

## NAG C Library Function Document

### **nag\_pde\_interp\_1d\_fd (d03pzc)**

#### 1 Purpose

nag\_pde\_interp\_1d\_fd (d03pzc) interpolates in the spatial co-ordinate the solution and derivative of a system of partial differential equations (PDEs). The solution must first be computed using one of the finite difference schemes nag\_pde\_parab\_1d\_fd (d03pcc), nag\_pde\_parab\_1d\_fd\_ode (d03phc) or nag\_pde\_parab\_1d\_fd\_ode\_remesh (d03ppc), or one of the Keller box schemes nag\_pde\_parab\_1d\_keller (d03pec), nag\_pde\_parab\_1d\_keller\_ode (d03pkc) or nag\_pde\_parab\_1d\_keller\_ode\_remesh (d03prc).

#### 2 Specification

```
void nag_pde_interp_1d_fd (Integer npde, Integer m, const double u[],  
    Integer npts, const double x[], const double xp[], Integer intpts, Integer itype,  
    double up[], NagError *fail)
```

#### 3 Description

nag\_pde\_interp\_1d\_fd (d03pzc) is an interpolation function for evaluating the solution of a system of partial differential equations (PDEs), at a set of user-specified points. The solution of the system of equations (possibly with coupled ordinary differential equations) must be computed using a finite difference scheme or a Keller box scheme on a set of mesh points. nag\_pde\_interp\_1d\_fd (d03pzc) can then be employed to compute the solution at a set of points anywhere in the range of the mesh. It can also evaluate the first spatial derivative of the solution. It uses linear interpolation for approximating the solution.

#### 4 References

None.

#### 5 Parameters

**Note:** the parameters **x**, **m**, **u**, **npts** and **npde** must be supplied unchanged from the PDE function.

1: **npde** – Integer *Input*

*On entry:* the number of PDEs.

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

2: **m** – Integer *Input*

*On entry:* the co-ordinate system used. If the call to nag\_pde\_interp\_1d\_fd (d03pzc) follows one of the finite difference functions then **m** must be the same parameter **m** as used in that call. For the Keller box scheme only Cartesian co-ordinate systems are valid and so **m** **must** be set to zero. No check will be made by nag\_pde\_interp\_1d\_fd (d03pzc) in this case.

**m** = 0

Indicates Cartesian co-ordinates.

**m** = 1

Indicates cylindrical polar co-ordinates.

**m** = 2

Indicates spherical polar co-ordinates.

*Constraints:*

$0 \leq \mathbf{m} \leq 2$  following a finite difference function;  
 $\mathbf{m} = 0$  following a Keller box scheme function.

3: **u**[**npde** × **npts**] – const double *Input*

**Note:** where  $\mathbf{U}(i, j)$  appears in this document it refers to the array element  $\mathbf{u}[\mathbf{npde} \times (j - 1) + i - 1]$ . We recommend using a #define to make the same definition in your calling program.

*On entry:* the PDE part of the original solution returned in the parameter **u** by the PDE function.

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

4: **npts** – Integer *Input*

*On entry:* the number of mesh points.

*Constraint:* **npts**  $\geq 3$ .

5: **x**[**npts**] – const double *Input*

*On entry:*  $\mathbf{x}[i - 1]$ , for  $i = 1, 2, \dots, \mathbf{npts}$ , must contain the mesh points as used by the PDE function.

6: **xp**[**intpts**] – const double *Input*

*On entry:*  $\mathbf{xp}[i - 1]$ , for  $i = 1, 2, \dots, \mathbf{intpts}$ , must contain the spatial interpolation points.

*Constraint:*  $\mathbf{x}[0] \leq \mathbf{xp}[0] < \mathbf{xp}[1] < \dots < \mathbf{xp}[\mathbf{intpts} - 1] \leq \mathbf{x}[\mathbf{npts} - 1]$ .

7: **intpts** – Integer *Input*

*On entry:* the number of interpolation points.

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

8: **itype** – Integer *Input*

*On entry:* specifies the interpolation to be performed.

If **itype** = 1, the solutions at the interpolation points are computed. If **itype** = 2, both the solutions and their first derivatives at the interpolation points are computed.

*Constraint:* **itype** = 1 or 2.

9: **up**[**npde** × **intpts** × **itype**] – double *Output*

**Note:** where  $\mathbf{UP}(i, j, k)$  appears in this document it refers to the array element  $\mathbf{up}[\mathbf{npde} \times (\mathbf{intpts} \times (k - 1) + j - 1) + i - 1]$ . We recommend using a #define to make the same definition in your calling program.

*On exit:* if **itype** = 1,  $\mathbf{UP}(i, j, 1)$ , contains the value of the solution  $U_i(x_j, t_{\text{out}})$ , at the interpolation points  $x_j = \mathbf{xp}[j - 1]$ , for  $j = 1, 2, \dots, \mathbf{intpts}$ ;  $i = 1, 2, \dots, \mathbf{npde}$ .

If **itype** = 2,  $\mathbf{UP}(i, j, 1)$  contains  $U_i(x_j, t_{\text{out}})$  and  $\mathbf{UP}(i, j, 2)$  contains  $\frac{\partial U_i}{\partial x}$  at these points.

10: **fail** – NagError \* *Input/Output*

The NAG error parameter (see the Essential Introduction).

## 6 Error Indicators and Warnings

### NE\_INT

On entry, **itype** is not equal to 1 or 2: **itype** =  $\langle \text{value} \rangle$ .

On entry, **m** is not equal to 0, 1, or 2: **m** =  $\langle value \rangle$ .

On entry, **intpts**  $\leq 0$ : **intpts** =  $\langle value \rangle$ .

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

Constraint: **npts**  $> 2$ .

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

Constraint: **npde**  $> 0$ .

### NE\_EXTRAPOLATION

On entry, interpolating point  $\langle value \rangle$  with the value  $\langle value \rangle$  is outside the **x** range.

### NE\_NOT\_STRICTLY\_INCREASING

On entry, interpolation points **xp** badly ordered:  $i = \langle value \rangle$ ,  $\mathbf{xp}[i - 1] = \langle value \rangle$   $j = \langle value \rangle$ ,  $\mathbf{xp}[j - 1] = \langle value \rangle$ .

On entry, mesh points **x** badly ordered:  $i = \langle value \rangle$ ,  $\mathbf{x}[i - 1] = \langle value \rangle$   $j = \langle value \rangle$ ,  $\mathbf{x}[j - 1] = \langle value \rangle$ .

### NE\_BAD\_PARAM

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

### 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 consult NAG for assistance.

## 7 Accuracy

See the PDE function documents.

## 8 Further Comments

None.

## 9 Example

See Section 9 of the documents for `nag_pde_parab_1d_fd` (d03pcc), `nag_pde_parab_1d_fd_ode_remesh` (d03ppc) and `nag_pde_parab_1d_keller_ode_remesh` (d03prc).