

Using Rcpp* packages for easy and fast extension of R with C++



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Outline

1 Short presentation of Rcpp* packages

- Rcpp : extending R with C++
- RcppGSL for fast random draws
- RcppArmadillo for high-performance linear algebra

2 Build of R package using Rcpp

- Useful functions
- Example of package using Rcpp



Rcpp R package

- **Rcpp** is an R package to extend R with C++ code
- Main advantage : C++ is fast, it accelerates R as shown in the examples
- Written by **Dirk EDDELBUETTEL** and **Romain FRANCOIS**
- <http://www.rcpp.org/>

Useful Rcpp features

// [[Rcpp::export]] preceding the C++ function definition

- Indicate that it should be made available as an R function
- Check if the function have return and entry types compatible with Rcpp i.e. convertible into R object according to the following correspondence tables of data types :

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Value	R vector	Rcpp vector	Rcpp matrix
Logical	logical	LogicalVector	LogicalMatrix
Integer	integer	IntegerVector	IntegerMatrix
Real	numeric	NumericVector	NumericMatrix
Complex	complex	ComplexVector	ComplexMatrix
String	character	CharacterVector (StringVector)	CharacterMatrix (StringMatrix)

R	Rcpp
data.frame	DataFrame
list	List
S3 class	
S4 class	S4

Useful Rcpp features

Thanks to `Rcpp:::sourceCpp()`

- Compile the C++ code
- Export the function to the R session
- Direct conversion of objects (including S3, S4) between R and C++
- For more details see `vignette("Rcpp-package")`

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Thanks to `Rcpp::depends`

- Specify additional build dependencies on other packages for `Rcpp::sourceCpp()`
- `Rcpp::sourceCpp()` therefore configures the build environment to correctly compile and link against the package specified
- examples : `[[Rcpp::depends(RcppArmadillo)]],`
`[[Rcpp::depends(RcppGSL)]]` ...

Simple Rcpp example

C++ code (in file Code/addition.cpp)

```
#include <Rcpp.h>
using namespace Rcpp;

// [[Rcpp::export]]
int addition(const int& a, const int& b) {
  return a + b;
}
```

R code

```
Rcpp::sourceCpp("Code/addition.cpp")
addition(2, 2)

## [1] 4
```



Reference in C++

- A variable can be declared as reference by putting & in the declaration.
- The variable declared as reference becomes an alternative name for an existing variable, avoiding copy of large structures.
- Useful to save copying of big objects when passed as arguments to functions, if we pass it without reference, a new copy of it is created which causes wastage of CPU time and memory.
- If a function receives a reference to a variable as argument, it can modify the value of the variable in memory, the const added in the argument declaration will stop it from being altered.



GSL and RcppGSL



GNU Scientific Library

- Numerical library for C and C++ programmers
- Reliable random number generator algorithms
- Thoroughly tested and fast random number distributions
- Linear algebra (matrices and vectors)
- <https://www.gnu.org/software/gsl/>

RcppGSL

- Interface between R and GSL
- Using Rcpp to interface R and C
- <http://dirk.eddelbuettel.com/code/rcpp.gsl.html>



GSL random number distributions

- GSL v2.6 includes **38 random number distributions** (see [GNU GSL](#))
- For comparison, R API includes “only” 24 random number distributions (see [Writing R Extensions](#))





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- Random draws are faster with GSL than with R (eg. `gsl_ran_gamma()` vs. `R::rgamma()`)





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- Random draws are faster with GSL than with R (eg. `gsl_ran_gamma()` vs. `R::rgamma()`)
- Examples of functions to generate random sample :
`gsl_ran_multivariate_gaussian()`,
`gsl_ran_wishart()`, `gsl_ran_dirichlet()`
- Probability density function (`_pdf`), upper or lower cumulative distribution functions (`_Q` or `_P`) and quantile functions (`_Qinv` or `_Pinv`) are also available for each distribution.



Armadillo and RcppArmadillo

Armadillo

- C++ library for linear algebra and scientific computing
- Provides high-level syntax and functionality : speed and ease of use
- Classes for vectors, matrices and cubes convertible in R vector, matrix and array.
- Matrix operations (+, -, *, %), identify the elements of a matrix that meet a condition (`arma::find(A>0)`), matrix decomposition (`arma::chol()`), linear model solver (`arma::solve(A,B)`), etc.
- <http://arma.sourceforge.net/>





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RcppArmadillo

- Interface between R and Armadillo
- Using Rcpp to interface R and C++
- <http://dirk.eddelbuettel.com/code/rcpp.armadillo.html>



Licenses

- Licenses : GNU General Public License, Apache License 2.0 for Armadillo
- Free software licenses : we can use, modify and redistribute these softwares



How to build an R package around C++ functions

- `Rcpp.package.skeleton()` to generate a new Rcpp package (modifying `DESCRIPTION` and `NAMESPACE`)
- `Rcpp::compileAttributes()` scans the C++ files and generates the `RcppExports.cpp` file to make the functions preceded by `[[Rcpp::export]]` available in R.
- Implement R function that checks the conformity of user-defined parameters, calls functions in C++ and returns the results in an easy-to-use format.

jSDM R package

jSDM 0.1.0  Get started Reference Articles Change log  

jSDM R Package

Package for fitting joint species distribution models (jSDM) in a hierarchical Bayesian framework (Warton *et al.* 2015). The Gibbs sampler is written in C++. It uses Rcpp, Armadillo and GSL to maximize computation efficiency.

System requirements

Make sure the GNU Scientific Library (GSL) is installed on your system.

Installation

Install the latest stable version of jSDM from CRAN with:

```
install.packages("jSDM")
```

Or install the development version of jSDM from GitHub with:

```
devtools::install_github("ghislainv/jSDM")
```

References

Warton, D.I., Blanchet, F.G., O'Hara, R.B., Ovaskainen, O., Taskinen, S., Walker, S.C. & Hui, F.K. (2015) So many variables: Joint modeling in community ecology. *Trends in Ecology & Evolution*, **30**, 766–779.

Links

Download from CRAN at <https://cloud.r-project.org/package=jSDM>
Browse source code at <https://github.com/ghislainv/jSDM>
Report a bug at <https://github.com/ghislainv/jSDM/issues>

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Developers

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Copyright holder, funder

Dev status

build  CRAN 0.1.0  DOI 10.5281/zenodo.3253460  downloads 231/month 

- <https://ecology.ghislainv.fr/jSDM>
- Made with Rcpp, RcppGSL and RcppArmadillo packages



... Thank you for attention ...



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