

NAG Fortran Library Routine Document

D03PZF

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/D03PCA, D03PHF/D03PHA or D03PPF/D03PPA, 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 \geq 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:

$0 \leq M \leq 2$ following a finite difference routine.

$M = 0$ 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 $i = 1, 2, \dots, \text{NPTS}$, must contain the mesh points as used by the PDE routine.
- 6: XP(INTPTS) – *real* array *Input*
On entry: XP(*i*), for $i = 1, 2, \dots, \text{INTPTS}$, must contain the spatial interpolation points.
Constraint: X(1) \leq XP(1) $<$ XP(2) $< \dots <$ XP(INTPTS) \leq X(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 $U_i(x_j, t_{\text{out}})$, at the interpolation points $x_j = \text{XP}(j)$, for $j = 1, 2, \dots, \text{INTPTS}$; $i = 1, 2, \dots, \text{NPDE}$.
 If ITYPE = 2, UP(*i*, *j*, 1) contains $U_i(x_j, t_{\text{out}})$ 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. Users who are unfamiliar with this parameter should refer to Chapter P01 for details.
On exit: IFAIL = 0 unless the routine detects an error (see Section 6).
 For environments where it might be inappropriate to halt program execution when an error is detected, the value -1 or 1 is recommended. If the output of error messages is undesirable, then the value 1 is recommended. Otherwise, for users not familiar with this parameter the recommended value is 0. **When the value -1 or 1 is used it is essential to test the value of IFAIL on exit.**

6 Error Indicators and Warnings

If on entry IFAIL = 0 or -1, explanatory error messages are output on the current error message unit (as defined by X04AAF).

Errors or warnings 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 $i = 1, 2, \dots, \text{NPTS}$, are not in strictly increasing order.

IFAIL = 2

On entry, the interpolation points $XP(i)$, for $i = 1, 2, \dots, \text{INTPTS}$, 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 $[X(1), X(\text{NPTS})]$. 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/D03PCA, D03PPF/D03PPA and D03PRF.
