

A Julia Tool for Stagnation Detection

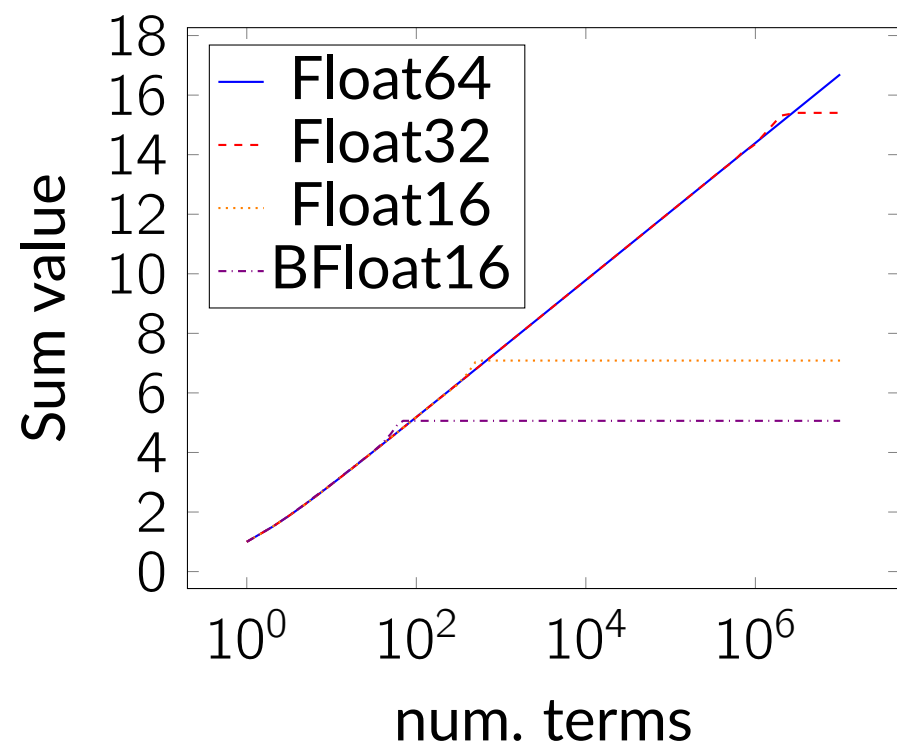
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Motivation

Stagnation occurs in floating-point summation when small terms are added to a big accumulator and get rounded off. See the harmonic series

$$\sum_{k=1}^{\infty} \frac{1}{k}$$

in finite precision.



Design

Measure stagnation by defining a type in Julia that has its own method for addition. FloatSD is a data structure with:

- value for floating-point addition,
- u for counting bits carried in the sum,
- additions (number of),
- absorptions counts stagnation.

StagnationDetection.jl provides Float64SD, Float32SD and Float16SD types.



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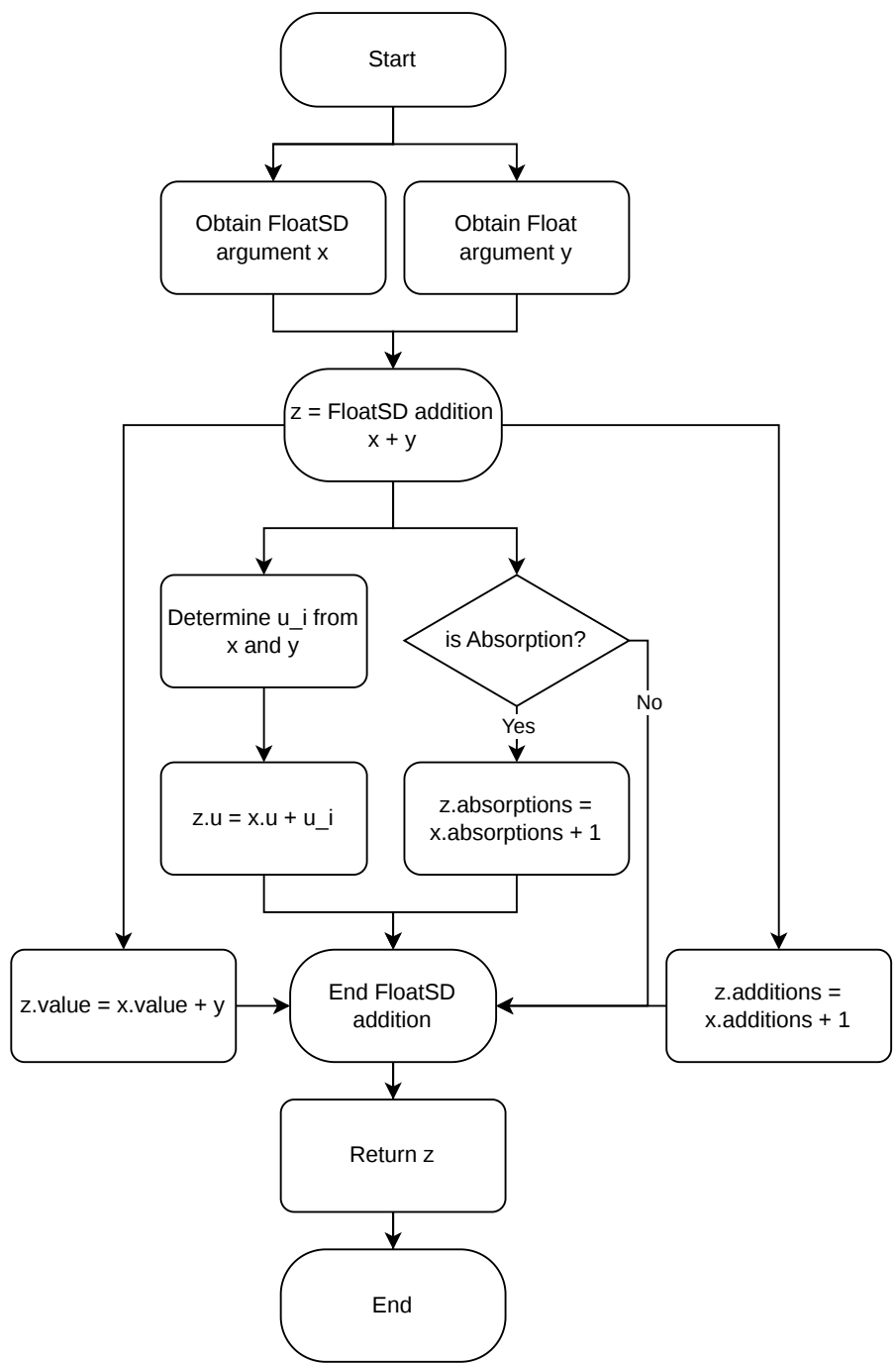
StagnationDetection.jl measures round-off during addition, requiring minimal code modification. Runs 10× faster than emulated high precision (variable).

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Paper “Analysis and Detection of Stagnation in Floating-Point Summation” in progress. StagnationDetection.jl is a dynamic analysis tool that performs stagnation detection on the alternative types it provides. When performing summations using Float64SD or similar types, information relating to stagnation is recorded in the Float64SD and can be read at any point. The slowdown over regular arithmetic is around 10×, due to increased compute cost and throughput, worse for larger problems like matrix multiplication, but is faster than other error analysis methods. All the FloatSD types behave like any other Julia Real type.

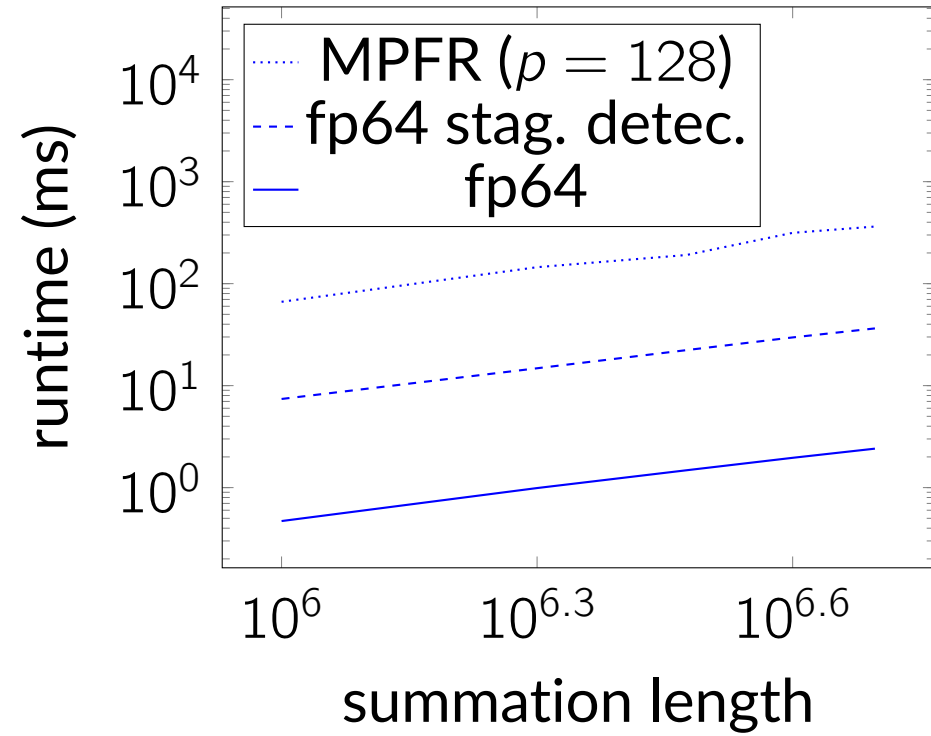
Implementation

Addition with stagnation detection:



Performance analysis

Double precision summation with stagnation detection outperforms arbitrary precision.



Conclusion

We have provided a lightweight tool that can detect loss of information due to floating-point rounding. It is easy to implement into already-written code. Stagnation detection can show where significant accumulation of rounding error is occurring. This can indicate to a user where they should apply a fix, such as stochastic rounding or an alternative summation algorithm.