

Newton-Raphson

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Output using GLM

```
m1 <- glm(crashes ~ traffic_vol + pct_rural,  
          data = bike, family = "poisson")  
round(summary(m1)$coef[,1], 4)
```

```
## (Intercept) traffic_vol  pct_rural  
##          5.9822      0.0015      -0.0446
```

Numerical implementation of Poisson regression

```
# Prepare data for computation  
bike$intercept = 1  
X <- bike %>% select(intercept, traffic_vol, pct_rural)  
y <- bike$crashes  
  
y <- matrix(y, ncol = 1)  
X <- data.matrix(X)  
colnames(X) <- NULL  
  
# Initialize beta  
beta <- c(1, 0.1, 0.1) # [1] 5.0 0.1 0.1 # current dimension 3*1
```

```
# calculating the score  
calc.score <- function(beta, X, y){  
  d1 <- rep(0, length(beta))  
  for(i in 1:length(y)){  
    d1 <- d1 + (y[i] - exp(X[i,] %*% beta)) %*% X[i,]  
  }  
  return(t(d1)) # returns 3*1 matrix  
}  
  
#calculating hessian matrix  
calc.hess <- function(beta, X, y){  
  d1 <- matrix(rep(0,9), ncol=3)  
  for(i in 1:length(y)){  
    d1 <- d1 + (exp(X[i,] %*% beta)[1,1]*(X[i,]%*%t(X[i,])))  
  }  
}
```

```

    return(-d1) # returns 3*3 matrix
}

```

```

iter = 1

while (iter <= 100){ # max 100 iter

  beta_new = beta- t(solve(calc.hess(beta, X, y)) %% calc.score(beta, X, y))[1,]
  # 1*3 vector = 1*3 vector - t( 3*3 matrix %% 3*1 matrix )'s first row
  # 1*3 vector = 1*3 vector - 1*3 vector

  if (dist(rbind(beta, beta_new)) < 0.00000001){
    # using distance between vector to define convergence
    print("satisfied criteria of convergence")
    print("stopped at:")
    print(iter)
    break
  }
  beta <- beta_new
  iter = iter + 1
}

```

```

## [1] "satisfied criteria of convergence"
## [1] "stopped at:"
## [1] 39

```

```

beta # matchs

```

```

## [1] 5.98218054 0.00154064 -0.04455809

```

(Note: I found whether the convergence criteria is met depends on the initial value. It works well when I set beta to (1, 0.1, 0.1), but if I set it to something too far from the solution it's unable to converge, especially for beta2, and beta3. It runs into the issue of singular matrix).