STATISTICAL RETHINKING 2025
WEEK 3 SOLUTIONS

1. Because there are no back-door paths from `area` to `avgfood`, we only need to include `area` to the causal effect of area. No other variables are needed. In fact, adding other variables could cause bias. Here is a model using standardized versions of the variables and those standardized priors from the book:

```
library(rethinking)
data(foxes)
d <- foxes
d$W <- standardize(d$weight)
d$A <- standardize(d$area)
d$F <- standardize(d$avgfood)
d$G <- standardize(d$groupsize)

m1 <- quap(
    alist(
        F ~ dnorm( mu , sigma ),
        mu <- a + bA*A,
        a ~ dnorm(0,0.2),
        bA ~ dnorm(0,0.5),
        sigma ~ dexp(1)
    ), data=d )

precis(m1)
```

```
      mean   sd  5.5% 94.5%
a     0.00 0.04 -0.07  0.07
bA    0.88 0.04  0.81  0.95
sigma 0.47 0.03  0.42  0.52
```

Territory size seems to have a substantial effect on food availability. These are standardized variables, so `bA` above means that each standard deviation change in area results on average in about 0.9 standard deviations of change in food availability.

2. The problem is that the adjustment set of $\{F, G, A\}$ is not correct for estimate the effect of F on W. The reason is that the DAG I gave you contains

no backdoor paths from F to W. So no other variables are necessary in the adjustment set. Just a simple regression of W on F will do.

Here is how you can do it:

```
m2 <- quap(
    alist(
        W ~ dnorm( mu , sigma ),
        mu <- a + bF*F,
        a ~ dnorm(0,0.2),
        bF ~ dnorm(0,0.5),
        sigma ~ dexp(1)
    ), data=d )
precis(m2)
```

```
       mean   sd  5.5% 94.5%
a      0.00 0.08 -0.13  0.13
bF    -0.02 0.09 -0.17  0.12
sigma  0.99 0.06  0.89  1.09
```

There seems to be only a small total effect of food on weight, if there is any effect at all. It's about equally plausible that it's negative as positive, and it's small either way.

The effect your imaginary colleague estimated is some garbled over-adjusted coefficient. Since your colleague adjusted for G as well, this closes the pipe that carries influence of F through G to W. So the large 2.5 estimate for F is at best the direct effect of F on W, not the total causal effect.

The total causal effect of F on W is plausibly zero, because more food in a territory attracts more foxes (larger G), resulting in each fox eating the same as before. Ecologists call this general result an ideal free distribution.