

Example analysis

Linear model, smoking is the exposure, birthweight in grams the outcome

```
infunc_confint <- function(ofit, wfit, exposurename, outcomename) {  
  
  data <- ofit$data  
  data1 <- data0 <- data  
  data1[[exposurename]] <- 1  
  data0[[exposurename]] <- 0  
  
  n <- nrow(data1)  
  
  est1f <- mean(predict(ofit, newdata = data1, type = "response"))  
  est0f <- mean(predict(ofit, newdata = data0, type = "response"))  
  
  # refit using unweighted eqs  
  ofitunwt <- glm(ofit$formula, family = ofit$family,  
                 data = data)  
  
  phat <- predict(wfit, type = "response")  
  
  est1 <- predict(ofitunwt, newdata = data1, type = "response")  
  est0 <- predict(ofitunwt, newdata = data0, type = "response")  
  
  XXw <- model.matrix(wfit)  
  XXo <- XXo1 <- XXo0 <- model.matrix(ofitunwt)  
  XXo1[,exposurename] <- 1  
  XXo0[,exposurename] <- 0  
  
  ifweight <- t(vcov(wfit)) %*% t(sandwich::estfun(wfit)))
```

```

ifout <- t(vcov(ofit) %*% t(sandwich::estfun(ofitunwt)))

eifterms1 <- (data[[exposurename]] / phat * (data[[outcomename]] - est1) + (est1 - est1f
eifterms0 <- ((1 - data[[exposurename]]) / (1 - phat) * (data[[outcomename]] - est0) + (

hdot <- family(wfit)$mu.eta(predict(wfit, type = "link"))

gdot0 <- family(ofit)$mu.eta(predict(ofitunwt, newdata = data0, type = "link"))
gdot1 <- family(ofit)$mu.eta(predict(ofitunwt, newdata = data1, type = "link"))

Kterm1 <- (-1/n) * matrix(((data[[exposurename]] * hdot) / phat^2) *
                        (data[[outcomename]] - est1), nrow = 1, ncol = n) %*%
  XXw
Kterm0 <- (1/n) * matrix((((1 - data[[exposurename]]) * hdot) / (1 - phat)^2) *
                        (data[[outcomename]] - est0), nrow = 1, ncol = n) %*%
  XXw

Lterm1 <- (1/ n) * matrix(gdot1 * (1 - data[[exposurename]]/phat), nrow = 1, ncol = n) %
  XXo1
Lterm0 <- (1/ n) * matrix(gdot0 * ((1 - data[[exposurename]])/(1 - phat) - 1), nrow = 1,
  XXo0

fullif1 <- cbind(eifterms1, (ifweight %*% t(Kterm1)), (ifout %*% t(Lterm1)))
fullif0 <- cbind(eifterms0, (ifweight %*% t(Kterm0)), (ifout %*% t(Lterm0)))

estse <- sqrt(sum((rowSums(fullif1) - rowSums(fullif0))^2))
est <- est1f - est0f

c(lower = est - 1.96 * estse, upper = est + 1.96 * estse)

}

data <- AF::clslowbwt
head(data)

```

```

id birth  smoke      race age lwt  bwt    low lbw smoker
1  1      1 1. Yes 3. Other  28 120 2865  0. No   0      1

```

2	1	2	1. Yes	3. Other	33	141	2609	0. No	0	1
3	2	1	0. No	1. White	29	130	2613	0. No	0	0
4	2	2	0. No	1. White	34	151	3125	0. No	0	0
5	2	3	0. No	1. White	37	144	2481	1. Yes	1	0
6	3	1	1. Yes	2. Black	31	187	1841	1. Yes	1	1

```
## propensity score fit
```

```
pwfit <- glm(smoker ~ race * age * lwt + I(age^2) + I(lwt^2), data = data,
            family = "binomial")
```

```
phat <- predict(pwfit, type = "response")
```

```
data$weight <- data$smoker / phat + (1 - data$smoker) / (1 - phat)
```

```
## outcome model
```

```
outfit <- glm(bwt ~ smoker * (race + age + lwt) + I(age^2) + I(lwt^2),
            data = data, family = "gaussian", weights = weight)
```

```
## dummy data, where we set X to 0 and 1
```

```
data0 <- data1 <- data
```

```
data0$smoker <- 0
```

```
data1$smoker <- 1
```

```
## predicted counterfactuals
```

```
Yhat0 <- predict(outfit, newdata = data0, type = "response")
```

```
Yhat1 <- predict(outfit, newdata = data1, type = "response")
```

```
ATEmean <- mean(Yhat1) - mean(Yhat0)
```

```
ATEmean
```

```
[1] -223.6736
```

```
infunc_confint(outfit, pwfit, "smoker", "bwt")
```

lower	upper
-446.081852	-1.265258

```

## CAN Richard Funk?

## separate outcome models, unweighted

ofit1 <- glm(bwt ~ (race + age + lwt) + I(age^2) + I(lwt^2),
             data = subset(data, smoker == 1), family = "gaussian")

ofit0 <- glm(bwt ~ (race + age + lwt) + I(age^2) + I(lwt^2),
             data = subset(data, smoker == 0), family = "gaussian")

dr1 <- data$bwt * (data$smoker == 1) / phat -
  predict(ofit1, newdata = data1, type = "response") *
  ((data$smoker == 1) - phat) / phat
dr0 <- data$bwt * (data$smoker == 0) / (1 - phat) +
  predict(ofit0, newdata = data0, type = "response") *
  ((data$smoker == 1) - phat) / (1 - phat)

ATEfunk <- mean(dr1) - mean(dr0)
ATEfunk

```

[1] -225.5489

Bootstrap for confidence interval, not echoed

2.5%	97.5%
-387.12347	-46.48662

Logistic model, smoking is the exposure, low birthweight (birth weight < 2500g) the outcome

```

## propensity score fit

pwfit <- glm(smoker ~ race * age * lwt + I(age^2) + I(lwt^2), data = data,
             family = "binomial")
phat <- predict(pwfit, type = "response")

data$weight <- data$smoker / phat + (1 - data$smoker) / (1 - phat)
## outcome model

```

```
outfit <- glm(lbw ~ smoker * (race + age + lwt) + I(age^2) + I(lwt^2),
             data = data, family = "binomial", weights = weight)
```

Warning in eval(family\$initialize): non-integer #successes in a binomial glm!

```
## dummy data, where we set X to 0 and 1
```

```
data0 <- data1 <- data
data0$smoker <- 0
data1$smoker <- 1
```

```
## predicted counterfactuals
```

```
Yhat0 <- predict(outfit, newdata = data0, type = "response")
Yhat1 <- predict(outfit, newdata = data1, type = "response")
```

```
ATEmean <- mean(Yhat1) - mean(Yhat0)
ATEmean
```

```
[1] 0.134932
```

```
infunc_confint(outfit, pwfit, "smoker", "lbw")
```

```
      lower      upper
0.0009662041 0.2688977028
```

```
RRmean <- mean(Yhat1) / mean(Yhat0)
RRmean
```

```
[1] 1.478392
```

```
## separate outcome models, unweighted
```

```
ofit1 <- glm(lbw ~ (race + age + lwt) + I(age^2) + I(lwt^2),
             data = subset(data, smoker == 1), family = "binomial")
```

```
ofit0 <- glm(lbw ~ (race + age + lwt) + I(age^2) + I(lwt^2),
             data = subset(data, smoker == 0), family = "binomial")
```

```

dr1 <- data$lbw * (data$smoker == 1) / phat -
  predict(ofit1, newdata = data1, type = "response") *
  ((data$smoker == 1) - phat) / phat
dr0 <- data$lbw * (data$smoker == 0) / (1 - phat) +
  predict(ofit0, newdata = data0, type = "response") *
  ((data$smoker == 1) - phat) / (1 - phat)

ATEfunk <- mean(dr1) - mean(dr0)
RRfunk <- mean(dr1) / mean(dr0)
ATEfunk

```

```
[1] 0.1372512
```

```
RRfunk
```

```
[1] 1.488187
```

Bootstrap for confidence interval, not echoed

```

      2.5%      97.5%
0.0279252 0.2411590

```

```

      2.5%      97.5%
1.082286 2.004029

```