D03PZF – NAG Fortran Library Routine Document

Note. Before using this routine, please read the Users' Note for your implementation to check the interpretation of bold italicised terms and other implementation-dependent details.

1 Purpose

This routine 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 scheme routines D03PCF, D03PHF or D03PPF, or one of the Keller box scheme routines D03PEF, D03PKF or D03PRF.

2 Specification

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SUBROUTINE D03PZF(NPDE, M, U, NPTS, X, XP, INTPTS, ITYPE, UP, IFAIL)
INTEGER           NPDE, M, NPTS, INTPTS, ITYPE, IFAIL
real              U(NPDE,NPTS), X(NPTS), XP(INTPTS),
1                 UP(NPDE,INTPTS,ITYPE)
```

3 Description

D03PZF is an interpolation routine 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 routine or a Keller box scheme routine on a set of mesh points. D03PZF 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. The routine 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 routine.

1: NPDE — INTEGER *Input*

On entry: the number of PDEs.

Constraint: NPDE ≥ 1.

2: M — INTEGER *Input*

On entry: the co-ordinate system used. If the call to D03PZF follows one of the finite difference routines then M must be the same parameter M as used by the finite difference routines. For the Keller box scheme routines only Cartesian co-ordinate systems are valid and so M **must** be set to zero. No check will be made by D03PZF in this case.

M = 0
: indicates Cartesian co-ordinates

M = 1
: indicates cylindrical polar co-ordinates

M = 2
: indicates spherical polar co-ordinates

Constraints:

$0 \leq \mathrm{M} \leq 2$ following a finite difference routine.
$\mathrm{M} = 0$ following a Keller box scheme routine.

3: U(NPDE,NPTS) — ***real*** array *Input*

On entry: the PDE part of the original solution returned in the parameter U by the PDE routine.

Constraint: NPDE ≥ 1.

4: NPTS — INTEGER *Input*

On entry: the number of mesh points.

Constraint: NPTS ≥ 3.

5: X(NPTS) — ***real*** array *Input*

On entry: X(i), for $i = 1, 2, \ldots,$ NPTS, must contain the mesh points as used by the PDE routine.

6: XP(INTPTS) — ***real*** array *Input*

On entry: XP(i), for $i = 1, 2, \ldots,$ INTPTS, must contain the spatial interpolation points.

Constraint: $\mathrm{X}(1) \leq \mathrm{XP}(1) < \mathrm{XP}(2) < \ldots < \mathrm{XP}(\mathrm{INTPTS}) \leq \mathrm{X}(\mathrm{NPTS})$.

7: INTPTS — INTEGER *Input*

On entry: the number of interpolation points.

Constraint: INTPTS ≥ 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) — ***real*** array *Output*

On exit: if ITYPE = 1, UP($i, j, 1$), contains the value of the solution $U_i(x_j, t_{out})$, at the interpolation points $x_j = \mathrm{XP}(j)$, for $j = 1, 2, \ldots,$ INTPTS; $i = 1, 2, \ldots,$ NPDE.

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

10: IFAIL — INTEGER *Input/Output*

On entry: IFAIL must be set to 0, -1 or 1. For users not familiar with this parameter (described in Chapter P01) the recommended value is 0.

On exit: IFAIL = 0 unless the routine detects an error (see Section 6).

6 Error Indicators and Warnings

Errors detected by the routine:

IFAIL = 1

On entry, ITYPE $\neq 1$ or 2,
or INTPTS < 1,
or NPDE < 1,
or NPTS < 3,
or M $\neq 0$, 1 or 2,
or the mesh points X(i), for $i = 1, 2, \ldots,$ NPTS, are not in strictly increasing order.

IFAIL = 2

On entry, the interpolation points XP(i), for $i = 1, 2, \ldots,$ INTPTS, are not in strictly increasing order.

IFAIL = 3

The user is attempting extrapolation, that is, one of the interpolation points XP(i), for some i, lies outside the interval [X(1),X(NPTS)]. Extrapolation is not permitted.

7 Accuracy

See the PDE routine documents.

8 Further Comments

None.

9 Example

See Section 9 of the documents for D03PCF, D03PPF and D03PRF.