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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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.

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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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