Package 'inline'

August 29, 2016

Version 0.3.14

Date 2015-04-11

Title Functions to Inline C, C++, Fortran Function Calls from R

Author Oleg Sklyar, Duncan Murdoch, Mike Smith, Dirk Eddelbuettel, Romain Francois, Karline Soetaert

Maintainer Dirk Eddelbuettel <edd@debian.org>

Depends R (>= 2.4.0), methods

Suggests Rcpp (>= 0.11.0)

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

License LGPL

Copyright Oleg Sklyar, 2005-2010 and other authors per their commits

LazyLoad yes

BugReports https://github.com/eddelbuettel/inline/issues

NeedsCompilation no

Repository CRAN

Date/Publication 2015-04-13 09:20:41

R topics documented:

`inline-package` *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.

Details

Package:	inline
Type:	Package
Version:	0.3.8
Date:	2010-12-07
License:	LGPL
LazyLoad:	yes

Author(s)

Oleg Sklyar, Duncan Murdoch, Mike Smith, Dirk Eddelbuettel, Romain Francois

Maintainer: Oleg Sklyar <oleg.sklyar@googlemail.com>

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(),
          otherdefs=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:
  #  setCMethod(f, sig, body, includes="", otherdefs="", cpp=TRUE,
  #  verbose=FALSE, where=topenv(.GlobalEnv), ...)
```

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", "- 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", "- 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 -lfo 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 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)

Oleg Sklyar, Duncan Murdoch, Mike Smith, Dirk Eddelbuettel

See Also

Foreign Function Interface

Examples

```
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("", "(n)"), 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 = modct, 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 'setCMethod'
setCMethod(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
## Multyplying 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
setCMethod("funy", signature(a="array", s="numeric", centre="numeric"), code, verbose=TRUE)

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

`cxxfunction` *inline C++ function*

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

```
## Not run:

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

# Rcpp plugin
if( require( Rcpp ) ){

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

```
## 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

```
## 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

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

Arguments

name	name of the plugin.
...	Further argments 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 returned 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 implicitely 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

```
## 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

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

Arguments

x	A CFunc or CFuncList object as created by 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 so or DLL) and one that holds the CFunc or CFuncList specification, without the function address (extension CFunc).

Details

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

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

Value

Function readDynLib returns a CFunc or CFuncList object.

Methods

- Method print(x, ...) prints the entire object x

  signature(x = "CFunc") Prints the CFunc object generated by cfunction, including the code that generated it.

  signature(x = "CFuncList") Print all CFunc objects generated by cfunction, including the code that generated them.

- Method code(x, linenumbers = TRUE, ...) prints the code only

  signature(x) The CFunc or CFuncList object as generated by cfunction.

  linenumbers If TRUE all code lines will be numbered.

Note

- The code of a `CFunc` or `CFuncList` object `x` can be extracted (rather than printed), using: `x@code`.
- To write the code to a file (here called `"fn"`), without the new-line character `"\n"`: `write (strsplit(x, "\n")[[1]], file = "fn")`

Author(s)

Karline Soetaert

See Also

`getDynLib`

Examples

```
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")
code(cubefn)

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