

STAT 5400 (22S:166) Computing in Statistics

More on R

Lecture 6
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Types of data in R

- numeric
- character
- logical
- factor

Types of R objects

- vectors
- matrices
- data frames
- lists

Lists in R

- lists are R objects that contain other named R objects
- often used to return results of functions when different parts of the results are of different types and lengths

Example: Using the glm function for generalized linear models

```
> help(glm)

glm                                package:stats                                R Documentation
Fitting Generalized Linear Models

Description:

'glm' is used to fit generalized linear models, specified by
giving a symbolic description of the linear predictor and a
description of the error distribution.

Usage:

glm(formula, family = gaussian, data, weights, subset,
na.action, start = NULL, etastart, mustart,
offset, control = glm.control(...), model = TRUE,
method = "glm.fit", x = FALSE, y = TRUE, contrasts = NULL, ...)
```

Arguments:

formula: a symbolic description of the model to be fit. The details of model specification are given below.

family: a description of the error distribution and link function to be used in the model. This can be a character string naming a family function, a family function or the result of a call to a family function. (See 'family' for details of family functions.)

data: an optional data frame, list or environment (or object coercible by 'as.data.frame' to a data frame) containing the variables in the model. If not found in 'data', the variables are taken from 'environment(formula)', typically the environment from which 'glm' is called.

weights: an optional vector of weights to be used in the fitting process. Should be 'NULL' or a numeric vector.

method: the method to be used in fitting the model. The default method 'glm.fit' uses iteratively reweighted least squares (IWLS). The only current alternative is 'model.frame' which returns the model frame and does no fitting.

intercept: logical. Should an intercept be included in the `_null_model`?

...: further arguments passed to or from other methods.

deviance: up to a constant, minus twice the maximized log-likelihood. Where sensible, the constant is chosen so that a saturated model has deviance zero.

aic: Akaike's `_An Information Criterion`, minus twice the maximized log-likelihood plus twice the number of coefficients (so assuming that the dispersion is known).

null.deviance: The deviance for the null model, comparable with 'deviance'. The null model will include the offset, and an intercept if there is one in the model

iter: the number of iterations of IWLS used.

weights: the `_working_ weights`, that is the weights in the final iteration of the IWLS fit.

prior.weights: the case weights initially supplied.

df.residual: the residual degrees of freedom.

df.null: the residual degrees of freedom for the null model.

y: the 'y' vector used. (It is a vector even for a binomial model.)

converged: logical. Was the IWLS algorithm judged to have converged?

boundary: logical. Is the fitted value on the boundary of the attainable values?

call: the matched call.

Value:

'glm' returns an object of class inheriting from "glm" which inherits from the class "lm". See later in this section.

The function 'summary' (i.e., 'summary.glm') can be used to obtain or print a summary of the results and the function 'anova' (i.e., 'anova.glm') to produce an analysis of variance table.

The generic accessor functions 'coefficients', 'effects', 'fitted.values' and 'residuals' can be used to extract various useful features of the value returned by 'glm'.

'weights' extracts a vector of weights, one for each case in the fit (after subsetting and 'na.action').

An object of class "glm" is a list containing at least the following components:

coefficients: a named vector of coefficients

residuals: the `_working_ residuals`, that is the residuals in the final iteration of the IWLS fit. Since cases with zero weights are omitted, their working residuals are 'NA'.

fitted.values: the fitted mean values, obtained by transforming the linear predictors by the inverse of the link function.

rank: the numeric rank of the fitted linear model.

family: the 'family' object used.

linear.predictors: the linear fit on link scale.

formula: the formula supplied.

terms: the 'terms' object used.

data: the 'data argument'.

offset: the offset vector used.

control: the value of the 'control' argument used.

method: the name of the fitter function used, currently always 'glm.fit'.

contrasts: (where relevant) the contrasts used.

xlevels: (where relevant) a record of the levels of the factors used in fitting.

In addition, non-empty fits will have components 'qr', 'R' and 'effects' relating to the final weighted linear fit.

A worked example

Create the data frame for analysis

```
> clotting <- data.frame(
+   u = c(5,10,15,20,30,40,60,80,100),
+   lot1 = c(118,58,42,35,27,25,21,19,18),
+   lot2 = c(69,35,26,21,18,16,13,12,12))
```

Assign output of glm function to an object

```
> clot.glm <- glm(lot1 ~ log(u), data=clotting, family=Gamma)
> names(clot.glm)
 [1] "coefficients"      "residuals"        "fitted.values"
 [4] "effects"           "R"                 "rank"
 [7] "qr"                "family"            "linear.predictors"
[10] "deviance"          "aic"               "null.deviance"
[13] "iter"              "weights"           "prior.weights"
[16] "df.residual"       "df.null"           "y"
[19] "converged"         "boundary"          "model"
[22] "call"              "formula"           "terms"
[25] "data"              "offset"            "control"
[28] "method"            "contrasts"         "xlevels"
```

Extract items from the list object

```
> clot.glm$coefficients
(Intercept)      log(u)
-0.01655438  0.01534311
> coefficients(clot.glm)
(Intercept)      log(u)
-0.01655438  0.01534311
> clot.glm[[1]]
(Intercept)      log(u)
i-0.01655438  0.01534311
> clot.glm$residuals
      1          2          3          4          5
3.219040e-04 -1.669367e-03 -1.245089e-03 -8.626301e-04  1.353040e-03
      6          7          8          9
-4.456895e-05  1.314957e-03  1.879617e-03  1.414312e-03

> clot.glm$call
glm(formula = lot1 ~ log(u), family = Gamma, data = clotting)
```

Apply generic R function to the object

```
> summary(clot.glm)

Call:
glm(formula = lot1 ~ log(u), family = Gamma, data = clotting)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.04008  -0.03756  -0.02637   0.02905   0.08641

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.0165544  0.0009275  -17.85 4.28e-07 ***
log(u)       0.0153431  0.0004150   36.98 2.75e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for Gamma family taken to be 0.002446013)

Null deviance: 3.512826  on 8  degrees of freedom
Residual deviance: 0.016730  on 7  degrees of freedom
AIC: 37.99

Number of Fisher Scoring iterations: 3
```

Writing your own R functions

- structure of a function

```
function( <arguments> )
{
  <body of function>
  <object to return>
}
```

example: function to solve quadratic equations

```
quadratic <- function( a, b, c)
{
  discrim <- b * b - 4 * a * c

  if( discrim < 0 )
  {
    solution <- c(NA,NA)
    errflag <- 1
  }
  else
  {
    if( a ) # if a is not 0
    {
      mult <- c(1,-1)
      solution <- ( -b + mult * sqrt( discrim ) ) / (2 * a)
      errflag <- 0
    }
    else
    {
      solution <- c(NA,NA)
      errflag <- 2
    }
  }

  list( solution = solution, errflag = errflag)
}
```

This program is saved in a file called “quadratic.R.” Using **source** to execute this file in R will put the function in R’s memory.

```
source("quadratic.R")
```

Looping in R

```
for (i in 1:10) {
}

for (j in c(1,37, 81) {
  print( j/2 )
}
```

Timing R calculations

- **system.time** function with a line of R code as its argument
- third number returned is the elapsed time
- in example below, execution of the loop took .004 seconds

```
> ans <- 0
> system.time( for(i in 1:5000) ans <- i + ans )
   user  system elapsed 
0.003  0.000  0.004
```