

## NAG Library Function Document

### nag\_anderson\_darling\_normal\_prob (g08ckc)

#### 1 Purpose

nag\_anderson\_darling\_normal\_prob (g08ckc) calculates the Anderson–Darling goodness-of-fit test statistic and its probability for the case of a fully-unspecified Normal distribution.

#### 2 Specification

```
#include <nag.h>
#include <nagg08.h>

void nag_anderson_darling_normal_prob (Integer n, Nag_Boolean issort,
    const double y[], double *ybar, double *yvar, double *a2, double *aa2,
    double *p, NagError *fail)
```

#### 3 Description

Calculates the Anderson–Darling test statistic  $A^2$  (see nag\_anderson\_darling\_stat (g08chc)) and its upper tail probability for the small sample correction:

$$\text{Adjusted } A^2 = A^2(1 + 0.75/n + 2.25/n^2),$$

for  $n$  observations.

#### 4 References

Anderson T W and Darling D A (1952) Asymptotic theory of certain ‘goodness-of-fit’ criteria based on stochastic processes *Annals of Mathematical Statistics* **23** 193–212

Stephens M A and D’Agostino R B (1986) *Goodness-of-Fit Techniques* Marcel Dekker, New York

#### 5 Arguments

- |    |  |               |
|----|--|---------------|
| 1: | <b>n</b> – Integer<br><i>On entry:</i> $n$ , the number of observations.<br><i>Constraint:</i> $n > 1$ .   | <i>Input</i>  |
| 2: | <b>issort</b> – Nag_Boolean<br><i>On entry:</i> set <b>issort</b> = Nag_TRUE if the observations are sorted in ascending order; otherwise the function will sort the observations.                       | <i>Input</i>  |
| 3: | <b>y[n]</b> – const double<br><i>On entry:</i> $y_i$ , for $i = 1, 2, \dots, n$ , the $n$ observations.<br><i>Constraint:</i> if <b>issort</b> = Nag_TRUE, the values must be sorted in ascending order. | <i>Input</i>  |
| 4: | <b>ybar</b> – double *<br><i>On exit:</i> the maximum likelihood estimate of mean.   | <i>Output</i> |
| 5: | <b>yvar</b> – double *<br><i>On exit:</i> the maximum likelihood estimate of variance.   | <i>Output</i> |

- 6: **a2** – double \* *Output*  
*On exit:*  $A^2$ , the Anderson–Darling test statistic.
- 7: **aa2** – double \* *Output*  
*On exit:* the adjusted  $A^2$ .
- 8: **p** – double \* *Output*  
*On exit:*  $p$ , the upper tail probability for the adjusted  $A^2$ .
- 9: **fail** – NagError \* *Input/Output*  
 The NAG error argument (see Section 2.7 in How to Use the NAG Library and its Documentation).

## 6 Error Indicators and Warnings

### NE\_ALLOC\_FAIL

Dynamic memory allocation failed.

See Section 2.3.1.2 in How to Use the NAG Library and its Documentation for further information.

### NE\_BAD\_PARAM

On entry, argument  $\langle value \rangle$  had an illegal value.

### NE\_INT

On entry,  $n = \langle value \rangle$ .

Constraint:  $n > 1$ .

### NE\_INTERNAL\_ERROR

An internal error has occurred in this function. Check the function call and any array sizes. If the call is correct then please contact NAG for assistance.

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

See Section 2.7.6 in How to Use the NAG Library and its Documentation for further information.

### NE\_NO\_LICENCE

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

See Section 2.7.5 in How to Use the NAG Library and its Documentation for further information.

### NE\_NOT\_INCREASING

**issort** = Nag\_TRUE and the data in **y** is not sorted in ascending order.

## 7 Accuracy

Probabilities are calculated using piecewise polynomial approximations to values estimated by simulation.

## 8 Parallelism and Performance

nag\_anderson\_darling\_normal\_prob (g08ckc) is not threaded in any implementation.

## 9 Further Comments

None.

## 10 Example

This example calculates the  $A^2$  statistics for data assumed to arise from a fully-unspecified Normal distribution and the  $p$ -value.

### 10.1 Program Text

```

/* nag_anderson_darling_normal_prob (g08ckc) Example Program.
 *
 * NAGPRODCODE Version.
 *
 * Copyright 2016 Numerical Algorithms Group.
 *
 * Mark 26, 2016.
 */
#include <stdio.h>
#include <string.h>
#include <math.h>
#include <nag.h>
#include <nag_stdlib.h>
#include <nagg08.h>

int main(void)
{
    Integer exit_status = 0;
    /* Scalars */
    double a2, aa2, p, ybar, yvar;
    Integer i, n;
    /* Arrays */
    double *y = 0;
    /* Nag types */
    Nag_Boolean issort;
    NagError fail;

    printf("%s\n\n",
           "nag_anderson_darling_normal_prob (g08ckc) Example Program Results");

    /* Skip heading in data file */
#ifdef _WIN32
    scanf_s("%*[\n] ");
#else
    scanf("%*[\n] ");
#endif

    /* Read number of observations */
#ifdef _WIN32
    scanf_s("%" NAG_IFMT " ", &n);
#else
    scanf("%" NAG_IFMT " ", &n);
#endif
#ifdef _WIN32
    scanf_s("%*[\n] ");
#else
    scanf("%*[\n] ");
#endif

    /* Memory allocation */
    if (!(y = NAG_ALLOC(n, double)))
    {
        printf("Allocation failure\n");
        exit_status = -1;
        goto END;
    }
}

```

```

    /* Read observations */
    for (i = 0; i < n; i++) {
#ifdef _WIN32
        scanf_s("%lf", y + i);
#else
        scanf("%lf", y + i);
#endif
    }
#ifdef _WIN32
    scanf_s("%*[\n] ");
#else
    scanf("%*[\n] ");
#endif

    /* Let nag_anderson_darling_normal_prob (g08ckc) sort the data */
    issort = Nag_FALSE;

    /* Calculate the Anderson-Darling goodness-of-fit test statistic and its
       probability for the case of a fully-unspecified Normal distribution */
    INIT_FAIL(fail);
    /* nag_anderson_darling_normal_prob (g08ckc) */
    nag_anderson_darling_normal_prob(n, issort, (const double *) y, &ybar,
                                     &yvar, &a2, &aa2, &p, &fail);

    /* Results */
    printf("%s ", "H0: data from Normal distribution with mean");
    printf("%6g ", ybar);
    printf("%s ", "and variance");
    printf("%6g\n", yvar);
    printf("%s", " Test statistic, A-squared: ");
    printf("%6g\n", a2);
    printf("%s", " Adjusted A-squared:      ");
    printf("%6g\n", aa2);
    printf("%s", " Upper tail probability:  ");
    printf("%6g\n", p);

END:
    NAG_FREE(y);

    return exit_status;
}

```

## 10.2 Program Data

```

nag_anderson_darling_normal_prob (g08ckc) Example Program Data
26 :: n
 0.3131132  0.2520412  1.5788841  1.4416712 -0.8246043 -1.6466685
 0.7943184  1.2874915 -0.8347250  0.3352505  0.9434467  2.1099520
-0.2801654 -0.7843009  0.6218187  2.0963809  1.7170403 -0.1350142
 0.7982763 -0.2980977  1.2283043  1.5576090 -0.4828757  2.6070754
 0.1213996  0.1431621 :: end of observations

```

## 10.3 Program Results

```

nag_anderson_darling_normal_prob (g08ckc) Example Program Results

```

```

H0: data from Normal distribution with mean 0.563876 and variance 1.1386
Test statistic, A-squared: 0.165956
Adjusted A-squared:      0.171296
Upper tail probability:   0.931155

```

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