

# 1 Functions to calculate Numerical Derivatives and Hessian Matrix

In R, the functions in this package are made available with

```
> library("numDeriv")
>
```

The code from the vignette that generates this guide can be loaded into an editor with `edit(vignette("Guide", package="numDeriv"))`. This uses the default editor, which can be changed using `options()`.

Here are some examples of `grad`.

```
> grad(sin, pi)
> grad(sin, (0:10)*2*pi/10)
> func0 <- function(x){ sum(sin(x)) }
> grad(func0, (0:10)*2*pi/10)
> func1 <- function(x){ sin(10*x) - exp(-x) }
> curve(func1, from=0, to=5)
> x <- 2.04
> numd1 <- grad(func1, x)
> exact <- 10*cos(10*x) + exp(-x)
> c(numd1, exact, (numd1 - exact)/exact)
> x <- c(1:10)
> numd1 <- grad(func1, x)
> exact <- 10*cos(10*x) + exp(-x)
> cbind(numd1, exact, (numd1 - exact)/exact)
```

Here are some examples of `jacobian`.

```
> func2 <- function(x) c(sin(x), cos(x))
> x <- (0:1)*2*pi
> jacobian(func2, x)
```

Here are some examples of `hessian`.

```
> x <- 0.25 * pi
> hessian(sin, x)
> fun1e <- function(x) sum(exp(2*x))
> x <- c(1, 3, 5)
> hessian(fun1e, x, method.args=list(d=0.01))
```

Here are some examples of `genD`.

```
> func <- function(x){c(x[1], x[1], x[2]^2)}
> z <- genD(func, c(2,2,5))
> z
```