

**NAME**

CUTEst\_ushprod – CUTEst tool to form the matrix-vector product of a vector with the Hessian matrix.

**SYNOPSIS**

```
CALL CUTEst_ushprod( status, n, goth, X, nnz_vector, INDEX_nz_vector, VECTOR, nnz_result, INDEX_nz_result, RESULT )
```

For real rather than double precision arguments, instead

```
CALL CUTEst_ushprod_s( ... )
```

and for quadruple precision arguments, when available,

```
CALL CUTEst_ushprod_q( ... )
```

**DESCRIPTION**

The CUTEst\_ushprod subroutine forms the product of a sparse vector with the Hessian matrix of the objective function of the problem decoded from a SIF file by the script *sifdecoder* at the point X.

The problem under consideration is to minimize or maximize an objective function  $f(x)$  over all  $x \in R^n$  subject to the simple bounds  $x^l \leq x \leq x^u$ . The objective function is group-partially separable.

**ARGUMENTS**

The arguments of CUTEst\_ushprod are as follows

**status** [out] - integer

the output status: 0 for a successful call, 1 for an array allocation/deallocation error, 2 for an array bound error, 3 for an evaluation error,

**n** [in] - integer

the number of variables for the problem,

**goth** [in] - logical

a logical variable that specifies whether the first and second derivatives of the groups and elements have already been set (goth = .TRUE.) or if they should be computed (goth = .FALSE.),

**X** [in] - real/double precision

when goth = .FALSE., the derivatives will be evaluated at X. Otherwise X is not used.

**nnz\_vector** [in] - integer

the number of nonzeros in the vector whose product with the Hessian is required,

**INDEX\_nz\_vector** [in] - integer

an array that gives the indices of the nonzeros of the vector whose product with the Hessian is required,

**VECTOR** [in] - real/double precision

an array that gives the vector whose product with the Hessian is required; only the nonzeros need be specified,

**nnz\_result** [out] - integer

the number of nonzeros in the result obtained by multiplying the Hessian by VECTOR,

**INDEX\_nz\_result** [out] - integer

an array that gives the indices of the nonzeros in the result obtained by multiplying the Hessian by VECTOR,

**RESULT** [out] - real/double precision

an array that gives the result of multiplying the Hessian by VECTOR; only the nonzeros will be set.

## NOTE

goth should be set to .TRUE. whenever

(1)

a call has been made to CUTEST\_udh, CUTEST\_ush, CUTEST\_ugrdh or CUTEST\_ugrsh at the current point, or

(2)

a previous call to CUTEST\_uhprod or CUTEST\_ushprod, with goth = .FALSE., at the current point has been made.

Otherwise, it should be set .FALSE.

## AUTHORS

I. Bongartz, A.R. Conn, N.I.M. Gould, D. Orban and Ph.L. Toint

## SEE ALSO

*CUTEst: a Constrained and Unconstrained Testing Environment with safe threads*,  
N.I.M. Gould, D. Orban and Ph.L. Toint,  
Computational Optimization and Applications **60**:3, pp.545-557, 2014.

*CUTEr (and SifDec): A Constrained and Unconstrained Testing Environment, revisited*,  
N.I.M. Gould, D. Orban and Ph.L. Toint,  
ACM TOMS, **29**:4, pp.373-394, 2003.

*CUTE: Constrained and Unconstrained Testing Environment*,  
I. Bongartz, A.R. Conn, N.I.M. Gould and Ph.L. Toint,  
ACM TOMS, **21**:1, pp.123-160, 1995.

cutest\_uhprod(3M), cutest\_cshprod(3M), sifdecoder(1).