Problem Set 3

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2025-04-21

Make a model of avgfood ~ area

```r
# Load Data
data("foxes")

# Set priors for model
priors <- c(
  prior(normal(1, 2), class = "Intercept"),
  prior(normal(0, 4), class = "b"),
  prior(exponential(1), class = "sigma")
)
```

```r
# Fit the model
food_by_area <- brm(
  formula = avgfood ~ 1 + area,
  data = foxes,
  family = gaussian(),
  prior = priors,
  iter = 2000,
  warmup = 500,
  seed = 213,
  file = here("files/models/foxes_food_by_area")
)

# Print the summarized results of the model
posterior_summary(food_by_area) %>% round(2)
```

```
##             Estimate Est.Error   Q2.5  Q97.5
## b_Intercept     0.15      0.03   0.09   0.21
## b_area          0.19      0.01   0.17   0.21
## sigma           0.09      0.01   0.08   0.11
## Intercept       0.75      0.01   0.73   0.77
## lprior         -4.02      0.01  -4.03  -4.01
## lp__          103.46      1.21 100.35 104.86
```

It appears that The more area the foxes have, the more food they have (.19 beta).

Total impact of food on weight + simulated intervention

```r
# Make centered versions of our variables
foxes$avgfoodc = (foxes$avgfood - mean(foxes$avgfood))
foxes$groupsizec = (foxes$groupsize - mean(foxes$groupsize))
foxes$areac = (foxes$area - mean(foxes$area))

# Define the linear formula for weight
w_model_total <- bf(weight ~ 1 + avgfoodc)

# Fit the model with appropriate priors
foxes_w_total <- brm(
  data = foxes,
  family = gaussian,
  w_model_total,
  prior = c(
    # Priors for weight model
    prior(normal(5, 2), class = "Intercept"),
    prior(normal(0, 2), class = "b"),
    prior(exponential(1), class = "sigma")),
    iter = 2000, warmup = 1000, chains = 4, seed = 213,
    file = here("files/models/foxes_weight_by_food")
)

posterior_summary(foxes_w_total) %>% round(2)
```

```
##              Estimate Est.Error    Q2.5   Q97.5
## b_Intercept      4.53      0.11    4.32    4.74
## b_avgfoodc      -0.15      0.54   -1.22    0.91
## sigma            1.20      0.08    1.05    1.37
## Intercept        4.53      0.11    4.32    4.74
## lprior          -4.49      0.10   -4.73   -4.32
## lp__          -189.42      1.25 -192.70 -188.04
```

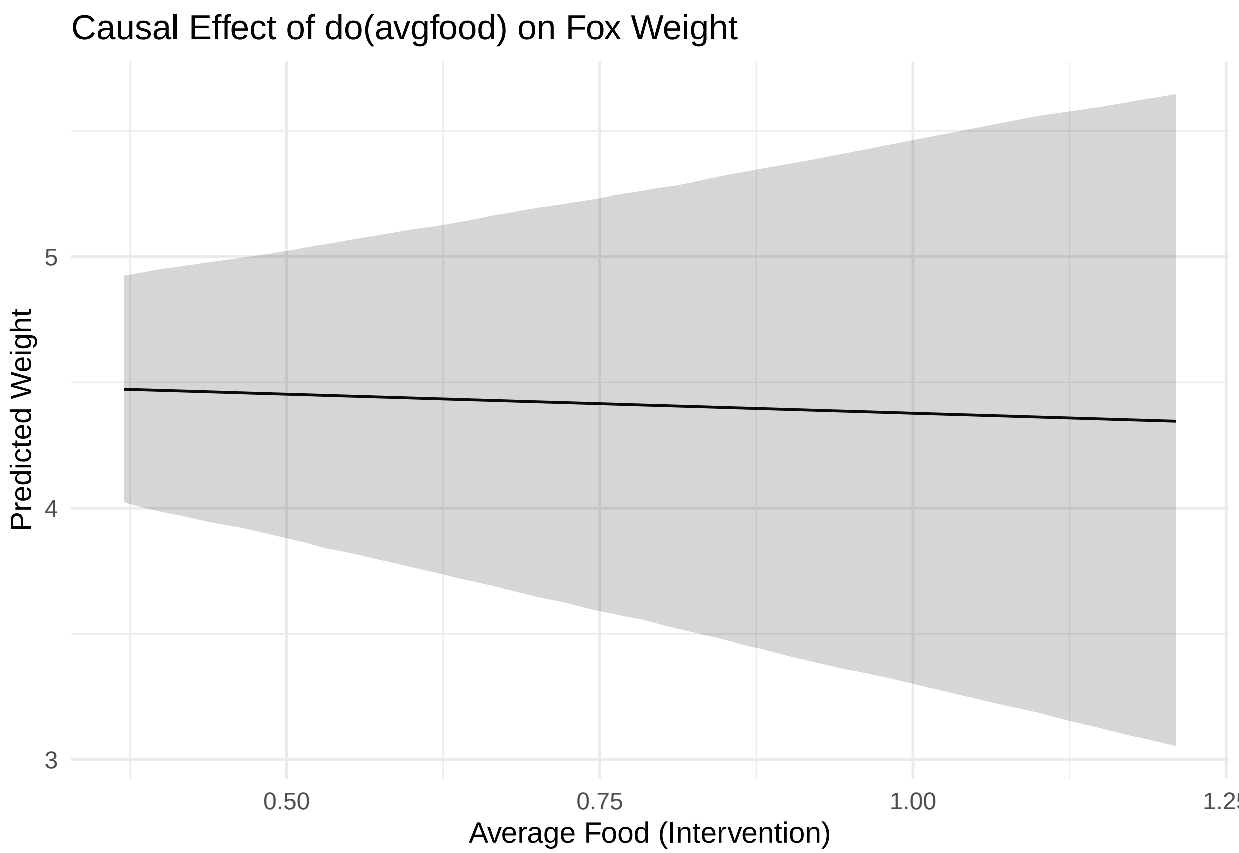
Simulated intervention

```r
new_food_levels <- data.frame(
  avgfoodc = seq(min(foxes$avgfood), max(foxes$avgfood), length.out = 100)
)

# Predict weights under the do(avgfood) operation
intervention_results <- posterior_epred(foxes_w_total, newdata = new_food_levels)

# Create result dataset
causal_effect <- data.frame(
  avgfood = new_food_levels$avgfood,
  predicted_weight = colMeans(intervention_results),
  lower = apply(intervention_results, 2, quantile, 0.025),
  upper = apply(intervention_results, 2, quantile, 0.975)
)
```

```r
# Visualize the causal effect
ggplot(causal_effect, aes(x = avgfood, y = predicted_weight)) +
  geom_line() +
  geom_ribbon(aes(ymin = lower, ymax = upper), alpha = 0.2) +
  labs(
    title = "Causal Effect of do(avgfood) on Fox Weight",
    x = "Average Food (Intervention)",
    y = "Predicted Weight"
  ) +
  theme_minimal()
```




```r
# Calculate the change in weight for a unit change in food
# at the median food level
median_food <- median(foxes$avgfood)
food_increase <- median_food + 1
food_points <- data.frame(avgfoodc = c(median_food, food_increase))
weight_change <- posterior_epred(foxes_w_total, newdata = food_points)
average_effect <- mean(weight_change[,2] - weight_change[,1])
```

Adding one unit of food to a territory causes, on average, a -0.15kg change in weight. Weird…maybe we need to consider other causal variables?

Incorporating group size into the model:

```
# Define the new nonlinear formula for weight
w_model <- bf(
  weight ~ a + bfood * avgfoodc + bgroup * groupsizec,
  a ~ 1,
  bfood ~ 1,
  bgroup ~ 1,
  nl = TRUE
)

# Define the formula for avgfood_c
f_model <- bf(avgfoodc ~ 1 + areac)

# Fit the model with appropriate priors
foxes_m1 <- brm(
  data = foxes,
  family = gaussian,
  w_model + f_model + set_rescor(FALSE),
  prior = c(
    # Priors for weight model nonlinear parameters
    prior(normal(5, 2), nlpar = "a",  resp = "weight"),
    prior(normal(0, 2), nlpar = "bfood",  resp = "weight"),
    prior(normal(0, 2), nlpar = "bgroup",  resp = "weight"),
    prior(exponential(1), class = "sigma", resp = "weight"),
    # Priors for avgfoodc model
    prior(normal(0, 2), class = "Intercept", resp = "avgfoodc"),
    prior(normal(0, 2), class = "b", resp = "avgfoodc"),
    prior(exponential(1), class = "sigma", resp = "avgfoodc")
  ),
  iter = 2000, warmup = 1000, chains = 4, seed = 213,
  file = here("files/models/foxes_groupsize")
)
```

```
posterior_summary(foxes_m1) %>% round(2)
```

```
##                            Estimate Est.Error   Q2.5  Q97.5
## b_avgfoodc_Intercept           0.00      0.01  -0.02   0.02
## b_weight_a_Intercept           4.53      0.11   4.32   4.74
## b_weight_bfood_Intercept       2.76      1.07   0.66   4.84
## b_weight_bgroup_Intercept     -0.45      0.14  -0.72  -0.16
## b_avgfoodc_areac               0.19      0.01   0.17   0.21
## sigma_weight                   1.14      0.08   1.00   1.30
## sigma_avgfoodc                 0.09      0.01   0.08   0.11
## Intercept_avgfoodc             0.00      0.01  -0.02   0.02
## lprior                       -10.46      0.77 -12.37  -9.41
## lp__                         -82.55      1.88 -86.94 -79.85
```

What's up with the foxes?

Group size decreases the the weight of foxes! It seems that as the foxes grow in numbers, they have to stretch their food resources more. This explains the ambiguous results above in the earlier model, which made it seem that more food caused lower weights.