

# Logistic Regression

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**text feature engineering:**

```
wine_words <- function(df, j = 1000, stem=F){
  library(tidytext)
  library(SnowballC)
  data(stop_words)
  words <- df %>%
    unnest_tokens(word, description) %>%
    anti_join(stop_words) %>% # get rid of stop words
    filter(!(word %in% c("wine", "pinot", "vineyard", "price", "points")))

  if(stem){
    words <- words %>%
      mutate(word = wordStem(word))
  }

  words <- words %>%
    count(id, word) %>%
    group_by(id) %>%
    mutate(exists = (n>0)) %>%
    ungroup %>%
    group_by(word) %>%
    mutate(total = sum(n)) %>%
    filter(total > j) %>%
    pivot_wider(id_cols = id, names_from = word, values_from = exists, values_fill = list(
    right_join(select(df, id, province)) %>%
    mutate(across(-province, ~replace_na(.x, F)))
  }
  wino <- wine_words(wine, j=400, stem=F)
```

Joining with `by = join\_by(word)`

Joining with `by = join\_by(id)`

bringing back numerical features from original dataset to wino:

```
wino = wino %>% left_join(select(wine, id, price, points, year), by = "id")
```

Numerical feature engineering:

```
#center and scale points:
wino = wino %>% select(points) %>% preProcess(method = c("center", "scale")) %>% predict(w

#year as factor, logprice:
wino = wino %>% mutate(year_f = as.factor(year),
                        lprice = log(price))

#binning year and price:
wino = wino %>%
  mutate(price_f = case_when(
    price < 16 ~ "low",
    price >= 16 & price < 41 ~ "med",
    price >= 41 ~ "high"
  ),
  year_f = case_when(
    year < 2005 ~ "old",
    year >= 2005 & year < 2011 ~ "recent",
    year >= 2011 ~ "current"
  ))
wino = wino %>% dplyr::select(-price)
#difference of wine's lprice from total average lprice
wino = wino %>% mutate(diff_from_avg_lprice = mean(lprice) - lprice)
wino = wino %>% mutate(cost_per_point = lprice/points)
wino = wino %>% select(-id)
wino = wino %>% select(-diff_from_avg_lprice)

head(wino)
```

# A tibble: 6 x 82

|   | bottling | earthy | herbal | berry | chocolate | drink | herb  | oak   | tart  | aromas | bodied |
|---|----------|--------|--------|-------|-----------|-------|-------|-------|-------|--------|--------|
|   | <lgl>    | <lgl>  | <lgl>  | <lgl> | <lgl>     | <lgl> | <lgl> | <lgl> | <lgl> | <lgl>  | <lgl>  |
| 1 | TRUE     | TRUE   | TRUE   | FALSE | FALSE     | FALSE | FALSE | FALSE | FALSE | FALSE  | FALSE  |
| 2 | FALSE    | FALSE  | FALSE  | TRUE  | TRUE      | TRUE  | TRUE  | TRUE  | TRUE  | FALSE  | FALSE  |
| 3 | FALSE    | FALSE  | FALSE  | FALSE | FALSE     | FALSE | FALSE | TRUE  | FALSE | TRUE   | TRUE   |

```

4 FALSE    FALSE TRUE    FALSE FALSE    FALSE TRUE  FALSE FALSE FALSE  FALSE
5 FALSE    TRUE  FALSE TRUE  FALSE    FALSE FALSE FALSE FALSE FALSE  FALSE
6 FALSE    FALSE FALSE FALSE FALSE    TRUE  FALSE FALSE FALSE FALSE  FALSE
# ... with 71 more variables: earth <lgl>, forest <lgl>, offers <lgl>,
#   raspberry <lgl>, smooth <lgl>, spice <lgl>, texture <lgl>, finish <lgl>,
#   flavor <lgl>, fruit <lgl>, notes <lgl>, sweet <lgl>, touch <lgl>,
#   flavors <lgl>, tannins <lgl>, fruity <lgl>, strawberry <lgl>,
#   cranberry <lgl>, dark <lgl>, palate <lgl>, acidity <lgl>, black <lgl>,
#   cherry <lgl>, cola <lgl>, dried <lgl>, nose <lgl>, soft <lgl>, juicy <lgl>,
#   ripe <lgl>, light <lgl>, spicy <lgl>, red <lgl>, age <lgl>, bit <lgl>, ...

```

Split data

```

set.seed(504)
wine_index <- createDataPartition(wino$province, p = 0.80, list = FALSE)

train <- wino[ wine_index, ]
test  <- wino[-wine_index, ]

table(train$province)

```

|          |            |                   |             |
|----------|------------|-------------------|-------------|
| Burgundy | California | Casablanca_Valley | Marlborough |
| 955      | 3168       | 105               | 184         |
| New_York | Oregon     |                   |             |
| 105      | 2190       |                   |             |

```
nrow(train)
```

```
[1] 6707
```

```
nrow(test)
```

```
[1] 1673
```

Fit Model

```
# Fit the mode

control <- trainControl(method="cv",
                        number=5,
                        savePredictions="all",
                        classProbs=TRUE)

model <- nnet::multinom(province ~.,
                        data = train,
                        trControl=control)
```

```
# weights:  510 (420 variable)
initial  value 12017.330760
iter   10 value 8584.413019
iter   20 value 3068.090564
iter   30 value 2720.523514
iter   40 value 2346.821262
iter   50 value 2180.750816
iter   60 value 2013.245391
iter   70 value 1957.417433
iter   80 value 1894.809457
iter   90 value 1836.014262
iter  100 value 1812.821335
final   value 1812.821335
stopped after 100 iterations
```

```
print(model)
```

Call:

```
nnet::multinom(formula = province ~ ., data = train, trControl = control)
```

Coefficients:

|                   | (Intercept)   | bottlingTRUE | earthyTRUE | herbalTRUE | berryTRUE  |
|-------------------|---------------|--------------|------------|------------|------------|
| California        | -2.4903923    | 3.19152606   | 2.3125022  | 1.979474   | -1.3508965 |
| Casablanca_Valley | -0.1730433    | 1.01126942   | 1.5323348  | 4.258987   | 0.9989287  |
| Marlborough       | 0.1549843     | 1.45115922   | 0.2046354  | 2.036594   | -1.7838920 |
| New_York          | 0.0999495     | 0.02852935   | 1.4992686  | 1.892184   | 0.3554109  |
| Oregon            | 1.9264725     | 2.37645290   | 1.2382801  | 1.876914   | -0.4266640 |
|                   | chocolateTRUE | drinkTRUE    | herbTRUE   | oakTRUE    | tartTRUE   |
| California        | 0.507100383   | -3.472278    | 2.7850935  | 3.469559   | 4.528674   |

|                   |               |             |            |                |              |            |
|-------------------|---------------|-------------|------------|----------------|--------------|------------|
| Casablanca_Valley | 3.859721213   | -1.174014   | -0.9067615 | 4.705098       | 2.138257     |            |
| Marlborough       | 0.626777217   | 1.099512    | 3.0707601  | 3.202391       | 5.188310     |            |
| New_York          | -0.004787873  | -2.753924   | 2.7015417  | 2.808130       | 5.907882     |            |
| Oregon            | 2.936022493   | -2.134025   | 3.3666334  | 2.606519       | 5.158366     |            |
|                   | aromasTRUE    | bodiedTRUE  | earthTRUE  | forestTRUE     | offersTRUE   |            |
| California        | 3.449423      | 2.9542409   | 4.383468   | 4.415977       | 1.6246831    |            |
| Casablanca_Valley | 5.598780      | 1.8266714   | 3.970641   | 1.791635       | 0.8646075    |            |
| Marlborough       | 2.428074      | 3.4566834   | 4.940110   | 4.091309       | 1.4079725    |            |
| New_York          | 2.513703      | 3.2246257   | 5.285969   | 3.276782       | 0.8137083    |            |
| Oregon            | 1.097343      | 0.7475735   | 4.239178   | 2.590290       | 1.3752110    |            |
|                   | raspberryTRUE | smoothTRUE  | spiceTRUE  | textureTRUE    | finishTRUE   |            |
| California        | 0.7278153     | 0.4959137   | -0.4117102 | 1.0776575      | 1.744125     |            |
| Casablanca_Valley | 2.4694370     | 1.1319468   | 0.8690474  | -3.3132198     | 3.864939     |            |
| Marlborough       | -1.7602224    | 0.7941269   | -2.0888872 | 0.7908803      | 2.954930     |            |
| New_York          | 1.6222959     | -1.3710536  | -0.2881626 | -4.9526836     | 2.656226     |            |
| Oregon            | 0.6899553     | 0.7365484   | -1.5494376 | -1.3127036     | 1.891754     |            |
|                   | flavorTRUE    | fruitTRUE   | notesTRUE  | sweetTRUE      | touchTRUE    |            |
| California        | 0.6817441     | -0.8968381  | 1.328931   | -0.49612295    | -2.189701    |            |
| Casablanca_Valley | 2.5714614     | -1.3959790  | 3.072088   | 0.07092911     | -1.477218    |            |
| Marlborough       | -1.1354230    | 0.5794106   | 3.488000   | -2.49622800    | -1.439735    |            |
| New_York          | 0.8695785     | -1.9929400  | 2.929370   | 0.61310051     | -2.820271    |            |
| Oregon            | 0.6097213     | 0.7711675   | 1.560460   | -0.19832238    | -1.722271    |            |
|                   | flavorsTRUE   | tanninsTRUE | fruityTRUE | strawberryTRUE |              |            |
| California        | 0.01935343    | -2.2521763  | -1.992863  | -0.27731054    |              |            |
| Casablanca_Valley | 3.23000048    | -3.3164165  | -1.415181  | -2.43080093    |              |            |
| Marlborough       | -0.31309278   | -1.3339309  | -4.919124  | -1.93416536    |              |            |
| New_York          | 0.41347247    | 0.8537133   | -2.200882  | 0.09741894     |              |            |
| Oregon            | 1.17314804    | -1.9741639  | -1.396537  | -0.74256360    |              |            |
|                   | cranberryTRUE | darkTRUE    | palateTRUE | acidityTRUE    | blackTRUE    |            |
| California        | 2.751459      | -0.5793567  | 2.432115   | -1.6954060     | -0.193780935 |            |
| Casablanca_Valley | 1.606306      | -0.8238596  | 3.654301   | -1.2683857     | -0.615344850 |            |
| Marlborough       | 2.617031      | -1.6692028  | 1.642772   | -5.0030727     | -0.507358726 |            |
| New_York          | 2.325585      | -4.6285679  | 4.275658   | -0.5860807     | -0.003105742 |            |
| Oregon            | 2.133687      | -2.3166982  | 1.176931   | -3.3520744     | -1.013831107 |            |
|                   | cherryTRUE    | colaTRUE    | driedTRUE  | noseTRUE       | softTRUE     | juicyTRUE  |
| California        | 2.029051      | 4.796390    | 3.084393   | 2.8947225      | -1.378703    | -1.1785986 |
| Casablanca_Valley | 2.232321      | 3.465643    | 3.789746   | 2.7127216      | -2.735048    | -0.9352497 |
| Marlborough       | 2.666183      | 5.614298    | 1.609912   | 0.6615162      | -3.121445    | -8.6451781 |
| New_York          | 4.030551      | 3.488180    | 4.658556   | 0.9962386      | -2.156449    | -0.9167991 |
| Oregon            | 1.867984      | 5.477643    | 1.896562   | 0.2116504      | -2.651208    | -1.5964193 |
|                   | ripeTRUE      | lightTRUE   | spicyTRUE  | redTRUE        | ageTRUE      |            |
| California        | -0.7145091    | -0.8068615  | 1.574647   | -1.8638905     | -1.0475117   |            |
| Casablanca_Valley | -0.8461249    | -1.4180780  | 1.710476   | -0.3364088     | -0.9102717   |            |

|                   |                  |             |                 |               |                |
|-------------------|------------------|-------------|-----------------|---------------|----------------|
| Marlborough       | -1.6183300       | -1.8921037  | -1.053672       | -3.2213397    | -1.1224974     |
| New_York          | 0.0623988        | -2.3609817  | -1.405304       | -0.6352222    | -0.9178618     |
| Oregon            | -1.0990458       | -0.6898331  | 1.156774        | -2.9772137    | 0.1457782      |
|                   | bitTRUE          | tightTRUE   | cherriesTRUE    | coreTRUE      | fruitsTRUE     |
| California        | 1.729324         | -1.832989   | 1.110549        | -1.0985606    | -2.8601307     |
| Casablanca_Valley | 2.086359         | -1.472307   | -1.086015       | -1.7201427    | -2.1148682     |
| Marlborough       | 3.073982         | -3.899829   | 3.890325        | -3.2049108    | -2.9478542     |
| New_York          | 3.709685         | -4.201880   | 2.752295        | 0.1252417     | -3.4789598     |
| Oregon            | 2.766241         | -1.403511   | 1.854408        | -0.5723807    | -0.3931736     |
|                   | richTRUE         | agingTRUE   | brightTRUE      | characterTRUE |                |
| California        | -0.6030032       | -3.4526578  | 1.4344197       | -2.182208     |                |
| Casablanca_Valley | -0.5250554       | -3.2986953  | -0.7983175      | -2.905853     |                |
| Marlborough       | -0.9192113       | -4.5732177  | 1.7996301       | -7.722947     |                |
| New_York          | -0.3621063       | -0.6594055  | 3.3951292       | -3.368290     |                |
| Oregon            | -1.9012457       | -1.4673480  | 0.4078073       | -2.765866     |                |
|                   | concentratedTRUE | vintageTRUE | complexTRUE     | estateTRUE    | teaTRUE        |
| California        | 1.09097951       | 0.03578609  | -0.23865100     | 1.3099703     | 3.4110565      |
| Casablanca_Valley | 0.93651550       | -0.34070490 | -4.32225959     | 0.9640788     | 3.9483617      |
| Marlborough       | -1.29339873      | 0.47627572  | 1.60207904      | -3.2131237    | 0.5080531      |
| New_York          | 2.58484537       | -2.15621975 | 0.82767462      | -1.4162088    | 2.1297061      |
| Oregon            | -0.01350098      | 0.57568007  | -0.06313269     | 1.4205864     | 2.6641949      |
|                   | wildTRUE         | firmTRUE    | noirTRUE        | mediumTRUE    | structureTRUE  |
| California        | -0.3711888       | -0.933318   | 0.04694081      | 0.9982214     | -2.0009165     |
| Casablanca_Valley | -1.2881344       | -1.434248   | 0.69745069      | -3.1371925    | -0.6941713     |
| Marlborough       | -5.1148185       | -1.436670   | 1.02257249      | 2.2207391     | -3.0755914     |
| New_York          | -1.2442590       | -1.745520   | 3.24734872      | -0.2752506    | -3.8420188     |
| Oregon            | -0.7221832       | -1.805921   | 0.03860044      | 0.3634314     | -3.1231278     |
|                   | cloveTRUE        | timeTRUE    | freshTRUE       | balancedTRUE  | structuredTRUE |
| California        | 3.8608396        | -0.9764876  | -0.5017651      | 0.3831027     | -0.968589      |
| Casablanca_Valley | 1.3475118        | 0.3573136   | 1.1308348       | 0.6868024     | -1.660596      |
| Marlborough       | 3.5406818        | -1.3166684  | -1.2690343      | -2.9646588    | -1.164750      |
| New_York          | 0.8015804        | -0.9853978  | -0.7830399      | 0.6876681     | -1.706760      |
| Oregon            | 1.8886869        | -1.3606015  | -0.5140162      | 0.5210022     | -2.408133      |
|                   | orangeTRUE       | plumTRUE    | pomegranateTRUE | cinnamonTRUE  | savoryTRUE     |
| California        | 4.1974094        | -0.7909078  | 7.780999        | 3.973379      | 5.773919       |
| Casablanca_Valley | 1.0515273        | 1.9711370   | 5.469248        | 3.060479      | 4.999376       |
| Marlborough       | 0.2480016        | -1.5851013  | 7.133738        | 2.068192      | 7.749665       |
| New_York          | 1.5520134        | -0.1817308  | 4.024873        | 3.919124      | 7.746135       |
| Oregon            | 3.6767749        | -0.6796184  | 6.250421        | 3.172116      | 3.532451       |
|                   | pepperTRUE       | roseTRUE    | points          | year          | year_fold      |
| California        | 6.252629         | 2.2591881   | 0.8378808       | 0.009167300   | -6.219025      |
| Casablanca_Valley | 6.013675         | -1.4681971  | -0.2878290      | 0.001318899   | -4.292145      |
| Marlborough       | 5.596277         | 0.9690789   | 0.6468290       | 0.008155244   | -3.733856      |

|                   |              |           |             |             |                |
|-------------------|--------------|-----------|-------------|-------------|----------------|
| New_York          | 1.870926     | 1.8175676 | 0.1836049   | 0.003859054 | -3.017218      |
| Oregon            | 6.241442     | 1.5957495 | 1.0244620   | 0.007669849 | -2.837956      |
|                   | year_frecent | lprice    | price_flow  | price_fmed  | cost_per_point |
| California        | -3.2490926   | -2.930724 | 0.44937236  | -1.5377855  | -0.0006394303  |
| Casablanca_Valley | 0.4089267    | -2.691536 | 2.86525386  | -0.3864364  | 0.0010391895   |
| Marlborough       | 0.6996697    | -4.782096 | 0.04910059  | 0.5597503   | -0.0003375881  |
| New_York          | -1.3190605   | -3.771706 | 2.59245507  | 1.2364957   | -0.0006165702  |
| Oregon            | -1.2592157   | -3.065537 | -0.65543868 | -1.3510616  | -0.0002013091  |

Residual Deviance: 3625.643

AIC: 4465.643

```
# Summarize the model
summary(model)
```

Call:

```
nnet::multinom(formula = province ~ ., data = train, trControl = control)
```

Coefficients:

|                   |               |              |            |             |            |
|-------------------|---------------|--------------|------------|-------------|------------|
|                   | (Intercept)   | bottlingTRUE | earthyTRUE | herbalTRUE  | berryTRUE  |
| California        | -2.4903923    | 3.19152606   | 2.3125022  | 1.979474    | -1.3508965 |
| Casablanca_Valley | -0.1730433    | 1.01126942   | 1.5323348  | 4.258987    | 0.9989287  |
| Marlborough       | 0.1549843     | 1.45115922   | 0.2046354  | 2.036594    | -1.7838920 |
| New_York          | 0.0999495     | 0.02852935   | 1.4992686  | 1.892184    | 0.3554109  |
| Oregon            | 1.9264725     | 2.37645290   | 1.2382801  | 1.876914    | -0.4266640 |
|                   | chocolateTRUE | drinkTRUE    | herbTRUE   | oakTRUE     | tartTRUE   |
| California        | 0.507100383   | -3.472278    | 2.7850935  | 3.469559    | 4.528674   |
| Casablanca_Valley | 3.859721213   | -1.174014    | -0.9067615 | 4.705098    | 2.138257   |
| Marlborough       | 0.626777217   | 1.099512     | 3.0707601  | 3.202391    | 5.188310   |
| New_York          | -0.004787873  | -2.753924    | 2.7015417  | 2.808130    | 5.907882   |
| Oregon            | 2.936022493   | -2.134025    | 3.3666334  | 2.606519    | 5.158366   |
|                   | aromasTRUE    | bodiedTRUE   | earthTRUE  | forestTRUE  | offersTRUE |
| California        | 3.449423      | 2.9542409    | 4.383468   | 4.415977    | 1.6246831  |
| Casablanca_Valley | 5.598780      | 1.8266714    | 3.970641   | 1.791635    | 0.8646075  |
| Marlborough       | 2.428074      | 3.4566834    | 4.940110   | 4.091309    | 1.4079725  |
| New_York          | 2.513703      | 3.2246257    | 5.285969   | 3.276782    | 0.8137083  |
| Oregon            | 1.097343      | 0.7475735    | 4.239178   | 2.590290    | 1.3752110  |
|                   | raspberryTRUE | smoothTRUE   | spiceTRUE  | textureTRUE | finishTRUE |
| California        | 0.7278153     | 0.4959137    | -0.4117102 | 1.0776575   | 1.744125   |
| Casablanca_Valley | 2.4694370     | 1.1319468    | 0.8690474  | -3.3132198  | 3.864939   |
| Marlborough       | -1.7602224    | 0.7941269    | -2.0888872 | 0.7908803   | 2.954930   |
| New_York          | 1.6222959     | -1.3710536   | -0.2881626 | -4.9526836  | 2.656226   |

|                   |               |             |              |                |              |
|-------------------|---------------|-------------|--------------|----------------|--------------|
| Oregon            | 0.6899553     | 0.7365484   | -1.5494376   | -1.3127036     | 1.891754     |
|                   | flavorTRUE    | fruitTRUE   | notesTRUE    | sweetTRUE      | touchTRUE    |
| California        | 0.6817441     | -0.8968381  | 1.328931     | -0.49612295    | -2.189701    |
| Casablanca_Valley | 2.5714614     | -1.3959790  | 3.072088     | 0.07092911     | -1.477218    |
| Marlborough       | -1.1354230    | 0.5794106   | 3.488000     | -2.49622800    | -1.439735    |
| New_York          | 0.8695785     | -1.9929400  | 2.929370     | 0.61310051     | -2.820271    |
| Oregon            | 0.6097213     | 0.7711675   | 1.560460     | -0.19832238    | -1.722271    |
|                   | flavorsTRUE   | tanninsTRUE | fruityTRUE   | strawberryTRUE |              |
| California        | 0.01935343    | -2.2521763  | -1.992863    | -0.27731054    |              |
| Casablanca_Valley | 3.23000048    | -3.3164165  | -1.415181    | -2.43080093    |              |
| Marlborough       | -0.31309278   | -1.3339309  | -4.919124    | -1.93416536    |              |
| New_York          | 0.41347247    | 0.8537133   | -2.200882    | 0.09741894     |              |
| Oregon            | 1.17314804    | -1.9741639  | -1.396537    | -0.74256360    |              |
|                   | cranberryTRUE | darkTRUE    | palateTRUE   | acidityTRUE    | blackTRUE    |
| California        | 2.751459      | -0.5793567  | 2.432115     | -1.6954060     | -0.193780935 |
| Casablanca_Valley | 1.606306      | -0.8238596  | 3.654301     | -1.2683857     | -0.615344850 |
| Marlborough       | 2.617031      | -1.6692028  | 1.642772     | -5.0030727     | -0.507358726 |
| New_York          | 2.325585      | -4.6285679  | 4.275658     | -0.5860807     | -0.003105742 |
| Oregon            | 2.133687      | -2.3166982  | 1.176931     | -3.3520744     | -1.013831107 |
|                   | cherryTRUE    | colaTRUE    | driedTRUE    | noseTRUE       | softTRUE     |
| California        | 2.029051      | 4.796390    | 3.084393     | 2.8947225      | -1.378703    |
| Casablanca_Valley | 2.232321      | 3.465643    | 3.789746     | 2.7127216      | -2.735048    |
| Marlborough       | 2.666183      | 5.614298    | 1.609912     | 0.6615162      | -3.121445    |
| New_York          | 4.030551      | 3.488180    | 4.658556     | 0.9962386      | -2.156449    |
| Oregon            | 1.867984      | 5.477643    | 1.896562     | 0.2116504      | -2.651208    |
|                   | ripeTRUE      | lightTRUE   | spicyTRUE    | redTRUE        | ageTRUE      |
| California        | -0.7145091    | -0.8068615  | 1.574647     | -1.8638905     | -1.0475117   |
| Casablanca_Valley | -0.8461249    | -1.4180780  | 1.710476     | -0.3364088     | -0.9102717   |
| Marlborough       | -1.6183300    | -1.8921037  | -1.053672    | -3.2213397     | -1.1224974   |
| New_York          | 0.0623988     | -2.3609817  | -1.405304    | -0.6352222     | -0.9178618   |
| Oregon            | -1.0990458    | -0.6898331  | 1.156774     | -2.9772137     | 0.1457782    |
|                   | bitTRUE       | tightTRUE   | cherriesTRUE | coreTRUE       | fruitsTRUE   |
| California        | 1.729324      | -1.832989   | 1.110549     | -1.0985606     | -2.8601307   |
| Casablanca_Valley | 2.086359      | -1.472307   | -1.086015    | -1.7201427     | -2.1148682   |
| Marlborough       | 3.073982      | -3.899829   | 3.890325     | -3.2049108     | -2.9478542   |
| New_York          | 3.709685      | -4.201880   | 2.752295     | 0.1252417      | -3.4789598   |
| Oregon            | 2.766241      | -1.403511   | 1.854408     | -0.5723807     | -0.3931736   |
|                   | richTRUE      | agingTRUE   | brightTRUE   | characterTRUE  |              |
| California        | -0.6030032    | -3.4526578  | 1.4344197    | -2.182208      |              |
| Casablanca_Valley | -0.5250554    | -3.2986953  | -0.7983175   | -2.905853      |              |
| Marlborough       | -0.9192113    | -4.5732177  | 1.7996301    | -7.722947      |              |
| New_York          | -0.3621063    | -0.6594055  | 3.3951292    | -3.368290      |              |
| Oregon            | -1.9012457    | -1.4673480  | 0.4078073    | -2.765866      |              |



|                   |                  |             |                 |              |                |
|-------------------|------------------|-------------|-----------------|--------------|----------------|
|                   | concentratedTRUE | vintageTRUE | complexTRUE     | estateTRUE   | teaTRUE        |
| California        | 1.09097951       | 0.03578609  | -0.23865100     | 1.3099703    | 3.4110565      |
| Casablanca_Valley | 0.93651550       | -0.34070490 | -4.32225959     | 0.9640788    | 3.9483617      |
| Marlborough       | -1.29339873      | 0.47627572  | 1.60207904      | -3.2131237   | 0.5080531      |
| New_York          | 2.58484537       | -2.15621975 | 0.82767462      | -1.4162088   | 2.1297061      |
| Oregon            | -0.01350098      | 0.57568007  | -0.06313269     | 1.4205864    | 2.6641949      |
|                   | wildTRUE         | firmTRUE    | noirTRUE        | mediumTRUE   | structureTRUE  |
| California        | -0.3711888       | -0.933318   | 0.04694081      | 0.9982214    | -2.0009165     |
| Casablanca_Valley | -1.2881344       | -1.434248   | 0.69745069      | -3.1371925   | -0.6941713     |
| Marlborough       | -5.1148185       | -1.436670   | 1.02257249      | 2.2207391    | -3.0755914     |
| New_York          | -1.2442590       | -1.745520   | 3.24734872      | -0.2752506   | -3.8420188     |
| Oregon            | -0.7221832       | -1.805921   | 0.03860044      | 0.3634314    | -3.1231278     |
|                   | cloveTRUE        | timeTRUE    | freshTRUE       | balancedTRUE | structuredTRUE |
| California        | 3.8608396        | -0.9764876  | -0.5017651      | 0.3831027    | -0.968589      |
| Casablanca_Valley | 1.3475118        | 0.3573136   | 1.1308348       | 0.6868024    | -1.660596      |
| Marlborough       | 3.5406818        | -1.3166684  | -1.2690343      | -2.9646588   | -1.164750      |
| New_York          | 0.8015804        | -0.9853978  | -0.7830399      | 0.6876681    | -1.706760      |
| Oregon            | 1.8886869        | -1.3606015  | -0.5140162      | 0.5210022    | -2.408133      |
|                   | orangeTRUE       | plumTRUE    | pomegranateTRUE | cinnamonTRUE | savoryTRUE     |
| California        | 4.1974094        | -0.7909078  | 7.780999        | 3.973379     | 5.773919       |
| Casablanca_Valley | 1.0515273        | 1.9711370   | 5.469248        | 3.060479     | 4.999376       |
| Marlborough       | 0.2480016        | -1.5851013  | 7.133738        | 2.068192     | 7.749665       |
| New_York          | 1.5520134        | -0.1817308  | 4.024873        | 3.919124     | 7.746135       |
| Oregon            | 3.6767749        | -0.6796184  | 6.250421        | 3.172116     | 3.532451       |
|                   | pepperTRUE       | roseTRUE    | points          | year         | year_fold      |
| California        | 6.252629         | 2.2591881   | 0.8378808       | 0.009167300  | -6.219025      |
| Casablanca_Valley | 6.013675         | -1.4681971  | -0.2878290      | 0.001318899  | -4.292145      |
| Marlborough       | 5.596277         | 0.9690789   | 0.6468290       | 0.008155244  | -3.733856      |
| New_York          | 1.870926         | 1.8175676   | 0.1836049       | 0.003859054  | -3.017218      |
| Oregon            | 6.241442         | 1.5957495   | 1.0244620       | 0.007669849  | -2.837956      |
|                   | year_frecent     | lprice      | price_flow      | price_fmcd   | cost_per_point |
| California        | -3.2490926       | -2.930724   | 0.44937236      | -1.5377855   | -0.0006394303  |
| Casablanca_Valley | 0.4089267        | -2.691536   | 2.86525386      | -0.3864364   | 0.0010391895   |
| Marlborough       | 0.6996697        | -4.782096   | 0.04910059      | 0.5597503    | -0.0003375881  |
| New_York          | -1.3190605       | -3.771706   | 2.59245507      | 1.2364957    | -0.0006165702  |
| Oregon            | -1.2592157       | -3.065537   | -0.65543868     | -1.3510616   | -0.0002013091  |

Std. Errors:

|                   |              |              |             |             |             |
|-------------------|--------------|--------------|-------------|-------------|-------------|
|                   | (Intercept)  | bottlingTRUE | earthyTRUE  | herbalTRUE  | berryTRUE   |
| California        | 1.436867e-04 | 0.0426018303 | 0.083489764 | 0.048487572 | 0.046355008 |
| Casablanca_Valley | 1.332607e-05 | 0.0004679623 | 0.001231905 | 0.001877727 | 0.001449538 |
| Marlborough       | 5.813583e-05 | 0.0007305688 | 0.003930539 | 0.003891772 | 0.002336336 |
| New_York          | 3.474149e-05 | 0.0004782892 | 0.002014236 | 0.001685384 | 0.004509413 |

|                   |               |                |               |              |              |
|-------------------|---------------|----------------|---------------|--------------|--------------|
| Oregon            | 1.822586e-04  | 0.0418056588   | 0.085212516   | 0.052855413  | 0.051188447  |
|                   | chocolateTRUE | drinkTRUE      | herbTRUE      | oakTRUE      |              |
| California        | 0.0446208274  | 0.068704835    | 5.643020e-02  | 0.0667861761 |              |
| Casablanca_Valley | 0.0012759587  | 0.001698723    | 7.617666e-05  | 0.0015140153 |              |
| Marlborough       | 0.0035590327  | 0.016482853    | 2.946991e-03  | 0.0044928609 |              |
| New_York          | 0.0007437873  | 0.002239998    | 1.153558e-03  | 0.0008117819 |              |
| Oregon            | 0.0499306998  | 0.090779785    | 5.824492e-02  | 0.0672904378 |              |
|                   | tartTRUE      | aromasTRUE     | bodiedTRUE    | earthTRUE    | forestTRUE   |
| California        | 0.0807296886  | 0.081543131    | 0.077791896   | 0.085159746  | 0.0084681175 |
| Casablanca_Valley | 0.0002824607  | 0.003110304    | 0.001804272   | 0.000740692  | 0.0002646477 |
| Marlborough       | 0.0073913500  | 0.007344575    | 0.016117868   | 0.004705299  | 0.0011841607 |
| New_York          | 0.0032522306  | 0.004072763    | 0.005074378   | 0.002131546  | 0.0008384368 |
| Oregon            | 0.0825606737  | 0.072352646    | 0.061499780   | 0.085918770  | 0.0085154636 |
|                   | offersTRUE    | raspberryTRUE  | smoothTRUE    | spiceTRUE    |              |
| California        | 0.082438568   | 0.067947423    | 0.0348827812  | 0.085311769  |              |
| Casablanca_Valley | 0.001156080   | 0.002377472    | 0.0005889961  | 0.003625356  |              |
| Marlborough       | 0.001897125   | 0.001305816    | 0.0026248836  | 0.005306490  |              |
| New_York          | 0.002739854   | 0.002346004    | 0.0009275827  | 0.006607153  |              |
| Oregon            | 0.081381116   | 0.068028022    | 0.0366534824  | 0.080120666  |              |
|                   | textureTRUE   | finishTRUE     | flavorTRUE    | fruitTRUE    | notesTRUE    |
| California        | 6.322978e-02  | 0.058073152    | 0.0686954230  | 0.050154700  | 0.084794363  |
| Casablanca_Valley | 6.854734e-04  | 0.002473013    | 0.0009674246  | 0.002286500  | 0.001872886  |
| Marlborough       | 9.628764e-03  | 0.006668421    | 0.0021523999  | 0.011717980  | 0.005459890  |
| New_York          | 5.536129e-05  | 0.006240024    | 0.0024266130  | 0.002428296  | 0.003990805  |
| Oregon            | 5.459832e-02  | 0.060179507    | 0.0720591446  | 0.053318637  | 0.087215362  |
|                   | sweetTRUE     | touchTRUE      | flavorsTRUE   | tanninsTRUE  |              |
| California        | 0.0148426473  | 0.081162756    | 0.051380567   | 0.0654235182 |              |
| Casablanca_Valley | 0.0006947792  | 0.001412468    | 0.001451122   | 0.0008638985 |              |
| Marlborough       | 0.0018256411  | 0.002959157    | 0.012092876   | 0.0050434337 |              |
| New_York          | 0.0015094364  | 0.001172264    | 0.008710950   | 0.0085879959 |              |
| Oregon            | 0.0155804548  | 0.086289333    | 0.057001297   | 0.0730533330 |              |
|                   | fruityTRUE    | strawberryTRUE | cranberryTRUE | darkTRUE     |              |
| California        | 0.0145836546  | 0.070088238    | 0.0782616106  | 0.068872593  |              |
| Casablanca_Valley | 0.0007387916  | 0.001706528    | 0.0006950173  | 0.001721827  |              |
| Marlborough       | 0.0006726083  | 0.001819948    | 0.0029043782  | 0.001856255  |              |
| New_York          | 0.0013214926  | 0.002844076    | 0.0026530334  | 0.000714366  |              |
| Oregon            | 0.0159237943  | 0.071012160    | 0.0782580898  | 0.069872908  |              |
|                   | palateTRUE    | acidityTRUE    | blackTRUE     | cherryTRUE   | colaTRUE     |
| California        | 0.069268999   | 0.072470388    | 0.063449280   | 0.052971614  | 0.0816796518 |
| Casablanca_Valley | 0.003897230   | 0.002693349    | 0.003390799   | 0.004394954  | 0.0008163055 |
| Marlborough       | 0.004176265   | 0.001213335    | 0.010312565   | 0.007526648  | 0.0046402397 |
| New_York          | 0.004657236   | 0.012226177    | 0.014969284   | 0.010184258  | 0.0005990154 |
| Oregon            | 0.066163354   | 0.071187749    | 0.064339530   | 0.055367309  | 0.0829786790 |

|                   |                  |               |                |               |             |
|-------------------|------------------|---------------|----------------|---------------|-------------|
|                   | driedTRUE        | noseTRUE      | softTRUE       | juicyTRUE     | ripeTRUE    |
| California        | 0.055308752      | 0.068864919   | 0.0709208196   | 4.434644e-02  | 0.074300648 |
| Casablanca_Valley | 0.001631619      | 0.002915319   | 0.0007550337   | 8.052249e-04  | 0.001032664 |
| Marlborough       | 0.001745639      | 0.002371225   | 0.0032366335   | 3.734356e-06  | 0.005953983 |
| New_York          | 0.003433417      | 0.004601010   | 0.0030365771   | 1.354233e-03  | 0.004302185 |
| Oregon            | 0.051930382      | 0.062598628   | 0.0708712530   | 4.454025e-02  | 0.077982772 |
|                   | lightTRUE        | spicyTRUE     | redTRUE        | ageTRUE       | bitTRUE     |
| California        | 0.067290755      | 0.0812273597  | 0.066990938    | 0.0121693892  | 0.028961653 |
| Casablanca_Valley | 0.001748811      | 0.0021293955  | 0.001639572    | 0.0004313865  | 0.002591199 |
| Marlborough       | 0.006022484      | 0.0009108465  | 0.003129041    | 0.0016800472  | 0.003950990 |
| New_York          | 0.004030333      | 0.0004909414  | 0.003936187    | 0.0016600193  | 0.003196615 |
| Oregon            | 0.070148716      | 0.0805553379  | 0.067457878    | 0.0177632971  | 0.031939736 |
|                   | tightTRUE        | cherriesTRUE  | coreTRUE       | fruitsTRUE    |             |
| California        | 0.0151592797     | 0.0319098176  | 0.0214382296   | 0.0233508812  |             |
| Casablanca_Valley | 0.0008710126     | 0.0001168995  | 0.0005452236   | 0.0014041506  |             |
| Marlborough       | 0.0007078799     | 0.0117480778  | 0.0004206215   | 0.0003044968  |             |
| New_York          | 0.0004976725     | 0.0019656180  | 0.0023891957   | 0.0007180453  |             |
| Oregon            | 0.0155201613     | 0.0307183503  | 0.0215260433   | 0.0299163591  |             |
|                   | richTRUE         | agingTRUE     | brightTRUE     | characterTRUE |             |
| California        | 0.050318278      | 0.0071481151  | 0.0493736315   | 0.0163745716  |             |
| Casablanca_Valley | 0.001680903      | 0.0002799907  | 0.0009430914   | 0.0006651073  |             |
| Marlborough       | 0.007133013      | 0.0009685494  | 0.0013346296   | 0.0001817097  |             |
| New_York          | 0.005160832      | 0.0029798602  | 0.0035470332   | 0.0007496834  |             |
| Oregon            | 0.046823999      | 0.0099249109  | 0.0466888482   | 0.0189003993  |             |
|                   | concentratedTRUE | vintageTRUE   | complexTRUE    | estateTRUE    |             |
| California        | 0.0265868515     | 0.0350155709  | 0.0362411357   | 0.0474544130  |             |
| Casablanca_Valley | 0.0003807299     | 0.0005107199  | 0.0004999304   | 0.0002626944  |             |
| Marlborough       | 0.0006473268     | 0.0025069055  | 0.0075672837   | 0.0006152521  |             |
| New_York          | 0.0056366128     | 0.0001815000  | 0.0023480973   | 0.0002013212  |             |
| Oregon            | 0.0259601834     | 0.0374815077  | 0.0365003270   | 0.0481558270  |             |
|                   | teaTRUE          | wildTRUE      | firmTRUE       | noirTRUE      |             |
| California        | 0.041518635      | 2.834001e-02  | 0.0144238566   | 0.076822295   |             |
| Casablanca_Valley | 0.001233583      | 9.596430e-04  | 0.0001920764   | 0.001518758   |             |
| Marlborough       | 0.001319421      | 2.874427e-05  | 0.0035322679   | 0.008915279   |             |
| New_York          | 0.002508375      | 2.198343e-03  | 0.0036414306   | 0.003908947   |             |
| Oregon            | 0.041003965      | 2.744907e-02  | 0.0127848949   | 0.083417551   |             |
|                   | mediumTRUE       | structureTRUE | cloveTRUE      | timeTRUE      |             |
| California        | 0.0492957283     | 0.0133238556  | 0.0122431008   | 0.0248023134  |             |
| Casablanca_Valley | 0.0004059511     | 0.0006398816  | 0.0002097967   | 0.0006289320  |             |
| Marlborough       | 0.0132453918     | 0.0026448140  | 0.0024801385   | 0.0006971686  |             |
| New_York          | 0.0038583650     | 0.0013372473  | 0.0001593824   | 0.0010100879  |             |
| Oregon            | 0.0389009127     | 0.0161088403  | 0.0115098069   | 0.0259581612  |             |
|                   | freshTRUE        | balancedTRUE  | structuredTRUE | orangeTRUE    |             |

|                   |                |                 |              |                          |
|-------------------|----------------|-----------------|--------------|--------------------------|
| California        | 0.087062436    | 0.0634220479    | 0.0072089914 | 3.075279e-02             |
| Casablanca_Valley | 0.001533710    | 0.0007609092    | 0.0003790639 | 1.556175e-04             |
| Marlborough       | 0.003439409    | 0.0006037273    | 0.0013781801 | 4.019115e-05             |
| New_York          | 0.004795406    | 0.0028102333    | 0.0015264828 | 1.239817e-04             |
| Oregon            | 0.086549641    | 0.0654091295    | 0.0072354839 | 3.075771e-02             |
|                   | plumTRUE       | pomegranateTRUE | cinnamonTRUE | savoryTRUE               |
| California        | 0.082288511    | 0.015241105     | 0.0405795191 | 0.0094195462             |
| Casablanca_Valley | 0.003496051    | 0.000335430     | 0.0007799209 | 0.0009874261             |
| Marlborough       | 0.002388494    | 0.001654756     | 0.0021528265 | 0.0043093167             |
| New_York          | 0.003965559    | 0.001035366     | 0.0018547464 | 0.0015028191             |
| Oregon            | 0.082318080    | 0.014425357     | 0.0393814883 | 0.0074998473             |
|                   | pepperTRUE     | roseTRUE        | points       | year year_fold           |
| California        | 0.0254014256   | 0.0507608609    | 0.06233245   | 1.422540e-04 0.010020625 |
| Casablanca_Valley | 0.0006868616   | 0.0003976797    | 0.02019810   | 1.257362e-04 0.001313375 |
| Marlborough       | 0.0013395686   | 0.0017490428    | 0.10041000   | 9.149057e-05 0.003140851 |
| New_York          | 0.0004431528   | 0.0024348716    | 0.06815036   | 1.073364e-04 0.002731357 |
| Oregon            | 0.0254783122   | 0.0498756531    | 0.06094985   | 1.488293e-04 0.013111006 |
|                   | year_frecent   | lprice          | price_flow   | price_fmed               |
| California        | 0.060389209    | 0.066877081     | 0.039419906  | 0.061071554              |
| Casablanca_Valley | 0.003293748    | 0.007204053     | 0.003236043  | 0.002559764              |
| Marlborough       | 0.018584261    | 0.026194210     | 0.005744761  | 0.012748004              |
| New_York          | 0.005364731    | 0.021188163     | 0.008153408  | 0.007623248              |
| Oregon            | 0.082596954    | 0.068017798     | 0.034448054  | 0.057935992              |
|                   | cost_per_point |                 |              |                          |
| California        | 0.0007105759   |                 |              |                          |
| Casablanca_Valley | 0.0014946793   |                 |              |                          |
| Marlborough       | 0.0011113792   |                 |              |                          |
| New_York          | 0.0012361178   |                 |              |                          |
| Oregon            | 0.0006866107   |                 |              |                          |

Residual Deviance: 3625.643  
AIC: 4465.643

```
# Make predictions
preds <- predict(model, type="class", newdata=test)

head(preds)
```

```
[1] Oregon      California Oregon      Burgundy   Burgundy   California
6 Levels: Burgundy California Casablanca_Valley Marlborough ... Oregon
```

```
postResample(test$province,preds)
```

```
Accuracy      Kappa  
0.8774656 0.8106702
```

```
varImp(model)%>%  
  arrange(desc(Overall))
```

|                 | Overall      |
|-----------------|--------------|
| pomegranateTRUE | 30.659279425 |
| savoryTRUE      | 29.801545488 |
| pepperTRUE      | 25.974947843 |
| tartTRUE        | 22.921489052 |
| colaTRUE        | 22.842154646 |
| earthTRUE       | 22.819366993 |
| year_fold       | 20.100200279 |
| characterTRUE   | 18.945162221 |
| lprice          | 17.241599380 |
| oakTRUE         | 16.791696814 |
| cinnamonTRUE    | 16.193289644 |
| forestTRUE      | 16.165993629 |
| aromasTRUE      | 15.087323980 |
| driedTRUE       | 15.039168496 |
| agingTRUE       | 13.451324249 |
| bitTRUE         | 13.365590630 |
| juicyTRUE       | 13.272244802 |
| palateTRUE      | 13.181776727 |
| finishTRUE      | 13.111975068 |
| herbTRUE        | 12.830790165 |
| cherryTRUE      | 12.826090951 |
| tightTRUE       | 12.810516580 |
| structureTRUE   | 12.735825872 |
| teaTRUE         | 12.661372395 |
| notesTRUE       | 12.378848661 |
| bodiedTRUE      | 12.209794938 |
| herbalTRUE      | 12.044152969 |
| softTRUE        | 12.042852724 |
| fruityTRUE      | 11.924587535 |
| acidityTRUE     | 11.905019555 |
| fruitsTRUE      | 11.794986515 |

|                  |              |
|------------------|--------------|
| textureTRUE      | 11.447144840 |
| cloveTRUE        | 11.439300501 |
| cranberryTRUE    | 11.434068603 |
| orangeTRUE       | 10.725726531 |
| cherriesTRUE     | 10.693593660 |
| drinkTRUE        | 10.633753271 |
| darkTRUE         | 10.017685208 |
| tanninsTRUE      | 9.730400878  |
| touchTRUE        | 9.649195905  |
| redTRUE          | 9.034074850  |
| wildTRUE         | 8.740583935  |
| estateTRUE       | 8.323967991  |
| roseTRUE         | 8.109781300  |
| bottlingTRUE     | 8.058936942  |
| chocolateTRUE    | 7.934409180  |
| structuredTRUE   | 7.908827913  |
| brightTRUE       | 7.835303856  |
| noseTRUE         | 7.476849370  |
| firmTRUE         | 7.355677008  |
| raspberryTRUE    | 7.269725940  |
| lightTRUE        | 7.167857978  |
| complexTRUE      | 7.053796931  |
| mediumTRUE       | 6.994835054  |
| year_frecent     | 6.935965333  |
| spicyTRUE        | 6.900872457  |
| earthyTRUE       | 6.787021240  |
| coreTRUE         | 6.721236588  |
| price_flow       | 6.611620552  |
| offersTRUE       | 6.086182372  |
| concentratedTRUE | 5.919240091  |
| flavorTRUE       | 5.867928297  |
| fruitTRUE        | 5.636335087  |
| strawberryTRUE   | 5.482259357  |
| balancedTRUE     | 5.243234299  |
| plumTRUE         | 5.208495233  |
| spiceTRUE        | 5.207245002  |
| flavorsTRUE      | 5.149067204  |
| price_fmed       | 5.071529527  |
| noirTRUE         | 5.052913151  |
| timeTRUE         | 4.996468871  |
| berryTRUE        | 4.915792116  |
| smoothTRUE       | 4.529589569  |
| ripeTRUE         | 4.340408599  |

```
richTRUE      4.310621863
freshTRUE     4.198690316
ageTRUE       4.143920770
sweetTRUE     3.874702934
vintageTRUE   3.584666524
points        2.980605708
blackTRUE     2.333421361
year          0.030170346
cost_per_point 0.002834087
```

```
confusionMatrix(predict(model, test),factor(test$province))
```

#### Confusion Matrix and Statistics

|                   | Reference |            |                   |             |          |
|-------------------|-----------|------------|-------------------|-------------|----------|
| Prediction        | Burgundy  | California | Casablanca_Valley | Marlborough | New_York |
| Burgundy          | 223       | 7          |                   | 1           | 1        |
| California        | 3         | 723        |                   | 5           | 6        |
| Casablanca_Valley | 1         | 1          | 19                | 1           | 3        |
| Marlborough       | 0         | 5          | 0                 | 26          | 3        |
| New_York          | 0         | 4          | 0                 | 1           | 12       |
| Oregon            | 11        | 51         | 1                 | 8           | 1        |

|                   | Reference |
|-------------------|-----------|
| Prediction        | Oregon    |
| Burgundy          | 13        |
| California        | 54        |
| Casablanca_Valley | 0         |
| Marlborough       | 8         |
| New_York          | 7         |
| Oregon            | 465       |

#### Overall Statistics

```
Accuracy : 0.8775
95% CI : (0.8608, 0.8928)
No Information Rate : 0.4728
P-Value [Acc > NIR] : <2e-16
```

```
Kappa : 0.8107
```

```
McNemar's Test P-Value : 0.2569
```

Statistics by Class:

|                      | Class: Burgundy    | Class: California | Class: Casablanca_Valley |
|----------------------|--------------------|-------------------|--------------------------|
| Sensitivity          | 0.9370             | 0.9140            | 0.73077                  |
| Specificity          | 0.9840             | 0.9138            | 0.99636                  |
| Pos Pred Value       | 0.9065             | 0.9049            | 0.76000                  |
| Neg Pred Value       | 0.9895             | 0.9222            | 0.99575                  |
| Prevalence           | 0.1423             | 0.4728            | 0.01554                  |
| Detection Rate       | 0.1333             | 0.4322            | 0.01136                  |
| Detection Prevalence | 0.1470             | 0.4776            | 0.01494                  |
| Balanced Accuracy    | 0.9605             | 0.9139            | 0.86356                  |
|                      | Class: Marlborough | Class: New_York   | Class: Oregon            |
| Sensitivity          | 0.57778            | 0.461538          | 0.8501                   |
| Specificity          | 0.99017            | 0.992714          | 0.9361                   |
| Pos Pred Value       | 0.61905            | 0.500000          | 0.8659                   |
| Neg Pred Value       | 0.98835            | 0.991510          | 0.9278                   |
| Prevalence           | 0.02690            | 0.015541          | 0.3270                   |
| Detection Rate       | 0.01554            | 0.007173          | 0.2779                   |
| Detection Prevalence | 0.02510            | 0.014345          | 0.3210                   |
| Balanced Accuracy    | 0.78397            | 0.727126          | 0.8931                   |