Using `car` Functions in Other Functions

John Fox[*]& Sanford Weisberg[†]

2019-06-05

Abstract

The `car` package (Fox and Weisberg, 2011) provides many functions that are applied to a fitted regression model, perform additional calculations on the model or possibly compute a different model, and then return values and graphs. In some cases, users may wish to write functions that call functions in `car` for a particular purpose. Because of the scoping rules used in R, several functions in `car` that work when called from the command prompt may fail when called inside another function. We discuss how users can modify their programs to avoid this problem.

1 `ncvTest`

The function `ncvTest` (Fox and Weisberg, 2011, Sec. 6.5.2) computes tests for non-constant variance in linear models as a function of the mean, the default, or any other linear function of regressors, even for regressors not part of the mean function. For example,

```
library(car)
m2 <- lm(prestige ~ education, Prestige)
ncvTest(m2, ~ income)

Non-constant Variance Score Test
Variance formula: ~ income
Chisquare = 1.521, Df = 1, p = 0.22
```

fits `prestige` as a linear function of `education`, and tests for nonconstant variance as a function of `income`, another regressor in the data set `Prestige`. Embedding this in a function fails:

```
f3 <- function(meanmod, dta, varmod) {
  m3 <- lm(meanmod, dta)
  ncvTest(m3, varmod)
  }
f3(prestige ~ education, Prestige, ~ income)
```

[*]Department of Sociology, McMaster University
[†]School of Statistics, University of Minnesota

```
Error in is.data.frame(data) : object 'dta' not found
```

In this case the model m3 is defined in the environment of the function, and the argument dta is defined in the global environment, and is therefore invisible when ncvTest is called. A solution is to copy dta to the global environment.

```
f4 <- function(meanmod, dta, varmod) {
   assign(".dta", dta, envir=.GlobalEnv)
   assign(".meanmod", meanmod, envir=.GlobalEnv)
   m1 <- lm(.meanmod, .dta)
   ans <- ncvTest(m1, varmod)
   remove(".dta", envir=.GlobalEnv)
   remove(".meanmod", envir=.GlobalEnv)
   ans
   }
f4(prestige ~ education, Prestige, ~income)
```

```
Non-constant Variance Score Test
Variance formula: ~ income
Chisquare = 1.521, Df = 1, p = 0.22
```

```
 f4(prestige ~ education, Prestige, ~income)
```

```
Non-constant Variance Score Test
Variance formula: ~ income
Chisquare = 1.521, Df = 1, p = 0.22
```

The assign function copies the dta and meanmod arguments to the global environment where ncvTest will be evaluated, and the remove function removes them before exiting the function. This is an inherently problematic strategy, because an object assigned in the global environment will replace an existing object of the same name. Consequently we renamed the dta argument .dta, with an initial period, but this is not a *guarantee* that there was no preexisting object with this name.

This same method can be used with functions in the effects package. Suppose, for example, you want to write a function that will fit a model, provide printed summaries and also draw a effects plot. The following function will fail:

```
library(effects)
fc <- function(dta, formula, terms) {
 print(m1 <- lm(formula, .dta))
 Effect(terms, m1)
 }
form <- prestige ~ income*type + education
terms <- c("income", "type")
fc(Duncan, form, terms)
```

As with ncvTest, dta will not be in the correct environment when Effect is evaluated. The solution is to copy dta to the global environment:

```
library(effects)
fc.working <- function(dta, formula, terms) {
 assign(".dta", dta, env=.GlobalEnv)
 print(m1 <- lm(formula, .dta))
 Effect(terms, m1)
 remove(".dta", envir=.GlobalEnv)
 }
fc.working(Duncan, form, terms)
```

Assigning `formula` to the global environment is not necessary here because it is used by `lm` but not by `Effect`.

2   Boot

The `Boot` function in `car` provides a convenience front-end for the function `boot` in the `boot` package (Canty and Ripley, 2013; Fox and Weisberg, 2012). With no arguments beyond the name of a regression object and the number of replications `R`, `Boot` creates the proper arguments for `boot` for case resampling bootstraps, and returns the coefficient vector for each sample:

```
 m1 <- lm(time ~ t1 + t2, Transact)
 b1 <- Boot(m1, R=999)
 summary(b1)

Number of bootstrap replications R = 999
            original bootBias  bootSE bootMed
(Intercept)   144.37  5.97165 196.381  155.74
t1              5.46  0.00579   0.679    5.48
t2              2.03 -0.00235   0.155    2.03
```

The returned object `b1` is of class `"boot"`, as are objects created directly from the `boot` function, so helper functions in the `boot` package and in `car` can be used on these objects, e.g.,

```
 confint(b1)

Bootstrap bca confidence intervals

              2.5 %  97.5 %
(Intercept) -258.087 512.535
t1             3.849   6.572
t2             1.772   2.385
```

The `Boot` function would have scoping problems even without the user embedding it in a function because the `boot` function called by `Boot` tries to evaluate the model defined in the global environment in a local environment. In `car` we define an environment

```
 .carEnv <- new.env(parent=emptyenv())
```

and then evaluate the model in the environment `.carEnv`. This environment is not exported, so to see that it exists you would need to enter `car:::.carEnv`. We use this same trick in the `Boot.default` function so that `.carEnv` is globally visible. Here is a copy of `Boot.default` to show how this works.

```
 Boot.default <- function(object, f=coef, labels=names(coef(object)),
                          R=999, method=c("case", "residual")) {
   if(!(require(boot))) stop("The 'boot' package is missing")
   f0 <- f(object)
   if(length(labels) != length(f0)) labels <- paste("V", seq(length(f0)), sep="")
   method <- match.arg(method)
   if(method=="case") {
      boot.f <- function(data, indices, .fn) {
       assign(".boot.indices", indices, envir=car:::.carEnv)
       mod <- update(object, subset=get(".boot.indices", envir=car:::.carEnv))
       if(mod$qr$rank != object$qr$rank){
             out <- .fn(object)
             out <- rep(NA, length(out)) } else  {out <- .fn(mod)}
      out
      }
     } else {
     boot.f <- function(data, indices, .fn) {
       first <- all(indices == seq(length(indices)))
       res <- if(first) object$residuals else
                    residuals(object, type="pearson")/sqrt(1 - hatvalues(object))
       res <- if(!first) (res - mean(res)) else res
       val <- fitted(object) + res[indices]
       if (!is.null(object$na.action)){
             pad <- object$na.action
             attr(pad, "class") <- "exclude"
             val <- naresid(pad, val)
             }
       assign(".y.boot", val, envir=car:::.carEnv)
       mod <- update(object, get(".y.boot", envir=car:::.carEnv) ~ .)
       if(mod$qr$rank != object$qr$rank){
             out <- .fn(object)
             out <- rep(NA, length(out)) } else  {out <- .fn(mod)}
      out
      }
   }
   b <- boot(data.frame(update(object, model=TRUE)$model), boot.f, R, .fn=f)
   colnames(b$t) <- labels
   if(exists(".y.boot", envir=car:::.carEnv))
      remove(".y.boot", envir=car:::.carEnv)
   if(exists(".boot.indices", envir=car:::.carEnv))
```

```
    remove(".boot.indices", envir=car:::.carEnv)
  b
  }
```

The was also fixed in `bootCase`.

References

Angelo Canty and Brian Ripley. boot: Bootstrap R (S-Plus) functions. R package version 1.3-9, 2013.

J. Fox and S. Weisberg. *An R Companion to Applied Regression*. Sage, Thousand Oaks CA, 2nd edition, 2011. URL `http://z.umn.edu/carbook`.

J. Fox and S. Weisberg. Bootstrapping regression models in R. Technical report, 2012. URL `http://socserv.mcmaster.ca/jfox/Books/Companion/appendix/Appendix-Bootstrapping.pdf`.