Improving Exception Handling in the BLAS and LAPACK

people.eecs.berkeley.edu/~demmel/Exception_Handling_for_the_BLAS_and_LAPACK_12Aug2021.pdf

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Examples of handling exceptions badly

https://www.reddit.com/r/formula1/comments/jk9jrg/ot_roborace_driverless_racecar_drives_straight/gai295l/

"During this initialization lap something happened which apparently cause the steering control signal to go to NaN"

A few examples of inconsistency

- ISAMAX([0,NaN,2]) = 3 ≠ 1 = ISAMAX([NaN,0,2])
- TRSV checks for zeros in x (sometimes)
- Ex: $T = \begin{vmatrix} 1 & NaN & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{vmatrix}, b = \begin{vmatrix} 2 \\ 1 \\ 1 \end{vmatrix}$ yields $x = \begin{vmatrix} 1 \\ 0 \\ 1 \end{vmatrix}$
- NaN does not propagate
- Solving $(T^T)^T * x = b$ does not check for zeros, so NaN does propagate
- BLAS inconsistencies combine so that SGESV may not propagate NaNs

In Conclusion:
High level goals, for BLAS and LAPACK

- Handle exceptions “consistently”
  - Always terminate, despite exceptions
  - Report exceptions for which a problem is “ill-posed”
    - Ex: eig(NaN)
  - Propagate exceptions “consistently”, to allow higher level applications to be consistent too
- Do not slow down (much)
- Accommodate inconsistent building blocks
  - Eg: How compilers implement max or complex/complex