NAG Toolbox

nag_interp_3d_scat_shep_eval (e01th)

1 Purpose

nag_interp_3d_scat_shep_eval (e01th) evaluates the three-dimensional interpolating function generated by nag_interp_3d_scat_shep (e01tg) and its first partial derivatives.

2 Syntax

```
[q, qx, qy, qz, ifail] = nag_interp_3d_scat_shep_eval(x, y, z, f, iq, rq, u, v, w, 'm', m, 'n', n)
[q, qx, qy, qz, ifail] = e01th(x, y, z, f, iq, rq, u, v, w, 'm', m, 'n', n)
```

3 Description

nag_interp_3d_scat_shep_eval (e01th) 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 $r = 1, 2, \ldots, m$, as computed by nag_interp_3d_scat_shep (e01tg), and evaluates the interpolant and its first partial derivatives at the set of points (u_i, v_i, w_i), for $i = 1, 2, \ldots, n$.

nag_interp_3d_scat_shep_eval (e01th) must only be called after a call to nag_interp_3d_scat_shep (e01tg).

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 Parameters

5.1 Compulsory Input Parameters

1: **x**(**m**) – REAL (KIND=nag_wp) array
2: **y**(**m**) – REAL (KIND=nag_wp) array
3: **z**(**m**) – REAL (KIND=nag_wp) array
4: **f**(**m**) – REAL (KIND=nag_wp) array

m, **x**, **y**, **z** and **f** must be the same values as were supplied in the preceding call to nag_interp_3d_scat_shep (e01tg).

5: **iq**(liq) – INTEGER array

liq, the dimension of the array, must satisfy the constraint $liq \geq 2 \times \mathbf{m} + 1$.

Must be unchanged from the value returned from a previous call to nag_interp_3d_scat_shep (e01tg).

6: **rq**(lrq) – REAL (KIND=nag_wp) array

lrq, the dimension of the array, must satisfy the constraint $lrq \geq 10 \times \mathbf{m} + 7$.

Must be unchanged from the value returned from a previous call to nag_interp_3d_scat_shep (e01tg).

7: **u**(**n**) – REAL (KIND=nag_wp) array
8: **v**(**n**) – REAL (KIND=nag_wp) array
9: **w**(**n**) – REAL (KIND=nag_wp) array

u(i), **v**(i), **w**(i) must be set to the evaluation point (u_i, v_i, w_i), for $i = 1, 2, \ldots, n$.

5.2 Optional Input Parameters

1: **m** – INTEGER

Default: the dimension of the arrays **x**, **y**, **z**, **f**. (An error is raised if these dimensions are not equal.)

m, **x**, **y**, **z** and **f** must be the same values as were supplied in the preceding call to nag_interp_3d_scat_shep (e01tg).

2: **n** – INTEGER

Default: the dimension of the arrays **u**, **v**, **w**. (An error is raised if these dimensions are not equal.)

n, the number of evaluation points.

Constraint: **n** ≥ 1.

5.3 Output Parameters

1: **q**(**n**) – REAL (KIND=nag_wp) array

q(i) contains the value of the interpolant, at (u_i, v_i, w_i), for $i = 1, 2, \ldots, n$. 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_machine_real_largest (x02al)), and nag_interp_3d_scat_shep_eval (e01th) returns with **ifail** $= 3$.

2: **qx**(**n**) – REAL (KIND=nag_wp) array
3: **qy**(**n**) – REAL (KIND=nag_wp) array
4: **qz**(**n**) – REAL (KIND=nag_wp) array

qx(i), **qy**(i), **qz**(i) contains the value of the partial derivatives of the interpolant $Q(x, y, z)$ at (u_i, v_i, w_i), for $i = 1, 2, \ldots, n$. 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_machine_real_largest (x02al)), and nag_interp_3d_scat_shep_eval (e01th) returns with **ifail** $= 3$.

5: **ifail** – INTEGER

ifail $= 0$ unless the function detects an error (see Section 5).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail $= 1$

On entry, **m** < 10,
or $liq < 2 \times \mathbf{m} + 1$,
or $lrq < 10 \times \mathbf{m} + 7$,
or **n** < 1.

ifail $= 2$

Values supplied in **iq** or **rq** appear to be invalid. Check that these arrays have not been corrupted between the calls to nag_interp_3d_scat_shep (e01tg) and nag_interp_3d_scat_shep_eval (e01th).

ifail $= 3$ (*warning*)

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 the largest machine representable number (see nag_machine_real_largest (x02al)).

ifail $= -99$

An unexpected error has been triggered by this routine. Please contact NAG.

ifail $= -399$

Your licence key may have expired or may not have been installed correctly.

ifail $= -999$

Dynamic memory allocation failed.

7 Accuracy

Computational errors should be negligible in most practical situations.

8 Further Comments

The time taken for a call to nag_interp_3d_scat_shep_eval (e01th) 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 $O(\mathbf{n})$. At worst $O(\mathbf{mn})$ time will be required.

9 Example

See Section 10 in nag_interp_3d_scat_shep (e01tg).

9.1 Program Text

```
function e01th_example

fprintf('e01th example results\n\n');

data = [ 0.80  0.23  0.37  0.51;
         0.23  0.88  0.05  1.80;
         0.18  0.43  0.04  0.11;
         0.58  0.95  0.62  2.65;
         0.64  0.69  0.20  0.93;
         0.88  0.35  0.49  0.72;
         0.30  0.10  0.78 -0.11;
         0.87  0.09  0.05  0.67;
         0.04  0.02  0.40  0.00;
         0.62  0.90  0.43  2.20;
         0.87  0.96  0.24  3.17;
         0.62  0.64  0.45  0.74;
         0.86  0.13  0.47  0.64;
         0.87  0.60  0.46  1.07;
         0.49  0.43  0.13  0.22;
         0.12  0.61  0.00  0.41;
         0.02  0.71  0.82  0.58;
         0.62  0.93  0.44  2.48;
         0.49  0.54  0.04  0.37;
         0.36  0.56  0.39  0.35;
         0.62  0.42  0.97 -0.20;
         0.01  0.72  0.45  0.78;
         0.41  0.36  0.52  0.11;
         0.17  0.99  0.65  2.82;
         0.51  0.29  0.59  0.14;
         0.85  0.05  0.04  0.61;
         0.20  0.20  0.87 -0.25;
```

```
         0.04  0.67  0.04  0.59;
         0.31  0.63  0.18  0.50;
         0.88  0.27  0.07  0.71];

x = data(:,1); y = data(:,2); z = data(:,3); f = data(:,4);
nw = nag_int(0);
nq = nw;
[iq, rq, ifail] = e01tg( ...
                         x, y, z, f, nw, nq);

% Evaluate at equispaced points on diagonal line
px = [0.1:0.1:0.6]'; py = px; pz = px;

[q, qx, qy, qz, ifail] = e01th( ...
                                x, y, z, f, iq, rq, px, py, pz);

fprintf('  Evaluation point       Q(x,y,z)\n');
fprintf(' (%4.1f, %4.1f, %4.1f)    %8.4f\n',[px py pz q]');
```

9.2 Program Results

```
     e01th example results

  Evaluation point       Q(x,y,z)
 ( 0.1,  0.1,  0.1)      0.2630
 ( 0.2,  0.2,  0.2)      0.1182
 ( 0.3,  0.3,  0.3)      0.0811
 ( 0.4,  0.4,  0.4)      0.1552
 ( 0.5,  0.5,  0.5)      0.3019
 ( 0.6,  0.6,  0.6)      0.5712
```