

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 EDELBUELTEL** 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	<code>logical</code>	<code>LogicalVector</code>	<code>LogicalMatrix</code>
Integer	<code>integer</code>	<code>IntegerVector</code>	<code>IntegerMatrix</code>
Real	<code>numeric</code>	<code>NumericVector</code>	<code>NumericMatrix</code>
Complex	<code>complex</code>	<code>ComplexVector</code>	<code>ComplexMatrix</code>
String	<code>character</code>	<code>CharacterVector</code> (<code>StringVector</code>)	<code>CharacterMatrix</code> (<code>StringMatrix</code>)

R	Rcpp
<code>data.frame</code>	<code>DataFrame</code>
<code>list</code>	<code>List</code>
S3 class	<code>List</code>
S4 class	<code>S4</code>

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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, matrice 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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- <http://arma.sourceforge.net/>

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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Dev status

build: passing
 CRAN: 0.1.0
 DOI: 10.5281/zenodo.3253460
 do wloads: 231/month

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



... Thank you for attention ...



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