

# Rcpp Quick Reference Guide

Romain François

Dirk Eddelbuettel

Rcpp version 0.10.2 as of December 21, 2012

## Important Notes

*// If you experience compiler errors, please check that you have more information.*

*// Many of the examples here imply the following:*

**using namespace Rcpp;**

*// The inline package adds this for you. Alternately, use e.g.:*

**Rcpp::NumericVector xx(10);**

## Extract and set single elements

*// extract single values*

**double x0 = xx[0];**

**double x1 = xx[1];**

**double y0 = yy["foo"];**

**double y1 = yy["bar"];**

*// set single values*

**xx[0] = 2.1;**

**xx[1] = 4.2;**

**yy["foo"] = 3.0;**

*// grow the vector*

**yy["foobar"] = 10.0;**

## Create simple vectors

**SEXP x; std::vector<double> y(10);**

*// from SEXP*

**NumericVector xx(x);**

*// of a given size (filled with 0)*

**NumericVector xx(10);**

*// ... with a default for all values*

**NumericVector xx(10, 2.0);**

*// range constructor*

**NumericVector xx( y.begin(), y.end() );**

*// using create*

**NumericVector xx = NumericVector::create(  
1.0, 2.0, 3.0, 4.0 );**

**NumericVector yy = NumericVector::create(  
Named["foo"] = 1.0,**

**\_["bar"] = 2.0 ); // short for Named**

## Using matrices

*// Initializing from SEXP,*

*// dimensions handled automatically*

**SEXP x;**

**NumericMatrix xx(x);**

*// Matrix of 4 rows & 5 columns (filled with 0)*

**NumericMatrix xx(4, 5);**

*// Fill with value*

**int xsize = xx.nrow() \* xx.ncol();**

**for (int i = 0; i < xsize; i++) {**

**xx[i] = 7;**

**}**

*// Same as above, using STL fill*

**std::fill(xx.begin(), xx.end(), 8);**

*// Assign this value to single element*

*// (1st row, 2nd col)*

**xx(0,1) = 4;**

*// Reference the second column*

*// Changes propagate to xx (same applies for Row)*

**NumericMatrix::Column zzcol = xx( \_, 1);**

**zzcol = zzcol \* 2;**

*// Copy the second column into new object*

**NumericVector zz1 = xx( \_, 1);**

*// Copy the submatrix (top left 3x3) into new object*

**NumericMatrix zz2 = xx( Range(0,2), Range(0,2));**

## Inline

```
## Note - this is R code. inline allows rapid testing.
require(inline)
testfun = cxxfunction(
  signature(x="numeric", i="integer"),
  body = '
    NumericVector xx(x);
    int ii = as<int>(i);
    xx = xx * ii;
    return( xx );
  ', plugin="Rcpp")
testfun(1:5, 3)
```

## STL interface

```
// sum a vector from beginning to end
double s = std::accumulate(x.begin(),
  x.end(), 0.0);
// prod of elements from beginning to end
int p = std::accumulate(vec.begin(),
  vec.end(), 1, std::multiplies<int>());
// inner_product to compute sum of squares
double s2 = std::inner_product(res.begin(),
  res.end(), res.begin(), 0.0);
```

## Interface with R

```
## In R, create a package shell. For details, see the "Writing R Extensions" manual.
```

```
Rcpp.package.skeleton("myPackage")
```

```
## Add R code to pkg R/ directory. Call C++ function. Do type checking in R.
```

```
myfunR = function(Rx, Ry) {
  ret = .Call("myCfun", Rx, Ry,
    package="myPackage")
  return(ret)
}
```

```
// Add C++ code to pkg src/ directory.
```

```
using namespace Rcpp;
```

```
// Define function as extern with RcppExport
```

```
RcppExport SEXP myCfun( SEXP x, SEXP y) {
```

```
  // If R/C++ types match, use pointer to x. Pointer is fast.
  Rx).
```

```
  NumericVector xx(x);
```

```
  // clone is slower and uses extra memory. Safe, R-like.
```

```
  NumericVector yy(clone(y));
```

```
  xx[0] = yy[0] = -1.5;
```

```
  int zz = xx[0];
```

```
  // use wrap() to return non-SEXP objects, e.g:
```

```
  // return(wrap(zz));
```

```
  // Build and return a list
```

```
  List ret; ret["x"] = xx; ret["y"] = yy;
```

```
  return(ret);
```

```
}
```

```
## From shell, above package directory
```

```
R CMD check myPackage ## Optional
```

```
R CMD INSTALL myPackage
```

```
## In R:
```

```
require(myPackage)
```

```
aa = 1.5; bb = 1.5; cc = myfunR(aa, bb)
```

```
aa == bb ## FALSE, C++ modifies aa
```

```
aa = 1:2; bb = 1:2; cc = myfunR(aa, bb)
```

```
identical(aa, bb)
```

```
## TRUE, R/C++ types don't match
```

## Function

```
Function rnorm("rnorm");
rnorm(100, _["mean"] = 10.2, _["sd"] = 3.2 );
```

## Environment

```
Environment stats("package:stats");
Environment env( 2 ); // by position
```

```
// special environments
```

```
Environment::Rcpp_namespace();
```

```
Environment::base_env();
```

```
Environment::base_namespace();
```

```
Environment::global_env();
```

```
Environment::empty_env();
```

```
Function rnorm = stats["rnorm"];
```

```
glob["x"] = "foo";
```

```
glob["y"] = 3;
```

```
std::string x = glob["x"];
```

```
glob.assign( "foo" , 3 );
```

```
int foo = glob.get( "foo" );
```

```
int foo = glob.find( "foo" );
```

```
CharacterVector names = glob.ls()
```

```
bool b = glob.exists( "foo" );
```

```
glob.remove( "foo" );
```

```
glob.lockBinding("foo");
```

```
glob.unlockBinding("foo");
```

```
bool b = glob.bindingIsLocked("foo");
```

```
bool b = glob.bindingIsActive("foo");
```

```
Environment e = stats.parent();
```

```
Environment e = glob.new_child();
```

## Modules

```
// Warning -- At present, module-based objects do not persist across R sessions.
// results to R objects and remove module objects before exiting R.

// To create a module-containing package from R, use:
Rcpp.package.skeleton("mypackage",module=TRUE)
// You will need to edit the RcppModules: line of the DESCRIPTION file
// from yada to mod_bar).

class Bar {
public:
  Bar(double x_) :
    x(x_), nread(0), nwrite(0) {}

  double get_x( ) {
    nread++;    return x;
  }

  void set_x( double x_) {
    nwrite++;   x = x_;
  }

  IntegerVector stats() const {
    return IntegerVector::create(
      _["read"] = nread,
      _["write"] = nwrite);
  }
private:
  double x; int nread, nwrite;
};

RCPP_MODULE(mod_bar) {
  class_<Bar>( "Bar" )
    .constructor<double>()
    .property( "x", &Bar::get_x, &Bar::set_x,
      "Docstring for x" )
    .method( "stats", &Bar::stats,
      "Docstring for stats" )
  ;}

## The following is R code.
require(mypackage); show(Bar)
b <- new(Bar, 10); b$x <- 10
b_persist <- list(stats=b$stats(), x=b$x)
rm(b)
```

## Rcpp sugar

```
NumericVector x = NumericVector::create(
  -2.0, -1.0, 0.0, 1.0, 2.0 );
IntegerVector y = IntegerVector::create(
  -2, -1, 0, 1, 2 );

NumericVector xx = abs( x );
IntegerVector yy = abs( y );

bool b = all( x < 3.0 ).is_true() ;
bool b = any( y > 2 ).is_true();

NumericVector xx = ceil( x );
NumericVector xx = ceiling( x );
NumericVector yy = floor( y );
NumericVector yy = floor( y );

NumericVector xx = exp( x );
NumericVector yy = exp( y );

NumericVector xx = head( x, 2 );
IntegerVector yy = head( y, 2 );

IntegerVector xx = seq_len( 10 );
IntegerVector yy = seq_along( y );

NumericVector xx = rep( x, 3 );
NumericVector xx = rep_len( x, 10 );
NumericVector xx = rep_each( x, 3 );

IntegerVector yy = rev( y );
```

## Random functions

```
// Set seed
```

```
RNGScope scope;
```

*// For details see Section 6.7.1--Distribution functions of the ‘Writing R Extensions’ manual. In some cases (e.g. rnorm), distribution-specific arguments can be omitted; when in doubt, specify all dist-specific arguments. The use of doubles rather than integers for dist-specific arguments is recommended. Unless explicitly specified, log=FALSE.*

```
// Equivalent to R calls
```

```
NumericVector xx = runif(20);
```

```
NumericVector xx1 = rnorm(20);
```

```
NumericVector xx1 = rnorm(20, 0);
```

```
NumericVector xx1 = rnorm(20, 0, 1);
```

```
// Example vector of quantiles
```

```
NumericVector quants(5);
```

```
for (int i = 0; i < 5; i++) {
```

```
    quants[i] = (i-2);
```

```
}
```

```
// in R, dnorm(-2:2)
```

```
NumericVector yy = dnorm(quants) ;
```

```
NumericVector yy = dnorm(quants, 0.0, 1.0) ;
```

```
// in R, dnorm(-2:2, mean=2, log=TRUE)
```

```
NumericVector yy = dnorm(quants, 2.0, true) ;
```

```
// Note - cannot specify sd without mean
```

```
// in R, dnorm(-2:2, mean=0, sd=2, log=TRUE)
```

```
NumericVector yy = dnorm(quants, 0.0, 2.0, true) ;
```

```
// To get original R api, use Rf_*
```

```
double zz = Rf_rnorm(0, 2);
```