Group_9_Analysis

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#Setup and Data Import

```
Rows: 1,145
Columns: 8
$ country_of_origin    <chr> "Myanmar", "Uganda", "Ethiopia", "Mexico", "Burun~
$ aroma                <dbl> 7.25, 8.33, 8.42, 7.17, 7.75, 7.92, 7.92, 7.83, 7~
$ flavor               <dbl> 7.42, 7.92, 8.00, 7.08, 7.67, 7.75, 7.83, 7.67, 6~
$ acidity              <dbl> 7.50, 7.92, 8.00, 7.25, 7.50, 7.75, 7.67, 7.58, 7~
$ category_two_defects <dbl> 4, 1, 7, 3, 5, 0, 1, 2, 2, 1, 0, 8, 0, 2, 0, 0, 2~
$ altitude_mean_meters <dbl> 1219.20, 1600.00, 1700.00, 1300.00, 1880.00, 1400~
$ harvested            <dbl> 2015, 2013, 2014, 2012, 2012, 2014, NA, 2015, 201~
$ Qualityclass         <chr> "Poor", "Good", "Good", "Poor", "Good", "Good", "~
```

```
[1] 0.5135371
```

#Exploratory Data Analysis

Table 1: Summary statistics of continuous variables in the data set.

Variable	Mean	SD	Min.	1st Q.	Median	3rd Q.	Max.
aroma	7.57	0.39	0	7.42	7.58	7.75	8.75
flavor	7.52	0.40	0	7.33	7.58	7.75	8.67
acidity	7.54	0.39	0	7.33	7.50	7.75	8.58
category_two_defects	3.67	5.41	0	0.00	2.00	5.00	55.00
altitude_mean_meters	1850.69	9392.09	1	1100.00	1310.64	1600.00	190164.00
harvested	2013.67	1.81	2010	2012.00	2014.00	2015.00	2018.00

Table 2: Summary statistics of the sepal length by species of irises

country_of_origin	number_of_batch	Proportion_of_good_quality
Brazil	116	0.47
Burundi	2	0.50
China	14	0.64
Colombia	158	0.80
Costa Rica	41	0.56
Cote d?Ivoire	1	0.00
Ecuador	3	0.33
El Salvador	20	0.70
Ethiopia	38	0.92
Guatemala	152	0.50
Haiti	5	0.20
Hawaii	62	0.55
Honduras	48	0.25
India	10	0.50
Indonesia	16	0.56
Japan	1	1.00
Kenya	24	0.92
Laos	2	0.00
Malawi	11	0.09
Mauritius	1	0.00
Mexico	203	0.27
Myanmar	6	0.00
Nicaragua	23	0.22
Panama	4	0.75
Peru	9	0.56
Philippines	5	0.40
Puerto Rico	3	0.33
Taiwan	62	0.42
Tanzania	32	0.50
Thailand	23	0.70
Uganda	32	0.78
United States	9	0.67
Vietnam	8	0.50
Zambia	1	0.00

The following boxplot is for good quality rates for each country, in which we can check if any countries have unusual high or low good quality rate.

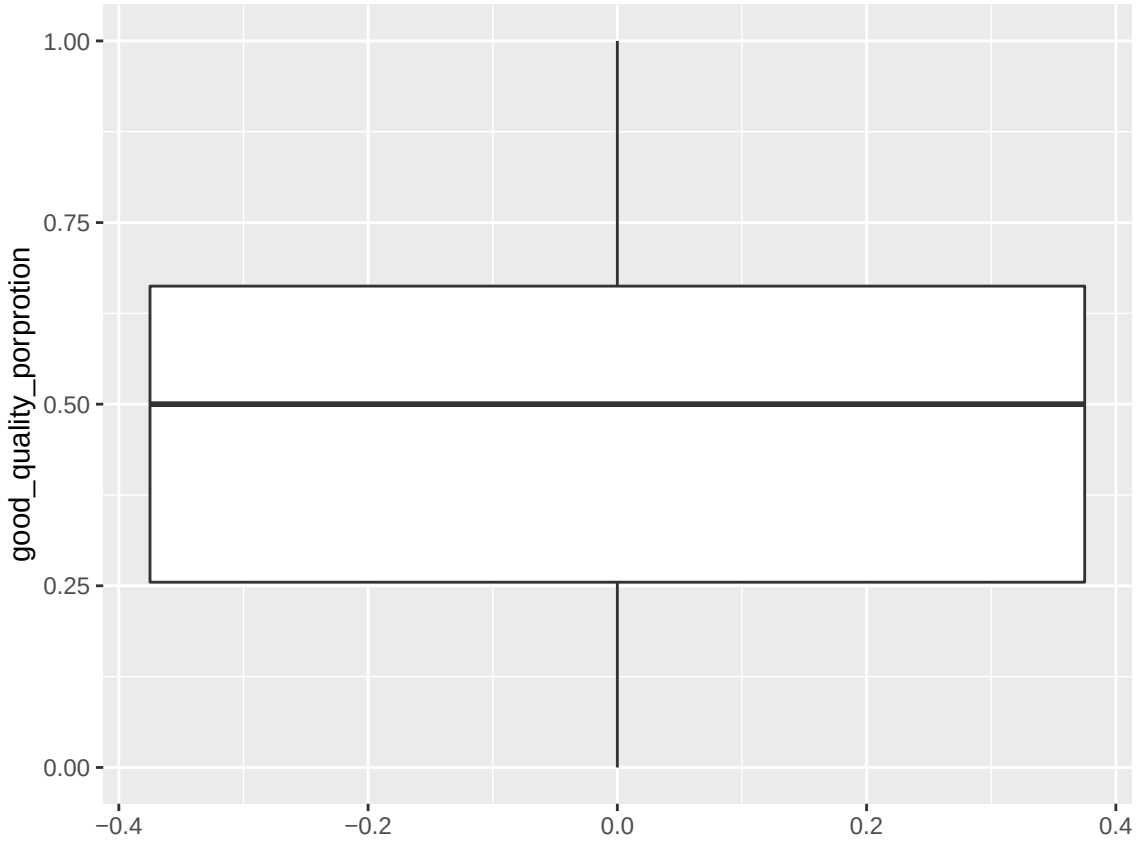


Figure 1: Boxplots of good quality rate for each country.

The following table filter countries and its number of batch with 20% good quality rate before and after, which proviedes more detailed information than the above boxplot. \begin{table}[H]

\caption{ Origins with 20% good quality rate before and after}

country_of_origin	good_quality_porprotion	number_of_batch
Cote d?Ivoire	0.00	1
Laos	0.00	2
Mauritius	0.00	1
Myanmar	0.00	6
Zambia	0.00	1
Malawi	0.09	11
Haiti	0.20	5
El Salvador	0.70	20
Thailand	0.70	23
Panama	0.75	4
Uganda	0.78	32
Colombia	0.80	158
Ethiopia	0.92	38
Kenya	0.92	24
Japan	1.00	1

\end{table}

The following table is the distribution of featers between good and poor coffee. We can check if there is obvious difference in some features between good and poor coffee.

Table 3: Summary statistics of the sepal length by species of irises

Variable	Qualityclass	n	Mean	SD	Min	Median	Max	IQR
aroma	Good	588	7.76	0.23	7.08	7.75	8.75	0.08
aroma	Poor	557	7.37	0.41	0.00	7.42	8.25	0.16
flavor	Good	588	7.74	0.23	7.00	7.67	8.67	0.16
flavor	Poor	557	7.29	0.42	0.00	7.33	8.08	0.17
acidity	Good	588	7.72	0.25	6.75	7.67	8.58	0.16
acidity	Poor	557	7.34	0.40	0.00	7.33	8.33	0.17
category_two_defects	Good	588	2.87	3.82	0.00	2.00	40.00	2.00
category_two_defects	Poor	557	4.52	6.60	0.00	2.00	55.00	4.00
altitude_mean_meters	Good	588	1431.04	629.05	1.00	1450.00	11000.00	255.16
altitude_mean_meters	Poor	557	2281.15	13346.02	1.00	1250.00	190164.00	200.00
harvested	Good	588	2013.74	1.90	2010.00	2014.00	2018.00	1.00
harvested	Poor	557	2013.59	1.71	2010.00	2013.00	2018.00	2.00

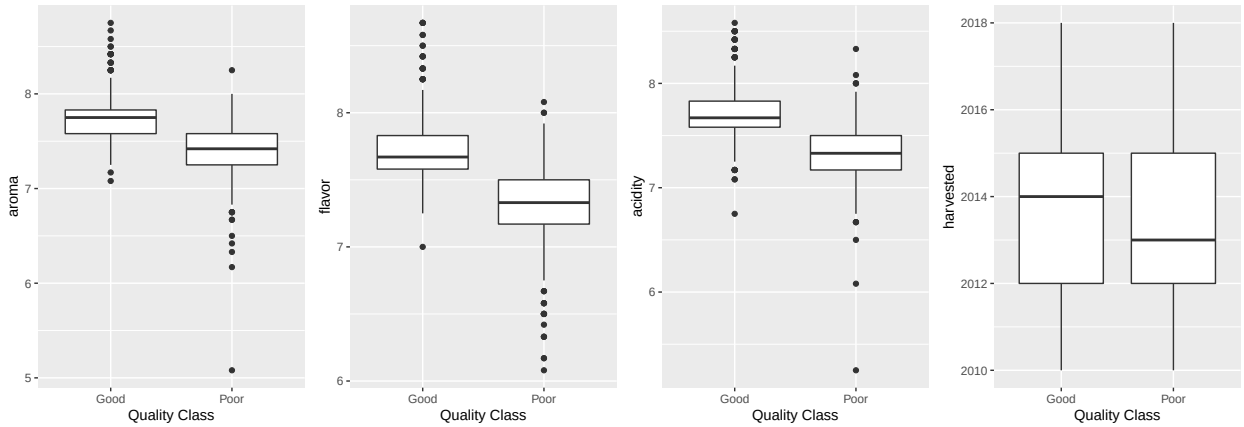


Figure 2: Boxplots of countinous features on different quality class.

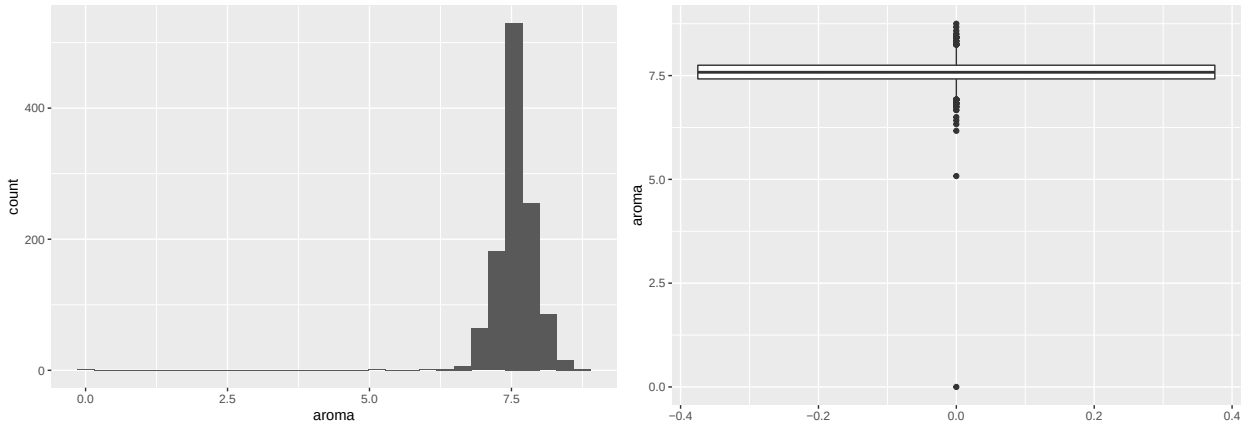


Figure 3: Histogram and boxplot for aroma.

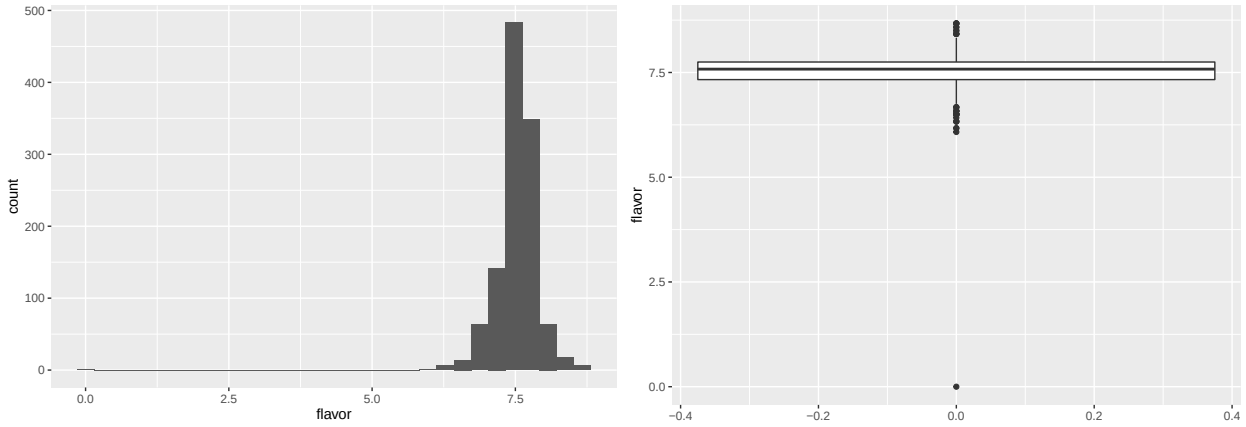


Figure 4: Histogram and boxplot for flavor.

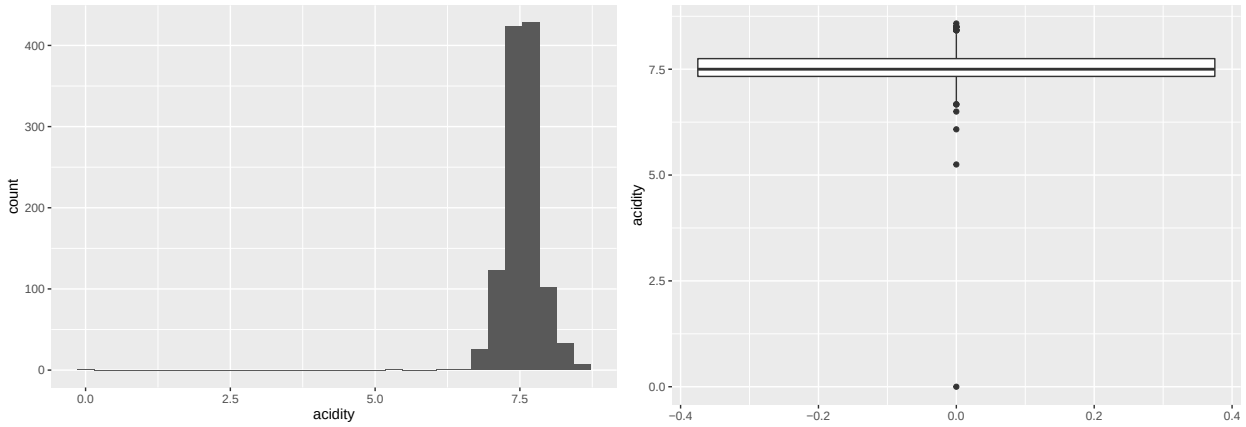


Figure 5: Histogram and boxplot for acidity.

```
# A tibble: 1 x 8
  country_of_origin aroma flavor acidity category_two_defects altitude_mean_met~
  <chr>             <dbl>  <dbl>   <dbl>                <dbl>              <dbl>
1 Honduras              0      0       0                    2               1400
# ... with 2 more variables: harvested <dbl>, Qualityclass <chr>
```

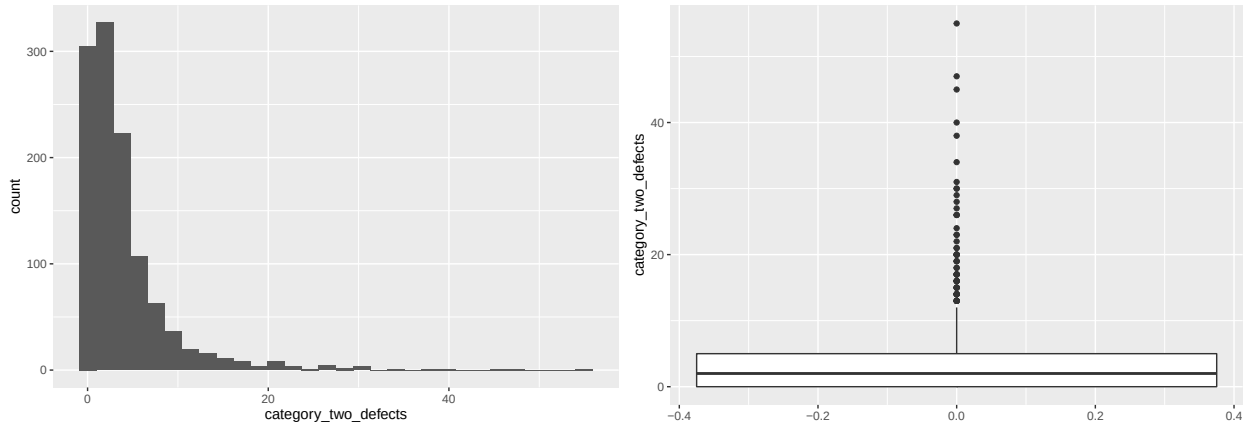


Figure 6: Histogram and boxplot for category two defects.

```
Rows: 1,145
Columns: 9
$ country_of_origin    <chr> "Myanmar", "Uganda", "Ethiopia", "Mexico", "Burun~
$ aroma                <dbl> 7.25, 8.33, 8.42, 7.17, 7.75, 7.92, 7.92, 7.83, 7~
$ flavor               <dbl> 7.42, 7.92, 8.00, 7.08, 7.67, 7.75, 7.83, 7.67, 6~
$ acidity              <dbl> 7.50, 7.92, 8.00, 7.25, 7.50, 7.75, 7.67, 7.58, 7~
$ category_two_defects <dbl> 4, 1, 7, 3, 5, 0, 1, 2, 2, 1, 0, 8, 0, 2, 0, 0, 2~
$ altitude_mean_meters <dbl> 1219.20, 1600.00, 1700.00, 1300.00, 1880.00, 1400~
$ harvested            <dbl> 2015, 2013, 2014, 2012, 2012, 2014, NA, 2015, 201~
$ Qualityclass         <chr> "Poor", "Good", "Good", "Poor", "Good", "Good", "~
$ defects_log          <dbl> 1.6094379, 0.6931472, 2.0794415, 1.3862944, 1.791~
```

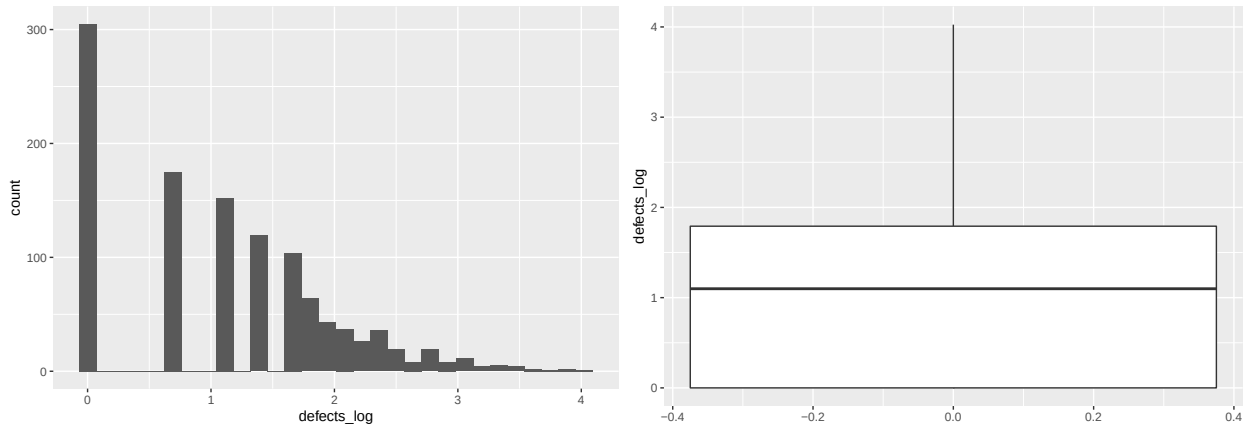


Figure 7: Histogram and boxplot for category two defects after log transformation.

The following two hists can show the effect of log-transformation on counts of type-2 defects

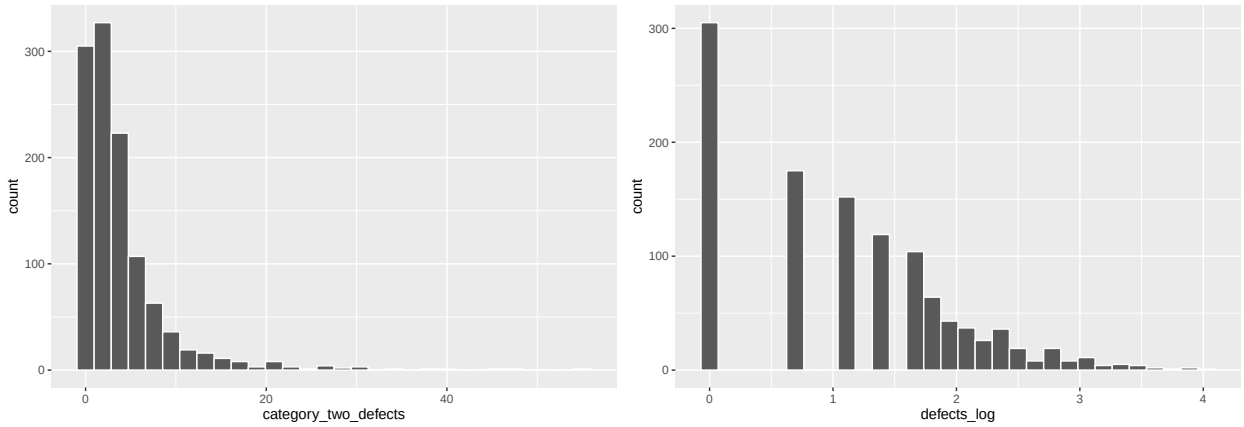


Figure 8: Histogram for category two defects and its log transformation.

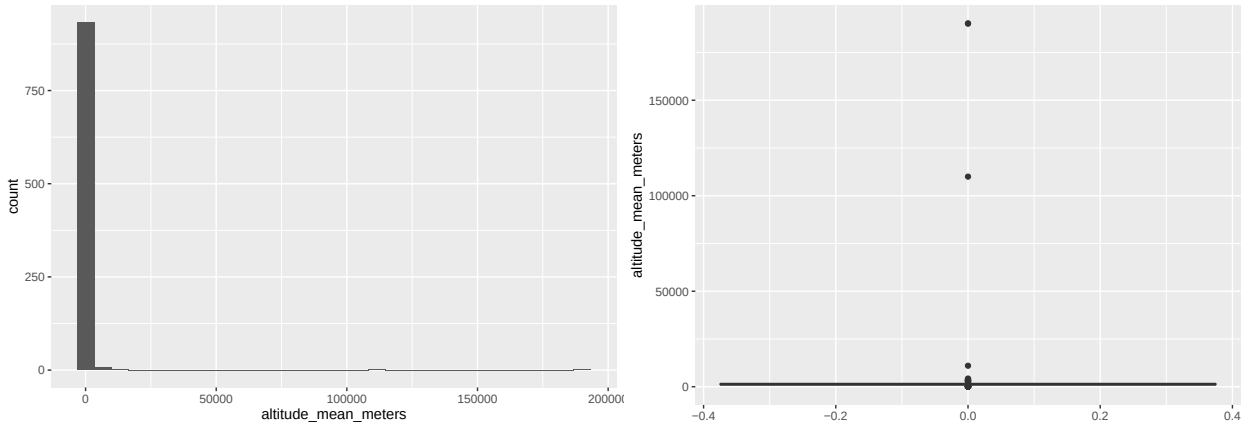


Figure 9: Histogram and boxplot for altitude.

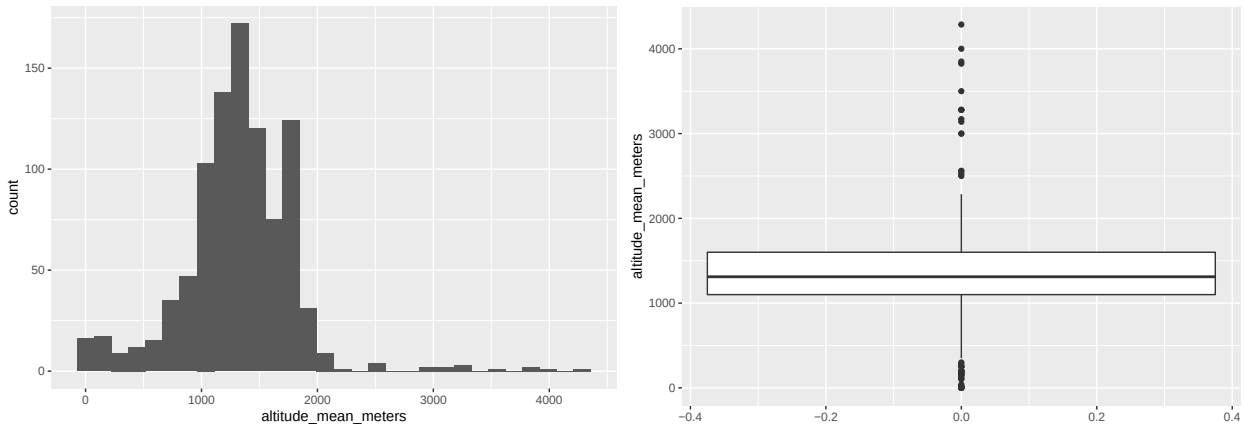


Figure 10: Histogram and boxplot for altitude after removing implausuble observations.

The following two hists shows the effect of remving outliers on mean altitude

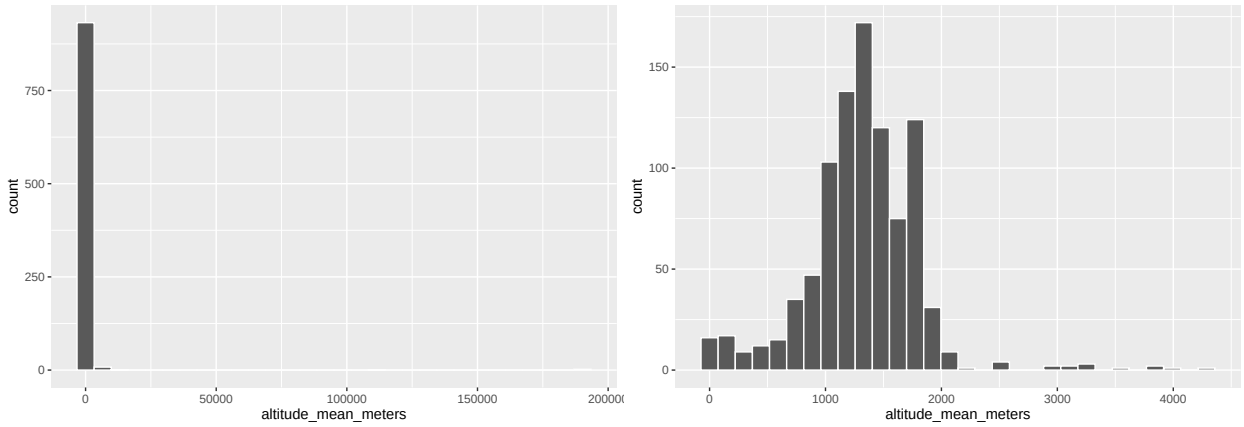


Figure 11: Histogram for altitude befor and after removing implausuble observations.

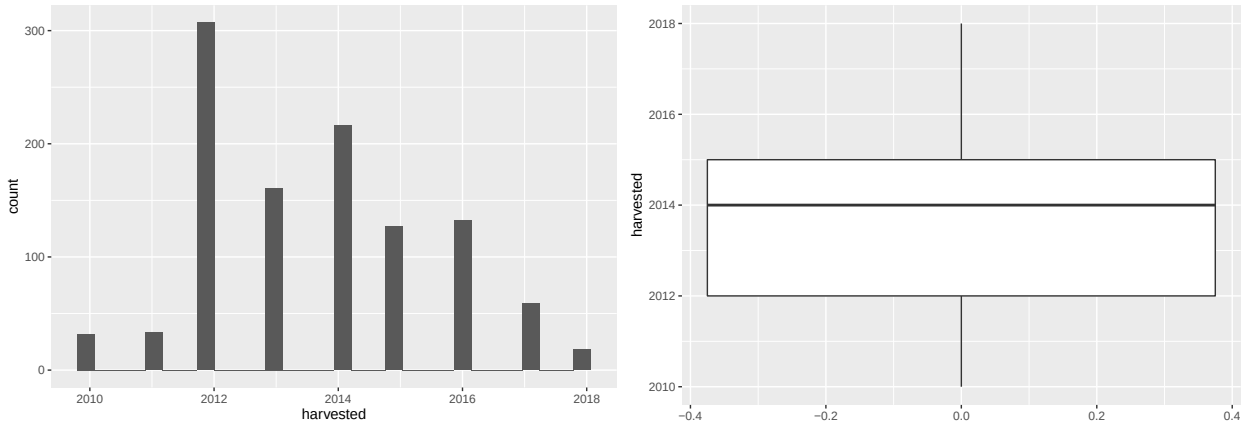


Figure 12: Histogram and boxplot for harvested.

The following table is the distribution of featers between good and poor coffee. We can check if there is obvious difference in some features between good and poor coffee.

Table 4: Summary statistics of the sepal length by species of irises

Variable	Qualityclass	n	Mean	SD	Min	Median	Max	IQR
aroma	Good	477	7.76	0.23	7.17	7.75	8.75	0.08
aroma	Poor	463	7.38	0.43	0.00	7.42	8.25	0.16
flavor	Good	477	7.74	0.22	7.25	7.67	8.67	0.16
flavor	Poor	463	7.30	0.43	0.00	7.33	8.08	0.17
acidity	Good	477	7.72	0.24	7.08	7.67	8.58	0.16
acidity	Poor	463	7.33	0.43	0.00	7.33	8.33	0.17
category_two_defects	Good	477	2.83	3.84	0.00	2.00	40.00	2.00
category_two_defects	Poor	463	4.43	6.43	0.00	2.00	47.00	4.00
altitude_mean_meters	Good	477	1410.98	451.40	1.00	1450.00	3850.00	250.00
altitude_mean_meters	Poor	463	1236.91	500.90	1.00	1250.00	4287.00	200.00
harvested	Good	477	2013.76	1.90	2010.00	2014.00	2018.00	1.00
harvested	Poor	463	2013.63	1.72	2010.00	2013.00	2018.00	2.00

Here is 6 boxplots comparing features distribution between good and poor coffee.

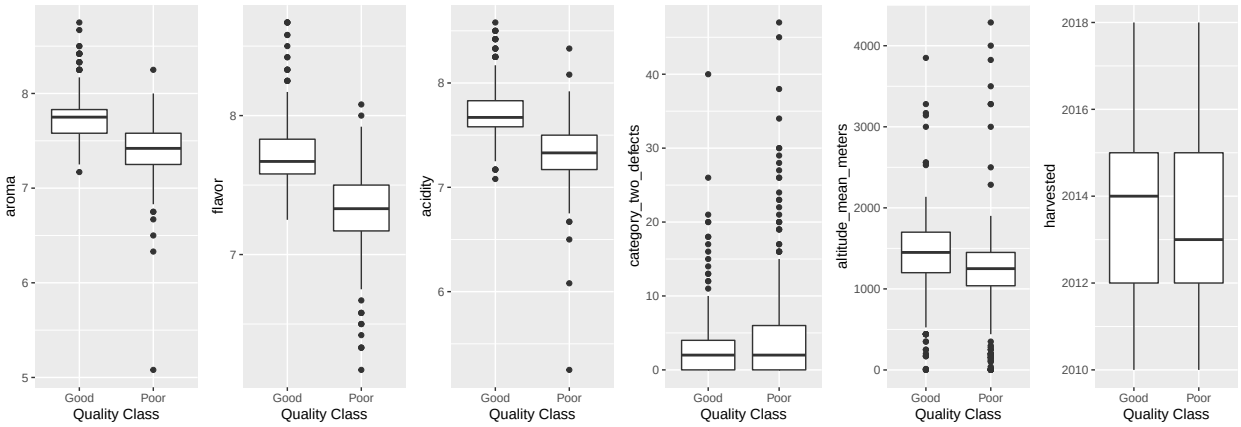
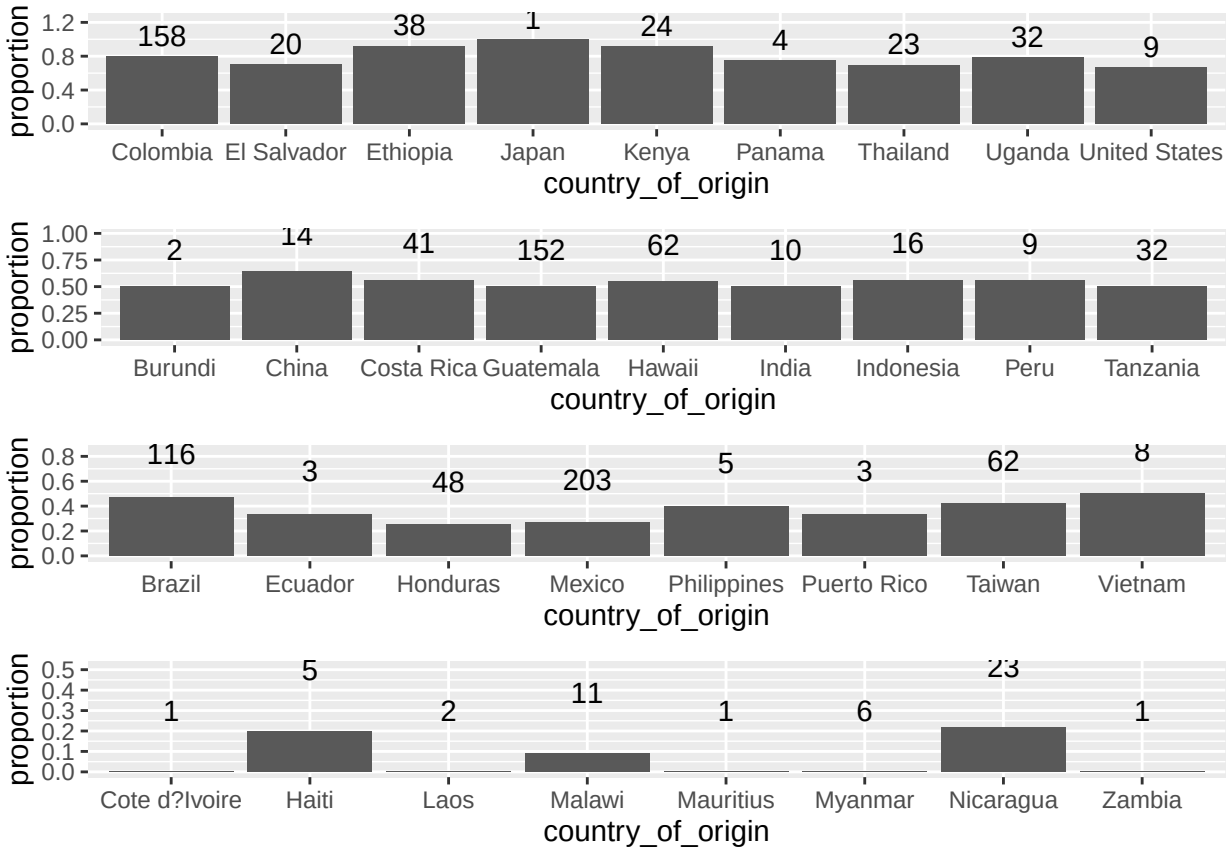


Figure 13: Boxplots2 of countinous features on different quality class.



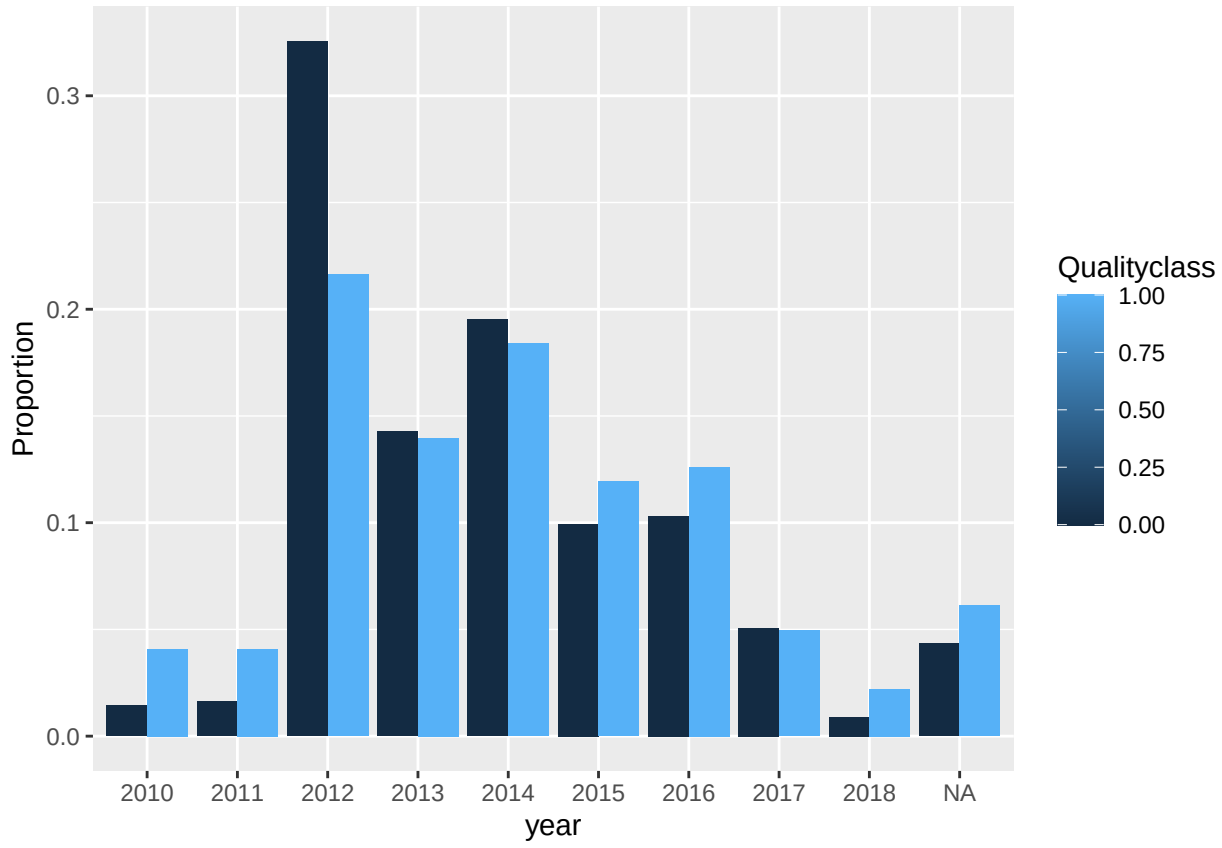

```
Rows: 1,140
Columns: 8
$ country_of_origin <chr> "Myanmar", "Uganda", "Ethiopia", "Mexico", "Burundi"~
$ aroma             <dbl[,1]> <matrix[26 x 1]>
$ flavor            <dbl[,1]> <matrix[26 x 1]>
$ acidity           <dbl[,1]> <matrix[26 x 1]>
$ defects_log       <dbl> 1.6094379, 0.6931472, 2.0794415, 1.3862944, 1.79~
$ year              <fct> 2015, 2013, 2014, 2012, 2012, 2014, NA, 2015, 20~
```

```
$ level            <chr> "3", "3", "3", "3", "3", "3", NA, "3", "3", "3",~
$ Qualityclass     <dbl> 0, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 0, 1, 0, 1, 1, 0, 1~
```

```
# A tibble: 10 x 2
   year      n
   <fct> <int>
 1 2010     32
 2 2011     33
 3 2012    307
 4 2013    161
 5 2014    216
 6 2015    125
 7 2016    131
 8 2017     57
 9 2018     18
10 <NA>     60
```

```
 Qualityclass     Brazil  Burundi    China    Colombia Costa Rica Cote d?Ivoire
            0 11.0% (61) 0.2% (1) 0.9% (5)  5.8%  (32)  3.3% (18)      0.2% (1)
            1  9.2% (54) 0.2% (1) 1.5% (9) 21.5% (126)  3.9% (23)      0.0% (0)
  Ecuador El Salvador  Ethiopia  Guatemala    Haiti    Hawaii  Honduras
 0.4% (2)   1.1%  (6) 0.5%  (3) 13.4% (74) 0.7% (4) 5.1% (28) 6.3% (35)
 0.2% (1)   2.4% (14) 6.0% (35) 12.9% (76) 0.2% (1) 5.8% (34) 2.0% (12)
    India Indonesia    Japan     Kenya     Laos    Malawi Mauritius      Mexico
 0.9% (5)  1.3% (7) 0.0% (0) 0.4%  (2) 0.4% (2) 1.8% (10)  0.2% (1) 26.9% (149)
 0.9% (5)  1.5% (9) 0.2% (1) 3.7% (22) 0.0% (0) 0.2%  (1)  0.0% (0)  9.2%  (54)
  Myanmar Nicaragua   Panama     Peru Philippines Puerto Rico    Taiwan
 1.1% (6) 3.1% (17) 0.2% (1) 0.7% (4)    0.5% (3)    0.4% (2) 6.5% (36)
 0.0% (0) 0.9%  (5) 0.5% (3) 0.9% (5)    0.3% (2)    0.2% (1) 4.4% (26)
  Tanzania  Thailand    Uganda United States  Vietnam   Zambia
 2.9% (16) 1.3%  (7) 1.3%  (7)      0.5% (3) 0.7% (4) 0.2% (1)
 2.7% (16) 2.7% (16) 4.3% (25)      1.0% (6) 0.7% (4) 0.0% (0)
```

```
 Qualityclass      2010      2011        2012       2013        2014       2015
            0 1.4%  (8) 1.6%  (9) 32.5% (180) 14.3% (79) 19.5% (108)  9.9% (55)
            1 4.1% (24) 4.1% (24) 21.6% (127) 14.0% (82) 18.4% (108) 11.9% (70)
       2016      2017      2018       NA_
 10.3% (57) 5.1% (28) 0.9%  (5) 4.3% (24)
 12.6% (74) 4.9% (29) 2.2% (13) 6.1% (36)
```



Formal Analysis Using Logistic Regression

```
Call:
glm(formula = Qualityclass ~ level - 1, family = binomial(link = "logit"),
    data = coffee_final)

Deviance Residuals:
   Min      1Q  Median      3Q     Max
-1.294  -1.294   1.065   1.065   1.360

Coefficients:
       Estimate Std. Error z value Pr(>|z|)
level1 -0.41871    0.18209  -2.299 0.021481 *
level2 -0.41376    0.14410  -2.871 0.004087 **
level3  0.26959    0.08158   3.305 0.000951 ***
---
Signif. codes:  0 ’***’ 0.001 ’**’ 0.01 ’*’ 0.05 ’.’ 0.1 ’ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1301.7  on 939  degrees of freedom
Residual deviance: 1276.9  on 936  degrees of freedom
  (201 observations deleted due to missingness)
AIC: 1282.9

Number of Fisher Scoring iterations: 4


Call:
glm(formula = Qualityclass ~ year, family = binomial(link = "logit"),
```

```
    data = coffee_final)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.6651  -1.1774   0.7585   1.1616   1.3287

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)   1.0986     0.4082   2.691 0.007123 **
year2011     -0.1178     0.5652  -0.208 0.834921
year2012     -1.4474     0.4244  -3.411 0.000648 ***
year2013     -1.0613     0.4376  -2.425 0.015300 *
year2014     -1.0986     0.4303  -2.553 0.010682 *
year2015     -0.8575     0.4462  -1.921 0.054671 .
year2016     -0.8376     0.4447  -1.884 0.059609 .
year2017     -1.0635     0.4867  -2.185 0.028872 *
year2018     -0.1431     0.6660  -0.215 0.829878
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1496.7  on 1079  degrees of freedom
Residual deviance: 1464.8  on 1071  degrees of freedom
  (60 observations deleted due to missingness)
AIC: 1482.8

Number of Fisher Scoring iterations: 4


Call:
glm(formula = Qualityclass ~ country_of_origin, family = binomial(link = "logit"),
    data = coffee_final)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-2.2534  -1.0427   0.4056   1.0961   2.1899

Coefficients:
                             Estimate Std. Error z value Pr(>|z|)
(Intercept)                   -0.1219     0.1868  -0.652 0.514176
country_of_originBurundi       0.1219     1.4265   0.085 0.931906
country_of_originChina         0.7097     0.5882   1.206 0.227646
country_of_originColombia      1.4924     0.2722   5.483 4.19e-08 ***
country_of_originCosta Rica    0.3670     0.3660   1.003 0.315955
country_of_originCote d?Ivoire -15.4442  1455.3975  -0.011 0.991533
country_of_originEcuador      -0.5713     1.2389  -0.461 0.644731
country_of_originEl Salvador   0.9692     0.5225   1.855 0.063610 .
country_of_originEthiopia      2.5786     0.6299   4.093 4.25e-05 ***
country_of_originGuatemala     0.1486     0.2482   0.599 0.549414
country_of_originHaiti        -1.2644     1.1335  -1.115 0.264658
country_of_originHawaii        0.3160     0.3163   0.999 0.317681
country_of_originHonduras     -0.9486     0.3832  -2.476 0.013303 *
country_of_originIndia         0.1219     0.6595   0.185 0.853364
country_of_originIndonesia     0.3732     0.5375   0.694 0.487453
country_of_originJapan        15.6880  1455.3975   0.011 0.991400
country_of_originKenya         2.5198     0.7618   3.308 0.000941 ***
country_of_originLaos        -15.4442  1029.1215  -0.015 0.988026
country_of_originMalawi       -2.1807     1.0653  -2.047 0.040660 *
country_of_originMauritius    -15.4442  1455.3975  -0.011 0.991533
country_of_originMexico       -0.8931     0.2452  -3.642 0.000271 ***
country_of_originMyanmar      -15.4442   594.1636  -0.026 0.979263
country_of_originNicaragua     -1.1019     0.5420  -2.033 0.042043 *
country_of_originPanama        1.2205     1.1697   1.043 0.296757
country_of_originPeru          0.3450     0.6964   0.495 0.620259
```

```
country_of_originPhilippines     -0.2836     0.9318  -0.304 0.760875
country_of_originPuerto Rico     -0.5713     1.2389  -0.461 0.644731
country_of_originTaiwan          -0.2035     0.3180  -0.640 0.522203
country_of_originTanzania         0.1219     0.3999   0.305 0.760512
country_of_originThailand         0.9486     0.4902   1.935 0.052969 .
country_of_originUganda           1.3949     0.4667   2.989 0.002799 **
country_of_originUnited States    0.8150     0.7314   1.114 0.265113
country_of_originVietnam          0.1219     0.7314   0.167 0.867639
country_of_originZambia         -15.4442  1455.3975  -0.011 0.991533
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1579.4  on 1139  degrees of freedom
Residual deviance: 1352.0  on 1106  degrees of freedom
AIC: 1420

Number of Fisher Scoring iterations: 14


Call:
glm(formula = Qualityclass ~ Colombia + Mexico + Honduras + Kenya -
    1, family = binomial(link = "logit"), data = coffee_final)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-2.2293  -1.1774   0.4172   1.1774   1.6524

Coefficients:
         Estimate Std. Error z value Pr(>|z|)
Colombia   1.3705     0.1980   6.923 4.41e-12 ***
Mexico    -1.0150     0.1588  -6.390 1.66e-10 ***
Honduras  -1.0704     0.3345  -3.200  0.00137 **
Kenya      2.3979     0.7382   3.248  0.00116 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1580.4  on 1140  degrees of freedom
Residual deviance: 1443.1  on 1136  degrees of freedom
AIC: 1451.1

Number of Fisher Scoring iterations: 4


Call:
glm(formula = Qualityclass ~ country_of_origin + year, family = binomial(link = "logit"),
    data = coffee_final)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-2.2542  -0.9979   0.4052   1.0378   2.1899

Coefficients:
                              Estimate Std. Error z value Pr(>|z|)
(Intercept)                  -6.651e-03  5.136e-01  -0.013 0.989669
country_of_originBurundi      2.191e-01  1.436e+00   0.153 0.878744
country_of_originChina        7.420e-01  6.232e-01   1.191 0.233757
country_of_originColombia     1.771e+00  3.042e-01   5.821 5.86e-09 ***
country_of_originCosta Rica   4.790e-01  3.910e-01   1.225 0.220603
country_of_originCote d?Ivoire -1.550e+01  1.455e+03  -0.011 0.991502
country_of_originEcuador     -4.227e-01  1.260e+00  -0.336 0.737240
country_of_originEl Salvador  1.073e+00  5.391e-01   1.989 0.046648 *
country_of_originEthiopia     2.465e+00  6.611e-01   3.729 0.000192 ***
```

```
country_of_originGuatemala      3.416e-01  2.798e-01   1.221 0.222123
country_of_originHaiti         -8.781e-01  1.148e+00  -0.765 0.444300
country_of_originHawaii         5.486e-01  3.821e-01   1.436 0.151063
country_of_originHonduras      -9.530e-01  4.051e-01  -2.353 0.018641 *
country_of_originIndia          2.318e-01  6.836e-01   0.339 0.734498
country_of_originIndonesia      3.926e-01  5.598e-01   0.701 0.483101
country_of_originKenya          2.650e+00  7.824e-01   3.387 0.000708 ***
country_of_originLaos          -1.559e+01  1.028e+03  -0.015 0.987904
country_of_originMalawi        -1.928e+00  1.085e+00  -1.777 0.075511 .
country_of_originMauritius     -1.550e+01  1.455e+03  -0.011 0.991502
country_of_originMexico        -6.438e-01  2.907e-01  -2.215 0.026779 *
country_of_originMyanmar       -1.559e+01  5.914e+02  -0.026 0.978966
country_of_originNicaragua     -1.475e+00  6.737e-01  -2.189 0.028621 *
country_of_originPanama         1.445e+00  1.181e+00   1.223 0.221412
country_of_originPeru           5.849e-01  7.559e-01   0.774 0.439090
country_of_originPhilippines   -1.290e-01  9.479e-01  -0.136 0.891743
country_of_originPuerto Rico    4.107e-02  1.260e+00   0.033 0.973987
country_of_originTaiwan        -6.318e-02  3.494e-01  -0.181 0.856514
country_of_originTanzania       2.934e-01  4.282e-01   0.685 0.493234
country_of_originThailand       1.036e+00  5.472e-01   1.894 0.058276 .
country_of_originUganda         1.797e+00  4.983e-01   3.605 0.000312 ***
country_of_originUnited States  1.068e+00  7.551e-01   1.414 0.157262
country_of_originVietnam        3.899e-01  7.499e-01   0.520 0.603108
country_of_originZambia        -1.519e+01  1.455e+03  -0.010 0.991672
year2011                        3.703e-01  6.341e-01   0.584 0.559245
year2012                       -3.664e-01  4.939e-01  -0.742 0.458170
year2013                       -7.276e-01  5.043e-01  -1.443 0.149064
year2014                       -3.683e-01  4.996e-01  -0.737 0.460985
year2015                        1.082e-01  5.187e-01   0.209 0.834784
year2016                       -5.850e-02  5.123e-01  -0.114 0.909095
year2017                       -2.518e-01  5.579e-01  -0.451 0.651666
year2018                        7.945e-01  7.396e-01   1.074 0.282718
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1496.7  on 1079  degrees of freedom
Residual deviance: 1262.1  on 1039  degrees of freedom
  (60 observations deleted due to missingness)
AIC: 1344.1

Number of Fisher Scoring iterations: 14


Call:
glm(formula = Qualityclass ~ level + Colombia + Mexico + Honduras +
    Kenya, family = binomial(link = "logit"), data = coffee_final)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-2.2692  -0.9892   0.3981   1.0264   1.9184

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -0.4603     0.1935  -2.379 0.017356 *
level2        0.3747     0.2458   1.524 0.127456
level3        0.8263     0.2132   3.876 0.000106 ***
Colombia      1.3099     0.2543   5.152 2.58e-07 ***
Mexico       -1.2070     0.1856  -6.502 7.91e-11 ***
Honduras     -1.3988     0.3520  -3.974 7.06e-05 ***
Kenya         2.1294     0.7506   2.837 0.004556 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1301.5  on 938  degrees of freedom
Residual deviance: 1146.5  on 932  degrees of freedom
  (201 observations deleted due to missingness)
AIC: 1160.5

Number of Fisher Scoring iterations: 4


Call:
glm(formula = Qualityclass ~ level + country_of_origin + year -
    1, family = binomial(link = "logit"), data = coffee_final)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-2.24878  -0.87349   0.00031   0.98739   2.12047

Coefficients:
                              Estimate Std. Error z value Pr(>|z|)
level1                       -6.057e-01  6.460e-01  -0.938  0.34842
level2                        6.539e-02  6.237e-01   0.105  0.91650
level3                        4.660e-01  6.327e-01   0.736  0.46144
country_of_originBurundi     -3.436e-01  1.454e+00  -0.236  0.81321
country_of_originChina        4.626e-01  6.421e-01   0.721  0.47119
country_of_originColombia     1.525e+00  3.612e-01   4.223 2.42e-05 ***
country_of_originCosta Rica   2.346e-01  4.355e-01   0.539  0.59011
country_of_originCote d?Ivoire -1.606e+01  2.400e+03  -0.007  0.99466
country_of_originEcuador      9.024e-01  1.481e+00   0.609  0.54239
country_of_originEl Salvador  7.797e-01  5.933e-01   1.314  0.18874
country_of_originEthiopia     1.639e+01  4.970e+02   0.033  0.97369
country_of_originGuatemala   -2.782e-03  3.394e-01  -0.008  0.99346
country_of_originHaiti       -7.446e-01  1.185e+00  -0.628  0.52988
country_of_originHawaii       1.717e+01  2.400e+03   0.007  0.99429
country_of_originHonduras    -1.345e+00  4.471e-01  -3.008  0.00263 **
country_of_originIndia        3.083e-01  7.105e-01   0.434  0.66438
country_of_originIndonesia    4.157e-03  6.167e-01   0.007  0.99462
country_of_originKenya        2.400e+00  8.037e-01   2.986  0.00283 **
country_of_originLaos        -1.707e+01  1.696e+03  -0.010  0.99197
country_of_originMalawi      -2.146e+00  1.097e+00  -1.957  0.05035 .
country_of_originMauritius   -1.606e+01  2.400e+03  -0.007  0.99466
country_of_originMexico      -9.546e-01  3.255e-01  -2.933  0.00336 **
country_of_originMyanmar     -1.682e+01  9.735e+02  -0.017  0.98622
country_of_originNicaragua   -1.245e+00  7.120e-01  -1.748  0.08044 .
country_of_originPanama       1.155e+00  1.192e+00   0.969  0.33234
country_of_originPeru        -1.669e+01  2.400e+03  -0.007  0.99445
country_of_originPhilippines -2.897e-01  9.557e-01  -0.303  0.76183
country_of_originPuerto Rico  6.030e-01  1.289e+00   0.468  0.63987
country_of_originTaiwan       2.949e-01  3.980e-01   0.741  0.45863
country_of_originTanzania    -1.655e-01  4.788e-01  -0.346  0.72962
country_of_originThailand     7.166e-01  6.329e-01   1.132  0.25752
country_of_originUganda       1.292e+00  5.338e-01   2.420  0.01554 *
country_of_originUnited States  8.490e-01  7.818e-01   1.086  0.27750
country_of_originVietnam      4.664e-01  8.165e-01   0.571  0.56787
country_of_originZambia      -1.658e+01  2.400e+03  -0.007  0.99449
year2011                      2.581e-01  7.296e-01   0.354  0.72350
year2012                     -3.418e-01  6.032e-01  -0.567  0.57092
year2013                     -6.905e-01  6.106e-01  -1.131  0.25814
year2014                     -4.561e-01  6.076e-01  -0.751  0.45289
year2015                     -1.422e-02  6.148e-01  -0.023  0.98154
year2016                      9.710e-02  6.157e-01   0.158  0.87469
year2017                     -4.201e-01  6.555e-01  -0.641  0.52156
year2018                      1.284e+00  8.242e-01   1.557  0.11939
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1289.3  on 930  degrees of freedom
Residual deviance: 1047.4  on 887  degrees of freedom
  (210 observations deleted due to missingness)
AIC: 1133.4

Number of Fisher Scoring iterations: 15


Call:
glm(formula = Qualityclass ~ aroma + flavor + acidity + country_of_origin +
    defects_log + level + year, family = binomial(link = "logit"),
    data = coffee_final)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-4.5914  -0.2397   0.0000   0.2843   3.5781

Coefficients:
                              Estimate Std. Error z value Pr(>|z|)
(Intercept)                   -1.52175    1.09510  -1.390  0.16465
aroma                          1.62814    0.26590   6.123 9.18e-10 ***
flavor                         2.89136    0.36116   8.006 1.19e-15 ***
acidity                        1.67688    0.26327   6.369 1.90e-10 ***
country_of_originBurundi       1.88240    5.12830   0.367  0.71357
country_of_originChina         0.49916    1.08844   0.459  0.64652
country_of_originColombia      1.84638    0.57358   3.219  0.00129 **
country_of_originCosta Rica    0.26961    0.76612   0.352  0.72491
country_of_originCote d?Ivoire -12.11826 6522.63865  -0.002  0.99852
country_of_originEcuador      -1.02265    1.52999  -0.668  0.50388
country_of_originEl Salvador   0.32640    0.96977   0.337  0.73644
country_of_originEthiopia     13.49329  894.76317   0.015  0.98797
country_of_originGuatemala    -0.75268    0.57572  -1.307  0.19108
country_of_originHaiti         2.27451    2.16150   1.052  0.29267
country_of_originHawaii        4.41740 6522.63880   0.001  0.99946
country_of_originHonduras     -0.72501    0.71286  -1.017  0.30913
country_of_originIndia        -2.55120    1.07559  -2.372  0.01770 *
country_of_originIndonesia    -0.38258    1.01141  -0.378  0.70524
country_of_originKenya         0.52684    1.54516   0.341  0.73313
country_of_originLaos        -15.24675 4515.00054  -0.003  0.99731
country_of_originMalawi       -0.65398    1.30094  -0.503  0.61518
country_of_originMauritius    -11.76872 6522.63865  -0.002  0.99856
country_of_originMexico       -0.80196    0.52029  -1.541  0.12323
country_of_originMyanmar      -15.49786 2401.00369  -0.006  0.99485
country_of_originNicaragua     0.53829    1.98308   0.271  0.78605
country_of_originPanama        3.27141    1.79738   1.820  0.06874 .
country_of_originPeru         -14.50164 6522.63864  -0.002  0.99823
country_of_originPhilippines   2.89981    2.57307   1.127  0.25975
country_of_originPuerto Rico   -2.65794    1.78541  -1.489  0.13657
country_of_originTaiwan        1.18951    0.70762   1.681  0.09276 .
country_of_originTanzania      0.91717    0.75964   1.207  0.22729
country_of_originThailand      2.87480    0.99592   2.887  0.00389 **
country_of_originUganda       -1.53625    0.79415  -1.934  0.05306 .
country_of_originUnited States  0.19578    1.52935   0.128  0.89814
country_of_originVietnam       2.24627    1.15874   1.939  0.05256 .
country_of_originZambia       -13.96552 6522.63865  -0.002  0.99829
defects_log                    0.33145    0.17162   1.931  0.05345 .
level2                         0.52403    0.48450   1.082  0.27943
level3                         1.03968    0.48225   2.156  0.03109 *
year2011                      -0.22625    1.12956  -0.200  0.84125
year2012                       0.03098    0.98109   0.032  0.97481
year2013                       0.48471    0.98717   0.491  0.62342
year2014                      -0.07904    0.99385  -0.080  0.93661
```

```
year2015                         -0.14258    0.98571  -0.145  0.88499
year2016                          0.78470    1.03677   0.757  0.44913
year2017                          0.46753    1.03839   0.450  0.65254
year2018                          2.35570    1.32235   1.781  0.07484 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1289.15  on 929  degrees of freedom
Residual deviance:  448.42  on 883  degrees of freedom
  (210 observations deleted due to missingness)
AIC: 542.42

Number of Fisher Scoring iterations: 17


Rows: 930
Columns: 12
$ country_of_origin <chr> "Myanmar", "Uganda", "Ethiopia", "Mexico", "Burundi"~
$ aroma             <dbl[,1]> <matrix[26 x 1]>
$ flavor            <dbl[,1]> <matrix[26 x 1]>
$ acidity           <dbl[,1]> <matrix[26 x 1]>
$ defects_log       <dbl> 1.6094379, 0.6931472, 2.0794415, 1.3862944, 1.79~
$ year              <fct> 2015, 2013, 2014, 2012, 2012, 2014, 2015, 2013, ~
$ level             <chr> "3", "3", "3", "3", "3", "3", "3", "3", "3", "3"~
$ Qualityclass      <dbl> 0, 1, 1, 0, 1, 1, 1, 0, 0, 1, 0, 1, 0, 1, 1, 0, 1, 1~
$ Colombia          <dbl> 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0~
$ Mexico            <dbl> 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
$ Honduras          <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0~
$ Kenya             <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~


Call:
glm(formula = Qualityclass ~ aroma + flavor + acidity + Colombia +
    Mexico + Honduras + Kenya + defects_log + level + year, family = binomial(link = "logit"),
    data = coffee_final_nomiss)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-4.2576  -0.2933   0.0010   0.3296   3.6482

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -1.2894     0.9358  -1.378   0.1683
aroma         1.3883     0.2328   5.964 2.47e-09 ***
flavor        2.4519     0.3004   8.162 3.30e-16 ***
acidity       1.4874     0.2352   6.324 2.55e-10 ***
Colombia      1.9282     0.4095   4.708 2.50e-06 ***
Mexico       -0.7003     0.3512  -1.994   0.0461 *
Honduras     -0.5767     0.5473  -1.054   0.2920
Kenya         0.8497     1.3961   0.609   0.5427
defects_log   0.3119     0.1509   2.067   0.0387 *
level2        0.4545     0.4188   1.085   0.2779
level3        0.6754     0.3769   1.792   0.0731 .
year2011     -0.1599     1.0447  -0.153   0.8783
year2012      0.1019     0.8983   0.113   0.9097
year2013      0.1358     0.8937   0.152   0.8793
year2014      0.4155     0.8995   0.462   0.6441
year2015     -0.1081     0.9090  -0.119   0.9054
year2016      0.8173     0.9402   0.869   0.3847
year2017      0.2811     0.9682   0.290   0.7716
year2018      2.0529     1.1977   1.714   0.0865 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1289.15  on 929  degrees of freedom
Residual deviance:  493.82  on 911  degrees of freedom
AIC: 531.82

Number of Fisher Scoring iterations: 7


Start:  AIC=531.82
Qualityclass ~ aroma + flavor + acidity + Colombia + Mexico +
    Honduras + Kenya + defects_log + level + year

              Df Deviance    AIC
- year         8   503.11 525.11
- Kenya        1   494.24 530.24
- Honduras     1   494.97 530.97
- level        2   497.14 531.14
<none>             493.82 531.82
- Mexico       1   497.85 533.85
- defects_log  1   498.16 534.16
- Colombia     1   520.03 556.03
- acidity      1   543.95 579.95
- aroma        1   544.44 580.44
- flavor       1   584.68 620.68

Step:  AIC=525.11
Qualityclass ~ aroma + flavor + acidity + Colombia + Mexico +
    Honduras + Kenya + defects_log + level

              Df Deviance    AIC
- level        2   503.99 521.99
- Kenya        1   503.79 523.79
- Honduras     1   504.15 524.15
<none>             503.11 525.11
- defects_log  1   508.43 528.43
+ year         8   493.82 531.82
- Mexico       1   511.95 531.95
- Colombia     1   530.49 550.49
- aroma        1   551.81 571.81
- acidity      1   557.40 577.40
- flavor       1   593.89 613.89

Step:  AIC=521.99
Qualityclass ~ aroma + flavor + acidity + Colombia + Mexico +
    Honduras + Kenya + defects_log

              Df Deviance    AIC
- Honduras     1   504.71 520.71
- Kenya        1   504.78 520.78
<none>             503.99 521.99
+ level        2   503.11 525.11
- defects_log  1   509.68 525.68
- Mexico       1   512.91 528.91
+ year         8   497.14 531.14
- Colombia     1   535.47 551.47
- aroma        1   554.81 570.81
- acidity      1   560.36 576.36
- flavor       1   593.96 609.96

Step:  AIC=520.71
Qualityclass ~ aroma + flavor + acidity + Colombia + Mexico +
    Kenya + defects_log

              Df Deviance    AIC
```

```
- Kenya        1   505.57 519.57
<none>             504.71 520.71
+ Honduras     1   503.99 521.99
- defects_log  1   509.97 523.97
+ level        2   504.15 524.15
- Mexico       1   513.00 527.00
+ year         8   497.78 529.78
- Colombia     1   538.07 552.07
- aroma        1   556.11 570.11
- acidity      1   561.95 575.95
- flavor       1   594.88 608.88

Step:  AIC=519.57
Qualityclass ~ aroma + flavor + acidity + Colombia + Mexico +
    defects_log

              Df Deviance    AIC
<none>             505.57 519.57
+ Kenya        1   504.71 520.71
+ Honduras     1   504.78 520.78
+ level        2   504.92 522.92
- defects_log  1   510.96 522.96
- Mexico       1   514.26 526.26
+ year         8   498.34 528.34
- Colombia     1   538.58 550.58
- aroma        1   556.46 568.46
- acidity      1   563.79 575.79
- flavor       1   597.26 609.26


Call:  glm(formula = Qualityclass ~ aroma + flavor + acidity + Colombia +
    Mexico + defects_log, family = binomial(link = "logit"),
    data = coffee_final_nomiss)

Coefficients:
(Intercept)        aroma       flavor      acidity     Colombia       Mexico
    -0.4878       1.3231       2.3850       1.5695       1.8858      -0.8483
defects_log
     0.3276

Degrees of Freedom: 929 Total (i.e. Null);  923 Residual
Null Deviance:      1289
Residual Deviance: 505.6    AIC: 519.6


Start:  AIC=542.42
Qualityclass ~ aroma + flavor + acidity + country_of_origin +
    defects_log + level + year

                    Df Deviance    AIC
- year               8   459.25 537.25
<none>                  448.42 542.42
- level              2   453.47 543.47
- defects_log        1   452.20 544.20
- country_of_origin 32   535.78 565.78
- acidity            1   500.70 592.70
- aroma              1   502.69 594.69
- flavor             1   542.34 634.34

Step:  AIC=537.25
Qualityclass ~ aroma + flavor + acidity + country_of_origin +
    defects_log + level

                    Df Deviance    AIC
- level              2   462.09 536.09
<none>                  459.25 537.25
```

```
- defects_log        1   463.42 539.42
+ year               8   448.42 542.42
- country_of_origin 32   550.27 564.27
- aroma              1   511.50 587.50
- acidity            1   517.53 593.53
- flavor             1   549.37 625.37

Step:  AIC=536.09
Qualityclass ~ aroma + flavor + acidity + country_of_origin +
    defects_log

                   Df Deviance    AIC
<none>                  462.09 536.09
+ level             2   459.25 537.25
- defects_log        1   465.99 537.99
+ year              8   453.47 543.47
- country_of_origin 32   556.03 566.03
- aroma              1   514.97 586.97
- acidity            1   520.89 592.89
- flavor             1   550.89 622.89


Call:  glm(formula = Qualityclass ~ aroma + flavor + acidity + country_of_origin +
    defects_log, family = binomial(link = "logit"), data = coffee_final_nomiss)

Coefficients:
                  (Intercept)                         aroma
                      -0.49464                       1.54145
                       flavor                       acidity
                       2.67737                       1.74281
      country_of_originBurundi          country_of_originChina
                       2.24831                       0.23578
     country_of_originColombia     country_of_originCosta Rica
                       1.95260                       0.27247
country_of_originCote d?Ivoire        country_of_originEcuador
                     -12.45975                      -1.38917
  country_of_originEl Salvador       country_of_originEthiopia
                       0.73415                      14.15194
    country_of_originGuatemala          country_of_originHaiti
                      -0.50408                       1.95150
       country_of_originHawaii       country_of_originHonduras
                       4.02828                      -0.34806
        country_of_originIndia      country_of_originIndonesia
                      -2.81421                      -0.27768
        country_of_originKenya           country_of_originLaos
                       1.15187                     -15.21210
       country_of_originMalawi      country_of_originMauritius
                      -0.82095                     -12.20142
       country_of_originMexico        country_of_originMyanmar
                      -0.89212                     -15.87952
    country_of_originNicaragua         country_of_originPanama
                       0.31308                       2.86942
         country_of_originPeru    country_of_originPhilippines
                     -14.58670                       2.49771
  country_of_originPuerto Rico         country_of_originTaiwan
                      -3.00034                       0.54159
     country_of_originTanzania       country_of_originThailand
                       0.93913                       2.25693
       country_of_originUganda  country_of_originUnited States
                      -1.19901                      -0.05301
     country_of_originVietnam         country_of_originZambia
                       2.17863                     -14.23631
                  defects_log
                       0.32329
```

```
Degrees of Freedom: 929 Total (i.e. Null);  893 Residual
Null Deviance:      1289
Residual Deviance: 462.1    AIC: 536.1


  1   2   3
126 201 612


2010 2011 2012 2013 2014 2015 2016 2017 2018
  32   33  307  161  216  125  131   57   18


Rows: 1,140
Columns: 12
$ country_of_origin <chr> "Myanmar", "Uganda", "Ethiopia", "Mexico", "Burundi"~
$ aroma             <dbl[,1]> <matrix[26 x 1]>
$ flavor            <dbl[,1]> <matrix[26 x 1]>
$ acidity           <dbl[,1]> <matrix[26 x 1]>
$ defects_log       <dbl> 1.6094379, 0.6931472, 2.0794415, 1.3862944, 1.79~
$ year              <dbl> 6, 4, 5, 3, 3, 5, 5, 6, 4, 4, 3, 7, 3, 6, 6, 5, ~
$ level             <chr> "3", "3", "3", "3", "3", "3", "3", "3", "3", "3"~
$ Qualityclass      <dbl> 0, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 0, 1, 0, 1, 1, 0, 1~
$ Colombia          <dbl> 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0~
$ Mexico            <dbl> 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
$ Honduras          <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0~
$ Kenya             <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~


  1   2   3   4   5   6   7   8   9
 32  33 307 161 276 125 131  57  18


Call:
glm(formula = Qualityclass ~ aroma + flavor + acidity + Colombia +
    Mexico + Honduras + Kenya + defects_log + level + year, family = binomial(link = "logit"),
    data = coffee_final_nomiss)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-4.2576  -0.2933   0.0010   0.3296   3.6482

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -1.2894     0.9358  -1.378   0.1683
aroma         1.3883     0.2328   5.964 2.47e-09 ***
flavor        2.4519     0.3004   8.162 3.30e-16 ***
acidity       1.4874     0.2352   6.324 2.55e-10 ***
Colombia      1.9282     0.4095   4.708 2.50e-06 ***
Mexico       -0.7003     0.3512  -1.994   0.0461 *
Honduras     -0.5767     0.5473  -1.054   0.2920
Kenya         0.8497     1.3961   0.609   0.5427
defects_log   0.3119     0.1509   2.067   0.0387 *
level2        0.4545     0.4188   1.085   0.2779
level3        0.6754     0.3769   1.792   0.0731 .
year2011     -0.1599     1.0447  -0.153   0.8783
year2012      0.1019     0.8983   0.113   0.9097
year2013      0.1358     0.8937   0.152   0.8793
year2014      0.4155     0.8995   0.462   0.6441
year2015     -0.1081     0.9090  -0.119   0.9054
year2016      0.8173     0.9402   0.869   0.3847
year2017      0.2811     0.9682   0.290   0.7716
year2018      2.0529     1.1977   1.714   0.0865 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)
```

```
    Null deviance: 1289.15  on 929  degrees of freedom
Residual deviance:  493.82  on 911  degrees of freedom
AIC: 531.82

Number of Fisher Scoring iterations: 7


Start:  AIC=682.29
Qualityclass ~ aroma + flavor + acidity + Colombia + Mexico +
    Honduras + Kenya + defects_log + level + year

              Df Deviance    AIC
- level        2   660.94 680.94
- Kenya        1   659.20 681.20
- year         1   659.91 681.91
<none>             658.29 682.29
- defects_log  1   660.50 682.50
- Honduras     1   660.75 682.75
- Mexico       1   664.26 686.26
- Colombia     1   679.44 701.44
- acidity      1   707.71 729.71
- aroma        1   720.74 742.74
- flavor       1   780.07 802.07

Step:  AIC=680.94
Qualityclass ~ aroma + flavor + acidity + Colombia + Mexico +
    Honduras + Kenya + defects_log + year

              Df Deviance    AIC
- Kenya        1   662.03 680.03
- year         1   662.09 680.09
- Honduras     1   662.65 680.65
<none>             660.94 680.94
- defects_log  1   663.63 681.63
+ level        2   658.29 682.29
- Mexico       1   667.72 685.72
- Colombia     1   685.20 703.20
- acidity      1   713.05 731.05
- aroma        1   724.84 742.84
- flavor       1   780.58 798.58

Step:  AIC=680.03
Qualityclass ~ aroma + flavor + acidity + Colombia + Mexico +
    Honduras + defects_log + year

              Df Deviance    AIC
- year         1   663.40 679.40
- Honduras     1   663.88 679.88
<none>             662.03 680.03
- defects_log  1   664.80 680.80
+ Kenya        1   660.94 680.94
+ level        2   659.20 681.20
- Mexico       1   668.97 684.97
- Colombia     1   686.08 702.08
- acidity      1   715.04 731.04
- aroma        1   725.78 741.78
- flavor       1   783.23 799.23

Step:  AIC=679.4
Qualityclass ~ aroma + flavor + acidity + Colombia + Mexico +
    Honduras + defects_log

              Df Deviance    AIC
- Honduras     1   664.76 678.76
```

```
<none>              663.40 679.40
+ year         1    662.03 680.03
+ Kenya        1    662.09 680.09
- defects_log  1    666.23 680.23
+ level        2    661.06 681.06
- Mexico       1    673.96 687.96
- Colombia     1    686.09 700.09
- acidity      1    716.17 730.17
- aroma        1    725.99 739.99
- flavor       1    785.34 799.34

Step:  AIC=678.76
Qualityclass ~ aroma + flavor + acidity + Colombia + Mexico +
    defects_log

              Df Deviance    AIC
<none>              664.76 678.76
- defects_log  1    667.20 679.20
+ Kenya        1    663.36 679.36
+ Honduras     1    663.40 679.40
+ year         1    663.88 679.88
+ level        2    662.94 680.94
- Mexico       1    674.44 686.44
- Colombia     1    689.05 701.05
- acidity      1    718.88 730.88
- aroma        1    727.99 739.99
- flavor       1    786.93 798.93


Call:  glm(formula = Qualityclass ~ aroma + flavor + acidity + Colombia +
    Mexico + defects_log, family = binomial(link = "logit"),
    data = coffee_final_imputed)

Coefficients:
(Intercept)        aroma       flavor      acidity     Colombia       Mexico
    -0.2442       1.2827       2.2675       1.2183       1.4034      -0.8231
defects_log
     0.1857

Degrees of Freedom: 1139 Total (i.e. Null);  1133 Residual
Null Deviance:      1579
Residual Deviance: 664.8    AIC: 678.8
```

##Final Model

```
Call:
glm(formula = Qualityclass ~ aroma + flavor + acidity + Colombia +
    Mexico + defects_log, family = binomial(link = "logit"),
    data = coffee_final)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.8880  -0.3570   0.0092   0.4077   3.2372

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -0.2442     0.1672  -1.461  0.14404
aroma         1.2827     0.1842   6.964 3.31e-12 ***
flavor        2.2675     0.2399   9.451  < 2e-16 ***
acidity       1.2183     0.1768   6.891 5.56e-12 ***
Colombia      1.4034     0.3017   4.651 3.30e-06 ***
Mexico       -0.8231     0.2683  -3.068  0.00215 **
defects_log   0.1857     0.1192   1.559  0.11903
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1579.36  on 1139  degrees of freedom
Residual deviance:  664.76  on 1133  degrees of freedom
AIC: 678.76

Number of Fisher Scoring iterations: 7


 [1] "Myanmar"       "Uganda"        "Ethiopia"      "Mexico"
 [5] "Burundi"       "Tanzania"      "Colombia"      "Guatemala"
 [9] "Honduras"      "Nicaragua"     "Vietnam"       "Indonesia"
[13] "Taiwan"        "Costa Rica"    "Brazil"        "Malawi"
[17] "Kenya"         "Laos"          "El Salvador"   "Thailand"
[21] "China"         "United States" "Puerto Rico"   "Philippines"
[25] "India"         "Haiti"         "Zambia"        "Peru"
[29] "Ecuador"       "Cote d?Ivoire" "Panama"        "Hawaii"
[33] "Mauritius"


# A tibble: 6 x 43
  country_of_origin aroma flavor acidity category_two_defects altitude_mean_met~
  <chr>             <dbl>  <dbl>   <dbl>                <dbl>              <dbl>
1 Myanmar            7.25   7.42    7.5                     4              1219.
2 Uganda             8.33   7.92    7.92                    1              1600
3 Ethiopia           8.42   8       8                       7              1700
4 Mexico             7.17   7.08    7.25                    3              1300
5 Burundi            7.75   7.67    7.5                     5              1880
6 Tanzania           7.92   7.75    7.75                    0              1400
# ... with 37 more variables: harvested <dbl>, Qualityclass <dbl>,
#   defects_log <dbl>, year <fct>, Myanmar <dbl>, Uganda <dbl>, Ethiopia <dbl>,
#   Mexico <dbl>, Burundi <dbl>, Tanzania <dbl>, Colombia <dbl>,
#   Guatemala <dbl>, Honduras <dbl>, Nicaragua <dbl>, Vietnam <dbl>,
#   Indonesia <dbl>, Taiwan <dbl>, Costa Rica <dbl>, Brazil <dbl>,
#   Malawi <dbl>, Kenya <dbl>, Laos <dbl>, El Salvador <dbl>, Thailand <dbl>,
#   China <dbl>, United States <dbl>, Puerto Rico <dbl>, Philippines <dbl>, ...


Call:
glm(formula = Qualityclass ~ country_of_origin - 1, family = binomial(link = "logit"),
    data = coffee_all_variables)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-2.14597  -1.01655   0.00036   1.08424   2.18993

Coefficients:
                              Estimate Std. Error z value Pr(>|z|)
country_of_originBrazil       6.596e-02  2.098e-01   0.314  0.75320
country_of_originBurundi      0.000e+00  1.414e+00   0.000  1.00000
country_of_originChina        5.878e-01  5.578e-01   1.054  0.29197
country_of_originColombia     1.563e+00  2.345e-01   6.666 2.64e-11 ***
country_of_originCosta Rica   2.231e-01  3.354e-01   0.665  0.50587
country_of_originCote d?Ivoire -1.657e+01  2.400e+03  -0.007  0.99449
country_of_originEcuador      1.570e-16  1.414e+00   0.000  1.00000
country_of_originEl Salvador  9.555e-01  5.262e-01   1.816  0.06941 .
country_of_originEthiopia     1.657e+01  5.003e+02   0.033  0.97359
country_of_originGuatemala    7.878e-02  1.776e-01   0.444  0.65736
country_of_originHaiti       -1.386e+00  1.118e+00  -1.240  0.21500
country_of_originHawaii       1.657e+01  2.400e+03   0.007  0.99449
country_of_originHonduras    -1.041e+00  3.358e-01  -3.102  0.00192 **
country_of_originIndia        0.000e+00  6.325e-01   0.000  1.00000
country_of_originIndonesia    2.877e-01  5.401e-01   0.533  0.59425
country_of_originKenya        2.197e+00  7.454e-01   2.948  0.00320 **
```

```
country_of_originLaos          -1.657e+01  1.697e+03  -0.010  0.99221
country_of_originMalawi        -2.303e+00  1.049e+00  -2.195  0.02813 *
country_of_originMauritius     -1.657e+01  2.400e+03  -0.007  0.99449
country_of_originMexico        -1.046e+00  1.612e-01  -6.488 8.68e-11 ***
country_of_originMyanmar       -1.657e+01  9.796e+02  -0.017  0.98651
country_of_originNicaragua     -1.204e+00  6.583e-01  -1.829  0.06740 .
country_of_originPanama         1.099e+00  1.155e+00   0.951  0.34139
country_of_originPeru          -1.657e+01  2.400e+03  -0.007  0.99449
country_of_originPhilippines   -4.055e-01  9.129e-01  -0.444  0.65692
country_of_originPuerto Rico   -6.931e-01  1.225e+00  -0.566  0.57143
country_of_originTaiwan        -3.909e-01  2.700e-01  -1.448  0.14769
country_of_originTanzania      -6.899e-02  3.716e-01  -0.186  0.85271
country_of_originThailand       2.877e-01  5.401e-01   0.533  0.59425
country_of_originUganda         1.190e+00  4.317e-01   2.756  0.00585 **
country_of_originUnited States  6.931e-01  7.071e-01   0.980  0.32696
country_of_originVietnam        2.877e-01  7.638e-01   0.377  0.70642
country_of_originZambia        -1.657e+01  2.400e+03  -0.007  0.99449
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1289.3  on 930  degrees of freedom
Residual deviance: 1072.1  on 897  degrees of freedom
AIC: 1138.1

Number of Fisher Scoring iterations: 15


Call:
glm(formula = Qualityclass ~ aroma + flavor + acidity + altitude_mean_meters +
    harvested + defects_log + Colombia + Honduras + Kenya + Malawi +
    Mexico + Uganda, family = binomial(link = "logit"), data = coffee_all_variables)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-4.2034  -0.3073   0.0010   0.3324   3.4829

Coefficients:
                       Estimate Std. Error z value Pr(>|z|)
(Intercept)          -3.346e+02  1.462e+02  -2.289   0.0221 *
aroma                 4.623e+00  7.362e-01   6.279 3.40e-10 ***
flavor                7.041e+00  8.685e-01   8.107 5.20e-16 ***
acidity               4.803e+00  7.265e-01   6.610 3.84e-11 ***
altitude_mean_meters  2.727e-04  2.449e-04   1.113   0.2655
harvested             1.041e-01  7.203e-02   1.445   0.1486
defects_log           2.994e-01  1.463e-01   2.047   0.0407 *
Colombia              1.826e+00  3.970e-01   4.600 4.22e-06 ***
Honduras             -6.779e-01  5.323e-01  -1.273   0.2029
Kenya                 8.213e-01  1.329e+00   0.618   0.5366
Malawi               -1.069e+00  1.148e+00  -0.931   0.3517
Mexico               -7.517e-01  3.312e-01  -2.270   0.0232 *
Uganda               -1.160e+00  6.223e-01  -1.865   0.0622 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1289.15  on 929  degrees of freedom
Residual deviance:  496.96  on 917  degrees of freedom
AIC: 522.96

Number of Fisher Scoring iterations: 7


Start:  AIC=522.96
```

```
Qualityclass ~ aroma + flavor + acidity + altitude_mean_meters +
    harvested + defects_log + Colombia + Honduras + Kenya + Malawi +
    Mexico + Uganda

                       Df Deviance    AIC
- Kenya                 1   497.39 521.39
- Malawi                1   498.02 522.02
- altitude_mean_meters  1   498.19 522.19
- Honduras              1   498.66 522.66
<none>                      496.96 522.96
- harvested             1   499.06 523.06
- Uganda                1   500.24 524.24
- defects_log           1   501.21 525.21
- Mexico                1   502.21 526.21
- Colombia              1   521.56 545.56
- acidity               1   550.88 574.88
- aroma                 1   552.30 576.30
- flavor                1   584.78 608.78

Step:  AIC=521.39
Qualityclass ~ aroma + flavor + acidity + altitude_mean_meters +
    harvested + defects_log + Colombia + Honduras + Malawi +
    Mexico + Uganda

                       Df Deviance    AIC
- Malawi                1   498.46 520.46
- altitude_mean_meters  1   498.71 520.71
- Honduras              1   499.19 521.19
<none>                      497.39 521.39
- harvested             1   499.68 521.68
- Uganda                1   500.71 522.71
+ Kenya                 1   496.96 522.96
- defects_log           1   501.68 523.68
- Mexico                1   502.73 524.73
- Colombia              1   521.83 543.83
- acidity               1   551.94 573.94
- aroma                 1   552.48 574.48
- flavor                1   586.58 608.58

Step:  AIC=520.46
Qualityclass ~ aroma + flavor + acidity + altitude_mean_meters +
    harvested + defects_log + Colombia + Honduras + Mexico +
    Uganda

                       Df Deviance    AIC
- altitude_mean_meters  1   499.59 519.59
- Honduras              1   500.15 520.15
<none>                      498.46 520.46
- harvested             1   500.82 520.82
+ Malawi                1   497.39 521.39
- Uganda                1   501.62 521.62
+ Kenya                 1   498.02 522.02
- defects_log           1   503.45 523.45
- Mexico                1   503.59 523.59
- Colombia              1   524.48 544.48
- aroma                 1   553.62 573.62
- acidity               1   553.83 573.83
- flavor                1   589.74 609.74

Step:  AIC=519.59
Qualityclass ~ aroma + flavor + acidity + harvested + defects_log +
    Colombia + Honduras + Mexico + Uganda

                       Df Deviance    AIC
- Honduras              1   501.06 519.06
```

```
<none>                      499.59 519.59
- harvested             1   501.68 519.68
- Uganda                1   502.34 520.34
+ altitude_mean_meters  1   498.46 520.46
+ Malawi                1   498.71 520.71
+ Kenya                 1   499.06 521.06
- Mexico                1   504.97 522.97
- defects_log           1   505.21 523.21
- Colombia              1   529.78 547.78
- aroma                 1   554.96 572.96
- acidity               1   557.04 575.04
- flavor                1   589.81 607.81

Step:  AIC=519.06
Qualityclass ~ aroma + flavor + acidity + harvested + defects_log +
    Colombia + Mexico + Uganda

                       Df Deviance    AIC
- harvested             1   502.63 518.63
<none>                      501.06 519.06
+ Honduras              1   499.59 519.59
- Uganda                1   503.66 519.66
+ altitude_mean_meters  1   500.15 520.15
+ Malawi                1   500.25 520.25
+ Kenya                 1   500.43 520.43
- Mexico                1   505.97 521.97
- defects_log           1   506.05 522.05
- Colombia              1   532.39 548.39
- aroma                 1   556.42 572.42
- acidity               1   559.78 575.78
- flavor                1   591.76 607.76

Step:  AIC=518.63
Qualityclass ~ aroma + flavor + acidity + defects_log + Colombia +
    Mexico + Uganda

                       Df Deviance    AIC
<none>                      502.63 518.63
+ harvested             1   501.06 519.06
- Uganda                1   505.57 519.57
+ Honduras              1   501.68 519.68
+ Malawi                1   501.75 519.75
+ Kenya                 1   501.82 519.82
+ altitude_mean_meters  1   501.90 519.90
- defects_log           1   507.92 521.92
- Mexico                1   512.34 526.34
- Colombia              1   532.82 546.82
- aroma                 1   556.43 570.43
- acidity               1   561.11 575.11
- flavor                1   594.72 608.72


Call:
glm(formula = Qualityclass ~ aroma + flavor + acidity + defects_log +
    Colombia + Mexico + Uganda, family = binomial(link = "logit"),
    data = coffee_all_variables)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-4.1629  -0.3116   0.0011   0.3408   3.5210

Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept) -125.7756     9.2952 -13.531  < 2e-16 ***
aroma          4.4946     0.7234   6.213 5.19e-10 ***
```

```
flavor         7.1317     0.8609   8.284  < 2e-16 ***
acidity        4.9842     0.7223   6.900 5.19e-12 ***
defects_log    0.3247     0.1425   2.279  0.02267 *
Colombia       1.8317     0.3617   5.065 4.09e-07 ***
Mexico        -0.9074     0.2961  -3.064  0.00218 **
Uganda        -1.0808     0.6117  -1.767  0.07722 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1289.15  on 929  degrees of freedom
Residual deviance:  502.63  on 922  degrees of freedom
AIC: 518.63

Number of Fisher Scoring iterations: 7


Analysis of Deviance Table

Model 1: Qualityclass ~ aroma + flavor + acidity + defects_log + Colombia +
    Mexico + Uganda
Model 2: Qualityclass ~ aroma + flavor + acidity + defects_log + Colombia +
    Mexico
  Resid. Df Resid. Dev Df Deviance
1       922     502.63
2       923     505.57 -1  -2.9425


[1] 0.8815789


[1] 0.8904022


[1] 0.8731034
```

##Sensitivity Analysis

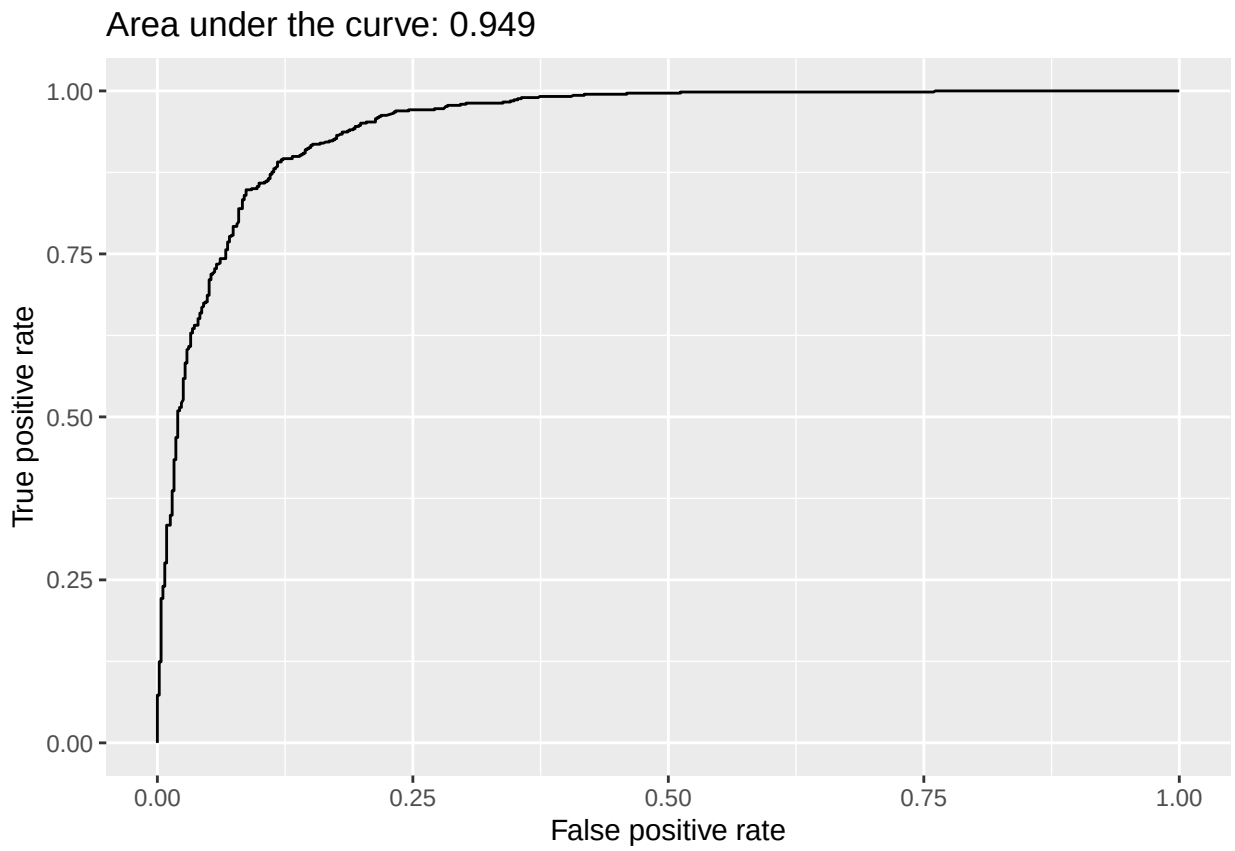
```
Generalized linear mixed model fit by maximum likelihood (Laplace
  Approximation) [glmerMod]
 Family: binomial  ( logit )
Formula: Qualityclass ~ 1 + aroma + flavor + acidity + defects_log + (1 |
    country_of_origin)
   Data: coffee_final

     AIC      BIC   logLik deviance df.resid
   681.5    711.7   -334.8    669.5     1134

Scaled residuals:
    Min      1Q  Median      3Q     Max
-51.267  -0.239   0.004   0.268  13.385

Random effects:
 Groups            Name        Variance Std.Dev.
 country_of_origin (Intercept) 0.6285   0.7928
Number of obs: 1140, groups:  country_of_origin, 34

Fixed effects:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -0.2502     0.2443  -1.024   0.3059
aroma         1.3733     0.1950   7.043 1.88e-12 ***
flavor        2.4130     0.2562   9.418  < 2e-16 ***
acidity       1.2662     0.1872   6.765 1.33e-11 ***
defects_log   0.2338     0.1279   1.828   0.0675 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
[1] 0.8701754
```

```
[1] 0.8823189
```

```
[1] 0.8592056
```

Classfication boundry




```
          cut       fpr       tpr       dif
555 0.5091171 0.1175407 0.8909710 0.7734304
559 0.5041421 0.1211573 0.8943782 0.7732209
561 0.5024577 0.1229656 0.8960818 0.7731161
554 0.5132069 0.1175407 0.8892675 0.7717268
556 0.5079264 0.1193490 0.8909710 0.7716220
558 0.5063213 0.1211573 0.8926746 0.7715173
```

```
[1] 0.5091171
```

```
          cut       fpr       tpr       dif
555 0.5091171 0.1175407 0.8909710 0.7734304
559 0.5041421 0.1211573 0.8943782 0.7732209
561 0.5024577 0.1229656 0.8960818 0.7731161
554 0.5132069 0.1175407 0.8892675 0.7717268
556 0.5079264 0.1193490 0.8909710 0.7716220
558 0.5063213 0.1211573 0.8926746 0.7715173
```

```
[1] 0.8798246
```

```
[1] 0.8855754

[1] 0.8750265

[1] 0.8824561

[1] 0.8917863

[1] 0.8731034

[1] 0.8763441

[1] 0.897054

[1] 0.8594719

Generalized linear mixed model fit by maximum likelihood (Laplace
  Approximation) [glmerMod]
 Family: binomial  ( logit )
Formula: Qualityclass ~ 1 + aroma + flavor + acidity + defects_log + (1 |
    country_of_origin)
   Data: coffee_all_variables

     AIC      BIC   logLik deviance df.resid
   525.4    554.4   -256.7    513.4      924

Scaled residuals:
    Min      1Q  Median      3Q     Max
-90.757  -0.200   0.000   0.235  21.028

Random effects:
 Groups            Name        Variance Std.Dev.
 country_of_origin (Intercept) 0.8233   0.9074
Number of obs: 930, groups:  country_of_origin, 33

Fixed effects:
             Estimate Std. Error z value Pr(>|z|)
(Intercept) -131.5202    10.2343 -12.851  < 2e-16 ***
aroma          4.6274     0.7523   6.151 7.70e-10 ***
flavor         7.5103     0.9278   8.094 5.75e-16 ***
acidity        5.2468     0.7647   6.861 6.83e-12 ***
defects_log    0.3491     0.1529   2.284   0.0224 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```