

# ropenblas: Download, Compile and Link OpenBLAS Library with R

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## Summary

The ropenblas package aims to facilitate the day-to-day life of R programmers who want a little more performance on GNU/Linux systems, without removing the possibility that specific configurations are made, if they deem convenient. Through the package's ropenblas() and rcompiler() functions, the library user will be able to compile and link the R language in his GNU/Linux distribution with the OpenBLAS library, all within R and in a very simple fashion. All functions work without being influenced by the GNU/Linux distribution and are independent of their repositories, that is, it does not matter which GNU/Linux distribution is being used. Linking the OpenBLAS library to R will bring better computational performance to the language in the most diverse algebraic operations commonly used in areas such as statistics, data science, and machine learning.

#### Introduction

The ropenblas package aims to provide useful and simple experiences to R (R Core Team, 2016) programmers who develop their activities on GNU/Linux operating systems, these many developers around the world producing codes of great impact for the community. These experiences consist of being able to link any version of the OpenBLAS (Xianyi, Zhang, Wang Qian, and Werner Saar, 2016) library to the R language, as well as allowing the programmer to install and link various versions of R and make them available on his operating system as well as switch between these versions as they see fit.

Linking the R language to the OpenBLAS library can bring several benefits to algebraic computing in R. OpenBLAS is an Open-Source implementation of the Basic Linear Algebra Subprograms - BLAS library that is often the first library option for algebraic computing to be linked in the installation of R on many GNU/Linux distributions. The OpenBLAS library is available at https://github.com/xianyi/OpenBLAS and adds optimized implementations of linear algebra kernels that can run optimized on various processor architectures. OpenBLAS is based on the GotoBLAS2 project code in version 1.13 (Goto, 2010), code available under the terms of the BSD license.

The ropenblas is a package designed to facilitate the linking of the library OpenBLAS with the language R. The package, which works only for Linux systems, will automatically download the latest source code from the OpenBLAS library and compile the code. The package will automatically bind the language R, through the ropenblas() function, to use the OpenBLAS library. Everything will be done automatically regardless of the Linux distribution you are using. Enumerating some advantages of the package:

- 1. Everything is done within the R language;
- 2. The procedure (use of functions) will be the same for any Linux distribution;

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#### Software

- Review 12
- Repository 2
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- 3. The OpenBLAS library will be compiled and you will choose which build version to bind to R, regardless of your Linux distribution;
- 4. The package allows you to install  $R \ge 3.1.0$ , also allowing you to install one more version, in addition to allowing you to easily switch between those versions;
- 5. The linked versions of R will continue to be recognized by their Integrated Development Environment IDE and nothing will have to be adjusted in your GNU/Linux distribution after using any function of the package;
- 6. Unnecessary builds will be avoided. Therefore, if you need to switch between compiled versions of the R language, the use of binaries compiled compiled previously will be suggested;
- 7. If any errors occur, the functions of the package will not damage the previous installation of the language;
- 8. If something better can be done or if a newer version of what you want to install (R or OpenBLAS) exists, the functions will automatically suggest that you should consider installing newer versions.

The ropenblas package is already available on the Comprehensive R Archive Network - CRAN, currently in version 0.2.9, and the project is maintained on GitHub at <a href="https://github.com/prdm0/ropenblas">https://github.com/prdm0/ropenblas</a> where contributors can find other details of the code, information, as well as being able to contribute with the development of the project.

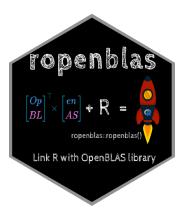


Figure 1: Computer library logo.

# **Brief explanation**

The ropenblas library exports six functions for use which are the rcompiler(), ropenblas(), last\_version\_r(), last\_version\_openblas(), link\_again() and rnews(). All of them are very simple to use and have few arguments that are sufficient to maintain the flexibility of use. Any example that follows will consider that the installation of the ropenblas package has been carried out and the package has been loaded (library(ropenblas)). Also, functions like rcompiler() and ropenblas() do not return content or data structures that are of any practical use. What these functions do is configure the GNU/Linux system to use R, configure different versions of the language, switch between versions, and link with the OpenBLAS library. It is also possible to obtain a summary of the versions of R and the OpenBLAS library that are available.

#### 'last\_version\_r' function

The function last\_version\_r() automatically searches, in the official repositories of language R, for information about versions of language R. Its general use is last\_version\_r(major = NULL), where the argument major indicates which is the



largest version of R that you want to search for the version list. Therefore, for argument major, a number must be passed, preferably an integer that indicates which is the largest version to be considered.

#### 'last\_version\_openblas' function

The last\_version\_openblas() function works similarly to the last\_version\_r() function, returning a list of three elements named in the same way with the information from the latest version, all the versions, and the number of versions of the OpenBLAS library, respectively.

### 'rcompiler' function

This function is responsible for compiling a version of the R language. The x argument is the version of R that you want to compile. For example, x = "4.0.4" will compile and link the R-4.0.4 version as the major version on your system. By default (x = NULL) will be compiled the latest stable version of the R. For example, to compile the latest stable version of the R language, run rcompiler(). The rcompiler() function can only be used if the user is an administrator of the GNU/Linux distribution. If the user is using programming IDE's, a screen similar to the image below will be displayed requesting the entry of the system administrator password.

```
> rcompiler(x = NULL, with_blas = NULL, complementary_flags = NULL)
```

- x: String with a valid R language version. A list valid of the latest language versions can be obtained using the last\_version\_r() function. You can move to x any of the returned versions. This is the best way to choose a valid argument for x. By default, x = NULL is equivalent to pass last\_version\_r()\$last\_version, that is, it will be considered the last stable version of the R language;
- with\_blas: This argument sets the --with-blas flag in the R language compilation process and must be passed as a string. Details on the use of this flag can be found here;
- complementary\_flags: String with complementary flags to be used in the R language compilation process.

If the goal is to install the R language, switch between versions of R, and link the installed versions of the language with the OpenBLAS library, you shouldn't have to worry about the with\_blas and complementary\_flags arguments, respectively. For more details, consult the README.md of the project or the official documentation of the package in CRAN.

#### 'ropenblas' function

The ropenblas() function, a function of the same name in the package, links the main version of the R language installed on your operating system with the OpenBLAS library. As in the rcompiler() function, the ropenblas() function requires the operating system administration password, that is, it must be executed by the system administrator.

```
> ropenblas(x = NULL, restart_r = TRUE)
```

The ropenblas() function is made up of two arguments. Are they:

- x: String with the version of the OpenBLAS library to be compiled, installed, and linked with the main R installation (by default it is considered the latest version);
- restart\_r: Logical value (default restart\_r = TRUE) to update the R section after compiling, installing, and linking the OpenBLAS library.



Table 1 below presents the benefit of considering an optimized version of BLAS. Computational costs are presented in the calculation of the singular decomposition in a rectangular matrix (svd() function) and in the calculation of the inverse of that same matrix (solve() function). Some repetitions (100 repetitions) of each of the respective functions were performed. The benchmark can be better observed through the violin plots shown in Figure 2.

**Table 1:** Comparison of the computational costs of the svd() and solve() functions (average of 100 repetitions).

Functions	Library	Time (seconds)
svd(x)	BLAS	6.520
svd(x)	OpenBLAS	0.641
solve(x)	BLAS	1.640
solve(x)	OpenBLAS	0.640

Through a benchmark it is possible to better understand the performance gain that can be achieved by linking the R language to the OpenBLAS library. Figure 2 presents the benchmarks in the form of a violin plot, in which 100 reproductions of the svd(X) expression were considered, in the form of the code above, with the R linked to the BLAS library and linked to the OpenBLAS library, respectively, on the same hardware. It was observed that the average time of execution of the routine svd(X) considering the OpenBLAS library was less than 10 times the time necessary to execute it in R linking to a non-optimized version of BLAS, being the average time of 0.64 and 6.52 seconds, respectively.

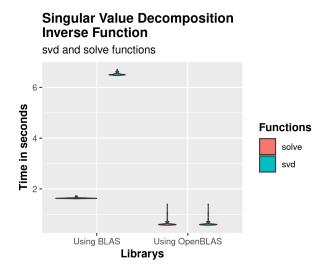


Figure 2: Benchmarks of a decomposition of singular and inverse value of a matrix of dimension  $1000 \times 1000$ .

#### 'link\_again' function

The link\_again() function links again the OpenBLAS library with the R language, being useful to correct problems of untying the OpenBLAS library that is common when the operating system is updated. The function can link again the R language with the



OpenBLAS library.

Thus, link\_again() will only make the linkage when in some previous section of R the ropenblas() function has been used for the initial binding of the R language with the OpenBLAS library.

#### 'rnews function'

The rnews() function returns the contents of the NEWS.html file in the standard browser installed on the operating system. The NEWS.html file contains the main changes from the recently released versions of the R language. The goal is to facilitate the query by invoking it directly from the R command prompt.

## **Improvements**

The package will continue to evolve and code reviews will always be carried out. In addition, contributions to the development of the package are always welcome, especially those that aim to allow the rcompiler() and ropenblas() functions to work on Windows systems. There is also an interest that the ropenblas package will allow the linking of the Intel Math Kernel Library - MKL, just as it is done with the OpenBLAS library. All of these are improvements that we would like to see in future versions of the package.

#### References

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