RIWIAD	CERN Program Library	D114

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Adaptive Multidimensional Monte-Carlo Integration

> **OBSOLETE**
> Please note that this routine has been obsoleted in CNL 223. Users are advised not to use it any longer and to replace it in older programs. No maintenance for it will take place and it will eventually disappear.
>
> Suggested replacement: (in part) `RADMUL` (D120)

`RIWIAD` is an adaptive multidimensional integration subroutine based on an original by G. Sheppey. It permits numerical integration of a large class of functions, in particular those that are irregular at the border of the integration region. The integral is always performed over the unit hypercube.

Structure:

`SUBROUTINE` subprogram
User Entry Names: `RIWIAD`
Files Referenced: `Unit 6`
External References: `RNDM` (V104) user-supplied `FUNCTION` subprogram
`COMMON` Block Names and Lengths: `/ANSWER/ 2, /INTERN/ 7, /OPTION/ 3, /PARAMS/ 4, /RANDOM/ 1, /STORE/ 77, /STORE1/ 10001`

Usage:

See **Long Write-up** for a description of all features. Here only the standard use is described.
The `COMMON` block `PARAMS` must always be set by the user:

```
COMMON /PARAMS/ ACC,NDIM,NSUB,ITER
```

`ACC`	(`REAL`) Relative accuracy desired.
`NDIM`	(`INTEGER`) Number of dimension parameters.
`NSUB`	(`INTEGER`) Number of subvolumes allowed.
`ITER`	(`INTEGER`) Maximal number of iterations.

The integrand is defined by a user-supplied `FUNCTION` subprogram having the array `Q(NDIM)` as parameter, for example

```
FUNCTION EXAMPLE(Q)
REAL EXAMPLE,Q
DIMENSION Q(7)
...
END
```

This program defines `EXAMPLE` as a function of the 7 variables `Q(1)`, `Q(2)`, ..., `Q(7)`. The sequence

```
EXTERNAL EXAMPLE
COMMON /PARAMS/ ACC,NDIM,NSUB,ITER
ACC=0.01
NDIM=7
NSUB=10000
ITER=5
CALL RIWIAD(EXAMPLE)
...
```

will then integrate `EXAMPLE` over the 7 variables `Q(1)`, ..., `Q(7)`, all in the interval from 0 to 1, i.e. over the 7-dimensional unit hypercube. The result will be printed in detail in a readily understandable form.

The program allows extensive user control via the `COMMON` blocks. See **Long Write-up** for details.

Method:

`RIWIAD` is iterative and in a given iteration it divides the unit hypercube into a certain number of subvolumes by means of a given set of intervals on each axis. Within each subvolume it estimates the mean value and variance of the integrand by random sampling, and then calculates the Riemann sum over the subvolumes. Using the variances found projected onto each axis it calculates a set of new interval divisions to be used in the next iteration. It returns when the desired accuracy is obtained or when the maximum number of iterations has been performed.

Restrictions:

There is, in principle, no limitations on the number of dimensions, although the present version only allows up to 9-dimensional integrals. The maximal dimensionality can easily be increased.

Notes:

1. The program is rather slow and should preferably be used only when other methods (for instance Gaussian quadrature) fail due to the irregular behaviour of the integrand. The time consumption is essentially proportional to the product of `NSUB` and `ITER`.
2. The non-CDC/Cray implementation of `RIWIAD` has `IMPLICIT DOUBLE PRECISION(A-H,O-Z)`, i.e. all non-`INTEGER` variables are `DOUBLE PRECISION`, including the user-supplied external function.

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