Tools Needed to Debug Floating-Point Computations in Science and Engineering

ABSTRACT: Floating-Point Computations differ from all others thus:

»» What you see is not exactly what you get.

»» What you got is not exactly what the program's text implied you'd get.

»» Unlike Correctness, Accuracy is not always ***Transitive*** across the composition of Floating-Point Subprograms.

»» Floating-Point Exceptions like Over/Underflow and Division-by-Zero are not always Errors; but when the are, whose are they?

Consequently Floating-Point computations can be spectacularly wrong very rarely, but more often unobviously wrong enough to mislead us.

Tools are needed to detect and diagnose inaccuracies, and to locate unanticipated exceptions without abandoning the execution of a program responsible for a vehicle or industrial process. Locutions are needed for Presubstitutions in programming languages, allowing 0/0, ∞/∞, ∞·0 and ∞ – ∞ to be treated without tests-and-branches that impede vectorization and clutter programs' texts.

Some such tools had been in use in the 1960s, but not all together,
and none are available now. Why not?

The would-be beneficiaries of such tools are currently unaware that such tools could exist if they were demanded and paid for.

Details have been posted for a decade at
people.eecs.berkeley.edu/~wkahan/Boulder.pdf .
Why resurrect it now? Now some computer architectures offer ***Tracing*** capabilities to reveal where programs spent their time and help find out where they went astray. Augmenting the list of traced branches with Floating-Point Exceptions would help locate exceptions handled badly, thereby providing a service more usable than what Boulder.pdf called "Retrospective Diagnostics". Thanks go to Dr. John Hauser for that suggestion.

A short series of lectures on the topics mentioned above are to be offered. The first on 4 Mar. 2020 will explain why users of Interval Arithmetic to assess a program's inaccuracy are so often disappointed, and what can be done instead.
Example: How much should $x^2 - 1$ differ from $(x - 1)\cdot(x + 1)$?