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Zero of a Function of One Real Variable

Subroutine subprograms RZERO and DZERO compute, to an attempted specified accuracy, a zero of a real-valued function $f(x)$ lying in a given interval $[a, b]$, where $f(a) * f(b) \leq 0$.

On CDC and Cray computers, the double-precision version DZERO is not available.

Structure:

SUBROUTINE subprograms
User Entry Names: RZERO, DZERO
Files Referenced: Unit 6
External References: MTLMTR (N002), ABEND (Z035), user-supplied FUNCTION subprogram

Usage:

For t = R (type REAL), t = D (type DOUBLE PRECISION),

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CALL tZERO(A,B,X0,R,EPS,MAXF,F)
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A,B (type according to t) On entry, A and B must specify the end-points of the search interval. Unchanged on exit.

X0 (type according to t) On exit, X0 is the computed approximation to a zero x_0 of the function $f(x)$.

R (type according to t) On exit, the value of R is such that X0 $-x_0 <$ R, unless an error condition is detected (see **Error Handling**).

EPS (type according to t) On entry, EPS must be equal to the accuracy parameter (see **Accuracy**). Unchanged on exit.

MAXF (INTEGER) On entry, MAXF must be equal to the maximum permitted number of references to the function F within the iteration loop. Unchanged on exit.

F (type according to t) Name of a user-supplied FUNCTION subprogram, declared EXTERNAL in the calling program.

The user-supplied function subprogram F must be of the form FUNCTION F(X,I) and must set F(X) $= f($X$)$. The INTEGER argument I is set by RZERO before each reference to F as follows:

I = 1 First reference.

I = 2 Subsequent references.

I = 3 Final reference, before a normal (R > 0) exit.

Method:

A mixed strategy is used, based on the Muller method of parabolic interpolation supplemented by bisection.

Accuracy:

The routine tries to compute a value X0 such that

$$|\mathtt{X0} - x_0| \leq (1 + \mathtt{X0}) * \mathtt{EPS}.$$

If this accuracy is obtained with fewer than MAXF references to the function F within the iteration loop, the subroutine exits with R positive.

Error handling:

Error C205.1: $\mathtt{F}(\mathtt{A}, 1) * \mathtt{F}(\mathtt{B}, 1) > 0$. X0 is set equal to zero and R is set equal to $-2|\mathtt{B} - \mathtt{A}|$.
Error C205.2: The number of calls to F exceeds MAXF. X0 is set equal to zero and R is set to $-|\mathtt{B} - \mathtt{A}|/2$.
A message is written on Unit 6, unless subroutine MTLSET (N002) has been called.
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