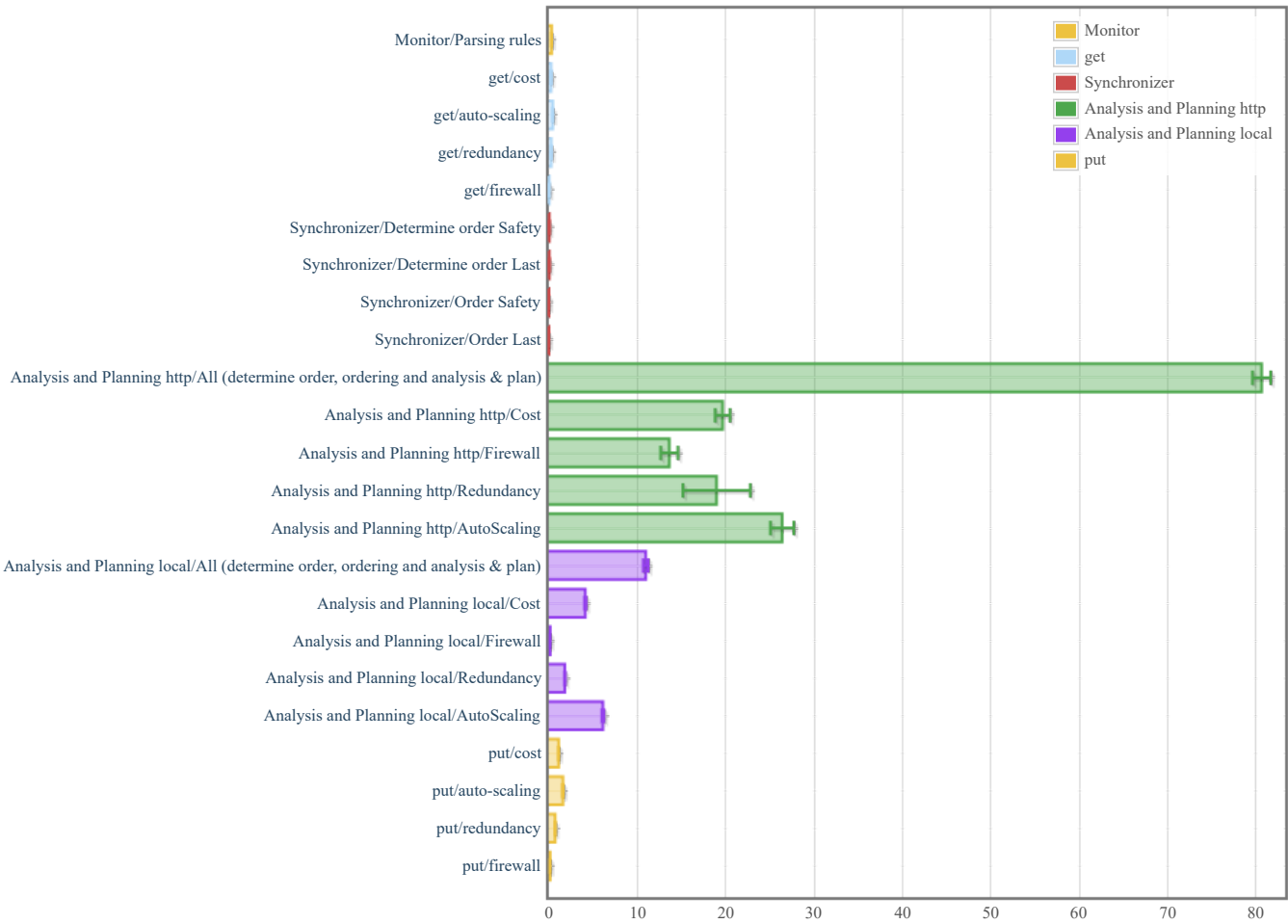# criterion performance measurements

overview

want to understand this report?
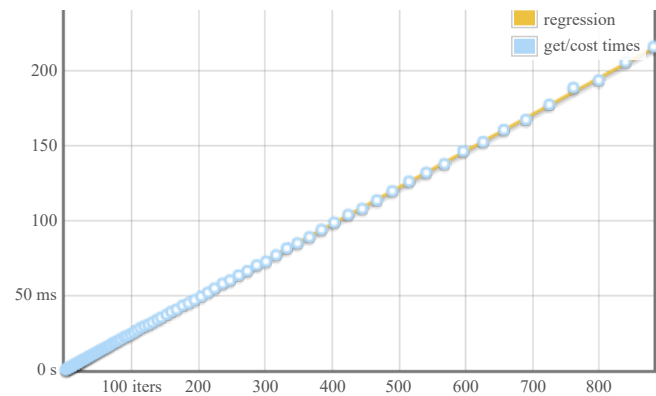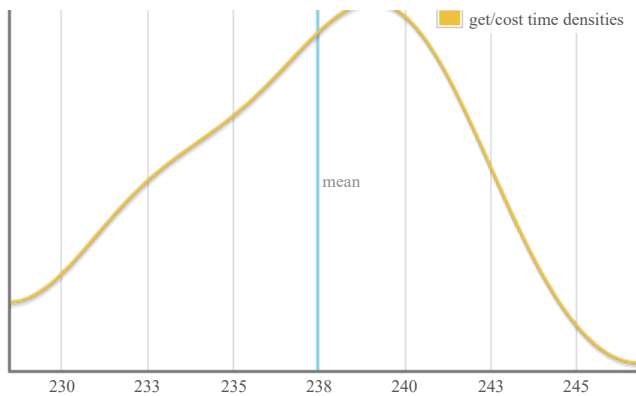

Monitor/Parsing rules

	lower bound	estimate	upper bound
OLS regression	306 µs	307 µs	309 µs
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	295 µs	297 µs	299 µs
Standard deviation	6.47 µs	7.76 µs	9.98 µs
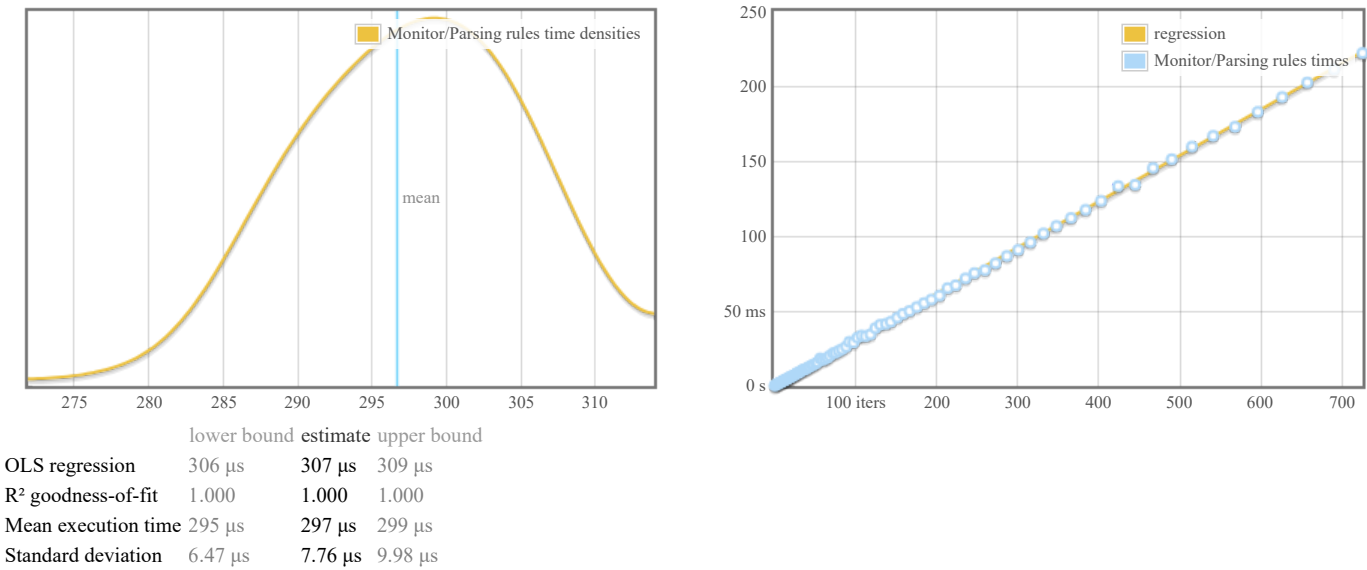
Outlying measurements have moderate (19.4%) effect on estimated standard deviation.

get/cost

	lower bound	estimate	upper bound
OLS regression	243 µs	244 µs	244 µs
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	236 µs	237 µs	239 µs
Standard deviation	3.21 µs	3.78 µs	4.49 µs

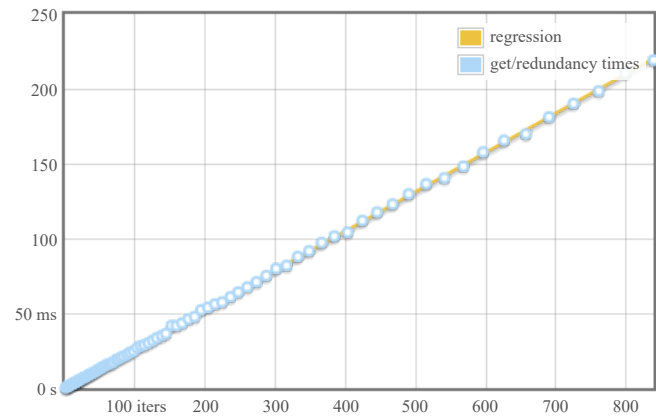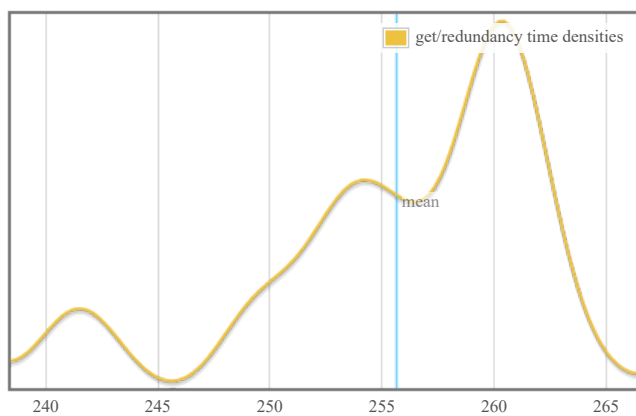Outlying measurements have slight (8.7%) effect on estimated standard deviation.

get/auto-scaling
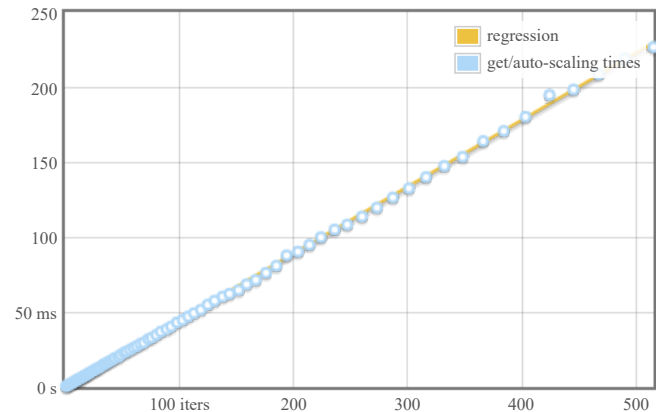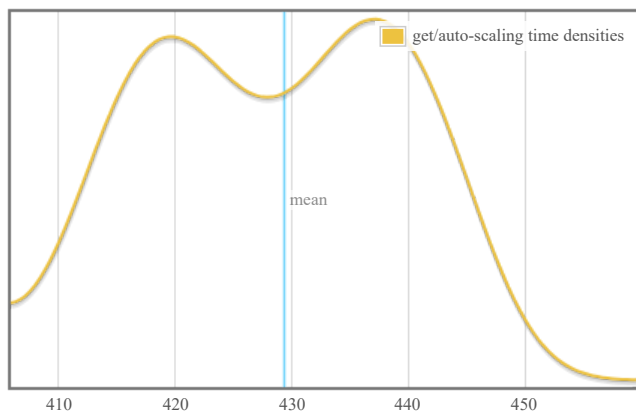
	lower bound	estimate	upper bound
OLS regression	443 µs	445 µs	448 µs
R² goodness-of-fit	0.999	1.000	1.000
Mean execution time	426 µs	429 µs	433 µs
Standard deviation	9.72 µs	11.0 µs	13.3 µs

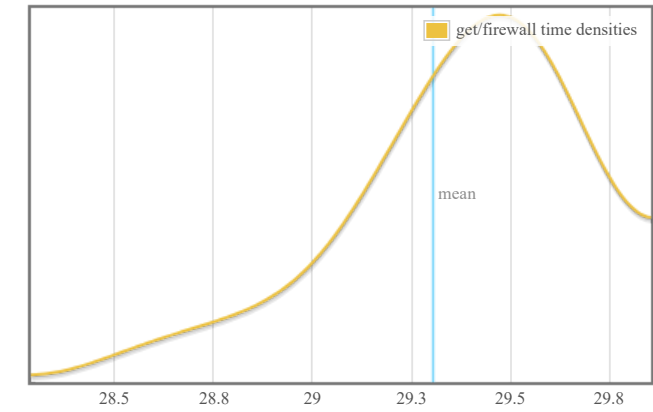Outlying measurements have moderate (17.6%) effect on estimated standard deviation.

get/redundancy

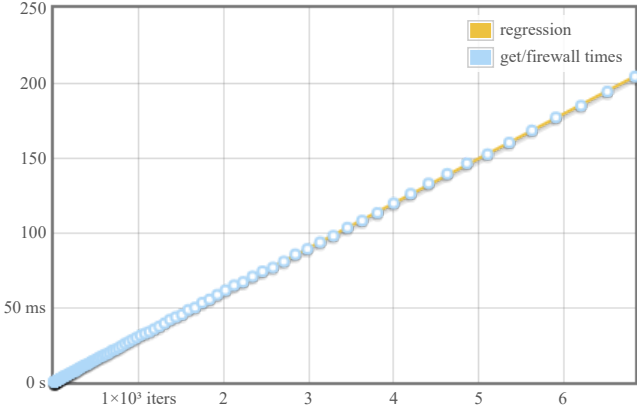|	lower bound	estimate	upper bound
OLS regression	262 µs	263 µs	264 µs
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	254 µs	256 µs	257 µs
Standard deviation	4.95 µs	6.14 µs	7.66 µs

Outlying measurements have moderate (16.8%) effect on estimated standard deviation.
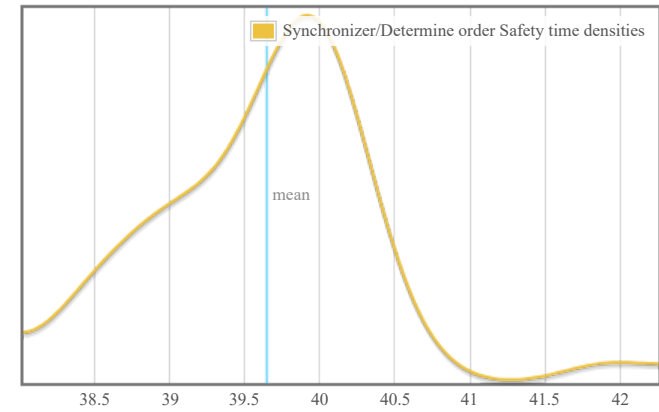
get/firewall

	lower bound	estimate	upper bound
OLS regression	29.8 µs	29.9 µs	29.9 µs
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	29.2 µs	29.3 µs	29.4 µs
Standard deviation	261 ns	331 ns	425 ns

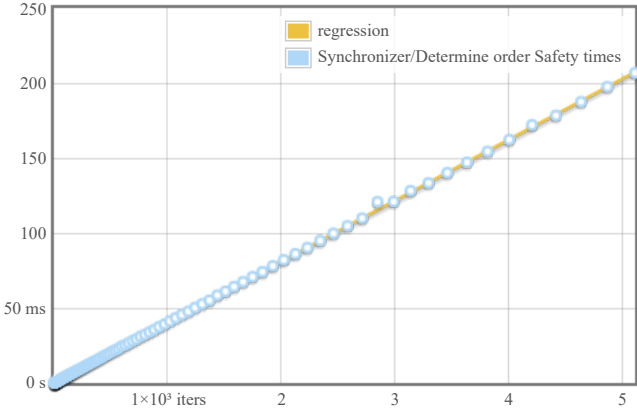Outlying measurements have slight (6.1%) effect on estimated standard deviation.
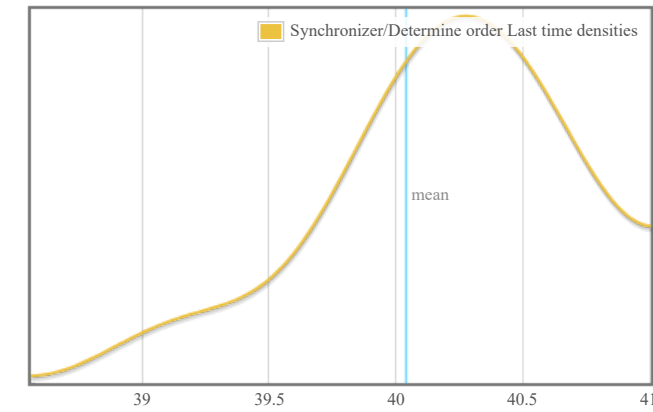
Synchronizer/Determine order Safety

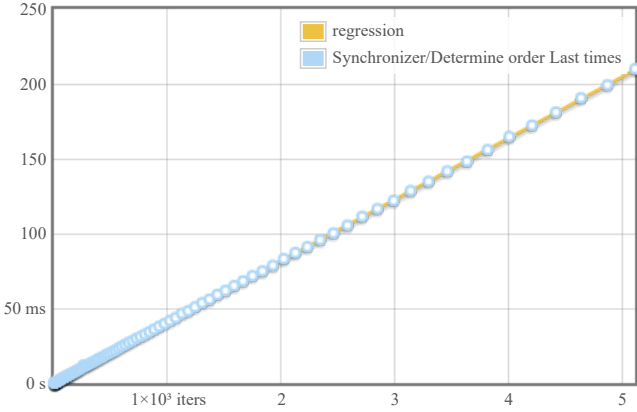|	lower bound	estimate	upper bound
OLS regression	40.5 µs	40.6 µs	40.8 µs
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	39.4 µs	39.7 µs	39.9 µs
Standard deviation	534 ns	680 ns	993 ns

Outlying measurements have moderate (12.8%) effect on estimated standard deviation.

Synchronizer/Determine order Last

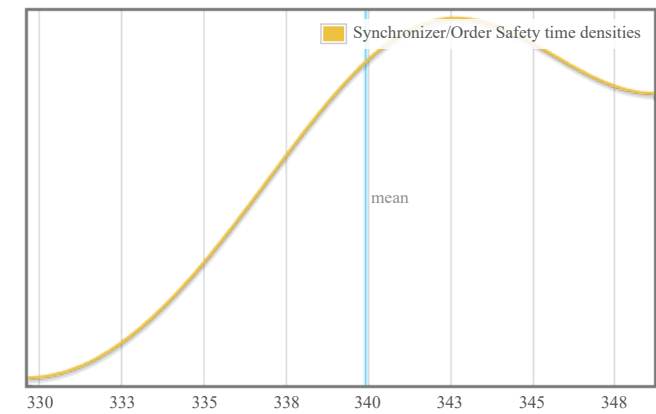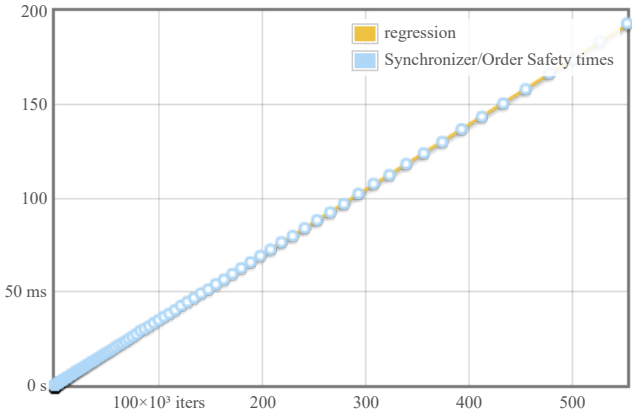|	lower bound	estimate	upper bound
OLS regression	41.0 µs	41.0 µs	41.1 µs
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	39.9 µs	40.0 µs	40.2 µs
Standard deviation	436 ns	553 ns	663 ns

Outlying measurements have slight (8.5%) effect on estimated standard deviation.
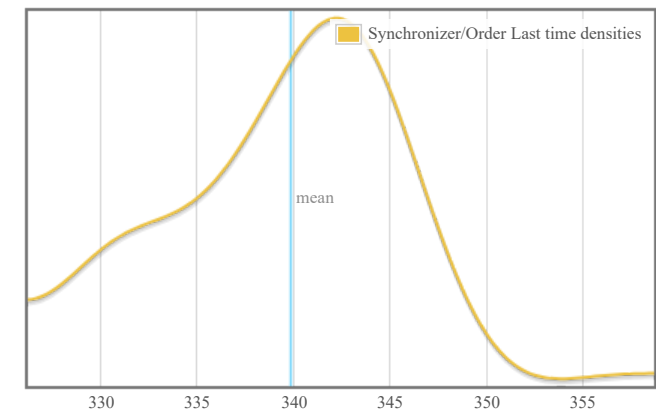
Synchronizer/Order Safety

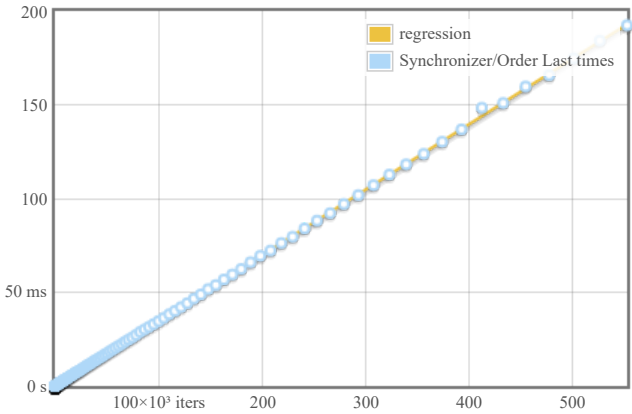|	lower bound	estimate	upper bound
OLS regression	348 ns	349 ns	349 ns
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	338 ns	340 ns	341 ns
Standard deviation	4.02 ns	4.73 ns	5.58 ns

Outlying measurements have moderate (13.7%) effect on estimated standard deviation.
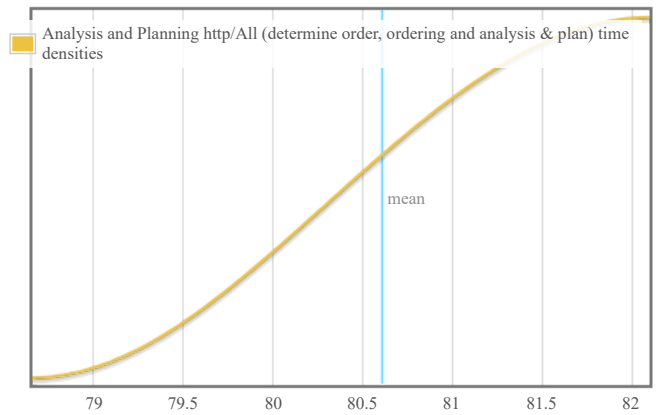
Synchronizer/Order Last

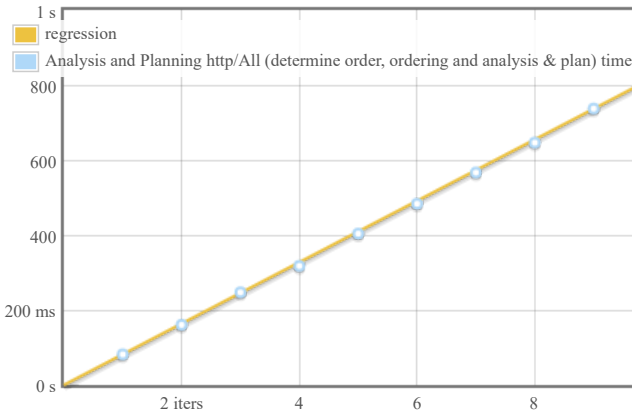|	lower bound	estimate	upper bound
OLS regression	348 ns	349 ns	351 ns
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	338 ns	340 ns	342 ns
Standard deviation	4.82 ns	5.91 ns	8.12 ns

Outlying measurements have moderate (20.0%) effect on estimated standard deviation.

# Analysis and Planning http/All (determine order, ordering and analysis & plan)

	lower bound	estimate	upper bound
OLS regression	80.6 ms	81.8 ms	83.3 ms
R² goodness-of-fit	0.999	1.000	1.000

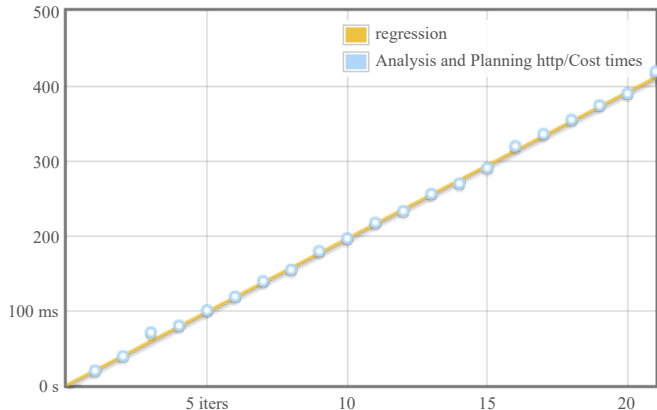|			
Mean execution time	79.9 ms	80.6 ms	81.2 ms
Standard deviation	730 μs	1.03 ms	1.43 ms

Outlying measurements have slight (9.0%) effect on estimated standard deviation.
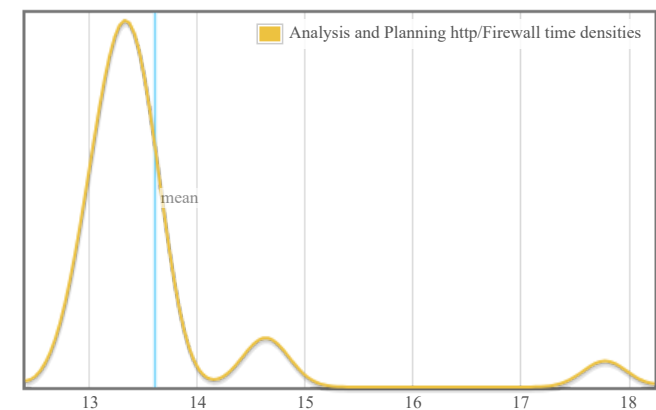
Analysis and Planning http/Cost
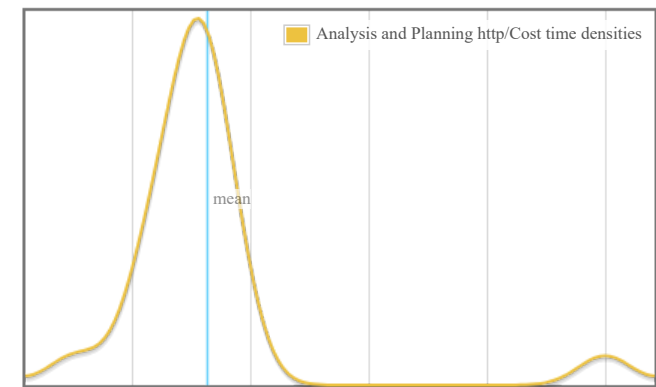
	lower bound	estimate	upper bound
OLS regression	19.3 ms	19.6 ms	19.9 ms
R² goodness-of-fit	0.998	0.999	1.000
Mean execution time	19.4 ms	19.6 ms	20.2 ms
Standard deviation	261 μs	840 μs	1.55 ms

Outlying measurements have moderate (13.5%) effect on estimated standard deviation.
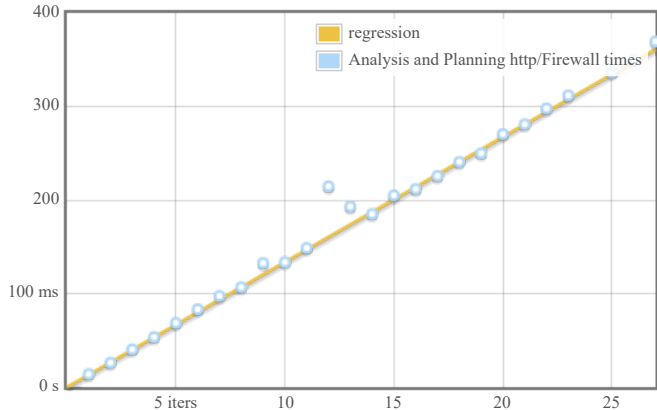
Analysis and Planning http/Firewall

	lower bound	estimate	upper bound
OLS regression	13.1 ms	13.4 ms	13.6 ms
R² goodness-of-fit	0.962	0.989	0.999
Mean execution time	13.4 ms	13.6 ms	14.6 ms
Standard deviation	355 μs	978 μs	1.86 ms

Outlying measurements have moderate (33.2%) effect on estimated standard deviation.
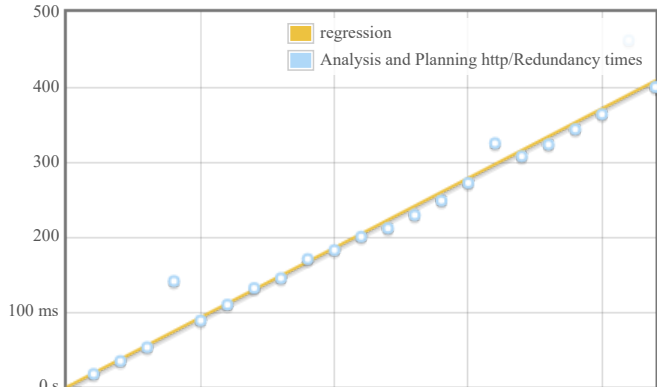
Analysis and Planning http/Redundancy
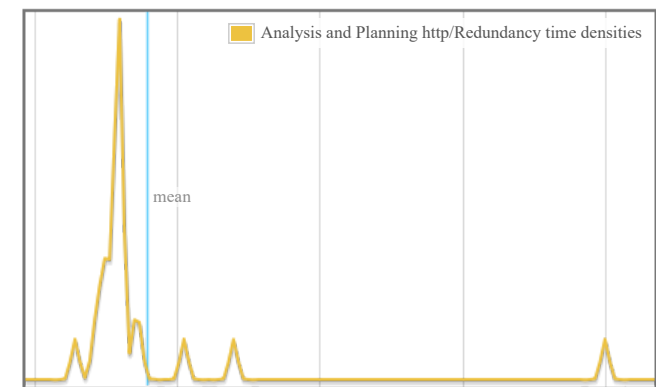
	lower bound	estimate	upper bound
OLS regression	16.7 ms	18.6 ms	20.5 ms
R² goodness-of-fit	0.932	0.964	0.999
Mean execution time	18.0 ms	19.0 ms	22.2 ms
Standard deviation	956 µs	3.81 ms	7.47 ms

Outlying measurements have severe (80.6%) effect on estimated standard deviation.

Analysis and Planning http/AutoScaling

	lower bound	estimate	upper bound
OLS regression	26.0 ms	26.9 ms	28.9 ms
R² goodness-of-fit	0.962	0.986	1.000
Mean execution time	26.0 ms	26.4 ms	27.6 ms
Standard deviation	295 µs	1.33 ms	2.54 ms

Outlying measurements have moderate (15.7%) effect on estimated standard deviation.
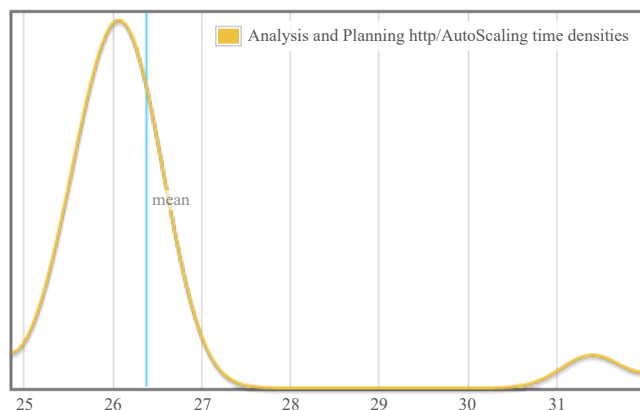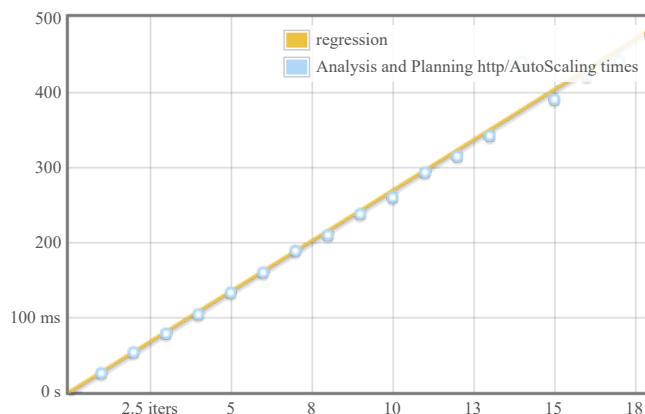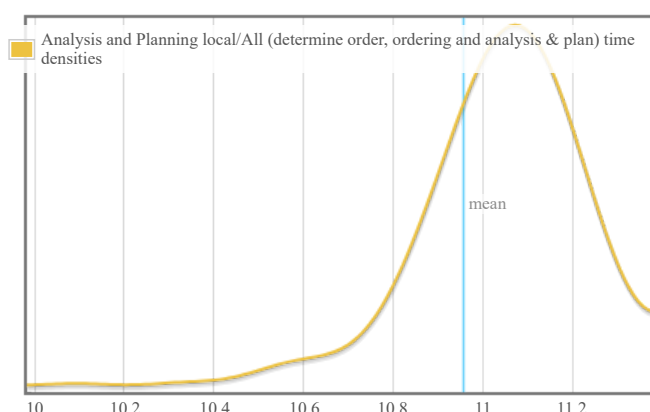
Analysis and Planning local/All (determine order, ordering and analysis & plan)

	lower bound	estimate	upper bound
OLS regression	11.2 ms	11.3 ms	11.3 ms
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	10.8 ms	11.0 ms	11.0 ms
Standard deviation	179 µs	277 µs	406 µs

Outlying measurements have slight (6.7%) effect on estimated standard deviation.
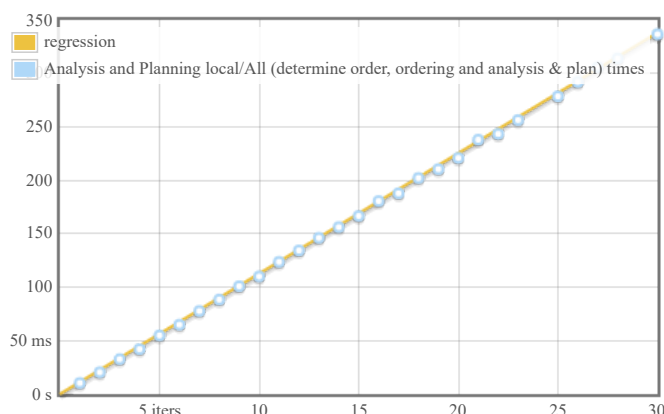
Analysis and Planning local/Cost
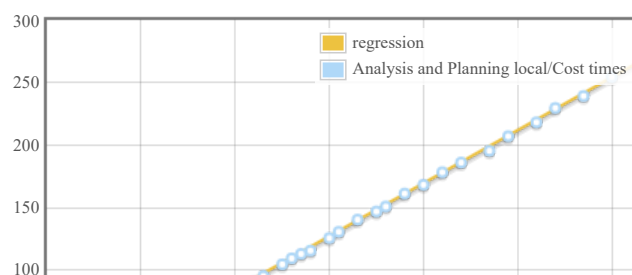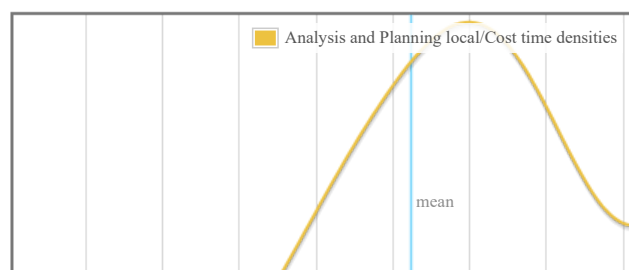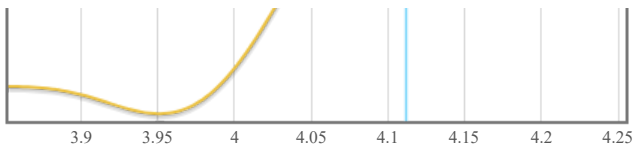
	lower bound	estimate	upper bound
OLS regression	4.22 ms	4.24 ms	4.25 ms
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	4.08 ms	4.11 ms	4.14 ms
Standard deviation	65.8 µs	86.5 µs	115 µs

Outlying measurements have slight (6.6%) effect on estimated standard deviation.

Analysis and Planning local/Firewall

	lower bound	estimate	upper bound
OLS regression	148 µs	150 µs	152 µs
R² goodness-of-fit	0.997	0.998	0.999
Mean execution time	146 µs	147 µs	150 µs
Standard deviation	3.74 µs	5.52 µs	9.31 µs

Outlying measurements have moderate (35.9%) effect on estimated standard deviation.

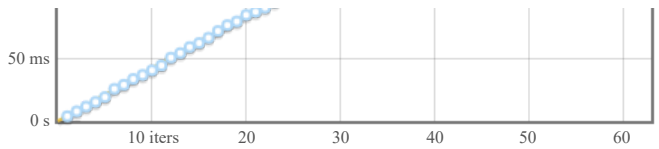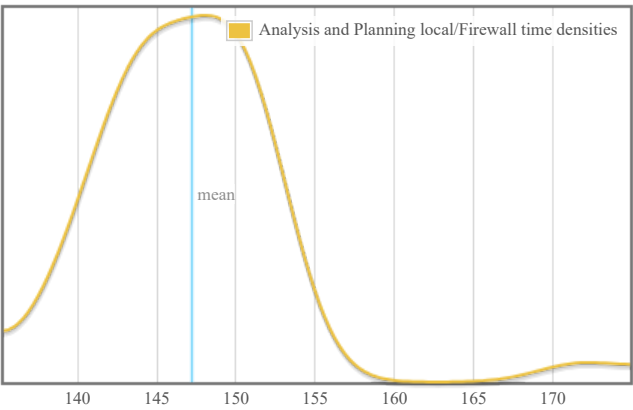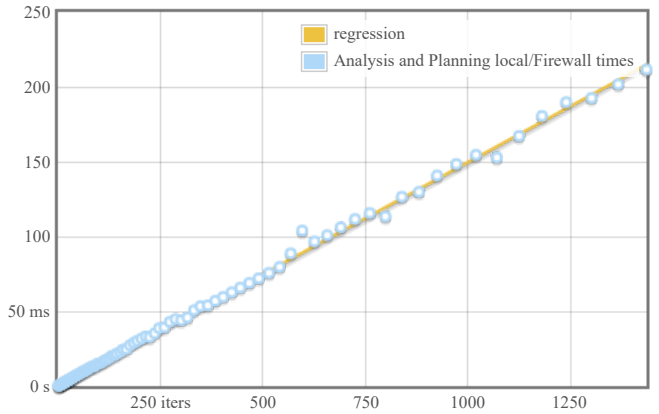## Analysis and Planning local/Redundancy
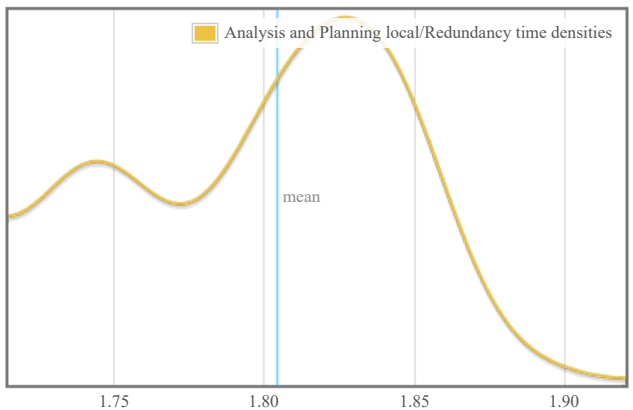
	lower bound	estimate	upper bound
OLS regression	1.86 ms	1.87 ms	1.88 ms
R² goodness-of-fit	0.999	1.000	1.000
Mean execution time	1.79 ms	1.80 ms	1.82 ms
Standard deviation	39.5 µs	45.1 µs	54.0 µs

Outlying measurements have moderate (13.0%) effect on estimated standard deviation.
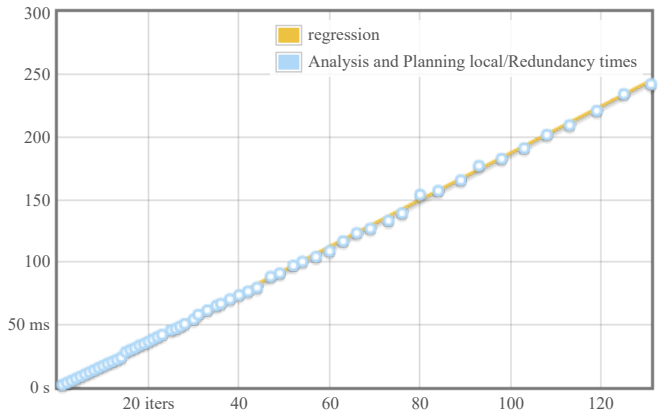
Analysis and Planning local/AutoScaling

	lower bound	estimate	upper bound
OLS regression	6.25 ms	6.27 ms	6.30 ms
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	6.06 ms	6.11 ms	6.14 ms
Standard deviation	97.9 µs	115 µs	139 µs

Outlying measurements have slight (2.6%) effect on estimated standard deviation.

put/cost

	lower bound	estimate	upper bound
OLS regression	1.14 ms	1.14 ms	1.14 ms
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	1.09 ms	1.10 ms	1.11 ms
Standard deviation	20.2 µs	22.7 µs	25.9 µs

Outlying measurements have slight (9.7%) effect on estimated standard deviation.

put/auto-scaling
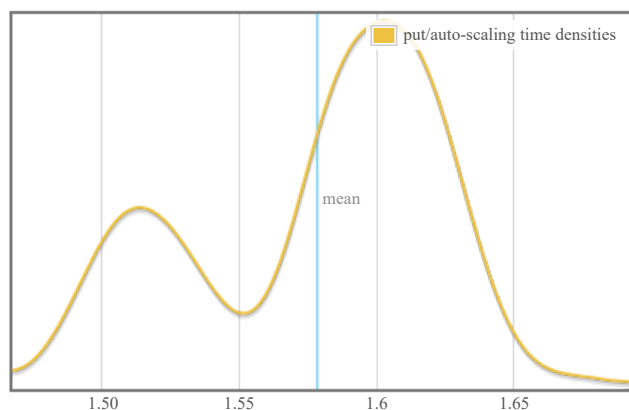
	lower bound	estimate	upper bound
OLS regression	1.64 ms	1.65 ms	1.66 ms
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	1.56 ms	1.58 ms	1.59 ms
Standard deviation	39.8 µs	46.4 µs	55.1 µs

Outlying measurements have moderate (17.1%) effect on estimated standard deviation.
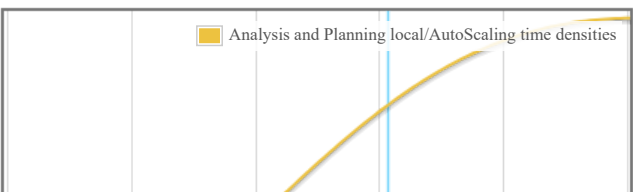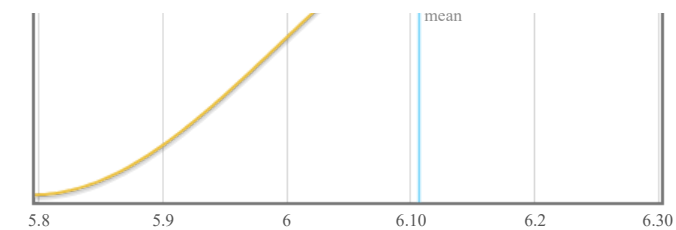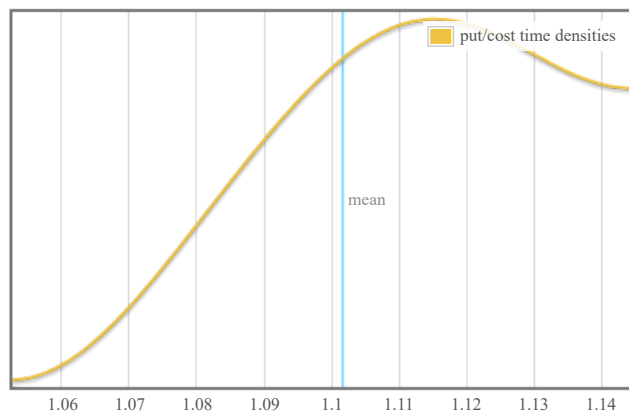
put/redundancy
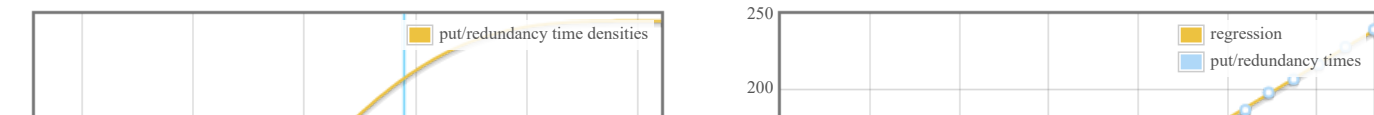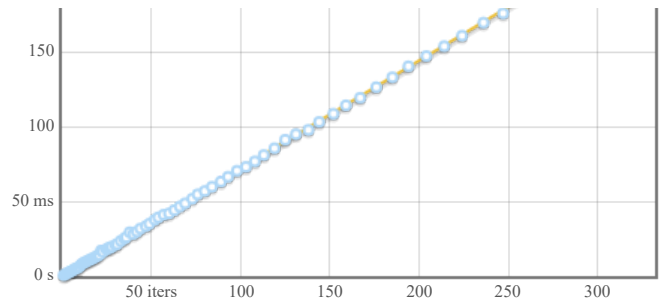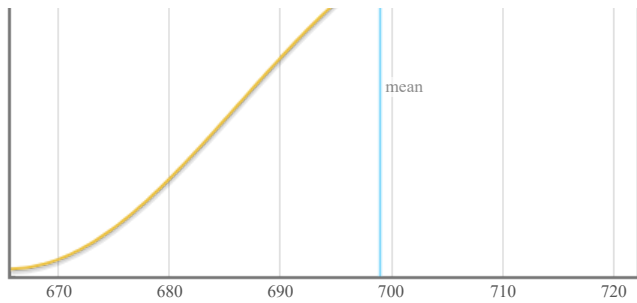
	lower bound	estimate	upper bound
OLS regression	718 µs	720 µs	722 µs
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	695 µs	699 µs	703 µs
Standard deviation	11.3 µs	13.2 µs	15.5 µs

Outlying measurements have slight (9.8%) effect on estimated standard deviation.

put/firewall

	lower bound	estimate	upper bound
OLS regression	141 µs	142 µs	142 µs
R² goodness-of-fit	1.000	1.000	1.000
Mean execution time	139 µs	139 µs	140 µs
Standard deviation	1.43 µs	1.88 µs	2.35 µs

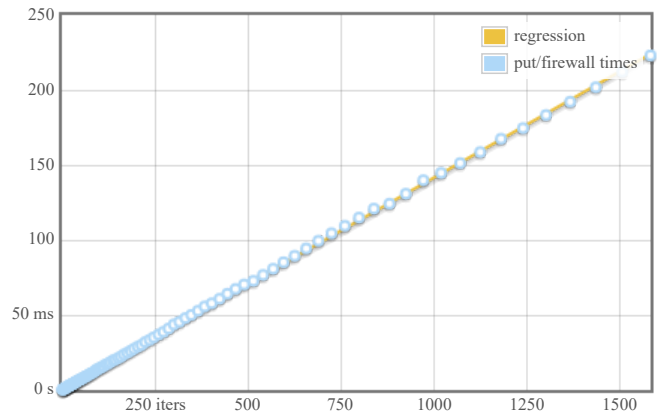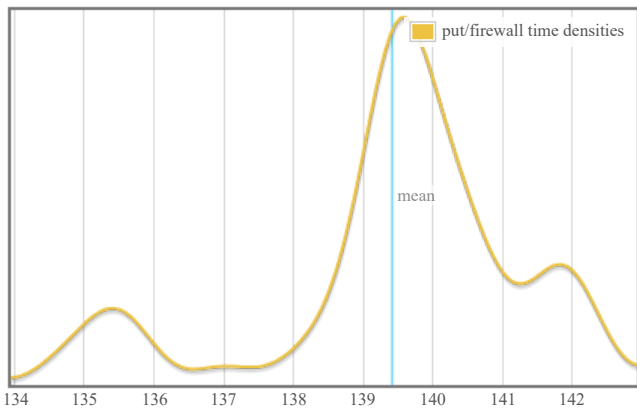Outlying measurements have slight (6.9%) effect on estimated standard deviation.

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.