

# Package ‘adk’

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**Type** Package

**Title** Anderson-Darling K-Sample Test and Combinations of Such Tests

**Version** 1.0-2

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**Description** The Anderson-Darling K-sample test can be used to test whether several independent random samples of various sizes come from the same but unspecified continuous distribution. It is a rank test and consistent against all alternatives. A low to moderate number of tied observations can be tolerated. The combination of such tests can be used to test whether M groups of samples (with K allowed to vary from group to group) come from respective common distributions, which may vary from group to group. This is useful in testing for treatment effects in randomized (incomplete) block designs or in examining whether several laboratories perform equally well when asked to measure a sufficient number of test specimens from different batches or materials.

**License** GPL (>= 2)

**LazyLoad** yes

**Repository** CRAN

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adk-package	<i>The Package adk Contains a K-Sample Anderson-Darling Test and its Combinations</i>
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**Description**

The K-sample Anderson-Darling test `adk.test` is used to test the hypothesis that K samples of various sizes come from a common continuous distribution that is otherwise unspecified. It is a rank test and it is consistent against all alternatives. The combined version of the test `adk.combined.test` is used to test several such hypotheses at the same time and the common distribution may vary from hypothesis to hypothesis.

**Details**

```

Package:    adk
Type:      Package
Version:   1.0-1
Date:      2011-05-21
License:   GPL version 2 or newer
LazyLoad:  yes

```

**Author(s)**

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**References**

Scholz, F. W. and Stephens, M. A. (1987), K-sample Anderson-Darling Tests, *Journal of the American Statistical Association*, **Vol 82, No. 399**, 918–924.

**Examples**

```

## Example using adk.test
x <- list(c(1,3,2,5,7),c(2,8,1,6,9,4),c(12,5,7,9,11))
out <- adk.test(x) # or out <- adk.test(c(1,3,2,5,7),c(2,8,1,6,9,4),c(12,5,7,9,11))

## Example using adk.combined.test
x1 <- list( c(1, 3, 2, 5, 7), c(2, 8, 1, 6, 9, 4), c(12, 5, 7, 9, 11) )
x2 <- list( c(51, 43, 31, 53, 21, 75), c(23, 45, 61, 17, 60) )
adk.combined.out <- adk.combined.test(x1,x2) # or out <- adk.combined.test(list(x1,x2))

```

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adk.combined.test      *Combined Anderson-Darling K-Sample Tests*


---

### Description

This function combines several independent Anderson-Darling k-sample tests into one overall test of the hypothesis that the independent samples within each group come from a common unspecified distribution, while the common distributions may vary from group to group. The k for each group of k independent samples may also change from group to group. All samples from all groups are independent and are assumed to come from continuous distributions. Also provided is a version that adjusts for a moderate number of ties (due to rounding).

NA values are removed and the user is alerted with the total NA count. It is up to the user to judge whether the removal of NA's is appropriate.

### Usage

```
adk.combined.test(...)
```

### Arguments

...                    Either several lists, say L.1, ... , L.M, where list L.i contains K.i sample vectors of respective sizes n.i[1], ..., n.i[K.i], where n.i[j] > 4 is recommended or a list of such lists.

### Details

If AD.i is the Anderson-Darling criterion for the i-th group of K.i samples, its standardized test statistic is  $T.i = (AD.i - \mu.i)/\text{sig}.i$ , with  $\mu.i$  and  $\text{sig}.i$  representing mean and standard deviation of AD.i. This test statistic is used to test the hypothesis that the samples in the i-th group all come from the same but unspecified continuous distribution function  $F(x)$ .

The combined Anderson-Darling criterion is  $AD.c = AD.1 + \dots + AD.M$  and  $T.combined = (AD.c - \mu.c)/\text{sig}.c$  is the standardized test statistic, where  $\mu.c$  and  $\text{sig}.c$  represent the mean and standard deviation of AD.c. This test statistic is used to simultaneously test whether the samples in each group come from the same continuous distribution function  $F(x)$ . However, the unspecified common distribution function  $F(x)$  may change from group to group.

### Value

A list with components

M	number of groups of samples being compared
n.samples	list of M vectors, each vector giving the sample sizes for each group of samples being compared
nt	vector of length M of total sample sizes involved in each of the M comparisons of K.i samples, respectively
n.ties	vector giving the number of ties in each the M comparison groups

adk.i	(2*M) * 3 matrix containing the T.kN, P-value, and extrapolation for the M individual Anderson-Darling tests, not adjusted for ties and adjusted for ties
mu	vector of means of the M AD statistics
sig	vector of standard deviations of the M AD statistics
adk.c	2*3 matrix containing T.combined, P-value, and extrapolation for the combined test not adjusted for ties and adjusted for ties
mu.c	mean of the combined AD statistic
sig.c	standard deviation of the combined AD statistic
warning	logical indicator, warning = TRUE when at least one of the sample sizes is < 5.

**Note**

This test is useful in analyzing treatment effects in randomized (incomplete) block experiments and in examining performance equivalence of several laboratories when presented with different test materials for comparison.

**Author(s)**

Fritz Scholz

**References**

Scholz, F. W. and Stephens, M. A. (1987), K-sample Anderson-Darling Tests, *Journal of the American Statistical Association*, **Vol 82, No. 399**, 918–924.

**See Also**

[adk.test](#)

**Examples**

```
## Create two lists of sample vectors.
x1 <- list( c(1, 3, 2, 5, 7), c(2, 8, 1, 6, 9, 4), c(12, 5, 7, 9, 11) )
x2 <- list( c(51, 43, 31, 53, 21, 75), c(23, 45, 61, 17, 60) )

## Run adk.combined.test.
adk.combined.out <- adk.combined.test(x1,x2)
# or out <- adk.combined.test(list(x1,x2))

## Examine list objects in adk.combined.out.
names(adk.combined.out)

## Extract matrix components adk.i and adk.c
adk.combined.out$adk.i
adk.combined.out$adk.c

## Fully formatted output
adk.combined.out
```

---

`adk.pval`*Function for computing p-values of Anderson-Darling test statistics*

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**Description**

This function "adk.pval" evaluates the p-value of the observed value `tx` of  $T_m$ , the standardized Anderson-Darling statistic. It is used by `adk.test` and `adk.combined.test`.

**Usage**

```
adk.pval(tx, m)
```

**Arguments**

<code>tx</code>	threshold for which the right tail probability of the standardized Anderson-Darling statistics $T_m$ is to be calculated
<code>m</code>	index of the standardized $T_m$ statistic (see reference)

**Details**

This function first interpolates the upper  $T_m$  quantiles as given in Table 1 (see reference below) to the given value of `m` by fitting a quadratic in  $1/\sqrt{m}$  to the quantiles as tabulated for the upper quantile levels .25, .10, .05, .025, .01.

Next a quadratic in the interpolated quantiles (for `m`) is fitted to the log-odds of the upper probability levels defining these quantiles and the fitted log-odds value at `tx` is converted back to the calculated upper probability value, i.e., the p-value. p-values outside the tabulated range [.01,.25] are obtained by linear extrapolation of the fitted quadratic.

**Value**

A list with components

<code>p0</code>	p-value of <code>tx</code> , i.e., $p0=P(T_m \geq tx)$
<code>extrap</code>	a logical indicator, <code>extrap = TRUE</code> indicates that linear extrapolation took place, otherwise quadratic interpolations was used.

**Author(s)**

Fritz Scholz

**References**

Scholz, F. W. and Stephens, M. A. (1987), K-sample Anderson-Darling Tests, *Journal of the American Statistical Association*, **Vol 82, No. 399**, 918–924.

**See Also**

[adk.test](#) and [adk.combined.test](#)

**Examples**

```
## compute p-value when tx = 3 and m = 6
adk.pval(3,6)
```

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adk.test	<i>Anderson-Darling K-Sample Test</i>
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**Description**

The Anderson-Darling k-sample test may be used to test the hypothesis that k samples of various sizes ( $> 4$ ) come from one common continuous distribution. It is a rank test and it is consistent against all alternatives, a property not shared by the Kruskal-Wallis k-sample rank test. Also provided is a version that adjusts for a moderate number of ties (due to rounding).

NA values are removed and the user is alerted with the total NA count. It is up to the user to judge whether the removal of NA's is appropriate.

**Usage**

```
adk.test(...)
```

**Arguments**

... Either several sample vectors of respective sizes  $n.1, \dots, n.k$ , with  $n.i > 4$  recommended, or a list of such sample vectors

**Details**

See the given reference for details on the Anderson-Darling k-sample criterion AD and its modification in case of ties. The standardized value of AD, i.e.,  $T = (AD - \mu)/\text{sig}$ , is used as test statistic. Here  $\mu = k-1$  and  $\text{sig}$  are the mean and standard deviation of AD. The P-value =  $P(T \geq t.\text{obs})$  corresponding to an observed  $t.\text{obs}$  of T is computed by quadratic interpolation w.r.t.  $1/\sqrt{\mu}$  and by quadratic interpolation w.r.t.  $\log(p/(1-p))$ , where p is the tail probability corresponding to the quantiles given in Table 1 of the cited reference. Both interpolations are reasonably accurate. For p beyond the range [.01,.25] of Table 1 linear extrapolation is used w.r.t. the  $\log(p/(1-p))$  fit. Such extrapolation affects the accuracy of the P-value calculation to some extent but this should not strongly affect any decisions regarding the tested hypothesis.

**Value**

A list of class adk with components

k	number of samples being compared
ns	vector of the k sample sizes $c(n.1, \dots, n.k)$
n	total sample size = $n.1 + \dots + n.k$
n.ties	number of ties in the combined set of all n observations

sig	standard deviation of the AD statistic
adk	2 x 3 matrix containing t.obs, P-value, extrapolation, not adjusting for ties and adjusting for ties. extrapolation = 1 when the P-value was extrapolated.
warning	logical variable, warning = TRUE if n.i < 5 for at least one of the samples, otherwise warning = FALSE .

**Author(s)**

Fritz Scholz

**References**

Scholz, F. W. and Stephens, M. A. (1987), K-sample Anderson-Darling Tests, *Journal of the American Statistical Association*, **Vol 82, No. 399**, 918–924.

**See Also**

[kruskal.test](#) as a nonparametric alternative to `adk.test` and [adk.combined.test](#) for combining several such tests for different and independent groups of samples

**Examples**

```
## Create input list of 3 sample vectors.
x <- list(c(1,3,2,5,7),c(2,8,1,6,9,4),c(12,5,7,9,11))
out <- adk.test(x)
# or out <- adk.test(c(1,3,2,5,7),c(2,8,1,6,9,4), c(12,5,7,9,11))
## Examine the component names of out
names(out)

## Examine the matrix adk of out.
out$adk

## Fully print formatted object out of class adk.
out
```

---

print.adk

*Print Function for Objects of Class adk*


---

**Description**

This print function is invoked for printing formatted output of class `adk` as it is output from `adk.test` or `adk.combined.test`.

**Usage**

```
## S3 method for class 'adk'
print(x,...)
```

**Arguments**

`x` an object of class `adk`, as output by `adk.test` or `adk.combined.test`  
`...` additional arguments, if needed

**Details**

The formatted output is different for objects generated by `adk.test` and for object generated by `adk.combined.test`.

**Author(s)**

Fritz Scholz

**See Also**

[adk.test](#) and [adk.combined.test](#)

**Examples**

```
## Create input list of 3 sample vectors.  
x <- list(c(1,3,2,5,7),c(2,8,1,6,9,4),c(12,5,7,9,11))  
out <- adk.test(x)  
print(out)
```

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