

Doing Numerical Integration in RStudio

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Definite integrals

For a built-in function like $\sin(x)$, integrating from 0 to π is as simple as

```
integrate(sin, 0, pi)
```

2 with absolute error < 2.2e-14

But, there may not *be* a built-in R function that suits your purposes. For instance, the pdf for exponential distributions is

$$f(x) := \begin{cases} 0, & \text{if } x < 0 \\ \lambda e^{-\lambda x}, & \text{if } x \geq 0 \end{cases}$$

implemented in R as `dexp()`. However, the integral one must calculate to find the mean involves the product of x with this function, and R does not have a built-in function for that.

When there is no built-in function, you have a couple of options for defining it yourself. One method is to use the native way R has for defining complicated user-defined functions:

```
meanIntegrand = function(x, lam) {  
  return( (x>=0) * x * lam*exp(-lam*x) )  
}
```

The other method is to use `makeFun()`, suitable when the function definition is less-complicated, as it is here, where I set $\lambda = 0.2$:

```
meanIntegrand <- makeFun( x*dexp(x, 0.2) ~ x )
```

Once defined, you can use `integrate()` to calculate definite integrals. It is even possible to use $(-\infty)$ or ∞ as endpoints of integration:

```
integrate(meanIntegrand, -Inf, Inf)
```

5 with absolute error < 3.8e-05

Indefinite integration (i.e., antidifferentiation)

The `antiD()` command is provided in the **mosaicCalc** package. Make sure you have it loaded before trying things such as the following.

The idea is to find an antiderivative for a given function, for purposes such as evaluating that antiderivative at various inputs, or displaying a graph of the antiderivative. Let's take $f(x) = \sin x$, a function we understand. We can produce an antiderivative, naming it $F(x)$, via

```
F <- antiD(sin(x) ~ x)    # There are many, with F(x) = -cos(x) + C
```

It can be evaluated:

```
F(3*pi/2) - F(0)
```

```
[1] 1
```

It can also be plotted:

```
gf_fun( F(x) ~ x, xlim = c(-3*pi/2, 3*pi/2))
```

