

# G - Computation: Code Example

## Estimating average response

```
mean_response <- function(treat_sequence, coef_estimates, MC) {
  mu0 <- coef_estimates[1]; sigma0 <- coef_estimates[2]
  beta0 <- coef_estimates[3]; beta1 <- coef_estimates[4]; beta2 <- coef_estimates[5];
  beta3 <- coef_estimates[6]; beta4 <- coef_estimates[7];
  beta5 <- coef_estimates[8]; beta6 <- coef_estimates[9];
  beta7 <- coef_estimates[10];

  sigma <- coef_estimates[11]; gamma0 <- coef_estimates[12]; gamma1 <- coef_estimates[13]

  ##### Time Period 0
  R0 <- rep(0, MC)
  logCD40 <- rnorm(MC, mu0, sigma0)
  A0 <- rep(treat_sequence[1], MC)
  cumA0 <- A0

  ### Time Period 1
  R1 <- rbinom(MC, 1, expit(gamma0 + gamma1*cumA0)
    ) * (cumA0 > 0 & R0 == 0) + 0*(cumA0 == 0) + 1*(R0 == 1)

  logCD41 <-
    beta0 + beta1*logCD40 + beta2*A0 + beta3*R1 +
    beta4*logCD40*A0 + beta5*logCD40*R1 + beta6*A0*R1 + beta7*logCD40*A0*R1 +
    rnorm(MC, 0, sigma)

  A1 <- rep(treat_sequence[2], MC)
  cumA1 <- A0 + A1

  ### Time Period 2
```

```

R2 <- rbinom(MC, 1, expit(gamma0 + gamma1*cumA1)
             )*(cumA1 > 0 & R1 == 0) + 0*(cumA1 == 0) + 1*(R1 == 1)

logCD42 <-
  beta0 + beta1*logCD41 + beta2*A1 + beta3*R2 +
  beta4*logCD41*A1 + beta5*logCD41*R2 + beta6*A1*R2 + beta7*logCD41*A1*R2 +
  rnorm(MC, 0, sigma)

A2 <- rep(treat_sequence[3], MC)
cumA2 <- A0 + A1 + A2

### Time Period 3
R3 <- rbinom(MC, 1, expit(gamma0 + gamma1*cumA2)
             )*(cumA2 > 0 & R2 == 0) + 0*(cumA2 == 0) + 1*(R2 == 1)

logCD43 <-
  beta0 + beta1*logCD42 + beta2*A2 + beta3*R3 +
  beta4*logCD42*A2 + beta5*logCD42*R3 + beta6*A2*R3 + beta7*logCD42*A2*R3 +
  rnorm(MC, 0, sigma)

A3 <- rep(treat_sequence[4], MC)
cumA3 <- A0 + A1 + A2 + A3

### Time Period 4
R4 <- rbinom(MC, 1, expit(gamma0 + gamma1*cumA3)
             )*(cumA3 > 0 & R3 == 0) + 0*(cumA3 == 0) + 1*(R3 == 1)

logCD44 <-
  beta0 + beta1*logCD43 + beta2*A3 + beta3*R4 +
  beta4*logCD43*A3 + beta5*logCD43*R4 + beta6*A3*R4 + beta7*logCD43*A3*R4 +
  rnorm(MC, 0, sigma)

mean_response <- c(mean(logCD44), mean(exp(logCD44)))
names(mean_response) <- c("mean_logCD4", "mean_CD4")
return(mean_response)
}

trt_sequences <- list(
  c(0, 0, 0, 0),
  c(0, 0, 0, 1),
  c(0, 0, 1, 1),

```

```

      c(0, 1, 1, 1),
      c(1, 1, 1, 1),
      c(1, 1, 1, 0),
      c(1, 1, 0, 0),
      c(1, 0, 0, 0)
    )
  set.seed(8172013)
  mean_trt_response <-
    sapply(trt_sequences,
           mean_response,
           coef_estimates = as.vector(coef_estimates[, 1]), MC = 100000)

  mean_trt_response <- t(mean_trt_response)

  rownames(mean_trt_response) <-
    c("(0, 0, 0, 0)",
      "(0, 0, 0, 1)",
      "(0, 0, 1, 1)",
      "(0, 1, 1, 1)",
      "(1, 1, 1, 1)",
      "(1, 1, 1, 0)",
      "(1, 1, 0, 0)",
      "(1, 0, 0, 0)")
  #print(mean_trt_response, digits = 3)

```

## Bootstrap to Estimate SE

```
dataHW3_orig <- dataHW3

n <- nrow(dataHW3_orig)

boot <- 50

mean_trt_response_boot <- array(0, dim = c(8, 2, boot))

for(j in 1:boot) {
  dataHW3 <- dataHW3_orig[sample(1:n, n, replace = TRUE), ]

  # get estimates of mu0 and sigma0

  mu0 <- mean(dataHW3$logCD40)

  sigma0 <- sd(dataHW3$logCD40)

  dataHW3$ID <- 1:n

  dataHW3_long <-
    melt(setDT(dataHW3),
         id = 1L,
         measure = patterns("^logCD4", "^CD4", "^R", "^A"),
         value.name = c("logCD4", "CD4", "R", "A")
    )

  dataHW3_long <- data.frame(dataHW3_long)

  dataHW3_long <- dataHW3_long[order(dataHW3_long$ID), ]

  dataHW3_long <-
    dataHW3_long %>%
    group_by(ID) %>%
    mutate(
      lag_logCD4 = lag(logCD4, n = 1, default = NA),
      lag_A = lag(A, n = 1, default = NA),
      cum_A = cumsum(A),
      lag_cum_A = lag(cum_A, n = 1, default = NA),
      lag_R = lag(R, n = 1, default = NA)
    )
}
```

```

    )

dataHW3_long <-
  mutate(
    dataHW3_long,
    time = as.numeric(variable) - 1,
    logCD4_diff = logCD4 - lag_logCD4)

dataHW3_long_t0 <- filter(dataHW3_long, time > 0)

m1 <- lm(logCD4 ~ lag_logCD4 + lag_A + R +
  lag_logCD4*lag_A + lag_logCD4*R +
  lag_A*R + lag_logCD4*lag_A*R, data = dataHW3_long_t0)

dataHW3_long_resist_model <- filter(dataHW3_long_t0, lag_R == 0 & lag_cum_A > 0)

m2 <- glm(R ~ lag_cum_A, family = "binomial",
  data = dataHW3_long_resist_model)

coef_estimates <- c(mu0, sigma0, coef(m1), summary(m1)$sigma, coef(m2))

mean_trt_response <-
  sapply(trt_sequences,
    mean_response,
    coef_estimates = coef_estimates,
    MC = 100000)

mean_trt_response <- t(mean_trt_response)

mean_trt_response_boot[, , j] <- mean_trt_response
}

se <- apply(mean_trt_response_boot, c(1, 2), sd)
rownames(se) <- c("(0, 0, 0, 0)",
  "(0, 0, 0, 1)",
  "(0, 0, 1, 1)",
  "(0, 1, 1, 1)",
  "(1, 1, 1, 1)",
  "(1, 1, 1, 0)",
  "(1, 1, 0, 0)",
  "(1, 0, 0, 0)")

```

```
colnames(se) <- c("SE_logCD4", "SE_CD4")  
print(se, digits = 2)
```