Appendix

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##Data Prep

```
## remove unecessary columns
data = read.csv("WESAD-one-sec-shift.csv")
data_2min_window = read.csv('WESAD-2-min-window.csv')

bad_columns = c('X1',
                'wrist_BVP_HRV_low_high_freq_ratio', 'chest_ECG_HRV_low_high_freq_ratio',
                'wrist_BVP_HRV_low_freq_normalized', 'chest_ECG_HRV_low_freq_normalized',
                'wrist_BVP_HRV_low_freq','chest_ECG_HRV_low_freq',
                'wrist_BVP_HRV_ultra_low_freq', 'chest_ECG_HRV_ultra_low_freq')
data = data[!names(data) %in% bad_columns]
is_wrist_column = function(column) { substr(column, 1, 6) == 'wrist_' }
is_chest_column = function(column) { substr(column, 1, 6) == 'chest_' }
create_is_sensor_column = function(sensor) {
  function(column) {
    length(column) > 6 & substr(column, 7, 7+nchar(sensor)-1) == sensor
  }
}
get_columns = function(sensor) {
  is_sensor_column = create_is_sensor_column(sensor)
  is_sensor_column(colnames(data))
}
# remove acceleration components
get_ACC_component_cols = function(component) {
  get_columns(paste('ACC', component, sep='_'))
}
data = data[!get_ACC_component_cols('x')]
data = data[!get_ACC_component_cols('y')]
data = data[!get_ACC_component_cols('z')]

##data <- data %>%
  #mutate(affect = case_when(affect == "amusement" ~ 0,
 #                          affect == "stress" ~ 1))
```

#Correlation Analysis

#Boxplots of Means of All Features

#Boxplots of all Acceleration Features

#Boxplots of all Heart rate vars

#Boxplots of all temperature vars

Distribution of Average Skin Temperature and Number of Skin Conductivity Responses (SCR) Across Subjects

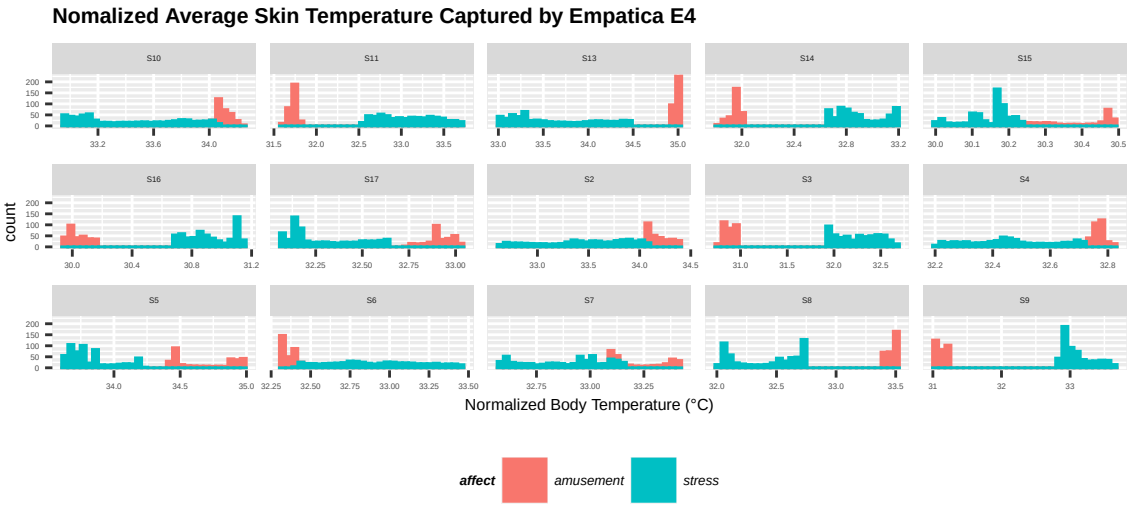
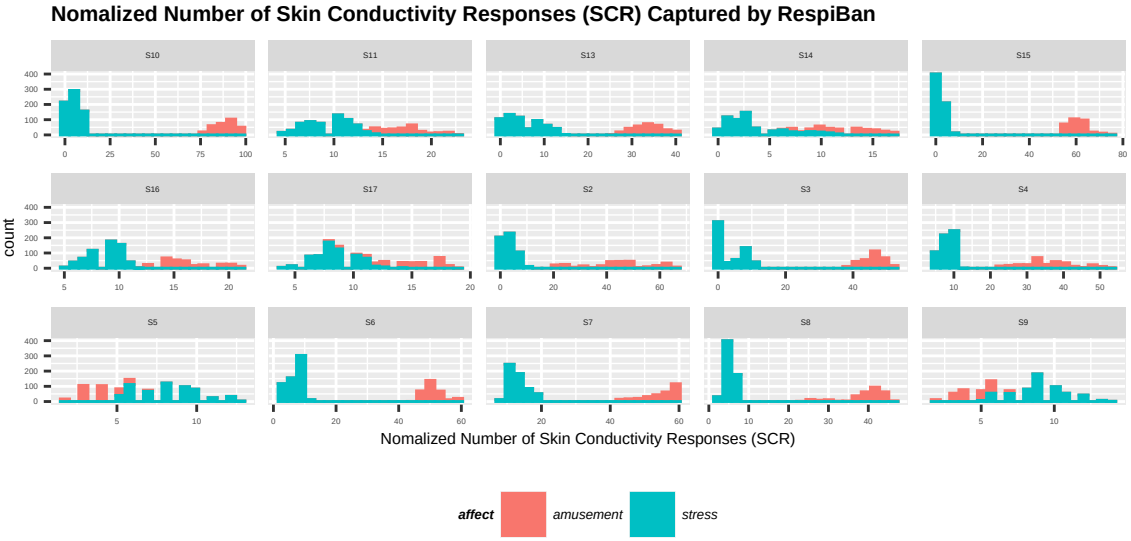


Figure 3



Model Fitting

Chest and wrist model

```
model_expression = affect ~ . -subject_id
DO_STRIDE = FALSE
chest_wrist_simple = get_logistic_model(model_expression, do_backwards_selection=TRUE, DO_STRIDE)
```

```
##
## Call:
```

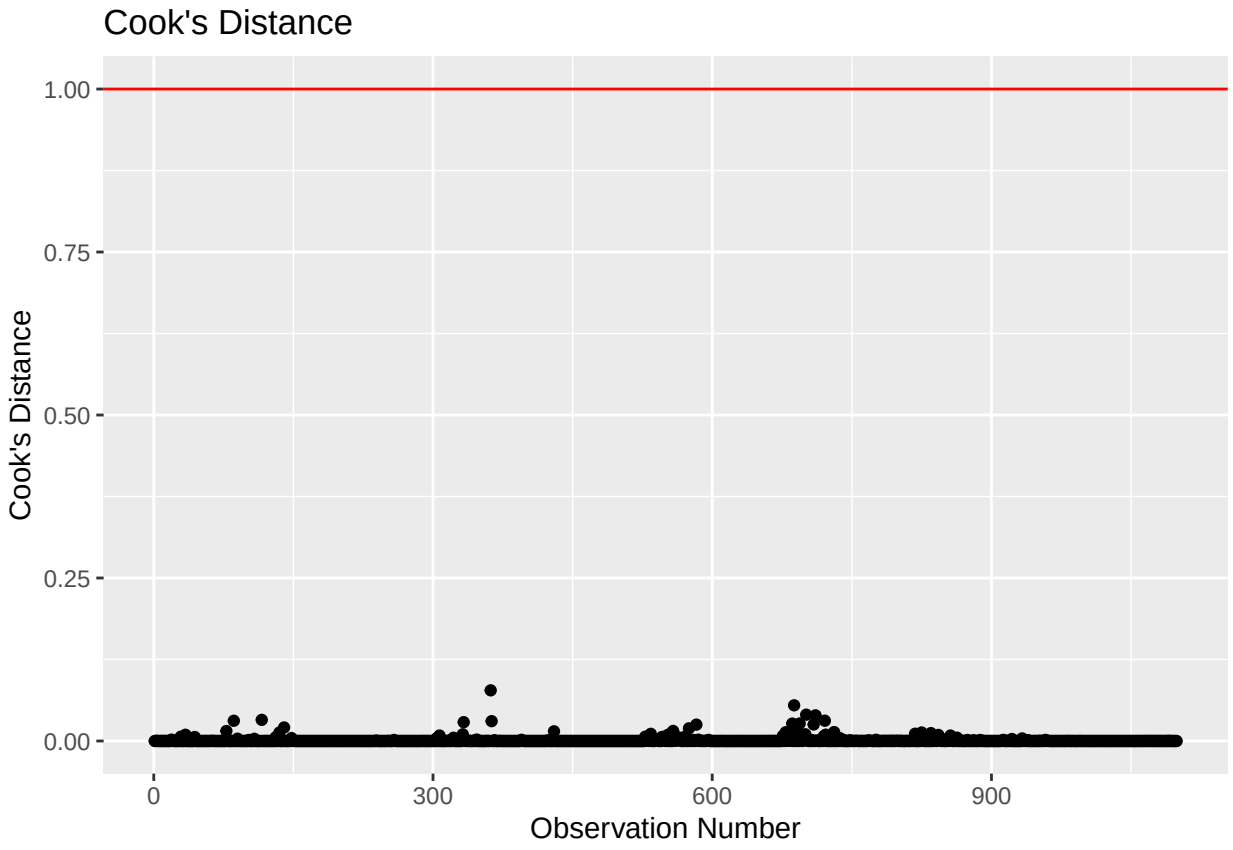
```
## glm(formula = affect ~ chest_EDA_slope + wrist_EDA_slope + chest_RESP_volume +
##     chest_SCR_num_segments + wrist_SCR_num_segments + wrist_ACC_magnitude_mean +
##     chest_TEMP_mean + chest_TEMP_slope + wrist_TEMP_mean + chest_ECG_HRV_mean +
##     wrist_BVP_HRV_mean, family = "binomial", data = model_data,
##     maxit = 100)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.6503  -0.0002   0.0039   0.0794   3.5316
##
## Coefficients:
##                           Estimate Std. Error z value Pr(>|z|)
## (Intercept)                0.9969     0.3101   3.215 0.001305 **
## chest_EDA_slope            0.4382     0.1979   2.215 0.026791 *
## wrist_EDA_slope            0.2780     0.1843   1.508 0.131448
## chest_RESP_volume          1.0475     0.2279   4.597 4.29e-06 ***
## chest_SCR_num_segments    -6.8040     0.7685  -8.853  < 2e-16 ***
## wrist_SCR_num_segments    -2.5835     0.3162  -8.171 3.05e-16 ***
## wrist_ACC_magnitude_mean   1.2796     0.3445   3.714 0.000204 ***
## chest_TEMP_mean           -0.8797     0.3179  -2.767 0.005657 **
## chest_TEMP_slope           0.6155     0.3561   1.729 0.083855 .
## wrist_TEMP_mean            0.7392     0.2489   2.970 0.002976 **
## chest_ECG_HRV_mean        -4.6243     0.6355  -7.277 3.41e-13 ***
## wrist_BVP_HRV_mean         0.6516     0.3933   1.657 0.097570 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 1433.1  on 1098  degrees of freedom
## Residual deviance:  231.4  on 1087  degrees of freedom
## AIC: 255.4
##
## Number of Fisher Scoring iterations: 9
```

```
print_stats(chest_wrist_simple, DO_STRIDE)
```

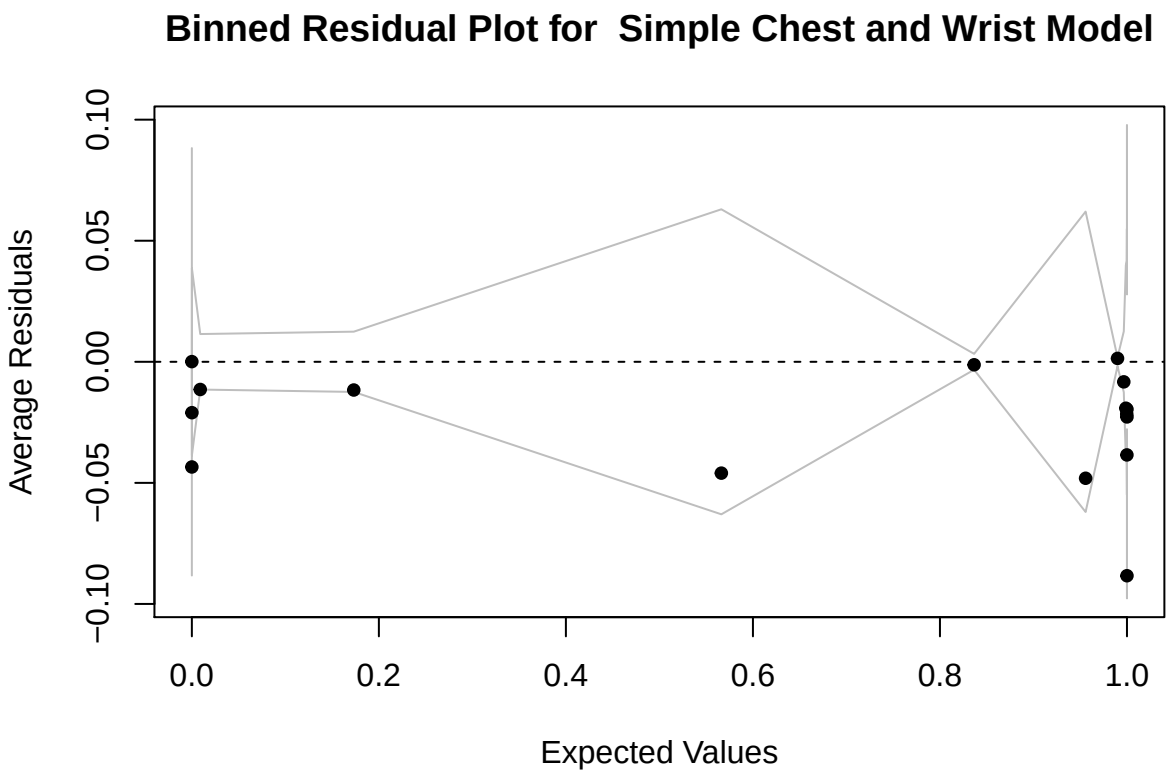
```
## [1] "accuracy:  0.949275362318841"
## Confusion Matrix and Statistics
##
##            Reference
## Prediction  amusement stress
##   amusement        85      6
##   stress            8    177
##
##                Accuracy : 0.9493
##                  95% CI : (0.9164, 0.972)
##     No Information Rate : 0.663
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.8859
##
##  Mcnemar's Test P-Value : 0.7893
##
```

```
##             Sensitivity : 0.9140
##             Specificity : 0.9672
##          Pos Pred Value : 0.9341
##          Neg Pred Value : 0.9568
##              Prevalence : 0.3370
##          Detection Rate : 0.3080
##    Detection Prevalence : 0.3297
##       Balanced Accuracy : 0.9406
##
##        'Positive' Class : amusement
##
```

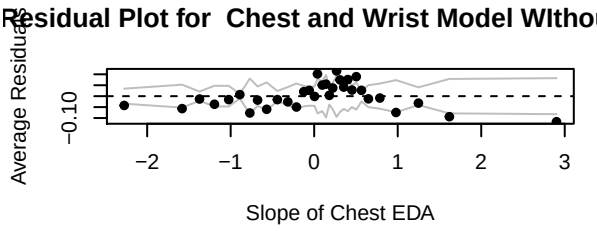
```
show_cooks(chest_wrist_simple, DO_STRIDE)
```

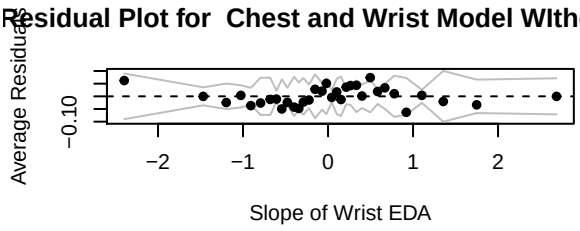


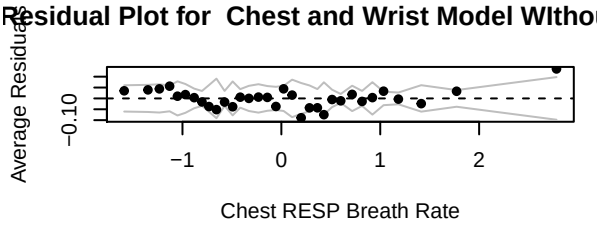

```
binned_residuals_vs_preds(chest_wrist_simple, 'Simple Chest and Wrist Model')
```

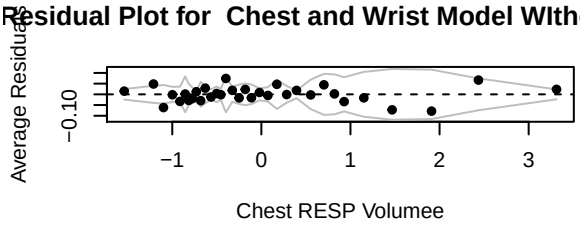


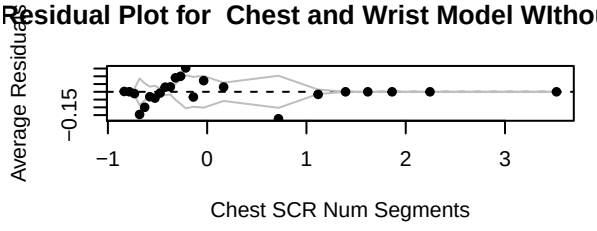

```
par(mfrow=c(3,2))
par(mfrow=c(3,2))
binned_residuals_vs_x(chest_wrist_simple, 'Chest and Wrist Model WIthout Interactions', train$chest_EDA
binned_residuals_vs_x(chest_wrist_simple, 'Chest and Wrist Model WIthout Interactions', train$wrist_EDA
binned_residuals_vs_x(chest_wrist_simple, 'Chest and Wrist Model WIthout Interactions', train$chest_RESI
binned_residuals_vs_x(chest_wrist_simple, 'Chest and Wrist Model WIthout Interactions', train$chest_RESI
binned_residuals_vs_x(chest_wrist_simple, 'Chest and Wrist Model WIthout Interactions', train$chest_SCR
binned_residuals_vs_x(chest_wrist_simple, 'Chest and Wrist Model WIthout Interactions', train$wrist_SCR
```

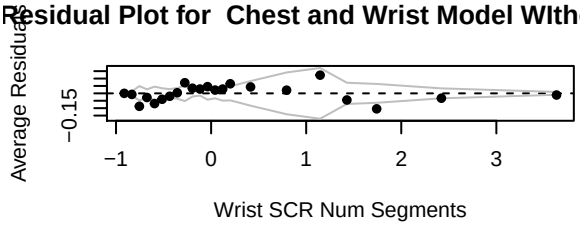




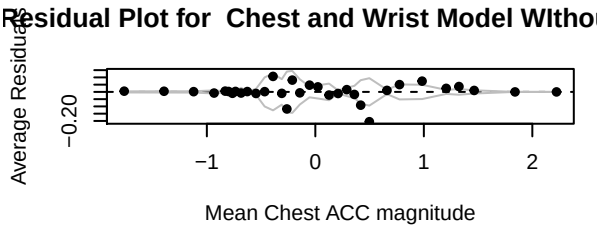


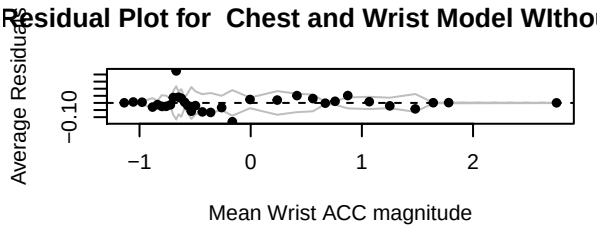


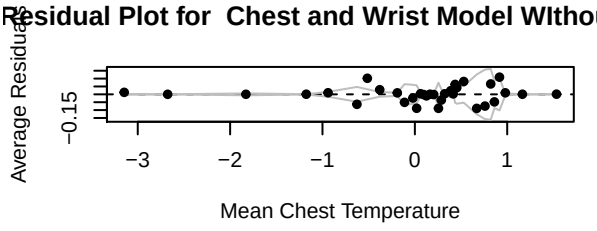


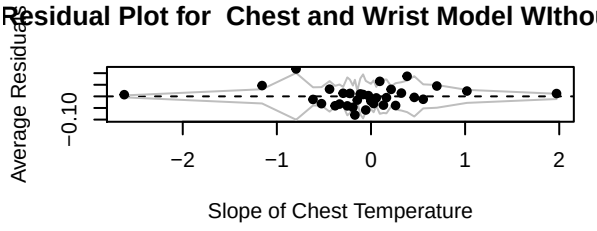


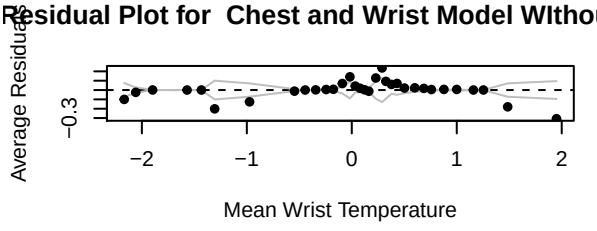

```
binned_residuals_vs_x(chest_wrist_simple, 'Chest and Wrist Model WIthout Interactions', train$chest_ACC
binned_residuals_vs_x(chest_wrist_simple, 'Chest and Wrist Model WIthout Interactions', train$wrist_ACC
binned_residuals_vs_x(chest_wrist_simple, 'Chest and Wrist Model WIthout Interactions', train$chest_TEM
binned_residuals_vs_x(chest_wrist_simple, 'Chest and Wrist Model WIthout Interactions', train$chest_TEM
binned_residuals_vs_x(chest_wrist_simple, 'Chest and Wrist Model WIthout Interactions', train$wrist_TEM
```












```
vif(chest_wrist_simple)
```

```
##          chest_EDA_slope          wrist_EDA_slope        chest_RESP_volume
##                 1.346269                 1.209025                 2.127112
##   chest_SCR_num_segments   wrist_SCR_num_segments wrist_ACC_magnitude_mean
##                 2.888188                 2.870302                 1.667454
##          chest_TEMP_mean         chest_TEMP_slope          wrist_TEMP_mean
##                 1.553540                 1.171172                 2.798950
##       chest_ECG_HRV_mean       wrist_BVP_HRV_mean
##                 3.799442                 1.623108
```

Wrist model without interactions

```
model_expression = affect ~ wrist_ACC_magnitude_mean+wrist_BVP_HRV_mean+wrist_EDA_slope+wrist_SCR_num_s
DO_STRIDE = FALSE
wrist_simple = get_logistic_model(model_expression, do_backwards_selection=TRUE, DO_STRIDE)
```

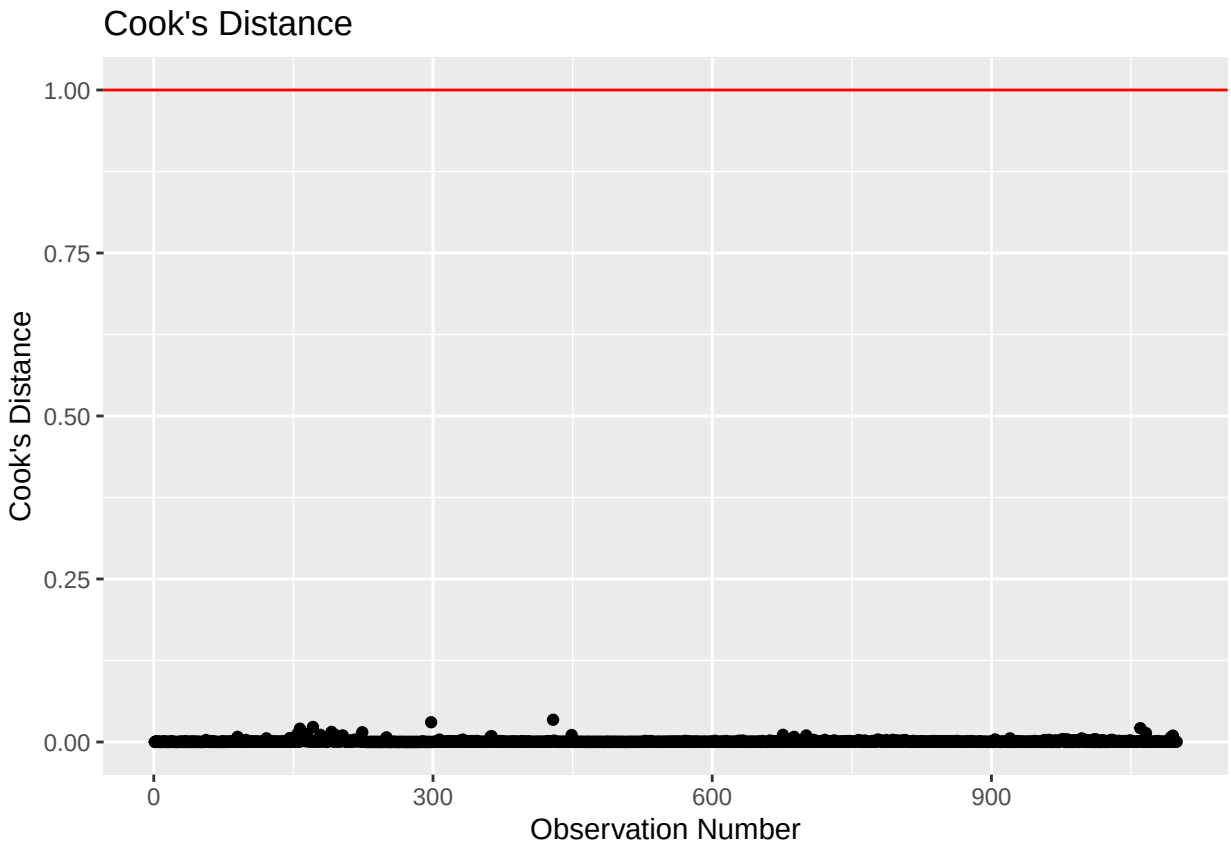
```
##
## Call:
## glm(formula = affect ~ wrist_ACC_magnitude_mean + wrist_BVP_HRV_mean +
##     wrist_EDA_slope + wrist_SCR_num_segments, family = "binomial",
##     data = model_data, maxit = 100)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
```

```
## -2.5990  -0.8139   0.5265   0.8569   2.1396
##
## Coefficients:
##                           Estimate Std. Error z value Pr(>|z|)
## (Intercept)                0.71658    0.07621   9.403  < 2e-16 ***
## wrist_ACC_magnitude_mean   0.56965    0.09022   6.314 2.72e-10 ***
## wrist_BVP_HRV_mean        -0.25781    0.07409  -3.480 0.000502 ***
## wrist_EDA_slope            0.48575    0.08101   5.996 2.02e-09 ***
## wrist_SCR_num_segments    -1.17079    0.09649 -12.133  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 1433.1  on 1098  degrees of freedom
## Residual deviance: 1128.9  on 1094  degrees of freedom
## AIC: 1138.9
##
## Number of Fisher Scoring iterations: 5
```

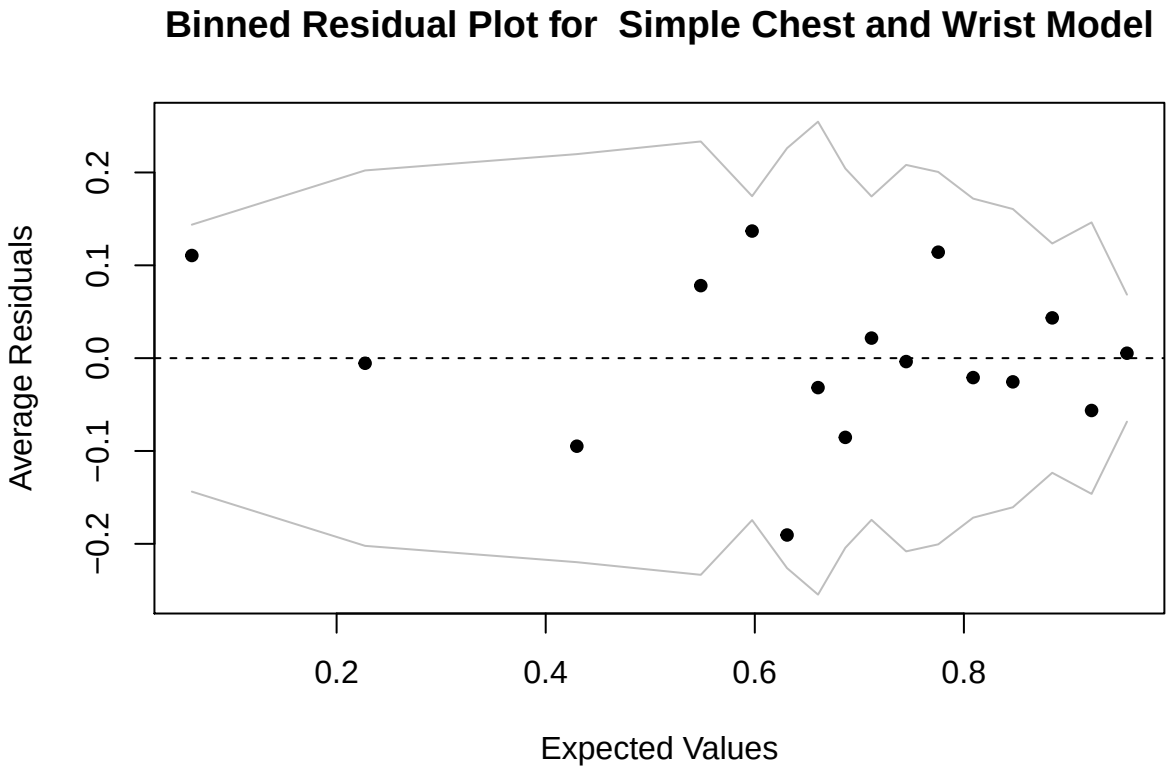
```
print_stats(wrist_simple, DO_STRIDE)
```

```
## [1] "accuracy:  0.778985507246377"
## Confusion Matrix and Statistics
##
##            Reference
## Prediction  amusement stress
##   amusement        41      9
##   stress           52    174
##
##                Accuracy : 0.779
##                  95% CI : (0.7254, 0.8265)
##     No Information Rate : 0.663
##     P-Value [Acc > NIR] : 1.685e-05
##
##                   Kappa : 0.4419
##
##  Mcnemar's Test P-Value : 7.551e-08
##
##             Sensitivity : 0.4409
##             Specificity : 0.9508
##          Pos Pred Value : 0.8200
##          Neg Pred Value : 0.7699
##              Prevalence : 0.3370
##          Detection Rate : 0.1486
##    Detection Prevalence : 0.1812
##       Balanced Accuracy : 0.6958
##
##        'Positive' Class : amusement
##
```

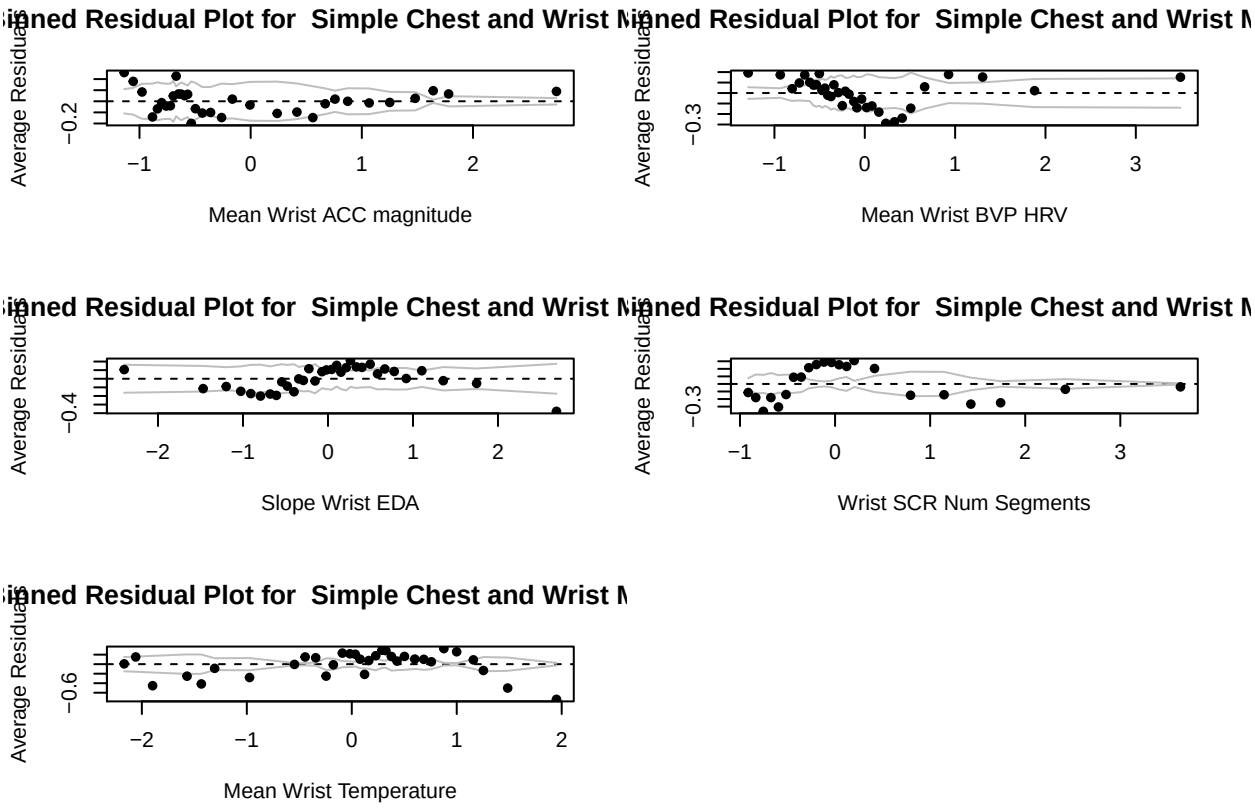
```
show_cooks(wrist_simple, DO_STRIDE)
```




```
binned_residuals_vs_preds(wrist_simple, 'Simple Chest and Wrist Model')
```



```
par(mfrow=c(3,2))
binned_residuals_vs_x(wrist_simple, 'Simple Chest and Wrist Model', train$wrist_ACC_magnitude_mean, 'Mea
binned_residuals_vs_x(wrist_simple, 'Simple Chest and Wrist Model', train$wrist_BVP_HRV_mean, 'Mean Wris
binned_residuals_vs_x(wrist_simple, 'Simple Chest and Wrist Model', train$wrist_EDA_slope, 'Slope Wrist
binned_residuals_vs_x(wrist_simple, 'Simple Chest and Wrist Model', train$wrist_SCR_num_segments, 'Wrist
binned_residuals_vs_x(wrist_simple, 'Simple Chest and Wrist Model', train$wrist_TEMP_mean, 'Mean Wrist T
```



Wrist model with interactions

```
model_expression = affect ~ (wrist_ACC_magnitude_mean+wrist_BVP_HRV_mean+wrist_EDA_slope+wrist_SCR_num_s
DO_STRIDE = FALSE
wrist_interaction = get_logistic_model(model_expression, do_backwards_selection=TRUE, DO_STRIDE)
```

```
##
## Call:
## glm(formula = affect ~ wrist_ACC_magnitude_mean + wrist_BVP_HRV_mean +
##     wrist_EDA_slope + wrist_SCR_num_segments + wrist_TEMP_mean +
##     wrist_ACC_magnitude_mean:wrist_BVP_HRV_mean + wrist_ACC_magnitude_mean:wrist_EDA_slope +
##     wrist_ACC_magnitude_mean:wrist_SCR_num_segments + wrist_ACC_magnitude_mean:wrist_TEMP_mean +
##     wrist_BVP_HRV_mean:wrist_EDA_slope + wrist_BVP_HRV_mean:wrist_TEMP_mean +
##     wrist_EDA_slope:wrist_TEMP_mean, family = "binomial", data = model_data,
##     maxit = 100)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
```

```
## -3.6880  -0.6303   0.3860   0.7624   1.9479
##
## Coefficients:
##                                                Estimate Std. Error z value
## (Intercept)                                     0.73849    0.08670   8.518
## wrist_ACC_magnitude_mean                        0.61631    0.10610   5.809
## wrist_BVP_HRV_mean                             -0.54648    0.11629  -4.699
## wrist_EDA_slope                                 0.65858    0.10087   6.529
## wrist_SCR_num_segments                         -1.28693    0.10906 -11.800
## wrist_TEMP_mean                                 0.45182    0.11340   3.984
## wrist_ACC_magnitude_mean:wrist_BVP_HRV_mean     0.30804    0.11022   2.795
## wrist_ACC_magnitude_mean:wrist_EDA_slope       -0.20283    0.12907  -1.571
## wrist_ACC_magnitude_mean:wrist_SCR_num_segments -0.61110    0.15815  -3.864
## wrist_ACC_magnitude_mean:wrist_TEMP_mean        0.58387    0.15125   3.860
## wrist_BVP_HRV_mean:wrist_EDA_slope              0.55713    0.13977   3.986
## wrist_BVP_HRV_mean:wrist_TEMP_mean             -0.44866    0.09801  -4.578
## wrist_EDA_slope:wrist_TEMP_mean                 0.46501    0.07924   5.868
##                                                Pr(>|z|)
## (Intercept)                                     < 2e-16 ***
## wrist_ACC_magnitude_mean                       6.29e-09 ***
## wrist_BVP_HRV_mean                             2.61e-06 ***
## wrist_EDA_slope                                6.61e-11 ***
## wrist_SCR_num_segments                          < 2e-16 ***
## wrist_TEMP_mean                                6.77e-05 ***
## wrist_ACC_magnitude_mean:wrist_BVP_HRV_mean    0.005193 **
## wrist_ACC_magnitude_mean:wrist_EDA_slope       0.116081
## wrist_ACC_magnitude_mean:wrist_SCR_num_segments 0.000112 ***
## wrist_ACC_magnitude_mean:wrist_TEMP_mean       0.000113 ***
## wrist_BVP_HRV_mean:wrist_EDA_slope             6.72e-05 ***
## wrist_BVP_HRV_mean:wrist_TEMP_mean             4.70e-06 ***
## wrist_EDA_slope:wrist_TEMP_mean                4.41e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 1433.1  on 1098  degrees of freedom
## Residual deviance: 1011.8  on 1086  degrees of freedom
## AIC: 1037.8
##
## Number of Fisher Scoring iterations: 5
```

```
print_stats(wrist_interaction, DO_STRIDE)
```

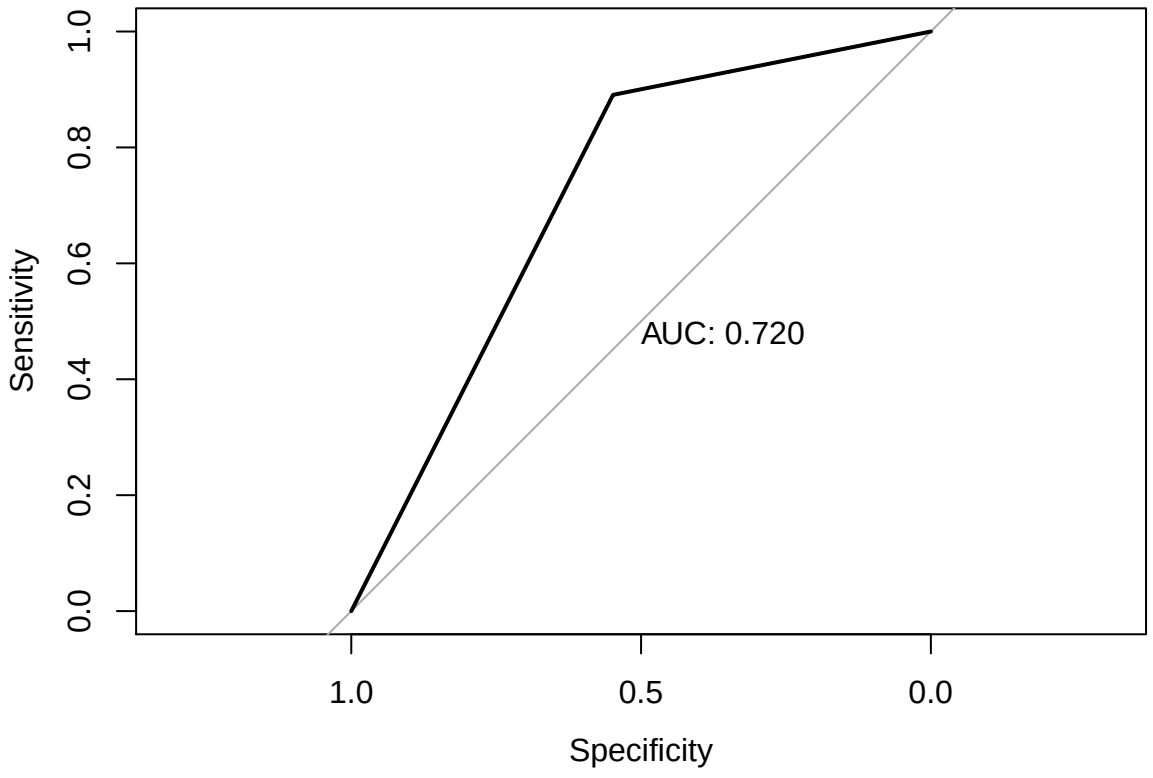
```
## [1] "accuracy:  0.77536231884058"
## Confusion Matrix and Statistics
##
##            Reference
## Prediction  amusement stress
##   amusement        51     20
##   stress           42    163
##
##                Accuracy : 0.7754
##                  95% CI : (0.7215, 0.8232)
```

```
##     No Information Rate : 0.663
##     P-Value [Acc > NIR] : 3.044e-05
##
##                   Kappa : 0.4662
##
##  Mcnemar's Test P-Value : 0.007653
##
##             Sensitivity : 0.5484
##             Specificity : 0.8907
##          Pos Pred Value : 0.7183
##          Neg Pred Value : 0.7951
##              Prevalence : 0.3370
##          Detection Rate : 0.1848
##    Detection Prevalence : 0.2572
##       Balanced Accuracy : 0.7195
##
##        'Positive' Class : amusement
##
```

```
show_roc(wrist_interaction, DO_STRIDE)
```

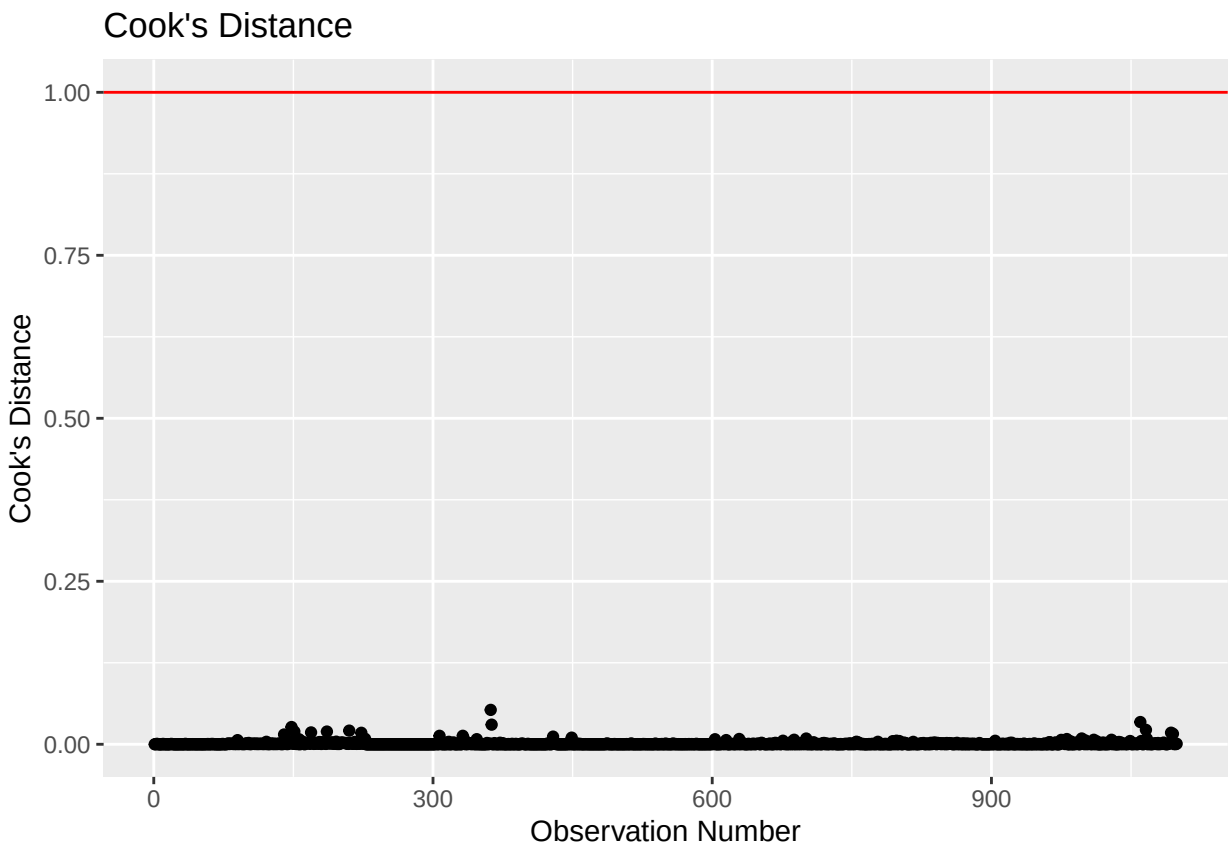
```
## Setting levels: control = amusement, case = stress
```

```
## Setting direction: controls > cases
```

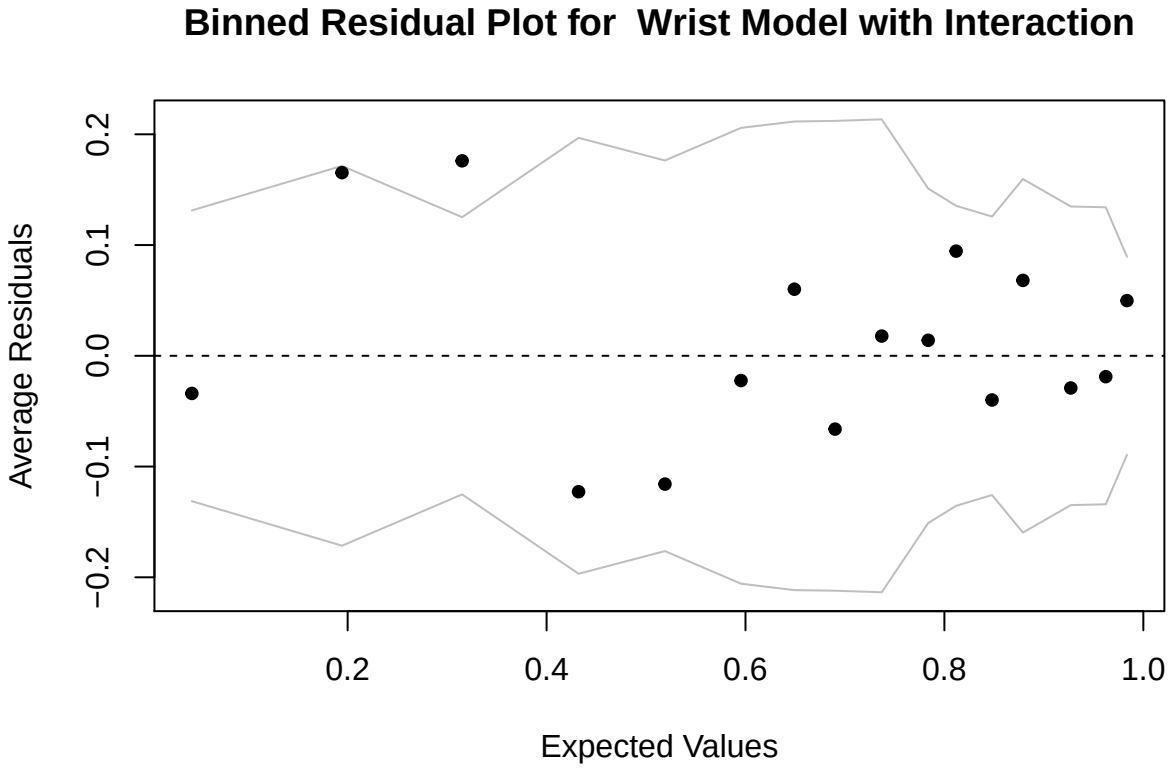



```
## NULL
```

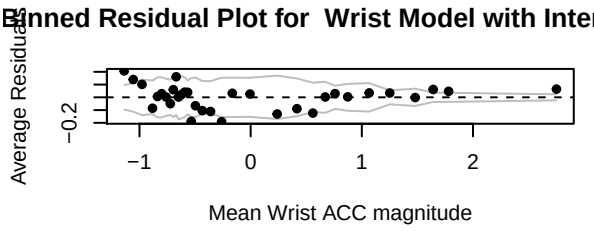
```
show_cooks(wrist_interaction, DO_STRIDE)
```

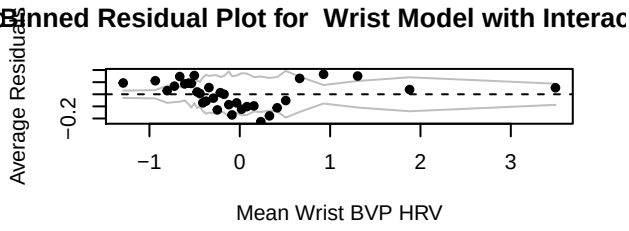


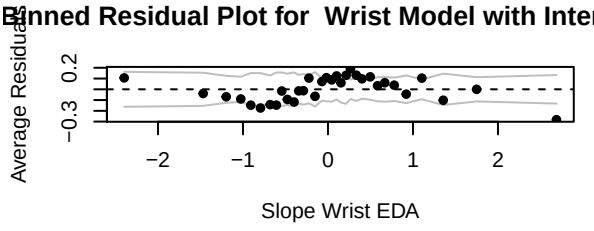

```
binned_residuals_vs_preds(wrist_interaction, 'Wrist Model with Interaction')
```

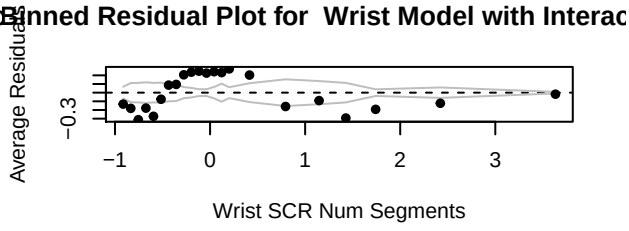


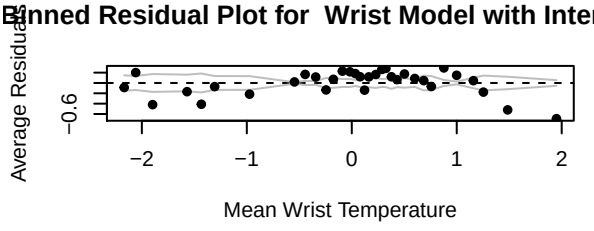

```
par(mfrow=c(3,2))
binned_residuals_vs_x(wrist_interaction, 'Wrist Model with Interaction', train$wrist_ACC_magnitude_mean
binned_residuals_vs_x(wrist_interaction, 'Wrist Model with Interaction', train$wrist_BVP_HRV_mean, 'Mea
binned_residuals_vs_x(wrist_interaction, 'Wrist Model with Interaction', train$wrist_EDA_slope, 'Slope
binned_residuals_vs_x(wrist_interaction, 'Wrist Model with Interaction', train$wrist_SCR_num_segments,
binned_residuals_vs_x(wrist_interaction, 'Wrist Model with Interaction', train$wrist_TEMP_mean, 'Mean W
```











Investigating Heterogeneity

Model indicating heterogeneity of chest temperature slope

```
model_expression = affect ~ (chest_TEMP_slope) + subject_id + (chest_TEMP_slope ):subject_id
DO_STRIDE = FALSE
chest_wrist_simple = get_logistic_model(model_expression, do_backwards_selection=FALSE, DO_STRIDE)
```

```
##
## Call:
## glm(formula = model_expression, family = "binomial", data = model_data,
##     maxit = 100)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.6349  -1.1787   0.6315   0.9394   2.5252
##
## Coefficients:
##                               Estimate Std. Error z value Pr(>|z|)
## (Intercept)                    0.59640    0.27804   2.145 0.031949 *
## chest_TEMP_slope               2.43410    0.76536   3.180 0.001471 **
## subject_idS11                  0.79835    0.41020   1.946 0.051623 .
## subject_idS13                  0.19609    0.37490   0.523 0.600947
## subject_idS14                  0.30271    0.41658   0.727 0.467432
## subject_idS15                 -0.40650    0.38478  -1.056 0.290753
```

```
## subject_idS16                   -0.17460    0.36731  -0.475 0.634542
## subject_idS17                    0.35287    0.38851   0.908 0.363736
## subject_idS2                     0.64993    0.43763   1.485 0.137509
## subject_idS3                    -0.81266    0.38225  -2.126 0.033503 *
## subject_idS4                    -0.23339    0.37656  -0.620 0.535384
## subject_idS5                    -0.24433    0.37138  -0.658 0.510606
## subject_idS6                    -0.13416    0.37537  -0.357 0.720789
## subject_idS7                     0.34928    0.40287   0.867 0.385951
## subject_idS8                     0.05473    0.37793   0.145 0.884858
## subject_idS9                    -0.02849    0.39419  -0.072 0.942384
## chest_TEMP_slope:subject_idS11 -4.61306    1.66697  -2.767 0.005652 **
## chest_TEMP_slope:subject_idS13 -2.54172    0.84237  -3.017 0.002550 **
## chest_TEMP_slope:subject_idS14  2.75158    1.67618   1.642 0.100677
## chest_TEMP_slope:subject_idS15  1.99804    1.51898   1.315 0.188382
## chest_TEMP_slope:subject_idS16 -2.77011    0.93136  -2.974 0.002937 **
## chest_TEMP_slope:subject_idS17 -0.62421    1.01427  -0.615 0.538273
## chest_TEMP_slope:subject_idS2  -3.69642    0.85427  -4.327 1.51e-05 ***
## chest_TEMP_slope:subject_idS3  -2.80953    0.78313  -3.588 0.000334 ***
## chest_TEMP_slope:subject_idS4  -1.98721    0.93061  -2.135 0.032730 *
## chest_TEMP_slope:subject_idS5  -2.63791    0.80896  -3.261 0.001111 **
## chest_TEMP_slope:subject_idS6  -1.85051    0.84421  -2.192 0.028379 *
## chest_TEMP_slope:subject_idS7  -0.46060    1.09172  -0.422 0.673097
## chest_TEMP_slope:subject_idS8  -0.89887    1.12330  -0.800 0.423591
## chest_TEMP_slope:subject_idS9  -0.25955    1.09732  -0.237 0.813021
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 1433.1  on 1098  degrees of freedom
## Residual deviance: 1297.6  on 1069  degrees of freedom
## AIC: 1357.6
##
## Number of Fisher Scoring iterations: 5
```

Model indicating heterogeneity of chest electrodermal activity slope

```
model_expression = affect ~ (chest_EDA_slope) + subject_id + (chest_EDA_slope ):subject_id
DO_STRIDE = FALSE
chest_wrist_simple = get_logistic_model(model_expression, do_backwards_selection=FALSE, DO_STRIDE)
```

```
##
## Call:
## glm(formula = model_expression, family = "binomial", data = model_data,
##     maxit = 100)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -3.5650  -1.0367   0.5517   0.8503   2.2822
##
## Coefficients:
##                               Estimate Std. Error z value Pr(>|z|)
```

```
## (Intercept)                    0.77310    0.26959   2.868  0.00414 **
## chest_EDA_slope               -1.16327    0.37627  -3.092  0.00199 **
## subject_idS11                  0.73764    0.44567   1.655  0.09790 .
## subject_idS13                  0.08591    0.37900   0.227  0.82068
## subject_idS14                 -0.22668    0.37351  -0.607  0.54393
## subject_idS15                  2.00767    0.80173   2.504  0.01227 *
## subject_idS16                 -0.05345    0.38580  -0.139  0.88982
## subject_idS17                  0.10188    0.36876   0.276  0.78234
## subject_idS2                   0.61823    0.44355   1.394  0.16337
## subject_idS3                  -0.75881    0.35944  -2.111  0.03477 *
## subject_idS4                  -0.18328    0.37906  -0.484  0.62874
## subject_idS5                  -0.29813    0.37434  -0.796  0.42579
## subject_idS6                   0.03165    0.41359   0.077  0.93900
## subject_idS7                   0.36943    0.46031   0.803  0.42223
## subject_idS8                   1.02139    0.55094   1.854  0.06375 .
## subject_idS9                  -0.14899    0.40978  -0.364  0.71616
## chest_EDA_slope:subject_idS11  3.33886    0.84652   3.944 8.01e-05 ***
## chest_EDA_slope:subject_idS13  0.48170    0.48043   1.003  0.31604
## chest_EDA_slope:subject_idS14  0.44681    0.46101   0.969  0.33244
## chest_EDA_slope:subject_idS15 -4.73384    1.65514  -2.860  0.00424 **
## chest_EDA_slope:subject_idS16  0.37542    0.50900   0.738  0.46078
## chest_EDA_slope:subject_idS17  1.14510    0.44053   2.599  0.00934 **
## chest_EDA_slope:subject_idS2   3.21037    0.70873   4.530 5.90e-06 ***
## chest_EDA_slope:subject_idS3   1.28635    0.40208   3.199  0.00138 **
## chest_EDA_slope:subject_idS4   0.58041    0.51389   1.129  0.25871
## chest_EDA_slope:subject_idS5   1.33187    0.41984   3.172  0.00151 **
## chest_EDA_slope:subject_idS6   2.13721    0.53991   3.958 7.54e-05 ***
## chest_EDA_slope:subject_idS7   4.31020    0.80237   5.372 7.79e-08 ***
## chest_EDA_slope:subject_idS8   3.99185    0.72138   5.534 3.14e-08 ***
## chest_EDA_slope:subject_idS9   3.28884    0.63738   5.160 2.47e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 1433.1  on 1098  degrees of freedom
## Residual deviance: 1180.0  on 1069  degrees of freedom
## AIC: 1240
##
## Number of Fisher Scoring iterations: 6
```

Sensitivity Checks

Probit Model

```
model_expression = affect ~ . - subject_id
DO_STRIDE = FALSE
Simple_probit = get_probit_model(model_expression, do_backwards_selection=TRUE, DO_STRIDE)
```

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

##
## Call:
## glm(formula = affect ~ chest_EDA_slope + wrist_EDA_slope + chest_RESP_volume +
##     chest_SCR_num_segments + wrist_SCR_num_segments + wrist_ACC_magnitude_mean +
##     chest_TEMP_mean + chest_TEMP_slope + wrist_TEMP_mean + chest_ECG_HRV_mean,
##     family = binomial(link = "probit"), data = model_data, maxit = 100)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.4958   0.0000   0.0001   0.0554   3.5622
##
## Coefficients:
##                         Estimate Std. Error z value Pr(>|z|)
## (Intercept)              0.47366    0.16074   2.947 0.003212 **
## chest_EDA_slope          0.28382    0.10606   2.676 0.007450 **
## wrist_EDA_slope          0.14034    0.09577   1.465 0.142829
## chest_RESP_volume        0.53041    0.11399   4.653 3.27e-06 ***
## chest_SCR_num_segments  -3.58174    0.35819  -9.999  < 2e-16 ***
```

```
## wrist_SCR_num_segments   -1.37282    0.15222  -9.019  < 2e-16 ***
## wrist_ACC_magnitude_mean  0.56697    0.16656   3.404 0.000664 ***
## chest_TEMP_mean          -0.56312    0.14861  -3.789 0.000151 ***
## chest_TEMP_slope          0.28488    0.17949   1.587 0.112472
## wrist_TEMP_mean           0.31093    0.11589   2.683 0.007298 **
## chest_ECG_HRV_mean       -2.22096    0.28412  -7.817 5.41e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 1433.15  on 1098  degrees of freedom
## Residual deviance:  236.88  on 1088  degrees of freedom
## AIC: 258.88
##
## Number of Fisher Scoring iterations: 10
```

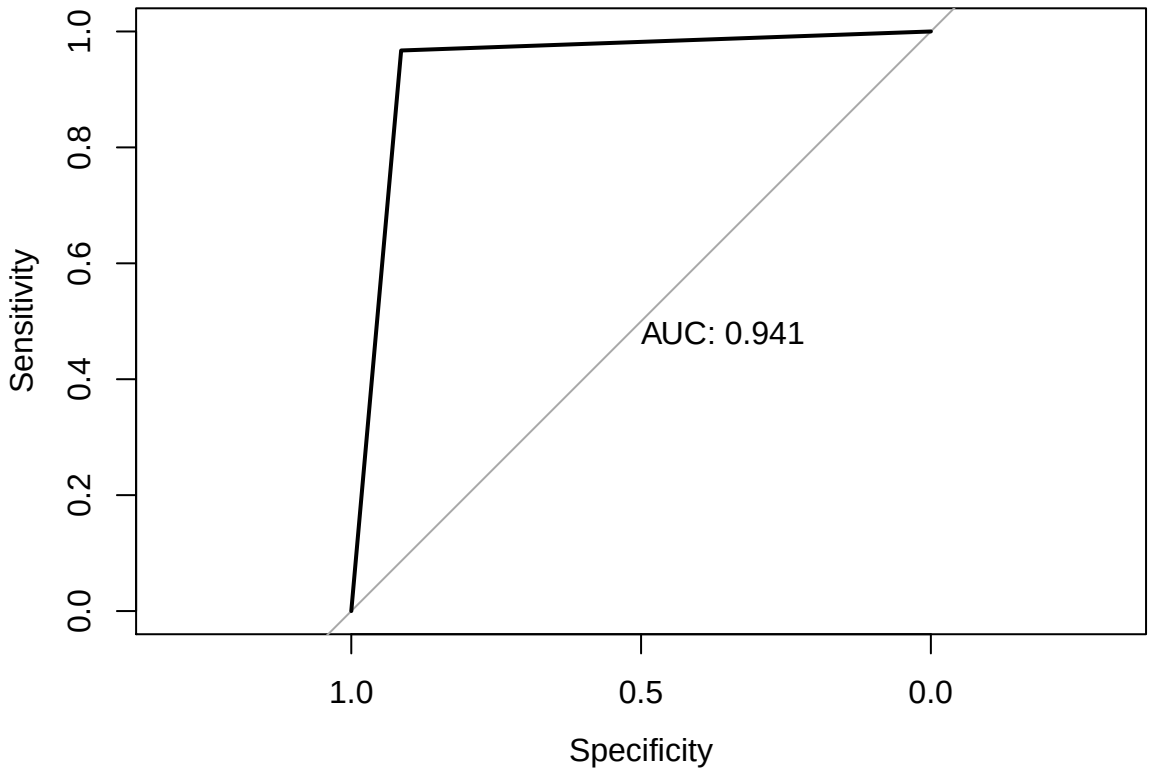
```
print_stats(Simple_probit, DO_STRIDE)
```

```
## [1] "accuracy:  0.949275362318841"
## Confusion Matrix and Statistics
##
##            Reference
## Prediction  amusement stress
##   amusement        85      6
##   stress            8    177
##
##                Accuracy : 0.9493
##                  95% CI : (0.9164, 0.972)
##     No Information Rate : 0.663
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.8859
##
##  Mcnemar's Test P-Value : 0.7893
##
##             Sensitivity : 0.9140
##             Specificity : 0.9672
##          Pos Pred Value : 0.9341
##          Neg Pred Value : 0.9568
##              Prevalence : 0.3370
##          Detection Rate : 0.3080
##    Detection Prevalence : 0.3297
##       Balanced Accuracy : 0.9406
##
##        'Positive' Class : amusement
##
```

```
show_roc(Simple_probit, DO_STRIDE)
```

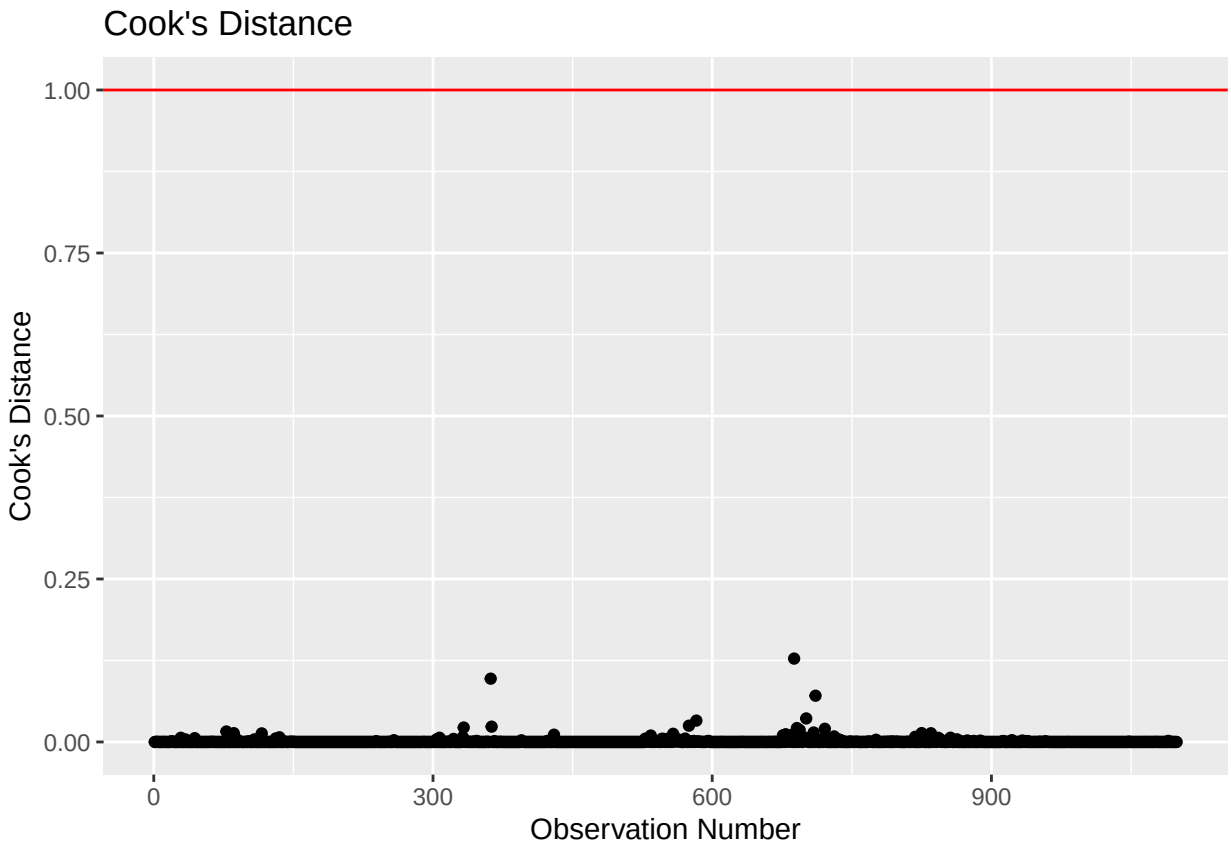
```
## Setting levels: control = amusement, case = stress
```

```
## Setting direction: controls > cases
```

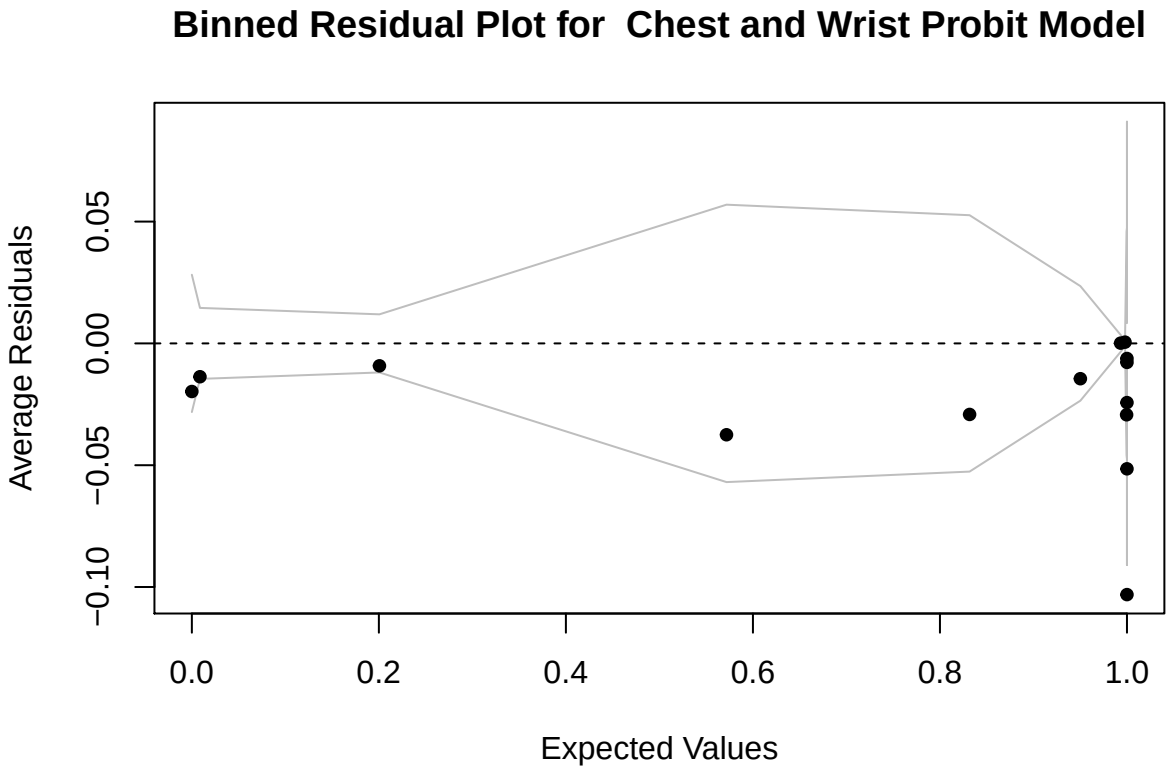



```
## NULL
```

```
show_cooks(Simple_probit, DO_STRIDE)
```




```
binned_residuals_vs_preds(Simple_probit, 'Chest and Wrist Probit Model')
```



Wrist model for 2 min window

```
model_expression = affect ~ (wrist_ACC_magnitude_mean+wrist_BVP_HRV_mean+wrist_EDA_slope+wrist_SCR_num_s
DO_STRIDE = FALSE
wrist_interaction_2min = get_2min_logistic_model(model_expression, do_backwards_selection=TRUE, DO_STRI
```

```
##
## Call:
## glm(formula = affect ~ wrist_ACC_magnitude_mean + wrist_BVP_HRV_mean +
##     wrist_EDA_slope + wrist_SCR_num_segments + wrist_TEMP_mean +
##     subject_id + wrist_ACC_magnitude_mean:wrist_BVP_HRV_mean +
##     wrist_ACC_magnitude_mean:wrist_EDA_slope + wrist_ACC_magnitude_mean:wrist_SCR_num_segments +
##     wrist_ACC_magnitude_mean:wrist_TEMP_mean + wrist_BVP_HRV_mean:wrist_SCR_num_segments +
##     wrist_BVP_HRV_mean:wrist_TEMP_mean + wrist_SCR_num_segments:wrist_TEMP_mean,
##     family = "binomial", data = model_data, maxit = 100)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -3.8854  -0.3551   0.1583   0.5088   1.9377
##
## Coefficients:
##                                                Estimate Std. Error z value
## (Intercept)                                      2.7950     0.5954   4.694
## wrist_ACC_magnitude_mean                         2.7509     0.3446   7.982
## wrist_BVP_HRV_mean                              -0.9614     0.2227  -4.317
## wrist_EDA_slope                                  1.1919     0.1649   7.228
## wrist_SCR_num_segments                          -2.8276     0.2535 -11.155
## wrist_TEMP_mean                                 -0.9559     0.2729  -3.502
## subject_idS11                                   -4.4377     0.8650  -5.131
## subject_idS13                                    1.1823     0.6771   1.746
## subject_idS14                                    3.2783     6.9204   0.474
## subject_idS15                                   -5.8324     0.9869  -5.910
## subject_idS16                                   -3.1613     0.9166  -3.449
## subject_idS17                                   -2.8407     1.5455  -1.838
## subject_idS2                                     1.4143     0.7032   2.011
## subject_idS3                                    -7.0802     0.9153  -7.735
## subject_idS4                                    -2.2621     0.9412  -2.403
## subject_idS5                                     1.7047     0.6842   2.491
## subject_idS6                                     1.1489     0.7337   1.566
## subject_idS7                                     1.6690     0.6586   2.534
## subject_idS8                                    -0.7777     0.6663  -1.167
## subject_idS9                                     0.7301     0.7564   0.965
## wrist_ACC_magnitude_mean:wrist_BVP_HRV_mean      1.2526     0.2500   5.010
## wrist_ACC_magnitude_mean:wrist_EDA_slope         0.3567     0.2118   1.684
## wrist_ACC_magnitude_mean:wrist_SCR_num_segments -1.4136     0.3616  -3.909
## wrist_ACC_magnitude_mean:wrist_TEMP_mean         1.1960     0.2760   4.334
## wrist_BVP_HRV_mean:wrist_SCR_num_segments       -0.3787     0.2714  -1.396
## wrist_BVP_HRV_mean:wrist_TEMP_mean              -1.0418     0.1509  -6.906
## wrist_SCR_num_segments:wrist_TEMP_mean           1.0336     0.1688   6.123
##                                                Pr(>|z|)
## (Intercept)                                    2.68e-06 ***
## wrist_ACC_magnitude_mean                       1.44e-15 ***
## wrist_BVP_HRV_mean                             1.58e-05 ***
```

```
## wrist_EDA_slope                                    4.89e-13 ***
## wrist_SCR_num_segments                              < 2e-16 ***
## wrist_TEMP_mean                                    0.000462 ***
## subject_idS11                                      2.89e-07 ***
## subject_idS13                                      0.080802 .
## subject_idS14                                      0.635703
## subject_idS15                                      3.42e-09 ***
## subject_idS16                                      0.000563 ***
## subject_idS17                                      0.066058 .
## subject_idS2                                       0.044292 *
## subject_idS3                                       1.03e-14 ***
## subject_idS4                                       0.016239 *
## subject_idS5                                       0.012721 *
## subject_idS6                                       0.117388
## subject_idS7                                       0.011279 *
## subject_idS8                                       0.243143
## subject_idS9                                       0.334435
## wrist_ACC_magnitude_mean:wrist_BVP_HRV_mean     5.44e-07 ***
## wrist_ACC_magnitude_mean:wrist_EDA_slope        0.092103 .
## wrist_ACC_magnitude_mean:wrist_SCR_num_segments 9.27e-05 ***
## wrist_ACC_magnitude_mean:wrist_TEMP_mean        1.47e-05 ***
## wrist_BVP_HRV_mean:wrist_SCR_num_segments       0.162785
## wrist_BVP_HRV_mean:wrist_TEMP_mean              4.98e-12 ***
## wrist_SCR_num_segments:wrist_TEMP_mean          9.18e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 1222.11  on 954  degrees of freedom
## Residual deviance:  612.32  on 928  degrees of freedom
## AIC: 666.32
##
## Number of Fisher Scoring iterations: 9
```

```
print_stats(wrist_interaction_2min, DO_STRIDE)
```

```
## [1] "accuracy:  0.829710144927536"
## Confusion Matrix and Statistics
##
##            Reference
## Prediction  amusement stress
##   amusement        60     14
##   stress           33    169
##
##                Accuracy : 0.8297
##                  95% CI : (0.7801, 0.8721)
##     No Information Rate : 0.663
##     P-Value [Acc > NIR] : 4.491e-10
##
##                   Kappa : 0.5987
##
##  Mcnemar's Test P-Value : 0.00865
##
```

```
##             Sensitivity : 0.6452
##             Specificity : 0.9235
##          Pos Pred Value : 0.8108
##          Neg Pred Value : 0.8366
##              Prevalence : 0.3370
##          Detection Rate : 0.2174
##    Detection Prevalence : 0.2681
##       Balanced Accuracy : 0.7843
##
##        'Positive' Class : amusement
##
```