Package 'dfsaneacc'

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Title Accelerated Derivative-Free Method for Large-Scale Nonlinear Systems of Equations

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Description Secant acceleration applied to derivative-free Spectral Residual Methods for solving large-scale nonlinear systems of equations. The main reference follows: E. G. Birgin and J. M. Martinez (2022) <doi:10.1137/20M1388024>.

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`dfsaneacc-package` *Accelerated Derivative-Free Method for Large-Scale Nonlinear Systems of Equations*

Description

Secant acceleration applied to derivative-free Spectral Residual Methods for solving large-scale nonlinear systems of equations. The main reference follows: E. G. Birgin and J. M. Martinez (2022) <doi:10.1137/20M1388024>.

Details

This package includes the function:

```
dfsaneacc function to solve large-scale nonlinear systems of
          equations using a derivative-free approach with sequential
          secant acceleration for spectral residual methods.
```

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References

J. Barzilai, and J. M. Borwein (1988), Two-point step size gradient methods, *IMA J Numerical Analysis*, 8, 141-148.

E. G. Birgin, J. M. Mart\'inez (2022), Secant acceleration of sequential residual methods for solving large-scale nonlinear systems of equations, *SIAM Journal on Numerical Analysis*, 60(6), 3145-3180.

W. LaCruz, and M. Raydan (2003), Nonmonotone spectral methods for large-scale nonlinear systems, *Optimization Methods and Software*, 18, 583-599.

W. LaCruz, J. M. Mart\'inez, and M. Raydan (2006), Spectral residual method without gradient information for solving large-scale nonlinear systems of equations, *Mathematics of Computation*, 75, 1429-1448.

M. Raydan (1997), Barzilai-Borwein gradient method for large-scale unconstrained minimization problem, *SIAM Journal on Optimization*, 7, 26-33.

`dfsaneacc` *Accelerated derivative-free spectral residual method for nonlinear systems of equations*

Description

Accelerated derivative-free algorithm to solve nonlinear systems of equations.

Usage

```
dfsaneacc(x, evalr, nhlim = 6, epsf = 1e-06, maxit = Inf, iprint = -1, ...)
```

Arguments

x	initial estimate for the solution of the nonlinear system.
evalr	a function that computes the nonlinear system evaluated at a given point as parameter and return the evaluated value. See details below.
nhlim	an integer that determines how many previous iterates must be considered in the sequential secant acceleration step. The default is 6.
epsf	a real value determining the absolute convergence tolerance. The default is 1.0e-6. See details below.
maxit	an integer determining the maximum number of iterations. The default is Inf.
iprint	the output level. The default is -1. See details below.
...	represents additional arguments that must be passed to evalr.

Details

The function dfsaneacc implements sequential residual methods (La Cruz and Raydan 2003; La Cruz, Mart\'inez, and Raydan 2006) with sequential secant acceleration approach proposed by Birgin and Mart\'inez (2022).

Convergence of the algorithm is declared when $\|F(x)\|_2^2 \leq \text{epsf}^2$. The default value for epsf is 1.0e-6.

The algorithm employ the function evalr to compute the value of the nonlinear system at a given point x. The function evalr must have the form evalr (x, ...).

The function has four output levels, based on the value of the input parameter iprint: iprint=-1 no output is generated, iprint=0 means basic information at every iteration, iprint=1 adds additional information related to the backtracking strategy, and iprint=2 adds information related to the computation of the acceleration step. Its default value is iprint=-1.

Value

A list with

x	the final estimate to the solution.
res	the final nonlinear system value.
normF	the final nonlinear system value squared L2-norm.
iter	the total number of iterations.
fcnt	the total number of functional evaluations.
istop	an integer indicating the convergence type. Possible values are 0 for successful convergence (squared L2-norm of the residual) and 1 for maximum number of iterations exceeded.

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References

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Examples

```
n <- 3
x0 <- rep(1/n^2, n)

expfun2 <- function(x) {
    n <- length(x)
    f <- rep(NA, n)
    f[1] <- exp(x[1]) - 1.0
    f[2:n] <- (2:n)/10.0 * (exp(x[2:n]) + x[1:n-1] - 1)
    f
}

ret <- dfsaneacc(x=x0, evalr=expfun2, nhlim=6, epsf=1.0e-6*sqrt(n),
iprint=0)
ret
```

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