Randall_Boyes_Week2

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1. Construct a linear regression of weight as predicted by height, using the adults (age 18 or greater) from the Howell1 dataset. The heights listed below were recorded in the !Kung census, but weights were not recorded for these individuals. Provide predicted weights and 89% compatibility intervals for each of these

```
data(Howell1)

d <- Howell1
d2 <- d[ d$age >= 18 , ]

flist <- alist(
  weight ~ dnorm( mu , sigma ) ,
  mu <- alpha + height * beta,
  alpha ~ dnorm(0, 10),
  beta ~ dnorm(1, 5),
  sigma ~ dexp(10)
)

m1 <- quap( flist , data=d2 )
```

```
gt::gt(data.frame(precis(m1)))
```

mean	sd	X5.5.	X94.5.
-44.1670061	3.97593395	-50.5213165	-37.8126958
0.5768418	0.02569128	0.5357822	0.6179015
4.0250292	0.14118518	3.7993880	4.2506704

```
sim.weight <- sim(m1, data=list(height=c(140,160,175)))
weight.PI <- apply( sim.weight , 2 , PI , prob=0.89 )
mean <- apply(sim.weight, 2, mean)
gt::gt(data.frame(cbind(c(140, 160, 175), mean, t(weight.PI))))
```

V1	mean	X5.	X94.
140	36.61769	30.29815	42.87357
160	48.30321	41.75651	55.03890
175	56.61173	50.30472	63.11501

2. From the Howell1 dataset, consider only the people younger than 13 years old. Estimate the causal association between age and weight. Assume that age influences weight through two paths. First, age influences height, and height influences weight. Second, age directly influences weight through age related changes in muscle growth and body proportions. All of this implies this causal model (DAG):

Use a linear regression to estimate the total (not just direct) causal effect of each year of growth on weight. Be sure to carefully consider the priors. Try using prior predictive simulation to assess what they imply.

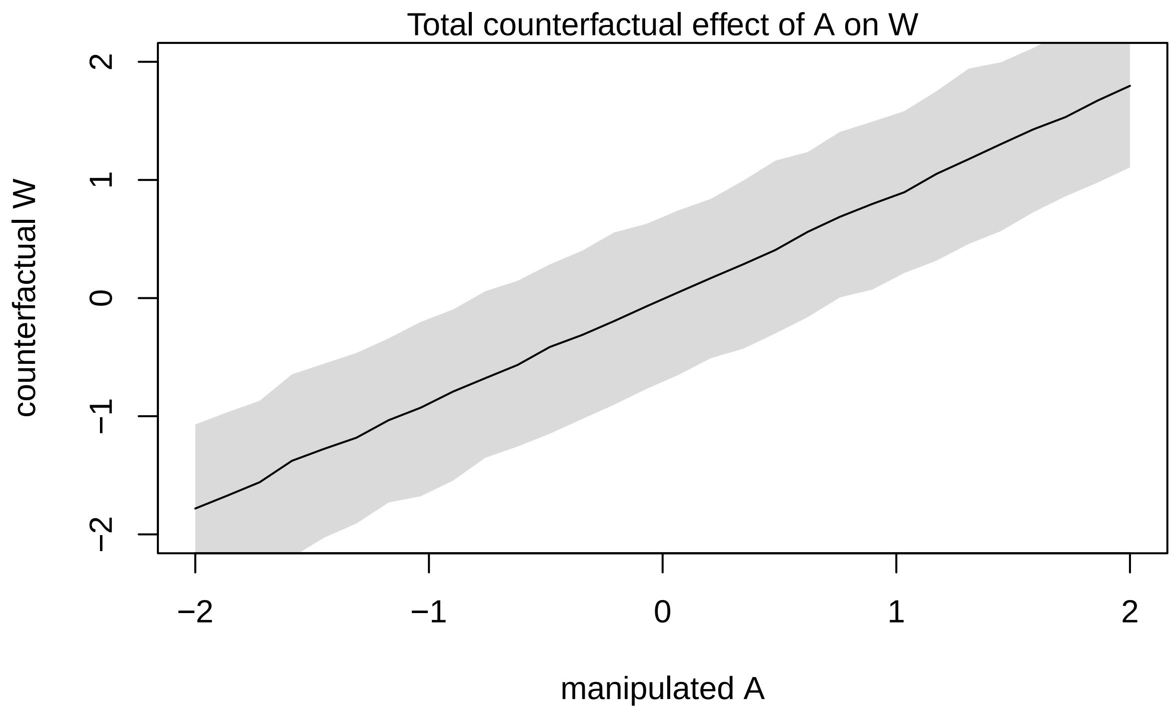
```
q2 <- d[d$age < 13, ]

q2l <- list()
q2l$A <- standardize( q2$age )
q2l$W <- standardize( q2$weight )
q2l$H <- standardize( q2$height )

m2 <- quap(
  alist(
  ## A -> W <- H
    W ~ dnorm( mu , sigma ) ,
    mu <- a + bH*H + bA*A ,
    a ~ dnorm( 0 , 0.2 ) ,
    bH ~ dnorm( 0 , 0.5 ) ,
    bA ~ dnorm( 0 , 0.5 ) ,
    sigma ~ dexp( 1 ),
  ## A -> H
    H ~ dnorm( mu_H , sigma_H ),
    mu_H <- aH + bAH*A,
    aH ~ dnorm( 0 , 0.2 ),
    bAH ~ dnorm( 0 , 0.5 ),
    sigma_H ~ dexp( 1 )
) , data = q2l )
```

```
sim_dat <- data.frame( A = seq( from=-2 , to=2 , length.out=30 ) )
s <- sim( m2 , data=sim_dat , vars=c("H","W") )

plot( sim_dat$A , colMeans(s$W) , ylim=c(-2,2) , type="l" ,
xlab="manipulated A" , ylab="counterfactual W" )
shade( apply(s$W,2,PI) , sim_dat$A )
mtext( "Total counterfactual effect of A on W" )
```



In kg per year:

```
(mean(s$W[,30]) - mean(s$W[,1]))/4 * sd(q2$weight)/sd(q2$age)
```

```
## [1] 1.338365
```

3. Now suppose the causal association between age and weight might be different for boys and girls. Use a single linear regression, with a categorical variable for sex, to estimate the total causal effect of age on weight separately for boys and girls. How do girls and boys differ? Provide one or more posterior contrasts as a summary.

```
q3 <- d[d$age < 13, ]

q3l <- list()
q3l$A <- standardize( q3$age )
q3l$W <- standardize( q3$weight )
q3l$H <- standardize( q3$height )
q3l$M <- q3$male

m3 <- quap(
  alist(
  ## A -> W <- H
    W ~ dnorm( mu , sigma ) ,
    mu <- aM*M + M*bMH*H + M*bMA*A + a + bH*H + bA*A,
    a ~ dnorm( 0 , 0.2 ) ,
    aM ~ dnorm( 0 , 0.2 ) ,
    bH ~ dnorm( 0 , 0.5 ) ,
    bA ~ dnorm( 0 , 0.5 ) ,
```

```r
    bMH ~ dnorm( 0 , 0.5 ) ,
    bMA ~ dnorm( 0 , 0.5 ) ,
    sigma ~ dexp( 1 ),
  ## A -> H
    H ~ dnorm( mu_H , sigma_H ),
    mu_H <- aH + M*aMH + bAH*A + M*A*bAHM,
    aH ~ dnorm( 0 , 0.2 ),
    aMH ~ dnorm( 0 , 0.2 ),
    bAH ~ dnorm( 0 , 0.5 ),
    bAHM ~ dnorm( 0 , 0.5 ),
    sigma_H ~ dexp( 1 )
) , data = q3l )
```

```r
precis(m3)
```

```
##                 mean         sd        5.5%        94.5%
## a       -0.051677442 0.02834603 -0.09697987 -0.006375018
## aM       0.081920832 0.04057259  0.01707800  0.146763667
## bH       0.754918542 0.06890062  0.64480204  0.865035043
## bA       0.165018579 0.06916873  0.05447359  0.275563571
## bMH      0.270794073 0.10095072  0.10945533  0.432132818
## bMA     -0.169324956 0.10027309 -0.32958071 -0.009069198
## sigma    0.245580086 0.01435538  0.22263741  0.268522762
## aH      -0.071318779 0.04250420 -0.13924871 -0.003388851
## aMH      0.150509697 0.06017957  0.05433112  0.246688274
## bAH      0.915211340 0.04406663  0.84478435  0.985638328
## bAHM    -0.005318731 0.06341585 -0.10666951  0.096032045
## sigma_H  0.385220757 0.02251436  0.34923846  0.421203056
```

1. Males are reliably taller than females on average (aM > 0).
2. Males gain more weight for the same amount of height gain (bMH > 0)