Week 3 Problems

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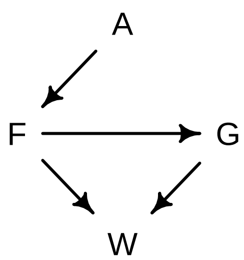
1. The first two problems are based on the same data. The data in data(foxes) are 116 foxes from 30 different urban groups in England. These fox groups are like street gangs. Group size (groupsize) varies from 2 to 8 individuals. Each group maintains its own (almost exclusive) urban territory. Some territories are larger than others. The area variable encodes this information. Some territories also have more avgfood than others. And food influences the weight of each fox. Assume this DAG:



where F is avgfood, G is groupsize, A is area, and W is weight.

Use the backdoor criterion and estimate the total causal influence of A on F. What effect would increasing the area of a territory have on the amount of food inside it?

Solution Based on the DAG, there are not other variables affecting A or mediating the effect of A on F, therefore it would be enough to produce a linear model

```
data("foxes")
d <- foxes

d$G <- scale(d$groupsize)
d$A <- scale(d$area)
d$W <- scale(d$weight)
d$F <- scale(d$avgfood)

m1_a <- quap(
  alist(
    F ~ dnorm(mu,sigma),
    mu  <- a + b_A*A,
    a ~ dnorm(0,1),
    b_A ~ dnorm(0,2),
    sigma ~ dexp(1)
    ),
  data = d
```

```
)

precis(m1_a)
```

```
                mean         sd        5.5%      94.5%
a      -3.318673e-07 0.04324665 -0.06911684 0.06911617
b_A     8.826871e-01 0.04346472  0.81322206 0.95215208
sigma   4.662169e-01 0.03051634  0.41744588 0.51498791
```

Based on the results, there is a positive effect of the change in area on the food availability, i.e. an increase of area is linked to an increase of avg food.

2. Infer the total causal effect of adding food F to a territory on the weight W of foxes. Can you calculate the causal effect by simulating an intervention on food?

Solution There are two paths through which food availability affects the weight of foxes. To determine the total causal effect it would be enough just to use F and W

```
m2 <- quap(
  alist(
    W ~ dnorm(mu,sigma),
    mu  <- a + b_F*F,
    a ~ dnorm(0,1),
    b_F ~ dnorm(0,2),
    sigma ~ dexp(1)
    ),
  data = d
)

precis(m2)
```

```
                mean         sd       5.5%     94.5%
a      -3.424736e-10 0.09163817 -0.1464555 0.1464555
b_F    -2.498556e-02 0.09232609 -0.1725405 0.1225694
sigma   9.911437e-01 0.06465853  0.8878069 1.0944805
```

The total casual effect of F is not conclusive.

3. Infer the direct causal effect of adding food F to a territory on the weight W of foxes. In light of your estimates from this problem and the previous one, what do you think is going on with these foxes?

Solution In this case, there is a *pipe* formed by F->G->W; so, to estimate the direct casual effect it is necessary to stratify by G

```
m3 <- quap(
  alist(
    W ~ dnorm(mu,sigma),
    mu  <- a + b_F*F + b_G*G,
    a ~ dnorm(0,1),
```

```r
    b_F ~ dnorm(0,2),
    b_G ~ dnorm(0,2),
    sigma ~ dexp(1)
    ),
  data = d
)

precis(m3)
```

```
               mean         sd       5.5%      94.5%
a      7.423111e-08 0.08688019 -0.1388512  0.1388514
b_F    6.279613e-01 0.20052555  0.3074827  0.9484398
b_G   -7.256985e-01 0.20052565 -1.0461773 -0.4052198
sigma  9.392799e-01 0.06129760  0.8413145  1.0372453
```

The direct effect of F on W is positive, while the effect of G on W is negative, which explains the results of the previous model.