Lab 9

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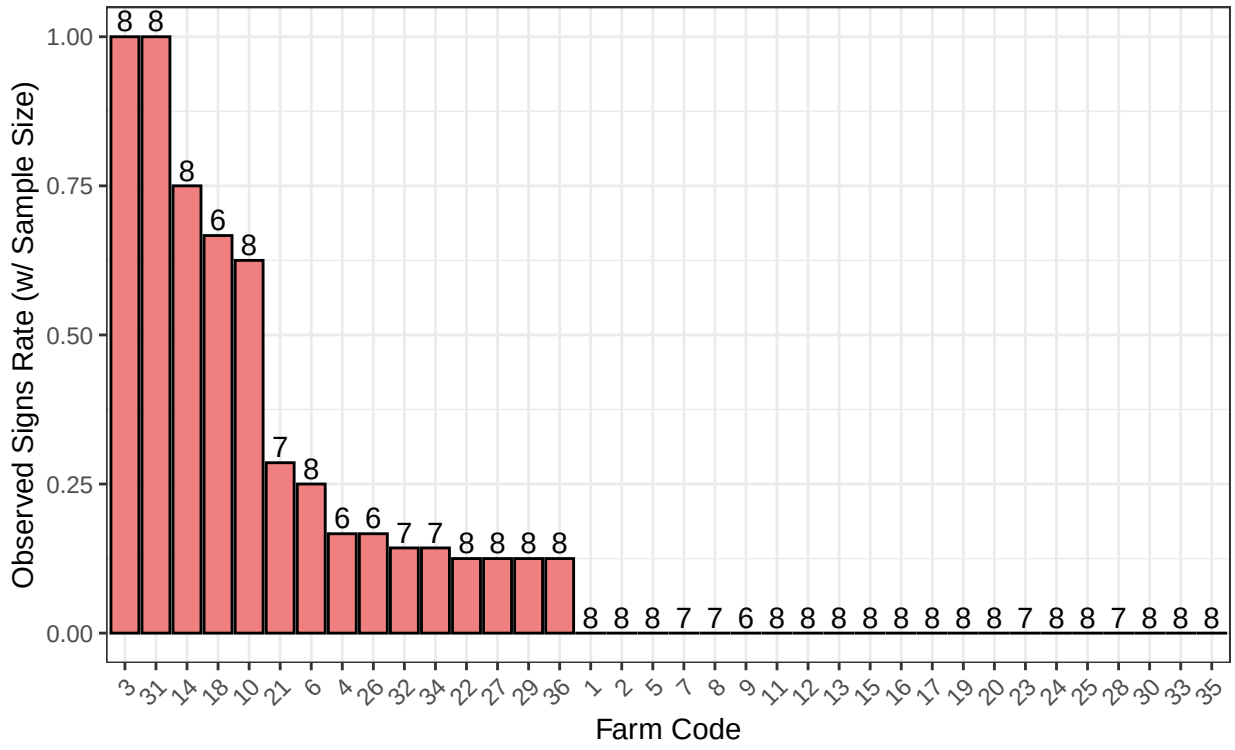
Introduction

This lab aims to examine the factors related to presence of badger activity in the farmyard, and the correlation over time in badger activity and farm-specific heterogeneity in the tendency to have badger activity.

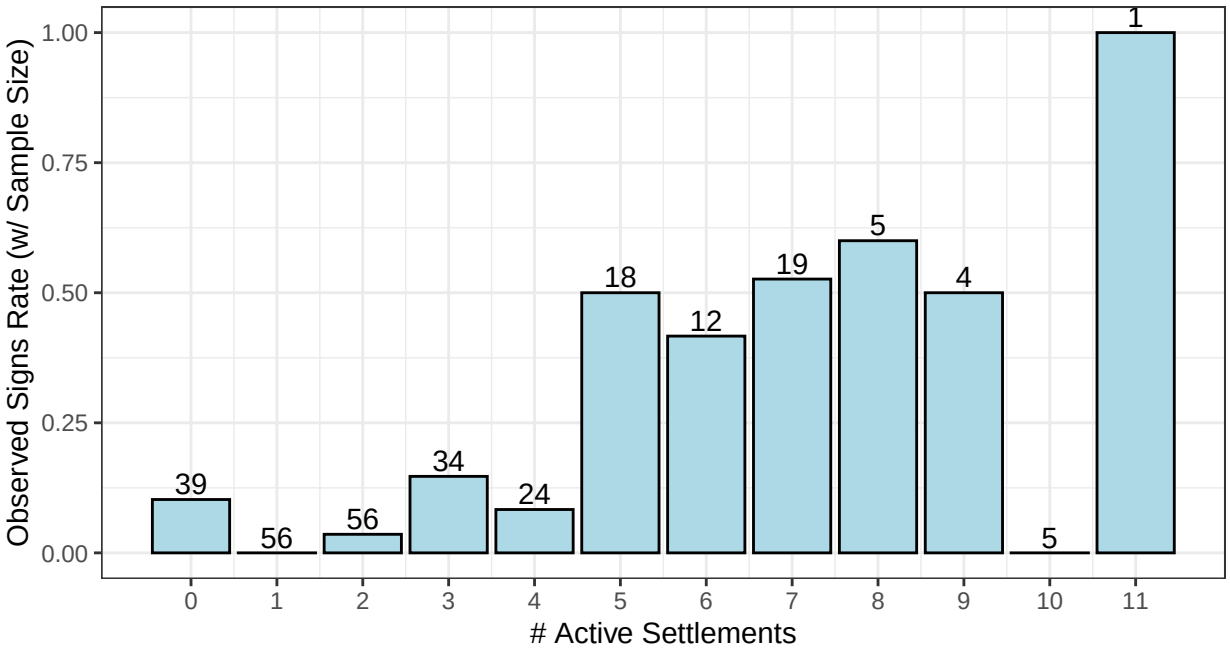
EDA

Reponse: Signs_in_yard

First a look at the distribution of the response. We can look at the mean **signs_in_yard** value for each farm to get a "rate" of signs being observed.

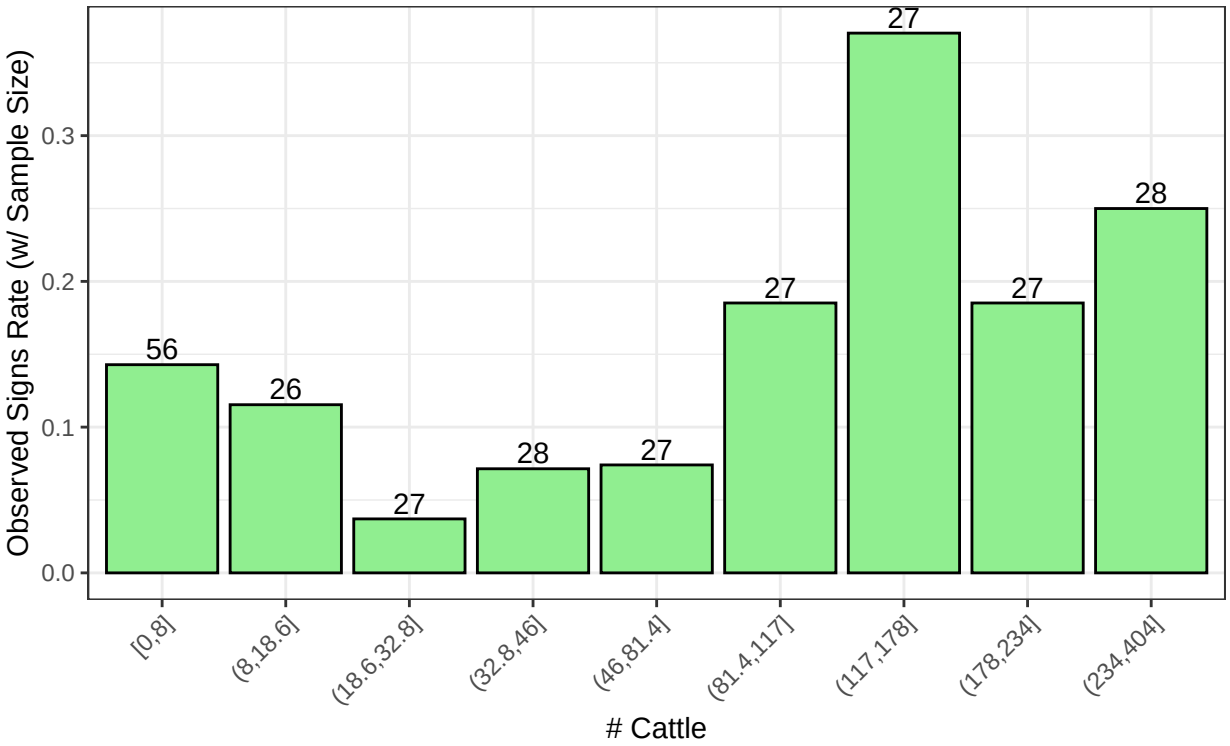


It seems like the signs rates vary widely across farms, so we should expect to see heterogeneity in our final model. Now we can look at the signs rates for some of the candidate predictors. First, a look at the rates for each value of the number of active badger settlements.



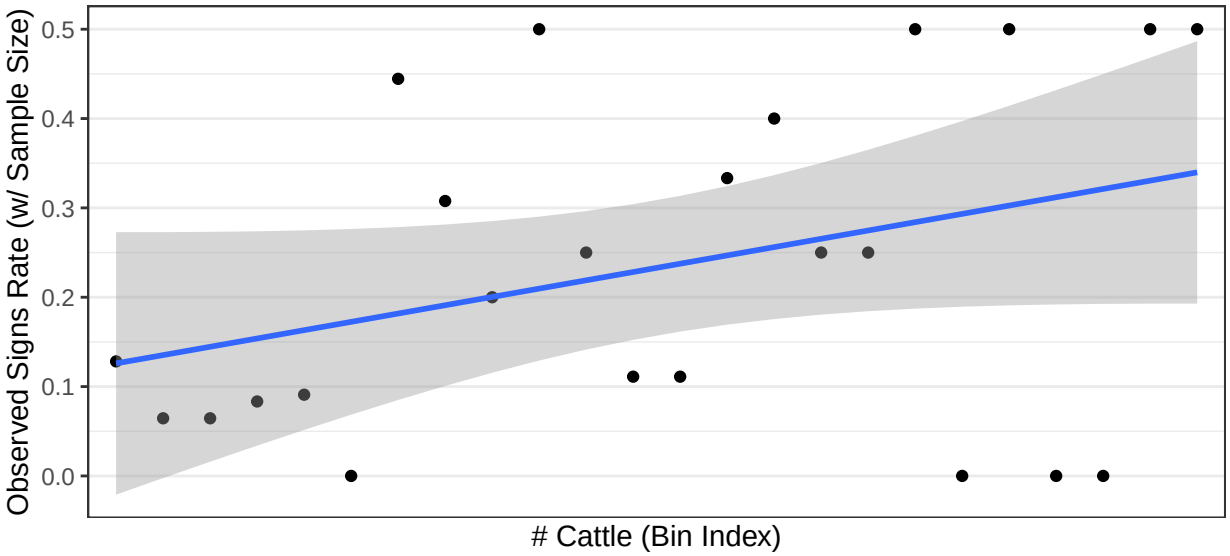
Number of cattle on the farm (no_cattle_in_buildings_yard)

There seems to be a positive relationship between the number of active settlements and the rate of badger signs in the yard. We may also look at the relationship between the number of cattle and the signs rate. To do so we will bin the number of cattle into 10% quantile increments and chart the rate for each bin.

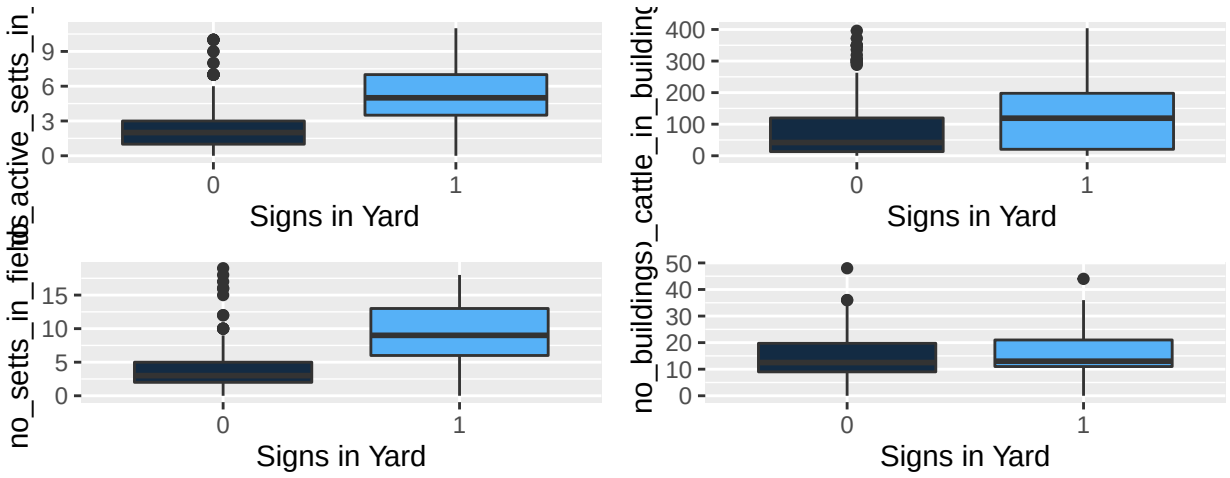


Again, there seems to be a slight positive relationship between the number of cattle and the rate of badger

sign observation. The plot below is an alternative view of this relationship.

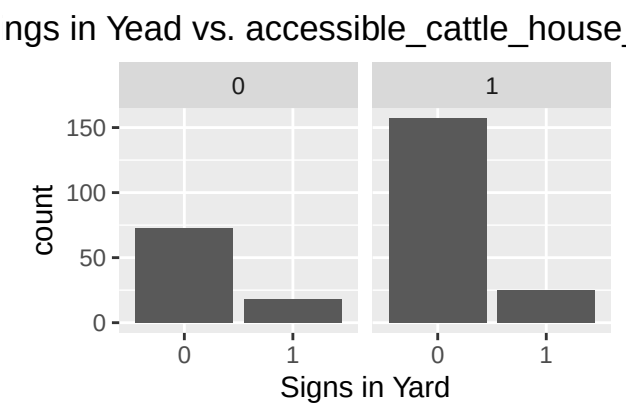


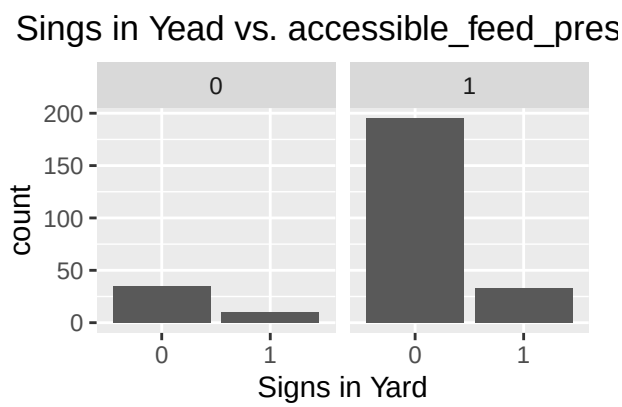
predictors in number

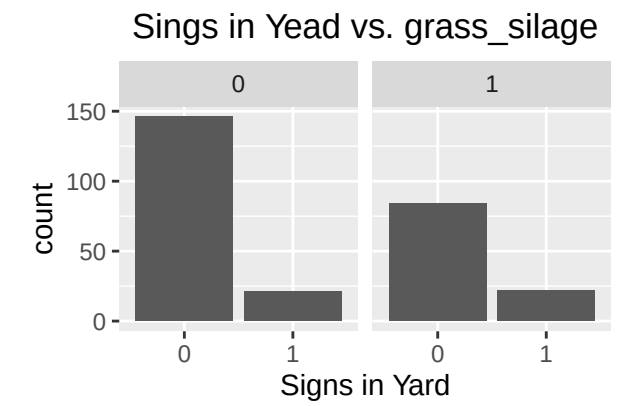


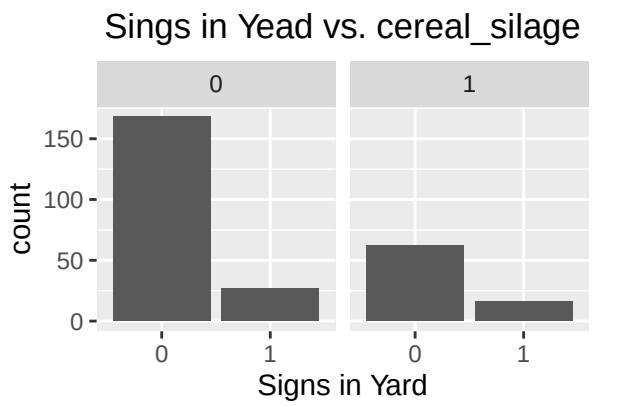
Other predictors in 0/1

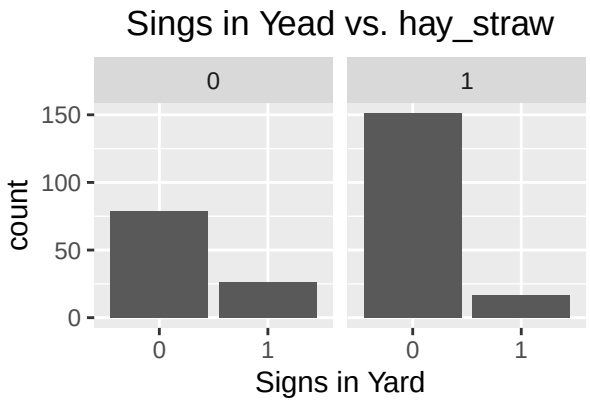
We also have several indicator variables to consider. To investigate these, we can look at the accuracy in predicting the response using each indicator as a sole predictor.

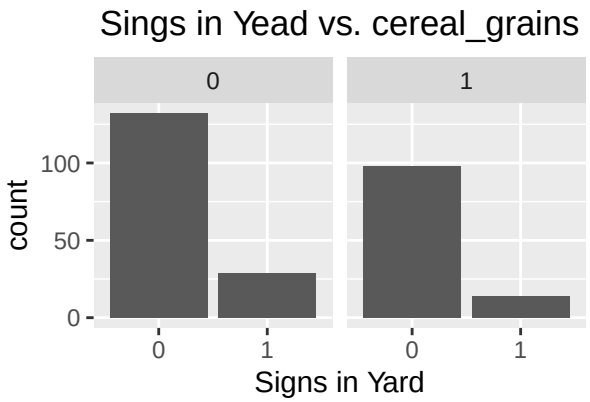

ngs in Yead vs. accessible_cattle_house
0
1
count
150
100
50
0
0
1
0
1
Signs in Yard

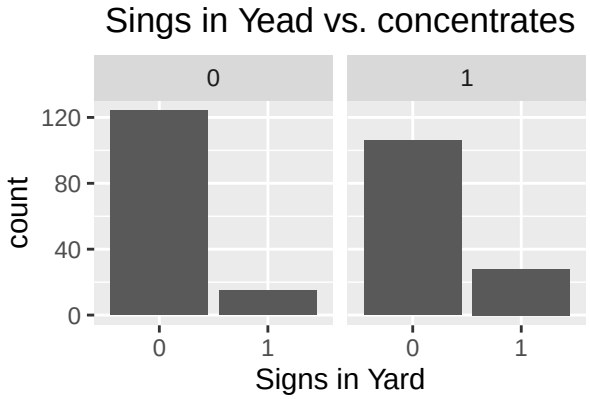

Sings in Yead vs. accessible_feed_pres
0
1
count
200
150
100
50
0
0
1
0
1
Signs in Yard

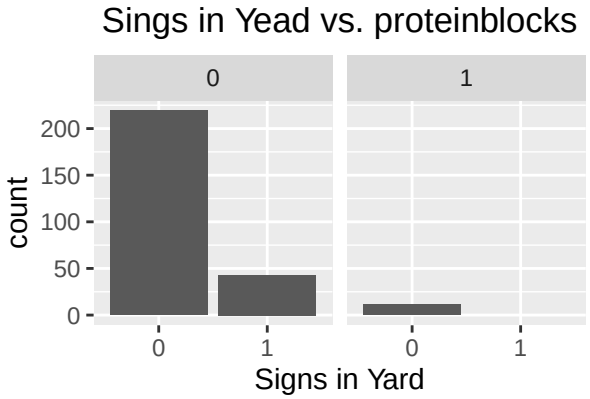

Sings in Yead vs. grass_silage
0
1
count
150
100
50
0
0
1
0
1
Signs in Yard

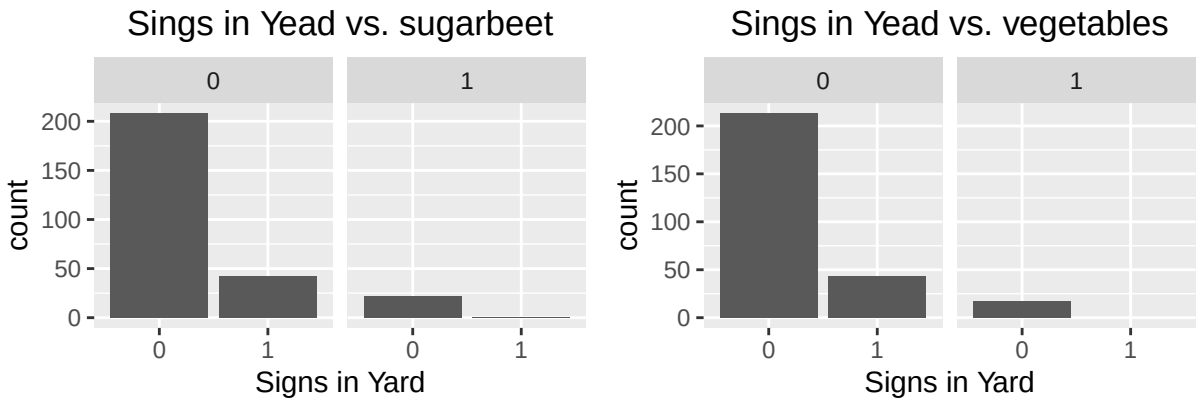

Sings in Yead vs. cereal_silage
0
1
count
150
100
50
0
0
1
0
1
Signs in Yard

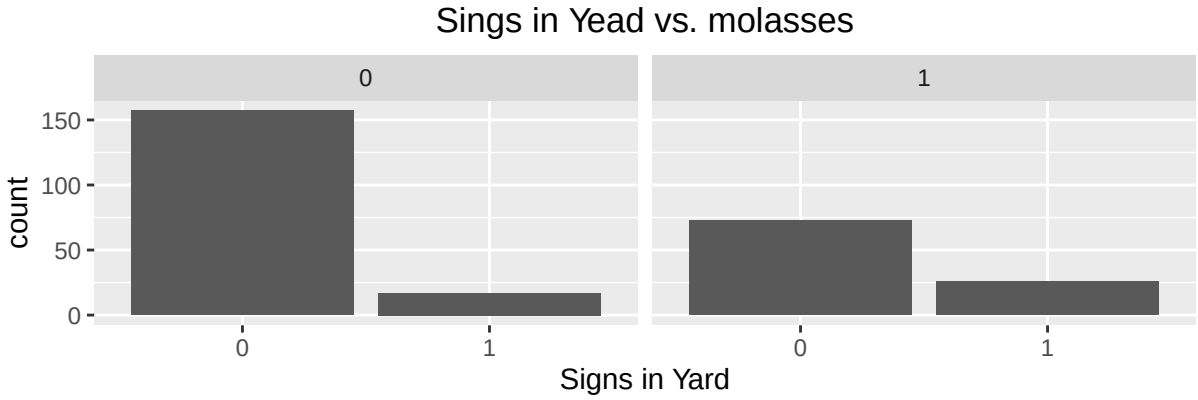

Sings in Yead vs. hay_straw
0
1
count
150
100
50
0
0
1
0
1
Signs in Yard


Sings in Yead vs. cereal_grains
0
1
count
100
50
0
0
1
0
1
Signs in Yard


Sings in Yead vs. concentrates
0
1
count
120
80
40
0
0
1
0
1
Signs in Yard


Sings in Yead vs. proteinblocks
0
1
count
200
150
100
50
0
0
1
0
1
Signs in Yard





Indicator	Accuracy
accessible_cattle_house_present	0.3590
accessible_feed_present	**0.2491**
grass_silage	0.6154
cereal_silage	0.6740
hay_straw	0.3516
cereal_grains	0.5348
concentrates	0.5568
proteinblocks	**0.8022**
sugarbeet	**0.7656**
vegetables	**0.7802**
molasses	0.6703

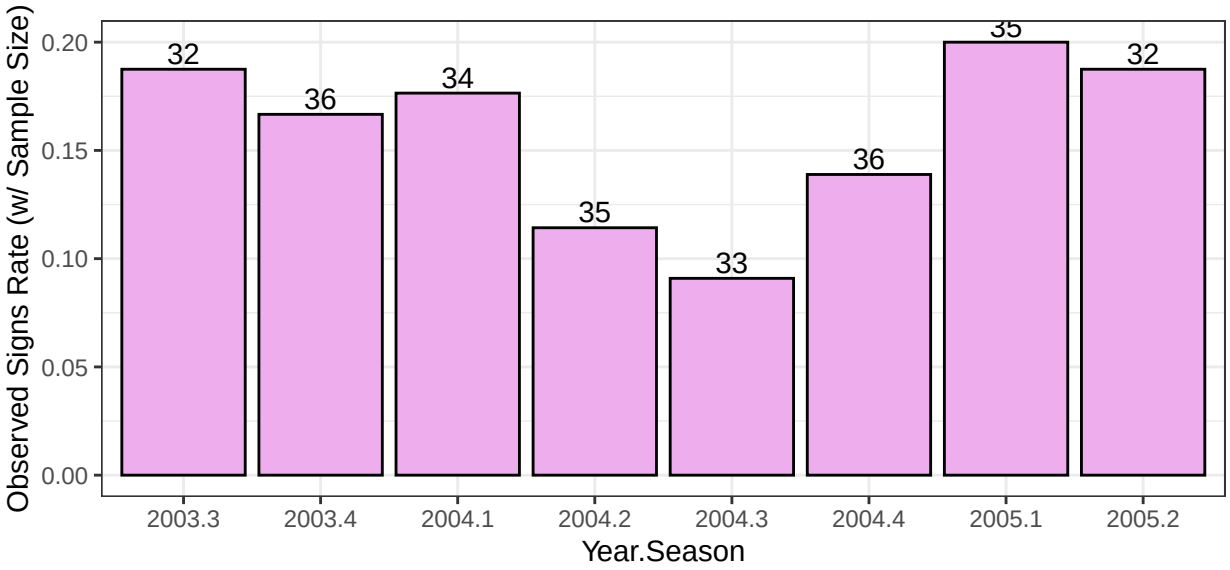
```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction   0   1
##          0 219  43
##          1  11   0
##
##                Accuracy : 0.8022
##                  95% CI : (0.7499, 0.8478)
##     No Information Rate : 0.8425
##     P-Value [Acc > NIR] : 0.969
##
```

```
##                   Kappa : -0.0686
##
##  Mcnemar's Test P-Value : 2.459e-05
##
##             Sensitivity : 0.9522
##             Specificity : 0.0000
##          Pos Pred Value : 0.8359
##          Neg Pred Value : 0.0000
##              Prevalence : 0.8425
##          Detection Rate : 0.8022
##    Detection Prevalence : 0.9597
##       Balanced Accuracy : 0.4761
##
##        'Positive' Class : 0
##
```

Note: accuracy is the proportion of the data that are predicted correctly. The accuracy is good for some indicators because most observations are 0 for the response. The confusion matrix shows that the indicators do not have as much predictive power as it may seem from the accuracy alone.

Year and season

Finally, we may look at the signs rate for each year and season combination.

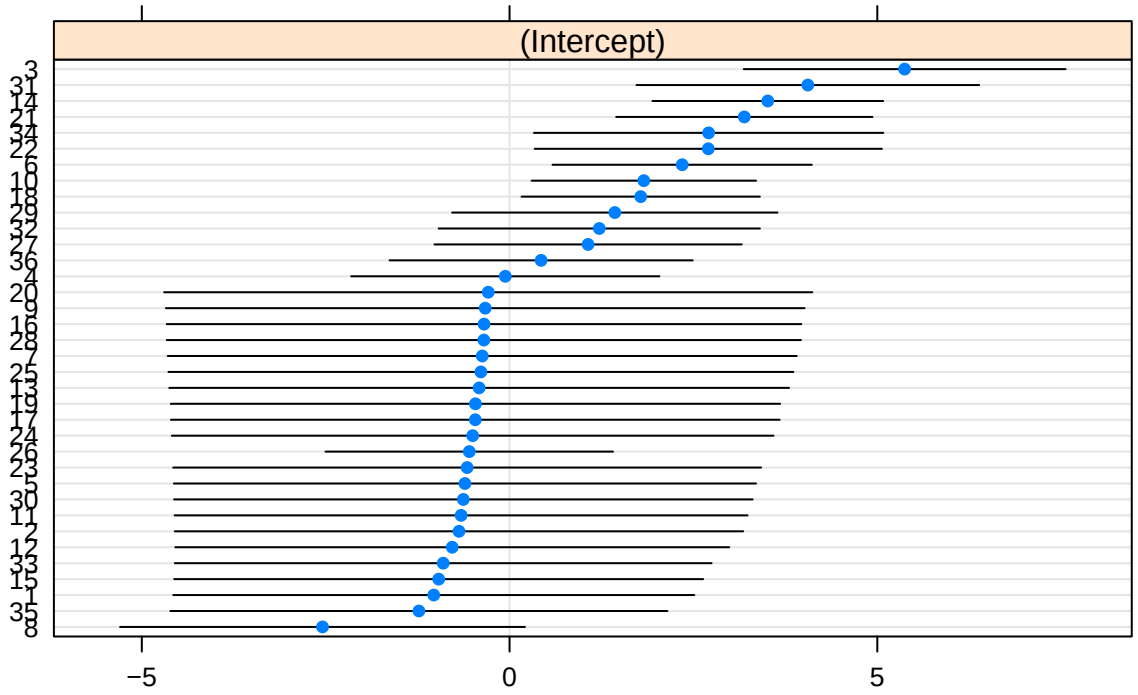


2003 and 2005 seem to have similar rates, but 2004 may have an appreciably lower rate of badger sign observations.

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula:
## signs_in_yard ~ no_active_setts_in_fields + no_cattle_in_buildings_yard +
##     year + (1 | farm_code_numeric)
##    Data: model_data
## Control: glmerControl(optimizer = "bobyqa")
```

```
##
##      AIC      BIC   logLik deviance df.resid
##    158.6    180.2    -73.3    146.6      267
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.9952 -0.1948 -0.1043 -0.0618  5.8024
##
## Random effects:
##  Groups            Name        Variance Std.Dev.
##  farm_code_numeric (Intercept) 6.514    2.552
## Number of obs: 273, groups:  farm_code_numeric, 36
##
## Fixed effects:
##                              Estimate Std. Error z value Pr(>|z|)
## (Intercept)                -5.102489   1.102378  -4.629 3.68e-06 ***
## no_active_setts_in_fields   0.510660   0.161161   3.169  0.00153 **
## no_cattle_in_buildings_yard 0.004465   0.003318   1.346  0.17844
## year2004                   -0.875619   0.636503  -1.376  0.16892
## year2005                    0.243728   0.686189   0.355  0.72245
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) n_ctv___ n_ctt___ yr2004
## n_ctv_stt__ -0.598
## n_cttl_n_b_ -0.285 -0.035
## year2004    -0.215 -0.055   -0.076
## year2005    -0.369  0.133   -0.103    0.549

## $farm_code_numeric
```



Notes from TA: can ignore interaction terma Step-forward selection logistic regression (binary response) Might not be good to incorporate time as a variable in model (if we take farm as the group) random intercept by farm ICC for farms (obs were taken over time, so answers question of corr over time) Not required to do model diagnostics

$$Y_{ij} = X_{ij}^T \beta + b_i + \epsilon_{ij}$$

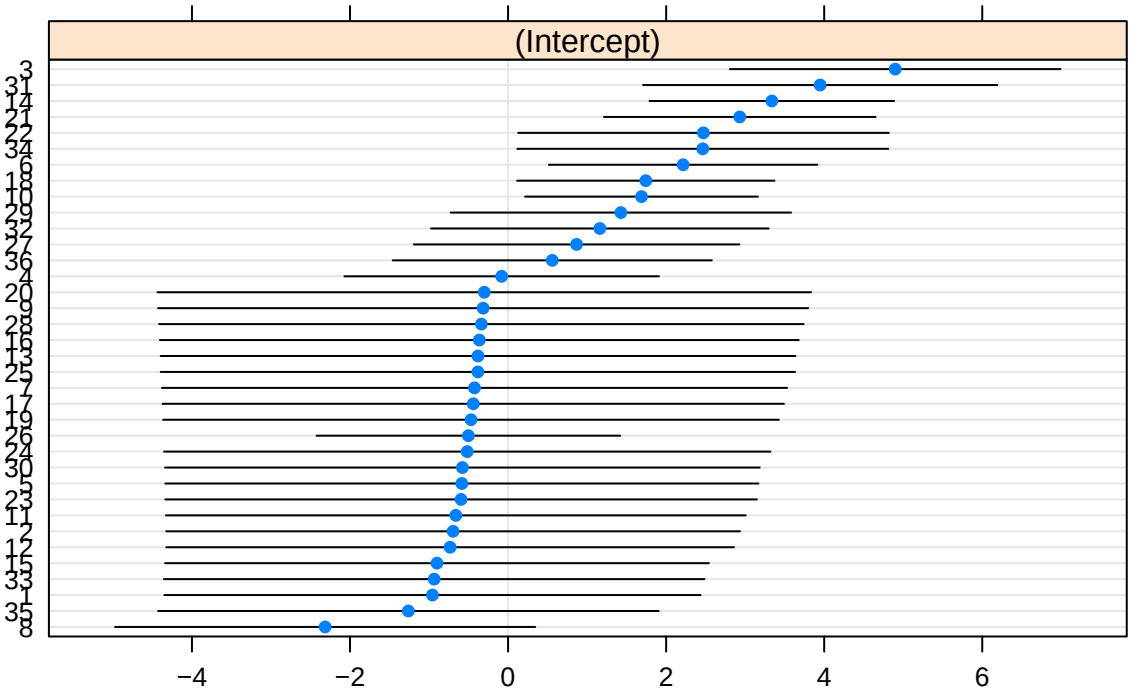
where $b_i \sim N(0, \sigma_b^2) \perp \epsilon_{ij} \sim N(0, \sigma_e^2)$ and $E(Y_{ij}|b_i) = X_{ij}^T \beta + b_i$. Here Y_{ij} represents the presence of badgers at time i on farm j.

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula:
## signs_in_yard ~ no_active_setts_in_fields + no_cattle_in_buildings_yard +
##     (1 | farm_code_numeric)
##    Data: model_data
## Control: glmerControl(optimizer = "bobyqa")
##
##      AIC      BIC   logLik deviance df.resid
##    158.5    172.9    -75.2    150.5      269
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.7115 -0.2508 -0.1093 -0.0769  4.0120
##
```

```
## Random effects:
##  Groups            Name        Variance Std.Dev.
##  farm_code_numeric (Intercept) 5.782    2.405
## Number of obs: 273, groups:  farm_code_numeric, 36
##
## Fixed effects:
##                              Estimate Std. Error z value Pr(>|z|)
## (Intercept)                 -5.227098   0.977143  -5.349 8.83e-08 ***
## no_active_setts_in_fields    0.477314   0.153424   3.111  0.00186 **
## no_cattle_in_buildings_yard  0.004632   0.003153   1.469  0.14183
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) n_ctv___
## n_ctv_stt__ -0.612
## n_cttl_n_b_ -0.354 -0.017
```

- Intercept: We can expect odds of the presence of badger activity in the farmyard to decrease by 99.5% ($1 - e^{-5.227} \approx 99.5$), if there is no settlements in the field and there is no cattles in the farm.
- Holding other variables constant, in general, for every 1 unit increase in the number of active settlements in the field, we expect the odds of the presence of signs of badgers in the farmyard to increase by 61.1% ($e^{0.477}3 - 1 \approx 61.1$).
- Holding other variables constant, in general, for every 1 unit increase in the number of cattle in the farm, we expect the odds of the presence of signs of badgers in the farmyard to increase by 4.6% ($e^{0.0046} - 1 \approx 4.6$).

```
## $farm_code_numeric
```



Research Question

1) What factors are relate to presence of badger activity in the farmyard?
2) Estimate the correlation over time in badger activity
3) Farm-specific heterogeneity in the tendency to have badger activity

```
## [1] 1.0000000 5.7819886 0.2331074
```

The interclass correlation is 0.233 which is our estimated correlation over time in badger activity. Since the observations for each farm are taken over a period of time, the ICC of this model represented the correlation over time.