

## NAG Library Function Document

### nag\_2d\_spline\_ts\_eval\_rect (e02jfc)

#### 1 Purpose

nag\_2d\_spline\_ts\_eval\_rect (e02jfc) calculates a mesh of values of a spline computed by nag\_2d\_spline\_fit\_ts\_scatter (e02jdc).

#### 2 Specification

```
#include <nag.h>
#include <nage02.h>

void nag_2d_spline_ts_eval_rect (Integer nxeval, Integer nyeval,
    const double xevalm[], const double yevalm[], const double coefs[],
    double fevalm[], const Integer iopts[], const double opts[],
    NagError *fail)
```

#### 3 Description

nag\_2d\_spline\_ts\_eval\_rect (e02jfc) calculates values on a rectangular mesh of a bivariate spline computed by nag\_2d\_spline\_fit\_ts\_scatter (e02jdc). The points in the mesh are defined by  $x$  coordinates ( $x_i$ ), for  $i = 1, 2, \dots, n_x$ , and  $y$  coordinates ( $y_j$ ), for  $j = 1, 2, \dots, n_y$ . This function is derived from the TSFIT package of O. Davydov and F. Zeilfelder.

#### 4 References

Davydov O and Zeilfelder F (2004) Scattered data fitting by direct extension of local polynomials to bivariate splines *Advances in Comp. Math.* **21** 223–271

Farin G and Hansford D (2000) *The Essentials of CAGD* Natic, MA: A K Peters, Ltd.

#### 5 Arguments

- 1: **nxeval** – Integer *Input*  
*On entry:*  $n_x$ , the number of values in the  $x$  direction forming the mesh on which the spline is to be evaluated.  
*Constraint:* **nxeval**  $\geq 1$ .
- 2: **nyeval** – Integer *Input*  
*On entry:*  $n_y$ , the number of values in the  $y$  direction forming the mesh on which the spline is to be evaluated.  
*Constraint:* **nyeval**  $\geq 1$ .
- 3: **xevalm**[**nxeval**] – const double *Input*  
*On entry:* the ( $x_i$ ) values forming the mesh on which the spline is to be evaluated.  
*Constraint:* for all  $i$ , **xevalm**[ $i - 1$ ] must lie inside, or on the boundary of, the spline's bounding box as determined by nag\_2d\_spline\_fit\_ts\_scatter (e02jdc).

- 4: **yevalm**[nyeval] – const double *Input*  
*On entry:* the  $(y_j)$  values forming the mesh on which the spline is to be evaluated.  
*Constraint:* for all  $j$ , **yevalm**[ $j - 1$ ] must lie inside, or on the boundary of, the spline's bounding box as determined by nag\_2d\_spline\_fit\_ts\_scatter (e02jdc).
- 5: **coefs**[dim] – const double *Communication Array*  
**Note:** the dimension,  $dim$ , of this array is dictated by the requirements of associated functions that must have been previously called. This array MUST be the same array passed as argument **coefs** in the previous call to nag\_2d\_spline\_fit\_ts\_scatter (e02jdc).  
*On entry:* the computed spline coefficients as output from nag\_2d\_spline\_fit\_ts\_scatter (e02jdc).
- 6: **fevalm**[nxeval  $\times$  nyeval] – double *Output*  
**Note:** the  $(i, j)$ th element of the matrix is stored in **fevalm**[( $j - 1$ )  $\times$  nxeval +  $i - 1$ ].  
*On exit:* if **fail.code** = NE\_NOERROR on exit **fevalm**[( $j - 1$ )  $\times$  nxeval +  $i - 1$ ] contains the computed spline value at  $(x_i, y_j)$ .
- 7: **iopts**[dim] – const Integer *Communication Array*  
**Note:** the dimension,  $dim$ , of this array is dictated by the requirements of associated functions that must have been previously called. This array MUST be the same array passed as argument **iopts** in the previous call to nag\_fit\_opt\_set (e02zkc).  
*On entry:* the contents of the array MUST NOT have been modified either directly or indirectly, by a call to nag\_fit\_opt\_set (e02zkc), between calls to nag\_2d\_spline\_fit\_ts\_scatter (e02jdc) and nag\_2d\_spline\_ts\_eval\_rect (e02jfc).
- 8: **opts**[dim] – const double *Communication Array*  
**Note:** the dimension,  $dim$ , of this array is dictated by the requirements of associated functions that must have been previously called. This array MUST be the same array passed as argument **opts** in the previous call to nag\_fit\_opt\_set (e02zkc).  
*On entry:* the contents of the array MUST NOT have been modified either directly or indirectly, by a call to nag\_fit\_opt\_set (e02zkc), between calls to nag\_2d\_spline\_fit\_ts\_scatter (e02jdc) and nag\_2d\_spline\_ts\_eval\_rect (e02jfc).
- 9: **fail** – NagError \* *Input/Output*  
The NAG error argument (see Section 3.6 in the Essential Introduction).

## 6 Error Indicators and Warnings

### NE\_ALLOC\_FAIL

Dynamic memory allocation failed.

### NE\_BAD\_PARAM

On entry, argument  $\langle value \rangle$  had an illegal value.

### NE\_INITIALIZATION

Option arrays are not initialized or are corrupted.

### NE\_INT

On entry, **nxeval** =  $\langle value \rangle$ .

Constraint: **nxeval**  $\geq 1$ .

On entry, **nyeval** =  $\langle value \rangle$ .  
Constraint: **nyeval**  $\geq 1$ .

### NE\_INTERNAL\_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please contact NAG for assistance.

### NE\_INVALID\_SPLINE

The fitting routine has not been called, or the array of coefficients has been corrupted.

### NE\_POINT\_OUTSIDE\_RECT

On entry, **xevalm**[ $\langle value \rangle$ ] =  $\langle value \rangle$  was outside the bounding box.  
Constraint:  $\langle value \rangle \leq \mathbf{xevalm}[i - 1] \leq \langle value \rangle$  for all  $i$ .

On entry, **yevalm**[ $\langle value \rangle$ ] =  $\langle value \rangle$  was outside the bounding box.  
Constraint:  $\langle value \rangle \leq \mathbf{yevalm}[j - 1] \leq \langle value \rangle$  for all  $j$ .

## 7 Accuracy

`nag_2d_spline_ts_eval_rect` (e02jfc) uses the de Casteljaou algorithm and thus is numerically stable. See Farin and Hansford (2000) for details.

## 8 Parallelism and Performance

`nag_2d_spline_ts_eval_rect` (e02jfc) is threaded by NAG for parallel execution in multithreaded implementations of the NAG Library.

Please consult the Users' Note for your implementation for any additional implementation-specific information.

## 9 Further Comments

A real array of length  $O(1)$  is dynamically allocated by each invocation of `nag_2d_spline_ts_eval_rect` (e02jfc).

## 10 Example

See Section 10 in `nag_2d_spline_fit_ts_scatter` (e02jdc).

---