# Addition Checker Description

Run a series of ADDITION tests to validate accuracy along with timing.

A raw test sequence is a sequence of natural numbers that fit in a Java double-precision floating-point value without loss of significance (see [Oracle Docs](https://docs.oracle.com/javase/specs/jvms/se6/html/Overview.doc.html).) Java DP values have 53 bits of significance and hold a natural number exactly up to 9,007,199,254,740,991. This is a little more than 15 digits.

When computing sums of natural numbers, exact DP calculations limit the sequence to 134,164,078 with an integer summation value of 8,999,999,979,877,081. This is our "*Natural*" test sequence of numbers that our *adder* implementations will sum.

We also create a "*scaled*" test sequence by dividing a natural number test sequence by a prime number; we do this to force round off error into the sequence, and therefore error into the computed sum (e.g., the prime *7919*.)

Given an initial sequence of natural numbers, and fractions from those natural numbers (scaled by a prime), we can then randomly order those numbers. Order is important because naive addition performs best when summed smallest-to-largest, and worst when ordered largest-to-smallest. Randomized sums are considered an average case.

Please note that our tests have sizes that are roughly logarithmically increasing in size. We also time the overall tests for performance analysis.

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| --- | --- | --- | --- |
| **Sequence** | **Order** | **Distribution** | **Label** |
| Natural | Smallest first | Sequential | NAT-SML-SEQ |
| Natural | Largest first | Sequential | NAT-LRG-SEQ |
| Natural | Random | Parallel | NAT-RND-PAR |
| Scaled | Smallest first | Sequential | SCL-SML-SEQ |
| Scaled | Largest first | Sequential | SCL-LRG-SEQ |
| Scaled | Random | Sequential | SCL-RND-SEQ |
| Scaled | Random | Parallel | SCL-RND-PAR |
| Scaled-Kahan | Random | Sequential | SCLK-RND-SEQ |

Test output is in CSV format to allow Excel analysis. The columns in the report are:

* *n* - number of values to sum
* *expected* - the expected or true sum
* *actual* - the observed or computed sum
* *delta* - the difference between expected and actual (expected / actual)
* *relative* - the relative error: (expected - actual) / expected; multiplied by 10\*\*9
* *sigd* - the number of significant digits [computed as log10(0.5) - log10(abs(relative))]
* *elapsed* - summation time in milliseconds
* *label* - test identification (taken from table above)

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## References:

* Java 8 parallelism selector: <http://gee.cs.oswego.edu/dl/html/StreamParallelGuidance.html>
* General Java parallelism benchmark: <https://dzone.com/articles/forkjoin-framework-vs-parallel>