

## Assignment 3 MATH 208 (Question 1)

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MATH 208 - Assignment 3

(a)

```
logistic_Regression = function(theta, x1, x2) {  
  p = 1/(1+exp(-x1*theta[1] - x2*theta[2] - theta[3]))  
  return(p)  
}
```

(b)

```
cross_entropy_loss = function(theta, x1, x2, y){  
  p = logistic_Regression(theta, x1, x2)  
  log_reg = 0  
  # Negative sum from 1 to n  
  for (i in seq_along(y)){  
    single_pass =  
      y[i]*log(p[i]) +  
      (1-y[i])*log(1-p[i])  
    log_reg = log_reg - single_pass  
  }  
  return(log_reg)  
}
```

(c)

```
loss_funct <- function(col1,col2){  
  x1_d <- c(HTRU2[[col1]])  
  x2_d <- c(HTRU2[[col2]])  
  y_d <- c(HTRU2$Class)  
  result<-optim(par=c(0,0,0), fn=cross_entropy_loss, x1=x1_d, x2=x2_d, y=y_d)  
}
```

```
result = loss_funct(1,5)  
result
```

```
## $par  
## [1] -0.10569326 0.01629013 7.28979911  
##  
## $value
```

```
## [1] 1991.015
##
## $counts
## function gradient
##      218      NA
##
## $convergence
## [1] 0
##
## $message
## NULL
```

```
# Thetas = -0.10569326 0.01629013 7.28979911
# Value = 1991.015
```

(d)

```
var_combs<-combn(names(HTRU2[, -9]), 2)
res = NULL
for(i in seq_along(names(HTRU2[1,]))){
  for(j in 1:8){
    if(j<=i){
      next
    }
    if(i == 8 & j == 8){
      break
    }
    cross_entropy <- loss_funct(i,j)
    cross_entropy_val <- cross_entropy$value
    table <- tibble(
      "col1" = var_combs[1,i],
      "col2" = var_combs[2,i],
      "cross entropy loss" = cross_entropy_val
    )
    res = bind_rows(table,res)
  }
}
kable(res[order(res$`cross entropy loss`),])
```

col1	col2	cross entropy loss
Mean_IP	SKW_IP	1427.745
Mean_IP	SKW_IP	1429.591
Mean_IP	SKW_IP	1434.257
Mean_IP	SKW_IP	1450.829
Mean_IP	SD_IP	1483.505
Mean_IP	EK_IP	1490.764
Mean_IP	SKW_IP	1502.008
Mean_IP	SD_IP	1759.214
Mean_IP	SD_IP	1763.425
Mean_IP	SD_IP	1790.573
Mean_IP	Mean_DMSNR	1834.243
Mean_IP	Mean_DMSNR	1839.221

col1	col2	cross entropy loss
Mean_IP	Mean_DMSNR	1875.364
Mean_IP	SD_IP	1918.023
Mean_IP	SD_IP	1991.015
Mean_IP	Mean_DMSNR	2021.685
Mean_IP	SD_IP	2052.101
Mean_IP	EK_IP	2305.642
Mean_IP	EK_IP	2777.460
Mean_IP	EK_IP	2877.531
Mean_IP	EK_IP	2953.056
Mean_IP	EK_IP	3365.135
Mean_IP	SD_DMSNR	3772.916
Mean_IP	EK_DMSNR	3800.222
Mean_IP	SKW_DMSNR	3808.527
Mean_IP	EK_DMSNR	3809.508
Mean_IP	SD_DMSNR	3869.097
Mean_IP	SD_DMSNR	3971.733

(e)

```
var_combs = combn(names(HTRU2[, -9]), 2)

loss_funct2 = function(columns){
  x1_d = c(HTRU2[[toString(columns[[1]])]])
  x2_d = c(HTRU2[[toString(columns[[2]])]])
  y_d = c(HTRU2$class)

  result = optim(
    par=c(0,0,0),
    fn=cross_entropy_loss,
    x1 = x1_d,
    x2 = x2_d,
    y = y_d
  )

  table = tibble(
    "col1" = columns[[1]],
    "col2" = columns[[2]],
    "cross entropy loss" = result$value
  )
  return(table)
}

end_result = map_dfr(as.data.frame(var_combs), loss_funct2)
end_result = end_result[order(end_result$`cross entropy loss`),]
kable(end_result)
```

col1	col2	cross entropy loss
EK_IP	SD_DMSNR	1427.745
EK_IP	EK_DMSNR	1429.591
EK_IP	SKW_DMSNR	1434.257
EK_IP	SKW_IP	1450.829

coll	col2	cross entropy loss
Mean_IP	EK_IP	1483.505
SD_IP	EK_IP	1490.764
EK_IP	Mean_DMSNR	1502.008
Mean_IP	SD_DMSNR	1759.214
Mean_IP	EK_DMSNR	1763.425
Mean_IP	SKW_DMSNR	1790.573
SKW_IP	SD_DMSNR	1834.243
SKW_IP	EK_DMSNR	1839.221
SKW_IP	SKW_DMSNR	1875.364
Mean_IP	SKW_IP	1918.023
Mean_IP	Mean_DMSNR	1991.015
SKW_IP	Mean_DMSNR	2021.685
Mean_IP	SD_IP	2052.101
SD_IP	SKW_IP	2305.642
SD_IP	EK_DMSNR	2777.460
SD_IP	SD_DMSNR	2877.531
SD_IP	SKW_DMSNR	2953.056
SD_IP	Mean_DMSNR	3365.135
Mean_DMSNR	EK_DMSNR	3772.916
SD_DMSNR	SKW_DMSNR	3800.222
EK_DMSNR	SKW_DMSNR	3808.527
SD_DMSNR	EK_DMSNR	3809.508
Mean_DMSNR	SKW_DMSNR	3869.097
Mean_DMSNR	SD_DMSNR	3971.733