NAG Toolbox for MATLAB

c02aj

1 Purpose

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

2 Syntax

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

3 Description

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 – double scalar**

Must contain a, the coefficient of z^2.

2: **b – double scalar**

Must contain b, the coefficient of z.

3: **c – double scalar**

Must contain c, the constant coefficient.

5.2 Optional Input Parameters

None.

5.3 Input Parameters Omitted from the MATLAB Interface

None.

5.4 Output Parameters

1: **zsm**(**2**) **– double array**

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

2: **zlg**(**2**) – **double array**

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

3: **ifail** – **int32 scalar**

0 unless the function detects an error (see Section 6).

6 Error Indicators and Warnings

Errors or warnings detected by the function:

ifail $= 1$

On entry, **a** $= 0$. In this case, **zsm**(1) contains the root $-c/b$ and **zsm**(2) contains zero.

ifail $= 2$

On entry, **a** $= 0$ and **b** $= 0$. In this case, **zsm**(1) contains the largest machine representable number (see x02al) and **zsm**(2) contains zero.

ifail $= 3$

On entry, **a** $= 0$ and the root $-c/b$ overflows. In this case, **zsm**(1) contains the largest machine representable number (see x02al) and **zsm**(2) contains zero.

ifail $= 4$

On entry, **c** $= 0$ 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.

If **ifail** > 0 on exit, then **zlg**(1) contains the largest machine representable number (see 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

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

```
zsm =
     2
     0
zlg =
    -5
```

```
     0
ifail =
           0
```