NAG Toolbox for MATLAB

e01th

1 Purpose

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

2 Syntax

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

3 Description

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 e01tg, and evaluates the interpolant and its first partial derivatives at the set of points (u_i,v_i,w_i), for $i = 1,2,\ldots,n$.

e01th must only be called after a call to e01tg.

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

4 References

Renka R J 1988b 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**) – **double array**

2: **y**(**m**) – **double array**

3: **z**(**m**) – **double array**

4: **f**(**m**) – **double array**

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

5: **iq**(**liq**) – **int32 array**

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

6: **rq**(**lrq**) – **double array**

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

7: **u**(**n**) – **double array**

8: **v**(**n**) – **double array**

9: **w**(**n**) – **double 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 – int32 scalar**

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 e01tg.

2: **n – int32 scalar**

Default: The dimension of the arrays **u**, **v**, **q**, **qx**, **qy**, **qz**. (An error is raised if these dimensions are not equal.)

n, the number of evaluation points.

Constraint: $\mathbf{n} \geq 1$.

5.3 Input Parameters Omitted from the MATLAB Interface

liq, lrq

5.4 Output Parameters

1: **q(n) – double array**

$\mathbf{q}(i)$ 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 x02al), and e01th returns with **ifail** $= 3$.

2: **qx(n) – double array**

3: **qy(n) – double array**

4: **qz(n) – double array**

$\mathbf{qx}(i)$, $\mathbf{qy}(i)$, $\mathbf{qz}(i)$ 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 x02al), and e01th returns with **ifail** $= 3$.

5: **ifail – int32 scalar**

0 unless the function detects an error (see Section 6).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail $= 1$

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

ifail $= 2$

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

ifail $= 3$

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 x02al).

7 Accuracy

Computational errors should be negligible in most practical situations.

8 Further Comments

The time taken for a call to 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

```
nw = int32(0);
nq = int32(0);
x = [0.8;
     0.23;
     0.18;
     0.58;
     0.64;
     0.88;
     0.3;
     0.87;
     0.04;
     0.62;
     0.87;
     0.62;
     0.86;
     0.87;
     0.49;
     0.12;
     0.02;
     0.62;
     0.49;
     0.36;
     0.62;
     0.01;
     0.41;
     0.17;
     0.51;
     0.85;
     0.2;
     0.04;
     0.31;
     0.88];
y = [0.23;
     0.88;
     0.43;
     0.95;
     0.69;
     0.35;
     0.1;
     0.09;
     0.02;
     0.9;
     0.96;
     0.64;
     0.13;
     0.6;
     0.43;
     0.61;
     0.71;
     0.93;
     0.54;
     0.56;
     0.42;
```

```
     0.72;
     0.36;
     0.99;
     0.29;
     0.05;
     0.2;
     0.67;
     0.63;
     0.27];
z = [0.37;
     0.05;
     0.04;
     0.62;
     0.2;
     0.49;
     0.78;
     0.05;
     0.4;
     0.43;
     0.24;
     0.45;
     0.47;
     0.46;
     0.13;
     0;
     0.82;
     0.44;
     0.04;
     0.39;
     0.97;
     0.45;
     0.52;
     0.65;
     0.59;
     0.04;
     0.87;
     0.04;
     0.18;
     0.07];
f = [0.51;
     1.8;
     0.11;
     2.65;
     0.93;
     0.72;
     -0.11;
     0.67;
     0;
     2.2;
     3.17;
     0.74;
     0.64;
     1.07;
     0.22;
     0.41;
     0.58;
     2.48;
     0.37;
     0.35;
     -0.2;
     0.78;
     0.11;
     2.82;
     0.14;
     0.61;
     -0.25;
     0.59;
     0.5;
     0.71];
u = [0.1;
```

```
     0.2;
     0.3;
     0.4;
     0.5;
     0.6];
v = [0.1;
     0.2;
     0.3;
     0.4;
     0.5;
     0.6];
w = [0.1;
     0.2;
     0.3;
     0.4;
     0.5;
     0.6];
[iq, rq, ifail] = e01tg(x, y, z, f, nw, nq);
[q, qx, qy, qz, ifail] = e01th(x, y, z, f, iq, rq, u, v, w)
```

```
q =
    0.2630
    0.1182
    0.0811
    0.1552
    0.3019
    0.5712
qx =
    0.6461
    0.5704
    0.4660
    0.6000
    0.5951
    1.1069
qy =
   -0.8302
   -0.7920
   -0.0879
    0.6071
    1.2569
    2.9164
qz =
   -1.7062
   -0.7648
   -0.1490
    0.0258
   -0.1253
   -0.2232
ifail =
           0
```