Homework 7

Krista Noe

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1. Load data and place into an unmarkedFrameOccu object

```
library(unmarked)
```

```
## Loading required package: lattice
```

```
y <- read.csv("Bobcat.csv")  # detection / nondetection data
p_covs <- read.csv("p covariates.csv")  # detection covariates
site_covs <- read.csv("psi covariates.csv")  # site coviariates

bobcat_mat <- as.matrix(y)

det_covs <- list(
  people = data.frame(p_covs[, c(1:71)])
)

occu_data <- unmarkedFrameOccu(y = bobcat_mat,
                               obsCovs = det_covs,
                               siteCovs = site_covs)
```

2. Fit the following candidate set of models:

detection model	occupancy model
intercept-only	intercept-only
people	intercept-only
intercept-only	disturbance
people	disturbance

```
# detection model intercept only, occupancy model intercept only
fit1 <- occu(~ 1 ~ 1, data = occu_data)

# detection model people, occupancy model intercept only
fit2 <- occu(~ people ~ 1, data = occu_data)

# detection model intercept only, occupancy model disturbance
fit3 <- occu(~ 1 ~ Dist_5km, data = occu_data)

# detection model people, occupancy model disturbance
```

```
fit4 <- occu(~ people ~ Dist_5km, data = occu_data)
```

3. Perform model selection with AIC. What is your top model? How do you know? Is there model selection uncertainty?

```
library(AICcmodavg)


cand.set <- list(
  m1 = fit1, m2 = fit2, m3 = fit3, m4 = fit4
)

mods <- aictab(cand.set = cand.set, second.ord = F)
head(mods)
```

```
##
## Model selection based on AIC:
##
##    K     AIC Delta_AIC AICWt Cum.Wt       LL
## m3 3 4461.01      0.00  0.73   0.73 -2227.50
## m4 4 4462.98      1.97  0.27   1.00 -2227.49
## m1 2 4490.77     29.77  0.00   1.00 -2243.39
## m2 3 4492.73     31.72  0.00   1.00 -2243.36
```

Model 3 is the top model (detection model intercept only, occupancy model disturbance), because it has the lowest AIC value. Yes, there is model selection uncertainty because the change in AIC between the "best" model (fit3) and the second best model (model 4) is <2. However, the remaining models have a much higher AIC and would not even be close to being a better a model.

4. Average both the effect of people on detection, and disturbance on occupancy, over all models. Report model-averaged slope coefficients and 95% confidence intervals.

```
## effect of people on detection ##

avg_type_peopleondetection <- modavgShrink(
              cand.set = cand.set,
              parm = "people",
              second.ord = F,
              parm.type = "detect")
avg_type_peopleondetection$Mod.avg.beta
```

```
## [1] -0.01653469
```

```
# 95% confidence intervals
avg_type_peopleondetection$Uncond.SE
```

```
## [1] 0.1988013
```

```
avg_type_peopleondetection$Lower.CL
```

```
## [1] -0.4061781
```

```
avg_type_peopleondetection$Upper.CL
```

```
## [1] 0.3731087
```

```
## effect of disturbance on occupancy ##

avg_type_distonoccupancy <- modavgShrink(
              cand.set = cand.set,
              parm = "Dist_5km",
              second.ord = F,
              parm.type = "psi")
avg_type_distonoccupancy$Mod.avg.beta
```

```
## [1] -23.65047
```

```
# 95% confidence intervals
avg_type_distonoccupancy$Uncond.SE
```

```
## [1] 4.773317
```

```
avg_type_distonoccupancy$Lower.CL
```

```
## [1] -33.006
```

```
avg_type_distonoccupancy$Upper.CL
```

```
## [1] -14.29494
```

For the effect of popele on detection, the model averaged slope coefficient is -0.016, with 95% confidence intervals of (-4.06, 0.37). For the effect of disturbance on occupancy, the model averaged slope coefficient is -23.65, with 95% confidence intervals of (-33.006, -14.29).

5. Obtain and plot model-averaged predictions of occupancy probability and detection probability. Average over all models, and make predictions over the observed range of each variable.

```
################ Predict ######################

## Occupancy Probability ##

new_dat <- data.frame(Dist_5km = seq(from = 0, to = 0.13, length.out = 100))

avg_prd_occupancy <- modavgPred(cand.set = cand.set,
                      newdata = new_dat,
                      second.ord = F,
                      parm.type = "psi"
                     )
avg_prd_occupancy
```

```
##
## Model-averaged predictions on the response scale
## based on entire model set and 95% confidence interval:
##
##     mod.avg.pred uncond.se lower.CL upper.CL
## 1          0.260     0.019    0.224    0.300
## 2          0.254     0.019    0.219    0.292
## 3          0.248     0.018    0.215    0.285
## 4          0.242     0.017    0.210    0.278
## 5          0.237     0.017    0.206    0.271
## 6          0.231     0.016    0.201    0.264
## 7          0.226     0.016    0.196    0.258
## 8          0.220     0.015    0.192    0.252
## 9          0.215     0.015    0.187    0.246
## 10         0.210     0.015    0.182    0.241
## 11         0.205     0.015    0.177    0.235
## 12         0.200     0.015    0.172    0.230
## 13         0.195     0.015    0.168    0.225
## 14         0.190     0.015    0.163    0.221
## 15         0.185     0.015    0.158    0.216
## 16         0.181     0.015    0.153    0.212
## 17         0.176     0.015    0.148    0.208
## 18         0.172     0.015    0.144    0.204
## 19         0.167     0.016    0.139    0.200
## 20         0.163     0.016    0.134    0.196
## 21         0.159     0.016    0.130    0.193
## 22         0.155     0.016    0.126    0.189
## 23         0.151     0.016    0.121    0.186
## 24         0.147     0.017    0.117    0.182
## 25         0.143     0.017    0.113    0.179
## 26         0.139     0.017    0.109    0.176
## 27         0.135     0.017    0.105    0.173
## 28         0.132     0.017    0.101    0.170
## 29         0.128     0.018    0.098    0.167
## 30         0.125     0.018    0.094    0.164
## 31         0.122     0.018    0.091    0.161
## 32         0.118     0.018    0.087    0.158
## 33         0.115     0.018    0.084    0.156
## 34         0.112     0.018    0.081    0.153
## 35         0.109     0.018    0.078    0.150
## 36         0.106     0.018    0.075    0.148
## 37         0.103     0.019    0.072    0.145
## 38         0.100     0.019    0.069    0.143
## 39         0.097     0.019    0.067    0.140
## 40         0.095     0.019    0.064    0.138
## 41         0.092     0.019    0.061    0.136
## 42         0.090     0.019    0.059    0.133
## 43         0.087     0.019    0.057    0.131
## 44         0.085     0.019    0.055    0.129
## 45         0.082     0.019    0.052    0.127
## 46         0.080     0.019    0.050    0.125
## 47         0.078     0.018    0.048    0.122
## 48         0.075     0.018    0.046    0.120
## 49         0.073     0.018    0.045    0.118
```

```
## 50         0.071     0.018    0.043    0.116
## 51         0.069     0.018    0.041    0.114
## 52         0.067     0.018    0.039    0.112
## 53         0.065     0.018    0.038    0.110
## 54         0.063     0.018    0.036    0.109
## 55         0.062     0.018    0.035    0.107
## 56         0.060     0.018    0.033    0.105
## 57         0.058     0.017    0.032    0.103
## 58         0.056     0.017    0.031    0.101
## 59         0.055     0.017    0.030    0.100
## 60         0.053     0.017    0.028    0.098
## 61         0.052     0.017    0.027    0.096
## 62         0.050     0.017    0.026    0.095
## 63         0.049     0.016    0.025    0.093
## 64         0.047     0.016    0.024    0.091
## 65         0.046     0.016    0.023    0.090
## 66         0.045     0.016    0.022    0.088
## 67         0.043     0.016    0.021    0.087
## 68         0.042     0.015    0.020    0.085
## 69         0.041     0.015    0.019    0.084
## 70         0.040     0.015    0.019    0.082
## 71         0.038     0.015    0.018    0.081
## 72         0.037     0.015    0.017    0.079
## 73         0.036     0.014    0.016    0.078
## 74         0.035     0.014    0.016    0.077
## 75         0.034     0.014    0.015    0.075
## 76         0.033     0.014    0.014    0.074
## 77         0.032     0.014    0.014    0.073
## 78         0.031     0.013    0.013    0.071
## 79         0.030     0.013    0.013    0.070
## 80         0.029     0.013    0.012    0.069
## 81         0.028     0.013    0.012    0.068
## 82         0.028     0.013    0.011    0.067
## 83         0.027     0.012    0.011    0.065
## 84         0.026     0.012    0.010    0.064
## 85         0.025     0.012    0.010    0.063
## 86         0.024     0.012    0.009    0.062
## 87         0.024     0.012    0.009    0.061
## 88         0.023     0.011    0.009    0.060
## 89         0.022     0.011    0.008    0.059
## 90         0.022     0.011    0.008    0.058
## 91         0.021     0.011    0.008    0.057
## 92         0.020     0.011    0.007    0.056
## 93         0.020     0.010    0.007    0.055
## 94         0.019     0.010    0.007    0.054
## 95         0.019     0.010    0.006    0.053
## 96         0.018     0.010    0.006    0.052
## 97         0.018     0.010    0.006    0.051
## 98         0.017     0.009    0.006    0.050
## 99         0.016     0.009    0.005    0.049
## 100        0.016     0.009    0.005    0.048
```

```
min(avg_prd_occupancy$mod.avg.pred)
```

```
## [1] 0.01597137
```

```
max(avg_prd_occupancy$mod.avg.pred)
```

```
## [1] 0.2599361
```

```
## Detection Probability ##

new_dat_2 <- data.frame(people = seq(from = 0, to = 0.35, length.out = 100))

avg_prd_detection <- modavgPred(cand.set = cand.set,
                       newdata = new_dat_2,
                       second.ord = F,
                       parm.type = "detect"
                      )

avg_prd_detection
```

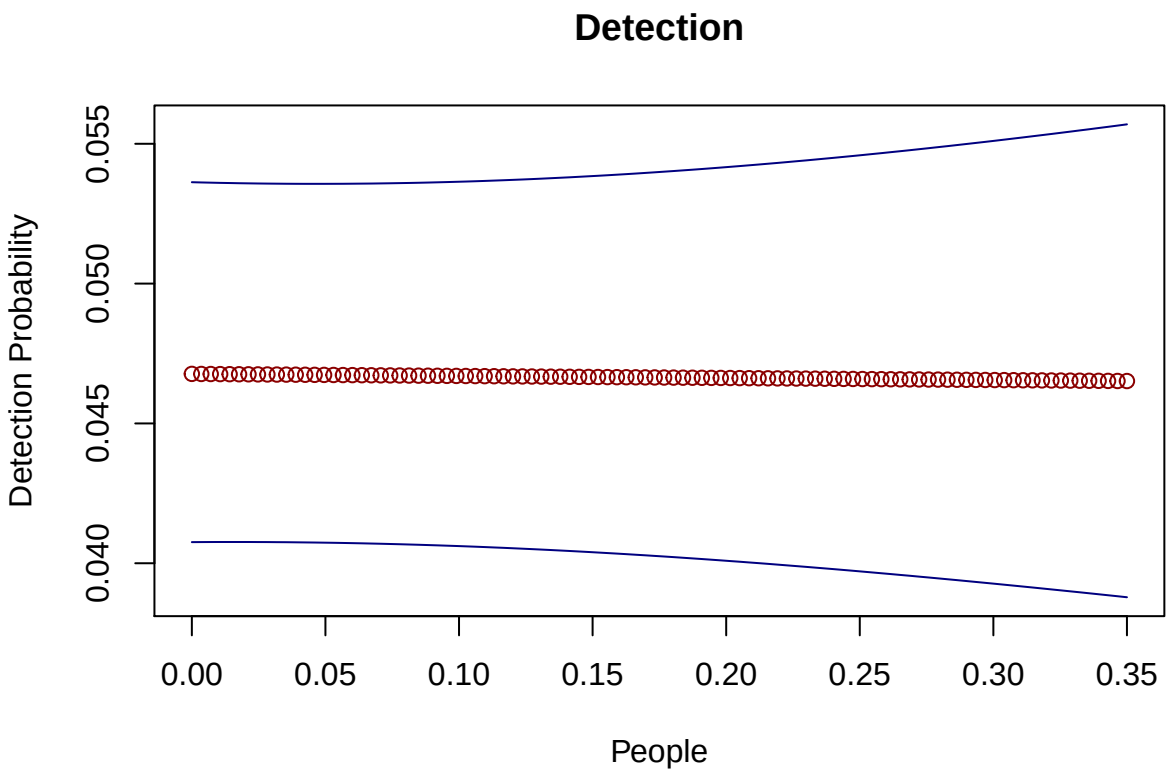
```
##
## Model-averaged predictions on the response scale
## based on entire model set and 95% confidence interval:
##
##     mod.avg.pred uncond.se lower.CL upper.CL
## 1          0.047     0.003    0.041    0.054
## 2          0.047     0.003    0.041    0.054
## 3          0.047     0.003    0.041    0.054
## 4          0.047     0.003    0.041    0.054
## 5          0.047     0.003    0.041    0.054
## 6          0.047     0.003    0.041    0.054
## 7          0.047     0.003    0.041    0.054
## 8          0.047     0.003    0.041    0.054
## 9          0.047     0.003    0.041    0.054
## 10         0.047     0.003    0.041    0.054
## 11         0.047     0.003    0.041    0.054
## 12         0.047     0.003    0.041    0.054
## 13         0.047     0.003    0.041    0.054
## 14         0.047     0.003    0.041    0.054
## 15         0.047     0.003    0.041    0.054
## 16         0.047     0.003    0.041    0.054
## 17         0.047     0.003    0.041    0.054
## 18         0.047     0.003    0.041    0.054
## 19         0.047     0.003    0.041    0.054
## 20         0.047     0.003    0.041    0.054
## 21         0.047     0.003    0.041    0.054
## 22         0.047     0.003    0.041    0.054
## 23         0.047     0.003    0.041    0.054
## 24         0.047     0.003    0.041    0.054
## 25         0.047     0.003    0.041    0.054
## 26         0.047     0.003    0.041    0.054
## 27         0.047     0.003    0.041    0.054
## 28         0.047     0.003    0.041    0.054
## 29         0.047     0.003    0.041    0.054
## 30         0.047     0.003    0.041    0.054
```

```
## 31        0.047    0.003    0.041    0.054
## 32        0.047    0.003    0.041    0.054
## 33        0.047    0.003    0.041    0.054
## 34        0.047    0.003    0.041    0.054
## 35        0.047    0.003    0.041    0.054
## 36        0.047    0.003    0.041    0.054
## 37        0.047    0.003    0.041    0.054
## 38        0.047    0.003    0.040    0.054
## 39        0.047    0.003    0.040    0.054
## 40        0.047    0.003    0.040    0.054
## 41        0.047    0.003    0.040    0.054
## 42        0.047    0.003    0.040    0.054
## 43        0.047    0.003    0.040    0.054
## 44        0.047    0.003    0.040    0.054
## 45        0.047    0.003    0.040    0.054
## 46        0.047    0.003    0.040    0.054
## 47        0.047    0.003    0.040    0.054
## 48        0.047    0.003    0.040    0.054
## 49        0.047    0.003    0.040    0.054
## 50        0.047    0.003    0.040    0.054
## 51        0.047    0.003    0.040    0.054
## 52        0.047    0.004    0.040    0.054
## 53        0.047    0.004    0.040    0.054
## 54        0.047    0.004    0.040    0.054
## 55        0.047    0.004    0.040    0.054
## 56        0.047    0.004    0.040    0.054
## 57        0.047    0.004    0.040    0.054
## 58        0.047    0.004    0.040    0.054
## 59        0.047    0.004    0.040    0.054
## 60        0.047    0.004    0.040    0.054
## 61        0.047    0.004    0.040    0.054
## 62        0.047    0.004    0.040    0.054
## 63        0.047    0.004    0.040    0.054
## 64        0.047    0.004    0.040    0.054
## 65        0.047    0.004    0.040    0.054
## 66        0.047    0.004    0.040    0.054
## 67        0.047    0.004    0.040    0.054
## 68        0.047    0.004    0.040    0.054
## 69        0.047    0.004    0.040    0.054
## 70        0.047    0.004    0.040    0.055
## 71        0.047    0.004    0.040    0.055
## 72        0.047    0.004    0.040    0.055
## 73        0.047    0.004    0.040    0.055
## 74        0.047    0.004    0.040    0.055
## 75        0.047    0.004    0.040    0.055
## 76        0.047    0.004    0.040    0.055
## 77        0.047    0.004    0.040    0.055
## 78        0.047    0.004    0.040    0.055
## 79        0.047    0.004    0.039    0.055
## 80        0.047    0.004    0.039    0.055
## 81        0.047    0.004    0.039    0.055
## 82        0.047    0.004    0.039    0.055
## 83        0.047    0.004    0.039    0.055
## 84        0.047    0.004    0.039    0.055
```

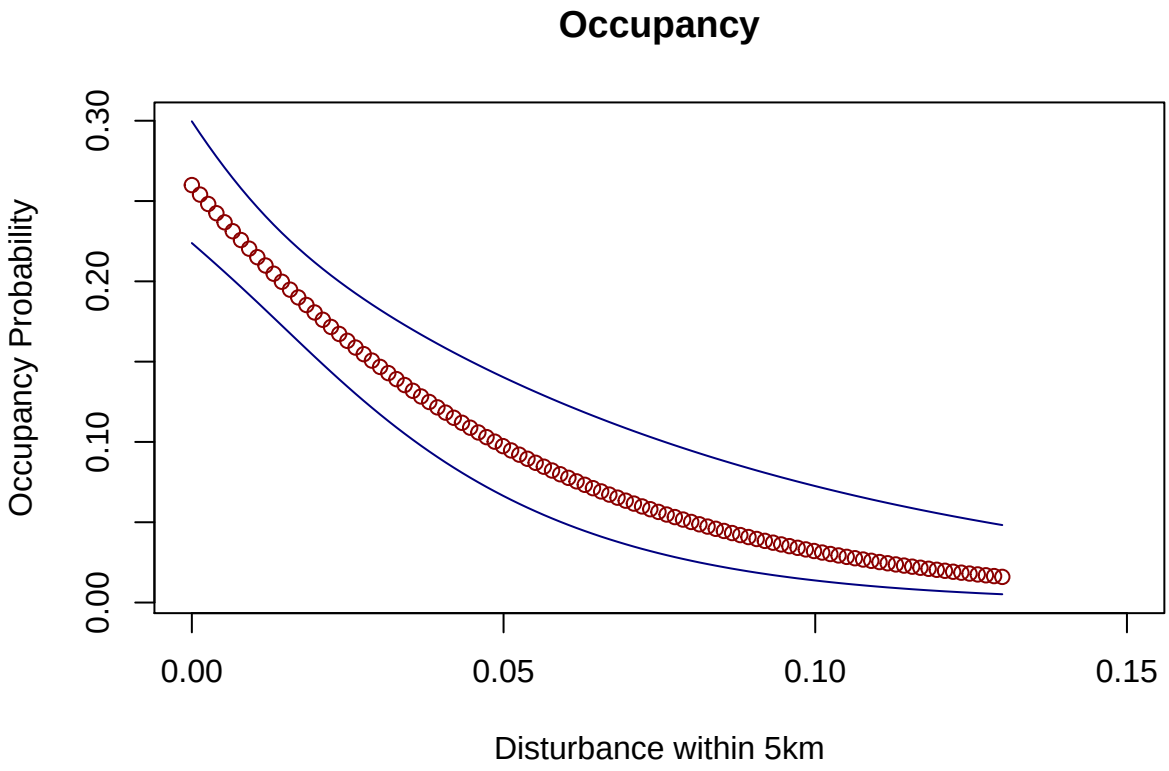
```
## 85         0.047     0.004    0.039    0.055
## 86         0.047     0.004    0.039    0.055
## 87         0.047     0.004    0.039    0.055
## 88         0.047     0.004    0.039    0.055
## 89         0.047     0.004    0.039    0.055
## 90         0.047     0.004    0.039    0.055
## 91         0.047     0.004    0.039    0.055
## 92         0.047     0.004    0.039    0.055
## 93         0.047     0.004    0.039    0.055
## 94         0.047     0.004    0.039    0.055
## 95         0.047     0.004    0.039    0.055
## 96         0.047     0.004    0.039    0.056
## 97         0.047     0.004    0.039    0.056
## 98         0.047     0.004    0.039    0.056
## 99         0.047     0.004    0.039    0.056
## 100        0.047     0.004    0.039    0.056
```

```r
################ Plot ######################

## detection ##
plot(y = avg_prd_detection$mod.avg.pred, x = new_dat_2$people,
     xlab = "People", ylab = "Detection Probability",
     ylim = c(min(avg_prd_detection$lower.CL), max(avg_prd_detection$upper.CL)),
     col = "red4")
title("Detection")
lines(x = new_dat_2$people, y = avg_prd_detection$lower.CL, col = "navy")
lines(x = new_dat_2$people, y = avg_prd_detection$upper.CL, col = "navy")
```




```
## occupancy ##
plot(y = avg_prd_occupancy$mod.avg.pred, x = new_dat$Dist_5km,
     xlab = "Disturbance within 5km", ylab = "Occupancy Probability",
     xlim = c(0, 0.15),
     ylim = c(min(avg_prd_occupancy$lower.CL), max(avg_prd_occupancy$upper.CL)),
     col = "red4")
title("Occupancy")
lines(x = new_dat$Dist_5km, y = avg_prd_occupancy$lower.CL, col = "navy")
lines(x = new_dat$Dist_5km, y = avg_prd_occupancy$upper.CL, col = "navy")
```


Occupancy
Occupancy Probability
0.00
0.10
0.20
0.30
0.00
0.05
0.10
0.15
Disturbance within 5km