NAG Toolbox

nag_zeros_quadratic_real (c02aj)

1 Purpose

nag_zeros_quadratic_real (c02aj) determines the roots of a quadratic equation with real coefficients.

2 Syntax

```
[zsm, zlg, ifail] = nag_zeros_quadratic_real(a, b, c)
[zsm, zlg, ifail] = c02aj(a, b, c)
```

3 Description

nag_zeros_quadratic_real (c02aj) attempts to find the roots of the quadratic equation $az^2 + bz + c = 0$ (where a, b and c are real coefficients), by carefully evaluating the 'standard' closed formula

$$z = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

It is based on the function QDRTC from Smith (1967).

Note: it is not necessary to scale the coefficients prior to calling the function.

4 References

Smith B T (1967) ZERPOL: a zero finding algorithm for polynomials using Laguerre's method *Technical Report* Department of Computer Science, University of Toronto, Canada

5 Parameters

5.1 Compulsory Input Parameters

1: **a** – REAL (KIND=nag_wp)

Must contain a, the coefficient of z^2.

2: **b** – REAL (KIND=nag_wp)

Must contain b, the coefficient of z.

3: **c** – REAL (KIND=nag_wp)

Must contain c, the constant coefficient.

5.2 Optional Input Parameters

None.

5.3 Output Parameters

1: **zsm**(**2**) – REAL (KIND=nag_wp) array

The real and imaginary parts of the smallest root in magnitude are stored in **zsm**(1) and **zsm**(2) respectively.

2: **zlg**(**2**) – REAL (KIND=nag_wp) array

The real and imaginary parts of the largest root in magnitude are stored in **zlg**(1) and **zlg**(2) respectively.

3: **ifail** – INTEGER

ifail = 0 unless the function detects an error (see Section 5).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail = 1 (*warning*)

On entry, **a** = 0.0. In this case, **zsm**(1) contains the root $-c/b$ and **zsm**(2) contains zero.

ifail = 2

On entry, **a** = 0.0 and **b** = 0.0. In this case, **zsm**(1) contains the largest machine representable number (see nag_machine_real_largest (x02al)) and **zsm**(2) contains zero.

ifail = 3

On entry, **a** = 0.0 and the root $-c/b$ overflows. In this case, **zsm**(1) contains the largest machine representable number (see nag_machine_real_largest (x02al)) and **zsm**(2) contains zero.

ifail = 4

On entry, **c** = 0.0 and the root $-b/a$ overflows. In this case, both **zsm**(1) and **zsm**(2) contain zero.

ifail = 5

On entry, b is so large that b^2 is indistinguishable from $b^2 - 4ac$ and the root $-b/a$ overflows. In this case, **zsm**(1) contains the root $-c/b$ and **zsm**(2) contains zero.

ifail = −99

An unexpected error has been triggered by this routine. Please contact NAG.

ifail = −399

Your licence key may have expired or may not have been installed correctly.

ifail = −999

Dynamic memory allocation failed.

If **ifail** > 0 on exit, then **zlg**(1) contains the largest machine representable number (see nag_machine_real_largest (x02al)) and **zlg**(2) contains zero.

7 Accuracy

If **ifail** = 0 on exit, then the computed roots should be accurate to within a small multiple of the ***machine precision*** except when underflow (or overflow) occurs, in which case the true roots are within a small multiple of the underflow (or overflow) threshold of the machine.

8 Further Comments

None.

9 Example

This example finds the roots of the quadratic equation $z^2 + 3z - 10 = 0$.

9.1 Program Text

```
     function c02aj_example

fprintf('c02aj example results\n\n');

% Roots of x^2 + 3*x - 10 = 0

a =   1;
b =   3;
c = -10;
[zsm, zlg, ifail] = c02aj(a, b, c);

disp('Roots of the quadratic equation:');

if (zsm(2) == 0)
  % two real roots
  z(1) = zsm(1);
  z(2) = zlg(1);
else
  % two complex roots
  z(1) = zsm(1) + i*zsm(2);
  z(2) = zlg(1) + i*zlg(2);
end
disp(z');
```

9.2 Program Results

```
     c02aj example results

Roots of the quadratic equation:
     2
    -5
```