Problem Set 4

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Part 1: Logistic Regression

Data Info

Variables in `dat`: `childs` Self-reported childish behavior when facing conflict (past month frequency) `physs` Self-reported physical aggression against partner (past month frequency) `any_phys` Dichotomized physical aggression (0=No, 1=Yes) `selfdet` Self-determined (intrinsic) motives to stay in the relationship `alcfreq` Frequency of binge drinking each month (5 categories: 1=0 times, 2=2-3 times, 3=3-4 times, 4=6-7 times, 5=8+ times) `bp` The Buss-Perry aggression scale (higher scores mean more aggression)

Q1: Run a logistic regression predicting whether there is any physical aggression in a relationship or not (`any_phys`) based on the Buss-Perry Aggression scale. Interpret your findings in terms of odds. [HINT: Remember to first convert the DV, `any_phys`, into a categorical variable using the `factor()` function.]

```
#factor DV and center predictor
dat <- dat %>%
  filter(!is.na(bp)) %>% #4 NAs in BP
  mutate(any_phys = factor(any_phys, levels = c(0, 1), labels = c("no", "yes"))) %>%
  mutate(bp_c = scale(bp, scale = FALSE))

#fit predictive model
bp_log_mod <- glm(any_phys ~ 1 + bp_c,
                  data = dat, family = "binomial")
summary(bp_log_mod)
```

```
##
## Call:
## glm(formula = any_phys ~ 1 + bp_c, family = "binomial", data = dat)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -1.7083  -0.8457  -0.6210   1.1040   2.1077
##
## Coefficients:
##             Estimate Std. Error z value        Pr(>|z|)
## (Intercept)  -0.8229     0.1150  -7.156 0.000000000000828 ***
## bp_c          1.4078     0.2122   6.636 0.000000000032282 ***
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 519.74  on 411  degrees of freedom
## Residual deviance: 468.48  on 410  degrees of freedom
## AIC: 472.48
##
## Number of Fisher Scoring iterations: 3
```

```r
#extract coefs
bp_odds <- coef(bp_log_mod) %>%
  exp()
bp_odds_int <- round(bp_odds[[1]],2)
bp_odds_slope <- round(bp_odds[[2]],2)
#threshold
-bp_log_mod$coef[[1]] / bp_log_mod$coef[[2]]
```

```
## [1] 0.5845691
```

```r
#pred probs
pred_probs_bp <- predict(bp_log_mod, type = "response")

#classification table
bp_classification <- dat %>%
  mutate(pred_reported = ifelse(pred_probs_bp < .50, "no", "yes")) %>%
  select(any_phys, pred_reported)
bp_class_table <- CrossTable(bp_classification$any_phys, bp_classification$pred_reported,
                             prop.r = F, prop.c = F, prop.chisq = F)
```

```
##
##
##    Cell Contents
## |-------------------------|
## |                       N |
## |         N / Table Total |
## |-------------------------|
##
##
## Total Observations in Table:  412
##
##
##                        | bp_classification$pred_reported
## bp_classification$any_phys |        no |       yes | Row Total |
## --------------------------|-----------|-----------|-----------|
##                       no |       253 |        25 |       278 |
##                          |     0.614 |     0.061 |           |
## --------------------------|-----------|-----------|-----------|
##                      yes |        93 |        41 |       134 |
##                          |     0.226 |     0.100 |           |
## --------------------------|-----------|-----------|-----------|
##             Column Total |       346 |        66 |       412 |
```

```
## --------------------------|----------|----------|----------|
##
##
```

We ran a logistic regression model to predict the presence of physical aggression in a relationship based on results from the Buss-Perry (BP) Aggression scale. At an average BP aggression score, the odds of physical aggression were .44 and BP aggression was a significant predictor of physical aggression, increasing the likelihood of the presence of physical aggression by 4 times for each standard deviation increase above an average BP aggression score. According to our model, centered scores above .58 on the BP scale indicate increased likelihood of physical aggression. These results should be taken with some caution, as our model correctly predicted the absence of physical aggression with 91% accuracy and the presence of physical aggression with only 30% accuracy.

Q2: Re-run the logistic regression from #1 but this time as a hierarchical regression. Enter the Buss-Perry scale in the first step, and then include frequency of binge drinking in the second step. (Hint: remember that binge drinking is also a categorical variable.) Based on the output, report the point at which the probability of any physical aggression reaches 50% (i.e., the threshold) for any of the binge drinking groups (your choice which one!).

```r
#factor binge drinking
dat <- dat %>%
  mutate(alcfreq = factor(alcfreq, levels = c(1:5), labels = c("0x/month", "2-3x/month", "3-4x/month",

#fit new model
alc_log_mod <- glm(any_phys ~ 1 + bp_c + alcfreq,
                   data = dat, family = "binomial")
#compare models
anova(bp_log_mod,
      alc_log_mod,
      test = "Chisq") #adding pred is significant p = 0.01582
```

```
## Analysis of Deviance Table
##
## Model 1: any_phys ~ 1 + bp_c
## Model 2: any_phys ~ 1 + bp_c + alcfreq
##   Resid. Df Resid. Dev Df Deviance Pr(>Chi)
## 1       410     468.48
## 2       406     456.27  4   12.215  0.01582 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
#extract coefs
contrasts(dat$alcfreq)
```

```
##            2-3x/month 3-4x/month 6-7x/month 8x+/month
## 0x/month            0          0          0         0
## 2-3x/month          1          0          0         0
## 3-4x/month          0          1          0         0
## 6-7x/month          0          0          1         0
## 8x+/month           0          0          0         1
```

```r
coef(alc_log_mod) %>%
  exp()
```

```
##       (Intercept)                 bp_c alcfreq2-3x/month alcfreq3-4x/month
##         0.4135594            3.7719944         0.7934039        1.1178301
## alcfreq6-7x/month  alcfreq8x+/month
##         1.9574893    14549472.8907617
```

```r
intercept    <- coef(alc_log_mod)[[1]]
aggression   <- coef(alc_log_mod)[[2]]
group_1      <- coef(alc_log_mod)[[3]]
group_2      <- coef(alc_log_mod)[[4]]
group_3      <- coef(alc_log_mod)[[5]]
group_4      <- coef(alc_log_mod)[[6]]

#predicted probs
pred_probs_alc <- predict(alc_log_mod, type = "response")
#classification table
alc_classification <- dat %>%
  mutate(pred_reported = ifelse(pred_probs_alc < .50, "no", "yes")) %>%
  filter(alcfreq == "3-4x/month") %>%
  select(any_phys, pred_reported)
alc_class_table <- CrossTable(alc_classification$any_phys, alc_classification$pred_reported,
                              prop.r = F, prop.c = F, prop.chisq = F)
```

```
##
##
##     Cell Contents
## |-------------------------|
## |                       N |
## |         N / Table Total |
## |-------------------------|
##
##
## Total Observations in Table:  174
##
##
##                             | alc_classification$pred_reported
## alc_classification$any_phys |        no |       yes | Row Total |
## ----------------------------|-----------|-----------|-----------|
##                          no |       101 |        12 |       113 |
##                             |     0.580 |     0.069 |           |
## ----------------------------|-----------|-----------|-----------|
##                         yes |        41 |        20 |        61 |
##                             |     0.236 |     0.115 |           |
## ----------------------------|-----------|-----------|-----------|
##                Column Total |       142 |        32 |       174 |
## ----------------------------|-----------|-----------|-----------|
##
##
```

```
#threshold for group 2 (drinking 3-4x month)
-(intercept + group_2)/aggression
```

```
## [1] 0.5811709
```

We next ran a hierarchical regression, using a second model that added alcohol use as an additional predictor for physical aggression. The addition of alcohol use as a predictor was significant, predicting the odds of physical aggression for those who never drank were .41. This likelihood increased by 3.75 times for each standard deviation unit increase in BP scores. Regardless of BP score, the odds for individuals who drank 2 to 3 times a month were .8 times greater than those who never drank. The odds for individuals who drank 3 to 4 times a month were 1.1 times greater than those who never drank. The odds for individuals who drank 6 to 7 times a month were nearly 2 times greater than those who never drank and, finally, those who drank more than 8 times a month saw an increased likelihood of 14,549,472–though this is vastly inflated (*and I have no idea why*). The BP score at which probability of any physical aggression reached 50% for individuals who drink 3 to 4 times a month was .58, with our model accurately predicting the absence of physical aggression 89% of the time and the presence 67% of the time for this group.

BONUS: Write down the equations to predict the probability of any physical aggression for each of the five binge drinking groups. Plot the probability curve for each using R.

Group 1: Non drinkers
$$AnyPhys = .4135594 + 3.7719944 * BP$$

Group 2: Drink 2-3 times/month
$$AnyPhys = .4135594 + 3.7719944 * BP + 0.7934039$$

$$AnyPhys = 1.206963 + 3.7719944 * BP$$

Group 3: Drink 3-4 times/month
$$AnyPhys = .4135594 + 3.7719944 * BP + 1.1178301$$

$$AnyPhys = 1.531389 + 3.7719944 * BP$$

Group 4: Drink 6-7 times/month
$$AnyPhys = .4135594 + 3.7719944 * BP + 1.9574893$$

$$AnyPhys = 2.371049 + 3.7719944 * BP$$

Group 5: Drink 8+ times/month
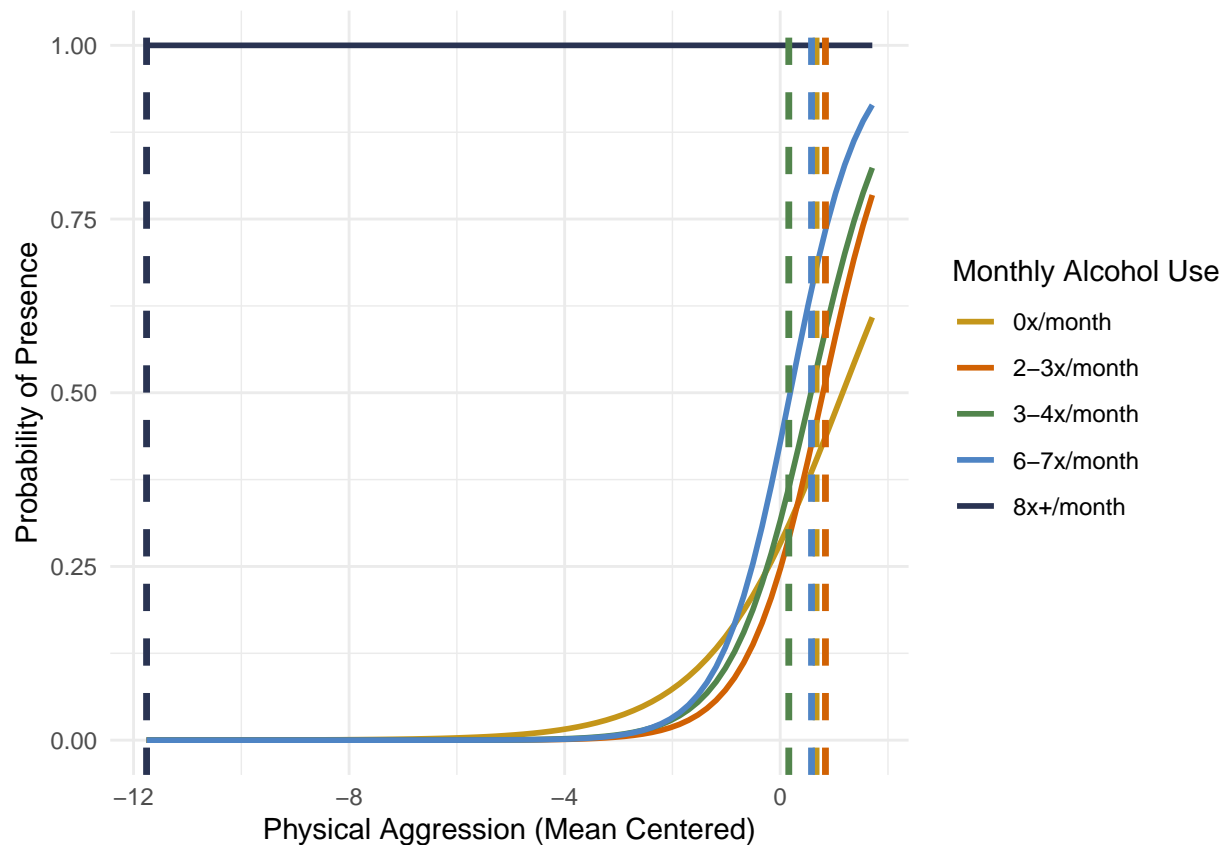$$AnyPhys = .4135594 + 3.7719944 * BP + 14549472.8907617$$

$$AnyPhys = 14549473 + 3.7719944 * BP$$

```r
#assign thresholds
thresh_g1 <- -intercept/aggression
thresh_g2 <- -(intercept + group_1)/aggression
thresh_g3 <- -(intercept + group_2)/aggression
thresh_g4 <- -(intercept + group_3)/aggression
thresh_g5 <- -(intercept + group_4)/aggression
#create numeric binary
agg_df <- dat %>%
  mutate(reported_bin = ifelse(any_phys == "yes", 1, 0))
#plot
ggplot(agg_df, aes(x = bp_c, y = reported_bin, color = alcfreq)) +
  scale_color_manual(values = c("#C4961A", "#D16103", "#52854C", "#4E84C4", "#293352")) +
  stat_smooth(method = "glm", method.args = list(family = "binomial"), se = FALSE, fullrange = TRUE) +
  geom_vline(xintercept = thresh_g1, linetype = 2, color = "#C4961A", size = 1.2) +
  geom_vline(xintercept = thresh_g2, linetype = 2, color = "#D16103", size = 1.2) +
  geom_vline(xintercept = thresh_g3, linetype = 2, color = "#4E84C4", size = 1.2) +
  geom_vline(xintercept = thresh_g4, linetype = 2, color = "#52854C", size = 1.2) +
  geom_vline(xintercept = thresh_g5, linetype = 2, color = "#293352", size = 1.2) +
  theme_minimal() +
#  theme(axis.line = element_line(colour = "black")) +
  labs(x = "Physical Aggression (Mean Centered)",
       y = "Probability of Presence",
       color = "Monthly Alcohol Use")
```

`geom_smooth()` using formula 'y ~ x'

Part 2: Machine Learning

Context & Data Info

Suppose you are interested in foraging wild mushrooms. Unfortunately, you don't know anything about which mushrooms are poisonous or edible. You begin recording information about the mushrooms you collect, and your friend agrees to taste them to determine whether they make him sick or not. Based on this information, train a model to be able to determine whether mushrooms no one has tasted yet are poisonous or edible.

The outcome variable is `class`, with `e` for edible and `p` for poisonous. The training set is `train_dat` and the test set is `test_dat`.

Q4: Run a logistic regression model on the training data to predict whether each mushroom is edible or poisonous. Use the parameters from this model to predict whether the mushrooms in the test set are poisonous or edible. How accurate is this model?

The best model we trained had a 92.7% accuracy on our training set, and 92.5% accuracy on our testing set.

```
# Model tuning
# glm_info <- getModelInfo("glm")
# glm_info$glm$parameters
#factor
train_dat <- train_dat %>%
  mutate(class = factor(class, levels = c("e", "p"), labels = c("edible", "poisonous")))
test_dat <- test_dat %>%
  mutate(class = factor(class, levels = c("e", "p"), labels = c("edible", "poisonous")))
# train model
glm_mush <- train(class ~ .,
                  data = train_dat,
                  method = "glm",
                  family = "binomial",
                  trControl = trainControl(method = "cv", number = 10))
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```
#look at results
glm_mush$bestTune
```

```
##   parameter
## 1      none
```

```
glm_mush$results
```

```
##   parameter  Accuracy     Kappa  AccuracySD   KappaSD
## 1      none 0.9273805 0.8546002 0.008857344 0.0177835
```

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```
#measure predictive accuracy
train_preds <- predict(glm_mush, train_dat) # Predict values in the testing set
test_preds <- predict(glm_mush, test_dat)

#determine accuracy
mean(test_preds==test_dat$class) #92.5% accurate
```

[1] 0.9248768

Q5: Repeat the previous problem with a linear SVM classifier. First, set a random seed. Next, use k-fold cross-validation to determine which tuning parameters to use and plot the results. What value will you use? Finally, apply this model to the test data. How accurate is this model? If you find a poisonous mushroom that you haven't seen yet, if you apply this model, how likely are you to incorrectly think it is edible?

Our best value for `C` was 1.577778, which is the value we'll use for the model. After applying the model to the test data, our model was 93.3% accurate, with a negative predictive value of 91%. So, we are 91% likely to incorrectly think the mushroom is edible when it's actually poisonous.

```
set.seed(12345)
#model tuning
svmLinear_info <- getModelInfo("svmLinear")
svmLinear_info$svmLinear$parameters # the hyperparameter is C
```

```
##   parameter   class label
## 1         C numeric  Cost
```

```
t_grid <- expand.grid(C = seq(from = .1, to = 2, length = 10))

#build and train model
svm_model <- train(class ~ .,
                   data = train_dat,
                   method = "svmLinear",
                   trControl = trainControl(method = "cv", number = 10),
                   tuneGrid = t_grid)

# Look at the results from model training
## See the final hyperparameter value from the tuning process
svm_model$bestTune
```

```
##    C
## 10 2
```

```
svm_model$results
```

```
##           C  Accuracy     Kappa   AccuracySD      KappaSD
## 1 0.1000000 0.9419976 0.8840080 0.007489076 0.01497943
## 2 0.3111111 0.9435346 0.8870653 0.008236526 0.01646785
```

8

```
## 3   0.5222222 0.9435349 0.8870648 0.007706314 0.01541478
## 4   0.7333333 0.9430733 0.8861404 0.007319263 0.01464087
## 5   0.9444444 0.9432272 0.8864471 0.007335498 0.01467116
## 6   1.1555556 0.9435349 0.8870622 0.007706314 0.01541492
## 7   1.3666667 0.9433808 0.8867501 0.007421212 0.01484587
## 8   1.5777778 0.9433808 0.8867501 0.007421212 0.01484587
## 9   1.7888889 0.9433808 0.8867501 0.007421212 0.01484587
## 10 2.0000000 0.9435349 0.8870571 0.007637215 0.01527885
```

```r
# Getting the model coefficients
coefs <- svm_model$finalModel@coef[[1]]
mat <- svm_model$finalModel@xmatrix[[1]]

coefs %*% mat
```

```
##      specimen cap_colorc cap_colore cap_colorg cap_colorn cap_colorp cap_colorr
## [1,] 1.525589 -0.4035044 -0.9465255 -0.4704192 -0.8420875 -0.2302056 -0.3258816
##      cap_coloru cap_colorw cap_colory cap_shapec cap_shapef cap_shapek
## [1,] -0.3248755 -0.4626954  -0.249469 0.02704154   1.279887 -0.2267065
##       cap_shapes cap_shapex cap_surfaceg cap_surfaces cap_surfacey gill_sizen
## [1,] -0.01480286   1.429836   0.03629472    0.1142996   0.09782638   1.406581
##      gill_colore gill_colorg gill_colorh gill_colork gill_colorn gill_coloro
## [1,]  -0.4223183 -0.04313199 -0.01994951  -0.1696485  -0.6561501  -0.1355218
##      gill_colorp gill_colorr gill_coloru gill_colorw gill_colory
## [1,]  -0.3206203   0.1106964  -0.5835474   -0.624421 -0.06630599
##      gill_attachmentf populationc populationn populations populationv
## [1,]         0.464189  0.04125441  -0.8459708   0.3093589   0.5607301
##      populationy
## [1,]   0.4342292
```

```r
#measure accuracy
test_preds2 <- predict(svm_model, test_dat) # Predict values in the testing set
# compare predictions vs actual
data.frame(actual    = test_dat$class,
           predicted = test_preds2)
```

```
##         actual predicted
## 1       edible    edible
## 2       edible    edible
## 3       edible    edible
## 4       edible    edible
## 5       edible    edible
## 6    poisonous poisonous
## 7       edible    edible
## 8    poisonous poisonous
## 9       edible    edible
## 10      edible    edible
## 11      edible    edible
## 12      edible    edible
## 13   poisonous poisonous
## 14      edible    edible
## 15      edible    edible
## 16      edible    edible
```

```
## 17      edible poisonous
## 18      edible poisonous
## 19      edible    edible
## 20      edible poisonous
## 21      edible    edible
## 22      edible    edible
## 23      edible    edible
## 24      edible    edible
## 25      edible    edible
## 26      edible    edible
## 27      edible    edible
## 28      edible    edible
## 29      edible poisonous
## 30      edible    edible
## 31      edible    edible
## 32      edible    edible
## 33      edible    edible
## 34      edible    edible
## 35   poisonous poisonous
## 36      edible    edible
## 37      edible    edible
## 38      edible    edible
## 39      edible    edible
## 40      edible poisonous
## 41      edible poisonous
## 42      edible    edible
## 43      edible    edible
## 44   poisonous poisonous
## 45      edible    edible
## 46      edible    edible
## 47      edible poisonous
## 48      edible    edible
## 49      edible    edible
## 50   poisonous poisonous
## 51   poisonous poisonous
## 52      edible poisonous
## 53      edible    edible
## 54   poisonous    edible
## 55      edible    edible
## 56      edible    edible
## 57      edible    edible
## 58   poisonous    edible
## 59      edible    edible
## 60   poisonous    edible
## 61      edible    edible
## 62      edible    edible
## 63      edible    edible
## 64      edible    edible
## 65   poisonous poisonous
## 66      edible    edible
## 67      edible    edible
## 68      edible    edible
## 69      edible    edible
## 70      edible poisonous
```

```
## 71       edible     edible
## 72       edible     edible
## 73       edible     edible
## 74       edible     edible
## 75       edible     edible
## 76       edible     edible
## 77       edible     edible
## 78       edible     edible
## 79       edible     edible
## 80       edible  poisonous
## 81       edible     edible
## 82       edible     edible
## 83    poisonous  poisonous
## 84       edible     edible
## 85       edible     edible
## 86       edible     edible
## 87       edible     edible
## 88       edible     edible
## 89       edible     edible
## 90       edible  poisonous
## 91       edible     edible
## 92       edible     edible
## 93       edible     edible
## 94       edible     edible
## 95       edible     edible
## 96       edible     edible
## 97       edible  poisonous
## 98       edible     edible
## 99       edible     edible
## 100      edible     edible
## 101      edible     edible
## 102      edible  poisonous
## 103      edible     edible
## 104      edible     edible
## 105      edible     edible
## 106      edible     edible
## 107   poisonous     edible
## 108      edible     edible
## 109      edible     edible
## 110      edible     edible
## 111      edible     edible
## 112      edible     edible
## 113      edible     edible
## 114      edible     edible
## 115      edible     edible
## 116      edible     edible
## 117      edible  poisonous
## 118      edible     edible
## 119      edible     edible
## 120      edible     edible
## 121   poisonous  poisonous
## 122   poisonous  poisonous
## 123      edible     edible
## 124      edible     edible
```

```
## 125      edible      edible
## 126      edible      edible
## 127      edible      edible
## 128   poisonous   poisonous
## 129      edible      edible
## 130      edible      edible
## 131      edible   poisonous
## 132      edible      edible
## 133      edible      edible
## 134      edible      edible
## 135      edible   poisonous
## 136   poisonous   poisonous
## 137      edible      edible
## 138      edible      edible
## 139   poisonous      edible
## 140      edible      edible
## 141      edible      edible
## 142      edible      edible
## 143   poisonous   poisonous
## 144      edible      edible
## 145      edible      edible
## 146      edible      edible
## 147      edible      edible
## 148      edible      edible
## 149      edible      edible
## 150      edible      edible
## 151      edible      edible
## 152   poisonous   poisonous
## 153      edible      edible
## 154      edible      edible
## 155   poisonous      edible
## 156      edible   poisonous
## 157      edible      edible
## 158      edible      edible
## 159   poisonous   poisonous
## 160      edible      edible
## 161      edible      edible
## 162      edible      edible
## 163   poisonous      edible
## 164      edible      edible
## 165      edible   poisonous
## 166      edible      edible
## 167      edible      edible
## 168      edible      edible
## 169      edible   poisonous
## 170      edible      edible
## 171      edible      edible
## 172      edible      edible
## 173      edible      edible
## 174      edible   poisonous
## 175      edible      edible
## 176      edible      edible
## 177      edible      edible
## 178      edible      edible
```

```
## 179  poisonous poisonous
## 180  poisonous poisonous
## 181     edible    edible
## 182     edible    edible
## 183     edible    edible
## 184     edible    edible
## 185     edible    edible
## 186     edible    edible
## 187     edible    edible
## 188     edible    edible
## 189     edible    edible
## 190     edible    edible
## 191     edible    edible
## 192     edible    edible
## 193     edible    edible
## 194     edible    edible
## 195     edible    edible
## 196     edible    edible
## 197     edible    edible
## 198     edible    edible
## 199     edible    edible
## 200     edible    edible
## 201     edible    edible
## 202     edible    edible
## 203     edible    edible
## 204     edible poisonous
## 205     edible    edible
## 206     edible    edible
## 207  poisonous poisonous
## 208     edible    edible
## 209     edible    edible
## 210     edible    edible
## 211     edible poisonous
## 212     edible    edible
## 213     edible    edible
## 214     edible    edible
## 215     edible    edible
## 216     edible    edible
## 217     edible    edible
## 218     edible    edible
## 219     edible poisonous
## 220     edible    edible
## 221     edible    edible
## 222     edible    edible
## 223     edible    edible
## 224     edible    edible
## 225     edible    edible
## 226     edible    edible
## 227     edible    edible
## 228     edible    edible
## 229     edible    edible
## 230  poisonous poisonous
## 231     edible    edible
## 232     edible    edible
```

```
## 233      edible      edible
## 234      edible      edible
## 235      edible      edible
## 236      edible  poisonous
## 237      edible      edible
## 238      edible      edible
## 239   poisonous  poisonous
## 240      edible      edible
## 241   poisonous  poisonous
## 242      edible      edible
## 243      edible      edible
## 244      edible      edible
## 245      edible      edible
## 246   poisonous  poisonous
## 247      edible      edible
## 248   poisonous  poisonous
## 249   poisonous  poisonous
## 250      edible      edible
## 251      edible      edible
## 252      edible      edible
## 253      edible      edible
## 254   poisonous  poisonous
## 255      edible      edible
## 256      edible      edible
## 257      edible      edible
## 258      edible      edible
## 259      edible      edible
## 260      edible      edible
## 261   poisonous  poisonous
## 262      edible      edible
## 263      edible      edible
## 264      edible      edible
## 265      edible      edible
## 266      edible      edible
## 267      edible      edible
## 268      edible      edible
## 269      edible      edible
## 270      edible      edible
## 271      edible      edible
## 272      edible      edible
## 273      edible      edible
## 274      edible      edible
## 275      edible      edible
## 276      edible      edible
## 277      edible      edible
## 278      edible      edible
## 279      edible      edible
## 280      edible      edible
## 281      edible      edible
## 282      edible      edible
## 283      edible      edible
## 284   poisonous  poisonous
## 285      edible      edible
## 286      edible      edible
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## 287      edible      edible
## 288      edible      edible
## 289      edible      edible
## 290      edible      edible
## 291      edible      edible
## 292      edible      edible
## 293      edible      edible
## 294      edible      edible
## 295      edible      edible
## 296      edible      edible
## 297      edible      edible
## 298      edible      edible
## 299      edible      edible
## 300      edible      edible
## 301      edible      edible
## 302      edible      edible
## 303      edible      edible
## 304      edible      edible
## 305      edible      edible
## 306      edible      edible
## 307      edible      edible
## 308      edible      edible
## 309   poisonous      edible
## 310   poisonous   poisonous
## 311   poisonous   poisonous
## 312      edible      edible
## 313      edible      edible
## 314      edible      edible
## 315      edible      edible
## 316      edible      edible
## 317      edible      edible
## 318      edible      edible
## 319   poisonous   poisonous
## 320   poisonous   poisonous
## 321      edible      edible
## 322      edible      edible
## 323      edible      edible
## 324      edible      edible
## 325      edible      edible
## 326      edible      edible
## 327      edible      edible
## 328      edible      edible
## 329      edible      edible
## 330      edible      edible
## 331      edible      edible
## 332      edible      edible
## 333      edible      edible
## 334      edible      edible
## 335      edible      edible
## 336      edible      edible
## 337      edible      edible
## 338      edible      edible
## 339      edible      edible
## 340      edible      edible
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## 341      edible      edible
## 342      edible      edible
## 343      edible      edible
## 344      edible      edible
## 345      edible      edible
## 346      edible      edible
## 347      edible      edible
## 348      edible      edible
## 349      edible   poisonous
## 350      edible      edible
## 351      edible      edible
## 352      edible      edible
## 353      edible      edible
## 354      edible      edible
## 355      edible      edible
## 356   poisonous   poisonous
## 357      edible      edible
## 358      edible      edible
## 359      edible      edible
## 360      edible      edible
## 361   poisonous   poisonous
## 362      edible      edible
## 363      edible      edible
## 364      edible      edible
## 365      edible      edible
## 366      edible      edible
## 367      edible      edible
## 368      edible      edible
## 369      edible      edible
## 370      edible      edible
## 371      edible      edible
## 372      edible      edible
## 373      edible      edible
## 374      edible      edible
## 375      edible      edible
## 376      edible      edible
## 377      edible      edible
## 378      edible      edible
## 379      edible      edible
## 380      edible      edible
## 381      edible      edible
## 382      edible      edible
## 383      edible      edible
## 384      edible      edible
## 385      edible      edible
## 386      edible      edible
## 387      edible      edible
## 388      edible      edible
## 389      edible      edible
## 390      edible      edible
## 391      edible      edible
## 392   poisonous   poisonous
## 393   poisonous   poisonous
## 394      edible      edible
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## 395      edible      edible
## 396      edible      edible
## 397      edible      edible
## 398      edible      edible
## 399      edible      edible
## 400      edible      edible
## 401      edible      edible
## 402      edible      edible
## 403      edible      edible
## 404      edible      edible
## 405      edible      edible
## 406      edible      edible
## 407      edible   poisonous
## 408      edible      edible
## 409      edible      edible
## 410      edible      edible
## 411      edible      edible
## 412      edible      edible
## 413   poisonous   poisonous
## 414      edible      edible
## 415      edible      edible
## 416      edible      edible
## 417      edible      edible
## 418      edible      edible
## 419      edible      edible
## 420      edible      edible
## 421      edible      edible
## 422      edible      edible
## 423      edible      edible
## 424      edible      edible
## 425      edible      edible
## 426   poisonous   poisonous
## 427      edible      edible
## 428      edible      edible
## 429      edible      edible
## 430      edible      edible
## 431      edible      edible
## 432      edible      edible
## 433      edible      edible
## 434      edible      edible
## 435      edible      edible
## 436      edible      edible
## 437      edible      edible
## 438      edible      edible
## 439      edible      edible
## 440      edible      edible
## 441      edible      edible
## 442      edible      edible
## 443      edible      edible
## 444      edible      edible
## 445      edible      edible
## 446      edible      edible
## 447      edible      edible
## 448      edible      edible
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## 449      edible     edible
## 450      edible     edible
## 451      edible     edible
## 452      edible     edible
## 453   poisonous  poisonous
## 454      edible     edible
## 455      edible     edible
## 456      edible     edible
## 457      edible     edible
## 458      edible     edible
## 459      edible     edible
## 460   poisonous  poisonous
## 461      edible     edible
## 462      edible     edible
## 463      edible     edible
## 464      edible     edible
## 465      edible     edible
## 466      edible     edible
## 467      edible     edible
## 468      edible     edible
## 469      edible     edible
## 470      edible     edible
## 471      edible     edible
## 472      edible     edible
## 473   poisonous  poisonous
## 474      edible     edible
## 475      edible     edible
## 476      edible     edible
## 477      edible     edible
## 478      edible     edible
## 479      edible     edible
## 480      edible     edible
## 481      edible     edible
## 482      edible     edible
## 483      edible     edible
## 484      edible     edible
## 485      edible     edible
## 486      edible     edible
## 487      edible     edible
## 488      edible     edible
## 489      edible     edible
## 490      edible     edible
## 491      edible     edible
## 492      edible     edible
## 493   poisonous  poisonous
## 494      edible     edible
## 495      edible     edible
## 496      edible     edible
## 497   poisonous  poisonous
## 498      edible     edible
## 499      edible     edible
## 500      edible     edible
## 501      edible     edible
## 502      edible     edible
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## 503     edible     edible
## 504     edible     edible
## 505     edible     edible
## 506     edible     edible
## 507     edible     edible
## 508  poisonous  poisonous
## 509     edible     edible
## 510     edible     edible
## 511     edible     edible
## 512     edible     edible
## 513     edible     edible
## 514     edible     edible
## 515     edible     edible
## 516     edible     edible
## 517     edible     edible
## 518     edible     edible
## 519     edible     edible
## 520     edible     edible
## 521     edible     edible
## 522     edible     edible
## 523     edible     edible
## 524     edible     edible
## 525     edible     edible
## 526     edible     edible
## 527     edible     edible
## 528     edible     edible
## 529     edible     edible
## 530     edible     edible
## 531     edible     edible
## 532     edible     edible
## 533     edible     edible
## 534     edible     edible
## 535  poisonous  poisonous
## 536     edible     edible
## 537     edible     edible
## 538     edible     edible
## 539     edible     edible
## 540     edible     edible
## 541     edible     edible
## 542     edible     edible
## 543     edible     edible
## 544  poisonous  poisonous
## 545     edible     edible
## 546     edible     edible
## 547     edible     edible
## 548     edible     edible
## 549     edible     edible
## 550     edible     edible
## 551     edible     edible
## 552     edible     edible
## 553     edible     edible
## 554     edible     edible
## 555     edible     edible
## 556     edible     edible
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## 557      edible      edible
## 558      edible      edible
## 559      edible      edible
## 560      edible      edible
## 561      edible      edible
## 562      edible      edible
## 563      edible      edible
## 564      edible      edible
## 565   poisonous   poisonous
## 566      edible      edible
## 567   poisonous   poisonous
## 568      edible      edible
## 569      edible      edible
## 570      edible      edible
## 571      edible      edible
## 572      edible      edible
## 573      edible      edible
## 574      edible      edible
## 575      edible      edible
## 576      edible      edible
## 577      edible      edible
## 578      edible      edible
## 579      edible      edible
## 580      edible      edible
## 581      edible      edible
## 582      edible      edible
## 583      edible      edible
## 584      edible      edible
## 585   poisonous   poisonous
## 586   poisonous   poisonous
## 587      edible      edible
## 588      edible      edible
## 589      edible      edible
## 590   poisonous   poisonous
## 591   poisonous   poisonous
## 592      edible      edible
## 593      edible      edible
## 594   poisonous   poisonous
## 595      edible      edible
## 596   poisonous   poisonous
## 597   poisonous   poisonous
## 598      edible      edible
## 599      edible      edible
## 600      edible      edible
## 601   poisonous   poisonous
## 602   poisonous      edible
## 603      edible      edible
## 604      edible      edible
## 605      edible      edible
## 606   poisonous   poisonous
## 607      edible      edible
## 608      edible      edible
## 609   poisonous      edible
## 610   poisonous   poisonous
```

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## 611   poisonous poisonous
## 612     edible     edible
## 613   poisonous poisonous
## 614     edible     edible
## 615   poisonous     edible
## 616     edible     edible
## 617     edible     edible
## 618     edible     edible
## 619     edible     edible
## 620   poisonous     edible
## 621     edible     edible
## 622     edible     edible
## 623   poisonous poisonous
## 624     edible     edible
## 625     edible     edible
## 626     edible     edible
## 627   poisonous     edible
## 628     edible     edible
## 629   poisonous poisonous
## 630     edible     edible
## 631   poisonous poisonous
## 632   poisonous poisonous
## 633     edible     edible
## 634     edible     edible
## 635   poisonous poisonous
## 636     edible     edible
## 637     edible     edible
## 638     edible     edible
## 639     edible     edible
## 640     edible     edible
## 641     edible     edible
## 642     edible     edible
## 643     edible     edible
## 644     edible     edible
## 645   poisonous poisonous
## 646     edible     edible
## 647   poisonous poisonous
## 648     edible     edible
## 649   poisonous poisonous
## 650   poisonous poisonous
## 651     edible     edible
## 652   poisonous poisonous
## 653   poisonous poisonous
## 654     edible     edible
## 655     edible     edible
## 656     edible     edible
## 657   poisonous poisonous
## 658     edible     edible
## 659     edible     edible
## 660   poisonous poisonous
## 661     edible     edible
## 662   poisonous poisonous
## 663     edible poisonous
## 664     edible     edible
```

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## 665   poisonous poisonous
## 666   poisonous poisonous
## 667   poisonous poisonous
## 668      edible    edible
## 669      edible    edible
## 670      edible    edible
## 671      edible    edible
## 672   poisonous poisonous
## 673      edible    edible
## 674      edible    edible
## 675   poisonous poisonous
## 676      edible    edible
## 677   poisonous poisonous
## 678      edible    edible
## 679      edible    edible
## 680   poisonous poisonous
## 681   poisonous poisonous
## 682      edible poisonous
## 683      edible    edible
## 684   poisonous poisonous
## 685      edible    edible
## 686      edible    edible
## 687      edible    edible
## 688      edible    edible
## 689   poisonous poisonous
## 690      edible    edible
## 691      edible    edible
## 692   poisonous poisonous
## 693   poisonous poisonous
## 694   poisonous poisonous
## 695   poisonous poisonous
## 696      edible    edible
## 697   poisonous poisonous
## 698      edible    edible
## 699   poisonous poisonous
## 700      edible    edible
## 701      edible    edible
## 702      edible    edible
## 703      edible    edible
## 704   poisonous poisonous
## 705      edible    edible
## 706   poisonous poisonous
## 707   poisonous poisonous
## 708   poisonous poisonous
## 709   poisonous    edible
## 710      edible    edible
## 711   poisonous poisonous
## 712   poisonous poisonous
## 713      edible    edible
## 714      edible    edible
## 715      edible    edible
## 716      edible    edible
## 717   poisonous poisonous
## 718   poisonous poisonous
```

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## 719     edible     edible
## 720     edible     edible
## 721  poisonous poisonous
## 722     edible     edible
## 723     edible     edible
## 724  poisonous poisonous
## 725     edible     edible
## 726     edible     edible
## 727     edible     edible
## 728     edible     edible
## 729     edible     edible
## 730  poisonous poisonous
## 731     edible     edible
## 732     edible     edible
## 733     edible     edible
## 734  poisonous poisonous
## 735  poisonous poisonous
## 736  poisonous poisonous
## 737  poisonous poisonous
## 738  poisonous poisonous
## 739  poisonous poisonous
## 740  poisonous poisonous
## 741     edible     edible
## 742     edible     edible
## 743  poisonous poisonous
## 744     edible     edible
## 745  poisonous poisonous
## 746     edible     edible
## 747     edible     edible
## 748     edible     edible
## 749     edible     edible
## 750     edible     edible
## 751     edible     edible
## 752     edible poisonous
## 753     edible     edible
## 754     edible poisonous
## 755     edible     edible
## 756     edible     edible
## 757     edible poisonous
## 758  poisonous poisonous
## 759     edible     edible
## 760  poisonous poisonous
## 761     edible     edible
## 762     edible     edible
## 763  poisonous poisonous
## 764  poisonous poisonous
## 765     edible     edible
## 766  poisonous poisonous
## 767     edible poisonous
## 768  poisonous poisonous
## 769  poisonous poisonous
## 770  poisonous poisonous
## 771     edible     edible
## 772  poisonous poisonous
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## 773  poisonous poisonous
## 774     edible     edible
## 775     edible     edible
## 776  poisonous poisonous
## 777     edible     edible
## 778     edible     edible
## 779  poisonous poisonous
## 780  poisonous     edible
## 781  poisonous poisonous
## 782  poisonous poisonous
## 783  poisonous poisonous
## 784  poisonous poisonous
## 785  poisonous poisonous
## 786     edible     edible
## 787  poisonous poisonous
## 788     edible     edible
## 789  poisonous poisonous
## 790  poisonous poisonous
## 791     edible     edible
## 792     edible     edible
## 793     edible     edible
## 794  poisonous poisonous
## 795     edible     edible
## 796  poisonous poisonous
## 797     edible     edible
## 798  poisonous poisonous
## 799     edible     edible
## 800  poisonous poisonous
## 801     edible     edible
## 802  poisonous poisonous
## 803     edible     edible
## 804     edible     edible
## 805     edible     edible
## 806     edible     edible
## 807  poisonous poisonous
## 808  poisonous poisonous
## 809  poisonous poisonous
## 810     edible     edible
## 811  poisonous poisonous
## 812  poisonous poisonous
## 813  poisonous poisonous
## 814     edible     edible
## 815  poisonous     edible
## 816     edible     edible
## 817  poisonous poisonous
## 818     edible     edible
## 819  poisonous poisonous
## 820  poisonous poisonous
## 821     edible     edible
## 822  poisonous poisonous
## 823  poisonous poisonous
## 824     edible     edible
## 825  poisonous poisonous
## 826  poisonous poisonous
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## 827   poisonous poisonous
## 828   poisonous poisonous
## 829   poisonous poisonous
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## 837   poisonous poisonous
## 838   poisonous poisonous
## 839   poisonous poisonous
## 840   poisonous poisonous
## 841   poisonous poisonous
## 842   poisonous poisonous
## 843      edible    edible
## 844   poisonous poisonous
## 845   poisonous poisonous
## 846   poisonous poisonous
## 847      edible    edible
## 848   poisonous poisonous
## 849   poisonous poisonous
## 850   poisonous poisonous
## 851   poisonous poisonous
## 852      edible    edible
## 853   poisonous poisonous
## 854   poisonous poisonous
## 855   poisonous poisonous
## 856   poisonous poisonous
## 857   poisonous poisonous
## 858   poisonous poisonous
## 859      edible    edible
## 860   poisonous poisonous
## 861   poisonous poisonous
## 862   poisonous poisonous
## 863   poisonous poisonous
## 864   poisonous poisonous
## 865   poisonous poisonous
## 866   poisonous poisonous
## 867   poisonous poisonous
## 868      edible    edible
## 869   poisonous    edible
## 870   poisonous poisonous
## 871   poisonous poisonous
## 872   poisonous poisonous
## 873   poisonous poisonous
## 874   poisonous poisonous
## 875   poisonous poisonous
## 876   poisonous poisonous
## 877   poisonous poisonous
## 878   poisonous poisonous
## 879   poisonous poisonous
## 880   poisonous poisonous
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## 881    poisonous poisonous
## 882    poisonous poisonous
## 883      edible    edible
## 884      edible    edible
## 885    poisonous poisonous
## 886    poisonous poisonous
## 887      edible    edible
## 888    poisonous poisonous
## 889    poisonous poisonous
## 890    poisonous poisonous
## 891    poisonous poisonous
## 892    poisonous poisonous
## 893    poisonous poisonous
## 894    poisonous poisonous
## 895    poisonous poisonous
## 896    poisonous poisonous
## 897    poisonous poisonous
## 898    poisonous poisonous
## 899    poisonous poisonous
## 900    poisonous poisonous
## 901    poisonous poisonous
## 902    poisonous poisonous
## 903    poisonous poisonous
## 904    poisonous poisonous
## 905      edible    edible
## 906    poisonous poisonous
## 907    poisonous poisonous
## 908    poisonous poisonous
## 909      edible    edible
## 910    poisonous poisonous
## 911      edible    edible
## 912    poisonous poisonous
## 913    poisonous poisonous
## 914    poisonous poisonous
## 915    poisonous poisonous
## 916    poisonous poisonous
## 917    poisonous poisonous
## 918    poisonous poisonous
## 919      edible poisonous
## 920    poisonous poisonous
## 921    poisonous poisonous
## 922    poisonous poisonous
## 923    poisonous poisonous
## 924    poisonous poisonous
## 925    poisonous poisonous
## 926    poisonous poisonous
## 927    poisonous poisonous
## 928    poisonous poisonous
## 929    poisonous poisonous
## 930    poisonous poisonous
## 931    poisonous poisonous
## 932    poisonous poisonous
## 933    poisonous poisonous
## 934    poisonous poisonous
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## 935    poisonous poisonous
## 936    poisonous poisonous
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## 938    poisonous poisonous
## 939    poisonous poisonous
## 940    poisonous poisonous
## 941    poisonous poisonous
## 942    poisonous poisonous
## 943    poisonous poisonous
## 944    poisonous poisonous
## 945    poisonous poisonous
## 946    poisonous poisonous
## 947    poisonous poisonous
## 948    poisonous poisonous
## 949    poisonous poisonous
## 950    poisonous poisonous
## 951       edible    edible
## 952    poisonous poisonous
## 953    poisonous poisonous
## 954    poisonous poisonous
## 955    poisonous poisonous
## 956    poisonous poisonous
## 957    poisonous    edible
## 958    poisonous poisonous
## 959    poisonous poisonous
## 960    poisonous    edible
## 961    poisonous poisonous
## 962    poisonous poisonous
## 963    poisonous    edible
## 964       edible    edible
## 965    poisonous poisonous
## 966    poisonous poisonous
## 967    poisonous poisonous
## 968       edible    edible
## 969    poisonous poisonous
## 970    poisonous poisonous
## 971    poisonous poisonous
## 972    poisonous poisonous
## 973    poisonous poisonous
## 974    poisonous poisonous
## 975    poisonous poisonous
## 976    poisonous poisonous
## 977    poisonous poisonous
## 978    poisonous poisonous
## 979       edible poisonous
## 980       edible    edible
## 981    poisonous poisonous
## 982    poisonous poisonous
## 983    poisonous poisonous
## 984       edible    edible
## 985    poisonous poisonous
## 986    poisonous poisonous
## 987    poisonous poisonous
## 988       edible poisonous
```

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## 989  poisonous poisonous
## 990  poisonous poisonous
## 991  poisonous poisonous
## 992  poisonous poisonous
## 993  poisonous poisonous
## 994  poisonous poisonous
## 995     edible    edible
## 996  poisonous poisonous
## 997  poisonous poisonous
## 998  poisonous poisonous
## 999  poisonous poisonous
## 1000 poisonous poisonous
## 1001 poisonous poisonous
## 1002 poisonous poisonous
## 1003 poisonous poisonous
## 1004 poisonous poisonous
## 1005 poisonous poisonous
## 1006 poisonous poisonous
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## 1090    edible    edible
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## 1096    edible    edible
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## 1104    edible poisonous
## 1105 poisonous poisonous
## 1106    edible    edible
## 1107 poisonous poisonous
## 1108    edible    edible
## 1109 poisonous poisonous
## 1110 poisonous poisonous
## 1111 poisonous poisonous
## 1112 poisonous poisonous
## 1113    edible    edible
## 1114 poisonous poisonous
## 1115 poisonous poisonous
## 1116 poisonous poisonous
## 1117    edible    edible
## 1118 poisonous poisonous
## 1119    edible    edible
## 1120 poisonous poisonous
## 1121 poisonous poisonous
## 1122    edible poisonous
## 1123 poisonous poisonous
## 1124 poisonous poisonous
## 1125 poisonous poisonous
## 1126 poisonous poisonous
## 1127    edible    edible
## 1128    edible    edible
## 1129 poisonous poisonous
## 1130 poisonous poisonous
## 1131    edible    edible
## 1132 poisonous poisonous
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## 1139    edible    edible
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## 1149 poisonous poisonous
## 1150    edible poisonous
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## 1151 poisonous poisonous
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## 1160 poisonous poisonous
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## 1180 poisonous poisonous
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## 1182 poisonous poisonous
## 1183 poisonous poisonous
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## 1187    edible    edible
## 1188    edible poisonous
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## 1198 poisonous poisonous
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## 1247    edible    edible
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## 1276 poisonous    edible
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## 1382 poisonous poisonous
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## 1386    edible    edible
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## 1400 poisonous poisonous
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## 1402 poisonous poisonous
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## 1404    edible    edible
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## 1475 poisonous poisonous
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## 1505    edible    edible
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## 1583    edible poisonous
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## 1613    edible    edible
## 1614    edible    edible
## 1615 poisonous poisonous
## 1616    edible    edible
## 1617    edible    edible
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## 1620 poisonous poisonous
## 1621    edible    edible
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## 1623    edible    edible
## 1624    edible    edible
```

```r
# compute model accuracy
accuracy_test_svm <- mean(test_preds2 == test_dat$class) #93.3% accurate
accuracy_test_svm
```

```
## [1] 0.9334975
```

```r
# confusion matrix
confusionMatrix(test_preds2, test_dat$class)
```

```
## Confusion Matrix and Statistics
```

```
##
##           Reference
## Prediction  edible poisonous
##    edible     768        35
##    poisonous   73       748
##
##                Accuracy : 0.9335
##                  95% CI : (0.9203, 0.9451)
##     No Information Rate : 0.5179
##     P-Value [Acc > NIR] : < 0.00000000000000022
##
##                   Kappa : 0.867
##
##  Mcnemar's Test P-Value : 0.0003704
##
##             Sensitivity : 0.9132
##             Specificity : 0.9553
##          Pos Pred Value : 0.9564
##          Neg Pred Value : 0.9111
##              Prevalence : 0.5179
##          Detection Rate : 0.4729
##    Detection Prevalence : 0.4945
##       Balanced Accuracy : 0.9342
##
##        'Positive' Class : edible
##
```