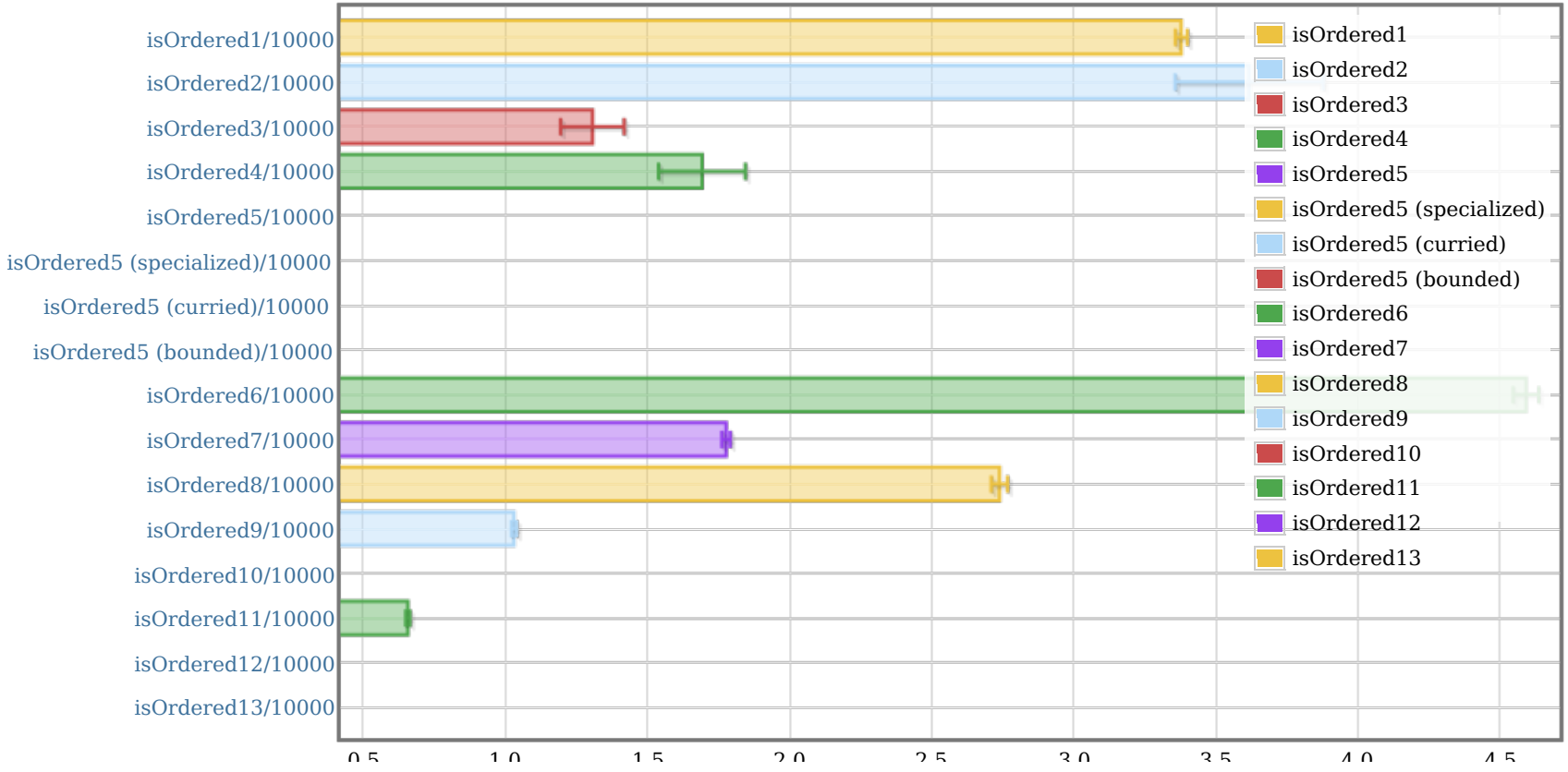
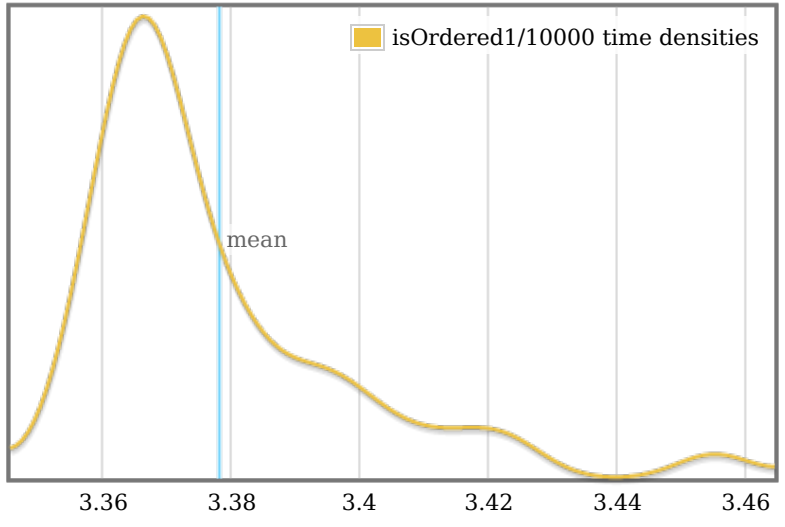
criterion performance measurements

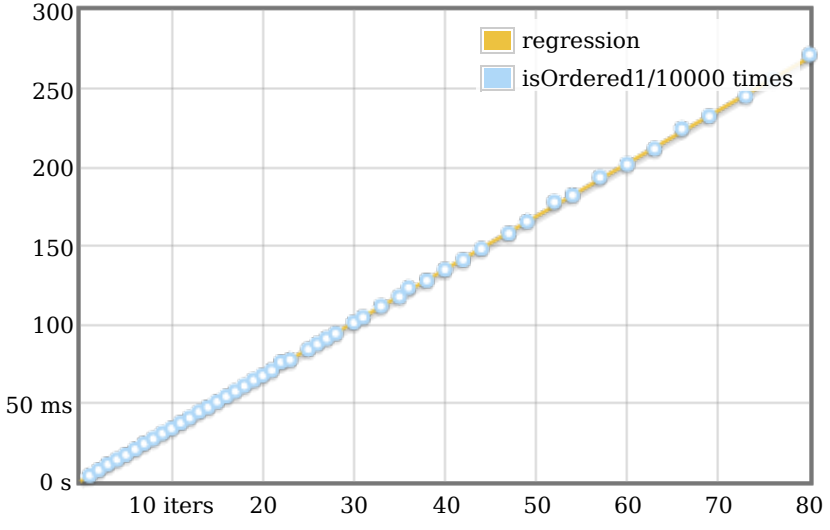
overview

want to understand this report?



isOrdered1/10000

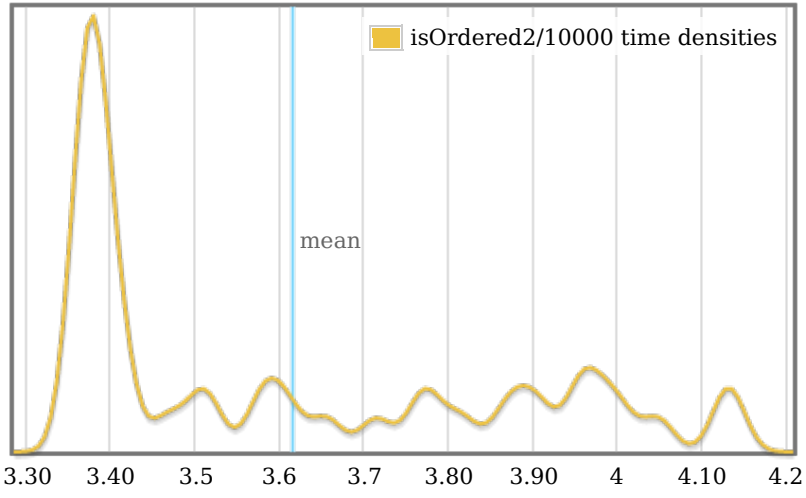


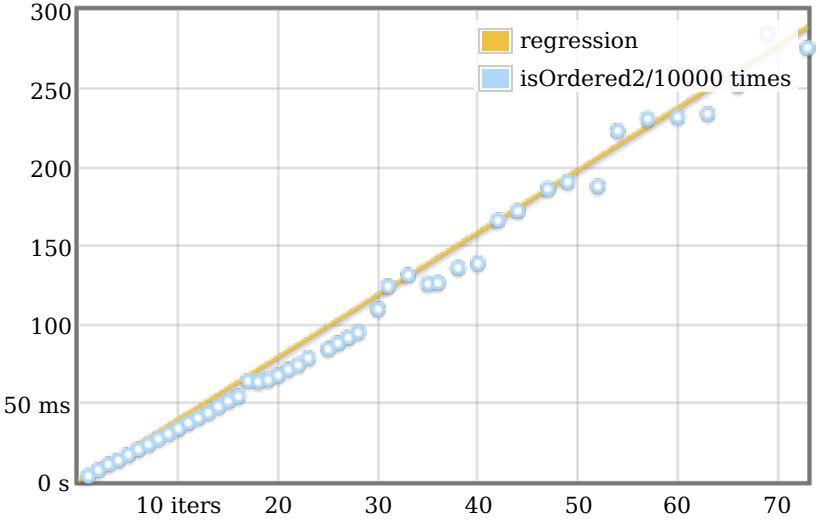


	lower bound	estimate	upper bound
OLS regression	3.36 ms	3.37 ms	3.38 ms
R^2 goodness-of-fit	1.000	1.000	1.000
Mean execution time	3.37 ms	3.38 ms	3.39 ms
Standard deviation	15.4 µs	21.0 µs	32.8 µs

Outlying measurements have slight (2.0%) effect on estimated standard deviation.

isOrdered2/10000

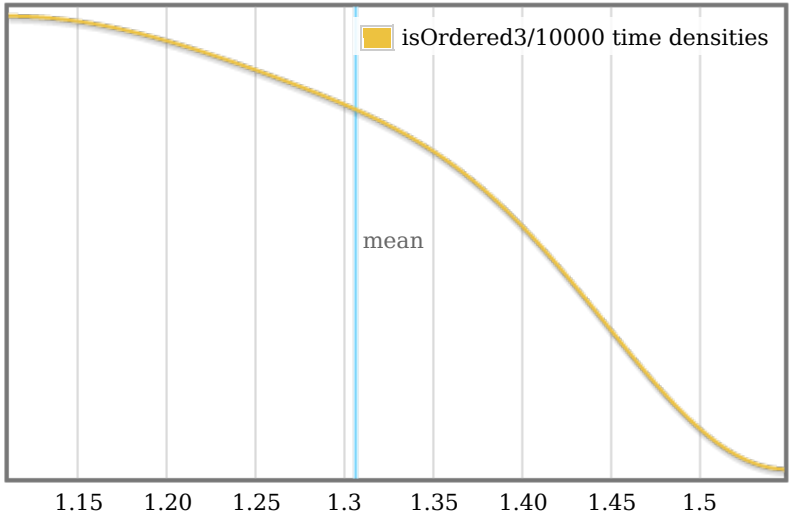


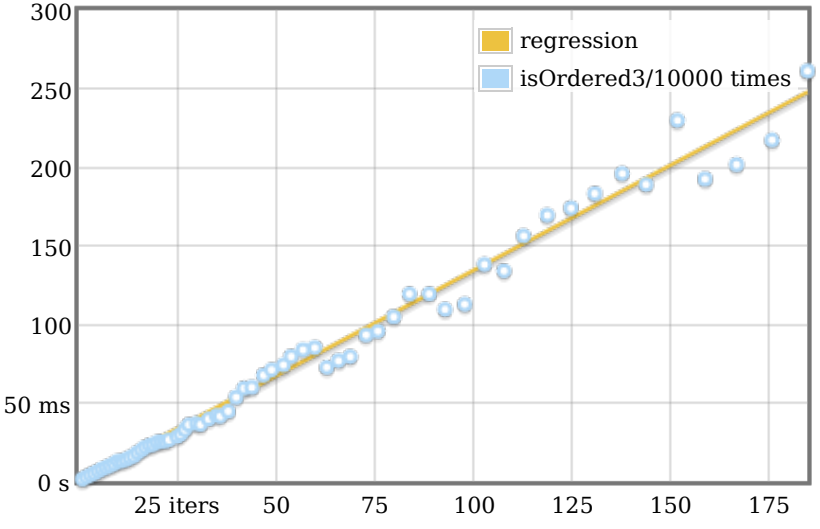


	lower bound	estimate	upper bound
OLS regression	3.85 ms	3.96 ms	4.09 ms
R² goodness-of-fit	0.989	0.992	0.996
Mean execution time	3.54 ms	3.62 ms	3.70 ms
Standard deviation	225 µs	261 µs	304 µs

Outlying measurements have moderate (48.4%) effect on estimated standard deviation.

isOrdered3/10000

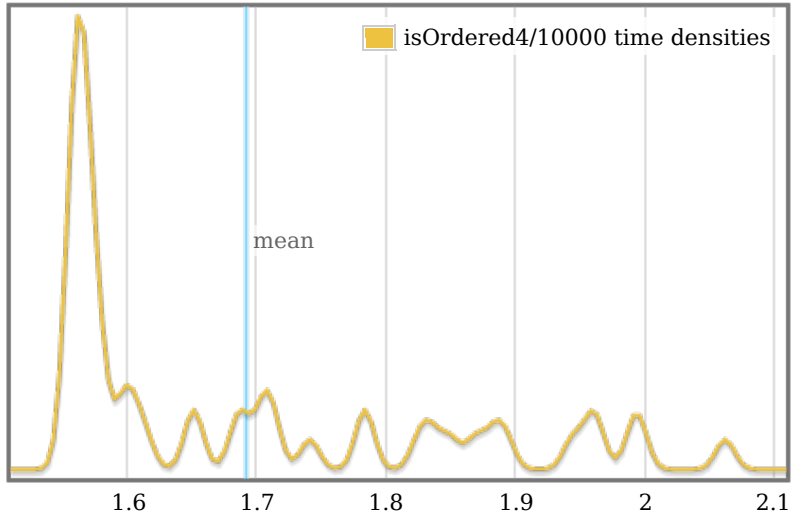


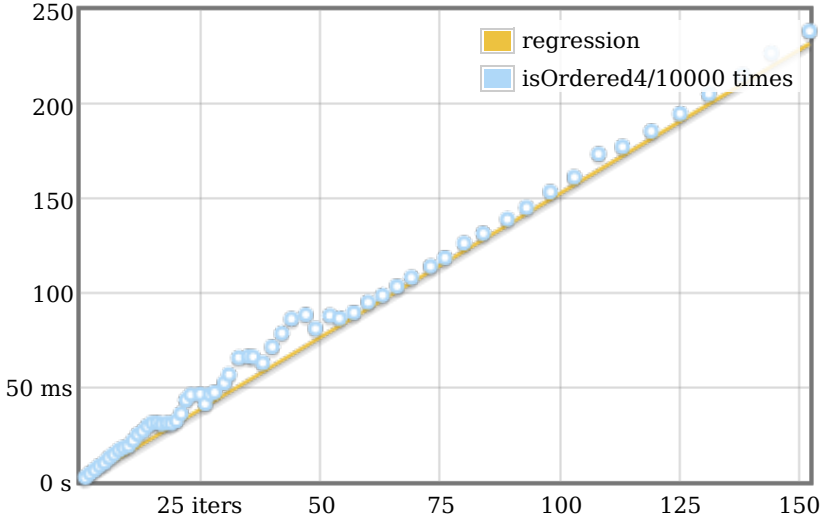


	lower bound	estimate	upper bound
OLS regression	1.28 ms	1.34 ms	1.40 ms
R² goodness-of-fit	0.981	0.986	0.992
Mean execution time	1.27 ms	1.31 ms	1.34 ms
Standard deviation	101 µs	112 µs	128 µs

Outlying measurements have severe (64.7%) effect on estimated standard deviation.

isOrdered4/10000

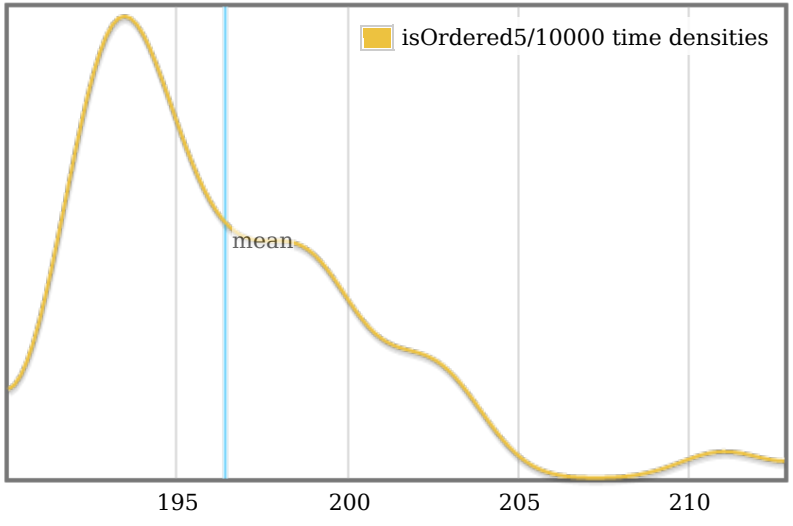


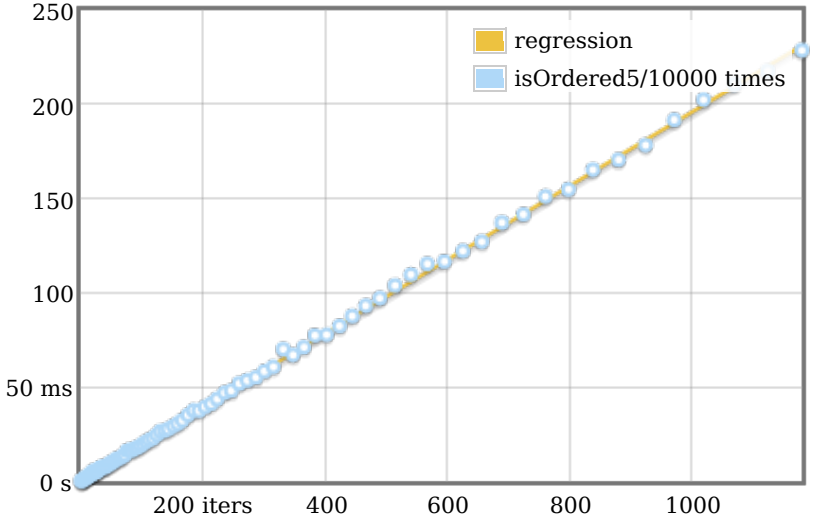


	lower bound	estimate	upper bound
OLS regression	1.51 ms	1.53 ms	1.54 ms
R² goodness-of-fit	0.993	0.996	0.998
Mean execution time	1.65 ms	1.69 ms	1.74 ms
Standard deviation	130 µs	153 µs	181 µs

Outlying measurements have severe (65.8%) effect on estimated standard deviation.

isOrdered5/10000

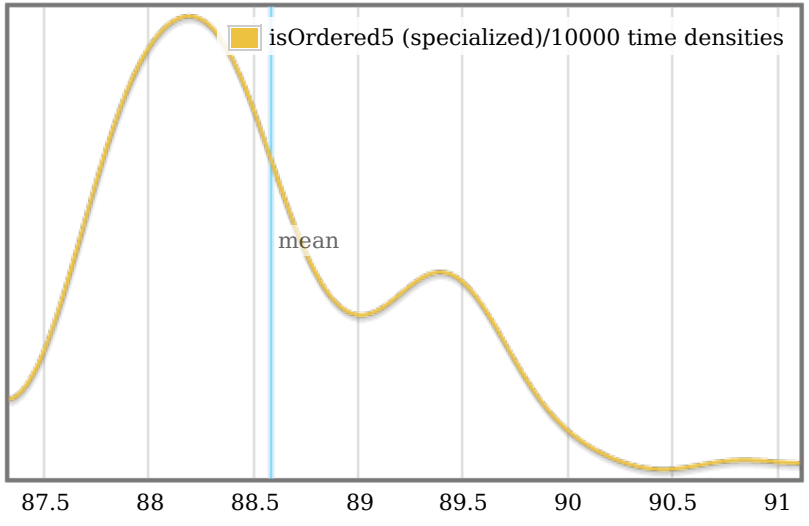


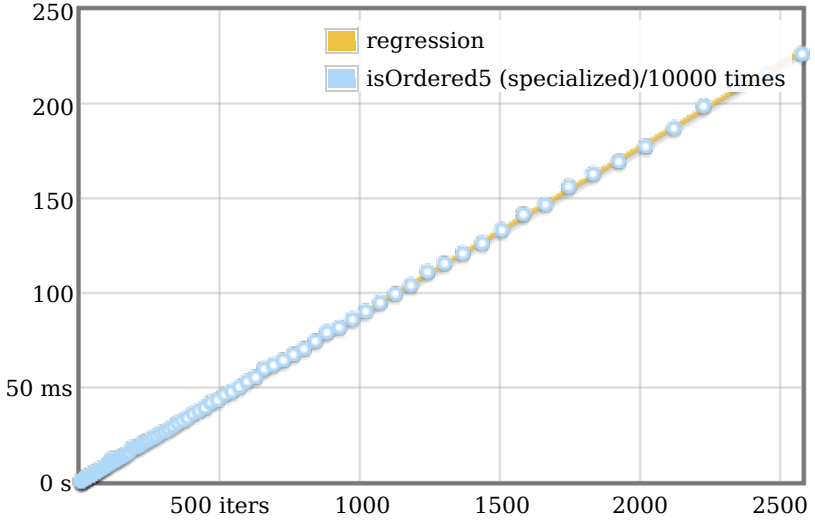


	lower bound	estimate	upper bound
OLS regression	195 µs	196 µs	197 µs
R² goodness-of-fit	0.999	1.000	1.000
Mean execution time	195 µs	196 µs	198 µs
Standard deviation	3.15 µs	4.00 µs	5.86 µs

Outlying measurements have moderate (13.8%) effect on estimated standard deviation.

isOrdered5 (specialized)/10000

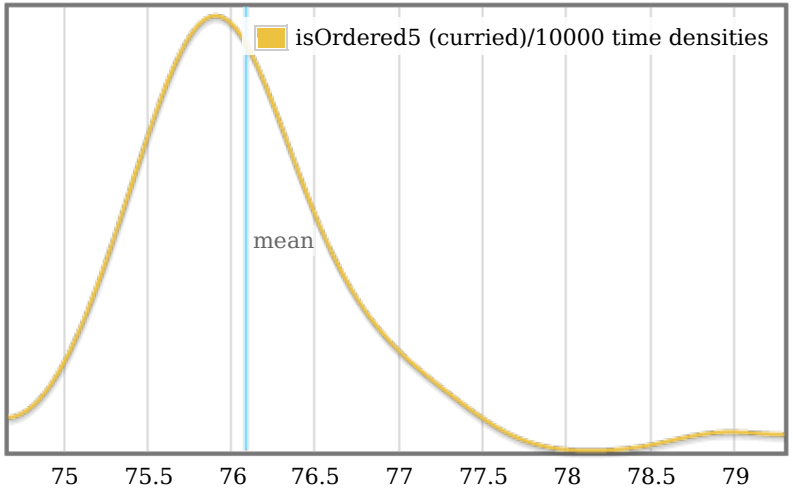


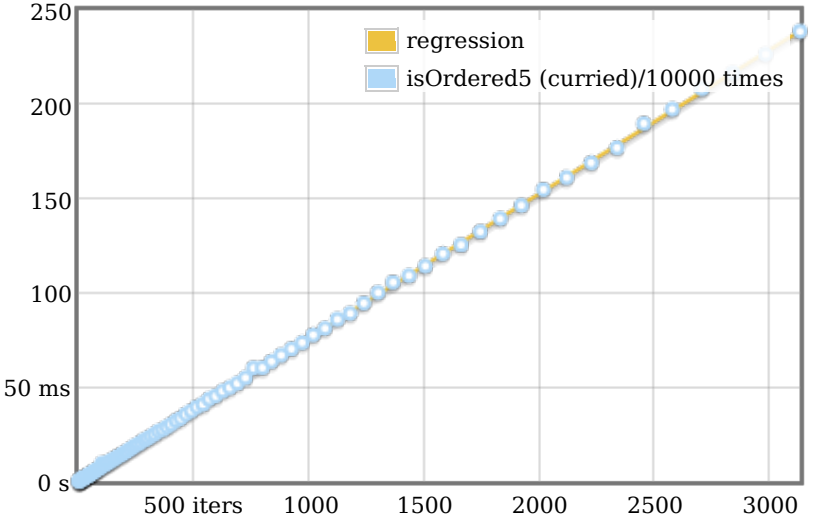


	lower bound	estimate	upper bound
OLS regression	88.2 µs	88.6 µs	89.0 µs
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	88.4 µs	88.6 µs	88.8 µs
Standard deviation	588 ns	719 ns	972 ns

Outlying measurements have no (0.8%) effect on estimated standard deviation.

isOrdered5 (curried)/10000

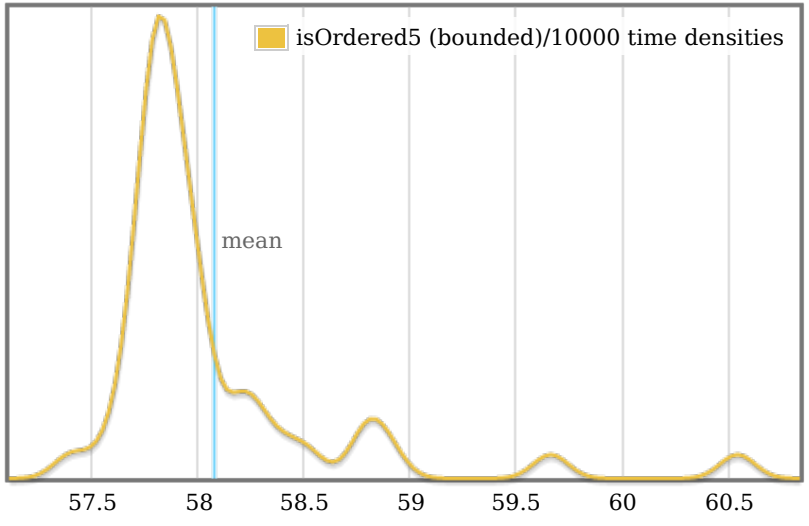


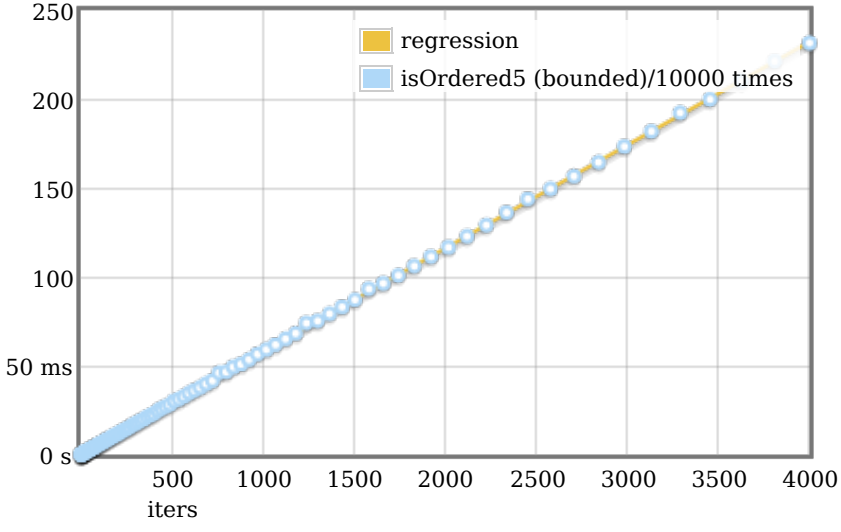


	lower bound	estimate	upper bound
OLS regression	76.0 µs	76.2 µs	76.5 µs
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	75.9 µs	76.1 µs	76.3 µs
Standard deviation	474 ns	669 ns	1.14 µs

Outlying measurements have no (0.8%) effect on estimated standard deviation.

isOrdered5 (bounded)/10000

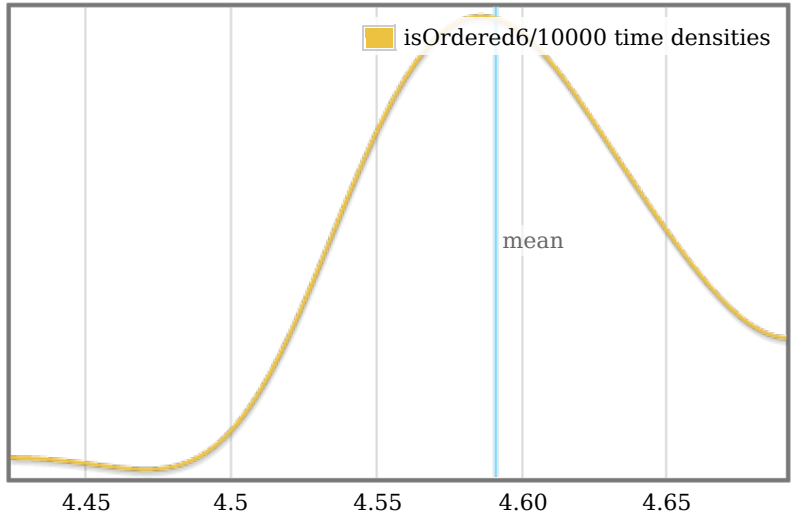


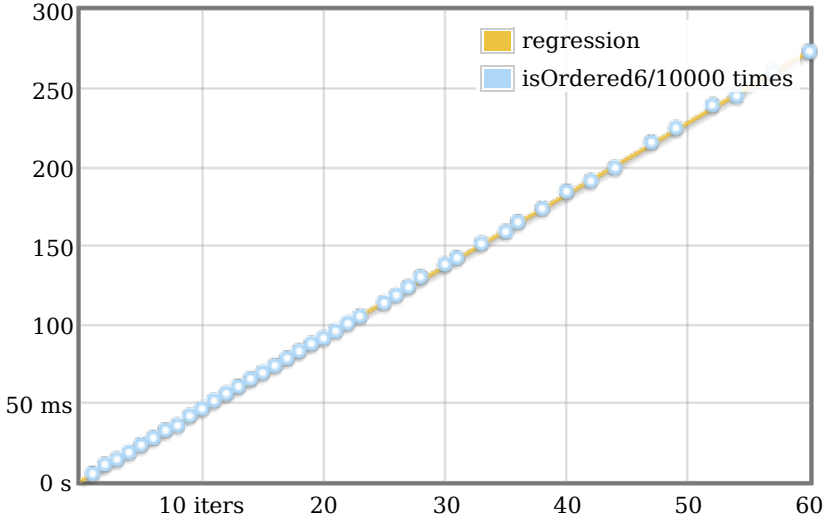


	lower bound	estimate	upper bound
OLS regression	57.9 µs	58.0 µs	58.1 µs
R^2 goodness-of-fit	1.000	1.000	1.000
Mean execution time	58.0 µs	58.1 µs	58.3 µs
Standard deviation	340 ns	558 ns	923 ns

Outlying measurements have no (0.8%) effect on estimated standard deviation.

isOrdered6/10000

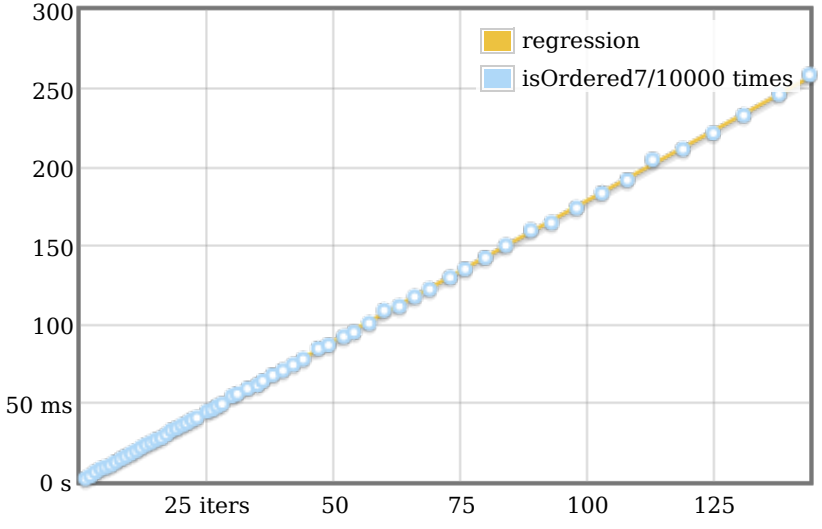




	lower bound	estimate	upper bound
OLS regression	4.54 ms	4.56 ms	4.58 ms
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	4.57 ms	4.59 ms	4.60 ms
Standard deviation	35.9 µs	45.0 µs	65.9 µs

Outlying measurements have slight (2.3%) effect on estimated standard deviation.

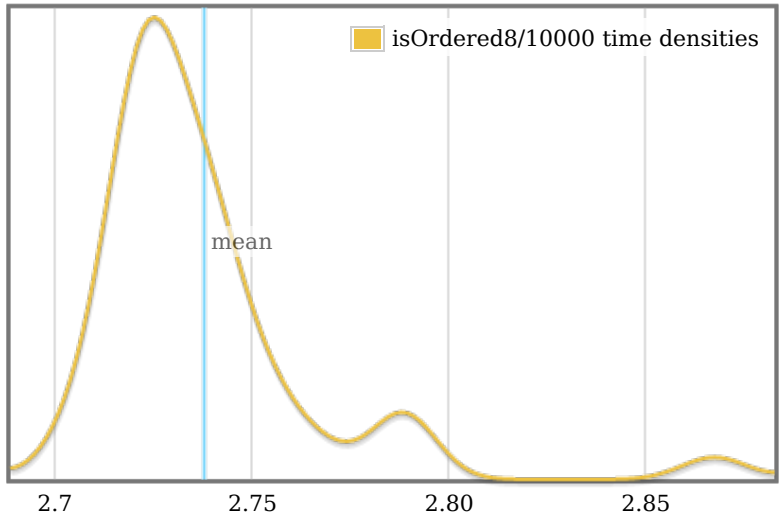
isOrdered7/10000

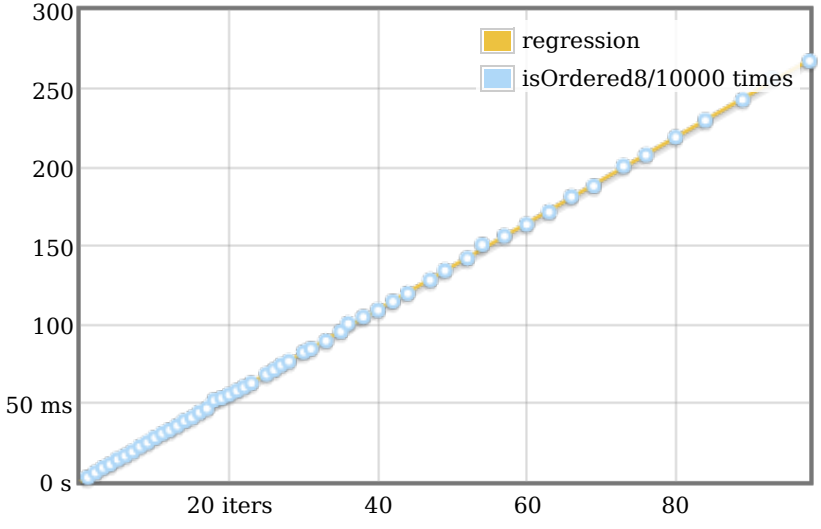


	lower bound	estimate	upper bound
OLS regression	1.78 ms	1.78 ms	1.79 ms
R^2 goodness-of-fit	1.000	1.000	1.000
Mean execution time	1.77 ms	1.78 ms	1.78 ms
Standard deviation	12.0 µs	14.8 µs	18.1 µs

Outlying measurements have slight (1.6%) effect on estimated standard deviation.

isOrdered8/10000

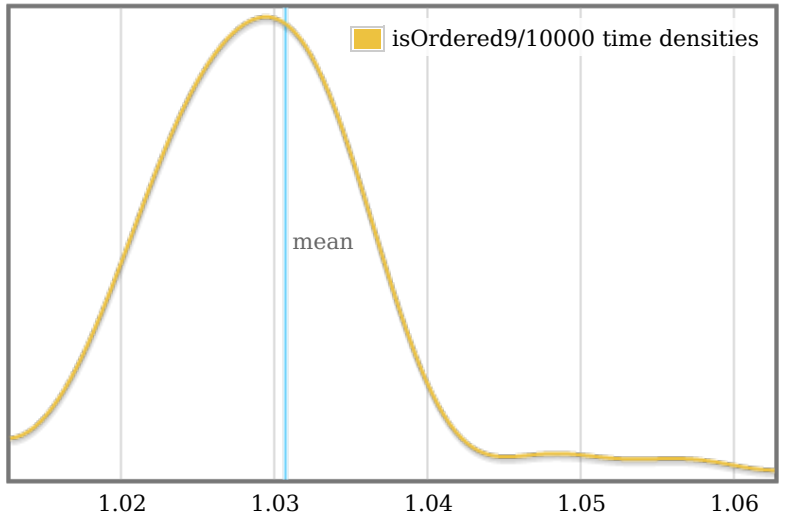


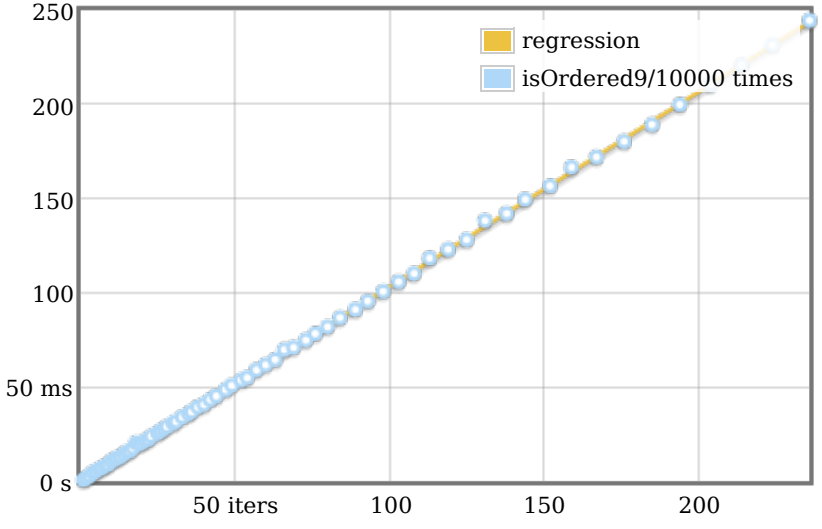


	lower bound	estimate	upper bound
OLS regression	2.73 ms	2.74 ms	2.75 ms
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	2.73 ms	2.74 ms	2.75 ms
Standard deviation	18.8 µs	28.5 µs	45.2 µs

Outlying measurements have slight (1.9%) effect on estimated standard deviation.

isOrdered9/10000

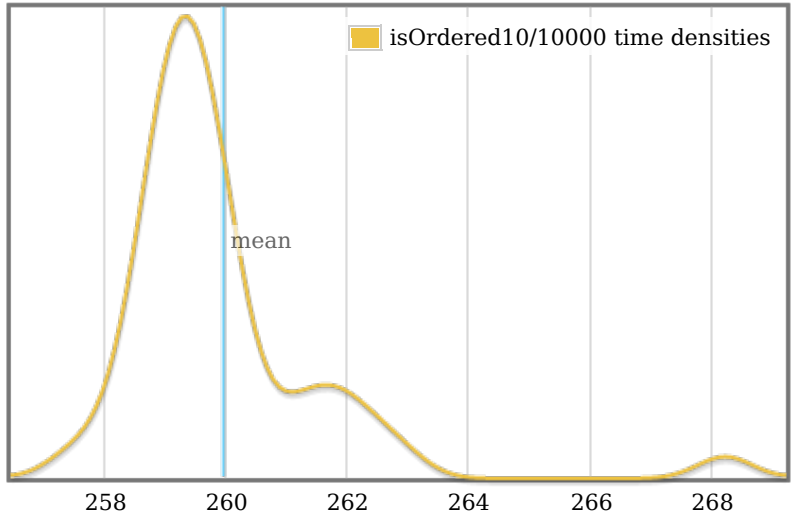


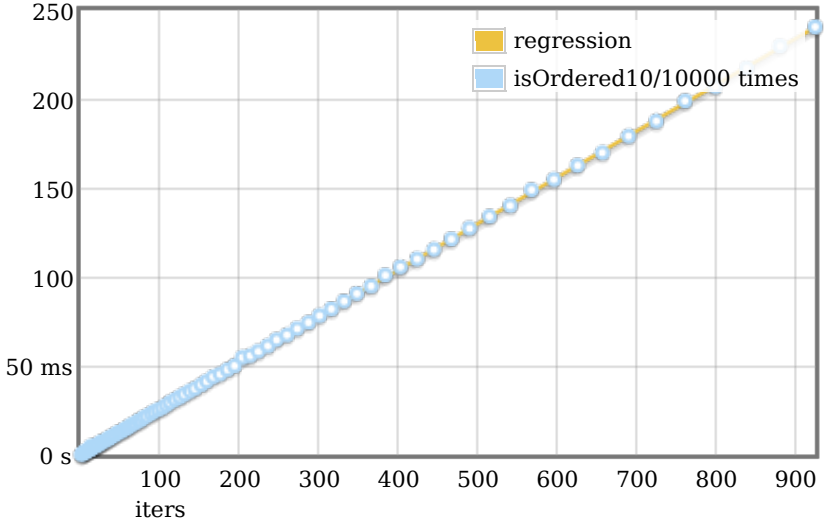


	lower bound	estimate	upper bound
OLS regression	1.03 ms	1.03 ms	1.04 ms
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	1.03 ms	1.03 ms	1.03 ms
Standard deviation	6.40 µs	8.77 µs	11.9 µs

Outlying measurements have slight (1.4%) effect on estimated standard deviation.

isOrdered10/10000

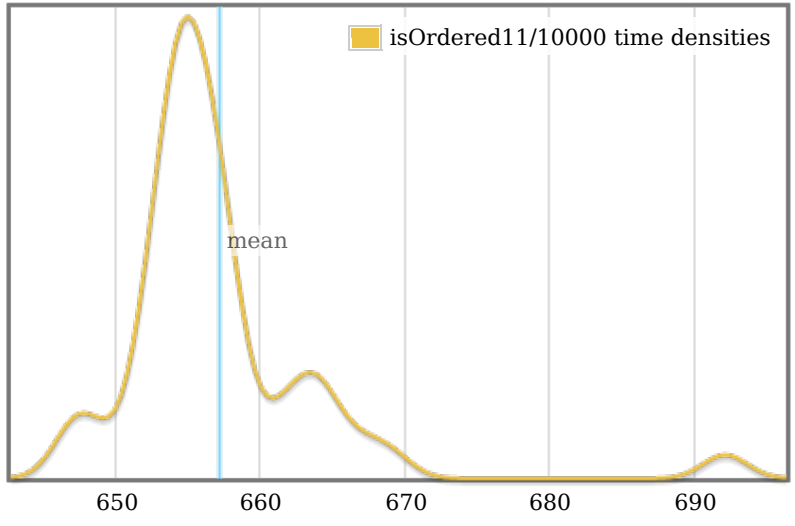


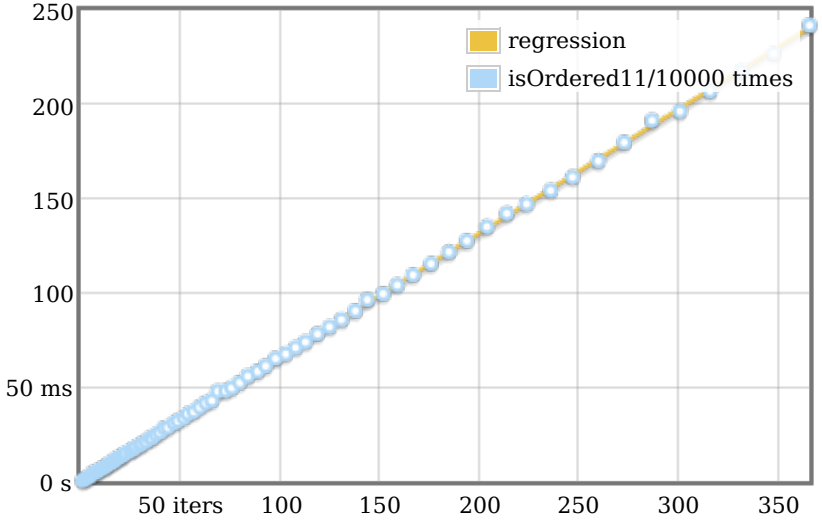


	lower bound	estimate	upper bound
OLS regression	259 µs	260 µs	260 µs
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	260 µs	260 µs	261 µs
Standard deviation	1.05 µs	1.72 µs	3.00 µs

Outlying measurements have slight (1.0%) effect on estimated standard deviation.

isOrdered11/10000

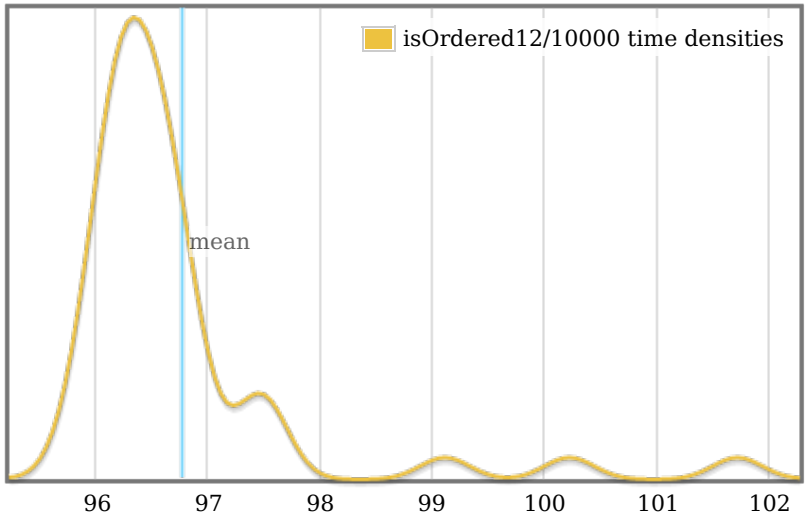


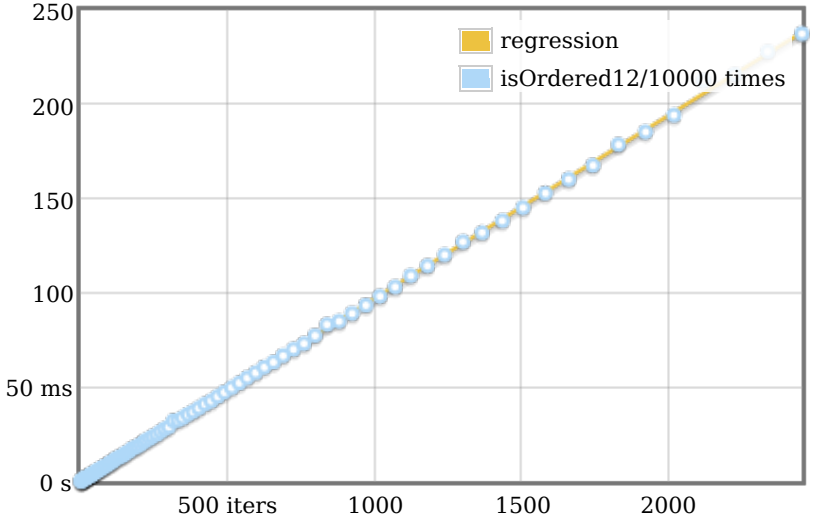


	lower bound	estimate	upper bound
OLS regression	655 µs	658 µs	660 µs
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	656 µs	657 µs	660 µs
Standard deviation	4.27 µs	7.14 µs	13.3 µs

Outlying measurements have slight (1.2%) effect on estimated standard deviation.

isOrdered12/10000

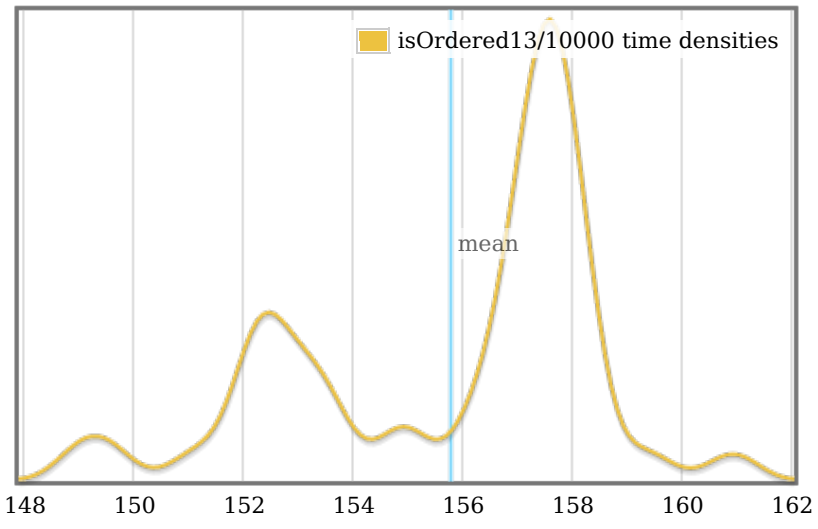


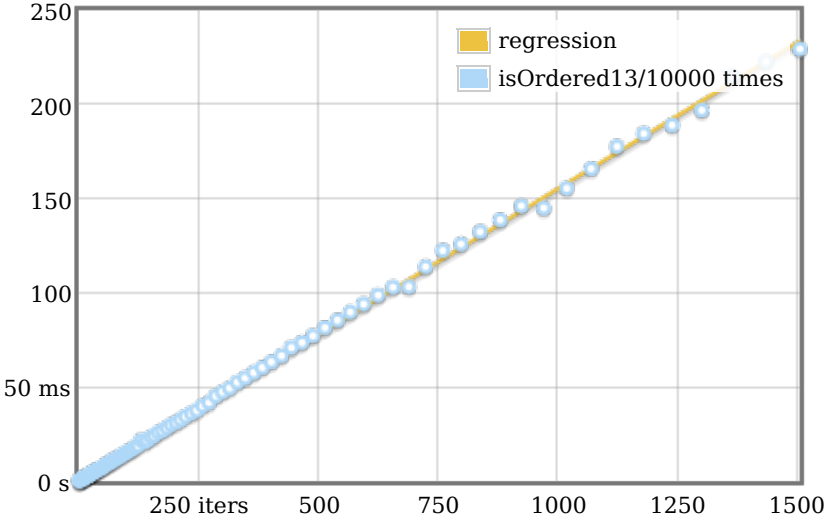


	lower bound	estimate	upper bound
OLS regression	96.5 µs	97.0 µs	97.6 µs
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	96.5 µs	96.8 µs	97.2 µs
Standard deviation	601 ns	1.10 µs	1.89 µs

Outlying measurements have no (0.8%) effect on estimated standard deviation.

isOrdered13/10000





	lower bound	estimate	upper bound
OLS regression	154 µs	155 µs	156 µs
R² goodness-of-fit	0.999	0.999	1.000
Mean execution time	155 µs	156 µs	157 µs
Standard deviation	2.28 µs	2.76 µs	3.36 µs

Outlying measurements have moderate (11.4%) 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^2 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^2 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.