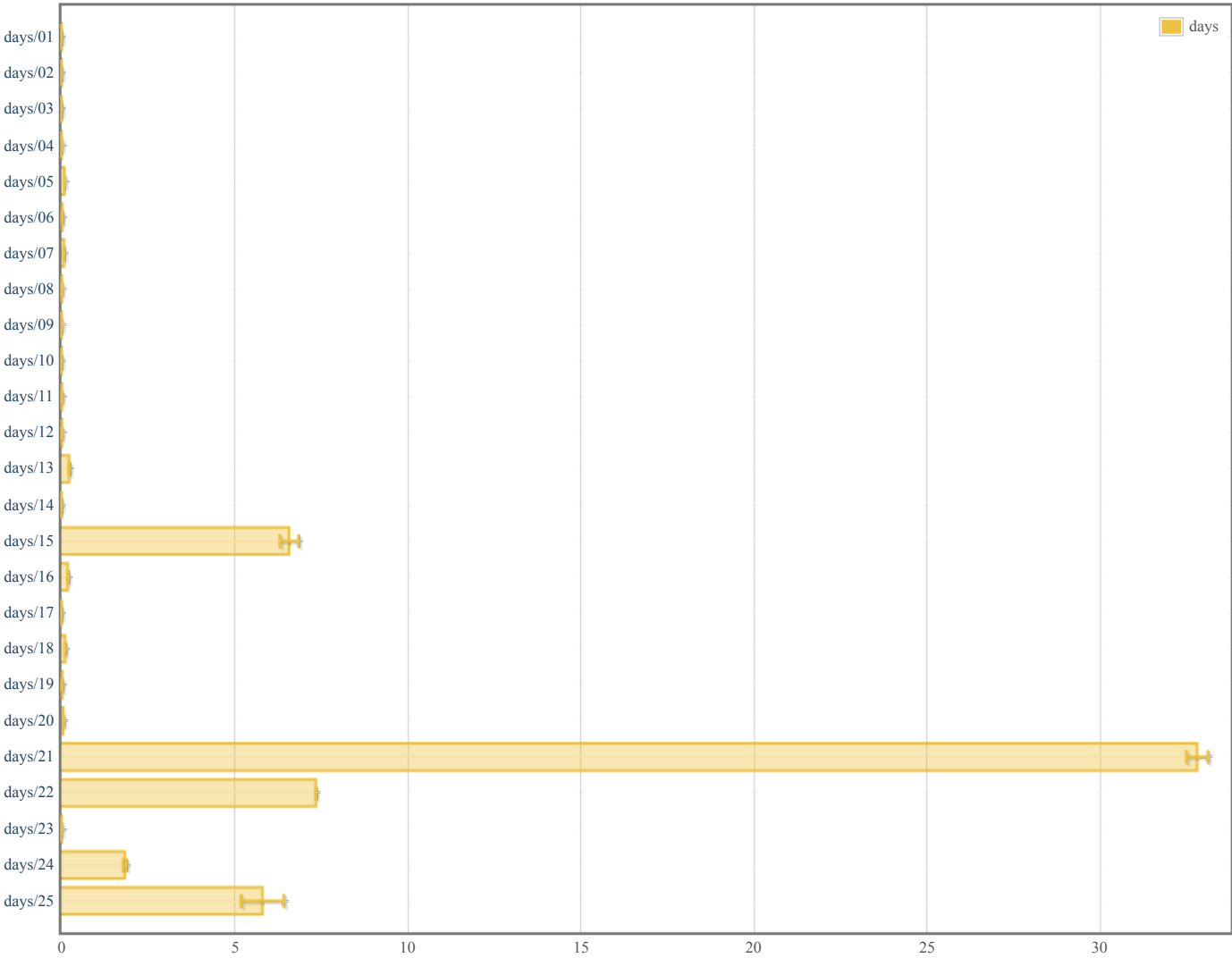


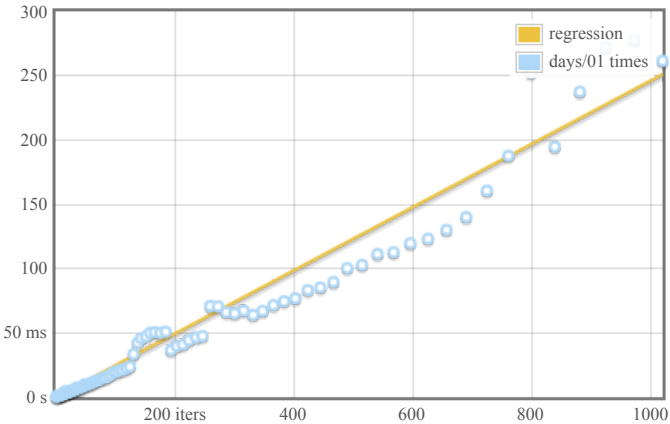
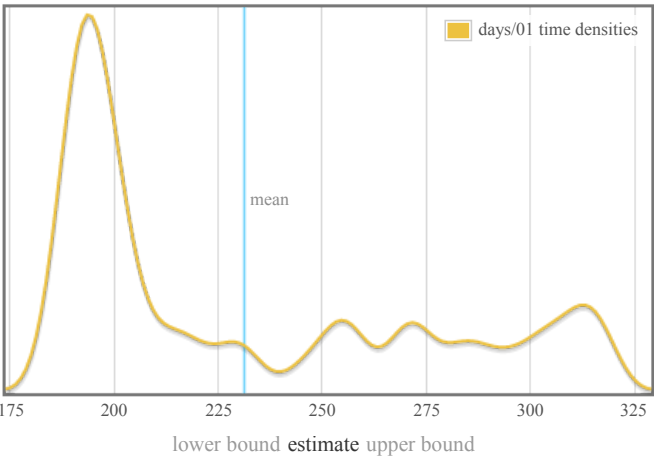
criterion performance measurements

overview

want to understand this report?



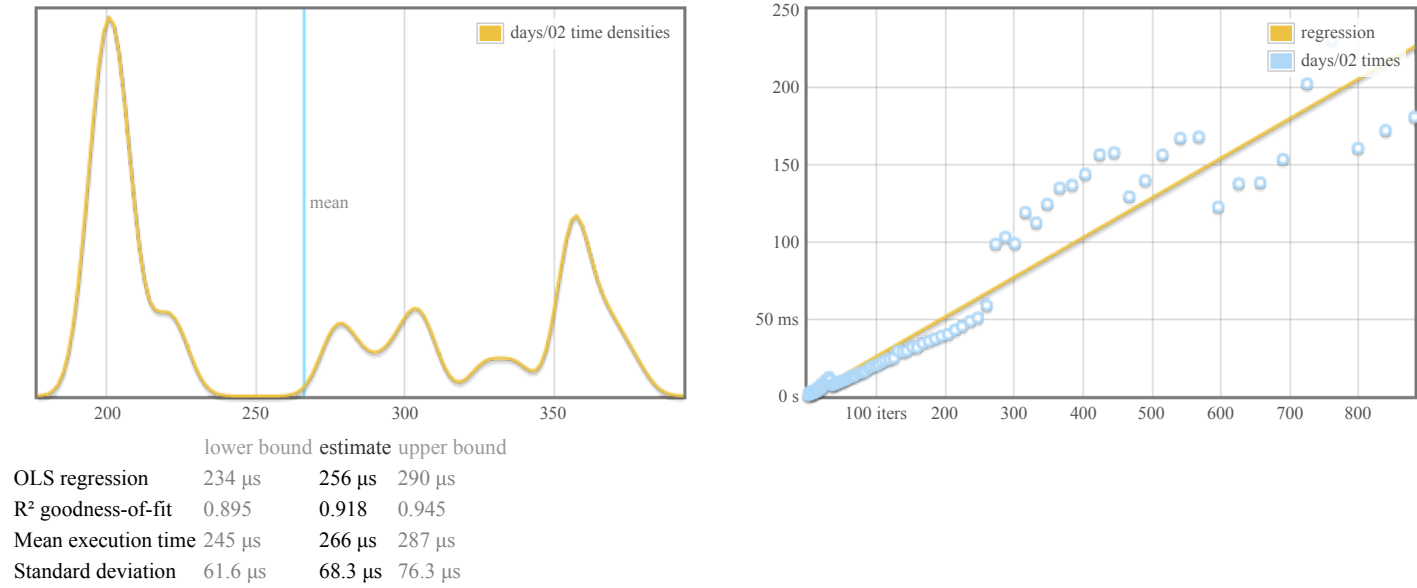
days/01



OLS regression	222 μ s	246 μ s	264 μ s
R ² goodness-of-fit	0.944	0.959	0.976
Mean execution time	220 μ s	231 μ s	247 μ s
Standard deviation	37.6 μ s	44.5 μ s	51.1 μ s

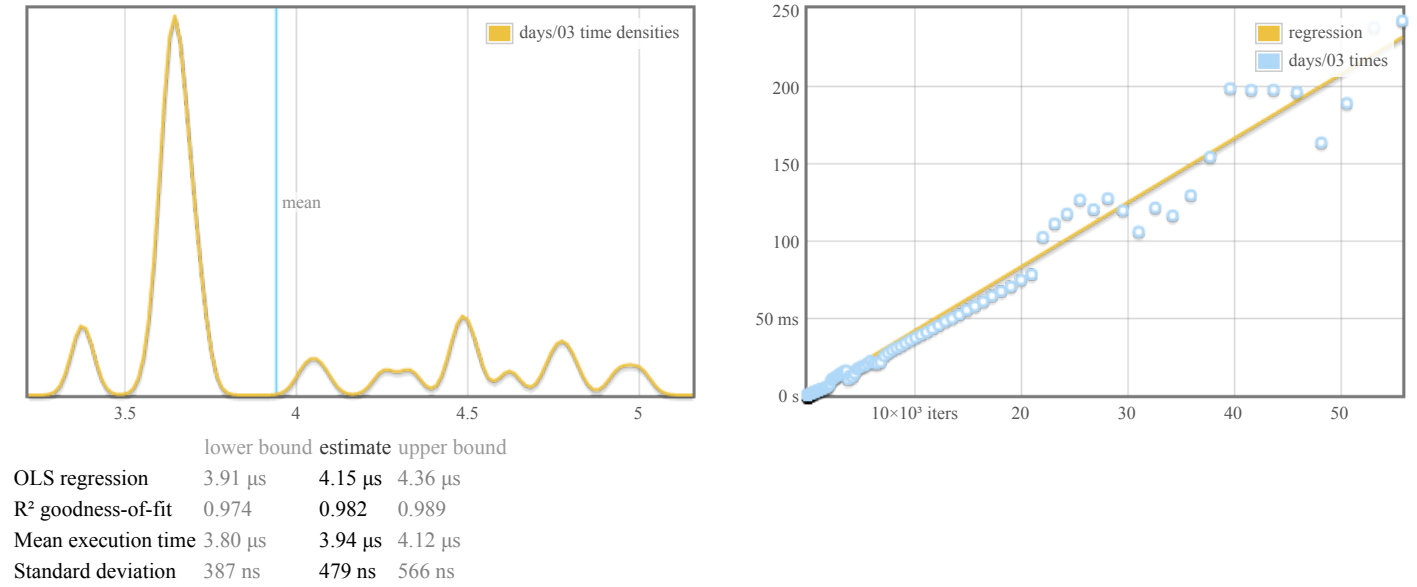
Outlying measurements have severe (93.6%) effect on estimated standard deviation.

days/02



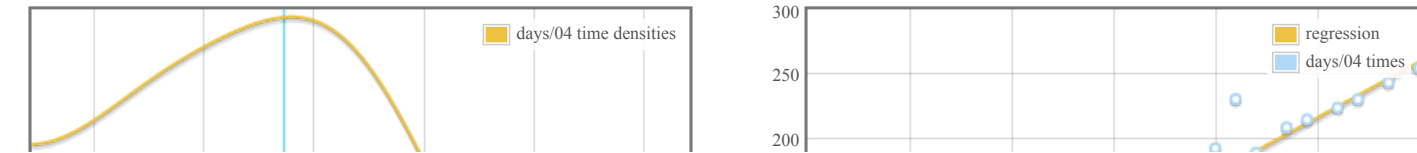
Outlying measurements have severe (96.7%) effect on estimated standard deviation.

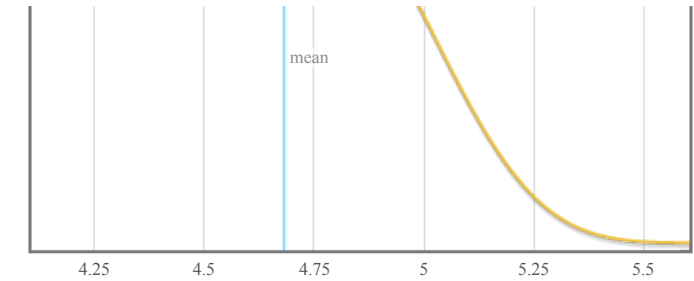
days/03



Outlying measurements have severe (91.3%) effect on estimated standard deviation.

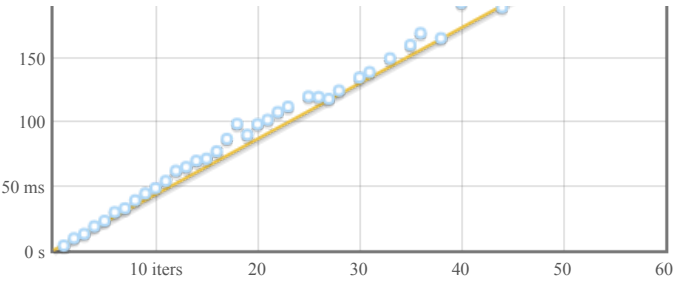
days/04



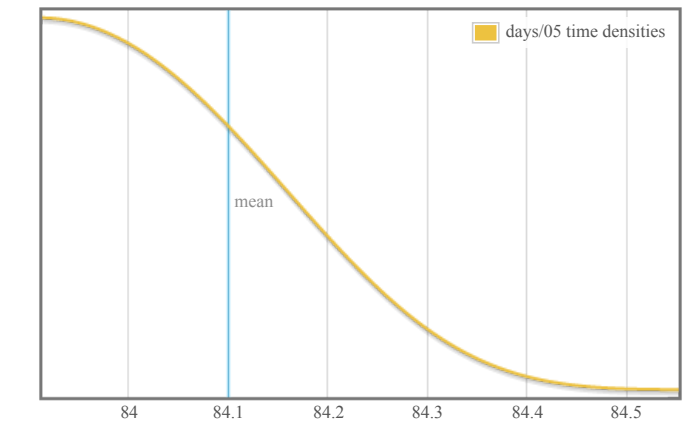


	lower bound	estimate	upper bound
OLS regression	4.17 ms	4.32 ms	4.58 ms
R ² goodness-of-fit	0.969	0.985	0.996
Mean execution time	4.59 ms	4.68 ms	4.80 ms
Standard deviation	249 μs	313 μs	406 μs

Outlying measurements have moderate (41.3%) effect on estimated standard deviation.

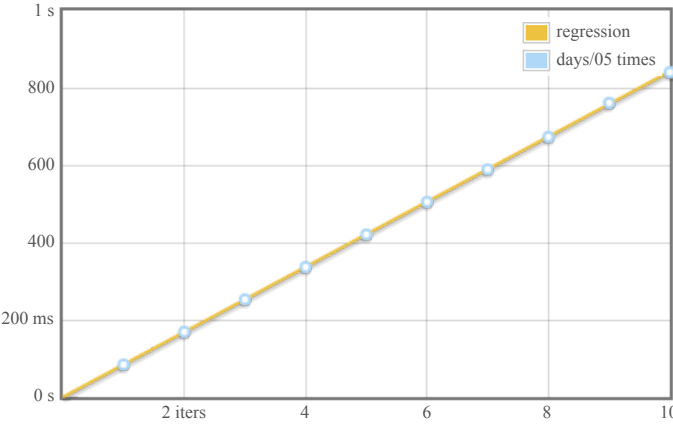


days/05

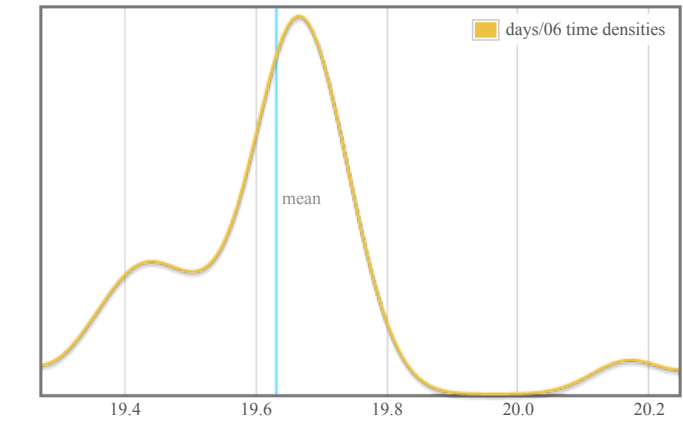


	lower bound	estimate	upper bound
OLS regression	84.0 ms	84.2 ms	84.6 ms
R ² goodness-of-fit	1.000	1.000	1.000
Mean execution time	84.0 ms	84.1 ms	84.3 ms
Standard deviation	50.9 μs	163 μs	265 μs

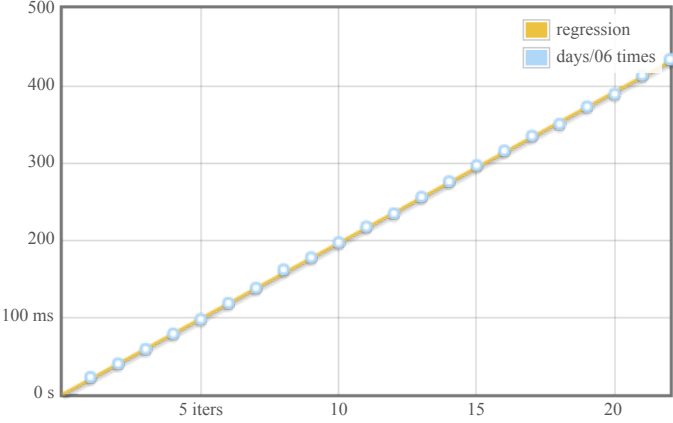
Outlying measurements have slight (9.0%) effect on estimated standard deviation.



days/06

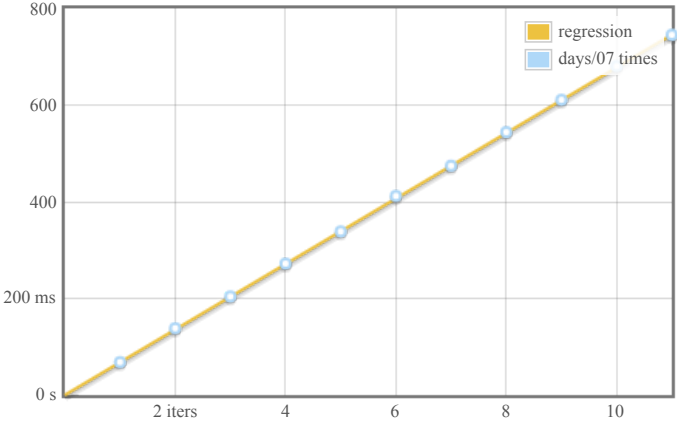
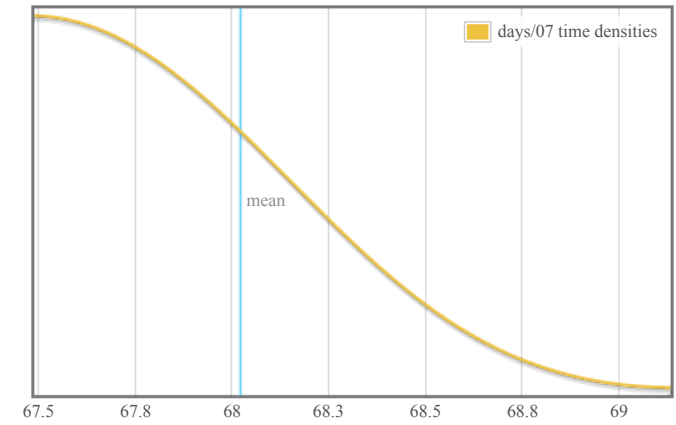


	lower bound	estimate	upper bound
OLS regression	19.4 ms	19.6 ms	19.7 ms
R ² goodness-of-fit	1.000	1.000	1.000
Mean execution time	19.6 ms	19.6 ms	19.7 ms
Standard deviation	99.4 μs	166 μs	266 μs



Outlying measurements have slight (4.3%) effect on estimated standard deviation.

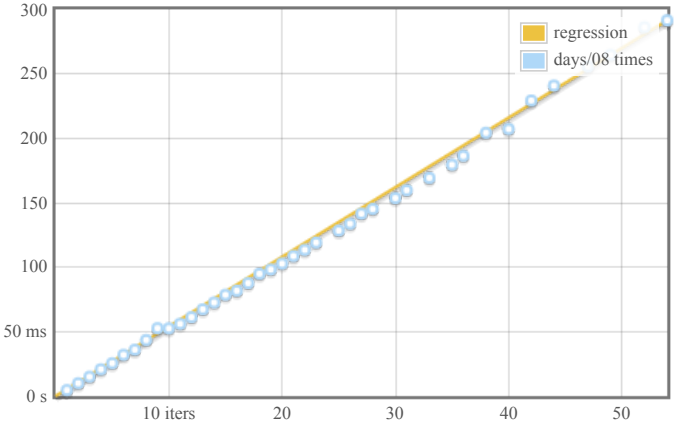
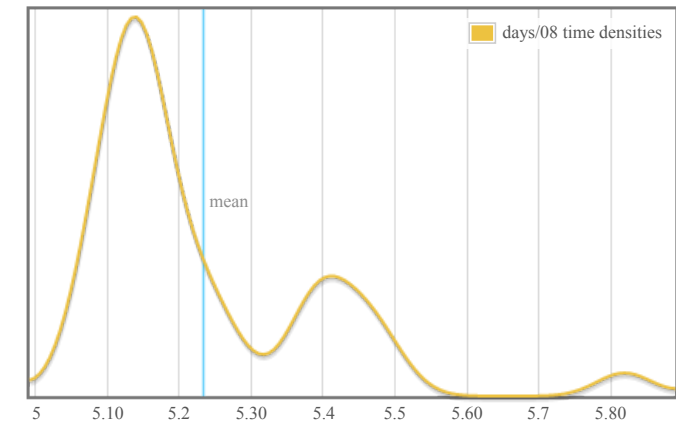
days/07



	lower bound	estimate	upper bound
OLS regression	67.5 ms	67.8 ms	68.1 ms
R ² goodness-of-fit	1.000	1.000	1.000
Mean execution time	67.8 ms	68.0 ms	68.4 ms
Standard deviation	141 μs	433 μs	647 μs

Outlying measurements have slight (8.3%) effect on estimated standard deviation.

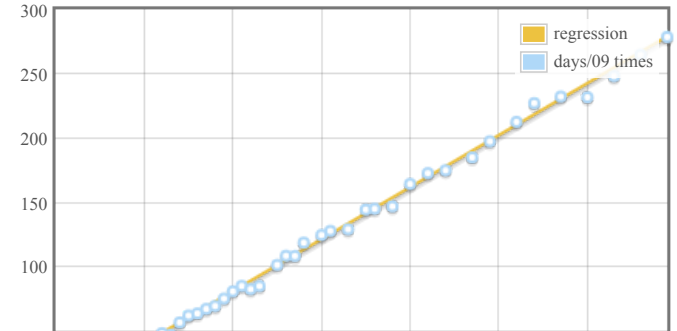
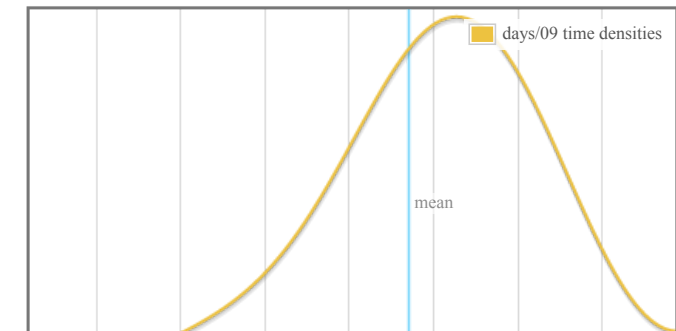
days/08

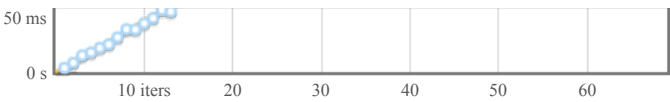
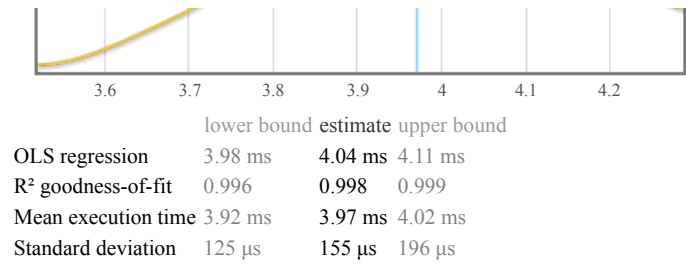


	lower bound	estimate	upper bound
OLS regression	5.28 ms	5.40 ms	5.48 ms
R ² goodness-of-fit	0.997	0.998	0.999
Mean execution time	5.19 ms	5.23 ms	5.30 ms
Standard deviation	120 μs	161 μs	246 μs

Outlying measurements have moderate (14.1%) effect on estimated standard deviation.

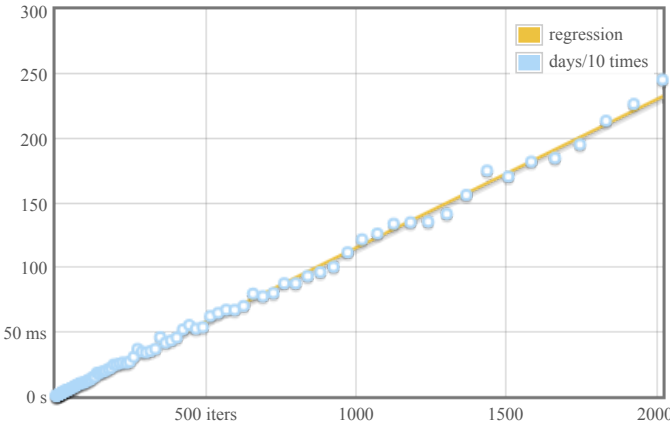
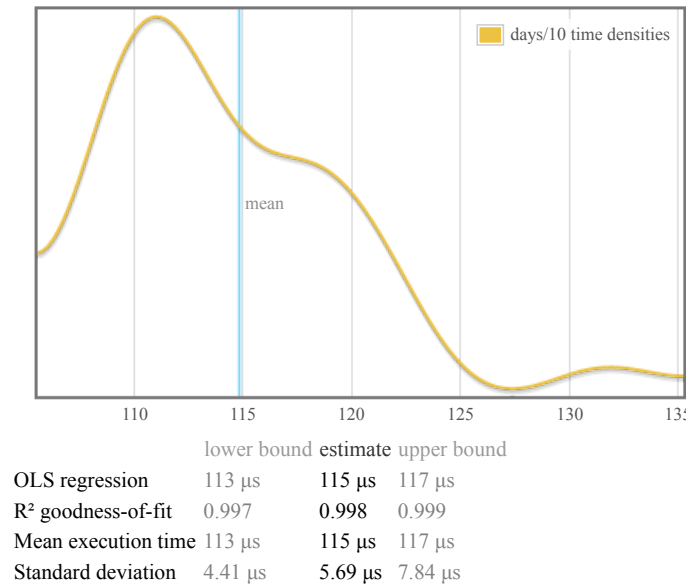
days/09





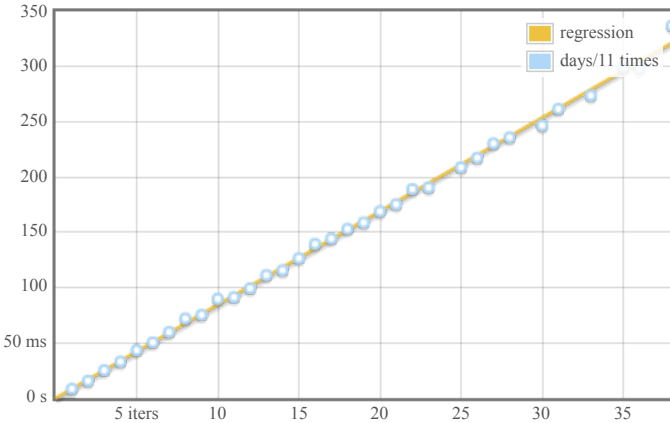
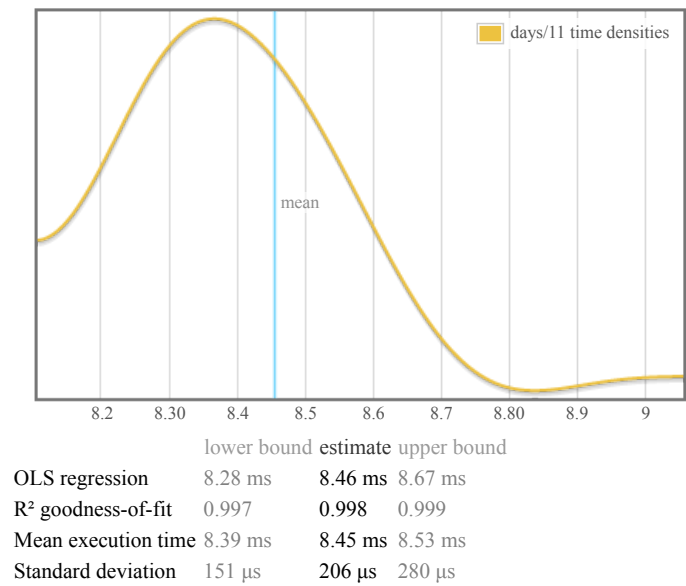
Outlying measurements have moderate (21.1%) effect on estimated standard deviation.

days/10



Outlying measurements have severe (51.1%) effect on estimated standard deviation.

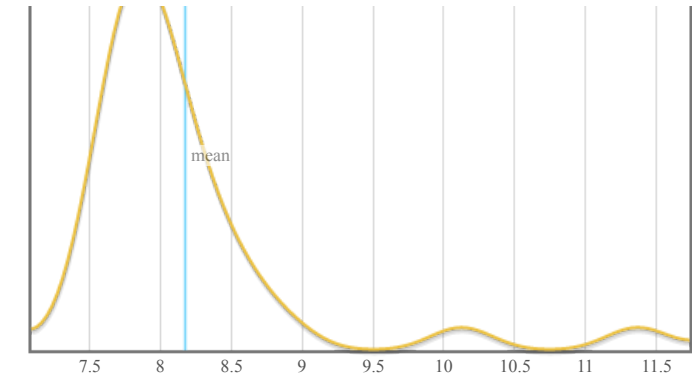
days/11



Outlying measurements have slight (8.4%) effect on estimated standard deviation.

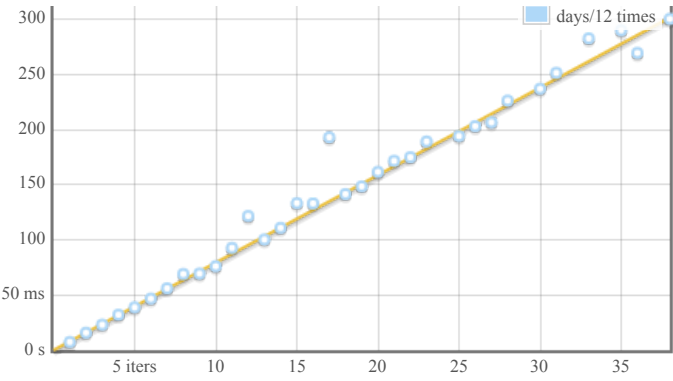
days/12



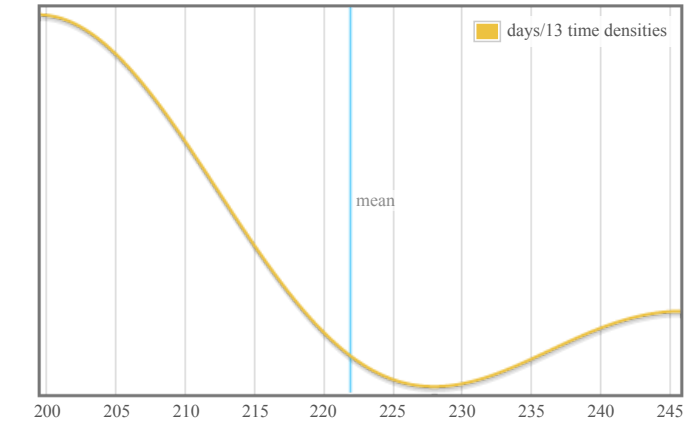


	lower bound	estimate	upper bound
OLS regression	7.61 ms	7.94 ms	8.25 ms
R ² goodness-of-fit	0.946	0.979	0.996
Mean execution time	7.97 ms	8.18 ms	8.60 ms
Standard deviation	359 μs	780 μs	1.33 ms

Outlying measurements have severe (53.0%) effect on estimated standard deviation.

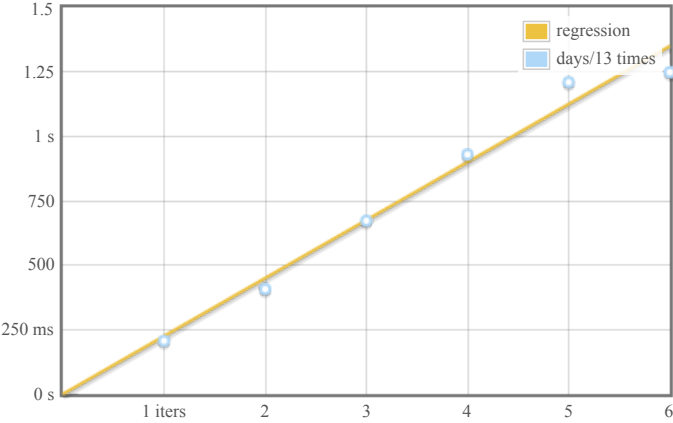


days/13

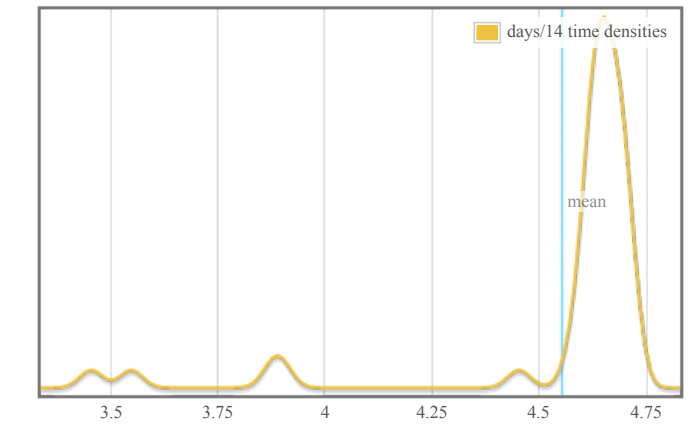


	lower bound	estimate	upper bound
OLS regression	192 ms	225 ms	268 ms
R ² goodness-of-fit	0.933	0.978	1.000
Mean execution time	210 ms	222 ms	234 ms
Standard deviation	10.6 ms	16.2 ms	21.1 ms

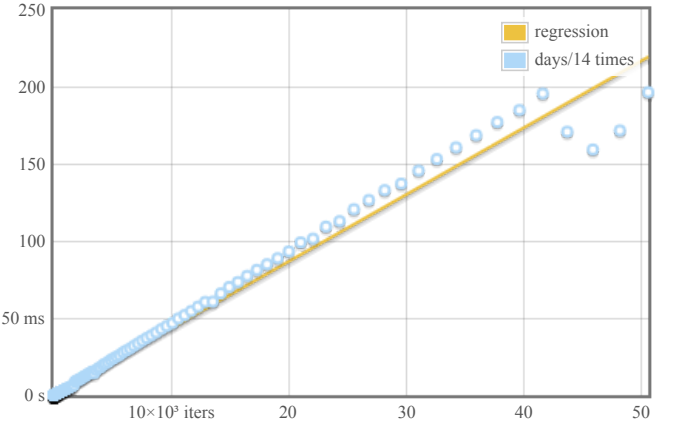
Outlying measurements have moderate (15.3%) effect on estimated standard deviation.



days/14



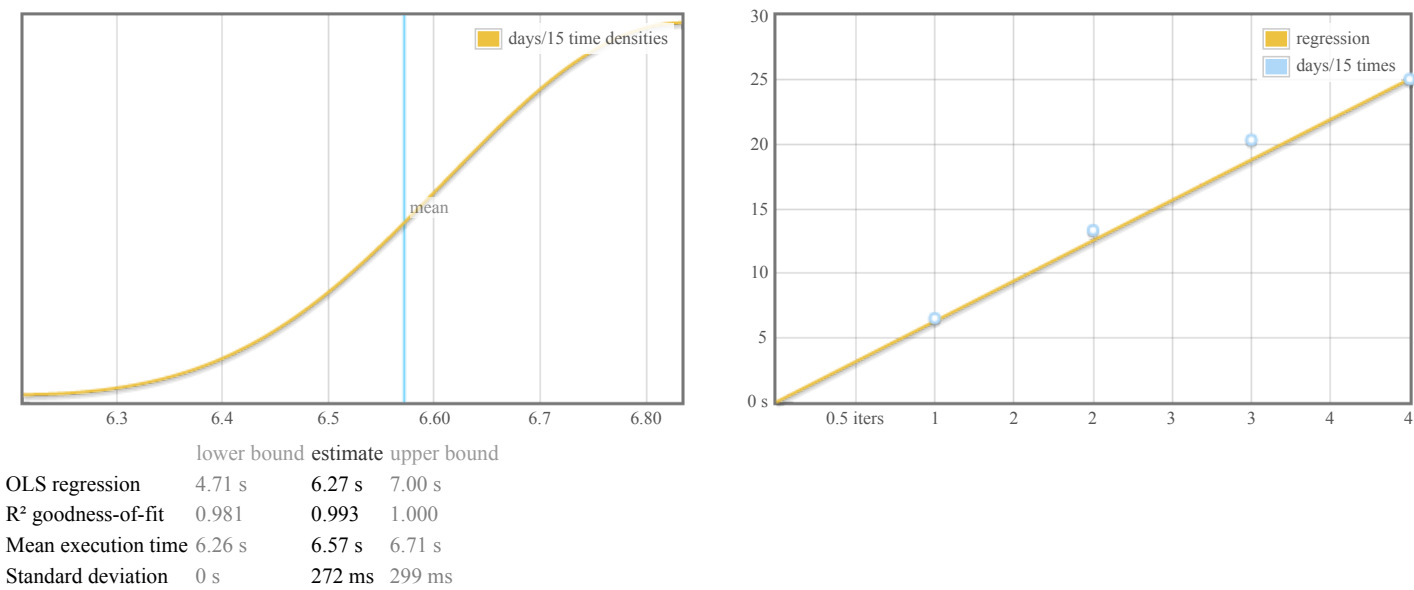
	lower bound	estimate	upper bound
OLS regression	4.09 μs	4.33 μs	4.60 μs



R ² goodness-of-fit	0.978	0.985	0.997
Mean execution time	4.43 μs	4.55 μs	4.62 μs
Standard deviation	175 ns	291 ns	440 ns

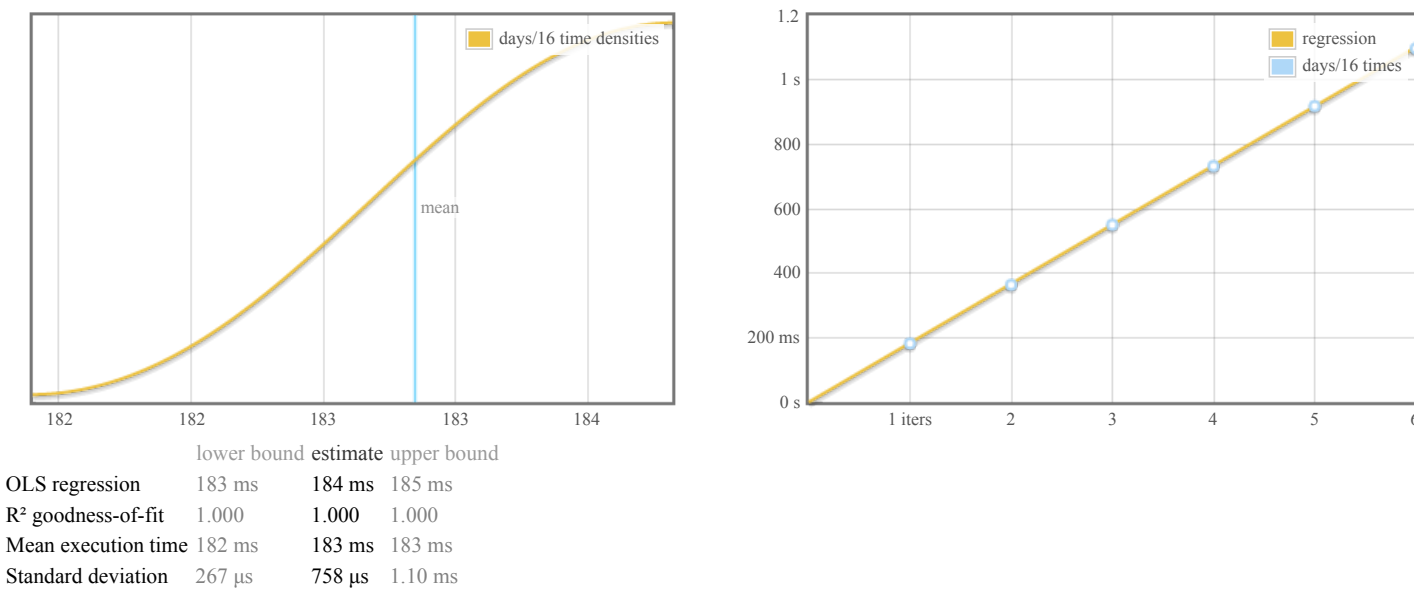
Outlying measurements have severe (73.3%) effect on estimated standard deviation.

days/15



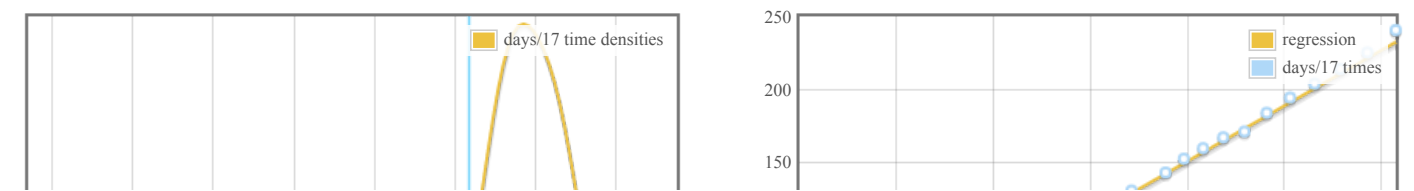
Outlying measurements have moderate (18.7%) effect on estimated standard deviation.

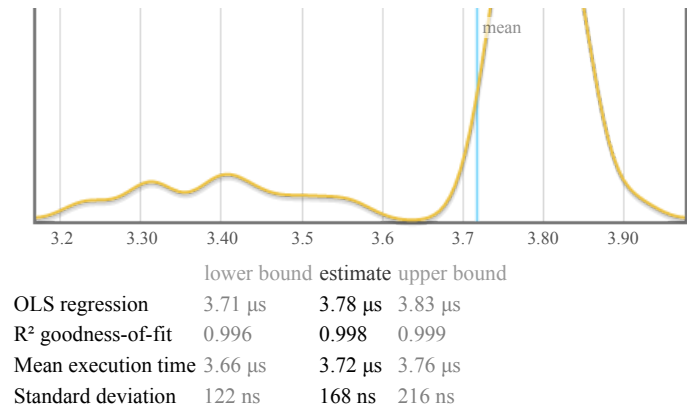
days/16



Outlying measurements have moderate (13.9%) effect on estimated standard deviation.

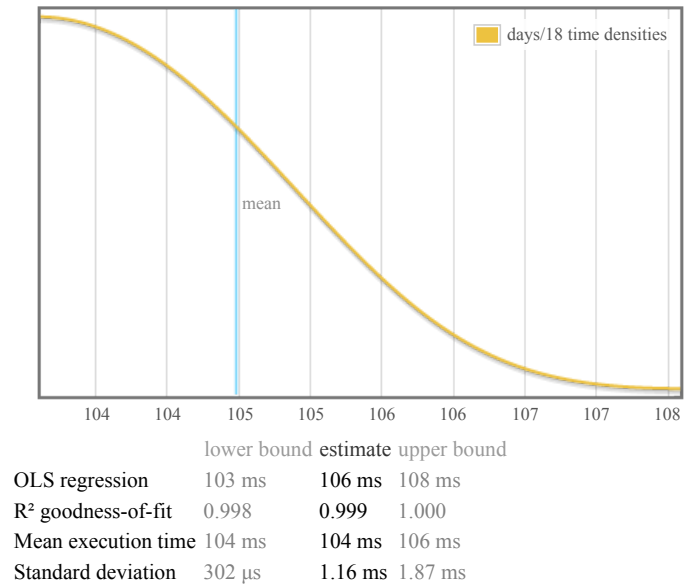
days/17





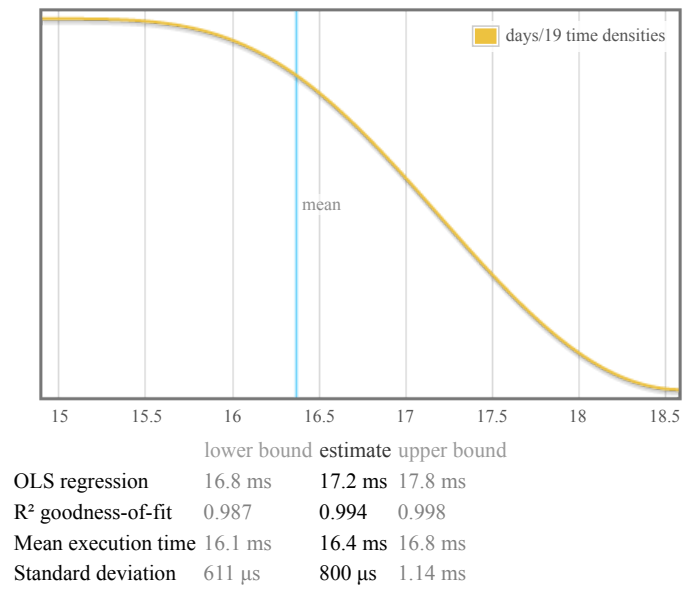
Outlying measurements have severe (58.3%) effect on estimated standard deviation.

days/18

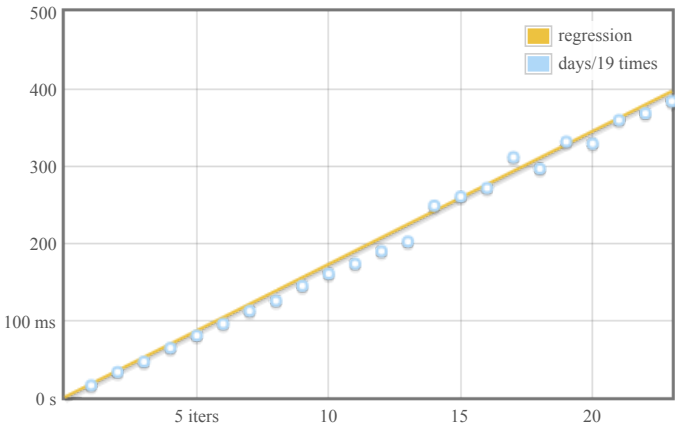
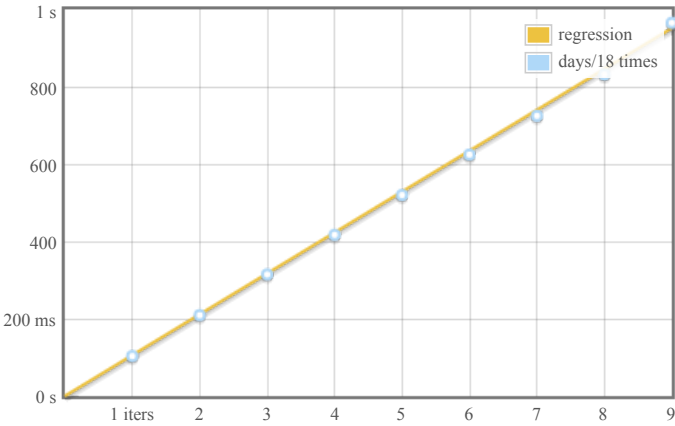
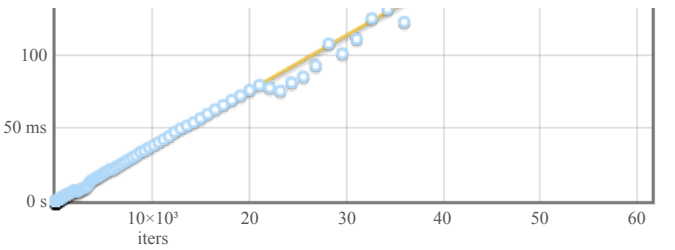


Outlying measurements have slight (9.9%) effect on estimated standard deviation.

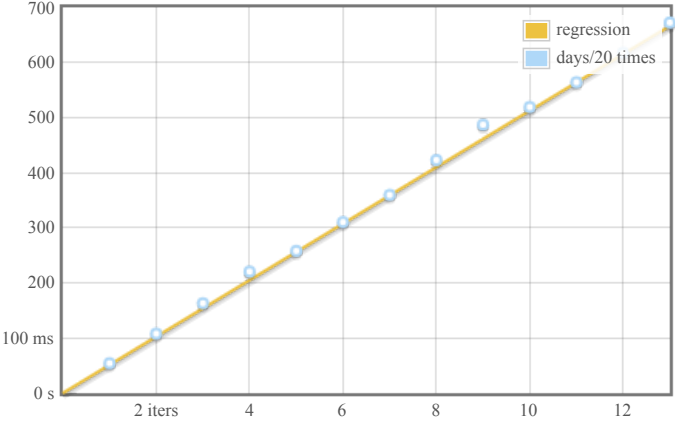
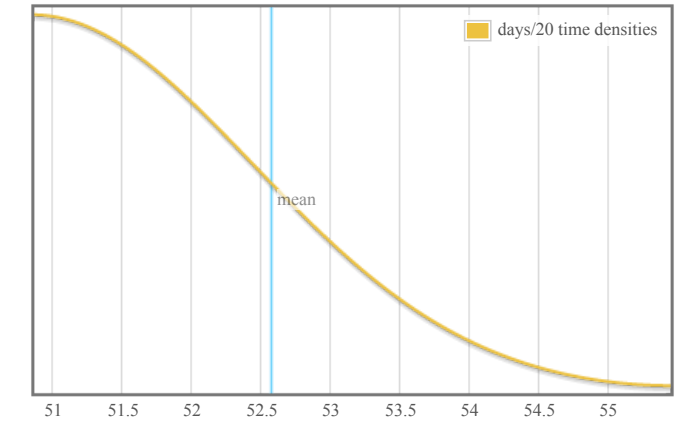
days/19



Outlying measurements have moderate (16.5%) effect on estimated standard deviation.



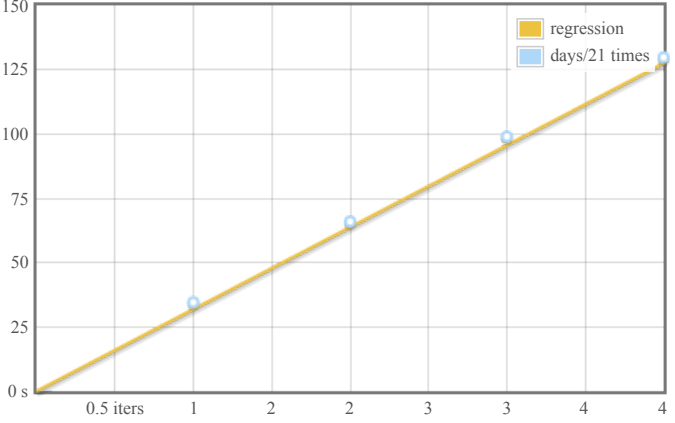
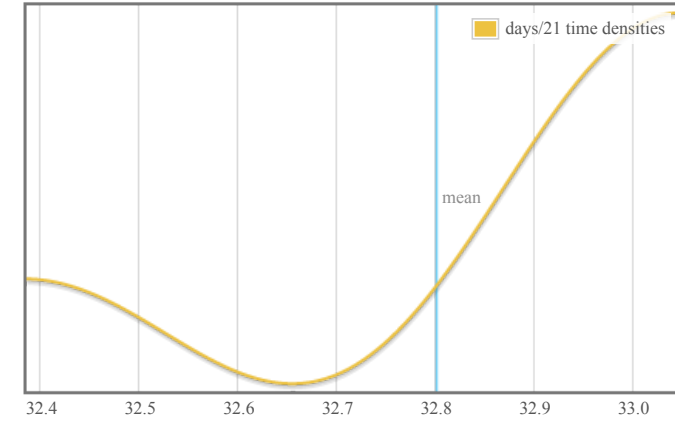
days/20



	lower bound	estimate	upper bound
OLS regression	50.4 ms	51.2 ms	52.5 ms
R ² goodness-of-fit	0.996	0.999	1.000
Mean execution time	51.9 ms	52.6 ms	53.4 ms
Standard deviation	1.07 ms	1.37 ms	1.80 ms

Outlying measurements have slight (7.1%) effect on estimated standard deviation.

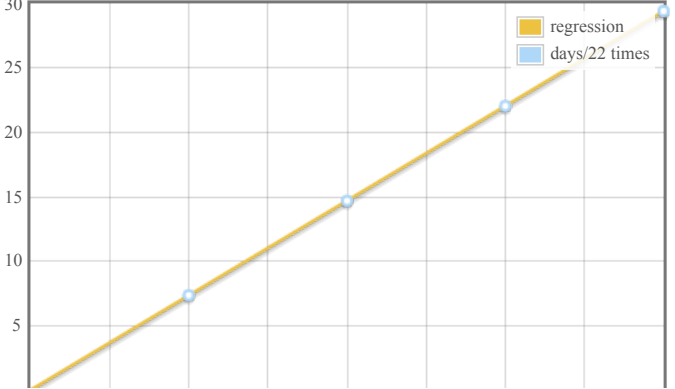
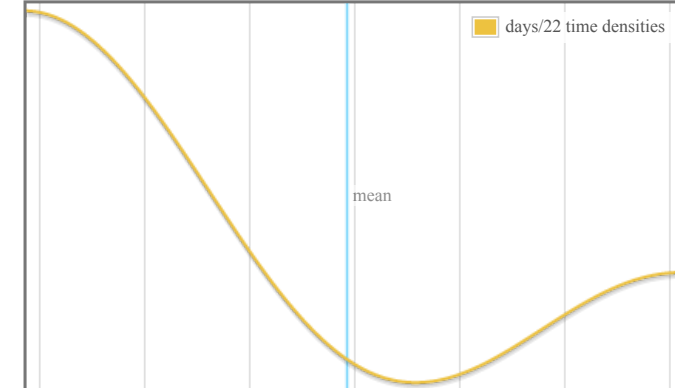
days/21



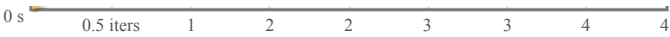
	lower bound	estimate	upper bound
OLS regression	30.8 s	31.9 s	33.0 s
R ² goodness-of-fit	0.999	1.000	1.000
Mean execution time	32.4 s	32.8 s	33.0 s
Standard deviation	0 s	312 ms	317 ms

Outlying measurements have moderate (18.7%) effect on estimated standard deviation.

days/22

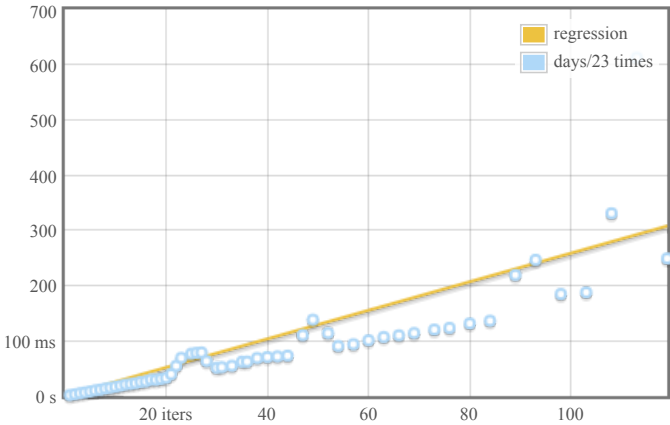
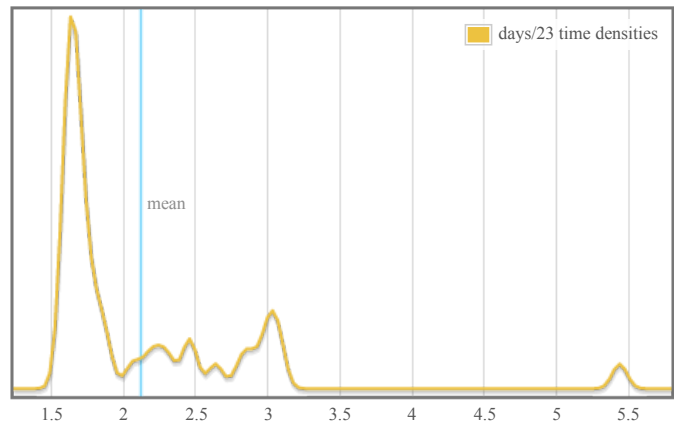


	7.34	7.34	7.34	7.35	7.35	7.35	7.35
	lower bound estimate upper bound						
OLS regression	7.33 s	7.35 s	7.37 s				
R ² goodness-of-fit	1.000	1.000	1.000				
Mean execution time	7.34 s	7.35 s	7.35 s				
Standard deviation	0 s	5.17 ms	5.97 ms				



Outlying measurements have moderate (18.8%) effect on estimated standard deviation.

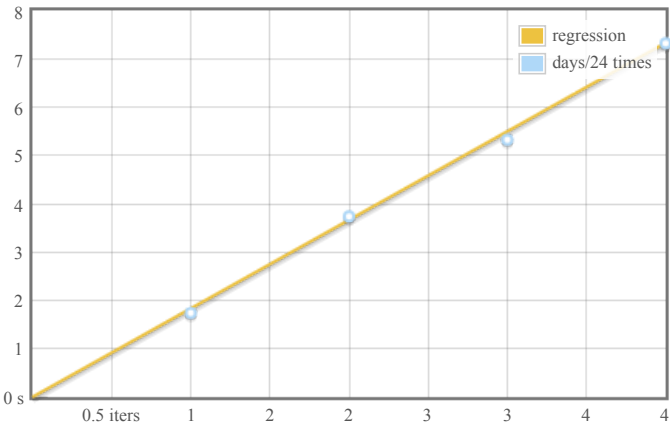
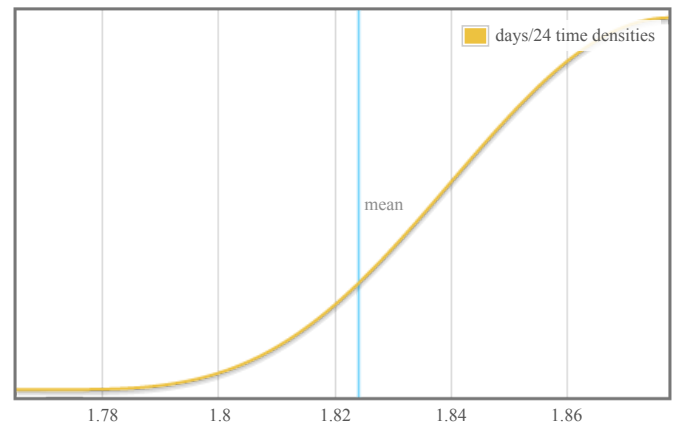
days/23



	lower bound estimate upper bound		
OLS regression	1.85 ms 2.59 ms 3.52 ms		
R ² goodness-of-fit	0.634 0.711 0.938		
Mean execution time	1.93 ms 2.12 ms 2.46 ms		
Standard deviation	463 μs 740 μs 1.26 ms		

Outlying measurements have severe (98.0%) effect on estimated standard deviation.

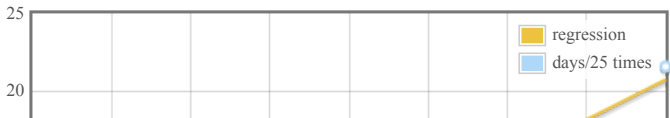
days/24

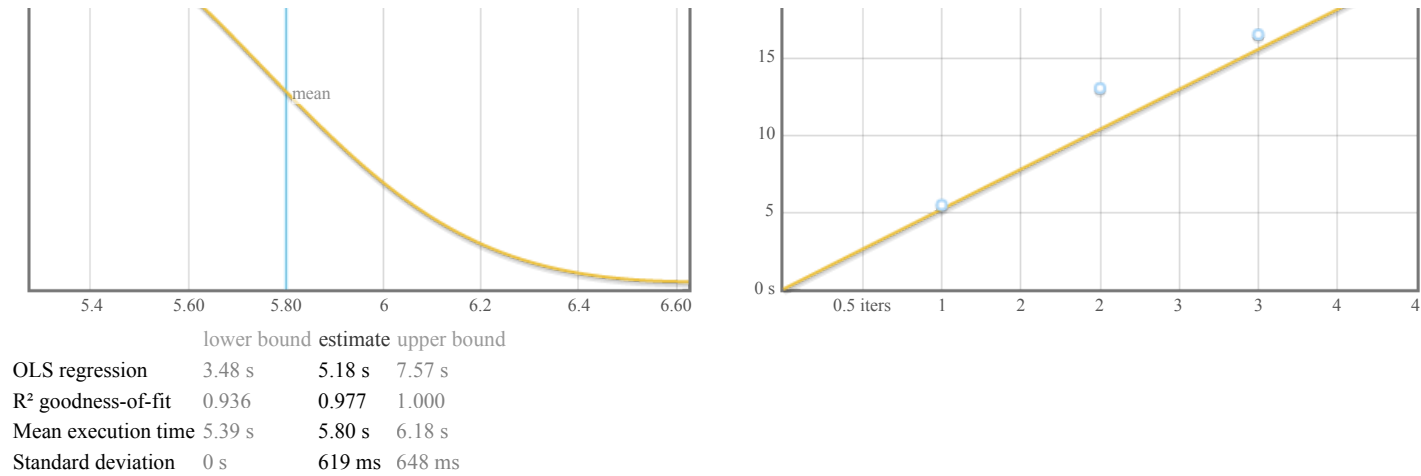


	lower bound estimate upper bound		
OLS regression	1.59 s 1.83 s 2.00 s		
R ² goodness-of-fit	0.994 0.998 1.000		
Mean execution time	1.77 s 1.82 s 1.86 s		
Standard deviation	0 s 47.0 ms 54.0 ms		

Outlying measurements have moderate (18.8%) effect on estimated standard deviation.

days/25





Outlying measurements have moderate (22.9%) 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.
- *R² goodness-of-fit* is a measure of how accurately the linear regression model fits the observed measurements. If the measurements are not too noisy, R² 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.