Use R to Compute Numerical Integrals

In short, you may use R to find out a numerical answer to an n-fold integral.

I. To integrate a one-dimensional integral over a finite or infinite interval, use R function `integrate`. For example, find out

$$\int_0^\infty \frac{1}{(x+1)\sqrt{x}} dx$$

```
>## define the integrated function
>integrand <- function(x) {1/((x+1)*sqrt(x))}
>## integrate the function from 0 to infinity
>integrate(integrand, lower = 0, upper = Inf)
3.141593 with absolute error < 2.7e-05
```

The numerical answer is 3.141593 up to a small error 2.7×10^{-5} .

Another example is to find out

$$\int_{-1.96}^{1.96} \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} dx$$

```
>f <- function(x) {1/sqrt(2*pi)*exp(-x^2/2)}
>integrate(f, lower = -1.96, upper = 1.96)
0.9500042 with absolute error < 1.0e-11
```

For more information about the function `integrate`, type `help(integrate)` in R.

II. To integrate a scalar function over a multidimensional rectangle, use R function `adaptIntegrate`. To use `adaptIntegrate`, you need to install the R package *cubature* first:

(1) Download the package file "`cubature_1.0.zip` " via

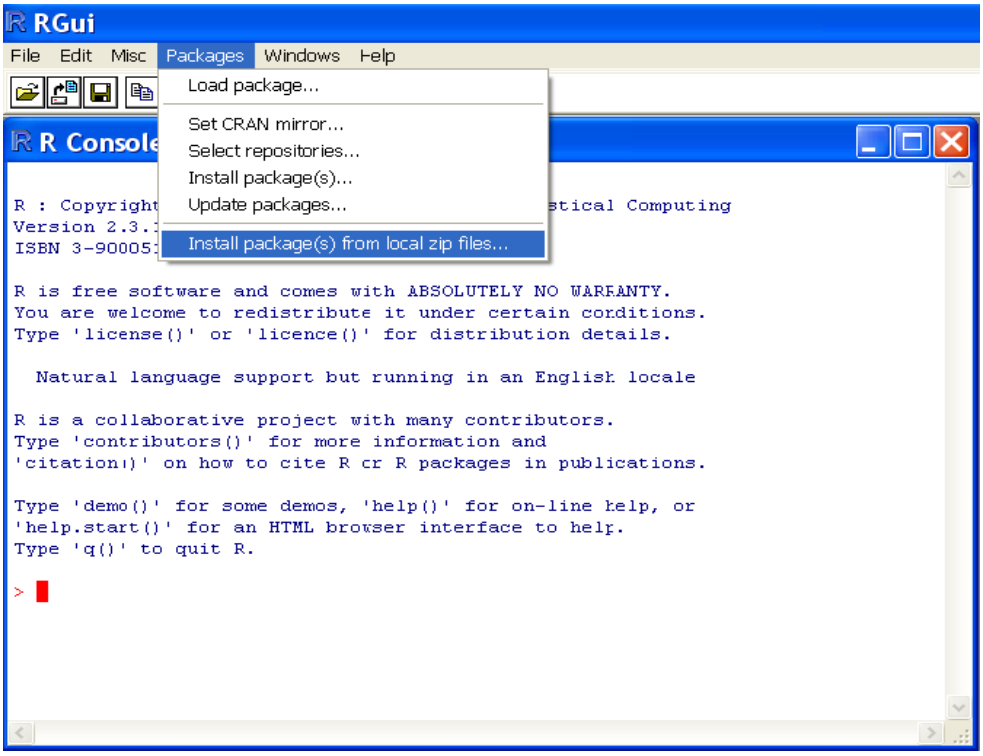
`http://cran.r-project.org/web/packages/cubature/index.html`

(2) Install the package *cubature* in R.

(i) Click R menu "packages".

(ii) Click the subitem "Install package(s) from local zip files..." .

(iii) Open the downloaded package file "`cubature_1.0.zip` " .



For more R packages, please check
`http://cran.r-project.org/web/packages/`

Now you can use the R function `adaptIntegrate` to compute n-fold integrals. For example, find out the integral

$$\int_0^{\frac{1}{2}} \int_0^{\frac{1}{2}} \int_0^{\frac{1}{2}} \frac{2}{3}(x_1 + x_2 + x_3) dx_1 dx_2 dx_3$$

```
> library(cubature)        # load the package "cubature"
> f <- function(x) { 2/3 * (x[1] + x[2] + x[3]) }  # "x" is vector
> adaptIntegrate(f, lowerLimit = c(0, 0, 0), upperLimit = c(0.5, 0.5, 0.5))
$integral
[1] 0.0625
$error
[1] 1.666961e-18
```

So the numerical answer for the 3-dimensional integral is 0.0625 with estimated relative error 1.666961×10^{-18} .

For more information about the function `adaptIntegrate`, type `help(adaptIntegrate)` after loading the package *cubature* in R.