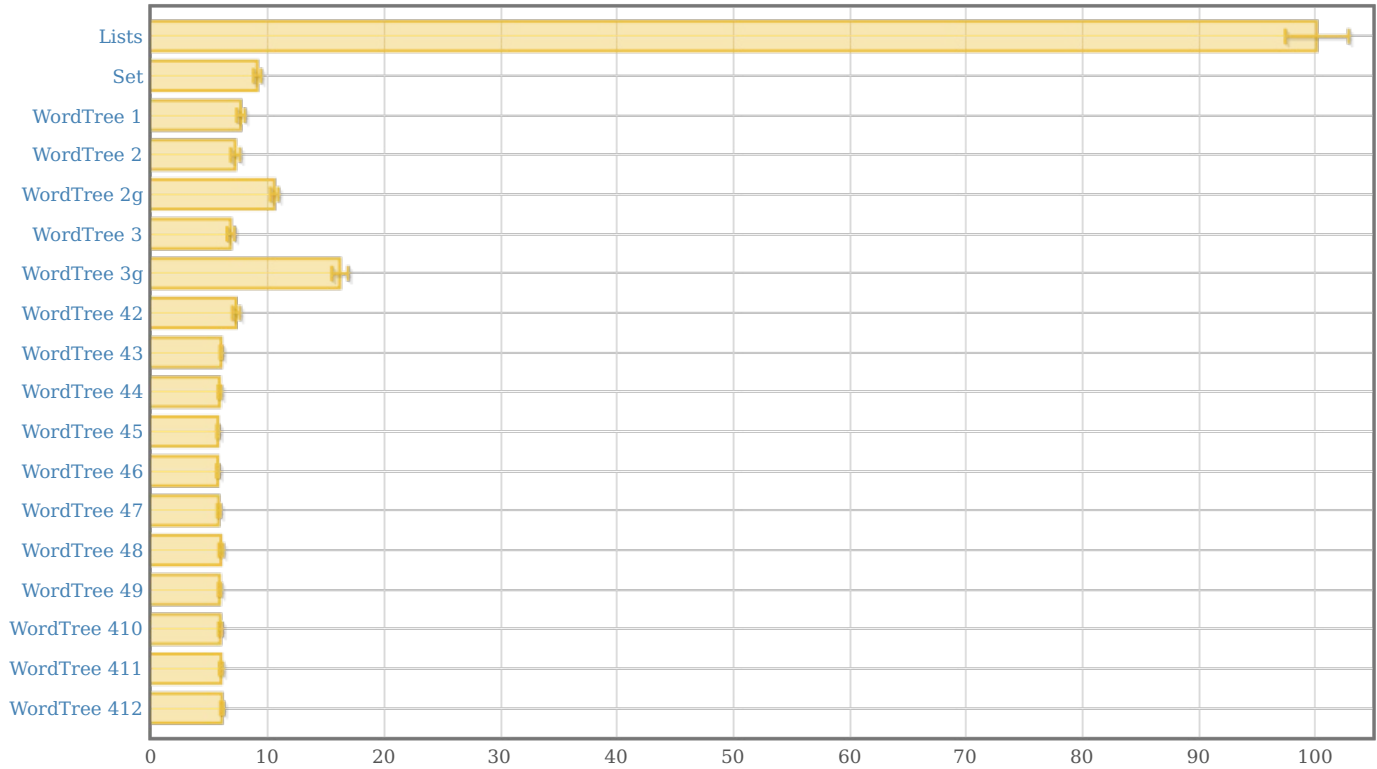


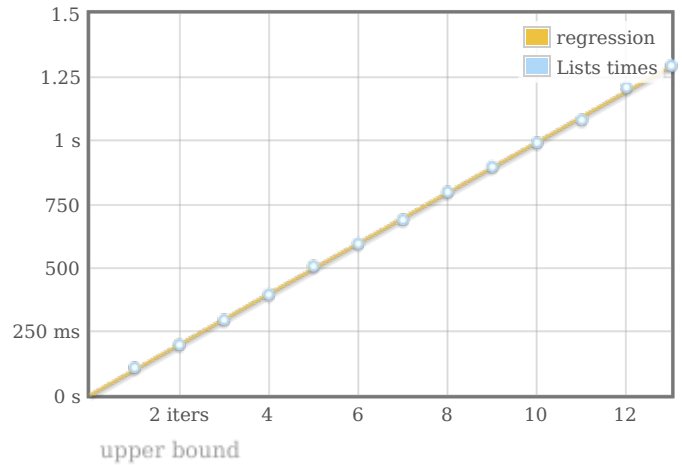
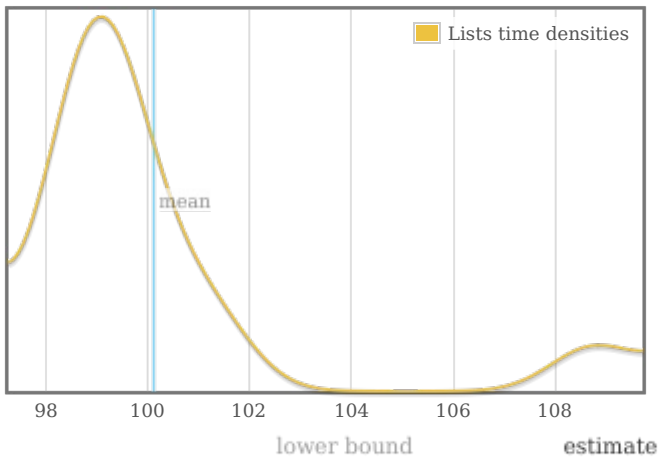
# criterion performance measurements

## overview

want to understand this report?



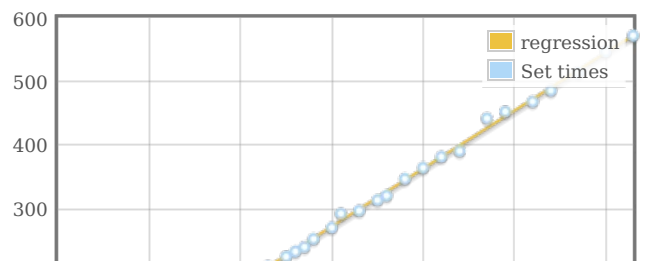
## Lists

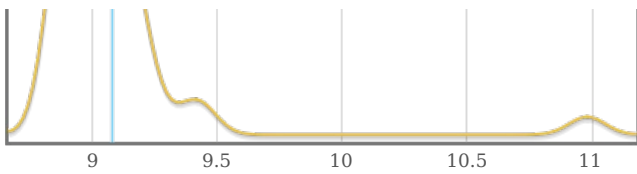


OLS regression	98.1 ms	99.4 ms	101 ms
R <sup>2</sup> goodness-of-fit	0.999	1.000	1.000
Mean execution time	9.92385334150678e-2	0.10011462904479562	0.1030582275524469
Standard deviation	8.076495931727008e-4	2.722534983701443e-3	4.785355520192993e-3

Outlying measurements have slight (7.10059171597633e-2%) effect on estimated standard deviation.

## Set

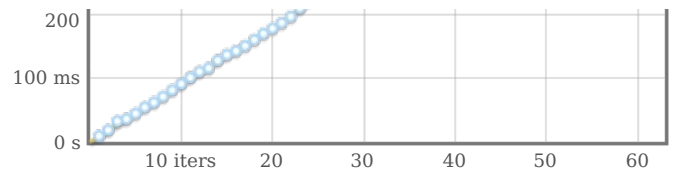




lower bound estimate

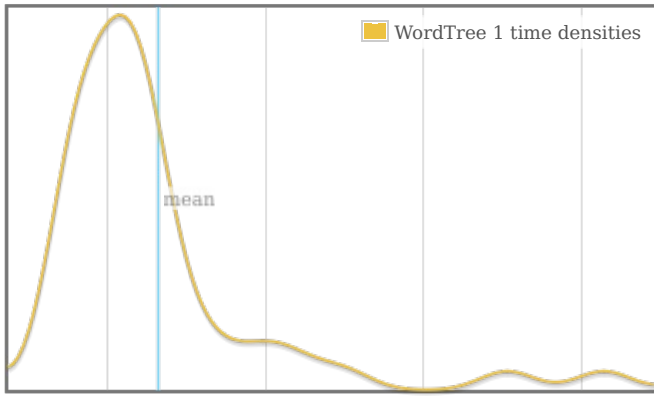
OLS regression	8.99 ms	9.07 ms	9.17 ms
R <sup>2</sup> goodness-of-fit	0.999	0.999	1.000
Mean execution time	9.018666184560218e-3	9.080852272405984e-3	9.25406643155184e-3
Standard deviation	1.2202734128598765e-4	3.299255278009203e-4	6.606153847318102e-4

Outlying measurements have moderate (0.17651819864602022%) effect on estimated standard deviation.



upper bound

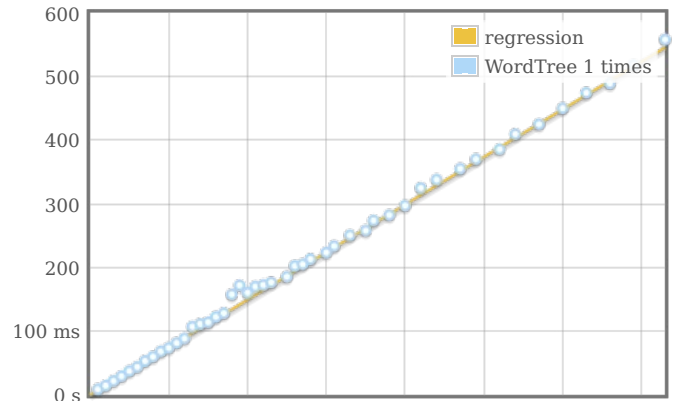
## WordTree 1



lower bound estimate

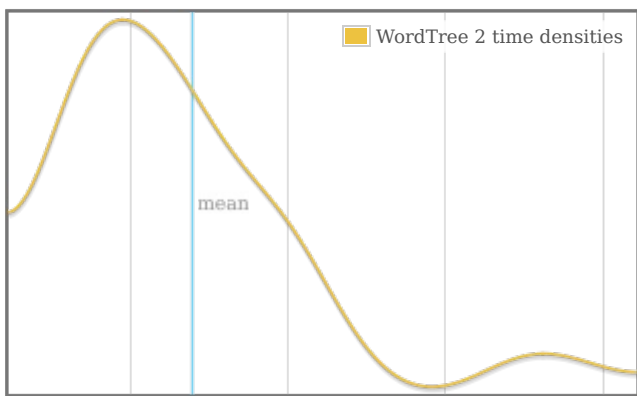
OLS regression	7.37 ms	7.46 ms	7.54 ms
R <sup>2</sup> goodness-of-fit	0.996	0.998	0.999
Mean execution time	7.58360086615258e-3	7.658407588362962e-3	7.811366884342645e-3
Standard deviation	2.1786380675319005e-4	3.475373787965779e-4	5.584759029191312e-4

Outlying measurements have moderate (0.2694350145694063%) effect on estimated standard deviation.



upper bound

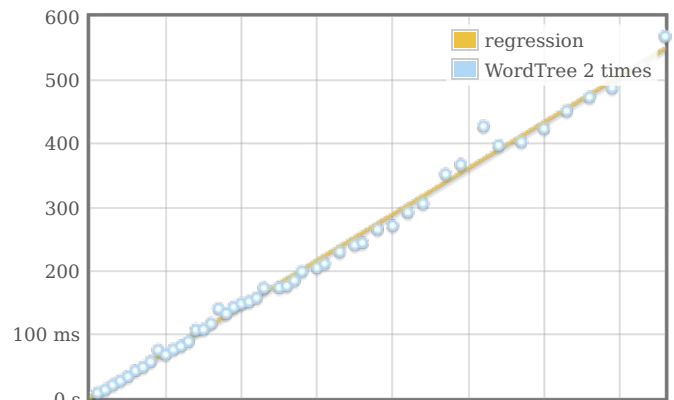
## WordTree 2



lower bound estimate

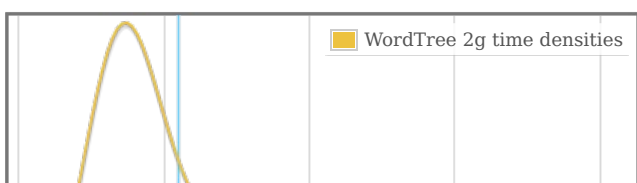
OLS regression	7.07 ms	7.24 ms	7.41 ms
R <sup>2</sup> goodness-of-fit	0.989	0.994	0.998
Mean execution time	7.088527536109496e-3	7.19493198199801e-3	7.327193262182635e-3
Standard deviation	2.863314399890243e-4	3.969219043602155e-4	5.31214704286876e-4

Outlying measurements have moderate (0.34741096548606726%) effect on estimated standard deviation.

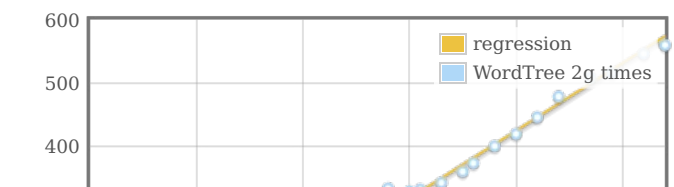


upper bound

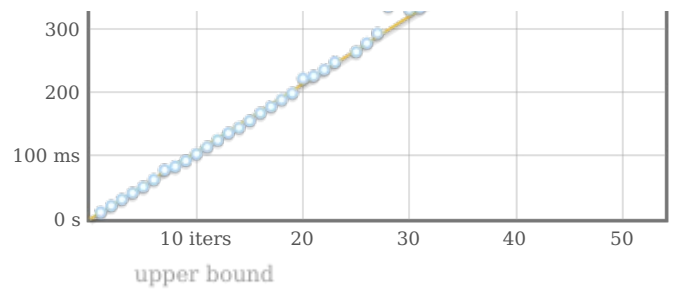
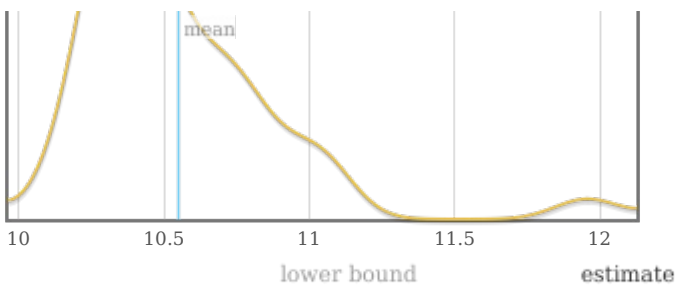
## WordTree 2g



WordTree 2g time densities



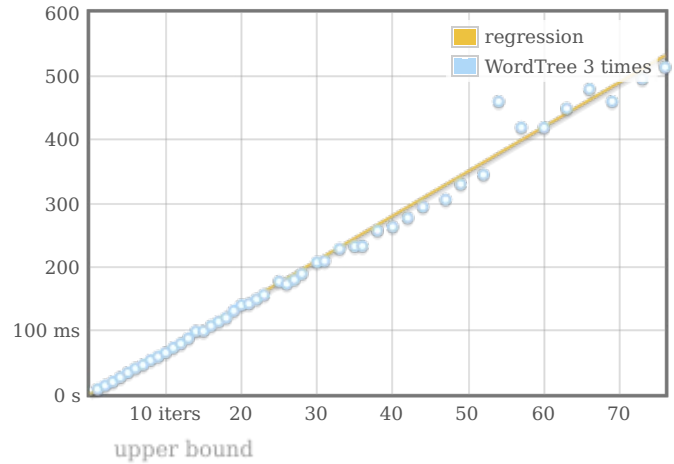
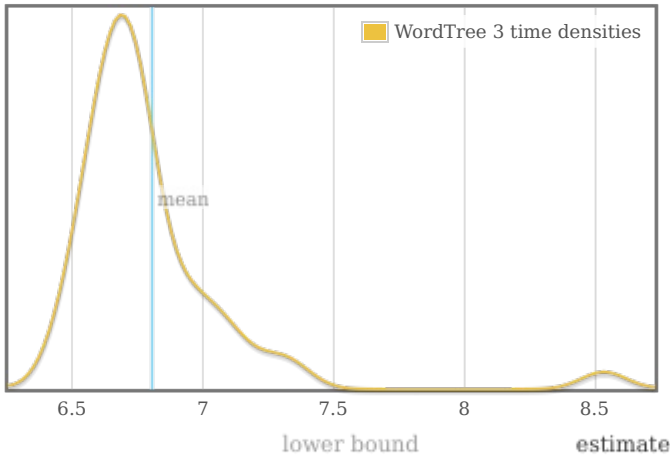
regression WordTree 2g times



OLS regression	10.5 ms	10.6 ms	10.8 ms
R <sup>2</sup> goodness-of-fit	0.993	0.997	0.999
Mean execution time	1.047745305232972e-2	1.0549451248654283e-2	1.0708211665466273e-2
Standard deviation	2.2757365181923304e-4	3.32106620627716e-4	5.45512010011542e-4

Outlying measurements have moderate (0.14113156014749795%) effect on estimated standard deviation.

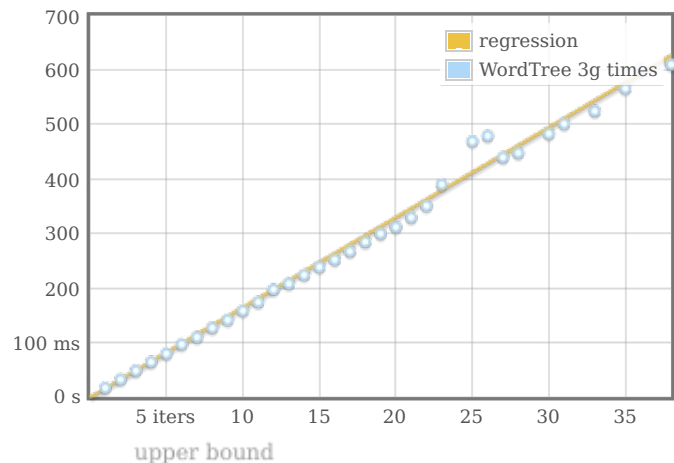
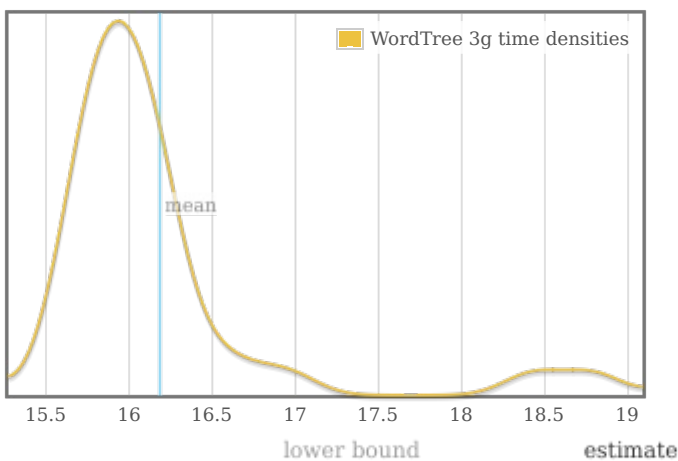
## WordTree 3



OLS regression	6.76 ms	7.00 ms	7.30 ms
R <sup>2</sup> goodness-of-fit	0.975	0.989	0.998
Mean execution time	6.731911213892791e-3	6.805152021903149e-3	6.942122318264191e-3
Standard deviation	1.80747790648362e-4	3.3109323104511535e-4	6.015849319983358e-4

Outlying measurements have moderate (0.30484406242090917%) effect on estimated standard deviation.

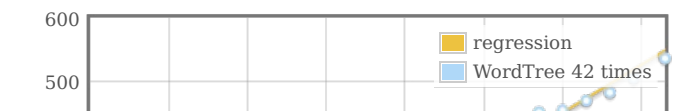
## WordTree 3g

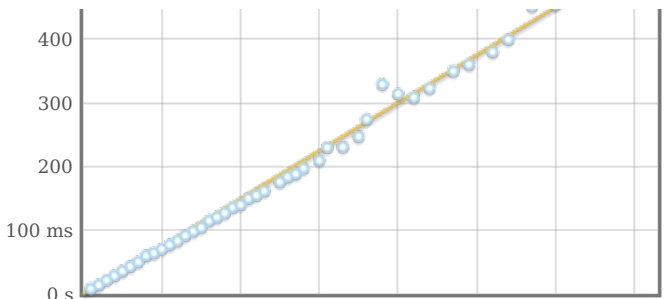
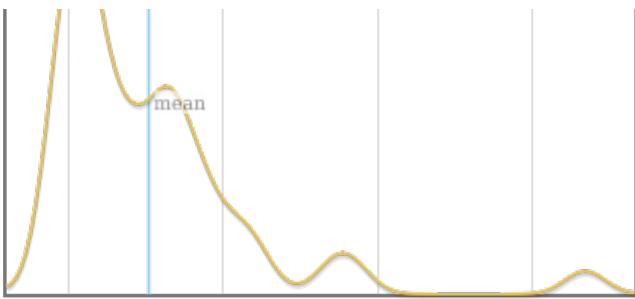


OLS regression	16.1 ms	16.5 ms	17.0 ms
R <sup>2</sup> goodness-of-fit	0.981	0.992	0.999
Mean execution time	1.6002745406420046e-2	1.6182307629152456e-2	1.6530330882020286e-2
Standard deviation	2.9486129135170204e-4	6.976123344882621e-4	1.0827177491291894e-3

Outlying measurements have moderate (0.20065745725536552%) effect on estimated standard deviation.

## WordTree 42

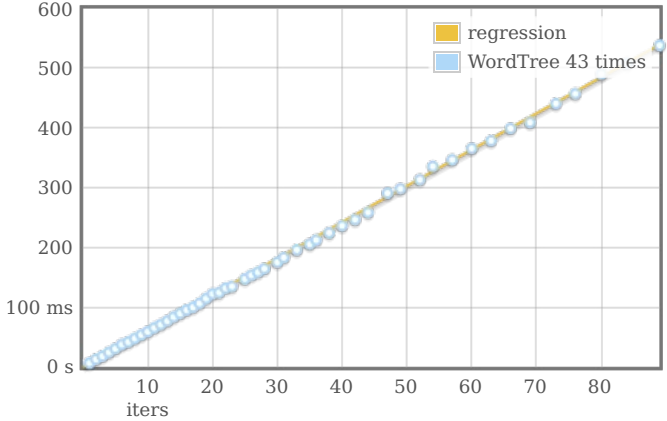
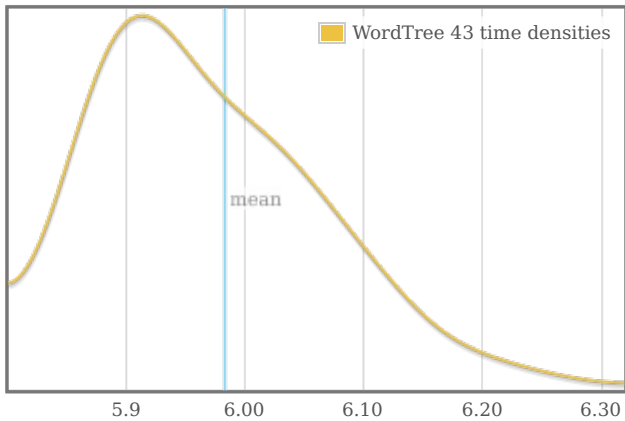




	lower bound	estimate	upper bound
OLS regression	7.39 ms	7.51 ms	7.66 ms
R <sup>2</sup> goodness-of-fit	0.989	0.995	0.999
Mean execution time	7.182836718229948e-3	7.259592789391504e-3	7.387522622587416e-3
Standard deviation	2.1762967775715004e-4	3.211392750473731e-4	5.181494681284145e-4

Outlying measurements have moderate (0.24905693255277922%) effect on estimated standard deviation.

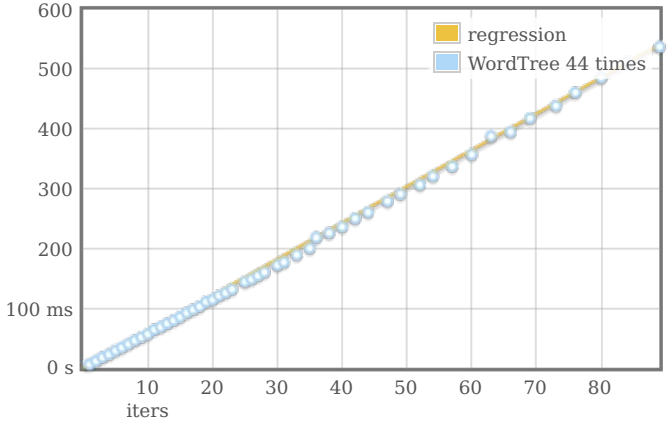
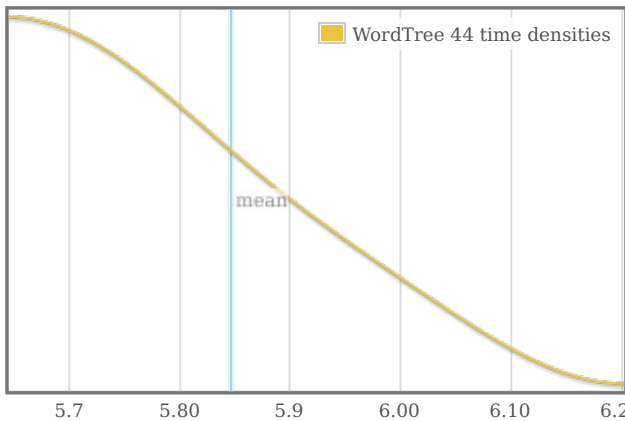
## WordTree 43



	lower bound	estimate	upper bound
OLS regression	6.01 ms	6.06 ms	6.10 ms
R <sup>2</sup> goodness-of-fit	0.999	0.999	1.000
Mean execution time	5.958695483298755e-3	5.9826052192521965e-3	6.01637239773946e-3
Standard deviation	8.435182470131664e-5	1.0182654627431117e-4	1.278431707977451e-4

Outlying measurements have slight (1.960000000000014e-2%) effect on estimated standard deviation.

## WordTree 44

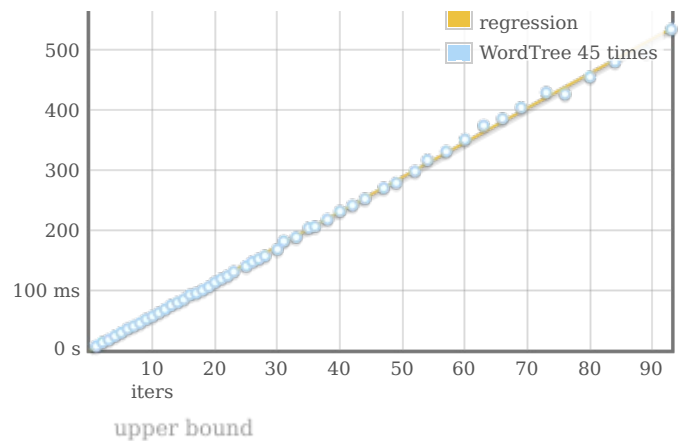
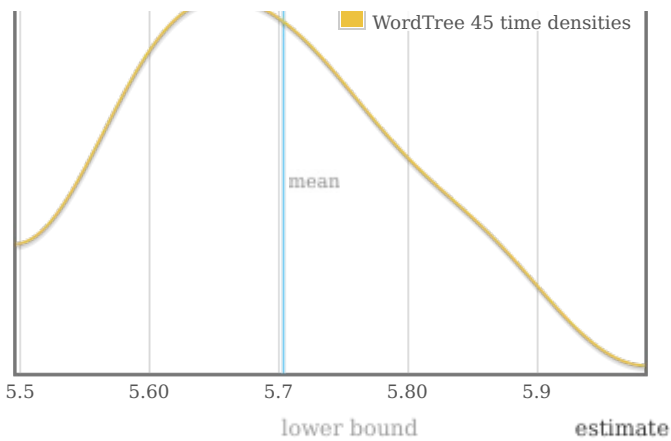


	lower bound	estimate	upper bound
OLS regression	6.03 ms	6.08 ms	6.12 ms
R <sup>2</sup> goodness-of-fit	0.999	0.999	1.000
Mean execution time	5.808819328966775e-3	5.8464228289192115e-3	5.890341882560505e-3
Standard deviation	1.1880880248943176e-4	1.3791044704163804e-4	1.6040227599318303e-4

Outlying measurements have slight (9.438388318966354e-2%) effect on estimated standard deviation.

## WordTree 45

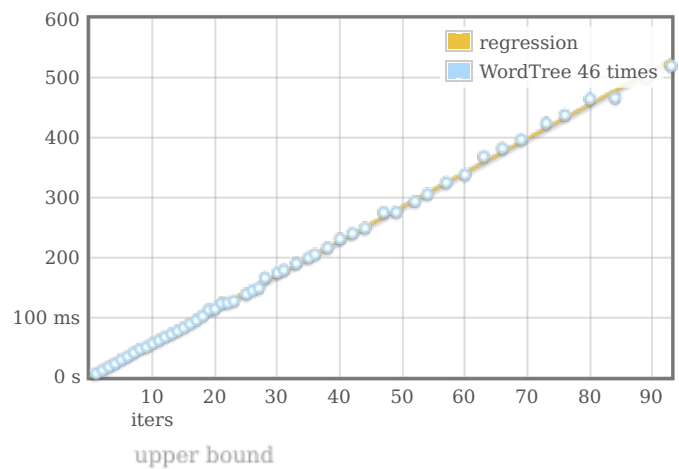
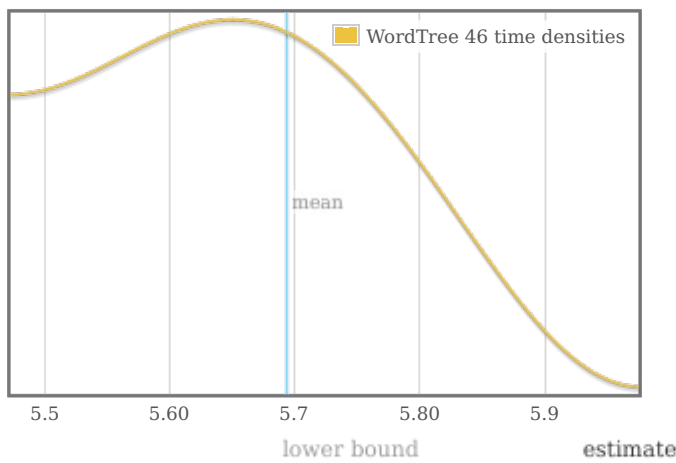




	lower bound	estimate	upper bound
OLS regression	5.70 ms	5.77 ms	5.85 ms
R <sup>2</sup> goodness-of-fit	0.999	0.999	1.000
Mean execution time	5.67340485931995e-3	5.70404139436189e-3	5.732189825644616e-3
Standard deviation	8.815788671945022e-5	1.0365981807752835e-4	1.211236534958826e-4

Outlying measurements have slight (7.272481852858419e-2%) effect on estimated standard deviation.

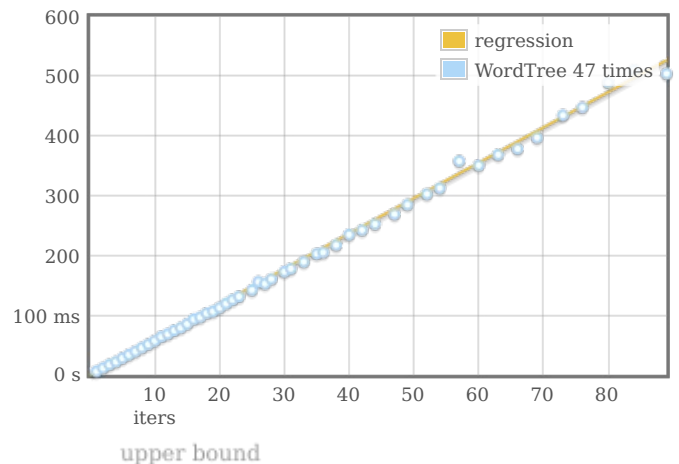
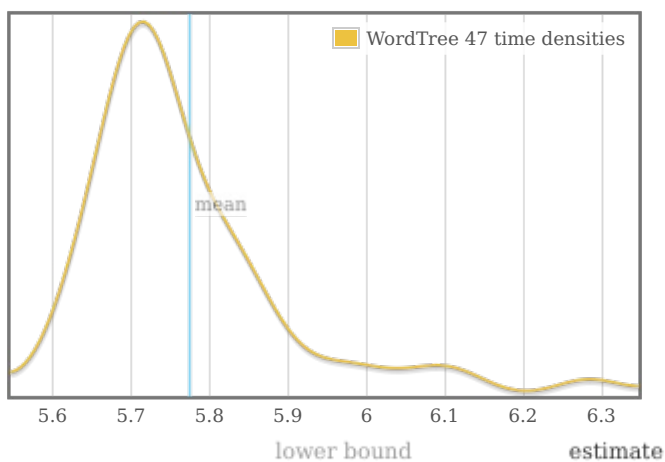
## WordTree 46



	lower bound	estimate	upper bound
OLS regression	5.64 ms	5.71 ms	5.79 ms
R <sup>2</sup> goodness-of-fit	0.999	0.999	0.999
Mean execution time	5.660044245824266e-3	5.693554953202592e-3	5.727806248840969e-3
Standard deviation	1.0248533399924767e-4	1.1765049599419285e-4	1.3754194021397994e-4

Outlying measurements have slight (7.40176097594713e-2%) effect on estimated standard deviation.

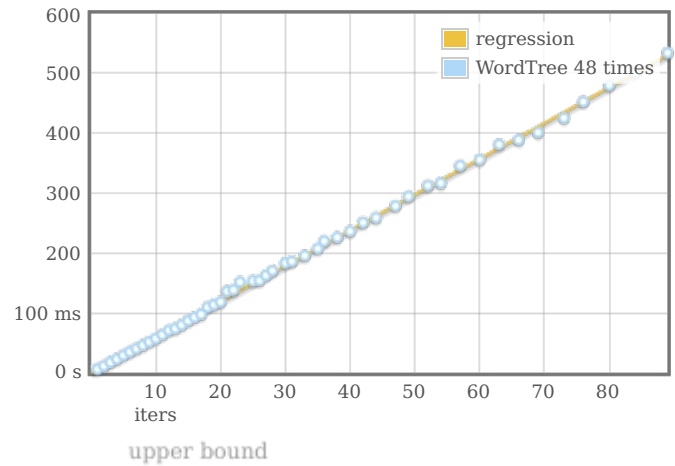
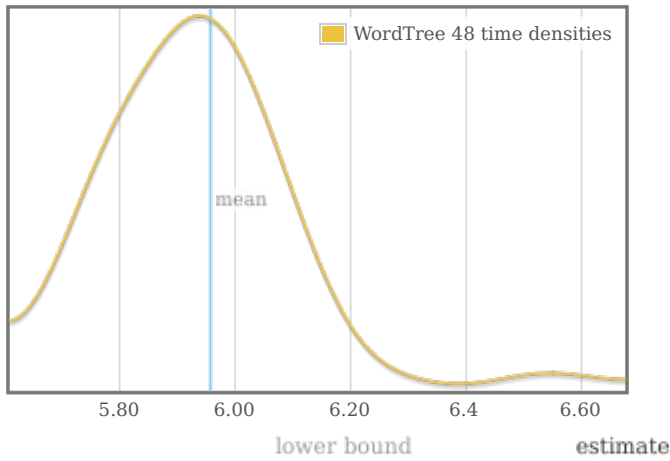
## WordTree 47



	lower bound	estimate	upper bound
OLS regression	5.79 ms	5.92 ms	6.05 ms
R <sup>2</sup> goodness-of-fit	0.997	0.998	0.999
Mean execution time	5.745107036317375e-3	5.774927070847071e-3	5.82036922856281e-3
Standard deviation	9.365885501919709e-5	1.3342683749649546e-4	1.8938927878113973e-4

Outlying measurements have slight (9.414594706820928e-2%) effect on estimated standard deviation.

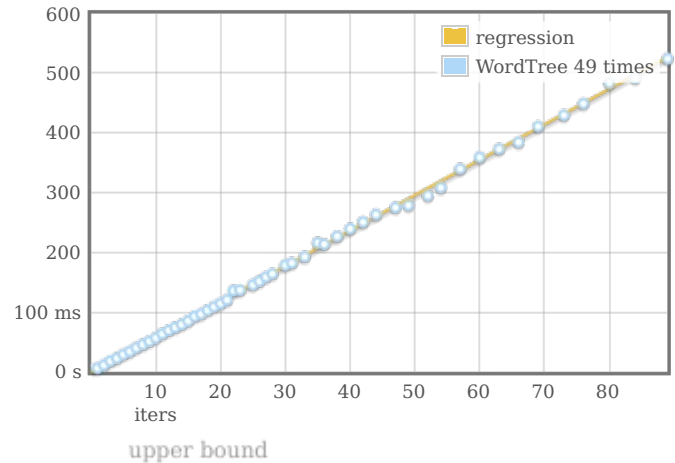
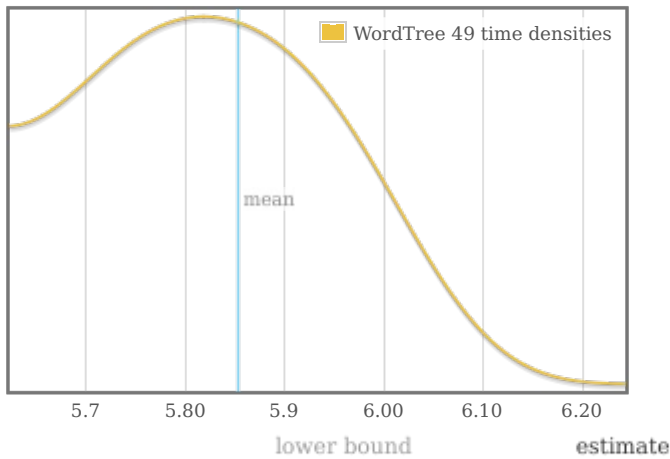
# WordTree 48



	lower bound	estimate	upper bound
OLS regression	5.90 ms	5.95 ms	6.00 ms
R <sup>2</sup> goodness-of-fit	0.998	0.999	1.000
Mean execution time	5.915462223857832e-3	5.9581227521055165e-3	6.016703898490221e-3
Standard deviation	1.3333425822155062e-4	1.7908555355394034e-4	2.517776251807815e-4

Outlying measurements have moderate (0.15114501616524773%) effect on estimated standard deviation.

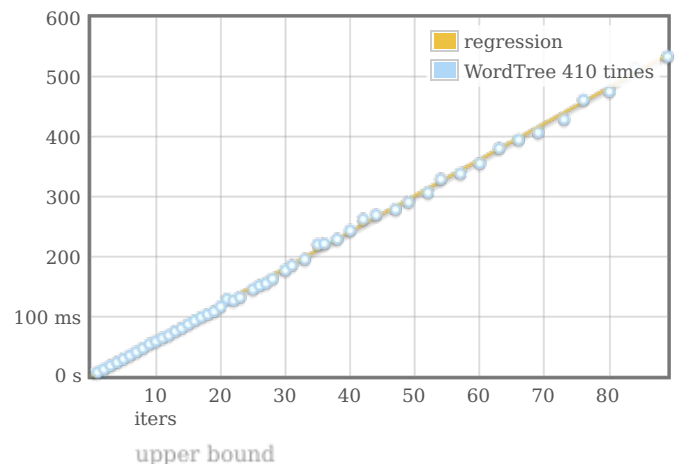
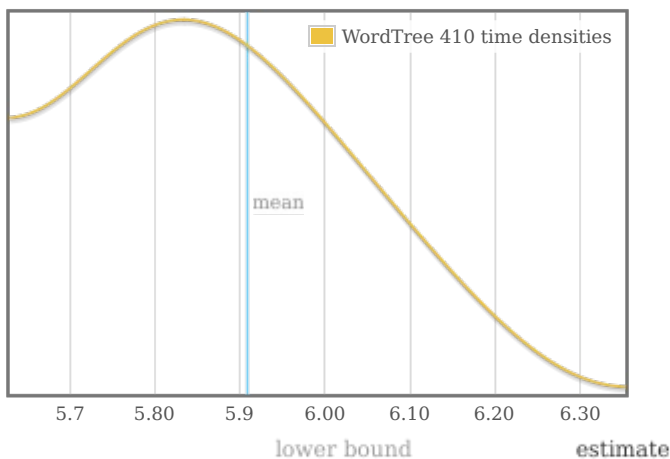
# WordTree 49



	lower bound	estimate	upper bound
OLS regression	5.87 ms	5.92 ms	5.97 ms
R <sup>2</sup> goodness-of-fit	0.999	0.999	1.000
Mean execution time	5.815440310120984e-3	5.8535796620459105e-3	5.89494581376543e-3
Standard deviation	1.0418689961079786e-4	1.252955010892376e-4	1.619951528038644e-4

Outlying measurements have slight (7.563482049766114e-2%) effect on estimated standard deviation.

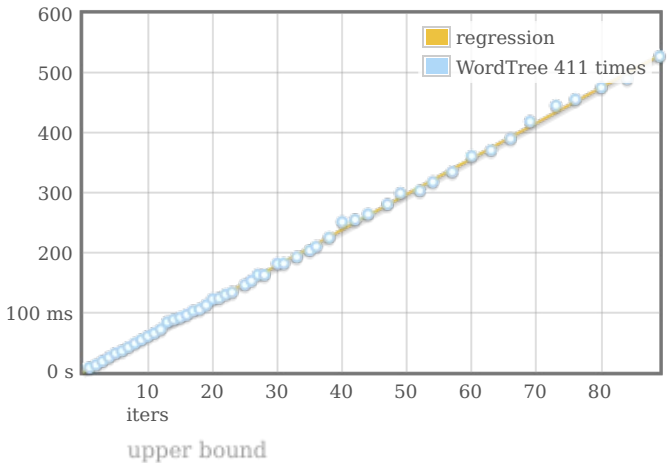
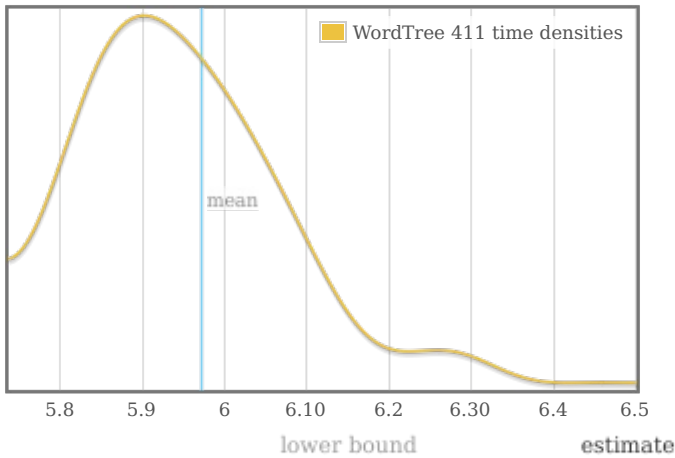
# WordTree 410



	lower bound	estimate	upper bound
OLS regression	5.98 ms	6.04 ms	6.10 ms
R <sup>2</sup> goodness-of-fit	0.998	0.999	1.000
Mean execution time	5.869582204679242e-3	5.9095968298347595e-3	5.957702213863452e-3
Standard deviation	1.3177467011702708e-4	1.5551643175171182e-4	1.8688369984318708e-4

Outlying measurements have moderate (0.11350206064452255%) effect on estimated standard deviation.

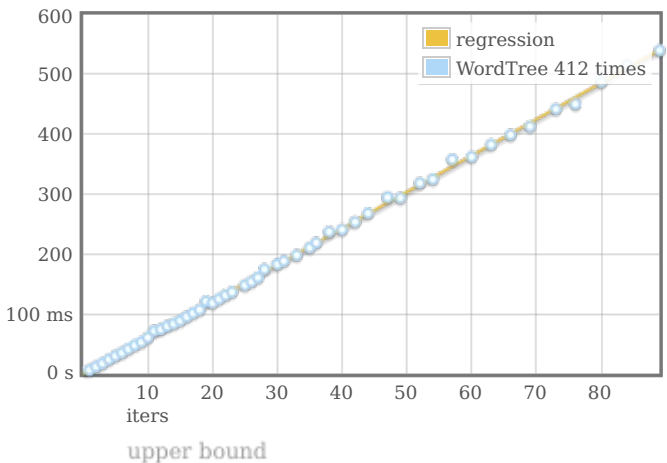
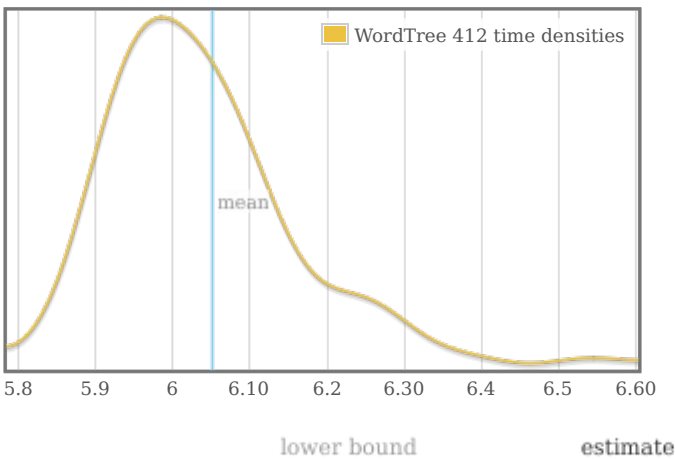
## WordTree 411



	lower bound	estimate	upper bound
OLS regression	5.89 ms	5.95 ms	6.01 ms
R <sup>2</sup> goodness-of-fit	0.999	0.999	1.000
Mean execution time	5.936799682175173e-3	5.971608979342353e-3	6.017794353542522e-3
Standard deviation	1.0852915499418401e-4	1.3864325583791165e-4	1.9934188230057853e-4

Outlying measurements have slight (9.420257352767261e-2%) effect on estimated standard deviation.

## WordTree 412



	lower bound	estimate	upper bound
OLS regression	6.02 ms	6.07 ms	6.12 ms
R <sup>2</sup> goodness-of-fit	0.999	0.999	1.000
Mean execution time	6.019889757617595e-3	6.051076881253821e-3	6.099044331192426e-3
Standard deviation	1.0154826353140109e-4	1.3413937467669838e-4	1.8924618218448019e-4

Outlying measurements have slight (9.364079524824973e-2%) effect on estimated standard deviation.

## understanding this report

In this report, each function benchmarked by criterion is assigned a section of its own. The charts in each section are active; if you hover your mouse over data points and annotations, you will see more details.

- The chart on the left is a [kernel density estimate](#) (also known as a KDE) of time measurements. This graphs the probability of any given time measurement occurring. A spike indicates that a measurement of a particular time occurred; its height indicates how often that measurement was repeated.
- The chart on the right is the raw data from which the kernel density estimate is built. The x axis indicates the number of loop iterations, while the y axis shows measured execution time for the given number of loop iterations. The line behind the values is the linear regression prediction of execution time for a given number of iterations. Ideally, all measurements will be on (or very near) this line.

Under the charts is a small table. The first two rows are the results of a linear regression run on the measurements displayed in the right-hand chart.

- *OLS regression* indicates the time estimated for a single loop iteration using an ordinary least-squares regression model. This number is more accurate than the *mean* estimate below it, as it more effectively eliminates measurement overhead and other constant factors.
- *R<sup>2</sup> goodness-of-fit* is a measure of how accurately the linear regression model fits the observed measurements. If the measurements are not too noisy, R<sup>2</sup> should lie between 0.99 and 1, indicating an excellent fit. If the number is below 0.99, something is confounding the accuracy of the linear model.
- *Mean execution time* and *standard deviation* are statistics calculated from execution time divided by number of iterations.

We use a statistical technique called the [bootstrap](#) to provide confidence intervals on our estimates. The bootstrap-derived upper and lower bounds on estimates let you see how accurate we believe those estimates to be. (Hover the mouse over the table headers to see the confidence levels.)

A noisy benchmarking environment can cause some or many measurements to fall far from the mean. These outlying measurements can have a significant inflationary effect on the estimate of the standard deviation. We calculate and display an estimate of the extent to which the standard deviation has been inflated by outliers.

## colophon

This report was created using the [criterion](#) benchmark execution and performance analysis tool.

Criterion is developed and maintained by [Bryan O'Sullivan](#).