

# NAG Library Function Document

## nag\_3d\_shep\_eval (e01thc)

### 1 Purpose

nag\_3d\_shep\_eval (e01thc) evaluates the three-dimensional interpolating function generated by nag\_3d\_shep\_interp (e01tgc) and its first partial derivatives.

### 2 Specification

```
#include <nag.h>
#include <nage01.h>

void nag_3d_shep_eval (Integer m, const double x[], const double y[],
    const double z[], const double f[], const Integer iq[],
    const double rq[], Integer n, const double u[], const double v[],
    const double w[], double q[], double qx[], double qy[], double qz[],
    NagError *fail)
```

### 3 Description

nag\_3d\_shep\_eval (e01thc) takes as input the interpolant  $Q(x, y, z)$  of a set of scattered data points  $(x_r, y_r, z_r, f_r)$ , for  $r = 1, 2, \dots, m$ , as computed by nag\_3d\_shep\_interp (e01tgc), and evaluates the interpolant and its first partial derivatives at the set of points  $(u_i, v_i, w_i)$ , for  $i = 1, 2, \dots, n$ .

nag\_3d\_shep\_eval (e01thc) must only be called after a call to nag\_3d\_shep\_interp (e01tgc).

This function is derived from the function QS3GRD described by Renka (1988).

### 4 References

Renka R J (1988) Algorithm 661: QSHEP3D: Quadratic Shepard method for trivariate interpolation of scattered data *ACM Trans. Math. Software* **14** 151–152

### 5 Arguments

- |    |                            |              |
|----|----------------------------|--------------|
| 1: | <b>m</b> – Integer         | <i>Input</i> |
| 2: | <b>x[m]</b> – const double | <i>Input</i> |
| 3: | <b>y[m]</b> – const double | <i>Input</i> |
| 4: | <b>z[m]</b> – const double | <i>Input</i> |
| 5: | <b>f[m]</b> – const double | <i>Input</i> |

*On entry:* **m**, **x**, **y**, **z** and **f** must be the same values as were supplied in the preceding call to nag\_3d\_shep\_interp (e01tgc).

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|----|--|--------------|
| 6: | <b>iq</b> [(2 × <b>m</b> + 1)] – const Integer | <i>Input</i> |
|----|--|--------------|

*On entry:* must be unchanged from the value returned from a previous call to nag\_3d\_shep\_interp (e01tgc).

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|----|--|--------------|
| 7: | <b>rq</b> [(10 × <b>m</b> + 7)] – const double | <i>Input</i> |
|----|--|--------------|

*On entry:* must be unchanged from the value returned from a previous call to nag\_3d\_shep\_interp (e01tgc).

- 8: **n** – Integer *Input*  
*On entry:*  $n$ , the number of evaluation points.  
*Constraint:*  $n \geq 1$ .
- 9: **u[n]** – const double *Input*  
10: **v[n]** – const double *Input*  
11: **w[n]** – const double *Input*  
*On entry:* **u**[ $i-1$ ], **v**[ $i-1$ ], **w**[ $i-1$ ] must be set to the evaluation point  $(u_i, v_i, w_i)$ , for  $i = 1, 2, \dots, n$ .
- 12: **q[n]** – double *Output*  
*On exit:* **q**[ $i-1$ ] contains the value of the interpolant, at  $(u_i, v_i, w_i)$ , for  $i = 1, 2, \dots, n$ . If any of these evaluation points lie outside the region of definition of the interpolant the corresponding entries in **q** are set to the largest machine representable number (see `nag_real_largest_number` (X02ALC)), and `nag_3d_shep_eval` (e01thc) returns with **fail.code** = NE\_BAD\_POINT.
- 13: **qx[n]** – double *Output*  
14: **qy[n]** – double *Output*  
15: **qz[n]** – double *Output*  
*On exit:* **qx**[ $i-1$ ], **qy**[ $i-1$ ], **qz**[ $i-1$ ] contains the value of the partial derivatives of the interpolant  $Q(x, y, z)$  at  $(u_i, v_i, w_i)$ , for  $i = 1, 2, \dots, n$ . If any of these evaluation points lie outside the region of definition of the interpolant, the corresponding entries in **qx**, **qy** and **qz** are set to the largest machine representable number (see `nag_real_largest_number` (X02ALC)), and `nag_3d_shep_eval` (e01thc) returns with **fail.code** = NE\_BAD\_POINT.
- 16: **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.  
See Section 3.2.1.2 in the Essential Introduction for further information.

### NE\_BAD\_PARAM

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

### NE\_BAD\_POINT

On entry, at least one evaluation point lies outside the region of definition of the interpolant. At all such points the corresponding values in **q**, **qx**, **qy** and **qz** have been set to `nag_real_largest_number`: `nag_real_largest_number` =  $\langle value \rangle$ .

### NE\_INT

On entry, **m** =  $\langle value \rangle$ .  
Constraint:  $m \geq 10$ .  
On entry, **n** =  $\langle value \rangle$ .  
Constraint:  $n \geq 1$ .

### NE\_INT\_ARRAY

On entry, values in **iq** appear to be invalid. Check that **iq** has not been corrupted between calls to `nag_3d_shep_interp` (e01tgc) and `nag_3d_shep_eval` (e01thc).

**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.

An unexpected error has been triggered by this function. Please contact NAG.  
See Section 3.6.6 in the Essential Introduction for further information.

**NE\_NO\_LICENCE**

Your licence key may have expired or may not have been installed correctly.  
See Section 3.6.5 in the Essential Introduction for further information.

**NE\_REAL\_ARRAY**

On entry, values in **rq** appear to be invalid. Check that **rq** has not been corrupted between calls to `nag_3d_shep_interp` (e01tgc) and `nag_3d_shep_eval` (e01thc).

**7 Accuracy**

Computational errors should be negligible in most practical situations.

**8 Parallelism and Performance**

`nag_3d_shep_eval` (e01thc) is threaded by NAG for parallel execution in multithreaded implementations of the NAG Library.

Please consult the X06 Chapter Introduction for information on how to control and interrogate the OpenMP environment used within this function. Please also consult the Users' Note for your implementation for any additional implementation-specific information.

**9 Further Comments**

The time taken for a call to `nag_3d_shep_eval` (e01thc) will depend in general on the distribution of the data points. If **x**, **y** and **z** are approximately uniformly distributed, then the time taken should be only  $O(n)$ . At worst  $O(mn)$  time will be required.

**10 Example**

See Section 10 in `nag_3d_shep_interp` (e01tgc).

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