Package ‘PreciseSums’

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Title Accurate Floating Point Sums and Products

Version 0.4

Description Most of the time floating point arithmetic does approximately the right thing. When adding sums or having products of numbers that greatly differ in magnitude, the floating point arithmetic may be incorrect. This package implements the Kahan (1965) sum <doi:10.1145/363707.363723>, Neumaier (1974) sum <doi:10.1002/zamm.19740540106>, pairwise-sum (adapted from 'NumPy', See Castaldo (2008) <doi:10.1137/070679946> for a discussion of accuracy), and arbitrary precision sum (adapted from the fsum in 'Python'; Shewchuk (1997) <http://www.cs.berkeley.edu/~jrs/papers/robustr.pdf>). In addition, products are changed to long double precision for accuracy, or changed into a log-sum for accuracy.

Depends R (>= 3.2)

License GPL (>= 2)

Encoding UTF-8

LazyData true

RoxygenNote 7.1.1

Suggests testthat

NeedsCompilation yes

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fsum

Return an accurate floating point sum of values

Description

This method avoids loss of precision by tracking multiple intermediate partial sums. Based on python’s math.fsum

Usage

fsum(numbers)

Arguments

numbers A vector of numbers to sum.

Value

Sum of numbers without loss of precision

The algorithm’s accuracy depends on IEEE-754 arithmetic guarantees and the typical case where the rounding mode is half-even. On some non-Windows builds, the underlying C library uses extended precision addition and may occasionally double-round an intermediate sum causing it to be off in its least significant bit.

Author(s)

Matthew Fidler (R implementation), Raymond Hettinger, Jonathan Shewchuk, Python Team

References

https://docs.python.org/2/library/math.html
https://code.activestate.com/recipes/393090/
https://github.com/python/cpython/blob/a0ce375e10b50f7606cb86b072fed7d8cd574fe7/Modules/mathmodule.c

**Examples**

```r
sum(c(1,1e100,1,-1e100)) ## Should be 2, gives 0
fsum(c(1,1e100,1,-1e100)) ## Gives 2.
```

---

**kahanSum**

*Using the Kahan method, take a more accurate sum*

**Description**

Using the Kahan method, take a more accurate sum

**Usage**

```r
kahanSum(numbers)
```

**Arguments**

- `numbers`: A vector of numbers to sum.

**Value**

Sum of numbers

**References**

https://en.wikipedia.org/wiki/Kahan_summation_algorithm

**Examples**

```r
sum(c(1,1e100,1,-1e100)) ## Should be 2, gives 0
kahanSum(c(1,1e100,1,-1e100)) ## Not accurate enough for the correct result. (still = 0)
```
neumaierSum  
*Using the Neumaier method, take a more accurate sum*

**Description**
Using the Neumaier method, take a more accurate sum

**Usage**
neumaierSum(numbers)

**Arguments**
numbers  
A vector of numbers to sum.

**Value**
Sum of numbers, a bit more accurate than kahanSum

**References**
https://en.wikipedia.org/wiki/Kahan_summation_algorithm

**Examples**
sum(c(1,1e100,1,-1e100))  
## Should be 2, gives 0
neumaierSum(c(1,1e100,1,-1e100))  
## Gives 2

---

pairwiseSum  
*Return an accurate floating point sum of values*

**Description**
This was taken by NumPy and adapted for use here. It is more accurate than a standard sum, but still has numerical issues. Its main benefit is that it is about the same amount of time as a standard time with the added accuracy.

**Usage**
pairwiseSum(numbers)

**Arguments**
numbers  
A vector of numbers to sum.
psProd

Value
A sum of numbers with a rounding error of O(lg n) instead of O(n).

Author(s)
Matthew Fidler (R implementation), Julian Taylor, Nathaniel J Smith, and NumPy team.  

Usage
psProd(numbers)

Arguments
numbers A vector of numbers to sum.

Value
Product of numbers

References
https://github.com/juliantaylor/numpy/blob/b0bc01275cac04483e6df021211c1fa2ba65eaa3/
numpy/core/src/umath/loops.c.src
https://github.com/numpy/numpy/pull/3685
psSetProd  
*Choose the type of product to use in PreciceSums. These are used in the PreciceSums prod blocks*

Description  
Choose the type of product to use in PreciceSums. These are used in the PreciceSums prod blocks.

Usage  
```r
psSetProd(type = c("long double", "double", "logify"))
```

Arguments  
- **type**: Product to use for `prod()` in PreciceSums blocks.
  - *long double*: converts to long double, performs the multiplication and then converts back.
  - *double*: uses the standard double scale for multiplication.

Value  
nothing

Author(s)  
Matthew L. Fidler

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psSetSum  
*Choose the type of sums to use for PreciceSums.*

Description  
Choose the types of sums to use in PreciceSums. These are used in the PreciceSums sum blocks and the `psSum` function.

Usage  
```r
psSetSum(type = c("pairwise", "fsum", "kahan", "neumaier", "klein", "c"))
```

Arguments  
- **type**: Sum type to use for `psSum` and `sum()` in PreciceSums code blocks.
  - *pairwise*: uses the pairwise sum (fast, default)
  - *fsum*: uses Python's `fsum` function (most accurate)
  - *kahan*: uses kahan correction
  - *neumaier*: uses Neumaier correction
  - *klein*: uses Klien correction
  - *c*: uses no correction, but default/native summing.
**psSum**

**Value**
nothing

**Author(s)**
Matthew L. Fidler

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**Description**
Using PreciceSums's default method, take a sum

**Usage**
psSum(numbers)

**Arguments**
numbers A vector of numbers to sum.

**Value**
Sum of numbers
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