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```r
##################  3  ##################
# Parameters
beta_hat <- c(1, 0.5)
phi_hat <- 0.1

X <- cbind(1, 1:10)

eta <- X %*% beta_hat
mu <- exp(eta)
W <- diag(1 / (phi_hat * mu^2))

cov_beta_hat <- solve(t(X) %*% W %*% X)

# Display the estimated covariance matrix
print(cov_beta_hat)
# [,1]      [,2]
# [1,]  4.736239 -2.191896
# [2,] -2.191896  1.385940
```

09

#

$y \sim N(X\beta, \sigma^2 I)$

Now, $\hat{y}_f = x_f' \hat{\beta}$

$V(e_f) = \sigma^2 (1 + x_f' (X'X)^{-1} x_f)$

$C.I = \hat{y}_f \pm t_{\alpha/2} \sqrt{\hat{\sigma}^2 (1 + x_f' (X'X)^{-1} x_f)}$

Here, $\hat{y}_f$: The predicted value of new observation

$t_{\alpha/2}$: The c.v

$\hat{\sigma}^2$: Estimated variance

```r

################### Start  5  ###################

# Coefficients for RET=3
beta_03 <- -4.27817
beta_13 <- 0.178304
X_i <- 20
eta_i3 <- beta_03 + beta_13 * X_i
P_Y_i_3_given_X_i_20 <- exp(eta_i3) / (1 + exp(eta_i3))
print(P_Y_i_3_given_X_i_20) # 0.3291372

################### End  5   ###################
```

```r
###################  6  ###################
beta_0 <- 99.56799
beta_1 <- 21.61455
beta_2 <- -3.54113
x_i <- 50

mu_i <- beta_0 + (beta_1 - beta_0) * exp(-(exp(beta_2 * x_i)))
print(mu_i) # 21.61455
###################  6  ###################
```