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R topics documented:  
inline-package ......................................................... 2  
cfunction .......................................................... 2  
cxxfunction ........................................................ 7  
getDynLib-methods ................................................ 9  
package.skeleton-methods ....................................... 9  
plugins ............................................................ 10  
utilities ........................................................... 11  

Index 14
Description

Functionality to dynamically define R functions and S4 methods with 'inlined' C, C++ or Fortran code supporting the .C and .Call calling conventions.

Maintainer

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See Also

cfunction, cxxfunction

cfunction

Inline C, C++, Fortran function calls from R

Description

Functionality to dynamically define R functions and S4 methods with in-lined C, C++ or Fortran code supporting .C and .Call calling conventions.

Usage

cfunction(sig=character(), body=character(), includes=character(),
odterdefs=character(),
language=c("C++", "C", "Fortran", "F95", "ObjectiveC", "ObjectiveC++"),
verbose=FALSE,
convention=c(".Call", ",C", ",Fortran"),
Rcpp=FALSE,
cppargs=character(), cxxargs=character(), libargs=character(),
dim=NULL, implicit=NULL, module=NULL)

## S4 methods for signatures
# f='character', sig='list', body='list'
# f='character', sig='character', body='character'

setCMethod(f, sig, body, ...)

## Further arguments:
Arguments

f  A single character value if sig and body are character vectors or a character vector of the same length and the length of sig or body with the name(s) of methods to create.

sig A match of formal argument names for the function with the character-string names of corresponding classes. Alternatively, a list of such character vectors.

body A character vector with C, C++ or Fortran code omitting function declaration (only the body, i.e. in case of C starting after the function opening curly bracket and ending before the closing curly bracket, brackets excluded). In case of setCMethod with signature list – a list of such character vectors.

includes A character vector of additional includes and preprocessor statements etc that will be put between the R includes and the user function(s).

otherdefs A characted vector with the code for any further definitions of functions, classes, types, forward declarations, namespace usage clauses etc which is inserted between the includes and the declarations of the functions defined in sig.

language A character value that specifies the source language of the inline code. The possible values for language include all those supported by R CMD SHLIB on any platform, which are currently C, C++, Fortran, F95, ObjectiveC and ObjectiveC++; they may not all be supported on your platform. One can specify the language either in full as above, or using any of the following case insensitive shortened forms: c, cpp, c++, f, f95, objc, objcpp, objc++. Defaults to C++.

verbose If TRUE prints the compilation output, the source code of the resulting program and the definitions of all declared methods. If FALSE, the function is silent, but it prints compiler warning and error messages and the source code if compilation fails.

convention Which calling convention to use? See the Details section.

Rcpp If TRUE adds inclusion of Rcpp.h to includes, also queries the Rcpp package about the location of header and library files and sets environment variables PKG_CXXFLAGS and PKG_LIBS accordingly so that the R/C++ interface provided by the Rcpp package can be used. Default value is FALSE.

cppargs Optional character vector of tokens to be passed to the compiler via the PKG_CPPFLAGS environment variable. Elements should be fully formed as for example c("-I/usr/local/lib/foo", "-lfoo") and are passed along verbatim.

cxxargs Optional character vector of tokens to be passed to the compiler via the PKG_CXXFLAGS environment variable. Elements should be fully formed as for example c("-I/usr/local/lib/foo", "-lfoo") and are passed along verbatim.

libargs Optional character vector of tokens to be passed to the compiler via the PKG_LIBS environment variable. Elements should be fully formed as for example c("-L/usr/local/lib/foo -lfoo") and are passed along verbatim.

dim Optional character vector defining the dimensionality of the function arguments. Of same length as sig. Fortran or F95 only.
implicit A character vector defining the implicit declaration in Fortran or F95; the default is to use the implicit typing rules for Fortran, which is integer for names starting with the letters I through N, and real for names beginning with any other letter. As R passes double precision, this is not the best choice. Safest is to choose implicit = "none" which will require all names in the subroutine to be explicitly declared.

module Name(s) of any modules to be used in the Fortran or F95 subroutine.

... Reserved.

Details

To declare multiple functions in the same library one can use setCMethod supplying lists of signatures and implementations. In this case, provide as many method names in f as you define methods. Avoid clashes when selecting names of the methods to declare, i.e. if you provide the same name several times you must ensure that signatures are different but can share the same generic!

The source code in the body should not include the header or "front-matter" of the function or the close, e.g. in C or C++ it must start after the C-function opening curly bracket and end before the C-function closing curly bracket, brackets should not be included. The header will be automatically generated from the R-signature argument. Arguments will carry the same name as used in the signature, so avoid variable names that are not legal in the target language (e.g. names with dots).

C/C++: If convention == ".Call" (the default), the .Call mechanism is used and its result is returned directly as the result of the call of the generated function. As the last line of the generated C/C++ code a return R NilValue; is added in this case and a warning is generated in case the user has forgotten to provide a return value. To suppress the warning and still return NULL, add return R NilValue; explicitly.

Special care is needed with types, memory allocation and protection – exactly the same as if the code was not inline: see the Writing R Extension manual for information on .Call.

If convention == ".C" or convention == ".Fortran", the .C or .Fortran mechanism respectively is used, and the return value is a list containing all arguments.

Attached R includes include R.h for ".C", and additionally Rdefines.h and R_ext\error.h for ".Call".

Value

If sig is a single character vector, cfunction returns a single function; if it is a list, it returns a list of functions.

setCMethod declares new methods with given names and signatures and returns invisible NULL.

Author(s)

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See Also

Foreign Function Interface
Examples

```r
x <- as.numeric(1:10)
n <- as.integer(10)

## Not run:
## A simple Fortran example - n and x: assumed-size vector
code <- "
  integer i
  do 1 i=1, n(1)
    1 x(i) = x(i)**3
  "
cubefn <- cfunction(signature(n="integer", x="numeric"), code, convention=".Fortran")
print(cubefn)

cubefn(n, x)$x

## Same Fortran example - now n is one number
code2 <- "
  integer i
  do 1 i=1, n
    1 x(i) = x(i)**3
  "
cubefn2 <- cfunction(signature(n="integer", x="numeric"), implicit = "none",
                   dim = c("", "(*)"), code2, convention=".Fortran")

cubefn2(n, x)$x

## Same in F95, now x is fixed-size vector (length = n)
code3 <- "x = x*x*x"
cubefn3 <- cfunction(sig = signature(n="integer", x="numeric"), implicit = "none",
                   dim = c("", "(*)"), code3, language="F95")
cubefn3(20, 1:20)
print(cubefn3)

## Same example in C
code4 <- "
  int i;
  for (i = 0; i < n; i++)
    x[i] = x[i]*x[i]*x[i];
  "
cubefn4 <- cfunction(signature(n="integer", x="numeric"), code4, language = "C", convention = ".C")
cubefn4(20, 1:20)

## End(Not run)
## use of a module in F95
modct <- "module modcts
  double precision, parameter :: pi = 3.14159265358979
double precision, parameter :: e = 2.71828182845905
end"
```

getconstants <- "\(x(1) = \pi\)  \\
\(x(2) = e\)"

cgetcts <- cfunction(getconstants, module = "modcts", implicit = "none",  
          includes = modcts, sig = c(x = "double"), dim = c("(2)"), language = "F95")

cgetcts(x = 1:2)  
print(cgetcts)

## Use of .C convention with C code  
## Defining two functions, one of which calls the other
sigSq <- signature(n="integer", x="numeric")
codeSq <- "
for (int i=0; i < *n; i++) {
    x[i] = x[i]*x[i];
}"

sigQd <- signature(n="integer", x="numeric")
codeQd <- "
squarefn(n, x);  
squarefn(n, x);  
"

fns <- cfunction( list(squarefn=sigSq, quadfn=sigQd),  
          list(codeSq, codeQd),  
          convention=".C")

squarefn <- fns["squarefn"]
quadfn <- fns["quadfn"]

squarefn(n, x)$x
quadfn(n, x)$x

## Alternative declaration using 'setMethod'  
setMethod(c("squarefn", "quadfn"), list(sigSq, sigQd),  
          list(codeSq, codeQd), convention=".C")

squarefn(n, x)$x
quadfn(n, x)$x

## Use of .Call convention with C code  
## Multiplying each image in a stack with a 2D Gaussian at a given position
code <- "
SEXP res;  
int nprotect = 0, nx, ny, nz, x, y;  
PROTECT(res = RF_duplicate(a)); nprotect++;  
  nx = INTEGER(GET_DIM(a))[0];  
  ny = INTEGER(GET_DIM(a))[1];  
  nz = INTEGER(GET_DIM(a))[2];  
  double sigma2 = REAL(s)[0] * REAL(s)[0], d2;  
  double cx = REAL(centre)[0], cy = REAL(centre)[1], *data, *rdata;  
  for (int im = 0; im < nz; im++) {  
    data = &(REAL(a)[im*nx*ny]); rdata = &(REAL(res)[im*nx*ny]);
for (x = 0; x < nx; x++)
    for (y = 0; y < ny; y++) {
        d2 = (x-cx)*(x-cx) + (y-cy)*(y-cy);
        rdata[x + y*nx] = data[x + y*nx] * exp(-d2/sigma2);
    }
}

UNPROTECT(nprotect);
return res;

funx <- cfunction(signature(a="array", s="numeric", centre="numeric"), code)

x <- array(runif(50*50), c(50,50,1))
res <- funx(a=x, s=10, centre=c(25,15))
if (interactive()) image(res[,1])

## Same but done by registering an S4 method
setMethod("funy", signature(a="array", s="numeric", centre="numeric"), code, verbose=TRUE)

res <- funy(x, 10, c(35,35))
if (interactive()) { x11(); image(res[,1]) }

### Description

Functionality to dynamically define an R function with inlined C++ code using the .Call calling convention.

The rcpp() wrapper sets the plugin to the “Rcpp” value suitable for using Rcpp.

### Usage

cxxfunction(sig = character(), body = character(),
            plugin = "default", includes = "",
            settings = getPlugin(plugin), ..., verbose = FALSE)
rcpp(..., plugin="Rcpp")

### Arguments

- **sig**: Signature of the function. A named character vector
- **body**: A character vector with C++ code to include in the body of the compiled C++ function
- **plugin**: Name of the plugin to use. See getPlugin for details about plugins.
- **includes**: User includes, inserted after the includes provided by the plugin.
- **settings**: Result of the call to the plugin
- **...**: Further arguments to the plugin
- **verbose**: verbose output
Value

A function

See Also

cfunction

Examples

```r
## Not run:

# default plugin
fx <- cxxfunction( signature(x = "integer", y = "numeric" ), 
return ScalarReal( INTEGER(x)[0] * REAL(y)[0] )
)  
f(x( 2L, 5 )

# Rcpp plugin
if( require( Rcpp ) ){  

fx <- cxxfunction( signature(x = "integer", y = "numeric" ), 
return wrap( as<int>(x) * as<double>(y) )
', plugin = "Rcpp"
)  
f(x( 2L, 5 )

    ## equivalent shorter form using rcpp()
fx <- rcpp(signature(x = "integer", y = "numeric"),
         ' return wrap( as<int>(x) * as<double>(y) )
')

}

# RcppArmadillo plugin
if( require( RcppArmadillo ) ){  

fx <- cxxfunction( signature(x = "integer", y = "numeric" ), 
int dim = as<int>( x )
arma::mat z = as<double>(y) * arma::eye<arma::mat>( dim, dim )
return wrap( arma::accu(z) )
', plugin = "RcppArmadillo"
)  
f(x( 2L, 5 )

}

## End(Not run)
```
getDynLib-methods

Retrieve the dynamic library (or DLL) associated with a package of a function generated by cfunction

Description

The getDynLib function retrieves the dynamic library (or DLL) associated with a package or with a function generated by cfunction.

Methods

signature(x = "CFunc") Retrieves the dynamic library associated with the function generated by cfunction. The library is dynamically loaded if necessary.

signature(x = "CFuncList") Retrieves the dynamic library associated with a set of functions generated by cfunction. The library is dynamically loaded if necessary.

signature(x = "character") Retrieves the dynamic library of the given name. This typically refers to package names, but can be any name of the list returned by getLoadedDLLs.

See Also

getLoadedDLLs, dyn.load

Examples

```r
## Not run:
getDynLib( "base" )

f <- cfunction( signature(), "return R_NilValue ;" )
getDynLib( f )

## End(Not run)
```

package.skeleton-methods

Generate the skeleton of a package

Description

Generate the skeleton of a package
Methods

signature(name = "ANY", list = "ANY") Standard method. See package.skeleton
signature(name = "character", list = "CFunc") Method for a single generated by cfunction or cxxfunction
signature(name = "character", list = "CFuncList") Method for a set functions generated by cfunction or cxxfunction

Examples

```r
## Not run:

fx <- cxxfunction( signature(x = "integer", y = "numeric") ,'
return ScalarReal( INTEGER(x)[0] * REAL(y)[0] ) ;
')
package.skeleton("foo", fx )

functions <- cxxfunction(
list(
  ff = signature(),
  gg = signature( x = "integer", y = "numeric" )
),
c("return R_NilValue ;", "return ScalarReal( INTEGER(x)[0] * REAL(y)[0] ) ;")
)
package.skeleton("foobar", functions )

## End(Not run)
```

---

**plugins**

Plugin system for cxxfunction

Description

**cxxfunction** uses a plugin system to assembly the code that it compiles. These functions allow to register and get plugins by their name.

Usage

```r
getPlugin(name, ...)
registerPlugin(name, plugin)
```

Arguments

- **name** name of the plugin.
- **...** Further arguments to pass to the plugin.
- **plugin** plugin function.
Details

plugins are functions that return a list with:

- **includes** mandatory. It is included at the top of the compiled file by `cxxfunction`.
- **body** optional. A function that takes one argument (the body of the C++ function) and returns a modified version of the body. The "Rcpp" plugin uses this to surround the code with the `BEGIN_RCPP` and `END_RCPP` macros.
- **LinkingTo** optional. Character vector containing the list of packages that the code needs to link to. This adds the include path of the given packages. The "Rcpp" and "RcppArmadillo" plugins use this.
- **env** optional. Named list of environment variables. For example, the "Rcpp" plugin uses this to add Rcpp user library to the `PKG_LIBS` environment variable.

Plugins can be manually registered using the `registerPlugin` function. Alternatively, a package may supply an inline plugin implicitly by defining a function called `inlineCxxPlugin`, which does not necessarily need to be exported from the namespace of the package. Known packages implementing this scheme include Rcpp and RcppArmadillo.

Value

- `getPlugin` retrieves the plugin and invokes it with the...arguments.
- `registerPlugin` does not return anything.

See Also

- `cxxfunction`

Examples

```r
## Not run:
getPlugin("Rcpp")

## End(Not run)
```

utilities  printing, reading and writing CFunc objects

Description

`writeDynLib` saves the DLL and the CFunc or CFuncList object as generated by `cfunction`; `readDynLib` loads it.

The `print` and `code` methods respectively print the entire object or the code parts.

Usage

```r
writeDynLib(x, file)
readDynLib(file)
```
Arguments

x  A CFunc or CFuncList object as created by \texttt{cfunction} to be saved.

file  base name of the file to write the object to or to read from. Two files will be saved, one for the shared object or DLL (extension \texttt{so} or \texttt{dll}) and one that holds the CFunc or CFuncList specification, without the function address (extension \texttt{cfunc}).

Details

Both the CFunc or CFuncList object and the shared object or DLL are saved, in two files; the first has extension \texttt{cfunc}; the second \texttt{so} or \texttt{dll}, depending on the operating system used.

When reading, both files are loaded, and the compiled function address added to the object.

Value

Function \texttt{readDynLib} returns a CFunc or CFuncList object.

Methods

- Method \texttt{print(x, \ldots)} prints the entire object \texttt{x}
  
  \texttt{signature(x = "CFunc")} Prints the CFunc object generated by \texttt{cfunction}, including the code that generated it.
  
  \texttt{signature(x = "CFuncList")} Print all CFunc objects generated by \texttt{cfunction}, including the code that generated them.

- Method \texttt{code(x, linenumbers = TRUE, \ldots)} prints the code only
  
  \texttt{signature(x)} The CFunc or CFuncList object as generated by \texttt{cfunction}.
  
  \texttt{linenumbers} If \texttt{TRUE} all code lines will be numbered.

Note

- The code of a CFunc or CFuncList object \texttt{x} can be extracted (rather than printed), using: \texttt{x@code}.

- To write the code to a file (here called "fn"), without the new-line character "\n":
  
  \texttt{write (strsplit(x, "\n")[[1]], file = "fn")}

Author(s)

Karline Soetaert

See Also

\texttt{getDynLib}
Examples

```r
x <- as.numeric(1:10)
n <- as.integer(10)

code <- "
    integer i
    do 1 i=1, n(1)
      1 x(i) = x(i)**3
"
cubefn <- cfunction(signature(n="integer", x="numeric"), code, convention=".Fortran")

cubefn(n, x)$x

## Not run:
fname <- tempfile()
writeDynLib(cubefn, file = fname)
# load and assign different name to object
cfn <- readDynLib(fname)
print(cfn)
cfn(2, 1:2)

## End(Not run)
```
Index

*Topic file
  cfunction, 2
  utilities, 11

*Topic interface
  cxxfunction, 7
  plugins, 10

*Topic methods
  getDynLib-methods, 9
  package.skeleton-methods, 9

*Topic package
  inline-package, 2

*Topic programming
  cxxfunction, 7
  plugins, 10
  .C, 4
  .Call, 4, 7
  .Fortran, 4

  cfunction, 2, 2, 8–12
  code (utilities), 11
  code, CFunc-method (utilities), 11
  code, CFuncList-method (utilities), 11
  code, character-method (utilities), 11
  code-methods (utilities), 11
  cxxfunction, 2, 7, 10, 11
  dyn.load, 9

  Foreign, 4
  function, 4

  getDynLib, 12
  getDynLib (getDynLib-methods), 9
  getDynLib.CFunc-method (getDynLib-methods), 9
  getDynLib.CFuncList-method (getDynLib-methods), 9
  getDynLib.character-method (getDynLib-methods), 9
  getDynLib-methods, 9

  getLoadedDLLs, 9
  getPlugin, 7
  getPlugin (plugins), 10

  inline (inline-package), 2
  inline-package, 2

  package.skeleton, 10
  package.skeleton, ANY, ANY-method
    (package.skeleton-methods), 9
  package.skeleton, character, CFunc-method
    (package.skeleton-methods), 9
  package.skeleton, character, CFuncList-method
    (package.skeleton-methods), 9
  package.skeleton-methods, 9
  plugins, 10
  print, CFunc-method (utilities), 11
  print, CFuncList-method (utilities), 11

  rcpp (cxxfunction), 7
  readDynLib (utilities), 11
  registerPlugin (plugins), 10

  setCMethod (cfunction), 2

  utilities, 11

  writeDynLib (utilities), 11