流行病學與生物統計計算 Homework 8
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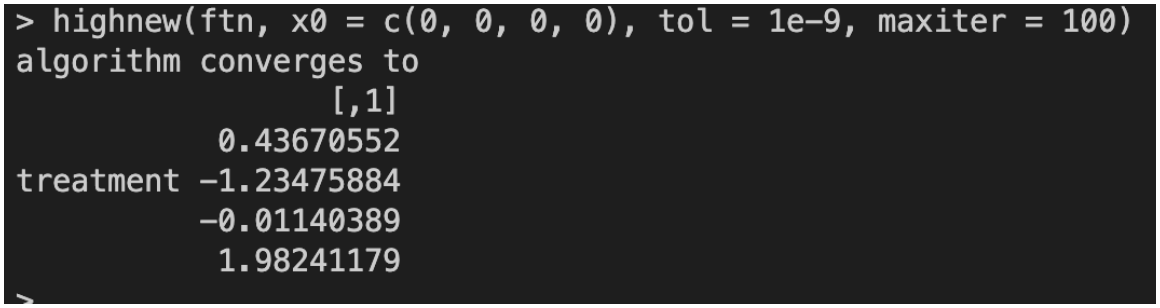
# Homework8

# EX 20-1

Q1 : use Newton-Raphson method to find MLE of the regression coefficient og logistic regression

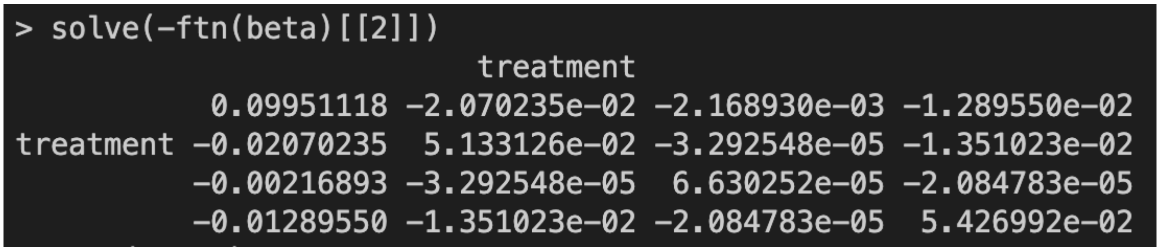
```
# EX 20-1
    setwd("/Users/raymond/Desktop/")
    resp <- read.csv("/Users/raymond/Desktop/resp.csv", header = TRUE)
    head(resp)
    dim(resp)

    # Q1 : use NR to find maximum likelihood estimate of beta

        # convert treatment to numeric, setting "P" be 1, "A" be 0
            respma <- as.data.frame(resp)
            for (i in 1 : length(resp$treatment)) {
                if (respma[i, 3] == "P") {
                    respma[i, 3] <- 1
                } else {
                    respma[i, 3] <- 0
                }
            }
            head(respma)
            (treatment <- as.numeric(respma[, 3]))

       # constructing matrix
            X <- cbind(rep(1, length(resp$outcome)), treatment, resp$age, resp$baseline) # nolint
            Y <- resp$outcome # nolint

        # ftn
            ftn <- function(betacoef) {
                pi1 <- exp(X %*% betacoef) / (1 + exp(X %*% betacoef))
                gradient <- t(X) %*% (Y - pi1)
                hessian <- - t(X) %*% diag(c(pi1 * (1 - pi1)),
length(resp$outcome)) %*% X # nolint

                return(list(gradient, hessian))
            }

        # highorder Newton-Raphson method
        highnew <- function(ftn, x0, tol, maxiter) {
            x <- x0
            fx <- ftn(x)
            iter <- 0

            while ((max(abs(fx[[1]])) > tol) && (iter < maxiter)) {
                x <- x - (solve(fx[[2]]) %*% fx[[1]])
                fx <- ftn(x)
                iter <- iter + 1
            }

            if (max(abs(fx[[1]])) > tol) {
                cat("algorithm failed to converge\n")
                return(NULL)
            } else {
                cat("algorithm converges to\n")
                return(x)
            }
        }
        highnew(ftn, x0 = c(0, 0, 0,0), tol = 1e-9, maxiter = 100)
```



```
> highnew(ftn, x0 = c(0, 0, 0, 0), tol = 1e-9, maxiter = 100)
algorithm converges to
                 [,1]
           0.43670552
treatment -1.23475884
          -0.01140389
           1.98241179
>
```

# Q2：find the variance-covariance matrix

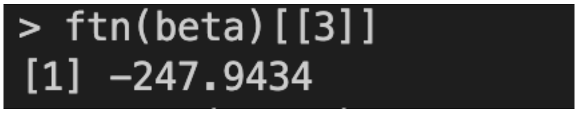
```
(beta <- highnew(ftn, c(0, 0, 0, 0), tol = 1e-9, maxiter = 100))
solve(-ftn(beta)[[2]])
```



```
> solve(-ftn(beta)[[2]])
                              treatment
             0.09951118 -2.070235e-02 -2.168930e-03 -1.289550e-02
treatment -0.02070235  5.133126e-02 -3.292548e-05 -1.351023e-02
            -0.00216893 -3.292548e-05  6.630252e-05 -2.084783e-05
            -0.01289550 -1.351023e-02 -2.084783e-05  5.426992e-02
```

# Q3：find the log likelihood

```
X <- cbind(rep(1, length(resp$outcome)), treatment, resp$age, resp$baseline)
Y <- resp$outcome
ftn <- function(betacoef) {
    pi1 <- exp(X %*% betacoef) / (1 + exp(X %*% betacoef))
    gradient <- t(X) %*% (Y - pi1)
    hessian <- - t(X) %*% diag(c(pi1 * (1 - pi1)), length(resp$outcome)) %*%
X # nolint
    loglike <- sum(Y * log(pi1 / (1 - pi1)) + log(1 - pi1))

    return(list(gradient, hessian, loglike))
}

ftn(beta)[[3]]
```



```
> ftn(beta)[[3]]
[1] -247.9434
```