DSC 520 Week 8 Logistic Regression Assignment

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##Dataset

This dataset contains information on life expectancy in lung cancer patients after surgery.

### a. Fit a binary logistic regression model to the data set that predicts whether or not the patient survived for one year (the Risk1Y variable) after the surgery. Use the glm() function to perform the logistic regression. See Generalized Linear Models for an example. Include a summary using the summary() function in your results.

#Logistic Regression  
  
lgm1 <- glm(Risk1Yr ~ DGN + PRE4 + PRE5 + PRE6 + PRE7 + PRE8 + PRE9 + PRE10 + PRE11 + PRE14 + PRE17 + PRE19 + PRE25 + PRE30 + PRE32 + AGE, data = data8, family = binomial() )  
summary(lgm1)

##   
## Call:  
## glm(formula = Risk1Yr ~ DGN + PRE4 + PRE5 + PRE6 + PRE7 + PRE8 +   
## PRE9 + PRE10 + PRE11 + PRE14 + PRE17 + PRE19 + PRE25 + PRE30 +   
## PRE32 + AGE, family = binomial(), data = data8)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -1.6084 -0.5439 -0.4199 -0.2762 2.4929   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.655e+01 2.400e+03 -0.007 0.99450   
## DGNDGN2 1.474e+01 2.400e+03 0.006 0.99510   
## DGNDGN3 1.418e+01 2.400e+03 0.006 0.99528   
## DGNDGN4 1.461e+01 2.400e+03 0.006 0.99514   
## DGNDGN5 1.638e+01 2.400e+03 0.007 0.99455   
## DGNDGN6 4.089e-01 2.673e+03 0.000 0.99988   
## DGNDGN8 1.803e+01 2.400e+03 0.008 0.99400   
## PRE4 -2.272e-01 1.849e-01 -1.229 0.21909   
## PRE5 -3.030e-02 1.786e-02 -1.697 0.08971 .   
## PRE6PRZ1 -4.427e-01 5.199e-01 -0.852 0.39448   
## PRE6PRZ2 -2.937e-01 7.907e-01 -0.371 0.71030   
## PRE7T 7.153e-01 5.556e-01 1.288 0.19788   
## PRE8T 1.743e-01 3.892e-01 0.448 0.65419   
## PRE9T 1.368e+00 4.868e-01 2.811 0.00494 \*\*  
## PRE10T 5.770e-01 4.826e-01 1.196 0.23185   
## PRE11T 5.162e-01 3.965e-01 1.302 0.19295   
## PRE14OC12 4.394e-01 3.301e-01 1.331 0.18318   
## PRE14OC13 1.179e+00 6.165e-01 1.913 0.05580 .   
## PRE14OC14 1.653e+00 6.094e-01 2.713 0.00668 \*\*  
## PRE17T 9.266e-01 4.445e-01 2.085 0.03709 \*   
## PRE19T -1.466e+01 1.654e+03 -0.009 0.99293   
## PRE25T -9.789e-02 1.003e+00 -0.098 0.92227   
## PRE30T 1.084e+00 4.990e-01 2.172 0.02984 \*   
## PRE32T -1.398e+01 1.645e+03 -0.008 0.99322   
## AGE -9.506e-03 1.810e-02 -0.525 0.59944   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for binomial family taken to be 1)  
##   
## Null deviance: 395.61 on 469 degrees of freedom  
## Residual deviance: 341.19 on 445 degrees of freedom  
## AIC: 391.19  
##   
## Number of Fisher Scoring iterations: 15

## b. According to the summary, which variables had the greatest effect on the survival rate?

PRE9T, PRE14OC14, pRE17T, PRE30T all had significant values, hence the greatest effect on survival rate.

## c. To compute the accuracy of your model, use the dataset to predict the outcome variable. The percent of correct predictions is the accuracy of your model. What is the accuracy of your model?

88.6%

# Split the data into training and validation data sets  
split <- sample.split(data8, SplitRatio = 0.8)  
split

## [1] TRUE TRUE TRUE TRUE TRUE TRUE FALSE TRUE TRUE TRUE TRUE TRUE  
## [13] TRUE FALSE FALSE FALSE TRUE

train <- subset(data8, split == "TRUE")  
validate <- subset(data8, split == "FALSE")  
  
# Train model using training data set  
lgm2 <- glm(Risk1Yr ~ DGN + PRE4 + PRE5 + PRE6 + PRE7 + PRE8 + PRE9 + PRE10 + PRE11 + PRE14 + PRE17 + PRE19 + PRE25 + PRE30 + PRE32 + AGE, data = train, family = binomial() )

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

summary(lgm2)

##   
## Call:  
## glm(formula = Risk1Yr ~ DGN + PRE4 + PRE5 + PRE6 + PRE7 + PRE8 +   
## PRE9 + PRE10 + PRE11 + PRE14 + PRE17 + PRE19 + PRE25 + PRE30 +   
## PRE32 + AGE, family = binomial(), data = train)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -1.5070 -0.5473 -0.4273 -0.2469 2.6266   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -14.64912 2399.54541 -0.006 0.9951   
## DGNDGN2 14.70645 2399.54480 0.006 0.9951   
## DGNDGN3 14.28146 2399.54477 0.006 0.9953   
## DGNDGN4 14.94979 2399.54480 0.006 0.9950   
## DGNDGN5 16.45438 2399.54486 0.007 0.9945   
## DGNDGN6 0.69439 2767.93332 0.000 0.9998   
## DGNDGN8 18.35190 2399.54525 0.008 0.9939   
## PRE4 0.03280 0.43293 0.076 0.9396   
## PRE5 -0.66558 0.51049 -1.304 0.1923   
## PRE6PRZ1 -0.24033 0.62118 -0.387 0.6988   
## PRE6PRZ2 -0.59444 1.01610 -0.585 0.5585   
## PRE7T 0.34821 0.75674 0.460 0.6454   
## PRE8T 0.25745 0.47379 0.543 0.5869   
## PRE9T 0.85156 0.60416 1.410 0.1587   
## PRE10T 0.27330 0.58190 0.470 0.6386   
## PRE11T 0.33008 0.47665 0.693 0.4886   
## PRE14OC12 0.48955 0.38515 1.271 0.2037   
## PRE14OC13 1.21612 0.73941 1.645 0.1000   
## PRE14OC14 1.64366 0.78945 2.082 0.0373 \*  
## PRE17T 0.49223 0.56011 0.879 0.3795   
## PRE19T -15.47169 2399.54478 -0.006 0.9949   
## PRE25T 0.35725 1.03237 0.346 0.7293   
## PRE30T 1.27280 0.64527 1.973 0.0486 \*  
## PRE32T -14.49031 1631.23074 -0.009 0.9929   
## AGE -0.03129 0.02087 -1.500 0.1337   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for binomial family taken to be 1)  
##   
## Null deviance: 290.42 on 360 degrees of freedom  
## Residual deviance: 249.48 on 336 degrees of freedom  
## AIC: 299.48  
##   
## Number of Fisher Scoring iterations: 15

# Run validation data through the model built on training data  
res <- predict(lgm2, validate, type = "response")  
res

## 7 14 15 16 24 31   
## 1.227502e-01 1.935638e-01 8.793238e-02 4.196784e-02 7.881073e-02 4.259876e-01   
## 32 33 41 48 49 50   
## 2.550353e-02 3.601121e-01 3.485339e-01 1.043277e-01 8.519437e-02 1.697528e-02   
## 58 65 66 67 75 82   
## 1.615988e-01 1.869416e-01 4.026633e-02 5.509961e-02 5.649896e-02 4.210326e-01   
## 83 84 92 99 100 101   
## 1.781071e-01 3.695523e-02 6.963383e-02 2.220446e-16 2.611905e-01 4.824342e-02   
## 109 116 117 118 126 133   
## 1.469069e-02 3.466522e-01 2.218499e-01 2.528887e-01 1.185725e-01 2.220446e-16   
## 134 135 143 150 151 152   
## 1.235436e-01 7.710389e-02 8.398058e-03 5.741188e-02 4.581404e-02 6.704924e-02   
## 160 167 168 169 177 184   
## 1.260499e-01 1.755723e-01 8.889324e-02 1.591204e-01 2.487824e-01 7.803173e-02   
## 185 186 194 201 202 203   
## 2.975529e-02 2.734921e-01 8.514821e-02 1.593366e-01 1.073673e-01 4.137597e-01   
## 211 218 219 220 228 235   
## 2.735357e-02 3.921740e-02 3.906591e-02 7.095492e-02 1.109208e-01 1.279369e-01   
## 236 237 245 252 253 254   
## 5.738217e-02 1.609480e-01 1.588656e-08 5.602780e-02 8.503744e-02 1.274657e-01   
## 262 269 270 271 279 286   
## 1.808366e-01 2.454943e-01 4.841211e-02 1.785268e-01 7.049208e-03 1.000281e-01   
## 287 288 296 303 304 305   
## 1.090724e-01 1.288534e-01 9.439664e-02 6.951166e-02 9.667296e-02 4.576888e-02   
## 313 320 321 322 330 337   
## 1.617198e-01 2.220446e-16 1.906012e-01 3.404400e-02 5.863755e-02 1.970392e-01   
## 338 339 347 354 355 356   
## 1.560882e-01 4.668351e-02 1.023523e-01 2.220446e-16 4.140429e-02 9.089572e-02   
## 364 371 372 373 381 388   
## 2.397450e-01 1.424705e-01 6.328830e-02 1.188776e-01 3.734447e-01 1.389445e-01   
## 389 390 398 405 406 407   
## 2.946992e-01 4.630967e-01 6.806972e-02 2.526253e-01 1.800822e-08 6.629151e-02   
## 415 422 423 424 432 439   
## 1.750568e-01 1.647222e-01 1.047314e-01 2.297646e-02 1.640390e-01 2.220446e-16   
## 440 441 449 456 457 458   
## 2.588368e-01 1.415993e-01 1.035402e-01 2.180923e-01 2.211040e-01 6.233467e-02   
## 466   
## 3.371191e-01

res2 <-predict(lgm2, train, type = "response")  
res2

## 1 2 3 4 5 6   
## 5.289521e-01 2.073221e-01 9.955335e-02 1.870137e-02 1.581661e-01 4.307815e-02   
## 8 9 10 11 12 13   
## 1.296047e-01 5.378465e-02 1.078013e-01 6.384902e-02 3.001510e-02 8.848612e-02   
## 17 18 19 20 21 22   
## 2.985525e-01 2.490367e-01 1.423506e-01 5.350447e-02 8.543757e-02 1.599442e-01   
## 23 25 26 27 28 29   
## 1.698940e-01 4.748909e-01 2.220446e-16 5.298355e-02 5.813729e-02 1.023744e-01   
## 30 34 35 36 37 38   
## 5.909175e-08 8.679372e-02 2.504075e-02 1.303911e-01 1.164301e-01 1.268024e-01   
## 39 40 42 43 44 45   
## 5.954469e-02 5.308924e-02 1.557830e-01 7.781573e-02 7.153935e-01 1.456860e-01   
## 46 47 51 52 53 54   
## 9.316060e-02 6.204792e-02 2.821318e-02 4.711294e-02 2.369252e-01 1.412319e-01   
## 55 56 57 59 60 61   
## 7.775582e-02 1.975950e-01 8.047331e-02 7.188729e-02 5.894182e-02 2.938251e-01   
## 62 63 64 68 69 70   
## 9.413432e-02 4.390553e-02 3.341017e-02 3.011851e-01 1.351214e-01 1.676213e-01   
## 71 72 73 74 76 77   
## 2.399924e-02 1.284753e-01 5.242566e-02 1.047330e-02 3.885396e-01 1.695412e-01   
## 78 79 80 81 85 86   
## 5.683791e-02 2.407522e-01 2.597973e-02 1.012288e-01 9.585944e-02 1.115974e-01   
## 87 88 89 90 91 93   
## 4.703494e-02 2.714334e-01 4.706593e-01 2.220446e-16 1.364483e-01 1.210393e-01   
## 94 95 96 97 98 102   
## 2.331910e-02 9.833968e-02 4.749915e-02 2.078497e-01 4.671523e-08 2.622170e-01   
## 103 104 105 106 107 108   
## 9.135126e-02 2.085023e-08 4.103263e-02 7.808349e-02 1.684508e-01 1.329960e-01   
## 110 111 112 113 114 115   
## 1.822570e-01 7.242201e-02 1.832391e-01 2.220446e-16 5.290262e-02 9.897916e-02   
## 119 120 121 122 123 124   
## 1.150213e-01 1.721653e-01 3.442078e-02 6.859784e-02 4.032282e-01 1.072672e-01   
## 125 127 128 129 130 131   
## 8.516769e-02 6.683212e-02 2.959511e-01 2.379297e-01 4.974451e-02 5.547113e-02   
## 132 136 137 138 139 140   
## 1.404263e-01 7.905570e-02 2.616519e-01 5.261868e-01 1.596884e-01 3.097963e-02   
## 141 142 144 145 146 147   
## 1.713689e-01 6.797776e-02 2.315564e-01 8.449042e-02 9.192960e-02 1.158047e-02   
## 148 149 153 154 155 156   
## 1.121544e-01 6.876566e-02 3.176091e-02 6.575961e-02 5.982904e-02 5.622727e-02   
## 157 158 159 161 162 163   
## 3.710847e-01 6.389220e-08 2.729528e-01 3.192059e-02 8.917858e-02 1.860274e-01   
## 164 165 166 170 171 172   
## 5.066536e-02 4.237592e-01 3.730268e-01 2.475371e-01 1.472149e-01 2.692949e-01   
## 173 174 175 176 178 179   
## 4.448174e-01 9.375470e-02 2.113045e-01 2.400363e-01 1.343303e-01 9.791464e-02   
## 180 181 182 183 187 188   
## 1.249407e-01 1.246889e-01 4.890531e-02 7.365070e-02 8.417728e-02 2.111776e-01   
## 189 190 191 192 193 195   
## 1.124773e-01 1.062819e-01 1.174029e-07 7.712485e-02 4.775242e-02 6.548760e-02   
## 196 197 198 199 200 204   
## 1.767193e-01 1.460641e-01 3.285470e-02 3.614570e-02 2.094480e-01 8.137141e-02   
## 205 206 207 208 209 210   
## 1.605270e-02 1.536636e-01 6.502877e-02 8.947876e-02 5.653458e-02 4.522576e-01   
## 212 213 214 215 216 217   
## 1.163782e-01 2.642292e-01 2.855602e-01 1.054594e-01 4.455916e-03 2.312296e-01   
## 221 222 223 224 225 226   
## 7.831865e-01 9.021010e-02 1.790300e-01 6.846141e-02 1.000407e-01 3.488027e-01   
## 227 229 230 231 232 233   
## 1.414400e-01 3.281863e-02 1.959004e-01 1.354795e-01 5.659241e-01 8.723402e-02   
## 234 238 239 240 241 242   
## 1.633720e-01 6.711979e-02 5.433103e-01 1.179621e-01 2.394622e-02 5.931931e-02   
## 243 244 246 247 248 249   
## 2.744536e-01 3.653869e-02 1.070153e-01 5.963547e-02 1.141238e-01 1.048836e-01   
## 250 251 255 256 257 258   
## 1.222848e-01 7.923956e-02 4.080398e-02 2.220446e-16 1.219724e-01 9.681016e-02   
## 259 260 261 263 264 265   
## 1.074644e-01 1.283394e-01 1.010857e-01 1.887363e-01 2.395888e-02 9.471084e-02   
## 266 267 268 272 273 274   
## 1.095048e-01 6.970589e-02 1.576250e-01 3.741504e-01 4.620240e-02 1.325282e-01   
## 275 276 277 278 280 281   
## 1.717764e-01 1.979474e-01 1.270611e-01 1.316541e-01 1.123483e-01 1.296140e-01   
## 282 283 284 285 289 290   
## 1.515102e-02 3.615293e-02 2.819376e-01 1.049778e-01 4.700189e-01 8.758317e-02   
## 291 292 293 294 295 297   
## 9.581978e-02 1.026478e-01 6.389220e-08 9.807518e-02 2.128899e-01 1.920249e-01   
## 298 299 300 301 302 306   
## 2.542626e-01 5.181399e-02 1.698301e-01 1.333095e-01 4.815036e-02 1.334810e-01   
## 307 308 309 310 311 312   
## 5.623829e-01 1.408216e-01 9.980914e-02 8.356579e-02 2.922932e-02 9.878960e-02   
## 314 315 316 317 318 319   
## 1.298376e-01 2.765535e-01 2.029557e-01 3.668417e-02 1.836976e-01 9.190376e-02   
## 323 324 325 326 327 328   
## 7.267223e-02 2.906053e-01 2.963065e-02 2.220446e-16 1.032423e-01 9.846572e-02   
## 329 331 332 333 334 335   
## 2.075874e-01 2.220446e-16 4.483388e-02 1.058438e-01 4.533948e-02 1.006927e-01   
## 336 340 341 342 343 344   
## 1.011861e-01 1.607257e-01 4.707102e-02 1.194078e-01 1.985063e-01 1.056033e-01   
## 345 346 348 349 350 351   
## 7.361324e-02 2.857792e-01 1.828504e-01 1.131478e-01 2.220446e-16 1.314823e-01   
## 352 353 357 358 359 360   
## 1.173492e-01 2.220446e-16 2.740438e-01 1.630704e-01 1.390735e-01 7.374357e-02   
## 361 362 363 365 366 367   
## 1.652967e-01 1.091347e-01 3.523038e-01 1.293011e-01 1.493976e-01 8.451604e-02   
## 368 369 370 374 375 376   
## 7.146551e-01 8.744360e-08 8.088867e-02 6.787411e-01 1.100092e-01 3.464202e-02   
## 377 378 379 380 382 383   
## 5.557790e-02 1.471226e-01 7.074714e-02 1.182324e-01 4.272145e-02 1.165647e-01   
## 384 385 386 387 391 392   
## 4.046857e-02 5.840884e-02 1.743297e-01 1.209857e-01 8.776511e-02 3.731890e-01   
## 393 394 395 396 397 399   
## 2.851060e-01 8.658307e-02 2.819894e-01 9.501678e-02 1.383333e-01 8.755383e-02   
## 400 401 402 403 404 408   
## 9.345762e-02 3.696004e-02 2.221881e-02 1.682354e-01 1.669338e-01 1.718906e-01   
## 409 410 411 412 413 414   
## 2.114161e-01 9.231514e-02 2.184229e-01 1.339184e-01 2.439755e-02 2.068567e-01   
## 416 417 418 419 420 421   
## 2.148907e-02 1.058475e-01 4.099460e-02 9.024651e-02 1.845734e-01 1.922545e-01   
## 425 426 427 428 429 430   
## 2.517018e-01 1.472971e-01 3.017901e-01 2.386600e-02 1.837324e-01 3.224838e-01   
## 431 433 434 435 436 437   
## 9.676151e-02 4.025733e-02 1.004957e-01 9.429977e-02 1.115377e-01 1.880043e-01   
## 438 442 443 444 445 446   
## 1.394094e-01 2.483098e-02 1.376810e-01 8.732882e-03 2.220446e-16 1.044558e-01   
## 447 448 450 451 452 453   
## 5.251091e-01 1.447637e-01 1.995461e-01 2.162933e-02 2.276734e-01 2.521272e-01   
## 454 455 459 460 461 462   
## 1.016874e-01 4.669653e-02 2.525985e-02 2.575186e-02 3.691771e-02 7.793855e-02   
## 463 464 465 467 468 469   
## 7.957585e-02 4.525547e-01 2.100459e-01 4.939895e-02 1.160237e-01 1.457336e-01   
## 470   
## 8.195804e-02

#Validate model using confusion matrix  
confmatrix <- table(Actual\_Value=train$Risk1Yr, Predicted\_Value = res2 >0.5)  
confmatrix

## Predicted\_Value  
## Actual\_Value FALSE TRUE  
## F 306 5  
## T 45 5

#Accuracy  
(confmatrix[[1,1]] + confmatrix[[2,2]])/sum(confmatrix)

## [1] 0.8614958

#8.2 Fit a logistic regression model to the dataset from the previous assignment

## a. What is the accuracy of the logistic regression classifier?

57.5%

# Split the data into training and validation data sets  
split <- sample.split(data8.2, SplitRatio = 0.8)  
split

## [1] FALSE TRUE TRUE

train <- subset(data8.2, split == "TRUE")  
validate <- subset(data8.2, split == "FALSE")  
  
  
# Train model using training data set  
lgm8.2 <- glm(label ~ x +y, data = train, family = binomial())  
summary(lgm8.2)

##   
## Call:  
## glm(formula = label ~ x + y, family = binomial(), data = train)  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -1.3658 -1.1672 -0.9614 1.1650 1.4004   
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) 0.415200 0.143553 2.892 0.003824 \*\*   
## x -0.002376 0.002237 -1.062 0.288036   
## y -0.007953 0.002302 -3.456 0.000549 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for binomial family taken to be 1)  
##   
## Null deviance: 1382.9 on 997 degrees of freedom  
## Residual deviance: 1367.6 on 995 degrees of freedom  
## AIC: 1373.6  
##   
## Number of Fisher Scoring iterations: 4

# Run validation data through the model built on training data  
res <- predict(lgm8.2, validate, type = "response")  
res

## 1 4 7 10 13 16 19 22   
## 0.3977673 0.4042790 0.3853257 0.3825992 0.3981837 0.3857950 0.3768663 0.3794590   
## 25 28 31 34 37 40 43 46   
## 0.3788121 0.3876935 0.4005309 0.3994941 0.3957225 0.3956623 0.3832636 0.3701284   
## 49 52 55 58 61 64 67 70   
## 0.3842516 0.3951534 0.3843245 0.4954530 0.4994679 0.4860272 0.4949504 0.4896907   
## 73 76 79 82 85 88 91 94   
## 0.4830109 0.4927486 0.5047070 0.4871315 0.5021351 0.5044042 0.5139531 0.5014514   
## 97 100 103 106 109 112 115 118   
## 0.4798234 0.4314930 0.4313161 0.4283464 0.4267198 0.4306351 0.4282186 0.4366567   
## 121 124 127 130 133 136 139 142   
## 0.4295201 0.4286252 0.4336776 0.4293152 0.4284116 0.4303541 0.4270534 0.4322570   
## 145 148 151 154 157 160 163 166   
## 0.4317959 0.4291048 0.4319417 0.4279352 0.4319919 0.4311006 0.4230409 0.4220366   
## 169 172 175 178 181 184 187 190   
## 0.4254915 0.4246210 0.4247007 0.4241695 0.4060710 0.4308843 0.4208624 0.4083780   
## 193 196 199 202 205 208 211 214   
## 0.4178333 0.4134836 0.4794247 0.4767779 0.4807273 0.4804414 0.4690502 0.4735529   
## 217 220 223 226 229 232 235 238   
## 0.4771430 0.4755777 0.3827384 0.3845051 0.3911307 0.3870332 0.3760181 0.3932622   
## 241 244 247 250 253 256 259 262   
## 0.3944128 0.3946762 0.3808742 0.3904907 0.4007251 0.3924161 0.3838895 0.5328529   
## 265 268 271 274 277 280 283 286   
## 0.5384941 0.5385540 0.5380433 0.5351827 0.5413458 0.5365877 0.5368384 0.5353943   
## 289 292 295 298 301 304 307 310   
## 0.5399065 0.5377078 0.5466507 0.5403124 0.5404028 0.5303579 0.5373611 0.5363369   
## 313 316 319 322 325 328 331 334   
## 0.5417280 0.4913804 0.4899161 0.4912349 0.4862078 0.4847235 0.4952330 0.4881346   
## 337 340 343 346 349 352 355 358   
## 0.4939212 0.4934924 0.4936127 0.4879397 0.4974921 0.4933311 0.4939454 0.5025995   
## 361 364 367 370 373 376 379 382   
## 0.4990867 0.4902849 0.4955709 0.5329797 0.5310851 0.5168753 0.5359665 0.5409683   
## 385 388 391 394 397 400 403 406   
## 0.5309293 0.5342076 0.5268316 0.5352597 0.5379883 0.5262060 0.5338689 0.5391159   
## 409 412 415 418 421 424 427 430   
## 0.5277617 0.5350061 0.5376833 0.5308223 0.5281087 0.5212671 0.5175785 0.5286295   
## 433 436 439 442 445 448 451 454   
## 0.5255544 0.5340328 0.5361724 0.5291256 0.5309436 0.5263626 0.5268140 0.5239280   
## 457 460 463 466 469 472 475 478   
## 0.5295672 0.5314519 0.5276100 0.5290064 0.5322092 0.5327931 0.5242716 0.5295104   
## 481 484 487 490 493 496 499 502   
## 0.5986335 0.5955333 0.6011943 0.6004924 0.6062439 0.5988243 0.6046938 0.5999525   
## 505 508 511 514 517 520 523 526   
## 0.6020176 0.6035150 0.6036680 0.6059221 0.5952913 0.6062122 0.6005091 0.6022645   
## 529 532 535 538 541 544 547 550   
## 0.6080079 0.4198562 0.4064610 0.3958583 0.4096641 0.4181626 0.4082451 0.3931338   
## 553 556 559 562 565 568 571 574   
## 0.4075589 0.3995033 0.4340935 0.4039533 0.4140193 0.3954005 0.4112012 0.4122719   
## 577 580 583 586 589 592 595 598   
## 0.5400533 0.5347425 0.5470211 0.5562836 0.5329767 0.5315190 0.5492481 0.5438291   
## 601 604 607 610 613 616 619 622   
## 0.5531801 0.5506387 0.5409519 0.5388725 0.5423908 0.5487297 0.5566146 0.5374575   
## 625 628 631 634 637 640 643 646   
## 0.5404452 0.5450808 0.5497523 0.5408552 0.5566192 0.5481136 0.5441862 0.5436392   
## 649 652 655 658 661 664 667 670   
## 0.5352556 0.5288365 0.5405346 0.5474551 0.5467726 0.5460389 0.5614501 0.5399182   
## 673 676 679 682 685 688 691 694   
## 0.5382995 0.5574178 0.4869652 0.4711272 0.4732088 0.4844801 0.4902641 0.4828467   
## 697 700 703 706 709 712 715 718   
## 0.5052442 0.4528893 0.4735644 0.4843985 0.4907011 0.4979385 0.3681975 0.3748495   
## 721 724 727 730 733 736 739 742   
## 0.3695699 0.3719246 0.3671987 0.3667063 0.3649603 0.3699320 0.3734149 0.3743469   
## 745 748 751 754 757 760 763 766   
## 0.3750611 0.3745513 0.3768387 0.3703722 0.3692650 0.3701412 0.3755060 0.3716052   
## 769 772 775 778 781 784 787 790   
## 0.4528963 0.4384844 0.4527142 0.4450445 0.4457255 0.4561621 0.4580500 0.4596299   
## 793 796 799 802 805 808 811 814   
## 0.4676460 0.4603691 0.4549946 0.4252948 0.4510663 0.4502078 0.4531078 0.4629077   
## 817 820 823 826 829 832 835 838   
## 0.4485700 0.5218260 0.5067683 0.5209743 0.5129134 0.5145611 0.5085064 0.5132225   
## 841 844 847 850 853 856 859 862   
## 0.5157388 0.5148689 0.5107409 0.5112926 0.5091500 0.5083831 0.5201983 0.5156602   
## 865 868 871 874 877 880 883 886   
## 0.5080362 0.5000631 0.5143283 0.5132004 0.5030905 0.5080310 0.5036898 0.5099958   
## 889 892 895 898 901 904 907 910   
## 0.5137313 0.5104993 0.5096968 0.5052245 0.5160565 0.5140506 0.5003021 0.5099809   
## 913 916 919 922 925 928 931 934   
## 0.5082098 0.5162526 0.5118293 0.5026046 0.5131344 0.5117206 0.5160433 0.5089581   
## 937 940 943 946 949 952 955 958   
## 0.4398655 0.4364723 0.4358376 0.4429055 0.4372280 0.4395787 0.4364861 0.4349431   
## 961 964 967 970 973 976 979 982   
## 0.4356625 0.4421379 0.4369462 0.4377057 0.4431954 0.4380982 0.4325799 0.4401721   
## 985 988 991 994 997 1000 1003 1006   
## 0.4397648 0.4987584 0.4996649 0.5288143 0.5172671 0.5134264 0.5195993 0.5108706   
## 1009 1012 1015 1018 1021 1024 1027 1030   
## 0.5109078 0.5135390 0.5156480 0.5126880 0.5052417 0.5067616 0.5075808 0.5072742   
## 1033 1036 1039 1042 1045 1048 1051 1054   
## 0.5065748 0.5074816 0.5178841 0.4519815 0.4448699 0.4449682 0.4467714 0.4445812   
## 1057 1060 1063 1066 1069 1072 1075 1078   
## 0.4475845 0.4504478 0.4460623 0.4500222 0.4433942 0.4506594 0.4469482 0.4459974   
## 1081 1084 1087 1090 1093 1096 1099 1102   
## 0.4394259 0.4455736 0.4490835 0.4474475 0.4466379 0.5198132 0.5114216 0.5071993   
## 1105 1108 1111 1114 1117 1120 1123 1126   
## 0.5173181 0.5059043 0.5031605 0.5046978 0.5074425 0.5155996 0.5166734 0.5101506   
## 1129 1132 1135 1138 1141 1144 1147 1150   
## 0.5163310 0.5082289 0.5128231 0.5751664 0.5789738 0.5738068 0.5698438 0.5689646   
## 1153 1156 1159 1162 1165 1168 1171 1174   
## 0.5776979 0.5760935 0.5688316 0.5654334 0.5637664 0.5637039 0.5630099 0.5582285   
## 1177 1180 1183 1186 1189 1192 1195 1198   
## 0.5624965 0.5596184 0.5577365 0.5532673 0.5606760 0.5628892 0.5580176 0.5613590   
## 1201 1204 1207 1210 1213 1216 1219 1222   
## 0.5591404 0.5636096 0.5602289 0.5618293 0.5589194 0.5595403 0.5540893 0.5498934   
## 1225 1228 1231 1234 1237 1240 1243 1246   
## 0.5451637 0.5508124 0.5384307 0.5560359 0.5476617 0.5434079 0.5476035 0.5489505   
## 1249 1252 1255 1258 1261 1264 1267 1270   
## 0.5434505 0.5436458 0.5439854 0.5466514 0.5411182 0.5480155 0.5472390 0.5512712   
## 1273 1276 1279 1282 1285 1288 1291 1294   
## 0.4480030 0.4432700 0.4309961 0.4350703 0.4426451 0.4385229 0.4326147 0.4480609   
## 1297 1300 1303 1306 1309 1312 1315 1318   
## 0.4273578 0.4412025 0.4363084 0.4401033 0.4180282 0.4260257 0.4381928 0.4404265   
## 1321 1324 1327 1330 1333 1336 1339 1342   
## 0.4284502 0.4395400 0.4400655 0.4338192 0.4493043 0.4274498 0.4412940 0.4491514   
## 1345 1348 1351 1354 1357 1360 1363 1366   
## 0.5012308 0.5056960 0.5063298 0.5016566 0.5026718 0.5030999 0.5006095 0.5022375   
## 1369 1372 1375 1378 1381 1384 1387 1390   
## 0.5014341 0.4979230 0.5004730 0.4992273 0.4991980 0.4986311 0.4988779 0.5019543   
## 1393 1396 1399 1402 1405 1408 1411 1414   
## 0.5003145 0.5022248 0.5020134 0.5731293 0.5704806 0.5866268 0.5960095 0.5836988   
## 1417 1420 1423 1426 1429 1432 1435 1438   
## 0.5780298 0.5830832 0.5816426 0.5869082 0.5834342 0.5711107 0.5770981 0.5827871   
## 1441 1444 1447 1450 1453 1456 1459 1462   
## 0.5770477 0.5970178 0.5625302 0.5732783 0.5935695 0.4000513 0.3921612 0.3863003   
## 1465 1468 1471 1474 1477 1480 1483 1486   
## 0.3946752 0.3874710 0.3870317 0.3937776 0.3891184 0.4036467 0.3960348 0.3970495   
## 1489 1492 1495 1498   
## 0.3929626 0.3913505 0.3830839 0.3953764

res2 <-predict(lgm8.2, train, type = "response")  
res2

## 2 3 5 6 8 9 11 12   
## 0.3864440 0.3790805 0.3962074 0.3909086 0.3650274 0.3793350 0.3952054 0.3633326   
## 14 15 17 18 20 21 23 24   
## 0.3855104 0.3915347 0.4011531 0.3833641 0.3857139 0.3831118 0.3932558 0.3859975   
## 26 27 29 30 32 33 35 36   
## 0.3950780 0.3830077 0.4056189 0.3901061 0.4053711 0.3906178 0.4005312 0.3904780   
## 38 39 41 42 44 45 47 48   
## 0.3735497 0.3978000 0.3799961 0.4011939 0.3961075 0.3897124 0.3712479 0.3769536   
## 50 51 53 54 56 57 59 60   
## 0.3873387 0.3946059 0.3777650 0.3996143 0.4953275 0.4981150 0.4883627 0.4910701   
## 62 63 65 66 68 69 71 72   
## 0.4908639 0.4962543 0.4832333 0.4897509 0.5076387 0.4882538 0.5042544 0.4970130   
## 74 75 77 78 80 81 83 84   
## 0.4811962 0.4882685 0.4941820 0.4860312 0.5009828 0.5022218 0.4995720 0.4984751   
## 86 87 89 90 92 93 95 96   
## 0.4861349 0.4882487 0.4960894 0.4968431 0.5020489 0.4915224 0.4866503 0.4921453   
## 98 99 101 102 104 105 107 108   
## 0.4799457 0.4287961 0.4318430 0.4335833 0.4300549 0.4272305 0.4331822 0.4316359   
## 110 111 113 114 116 117 119 120   
## 0.4277115 0.4273523 0.4308882 0.4327932 0.4310089 0.4330372 0.4328817 0.4267070   
## 122 123 125 126 128 129 131 132   
## 0.4289718 0.4289666 0.4306703 0.4343088 0.4305625 0.4297637 0.4317642 0.4305205   
## 134 135 137 138 140 141 143 144   
## 0.4257388 0.4290116 0.4306525 0.4296719 0.4313753 0.4293983 0.4285130 0.4340103   
## 146 147 149 150 152 153 155 156   
## 0.4279281 0.4300484 0.4277035 0.4289198 0.4302613 0.4316812 0.4293282 0.4358152   
## 158 159 161 162 164 165 167 168   
## 0.4329722 0.4271808 0.4196840 0.4203943 0.4216714 0.4230803 0.4296428 0.4018964   
## 170 171 173 174 176 177 179 180   
## 0.4207310 0.4348316 0.4253104 0.4307706 0.4191934 0.4313923 0.4286247 0.4146817   
## 182 183 185 186 188 189 191 192   
## 0.4184904 0.4160362 0.4268356 0.4321625 0.4229293 0.4335117 0.4210473 0.4203639   
## 194 195 197 198 200 201 203 204   
## 0.4068543 0.4274646 0.4765629 0.4731169 0.4741614 0.4778074 0.4784087 0.4769667   
## 206 207 209 210 212 213 215 216   
## 0.4840309 0.4767695 0.4822346 0.4758579 0.4820264 0.4755524 0.4742388 0.4809481   
## 218 219 221 222 224 225 227 228   
## 0.4801900 0.4822905 0.4735703 0.4769467 0.3870318 0.3803140 0.3938333 0.3819524   
## 230 231 233 234 236 237 239 240   
## 0.3837401 0.3848051 0.3826378 0.3891826 0.3895615 0.3956451 0.3826995 0.3831621   
## 242 243 245 246 248 249 251 252   
## 0.3864946 0.3741244 0.3886868 0.3879953 0.3898403 0.3942631 0.3860413 0.3939074   
## 254 255 257 258 260 261 263 264   
## 0.3815178 0.3882943 0.3976057 0.3853628 0.5318863 0.5346666 0.5398048 0.5360797   
## 266 267 269 270 272 273 275 276   
## 0.5405989 0.5396356 0.5331405 0.5286047 0.5418437 0.5313213 0.5339135 0.5379494   
## 278 279 281 282 284 285 287 288   
## 0.5336202 0.5401368 0.5392890 0.5401228 0.5374613 0.5344393 0.5394674 0.5450538   
## 290 291 293 294 296 297 299 300   
## 0.5361017 0.5393993 0.5352840 0.5422486 0.5414093 0.5386711 0.5325805 0.5389080   
## 302 303 305 306 308 309 311 312   
## 0.5270084 0.5320725 0.5340657 0.5378862 0.5465878 0.5359389 0.5356062 0.5428479   
## 314 315 317 318 320 321 323 324   
## 0.4936187 0.4758225 0.4766762 0.4895432 0.5020251 0.4967901 0.4971420 0.4901442   
## 326 327 329 330 332 333 335 336   
## 0.4917201 0.4939553 0.4823721 0.4977047 0.4945084 0.5073092 0.4971724 0.4836170   
## 338 339 341 342 344 345 347 348   
## 0.4853108 0.4818169 0.4958517 0.4962393 0.4942995 0.4869540 0.4940181 0.4963817   
## 350 351 353 354 356 357 359 360   
## 0.4939811 0.4831651 0.4924426 0.4965069 0.4959727 0.4938758 0.4880026 0.5013093   
## 362 363 365 366 368 369 371 372   
## 0.4748403 0.4913622 0.4948684 0.4845686 0.4996543 0.4870976 0.5285454 0.5387612   
## 374 375 377 378 380 381 383 384   
## 0.5281185 0.5330591 0.5282376 0.5153953 0.5234929 0.5231425 0.5397075 0.5285046   
## 386 387 389 390 392 393 395 396   
## 0.5426309 0.5267001 0.5255263 0.5260150 0.5308077 0.5237709 0.5229829 0.5263288   
## 398 399 401 402 404 405 407 408   
## 0.5337090 0.5294960 0.5287162 0.5226216 0.5305788 0.5251105 0.5257177 0.5215596   
## 410 411 413 414 416 417 419 420   
## 0.5326459 0.5320361 0.5311621 0.5353534 0.5236270 0.5411608 0.5371405 0.5248722   
## 422 423 425 426 428 429 431 432   
## 0.5213621 0.5377637 0.5277620 0.5367315 0.5264784 0.5296276 0.5339106 0.5295457   
## 434 435 437 438 440 441 443 444   
## 0.5303183 0.5275306 0.5338717 0.5261200 0.5217643 0.5253671 0.5278772 0.5264770   
## 446 447 449 450 452 453 455 456   
## 0.5310190 0.5323403 0.5262805 0.5275207 0.5335806 0.5291744 0.5294480 0.5244869   
## 458 459 461 462 464 465 467 468   
## 0.5294489 0.5223571 0.5312808 0.5272805 0.5268973 0.5287566 0.5257970 0.5252888   
## 470 471 473 474 476 477 479 480   
## 0.5232415 0.5299962 0.5251511 0.5258348 0.5324524 0.5297589 0.6033771 0.6016761   
## 482 483 485 486 488 489 491 492   
## 0.5962543 0.5940271 0.6033174 0.5942462 0.6022132 0.6002287 0.5973792 0.5957843   
## 494 495 497 498 500 501 503 504   
## 0.5998403 0.6064980 0.5996378 0.6003804 0.6051124 0.5951959 0.5958588 0.6033700   
## 506 507 509 510 512 513 515 516   
## 0.5988861 0.6031140 0.6001135 0.6010320 0.5933708 0.6055712 0.5978760 0.5975595   
## 518 519 521 522 524 525 527 528   
## 0.5996742 0.5997357 0.6063392 0.6010867 0.6008453 0.5982852 0.6020268 0.5983447   
## 530 531 533 534 536 537 539 540   
## 0.5958120 0.5945870 0.4003134 0.4073677 0.4096669 0.4093814 0.4221728 0.4099919   
## 542 543 545 546 548 549 551 552   
## 0.4210657 0.4211453 0.4147109 0.4026305 0.4148891 0.4153221 0.4083690 0.4065352   
## 554 555 557 558 560 561 563 564   
## 0.4239016 0.4073387 0.4108924 0.4065185 0.3948554 0.4228346 0.4177065 0.4108656   
## 566 567 569 570 572 573 575 576   
## 0.4167810 0.4126657 0.4043187 0.4187565 0.3991354 0.4120018 0.4075662 0.5342654   
## 578 579 581 582 584 585 587 588   
## 0.5516483 0.5427565 0.5353670 0.5395888 0.5393917 0.5527845 0.5380195 0.5337239   
## 590 591 593 594 596 597 599 600   
## 0.5502140 0.5373869 0.5297394 0.5333425 0.5440094 0.5348962 0.5391650 0.5411422   
## 602 603 605 606 608 609 611 612   
## 0.5433960 0.5308945 0.5463946 0.5533023 0.5534316 0.5465922 0.5392676 0.5322809   
## 614 615 617 618 620 621 623 624   
## 0.5273907 0.5526272 0.5227324 0.5478694 0.5475251 0.5448078 0.5552260 0.5373380   
## 626 627 629 630 632 633 635 636   
## 0.5327297 0.5420560 0.5633605 0.5451148 0.5487590 0.5597251 0.5595232 0.5426985   
## 638 639 641 642 644 645 647 648   
## 0.5534392 0.5539732 0.5495939 0.5423723 0.5453271 0.5423695 0.5359294 0.5555527   
## 650 651 653 654 656 657 659 660   
## 0.5463058 0.5481220 0.5404541 0.5326012 0.5483321 0.5430335 0.5459581 0.5509401   
## 662 663 665 666 668 669 671 672   
## 0.5555125 0.5408778 0.5377726 0.5497271 0.5349080 0.5464778 0.5406291 0.5500358   
## 674 675 677 678 680 681 683 684   
## 0.5351430 0.5447049 0.5418802 0.4827956 0.4730888 0.4818535 0.4722245 0.4946676   
## 686 687 689 690 692 693 695 696   
## 0.4672201 0.4958203 0.4894152 0.5060491 0.4950809 0.4916608 0.4786943 0.4931006   
## 698 699 701 702 704 705 707 708   
## 0.4861212 0.4838784 0.4782501 0.5006808 0.4874795 0.4889404 0.4671468 0.4973386   
## 710 711 713 714 716 717 719 720   
## 0.4769909 0.4955251 0.4869427 0.3740734 0.3692686 0.3765598 0.3715221 0.3693992   
## 722 723 725 726 728 729 731 732   
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## 0.3655407 0.3768325 0.3714475 0.3766287 0.3724371 0.3720302 0.3742344 0.3759474   
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## 758 759 761 762 764 765 767 768   
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## 0.4548843 0.4453781 0.4661475 0.4433995 0.4512429 0.4581659 0.4465434 0.4634007   
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## 0.4549336 0.4492421 0.4519165 0.4242657 0.4493163 0.4636130 0.4435009 0.4469974   
## 806 807 809 810 812 813 815 816   
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## 818 819 821 822 824 825 827 828   
## 0.4346098 0.5129625 0.5041655 0.5145983 0.5094085 0.5012281 0.5167394 0.5132338   
## 830 831 833 834 836 837 839 840   
## 0.5152423 0.5131192 0.5242294 0.5230291 0.5150588 0.5047231 0.5234098 0.5166514   
## 842 843 845 846 848 849 851 852   
## 0.5087070 0.5162499 0.5197185 0.5173732 0.5157765 0.5215026 0.5145544 0.5076600   
## 854 855 857 858 860 861 863 864   
## 0.5129813 0.5120817 0.5043733 0.5074234 0.5192794 0.5117692 0.5195451 0.5145485   
## 866 867 869 870 872 873 875 876   
## 0.4981962 0.5191630 0.5081164 0.5206988 0.5137132 0.5131964 0.5204550 0.5152126   
## 878 879 881 882 884 885 887 888   
## 0.5117623 0.5079594 0.5109842 0.5147270 0.5085265 0.5102999 0.5109371 0.5166201   
## 890 891 893 894 896 897 899 900   
## 0.5099266 0.5124980 0.5105126 0.5135105 0.5045639 0.5074277 0.5072595 0.5080124   
## 902 903 905 906 908 909 911 912   
## 0.5100779 0.5068722 0.5146337 0.5143848 0.5096221 0.5048044 0.5095129 0.5140431   
## 914 915 917 918 920 921 923 924   
## 0.5135065 0.5077271 0.5131279 0.5111548 0.5161028 0.5115764 0.5124756 0.5098475   
## 926 927 929 930 932 933 935 936   
## 0.5125384 0.5027327 0.5127044 0.5137117 0.5064448 0.5092688 0.4379993 0.4416928   
## 938 939 941 942 944 945 947 948   
## 0.4312836 0.4395500 0.4430731 0.4378109 0.4429087 0.4361586 0.4350112 0.4429412   
## 950 951 953 954 956 957 959 960   
## 0.4376098 0.4434929 0.4408530 0.4324507 0.4361049 0.4332146 0.4331985 0.4372260   
## 962 963 965 966 968 969 971 972   
## 0.4433048 0.4415758 0.4359253 0.4386520 0.4368021 0.4433634 0.4390770 0.4316452   
## 974 975 977 978 980 981 983 984   
## 0.4382371 0.4398763 0.4388802 0.4361811 0.4409417 0.4367541 0.4348510 0.4376832   
## 986 987 989 990 992 993 995 996   
## 0.4405096 0.5188269 0.4947951 0.5141178 0.5002618 0.5085944 0.5092533 0.5203062   
## 998 999 1001 1002 1004 1005 1007 1008   
## 0.5121182 0.5109580 0.5150530 0.5076517 0.5245870 0.5107758 0.5219362 0.4937855   
## 1010 1011 1013 1014 1016 1017 1019 1020   
## 0.5130545 0.5120470 0.5207545 0.5103535 0.5291046 0.5173165 0.5302658 0.5113211   
## 1022 1023 1025 1026 1028 1029 1031 1032   
## 0.5141624 0.5116004 0.5093395 0.5074473 0.5173151 0.5015704 0.5044679 0.5066631   
## 1034 1035 1037 1038 1040 1041 1043 1044   
## 0.5056496 0.5023178 0.5113630 0.5197224 0.4450000 0.4439649 0.4444900 0.4446797   
## 1046 1047 1049 1050 1052 1053 1055 1056   
## 0.4471705 0.4464691 0.4484977 0.4393093 0.4453602 0.4459835 0.4474415 0.4463804   
## 1058 1059 1061 1062 1064 1065 1067 1068   
## 0.4466937 0.4496313 0.4487553 0.4487339 0.4450492 0.4527761 0.4491982 0.4450803   
## 1070 1071 1073 1074 1076 1077 1079 1080   
## 0.4395164 0.4395516 0.4535614 0.4461640 0.4463124 0.4489837 0.4465470 0.4441644   
## 1082 1083 1085 1086 1088 1089 1091 1092   
## 0.4487404 0.4471342 0.4492607 0.4459614 0.4476545 0.4463899 0.4458657 0.4477569   
## 1094 1095 1097 1098 1100 1101 1103 1104   
## 0.4407661 0.4433364 0.5081973 0.5067357 0.5143176 0.4987057 0.5108799 0.5136424   
## 1106 1107 1109 1110 1112 1113 1115 1116   
## 0.5105071 0.5069391 0.5214757 0.5124065 0.5087476 0.5111857 0.5153853 0.5049649   
## 1118 1119 1121 1122 1124 1125 1127 1128   
## 0.5149851 0.5022015 0.5147303 0.5137281 0.5227940 0.5226694 0.5033434 0.5102087   
## 1130 1131 1133 1134 1136 1137 1139 1140   
## 0.5017507 0.5157639 0.5108048 0.5196115 0.4935814 0.5780043 0.5683017 0.5726842   
## 1142 1143 1145 1146 1148 1149 1151 1152   
## 0.5733323 0.5768736 0.5858017 0.5668187 0.5727829 0.5767691 0.5760130 0.5739748   
## 1154 1155 1157 1158 1160 1161 1163 1164   
## 0.5797798 0.5751888 0.5804216 0.5776263 0.5722605 0.5655185 0.5722166 0.5749712   
## 1166 1167 1169 1170 1172 1173 1175 1176   
## 0.5618764 0.5516417 0.5577474 0.5670066 0.5588398 0.5595479 0.5482490 0.5687826   
## 1178 1179 1181 1182 1184 1185 1187 1188   
## 0.5583237 0.5594037 0.5611863 0.5593805 0.5564321 0.5608529 0.5637187 0.5525276   
## 1190 1191 1193 1194 1196 1197 1199 1200   
## 0.5631669 0.5583761 0.5565774 0.5613659 0.5609141 0.5660573 0.5628781 0.5688722   
## 1202 1203 1205 1206 1208 1209 1211 1212   
## 0.5534775 0.5572931 0.5663533 0.5619037 0.5574963 0.5565679 0.5666840 0.5514221   
## 1214 1215 1217 1218 1220 1221 1223 1224   
## 0.5579740 0.5569225 0.5568945 0.5567160 0.5558747 0.5578570 0.5434965 0.5493107   
## 1226 1227 1229 1230 1232 1233 1235 1236   
## 0.5497334 0.5433517 0.5411371 0.5532866 0.5441884 0.5525330 0.5498858 0.5507218   
## 1238 1239 1241 1242 1244 1245 1247 1248   
## 0.5421553 0.5470723 0.5492014 0.5434592 0.5440411 0.5428242 0.5519844 0.5497519   
## 1250 1251 1253 1254 1256 1257 1259 1260   
## 0.5469963 0.5461289 0.5448900 0.5405234 0.5450121 0.5458232 0.5447688 0.5475498   
## 1262 1263 1265 1266 1268 1269 1271 1272   
## 0.5430295 0.5499628 0.5457714 0.5454904 0.5422902 0.5523110 0.4481029 0.4203197   
## 1274 1275 1277 1278 1280 1281 1283 1284   
## 0.4458330 0.4444479 0.4686818 0.4392748 0.4322076 0.4492708 0.4443028 0.4349508   
## 1286 1287 1289 1290 1292 1293 1295 1296   
## 0.4476998 0.4245360 0.4352801 0.4501315 0.4377613 0.4400979 0.4291438 0.4402564   
## 1298 1299 1301 1302 1304 1305 1307 1308   
## 0.4325353 0.4328895 0.4486225 0.4447265 0.4418536 0.4402509 0.4413554 0.4378312   
## 1310 1311 1313 1314 1316 1317 1319 1320   
## 0.4247062 0.4331553 0.4382826 0.4357394 0.4378237 0.4384414 0.4512488 0.4400030   
## 1322 1323 1325 1326 1328 1329 1331 1332   
## 0.4423826 0.4246518 0.4513200 0.4543303 0.4531315 0.4491300 0.4410961 0.4408380   
## 1334 1335 1337 1338 1340 1341 1343 1344   
## 0.4395715 0.4650507 0.4529066 0.4382397 0.4359778 0.4347589 0.4399865 0.4988282   
## 1346 1347 1349 1350 1352 1353 1355 1356   
## 0.5000362 0.4995042 0.5010688 0.5018656 0.5002367 0.5036163 0.4977762 0.4988738   
## 1358 1359 1361 1362 1364 1365 1367 1368   
## 0.4982638 0.5021552 0.5024434 0.5028223 0.5028037 0.5000109 0.5001506 0.5005988   
## 1370 1371 1373 1374 1376 1377 1379 1380   
## 0.5011458 0.5010325 0.5014890 0.5028802 0.5003653 0.4988058 0.4995212 0.4996335   
## 1382 1383 1385 1386 1388 1389 1391 1392   
## 0.5017102 0.4970873 0.5023378 0.4995754 0.4996911 0.5031686 0.5008723 0.4988996   
## 1394 1395 1397 1398 1400 1401 1403 1404   
## 0.5017024 0.5037299 0.5009749 0.5057386 0.5002465 0.5749424 0.5872935 0.5878459   
## 1406 1407 1409 1410 1412 1413 1415 1416   
## 0.5708345 0.5902520 0.5838060 0.5981133 0.5890015 0.5819373 0.5756862 0.5839995   
## 1418 1419 1421 1422 1424 1425 1427 1428   
## 0.5752046 0.5772801 0.5696379 0.5753853 0.5811793 0.5810831 0.5723843 0.5876272   
## 1430 1431 1433 1434 1436 1437 1439 1440   
## 0.5877565 0.5757320 0.5789263 0.5717885 0.5864299 0.5950618 0.5599572 0.5829373   
## 1442 1443 1445 1446 1448 1449 1451 1452   
## 0.5954978 0.5868901 0.5757122 0.5895607 0.5728889 0.5623862 0.5834595 0.5754769   
## 1454 1455 1457 1458 1460 1461 1463 1464   
## 0.5798598 0.3830383 0.3856705 0.3947470 0.3846475 0.3867331 0.3884741 0.3911125   
## 1466 1467 1469 1470 1472 1473 1475 1476   
## 0.3946060 0.3751245 0.3819350 0.3898251 0.3982435 0.4043783 0.3890936 0.3945966   
## 1478 1479 1481 1482 1484 1485 1487 1488   
## 0.3890715 0.4064780 0.3940380 0.4092299 0.3950810 0.4052099 0.3983261 0.3969363   
## 1490 1491 1493 1494 1496 1497   
## 0.3813926 0.4020394 0.3909374 0.3867452 0.4018312 0.3799412

#Validate model using confusion matrix  
confmatrix <- table(Actual\_Value=train$label, Predicted\_Value = res2 >0.5)  
confmatrix

## Predicted\_Value  
## Actual\_Value FALSE TRUE  
## 0 289 222  
## 1 202 285

#Accuracy  
(confmatrix[[1,1]] + confmatrix[[2,2]])/sum(confmatrix)

## [1] 0.5751503

## b. How does the accuracy of the logistic regression classifier compare to the nearest neighbors algorithm?

The accuracy for the nearest neighbors seemed much higher than the logistic regression accuracy.

##Generate a random number that is 90% of the total number of rows in dataset.  
ran <- sample(1:nrow(data8.2), 0.9 \* nrow(data8.2))   
  
##the normalization function is created  
nor <-function(x) { (x -min(x))/(max(x)-min(x)) }  
  
##Run nomalization on the last 2 columns of dataset because they are the predictors  
knn\_norm <- as.data.frame(lapply(data8.2[,c(2,3)], nor))  
  
summary(knn\_norm)

## x y   
## Min. :0.0000 Min. :0.0000   
## 1st Qu.:0.2275 1st Qu.:0.2274   
## Median :0.4278 Median :0.4386   
## Mean :0.4580 Mean :0.4421   
## 3rd Qu.:0.6522 3rd Qu.:0.6556   
## Max. :1.0000 Max. :1.0000

##extract training set  
knn\_train <- knn\_norm[ran,]   
##extract testing set  
knn\_test <- knn\_norm[-ran,]   
##extract 1st column of train dataset because it will be used as 'cl' argument in knn function.  
knn\_target\_category <- data8.2[ran,1]  
##extract 1st column if test dataset to measure the accuracy  
knn\_test\_category <- data8.2[-ran,1]  
##load the package class  
library(class)  
##run knn function  
pr <- knn(knn\_train,knn\_test,cl=knn\_target\_category,k=5)  
  
##create confusion matrix  
tab <- table(pr,knn\_test\_category)  
  
##this function divides the correct predictions by total number of predictions that tell us how accurate the model is.  
  
accuracy <- function(x){sum(diag(x)/(sum(rowSums(x)))) \* 100}  
accuracy(tab)

## [1] 96

## c. Why is the accuracy of the logistic regression classifier different from that of the nearest neighbors?

Logistic regression works better with linear relationships, and by looking at the plot below, you can see there is a non-linear relationship between the data and the predictor.

data\_space <-ggplot(data8.2, aes(x = x, y = y, col = label)) +   
 geom\_point()  
  
data\_space +  
 geom\_smooth(method = "glm", se = FALSE)

