Assignment 4

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## KNN model to predict whether a patient has AHD or Not

require(tidyverse)

## Loading required package: tidyverse

## ── Attaching packages ──────────────────────────────────────────────────────────────────────────────────── tidyverse 1.3.0 ──

## ✓ ggplot2 3.2.1 ✓ purrr 0.3.3  
## ✓ tibble 2.1.3 ✓ dplyr 0.8.4  
## ✓ tidyr 1.0.2 ✓ stringr 1.4.0  
## ✓ readr 1.3.1 ✓ forcats 0.4.0

## ── Conflicts ─────────────────────────────────────────────────────────────────────────────────────── tidyverse\_conflicts() ──  
## x dplyr::filter() masks stats::filter()  
## x dplyr::lag() masks stats::lag()

chest\_pain=read\_csv('https://raw.githubusercontent.com/PacktPublishing/Practical-Machine-Learning-Cookbook/master/Chapter%2006/Data/Decision%20tree%20learning%20-%20Advance%20Health%20Directive%20for%20Patients%20with%20Chest%20Pain.csv')

## Warning: Missing column names filled in: 'X1' [1]

## Parsed with column specification:  
## cols(  
## X1 = col\_double(),  
## Age = col\_double(),  
## Sex = col\_double(),  
## ChestPain = col\_character(),  
## RestBP = col\_double(),  
## Chol = col\_double(),  
## Fbs = col\_double(),  
## RestECG = col\_double(),  
## MaxHR = col\_double(),  
## ExAng = col\_double(),  
## Oldpeak = col\_double(),  
## Slope = col\_double(),  
## Ca = col\_double(),  
## Thal = col\_character(),  
## AHD = col\_character()  
## )

chest\_pain%>%column\_to\_rownames('X1') %>%write\_csv('chest\_pain.csv')  
  
chest\_pain=read\_csv('chest\_pain.csv')

## Parsed with column specification:  
## cols(  
## Age = col\_double(),  
## Sex = col\_double(),  
## ChestPain = col\_character(),  
## RestBP = col\_double(),  
## Chol = col\_double(),  
## Fbs = col\_double(),  
## RestECG = col\_double(),  
## MaxHR = col\_double(),  
## ExAng = col\_double(),  
## Oldpeak = col\_double(),  
## Slope = col\_double(),  
## Ca = col\_double(),  
## Thal = col\_character(),  
## AHD = col\_character()  
## )

chest\_pain%>%head()

## # A tibble: 6 x 14  
## Age Sex ChestPain RestBP Chol Fbs RestECG MaxHR ExAng Oldpeak Slope  
## <dbl> <dbl> <chr> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>  
## 1 63 1 typical 145 233 1 2 150 0 2.3 3  
## 2 67 1 asymptom… 160 286 0 2 108 1 1.5 2  
## 3 67 1 asymptom… 120 229 0 2 129 1 2.6 2  
## 4 37 1 nonangin… 130 250 0 0 187 0 3.5 3  
## 5 41 0 nontypic… 130 204 0 2 172 0 1.4 1  
## 6 56 1 nontypic… 120 236 0 0 178 0 0.8 1  
## # … with 3 more variables: Ca <dbl>, Thal <chr>, AHD <chr>

age = age in years  
sex(1 = male; 0 = female)  
cpchest = pain type  
trestbp = sresting blood pressure (in mm Hg on admission to the hospital)  
chol = serum cholestoral in mg/dl  
fbs (fasting blood sugar > 120 mg/dl) = (1 = true; 0 = false)  
restecg = resting electrocardiographic results  
thalach = maximum heart rate achieved  
exang = exercise induced angina (1 = yes; 0 = no)  
oldpeak = ST depression induced by exercise relative to rest  
slope = the slope of the peak exercise ST segment  
ca = number of major vessels (0-3) colored by flourosopy  
thal3 = normal; 6 = fixed defect; 7 = reversable defect

AHD = atherosclerotic heart disease.

## Create a knn model to predict whether a patient has AHD following the steps below

## Preprocessing

Are there any missing values? Define a strategy to manage missing values.

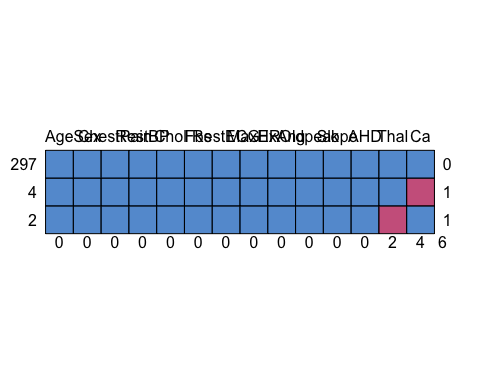
## There are two methods to remove the missing values and impute new values for categorical data- MICE package and missForest package.  
  
## I have used MICE package over here  
  
#install.packages("mice")  
require(mice)

## Loading required package: mice

##   
## Attaching package: 'mice'

## The following objects are masked from 'package:base':  
##   
## cbind, rbind

md.pattern(chest\_pain)



## Age Sex ChestPain RestBP Chol Fbs RestECG MaxHR ExAng Oldpeak Slope AHD  
## 297 1 1 1 1 1 1 1 1 1 1 1 1  
## 4 1 1 1 1 1 1 1 1 1 1 1 1  
## 2 1 1 1 1 1 1 1 1 1 1 1 1  
## 0 0 0 0 0 0 0 0 0 0 0 0  
## Thal Ca   
## 297 1 1 0  
## 4 1 0 1  
## 2 0 1 1  
## 2 4 6

## Now we come to know that there are 2 missing values in Thal and 4 missing values in Ca  
  
## Converting categorical data present in Thal column to numeric data. This is necessary to find the NA values and impute data into NA values.  
  
chest\_pain1 = as.numeric( factor(chest\_pain$Thal) ) -1  
chest\_pain1

## [1] 0 1 2 1 1 1 1 1 2 2 0 1 0 2 2 1 2 1 1 1 1 1 1 2 2  
## [26] 1 1 1 1 2 1 2 1 2 1 1 2 0 2 1 2 2 1 1 1 2 1 2 1 1  
## [51] 1 2 1 1 2 2 2 2 1 1 2 1 2 1 2 2 1 2 2 1 1 2 2 0 1  
## [76] 1 2 1 1 2 1 1 1 2 1 1 1 NA 1 1 1 2 2 1 1 2 2 2 1 1  
## [101] 1 1 1 1 2 2 2 2 2 2 2 1 0 2 2 0 1 1 2 2 2 2 1 2 1  
## [126] 1 2 2 1 1 2 2 1 1 1 1 2 2 2 1 1 2 1 2 2 1 2 1 1 1  
## [151] 2 1 2 2 1 1 2 2 2 2 2 1 1 1 1 2 1 1 2 1 2 2 1 1 0  
## [176] 2 2 0 1 1 2 2 1 2 1 1 2 0 2 2 1 2 2 1 1 1 1 1 1 1  
## [201] 1 1 2 2 2 2 2 2 1 1 1 2 1 2 1 2 1 1 1 1 1 1 1 2 1  
## [226] 1 1 1 1 1 1 1 1 1 1 1 2 2 1 1 1 1 1 1 1 1 2 1 2 1  
## [251] 0 2 2 1 1 1 1 1 1 2 1 1 1 1 1 0 NA 0 2 1 2 0 2 1 1  
## [276] 2 1 1 1 1 2 1 2 1 2 0 0 2 2 1 2 1 0 2 1 1 0 2 2 2  
## [301] 2 1 1

## Putting the numeric Thal into dataset and removing categorical Thal  
  
chest\_pain = chest\_pain %>% mutate(Thal\_new = chest\_pain1)  
chest\_pain = chest\_pain %>% select(-Thal)  
chest\_pain

## # A tibble: 303 x 14  
## Age Sex ChestPain RestBP Chol Fbs RestECG MaxHR ExAng Oldpeak Slope  
## <dbl> <dbl> <chr> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>  
## 1 63 1 typical 145 233 1 2 150 0 2.3 3  
## 2 67 1 asymptom… 160 286 0 2 108 1 1.5 2  
## 3 67 1 asymptom… 120 229 0 2 129 1 2.6 2  
## 4 37 1 nonangin… 130 250 0 0 187 0 3.5 3  
## 5 41 0 nontypic… 130 204 0 2 172 0 1.4 1  
## 6 56 1 nontypic… 120 236 0 0 178 0 0.8 1  
## 7 62 0 asymptom… 140 268 0 2 160 0 3.6 3  
## 8 57 0 asymptom… 120 354 0 0 163 1 0.6 1  
## 9 63 1 asymptom… 130 254 0 2 147 0 1.4 2  
## 10 53 1 asymptom… 140 203 1 2 155 1 3.1 3  
## # … with 293 more rows, and 3 more variables: Ca <dbl>, AHD <chr>,  
## # Thal\_new <dbl>

## count of missing values  
chest\_pain %>% group\_by(Thal\_new) %>% count()

## # A tibble: 4 x 2  
## # Groups: Thal\_new [4]  
## Thal\_new n  
## <dbl> <int>  
## 1 0 18  
## 2 1 166  
## 3 2 117  
## 4 NA 2

chest\_pain %>% group\_by(Ca) %>% count()

## # A tibble: 5 x 2  
## # Groups: Ca [5]  
## Ca n  
## <dbl> <int>  
## 1 0 176  
## 2 1 65  
## 3 2 38  
## 4 3 20  
## 5 NA 4

## Imputing data  
  
imputed\_Data <- mice(chest\_pain, m=5, maxit = 50, method = 'pmm', seed = 500)

##   
## iter imp variable  
## 1 1 Ca Thal\_new  
## 1 2 Ca Thal\_new  
## 1 3 Ca Thal\_new  
## 1 4 Ca Thal\_new  
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## 50 3 Ca Thal\_new  
## 50 4 Ca Thal\_new  
## 50 5 Ca Thal\_new

## Warning: Number of logged events: 2

summary(imputed\_Data)

## Class: mids  
## Number of multiple imputations: 5   
## Imputation methods:  
## Age Sex ChestPain RestBP Chol Fbs RestECG MaxHR   
## "" "" "" "" "" "" "" ""   
## ExAng Oldpeak Slope Ca AHD Thal\_new   
## "" "" "" "pmm" "" "pmm"   
## PredictorMatrix:  
## Age Sex ChestPain RestBP Chol Fbs RestECG MaxHR ExAng Oldpeak Slope  
## Age 0 1 0 1 1 1 1 1 1 1 1  
## Sex 1 0 0 1 1 1 1 1 1 1 1  
## ChestPain 1 1 0 1 1 1 1 1 1 1 1  
## RestBP 1 1 0 0 1 1 1 1 1 1 1  
## Chol 1 1 0 1 0 1 1 1 1 1 1  
## Fbs 1 1 0 1 1 0 1 1 1 1 1  
## Ca AHD Thal\_new  
## Age 1 0 1  
## Sex 1 0 1  
## ChestPain 1 0 1  
## RestBP 1 0 1  
## Chol 1 0 1  
## Fbs 1 0 1  
## Number of logged events: 2   
## it im dep meth out  
## 1 0 0 constant ChestPain  
## 2 0 0 constant AHD

## The following parameters are used  
  
## m – 5 imputed data sets  
## maxit – no. of iterations taken to impute missing values  
## method – Predictive mean matching

## Now we will check the imputed data  
  
imputed\_Data$imp$Ca

## 1 2 3 4 5  
## 167 1 0 0 0 0  
## 193 1 0 0 0 1  
## 288 0 0 0 0 0  
## 303 0 0 1 0 0

imputed\_Data$imp$Thal\_new

## 1 2 3 4 5  
## 88 1 1 1 1 1  
## 267 2 2 0 1 2

## View the complete dataset  
cp\_completed <- complete(imputed\_Data,2)  
cp\_completed

## Age Sex ChestPain RestBP Chol Fbs RestECG MaxHR ExAng Oldpeak Slope Ca  
## 1 63 1 typical 145 233 1 2 150 0 2.3 3 0  
## 2 67 1 asymptomatic 160 286 0 2 108 1 1.5 2 3  
## 3 67 1 asymptomatic 120 229 0 2 129 1 2.6 2 2  
## 4 37 1 nonanginal 130 250 0 0 187 0 3.5 3 0  
## 5 41 0 nontypical 130 204 0 2 172 0 1.4 1 0  
## 6 56 1 nontypical 120 236 0 0 178 0 0.8 1 0  
## 7 62 0 asymptomatic 140 268 0 2 160 0 3.6 3 2  
## 8 57 0 asymptomatic 120 354 0 0 163 1 0.6 1 0  
## 9 63 1 asymptomatic 130 254 0 2 147 0 1.4 2 1  
## 10 53 1 asymptomatic 140 203 1 2 155 1 3.1 3 0  
## 11 57 1 asymptomatic 140 192 0 0 148 0 0.4 2 0  
## 12 56 0 nontypical 140 294 0 2 153 0 1.3 2 0  
## 13 56 1 nonanginal 130 256 1 2 142 1 0.6 2 1  
## 14 44 1 nontypical 120 263 0 0 173 0 0.0 1 0  
## 15 52 1 nonanginal 172 199 1 0 162 0 0.5 1 0  
## 16 57 1 nonanginal 150 168 0 0 174 0 1.6 1 0  
## 17 48 1 nontypical 110 229 0 0 168 0 1.0 3 0  
## 18 54 1 asymptomatic 140 239 0 0 160 0 1.2 1 0  
## 19 48 0 nonanginal 130 275 0 0 139 0 0.2 1 0  
## 20 49 1 nontypical 130 266 0 0 171 0 0.6 1 0  
## 21 64 1 typical 110 211 0 2 144 1 1.8 2 0  
## 22 58 0 typical 150 283 1 2 162 0 1.0 1 0  
## 23 58 1 nontypical 120 284 0 2 160 0 1.8 2 0  
## 24 58 1 nonanginal 132 224 0 2 173 0 3.2 1 2  
## 25 60 1 asymptomatic 130 206 0 2 132 1 2.4 2 2  
## 26 50 0 nonanginal 120 219 0 0 158 0 1.6 2 0  
## 27 58 0 nonanginal 120 340 0 0 172 0 0.0 1 0  
## 28 66 0 typical 150 226 0 0 114 0 2.6 3 0  
## 29 43 1 asymptomatic 150 247 0 0 171 0 1.5 1 0  
## 30 40 1 asymptomatic 110 167 0 2 114 1 2.0 2 0  
## 31 69 0 typical 140 239 0 0 151 0 1.8 1 2  
## 32 60 1 asymptomatic 117 230 1 0 160 1 1.4 1 2  
## 33 64 1 nonanginal 140 335 0 0 158 0 0.0 1 0  
## 34 59 1 asymptomatic 135 234 0 0 161 0 0.5 2 0  
## 35 44 1 nonanginal 130 233 0 0 179 1 0.4 1 0  
## 36 42 1 asymptomatic 140 226 0 0 178 0 0.0 1 0  
## 37 43 1 asymptomatic 120 177 0 2 120 1 2.5 2 0  
## 38 57 1 asymptomatic 150 276 0 2 112 1 0.6 2 1  
## 39 55 1 asymptomatic 132 353 0 0 132 1 1.2 2 1  
## 40 61 1 nonanginal 150 243 1 0 137 1 1.0 2 0  
## 41 65 0 asymptomatic 150 225 0 2 114 0 1.0 2 3  
## 42 40 1 typical 140 199 0 0 178 1 1.4 1 0  
## 43 71 0 nontypical 160 302 0 0 162 0 0.4 1 2  
## 44 59 1 nonanginal 150 212 1 0 157 0 1.6 1 0  
## 45 61 0 asymptomatic 130 330 0 2 169 0 0.0 1 0  
## 46 58 1 nonanginal 112 230 0 2 165 0 2.5 2 1  
## 47 51 1 nonanginal 110 175 0 0 123 0 0.6 1 0  
## 48 50 1 asymptomatic 150 243 0 2 128 0 2.6 2 0  
## 49 65 0 nonanginal 140 417 1 2 157 0 0.8 1 1  
## 50 53 1 nonanginal 130 197 1 2 152 0 1.2 3 0  
## 51 41 0 nontypical 105 198 0 0 168 0 0.0 1 1  
## 52 65 1 asymptomatic 120 177 0 0 140 0 0.4 1 0  
## 53 44 1 asymptomatic 112 290 0 2 153 0 0.0 1 1  
## 54 44 1 nontypical 130 219 0 2 188 0 0.0 1 0  
## 55 60 1 asymptomatic 130 253 0 0 144 1 1.4 1 1  
## 56 54 1 asymptomatic 124 266 0 2 109 1 2.2 2 1  
## 57 50 1 nonanginal 140 233 0 0 163 0 0.6 2 1  
## 58 41 1 asymptomatic 110 172 0 2 158 0 0.0 1 0  
## 59 54 1 nonanginal 125 273 0 2 152 0 0.5 3 1  
## 60 51 1 typical 125 213 0 2 125 1 1.4 1 1  
## 61 51 0 asymptomatic 130 305 0 0 142 1 1.2 2 0  
## 62 46 0 nonanginal 142 177 0 2 160 1 1.4 3 0  
## 63 58 1 asymptomatic 128 216 0 2 131 1 2.2 2 3  
## 64 54 0 nonanginal 135 304 1 0 170 0 0.0 1 0  
## 65 54 1 asymptomatic 120 188 0 0 113 0 1.4 2 1  
## 66 60 1 asymptomatic 145 282 0 2 142 1 2.8 2 2  
## 67 60 1 nonanginal 140 185 0 2 155 0 3.0 2 0  
## 68 54 1 nonanginal 150 232 0 2 165 0 1.6 1 0  
## 69 59 1 asymptomatic 170 326 0 2 140 1 3.4 3 0  
## 70 46 1 nonanginal 150 231 0 0 147 0 3.6 2 0  
## 71 65 0 nonanginal 155 269 0 0 148 0 0.8 1 0  
## 72 67 1 asymptomatic 125 254 1 0 163 0 0.2 2 2  
## 73 62 1 asymptomatic 120 267 0 0 99 1 1.8 2 2  
## 74 65 1 asymptomatic 110 248 0 2 158 0 0.6 1 2  
## 75 44 1 asymptomatic 110 197 0 2 177 0 0.0 1 1  
## 76 65 0 nonanginal 160 360 0 2 151 0 0.8 1 0  
## 77 60 1 asymptomatic 125 258 0 2 141 1 2.8 2 1  
## 78 51 0 nonanginal 140 308 0 2 142 0 1.5 1 1  
## 79 48 1 nontypical 130 245 0 2 180 0 0.2 2 0  
## 80 58 1 asymptomatic 150 270 0 2 111 1 0.8 1 0  
## 81 45 1 asymptomatic 104 208 0 2 148 1 3.0 2 0  
## 82 53 0 asymptomatic 130 264 0 2 143 0 0.4 2 0  
## 83 39 1 nonanginal 140 321 0 2 182 0 0.0 1 0  
## 84 68 1 nonanginal 180 274 1 2 150 1 1.6 2 0  
## 85 52 1 nontypical 120 325 0 0 172 0 0.2 1 0  
## 86 44 1 nonanginal 140 235 0 2 180 0 0.0 1 0  
## 87 47 1 nonanginal 138 257 0 2 156 0 0.0 1 0  
## 88 53 0 nonanginal 128 216 0 2 115 0 0.0 1 0  
## 89 53 0 asymptomatic 138 234 0 2 160 0 0.0 1 0  
## 90 51 0 nonanginal 130 256 0 2 149 0 0.5 1 0  
## 91 66 1 asymptomatic 120 302 0 2 151 0 0.4 2 0  
## 92 62 0 asymptomatic 160 164 0 2 145 0 6.2 3 3  
## 93 62 1 nonanginal 130 231 0 0 146 0 1.8 2 3  
## 94 44 0 nonanginal 108 141 0 0 175 0 0.6 2 0  
## 95 63 0 nonanginal 135 252 0 2 172 0 0.0 1 0  
## 96 52 1 asymptomatic 128 255 0 0 161 1 0.0 1 1  
## 97 59 1 asymptomatic 110 239 0 2 142 1 1.2 2 1  
## 98 60 0 asymptomatic 150 258 0 2 157 0 2.6 2 2  
## 99 52 1 nontypical 134 201 0 0 158 0 0.8 1 1  
## 100 48 1 asymptomatic 122 222 0 2 186 0 0.0 1 0  
## 101 45 1 asymptomatic 115 260 0 2 185 0 0.0 1 0  
## 102 34 1 typical 118 182 0 2 174 0 0.0 1 0  
## 103 57 0 asymptomatic 128 303 0 2 159 0 0.0 1 1  
## 104 71 0 nonanginal 110 265 1 2 130 0 0.0 1 1  
## 105 49 1 nonanginal 120 188 0 0 139 0 2.0 2 3  
## 106 54 1 nontypical 108 309 0 0 156 0 0.0 1 0  
## 107 59 1 asymptomatic 140 177 0 0 162 1 0.0 1 1  
## 108 57 1 nonanginal 128 229 0 2 150 0 0.4 2 1  
## 109 61 1 asymptomatic 120 260 0 0 140 1 3.6 2 1  
## 110 39 1 asymptomatic 118 219 0 0 140 0 1.2 2 0  
## 111 61 0 asymptomatic 145 307 0 2 146 1 1.0 2 0  
## 112 56 1 asymptomatic 125 249 1 2 144 1 1.2 2 1  
## 113 52 1 typical 118 186 0 2 190 0 0.0 2 0  
## 114 43 0 asymptomatic 132 341 1 2 136 1 3.0 2 0  
## 115 62 0 nonanginal 130 263 0 0 97 0 1.2 2 1  
## 116 41 1 nontypical 135 203 0 0 132 0 0.0 2 0  
## 117 58 1 nonanginal 140 211 1 2 165 0 0.0 1 0  
## 118 35 0 asymptomatic 138 183 0 0 182 0 1.4 1 0  
## 119 63 1 asymptomatic 130 330 1 2 132 1 1.8 1 3  
## 120 65 1 asymptomatic 135 254 0 2 127 0 2.8 2 1  
## 121 48 1 asymptomatic 130 256 1 2 150 1 0.0 1 2  
## 122 63 0 asymptomatic 150 407 0 2 154 0 4.0 2 3  
## 123 51 1 nonanginal 100 222 0 0 143 1 1.2 2 0  
## 124 55 1 asymptomatic 140 217 0 0 111 1 5.6 3 0  
## 125 65 1 typical 138 282 1 2 174 0 1.4 2 1  
## 126 45 0 nontypical 130 234 0 2 175 0 0.6 2 0  
## 127 56 0 asymptomatic 200 288 1 2 133 1 4.0 3 2  
## 128 54 1 asymptomatic 110 239 0 0 126 1 2.8 2 1  
## 129 44 1 nontypical 120 220 0 0 170 0 0.0 1 0  
## 130 62 0 asymptomatic 124 209 0 0 163 0 0.0 1 0  
## 131 54 1 nonanginal 120 258 0 2 147 0 0.4 2 0  
## 132 51 1 nonanginal 94 227 0 0 154 1 0.0 1 1  
## 133 29 1 nontypical 130 204 0 2 202 0 0.0 1 0  
## 134 51 1 asymptomatic 140 261 0 2 186 1 0.0 1 0  
## 135 43 0 nonanginal 122 213 0 0 165 0 0.2 2 0  
## 136 55 0 nontypical 135 250 0 2 161 0 1.4 2 0  
## 137 70 1 asymptomatic 145 174 0 0 125 1 2.6 3 0  
## 138 62 1 nontypical 120 281 0 2 103 0 1.4 2 1  
## 139 35 1 asymptomatic 120 198 0 0 130 1 1.6 2 0  
## 140 51 1 nonanginal 125 245 1 2 166 0 2.4 2 0  
## 141 59 1 nontypical 140 221 0 0 164 1 0.0 1 0  
## 142 59 1 typical 170 288 0 2 159 0 0.2 2 0  
## 143 52 1 nontypical 128 205 1 0 184 0 0.0 1 0  
## 144 64 1 nonanginal 125 309 0 0 131 1 1.8 2 0  
## 145 58 1 nonanginal 105 240 0 2 154 1 0.6 2 0  
## 146 47 1 nonanginal 108 243 0 0 152 0 0.0 1 0  
## 147 57 1 asymptomatic 165 289 1 2 124 0 1.0 2 3  
## 148 41 1 nonanginal 112 250 0 0 179 0 0.0 1 0  
## 149 45 1 nontypical 128 308 0 2 170 0 0.0 1 0  
## 150 60 0 nonanginal 102 318 0 0 160 0 0.0 1 1  
## 151 52 1 typical 152 298 1 0 178 0 1.2 2 0  
## 152 42 0 asymptomatic 102 265 0 2 122 0 0.6 2 0  
## 153 67 0 nonanginal 115 564 0 2 160 0 1.6 2 0  
## 154 55 1 asymptomatic 160 289 0 2 145 1 0.8 2 1  
## 155 64 1 asymptomatic 120 246 0 2 96 1 2.2 3 1  
## 156 70 1 asymptomatic 130 322 0 2 109 0 2.4 2 3  
## 157 51 1 asymptomatic 140 299 0 0 173 1 1.6 1 0  
## 158 58 1 asymptomatic 125 300 0 2 171 0 0.0 1 2  
## 159 60 1 asymptomatic 140 293 0 2 170 0 1.2 2 2  
## 160 68 1 nonanginal 118 277 0 0 151 0 1.0 1 1  
## 161 46 1 nontypical 101 197 1 0 156 0 0.0 1 0  
## 162 77 1 asymptomatic 125 304 0 2 162 1 0.0 1 3  
## 163 54 0 nonanginal 110 214 0 0 158 0 1.6 2 0  
## 164 58 0 asymptomatic 100 248 0 2 122 0 1.0 2 0  
## 165 48 1 nonanginal 124 255 1 0 175 0 0.0 1 2  
## 166 57 1 asymptomatic 132 207 0 0 168 1 0.0 1 0  
## 167 52 1 nonanginal 138 223 0 0 169 0 0.0 1 0  
## 168 54 0 nontypical 132 288 1 2 159 1 0.0 1 1  
## 169 35 1 asymptomatic 126 282 0 2 156 1 0.0 1 0  
## 170 45 0 nontypical 112 160 0 0 138 0 0.0 2 0  
## 171 70 1 nonanginal 160 269 0 0 112 1 2.9 2 1  
## 172 53 1 asymptomatic 142 226 0 2 111 1 0.0 1 0  
## 173 59 0 asymptomatic 174 249 0 0 143 1 0.0 2 0  
## 174 62 0 asymptomatic 140 394 0 2 157 0 1.2 2 0  
## 175 64 1 asymptomatic 145 212 0 2 132 0 2.0 2 2  
## 176 57 1 asymptomatic 152 274 0 0 88 1 1.2 2 1  
## 177 52 1 asymptomatic 108 233 1 0 147 0 0.1 1 3  
## 178 56 1 asymptomatic 132 184 0 2 105 1 2.1 2 1  
## 179 43 1 nonanginal 130 315 0 0 162 0 1.9 1 1  
## 180 53 1 nonanginal 130 246 1 2 173 0 0.0 1 3  
## 181 48 1 asymptomatic 124 274 0 2 166 0 0.5 2 0  
## 182 56 0 asymptomatic 134 409 0 2 150 1 1.9 2 2  
## 183 42 1 typical 148 244 0 2 178 0 0.8 1 2  
## 184 59 1 typical 178 270 0 2 145 0 4.2 3 0  
## 185 60 0 asymptomatic 158 305 0 2 161 0 0.0 1 0  
## 186 63 0 nontypical 140 195 0 0 179 0 0.0 1 2  
## 187 42 1 nonanginal 120 240 1 0 194 0 0.8 3 0  
## 188 66 1 nontypical 160 246 0 0 120 1 0.0 2 3  
## 189 54 1 nontypical 192 283 0 2 195 0 0.0 1 1  
## 190 69 1 nonanginal 140 254 0 2 146 0 2.0 2 3  
## 191 50 1 nonanginal 129 196 0 0 163 0 0.0 1 0  
## 192 51 1 asymptomatic 140 298 0 0 122 1 4.2 2 3  
## 193 43 1 asymptomatic 132 247 1 2 143 1 0.1 2 0  
## 194 62 0 asymptomatic 138 294 1 0 106 0 1.9 2 3  
## 195 68 0 nonanginal 120 211 0 2 115 0 1.5 2 0  
## 196 67 1 asymptomatic 100 299 0 2 125 1 0.9 2 2  
## 197 69 1 typical 160 234 1 2 131 0 0.1 2 1  
## 198 45 0 asymptomatic 138 236 0 2 152 1 0.2 2 0  
## 199 50 0 nontypical 120 244 0 0 162 0 1.1 1 0  
## 200 59 1 typical 160 273 0 2 125 0 0.0 1 0  
## 201 50 0 asymptomatic 110 254 0 2 159 0 0.0 1 0  
## 202 64 0 asymptomatic 180 325 0 0 154 1 0.0 1 0  
## 203 57 1 nonanginal 150 126 1 0 173 0 0.2 1 1  
## 204 64 0 nonanginal 140 313 0 0 133 0 0.2 1 0  
## 205 43 1 asymptomatic 110 211 0 0 161 0 0.0 1 0  
## 206 45 1 asymptomatic 142 309 0 2 147 1 0.0 2 3  
## 207 58 1 asymptomatic 128 259 0 2 130 1 3.0 2 2  
## 208 50 1 asymptomatic 144 200 0 2 126 1 0.9 2 0  
## 209 55 1 nontypical 130 262 0 0 155 0 0.0 1 0  
## 210 62 0 asymptomatic 150 244 0 0 154 1 1.4 2 0  
## 211 37 0 nonanginal 120 215 0 0 170 0 0.0 1 0  
## 212 38 1 typical 120 231 0 0 182 1 3.8 2 0  
## 213 41 1 nonanginal 130 214 0 2 168 0 2.0 2 0  
## 214 66 0 asymptomatic 178 228 1 0 165 1 1.0 2 2  
## 215 52 1 asymptomatic 112 230 0 0 160 0 0.0 1 1  
## 216 56 1 typical 120 193 0 2 162 0 1.9 2 0  
## 217 46 0 nontypical 105 204 0 0 172 0 0.0 1 0  
## 218 46 0 asymptomatic 138 243 0 2 152 1 0.0 2 0  
## 219 64 0 asymptomatic 130 303 0 0 122 0 2.0 2 2  
## 220 59 1 asymptomatic 138 271 0 2 182 0 0.0 1 0  
## 221 41 0 nonanginal 112 268 0 2 172 1 0.0 1 0  
## 222 54 0 nonanginal 108 267 0 2 167 0 0.0 1 0  
## 223 39 0 nonanginal 94 199 0 0 179 0 0.0 1 0  
## 224 53 1 asymptomatic 123 282 0 0 95 1 2.0 2 2  
## 225 63 0 asymptomatic 108 269 0 0 169 1 1.8 2 2  
## 226 34 0 nontypical 118 210 0 0 192 0 0.7 1 0  
## 227 47 1 asymptomatic 112 204 0 0 143 0 0.1 1 0  
## 228 67 0 nonanginal 152 277 0 0 172 0 0.0 1 1  
## 229 54 1 asymptomatic 110 206 0 2 108 1 0.0 2 1  
## 230 66 1 asymptomatic 112 212 0 2 132 1 0.1 1 1  
## 231 52 0 nonanginal 136 196 0 2 169 0 0.1 2 0  
## 232 55 0 asymptomatic 180 327 0 1 117 1 3.4 2 0  
## 233 49 1 nonanginal 118 149 0 2 126 0 0.8 1 3  
## 234 74 0 nontypical 120 269 0 2 121 1 0.2 1 1  
## 235 54 0 nonanginal 160 201 0 0 163 0 0.0 1 1  
## 236 54 1 asymptomatic 122 286 0 2 116 1 3.2 2 2  
## 237 56 1 asymptomatic 130 283 1 2 103 1 1.6 3 0  
## 238 46 1 asymptomatic 120 249 0 2 144 0 0.8 1 0  
## 239 49 0 nontypical 134 271 0 0 162 0 0.0 2 0  
## 240 42 1 nontypical 120 295 0 0 162 0 0.0 1 0  
## 241 41 1 nontypical 110 235 0 0 153 0 0.0 1 0  
## 242 41 0 nontypical 126 306 0 0 163 0 0.0 1 0  
## 243 49 0 asymptomatic 130 269 0 0 163 0 0.0 1 0  
## 244 61 1 typical 134 234 0 0 145 0 2.6 2 2  
## 245 60 0 nonanginal 120 178 1 0 96 0 0.0 1 0  
## 246 67 1 asymptomatic 120 237 0 0 71 0 1.0 2 0  
## 247 58 1 asymptomatic 100 234 0 0 156 0 0.1 1 1  
## 248 47 1 asymptomatic 110 275 0 2 118 1 1.0 2 1  
## 249 52 1 asymptomatic 125 212 0 0 168 0 1.0 1 2  
## 250 62 1 nontypical 128 208 1 2 140 0 0.0 1 0  
## 251 57 1 asymptomatic 110 201 0 0 126 1 1.5 2 0  
## 252 58 1 asymptomatic 146 218 0 0 105 0 2.0 2 1  
## 253 64 1 asymptomatic 128 263 0 0 105 1 0.2 2 1  
## 254 51 0 nonanginal 120 295 0 2 157 0 0.6 1 0  
## 255 43 1 asymptomatic 115 303 0 0 181 0 1.2 2 0  
## 256 42 0 nonanginal 120 209 0 0 173 0 0.0 2 0  
## 257 67 0 asymptomatic 106 223 0 0 142 0 0.3 1 2  
## 258 76 0 nonanginal 140 197 0 1 116 0 1.1 2 0  
## 259 70 1 nontypical 156 245 0 2 143 0 0.0 1 0  
## 260 57 1 nontypical 124 261 0 0 141 0 0.3 1 0  
## 261 44 0 nonanginal 118 242 0 0 149 0 0.3 2 1  
## 262 58 0 nontypical 136 319 1 2 152 0 0.0 1 2  
## 263 60 0 typical 150 240 0 0 171 0 0.9 1 0  
## 264 44 1 nonanginal 120 226 0 0 169 0 0.0 1 0  
## 265 61 1 asymptomatic 138 166 0 2 125 1 3.6 2 1  
## 266 42 1 asymptomatic 136 315 0 0 125 1 1.8 2 0  
## 267 52 1 asymptomatic 128 204 1 0 156 1 1.0 2 0  
## 268 59 1 nonanginal 126 218 1 0 134 0 2.2 2 1  
## 269 40 1 asymptomatic 152 223 0 0 181 0 0.0 1 0  
## 270 42 1 nonanginal 130 180 0 0 150 0 0.0 1 0  
## 271 61 1 asymptomatic 140 207 0 2 138 1 1.9 1 1  
## 272 66 1 asymptomatic 160 228 0 2 138 0 2.3 1 0  
## 273 46 1 asymptomatic 140 311 0 0 120 1 1.8 2 2  
## 274 71 0 asymptomatic 112 149 0 0 125 0 1.6 2 0  
## 275 59 1 typical 134 204 0 0 162 0 0.8 1 2  
## 276 64 1 typical 170 227 0 2 155 0 0.6 2 0  
## 277 66 0 nonanginal 146 278 0 2 152 0 0.0 2 1  
## 278 39 0 nonanginal 138 220 0 0 152 0 0.0 2 0  
## 279 57 1 nontypical 154 232 0 2 164 0 0.0 1 1  
## 280 58 0 asymptomatic 130 197 0 0 131 0 0.6 2 0  
## 281 57 1 asymptomatic 110 335 0 0 143 1 3.0 2 1  
## 282 47 1 nonanginal 130 253 0 0 179 0 0.0 1 0  
## 283 55 0 asymptomatic 128 205 0 1 130 1 2.0 2 1  
## 284 35 1 nontypical 122 192 0 0 174 0 0.0 1 0  
## 285 61 1 asymptomatic 148 203 0 0 161 0 0.0 1 1  
## 286 58 1 asymptomatic 114 318 0 1 140 0 4.4 3 3  
## 287 58 0 asymptomatic 170 225 1 2 146 1 2.8 2 2  
## 288 58 1 nontypical 125 220 0 0 144 0 0.4 2 0  
## 289 56 1 nontypical 130 221 0 2 163 0 0.0 1 0  
## 290 56 1 nontypical 120 240 0 0 169 0 0.0 3 0  
## 291 67 1 nonanginal 152 212 0 2 150 0 0.8 2 0  
## 292 55 0 nontypical 132 342 0 0 166 0 1.2 1 0  
## 293 44 1 asymptomatic 120 169 0 0 144 1 2.8 3 0  
## 294 63 1 asymptomatic 140 187 0 2 144 1 4.0 1 2  
## 295 63 0 asymptomatic 124 197 0 0 136 1 0.0 2 0  
## 296 41 1 nontypical 120 157 0 0 182 0 0.0 1 0  
## 297 59 1 asymptomatic 164 176 1 2 90 0 1.0 2 2  
## 298 57 0 asymptomatic 140 241 0 0 123 1 0.2 2 0  
## 299 45 1 typical 110 264 0 0 132 0 1.2 2 0  
## 300 68 1 asymptomatic 144 193 1 0 141 0 3.4 2 2  
## 301 57 1 asymptomatic 130 131 0 0 115 1 1.2 2 1  
## 302 57 0 nontypical 130 236 0 2 174 0 0.0 2 1  
## 303 38 1 nonanginal 138 175 0 0 173 0 0.0 1 0  
## AHD Thal\_new  
## 1 No 0  
## 2 Yes 1  
## 3 Yes 2  
## 4 No 1  
## 5 No 1  
## 6 No 1  
## 7 Yes 1  
## 8 No 1  
## 9 Yes 2  
## 10 Yes 2  
## 11 No 0  
## 12 No 1  
## 13 Yes 0  
## 14 No 2  
## 15 No 2  
## 16 No 1  
## 17 Yes 2  
## 18 No 1  
## 19 No 1  
## 20 No 1  
## 21 No 1  
## 22 No 1  
## 23 Yes 1  
## 24 Yes 2  
## 25 Yes 2  
## 26 No 1  
## 27 No 1  
## 28 No 1  
## 29 No 1  
## 30 Yes 2  
## 31 No 1  
## 32 Yes 2  
## 33 Yes 1  
## 34 No 2  
## 35 No 1  
## 36 No 1  
## 37 Yes 2  
## 38 Yes 0  
## 39 Yes 2  
## 40 No 1  
## 41 Yes 2  
## 42 No 2  
## 43 No 1  
## 44 No 1  
## 45 Yes 1  
## 46 Yes 2  
## 47 No 1  
## 48 Yes 2  
## 49 No 1  
## 50 No 1  
## 51 No 1  
## 52 No 2  
## 53 Yes 1  
## 54 No 1  
## 55 Yes 2  
## 56 Yes 2  
## 57 Yes 2  
## 58 Yes 2  
## 59 No 1  
## 60 No 1  
## 61 Yes 2  
## 62 No 1  
## 63 Yes 2  
## 64 No 1  
## 65 Yes 2  
## 66 Yes 2  
## 67 Yes 1  
## 68 No 2  
## 69 Yes 2  
## 70 Yes 1  
## 71 No 1  
## 72 Yes 2  
## 73 Yes 2  
## 74 Yes 0  
## 75 Yes 1  
## 76 No 1  
## 77 Yes 2  
## 78 No 1  
## 79 No 1  
## 80 Yes 2  
## 81 No 1  
## 82 No 1  
## 83 No 1  
## 84 Yes 2  
## 85 No 1  
## 86 No 1  
## 87 No 1  
## 88 No 1  
## 89 No 1  
## 90 No 1  
## 91 No 1  
## 92 Yes 2  
## 93 No 2  
## 94 No 1  
## 95 No 1  
## 96 Yes 2  
## 97 Yes 2  
## 98 Yes 2  
## 99 No 1  
## 100 No 1  
## 101 No 1  
## 102 No 1  
## 103 No 1  
## 104 No 1  
## 105 Yes 2  
## 106 No 2  
## 107 Yes 2  
## 108 Yes 2  
## 109 Yes 2  
## 110 Yes 2  
## 111 Yes 2  
## 112 Yes 1  
## 113 No 0  
## 114 Yes 2  
## 115 Yes 2  
## 116 No 0  
## 117 No 1  
## 118 No 1  
## 119 Yes 2  
## 120 Yes 2  
## 121 Yes 2  
## 122 Yes 2  
## 123 No 1  
## 124 Yes 2  
## 125 Yes 1  
## 126 No 1  
## 127 Yes 2  
## 128 Yes 2  
## 129 No 1  
## 130 No 1  
## 131 No 2  
## 132 No 2  
## 133 No 1  
## 134 No 1  
## 135 No 1  
## 136 No 1  
## 137 Yes 2  
## 138 Yes 2  
## 139 Yes 2  
## 140 No 1  
## 141 No 1  
## 142 Yes 2  
## 143 No 1  
## 144 Yes 2  
## 145 No 2  
## 146 Yes 1  
## 147 Yes 2  
## 148 No 1  
## 149 No 1  
## 150 No 1  
## 151 No 2  
## 152 No 1  
## 153 No 2  
## 154 Yes 2  
## 155 Yes 1  
## 156 Yes 1  
## 157 Yes 2  
## 158 Yes 2  
## 159 Yes 2  
## 160 No 2  
## 161 No 2  
## 162 Yes 1  
## 163 No 1  
## 164 No 1  
## 165 No 1  
## 166 No 2  
## 167 No 1  
## 168 No 1  
## 169 Yes 2  
## 170 No 1  
## 171 Yes 2  
## 172 No 2  
## 173 Yes 1  
## 174 No 1  
## 175 Yes 0  
## 176 Yes 2  
## 177 No 2  
## 178 Yes 0  
## 179 No 1  
## 180 No 1  
## 181 Yes 2  
## 182 Yes 2  
## 183 No 1  
## 184 No 2  
## 185 Yes 1  
## 186 No 1  
## 187 No 2  
## 188 Yes 0  
## 189 Yes 2  
## 190 Yes 2  
## 191 No 1  
## 192 Yes 2  
## 193 Yes 2  
## 194 Yes 1  
## 195 No 1  
## 196 Yes 1  
## 197 No 1  
## 198 No 1  
## 199 No 1  
## 200 Yes 1  
## 201 No 1  
## 202 No 1  
## 203 No 2  
## 204 No 2  
## 205 No 2  
## 206 Yes 2  
## 207 Yes 2  
## 208 Yes 2  
## 209 No 1  
## 210 Yes 1  
## 211 No 1  
## 212 Yes 2  
## 213 No 1  
## 214 Yes 2  
## 215 Yes 1  
## 216 No 2  
## 217 No 1  
## 218 No 1  
## 219 No 1  
## 220 No 1  
## 221 No 1  
## 222 No 1  
## 223 No 1  
## 224 Yes 2  
## 225 Yes 1  
## 226 No 1  
## 227 No 1  
## 228 No 1  
## 229 Yes 1  
## 230 Yes 1  
## 231 No 1  
## 232 Yes 1  
## 233 Yes 1  
## 234 No 1  
## 235 No 1  
## 236 Yes 1  
## 237 Yes 2  
## 238 Yes 2  
## 239 No 1  
## 240 No 1  
## 241 No 1  
## 242 No 1  
## 243 No 1  
## 244 Yes 1  
## 245 No 1  
## 246 Yes 1  
## 247 Yes 2  
## 248 Yes 1  
## 249 Yes 2  
## 250 No 1  
## 251 No 0  
## 252 Yes 2  
## 253 No 2  
## 254 No 1  
## 255 No 1  
## 256 No 1  
## 257 No 1  
## 258 No 1  
## 259 No 1  
## 260 Yes 2  
## 261 No 1  
## 262 Yes 1  
## 263 No 1  
## 264 No 1  
## 265 Yes 1  
## 266 Yes 0  
## 267 Yes 2  
## 268 Yes 0  
## 269 Yes 2  
## 270 No 1  
## 271 Yes 2  
## 272 No 0  
## 273 Yes 2  
## 274 No 1  
## 275 Yes 1  
## 276 No 2  
## 277 No 1  
## 278 No 1  
## 279 Yes 1  
## 280 No 1  
## 281 Yes 2  
## 282 No 1  
## 283 Yes 2  
## 284 No 1  
## 285 Yes 2  
## 286 Yes 0  
## 287 Yes 0  
## 288 No 2  
## 289 No 2  
## 290 No 1  
## 291 Yes 2  
## 292 No 1  
## 293 Yes 0  
## 294 Yes 2  
## 295 Yes 1  
## 296 No 1  
## 297 Yes 0  
## 298 Yes 2  
## 299 Yes 2  
## 300 Yes 2  
## 301 Yes 2  
## 302 Yes 1  
## 303 No 1

## Thal and Ca are imputed with new values  
cp\_completed %>% group\_by(Ca) %>% count()

## # A tibble: 4 x 2  
## # Groups: Ca [4]  
## Ca n  
## <dbl> <int>  
## 1 0 180  
## 2 1 65  
## 3 2 38  
## 4 3 20

cp\_completed %>% group\_by(Thal\_new) %>% count()

## # A tibble: 3 x 2  
## # Groups: Thal\_new [3]  
## Thal\_new n  
## <dbl> <int>  
## 1 0 18  
## 2 1 167  
## 3 2 118

## Normalization

## Now we need to normalize only the numeric variables  
  
cp\_completed

## Age Sex ChestPain RestBP Chol Fbs RestECG MaxHR ExAng Oldpeak Slope Ca  
## 1 63 1 typical 145 233 1 2 150 0 2.3 3 0  
## 2 67 1 asymptomatic 160 286 0 2 108 1 1.5 2 3  
## 3 67 1 asymptomatic 120 229 0 2 129 1 2.6 2 2  
## 4 37 1 nonanginal 130 250 0 0 187 0 3.5 3 0  
## 5 41 0 nontypical 130 204 0 2 172 0 1.4 1 0  
## 6 56 1 nontypical 120 236 0 0 178 0 0.8 1 0  
## 7 62 0 asymptomatic 140 268 0 2 160 0 3.6 3 2  
## 8 57 0 asymptomatic 120 354 0 0 163 1 0.6 1 0  
## 9 63 1 asymptomatic 130 254 0 2 147 0 1.4 2 1  
## 10 53 1 asymptomatic 140 203 1 2 155 1 3.1 3 0  
## 11 57 1 asymptomatic 140 192 0 0 148 0 0.4 2 0  
## 12 56 0 nontypical 140 294 0 2 153 0 1.3 2 0  
## 13 56 1 nonanginal 130 256 1 2 142 1 0.6 2 1  
## 14 44 1 nontypical 120 263 0 0 173 0 0.0 1 0  
## 15 52 1 nonanginal 172 199 1 0 162 0 0.5 1 0  
## 16 57 1 nonanginal 150 168 0 0 174 0 1.6 1 0  
## 17 48 1 nontypical 110 229 0 0 168 0 1.0 3 0  
## 18 54 1 asymptomatic 140 239 0 0 160 0 1.2 1 0  
## 19 48 0 nonanginal 130 275 0 0 139 0 0.2 1 0  
## 20 49 1 nontypical 130 266 0 0 171 0 0.6 1 0  
## 21 64 1 typical 110 211 0 2 144 1 1.8 2 0  
## 22 58 0 typical 150 283 1 2 162 0 1.0 1 0  
## 23 58 1 nontypical 120 284 0 2 160 0 1.8 2 0  
## 24 58 1 nonanginal 132 224 0 2 173 0 3.2 1 2  
## 25 60 1 asymptomatic 130 206 0 2 132 1 2.4 2 2  
## 26 50 0 nonanginal 120 219 0 0 158 0 1.6 2 0  
## 27 58 0 nonanginal 120 340 0 0 172 0 0.0 1 0  
## 28 66 0 typical 150 226 0 0 114 0 2.6 3 0  
## 29 43 1 asymptomatic 150 247 0 0 171 0 1.5 1 0  
## 30 40 1 asymptomatic 110 167 0 2 114 1 2.0 2 0  
## 31 69 0 typical 140 239 0 0 151 0 1.8 1 2  
## 32 60 1 asymptomatic 117 230 1 0 160 1 1.4 1 2  
## 33 64 1 nonanginal 140 335 0 0 158 0 0.0 1 0  
## 34 59 1 asymptomatic 135 234 0 0 161 0 0.5 2 0  
## 35 44 1 nonanginal 130 233 0 0 179 1 0.4 1 0  
## 36 42 1 asymptomatic 140 226 0 0 178 0 0.0 1 0  
## 37 43 1 asymptomatic 120 177 0 2 120 1 2.5 2 0  
## 38 57 1 asymptomatic 150 276 0 2 112 1 0.6 2 1  
## 39 55 1 asymptomatic 132 353 0 0 132 1 1.2 2 1  
## 40 61 1 nonanginal 150 243 1 0 137 1 1.0 2 0  
## 41 65 0 asymptomatic 150 225 0 2 114 0 1.0 2 3  
## 42 40 1 typical 140 199 0 0 178 1 1.4 1 0  
## 43 71 0 nontypical 160 302 0 0 162 0 0.4 1 2  
## 44 59 1 nonanginal 150 212 1 0 157 0 1.6 1 0  
## 45 61 0 asymptomatic 130 330 0 2 169 0 0.0 1 0  
## 46 58 1 nonanginal 112 230 0 2 165 0 2.5 2 1  
## 47 51 1 nonanginal 110 175 0 0 123 0 0.6 1 0  
## 48 50 1 asymptomatic 150 243 0 2 128 0 2.6 2 0  
## 49 65 0 nonanginal 140 417 1 2 157 0 0.8 1 1  
## 50 53 1 nonanginal 130 197 1 2 152 0 1.2 3 0  
## 51 41 0 nontypical 105 198 0 0 168 0 0.0 1 1  
## 52 65 1 asymptomatic 120 177 0 0 140 0 0.4 1 0  
## 53 44 1 asymptomatic 112 290 0 2 153 0 0.0 1 1  
## 54 44 1 nontypical 130 219 0 2 188 0 0.0 1 0  
## 55 60 1 asymptomatic 130 253 0 0 144 1 1.4 1 1  
## 56 54 1 asymptomatic 124 266 0 2 109 1 2.2 2 1  
## 57 50 1 nonanginal 140 233 0 0 163 0 0.6 2 1  
## 58 41 1 asymptomatic 110 172 0 2 158 0 0.0 1 0  
## 59 54 1 nonanginal 125 273 0 2 152 0 0.5 3 1  
## 60 51 1 typical 125 213 0 2 125 1 1.4 1 1  
## 61 51 0 asymptomatic 130 305 0 0 142 1 1.2 2 0  
## 62 46 0 nonanginal 142 177 0 2 160 1 1.4 3 0  
## 63 58 1 asymptomatic 128 216 0 2 131 1 2.2 2 3  
## 64 54 0 nonanginal 135 304 1 0 170 0 0.0 1 0  
## 65 54 1 asymptomatic 120 188 0 0 113 0 1.4 2 1  
## 66 60 1 asymptomatic 145 282 0 2 142 1 2.8 2 2  
## 67 60 1 nonanginal 140 185 0 2 155 0 3.0 2 0  
## 68 54 1 nonanginal 150 232 0 2 165 0 1.6 1 0  
## 69 59 1 asymptomatic 170 326 0 2 140 1 3.4 3 0  
## 70 46 1 nonanginal 150 231 0 0 147 0 3.6 2 0  
## 71 65 0 nonanginal 155 269 0 0 148 0 0.8 1 0  
## 72 67 1 asymptomatic 125 254 1 0 163 0 0.2 2 2  
## 73 62 1 asymptomatic 120 267 0 0 99 1 1.8 2 2  
## 74 65 1 asymptomatic 110 248 0 2 158 0 0.6 1 2  
## 75 44 1 asymptomatic 110 197 0 2 177 0 0.0 1 1  
## 76 65 0 nonanginal 160 360 0 2 151 0 0.8 1 0  
## 77 60 1 asymptomatic 125 258 0 2 141 1 2.8 2 1  
## 78 51 0 nonanginal 140 308 0 2 142 0 1.5 1 1  
## 79 48 1 nontypical 130 245 0 2 180 0 0.2 2 0  
## 80 58 1 asymptomatic 150 270 0 2 111 1 0.8 1 0  
## 81 45 1 asymptomatic 104 208 0 2 148 1 3.0 2 0  
## 82 53 0 asymptomatic 130 264 0 2 143 0 0.4 2 0  
## 83 39 1 nonanginal 140 321 0 2 182 0 0.0 1 0  
## 84 68 1 nonanginal 180 274 1 2 150 1 1.6 2 0  
## 85 52 1 nontypical 120 325 0 0 172 0 0.2 1 0  
## 86 44 1 nonanginal 140 235 0 2 180 0 0.0 1 0  
## 87 47 1 nonanginal 138 257 0 2 156 0 0.0 1 0  
## 88 53 0 nonanginal 128 216 0 2 115 0 0.0 1 0  
## 89 53 0 asymptomatic 138 234 0 2 160 0 0.0 1 0  
## 90 51 0 nonanginal 130 256 0 2 149 0 0.5 1 0  
## 91 66 1 asymptomatic 120 302 0 2 151 0 0.4 2 0  
## 92 62 0 asymptomatic 160 164 0 2 145 0 6.2 3 3  
## 93 62 1 nonanginal 130 231 0 0 146 0 1.8 2 3  
## 94 44 0 nonanginal 108 141 0 0 175 0 0.6 2 0  
## 95 63 0 nonanginal 135 252 0 2 172 0 0.0 1 0  
## 96 52 1 asymptomatic 128 255 0 0 161 1 0.0 1 1  
## 97 59 1 asymptomatic 110 239 0 2 142 1 1.2 2 1  
## 98 60 0 asymptomatic 150 258 0 2 157 0 2.6 2 2  
## 99 52 1 nontypical 134 201 0 0 158 0 0.8 1 1  
## 100 48 1 asymptomatic 122 222 0 2 186 0 0.0 1 0  
## 101 45 1 asymptomatic 115 260 0 2 185 0 0.0 1 0  
## 102 34 1 typical 118 182 0 2 174 0 0.0 1 0  
## 103 57 0 asymptomatic 128 303 0 2 159 0 0.0 1 1  
## 104 71 0 nonanginal 110 265 1 2 130 0 0.0 1 1  
## 105 49 1 nonanginal 120 188 0 0 139 0 2.0 2 3  
## 106 54 1 nontypical 108 309 0 0 156 0 0.0 1 0  
## 107 59 1 asymptomatic 140 177 0 0 162 1 0.0 1 1  
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## 109 61 1 asymptomatic 120 260 0 0 140 1 3.6 2 1  
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## 112 56 1 asymptomatic 125 249 1 2 144 1 1.2 2 1  
## 113 52 1 typical 118 186 0 2 190 0 0.0 2 0  
## 114 43 0 asymptomatic 132 341 1 2 136 1 3.0 2 0  
## 115 62 0 nonanginal 130 263 0 0 97 0 1.2 2 1  
## 116 41 1 nontypical 135 203 0 0 132 0 0.0 2 0  
## 117 58 1 nonanginal 140 211 1 2 165 0 0.0 1 0  
## 118 35 0 asymptomatic 138 183 0 0 182 0 1.4 1 0  
## 119 63 1 asymptomatic 130 330 1 2 132 1 1.8 1 3  
## 120 65 1 asymptomatic 135 254 0 2 127 0 2.8 2 1  
## 121 48 1 asymptomatic 130 256 1 2 150 1 0.0 1 2  
## 122 63 0 asymptomatic 150 407 0 2 154 0 4.0 2 3  
## 123 51 1 nonanginal 100 222 0 0 143 1 1.2 2 0  
## 124 55 1 asymptomatic 140 217 0 0 111 1 5.6 3 0  
## 125 65 1 typical 138 282 1 2 174 0 1.4 2 1  
## 126 45 0 nontypical 130 234 0 2 175 0 0.6 2 0  
## 127 56 0 asymptomatic 200 288 1 2 133 1 4.0 3 2  
## 128 54 1 asymptomatic 110 239 0 0 126 1 2.8 2 1  
## 129 44 1 nontypical 120 220 0 0 170 0 0.0 1 0  
## 130 62 0 asymptomatic 124 209 0 0 163 0 0.0 1 0  
## 131 54 1 nonanginal 120 258 0 2 147 0 0.4 2 0  
## 132 51 1 nonanginal 94 227 0 0 154 1 0.0 1 1  
## 133 29 1 nontypical 130 204 0 2 202 0 0.0 1 0  
## 134 51 1 asymptomatic 140 261 0 2 186 1 0.0 1 0  
## 135 43 0 nonanginal 122 213 0 0 165 0 0.2 2 0  
## 136 55 0 nontypical 135 250 0 2 161 0 1.4 2 0  
## 137 70 1 asymptomatic 145 174 0 0 125 1 2.6 3 0  
## 138 62 1 nontypical 120 281 0 2 103 0 1.4 2 1  
## 139 35 1 asymptomatic 120 198 0 0 130 1 1.6 2 0  
## 140 51 1 nonanginal 125 245 1 2 166 0 2.4 2 0  
## 141 59 1 nontypical 140 221 0 0 164 1 0.0 1 0  
## 142 59 1 typical 170 288 0 2 159 0 0.2 2 0  
## 143 52 1 nontypical 128 205 1 0 184 0 0.0 1 0  
## 144 64 1 nonanginal 125 309 0 0 131 1 1.8 2 0  
## 145 58 1 nonanginal 105 240 0 2 154 1 0.6 2 0  
## 146 47 1 nonanginal 108 243 0 0 152 0 0.0 1 0  
## 147 57 1 asymptomatic 165 289 1 2 124 0 1.0 2 3  
## 148 41 1 nonanginal 112 250 0 0 179 0 0.0 1 0  
## 149 45 1 nontypical 128 308 0 2 170 0 0.0 1 0  
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## 151 52 1 typical 152 298 1 0 178 0 1.2 2 0  
## 152 42 0 asymptomatic 102 265 0 2 122 0 0.6 2 0  
## 153 67 0 nonanginal 115 564 0 2 160 0 1.6 2 0  
## 154 55 1 asymptomatic 160 289 0 2 145 1 0.8 2 1  
## 155 64 1 asymptomatic 120 246 0 2 96 1 2.2 3 1  
## 156 70 1 asymptomatic 130 322 0 2 109 0 2.4 2 3  
## 157 51 1 asymptomatic 140 299 0 0 173 1 1.6 1 0  
## 158 58 1 asymptomatic 125 300 0 2 171 0 0.0 1 2  
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## 162 77 1 asymptomatic 125 304 0 2 162 1 0.0 1 3  
## 163 54 0 nonanginal 110 214 0 0 158 0 1.6 2 0  
## 164 58 0 asymptomatic 100 248 0 2 122 0 1.0 2 0  
## 165 48 1 nonanginal 124 255 1 0 175 0 0.0 1 2  
## 166 57 1 asymptomatic 132 207 0 0 168 1 0.0 1 0  
## 167 52 1 nonanginal 138 223 0 0 169 0 0.0 1 0  
## 168 54 0 nontypical 132 288 1 2 159 1 0.0 1 1  
## 169 35 1 asymptomatic 126 282 0 2 156 1 0.0 1 0  
## 170 45 0 nontypical 112 160 0 0 138 0 0.0 2 0  
## 171 70 1 nonanginal 160 269 0 0 112 1 2.9 2 1  
## 172 53 1 asymptomatic 142 226 0 2 111 1 0.0 1 0  
## 173 59 0 asymptomatic 174 249 0 0 143 1 0.0 2 0  
## 174 62 0 asymptomatic 140 394 0 2 157 0 1.2 2 0  
## 175 64 1 asymptomatic 145 212 0 2 132 0 2.0 2 2  
## 176 57 1 asymptomatic 152 274 0 0 88 1 1.2 2 1  
## 177 52 1 asymptomatic 108 233 1 0 147 0 0.1 1 3  
## 178 56 1 asymptomatic 132 184 0 2 105 1 2.1 2 1  
## 179 43 1 nonanginal 130 315 0 0 162 0 1.9 1 1  
## 180 53 1 nonanginal 130 246 1 2 173 0 0.0 1 3  
## 181 48 1 asymptomatic 124 274 0 2 166 0 0.5 2 0  
## 182 56 0 asymptomatic 134 409 0 2 150 1 1.9 2 2  
## 183 42 1 typical 148 244 0 2 178 0 0.8 1 2  
## 184 59 1 typical 178 270 0 2 145 0 4.2 3 0  
## 185 60 0 asymptomatic 158 305 0 2 161 0 0.0 1 0  
## 186 63 0 nontypical 140 195 0 0 179 0 0.0 1 2  
## 187 42 1 nonanginal 120 240 1 0 194 0 0.8 3 0  
## 188 66 1 nontypical 160 246 0 0 120 1 0.0 2 3  
## 189 54 1 nontypical 192 283 0 2 195 0 0.0 1 1  
## 190 69 1 nonanginal 140 254 0 2 146 0 2.0 2 3  
## 191 50 1 nonanginal 129 196 0 0 163 0 0.0 1 0  
## 192 51 1 asymptomatic 140 298 0 0 122 1 4.2 2 3  
## 193 43 1 asymptomatic 132 247 1 2 143 1 0.1 2 0  
## 194 62 0 asymptomatic 138 294 1 0 106 0 1.9 2 3  
## 195 68 0 nonanginal 120 211 0 2 115 0 1.5 2 0  
## 196 67 1 asymptomatic 100 299 0 2 125 1 0.9 2 2  
## 197 69 1 typical 160 234 1 2 131 0 0.1 2 1  
## 198 45 0 asymptomatic 138 236 0 2 152 1 0.2 2 0  
## 199 50 0 nontypical 120 244 0 0 162 0 1.1 1 0  
## 200 59 1 typical 160 273 0 2 125 0 0.0 1 0  
## 201 50 0 asymptomatic 110 254 0 2 159 0 0.0 1 0  
## 202 64 0 asymptomatic 180 325 0 0 154 1 0.0 1 0  
## 203 57 1 nonanginal 150 126 1 0 173 0 0.2 1 1  
## 204 64 0 nonanginal 140 313 0 0 133 0 0.2 1 0  
## 205 43 1 asymptomatic 110 211 0 0 161 0 0.0 1 0  
## 206 45 1 asymptomatic 142 309 0 2 147 1 0.0 2 3  
## 207 58 1 asymptomatic 128 259 0 2 130 1 3.0 2 2  
## 208 50 1 asymptomatic 144 200 0 2 126 1 0.9 2 0  
## 209 55 1 nontypical 130 262 0 0 155 0 0.0 1 0  
## 210 62 0 asymptomatic 150 244 0 0 154 1 1.4 2 0  
## 211 37 0 nonanginal 120 215 0 0 170 0 0.0 1 0  
## 212 38 1 typical 120 231 0 0 182 1 3.8 2 0  
## 213 41 1 nonanginal 130 214 0 2 168 0 2.0 2 0  
## 214 66 0 asymptomatic 178 228 1 0 165 1 1.0 2 2  
## 215 52 1 asymptomatic 112 230 0 0 160 0 0.0 1 1  
## 216 56 1 typical 120 193 0 2 162 0 1.9 2 0  
## 217 46 0 nontypical 105 204 0 0 172 0 0.0 1 0  
## 218 46 0 asymptomatic 138 243 0 2 152 1 0.0 2 0  
## 219 64 0 asymptomatic 130 303 0 0 122 0 2.0 2 2  
## 220 59 1 asymptomatic 138 271 0 2 182 0 0.0 1 0  
## 221 41 0 nonanginal 112 268 0 2 172 1 0.0 1 0  
## 222 54 0 nonanginal 108 267 0 2 167 0 0.0 1 0  
## 223 39 0 nonanginal 94 199 0 0 179 0 0.0 1 0  
## 224 53 1 asymptomatic 123 282 0 0 95 1 2.0 2 2  
## 225 63 0 asymptomatic 108 269 0 0 169 1 1.8 2 2  
## 226 34 0 nontypical 118 210 0 0 192 0 0.7 1 0  
## 227 47 1 asymptomatic 112 204 0 0 143 0 0.1 1 0  
## 228 67 0 nonanginal 152 277 0 0 172 0 0.0 1 1  
## 229 54 1 asymptomatic 110 206 0 2 108 1 0.0 2 1  
## 230 66 1 asymptomatic 112 212 0 2 132 1 0.1 1 1  
## 231 52 0 nonanginal 136 196 0 2 169 0 0.1 2 0  
## 232 55 0 asymptomatic 180 327 0 1 117 1 3.4 2 0  
## 233 49 1 nonanginal 118 149 0 2 126 0 0.8 1 3  
## 234 74 0 nontypical 120 269 0 2 121 1 0.2 1 1  
## 235 54 0 nonanginal 160 201 0 0 163 0 0.0 1 1  
## 236 54 1 asymptomatic 122 286 0 2 116 1 3.2 2 2  
## 237 56 1 asymptomatic 130 283 1 2 103 1 1.6 3 0  
## 238 46 1 asymptomatic 120 249 0 2 144 0 0.8 1 0  
## 239 49 0 nontypical 134 271 0 0 162 0 0.0 2 0  
## 240 42 1 nontypical 120 295 0 0 162 0 0.0 1 0  
## 241 41 1 nontypical 110 235 0 0 153 0 0.0 1 0  
## 242 41 0 nontypical 126 306 0 0 163 0 0.0 1 0  
## 243 49 0 asymptomatic 130 269 0 0 163 0 0.0 1 0  
## 244 61 1 typical 134 234 0 0 145 0 2.6 2 2  
## 245 60 0 nonanginal 120 178 1 0 96 0 0.0 1 0  
## 246 67 1 asymptomatic 120 237 0 0 71 0 1.0 2 0  
## 247 58 1 asymptomatic 100 234 0 0 156 0 0.1 1 1  
## 248 47 1 asymptomatic 110 275 0 2 118 1 1.0 2 1  
## 249 52 1 asymptomatic 125 212 0 0 168 0 1.0 1 2  
## 250 62 1 nontypical 128 208 1 2 140 0 0.0 1 0  
## 251 57 1 asymptomatic 110 201 0 0 126 1 1.5 2 0  
## 252 58 1 asymptomatic 146 218 0 0 105 0 2.0 2 1  
## 253 64 1 asymptomatic 128 263 0 0 105 1 0.2 2 1  
## 254 51 0 nonanginal 120 295 0 2 157 0 0.6 1 0  
## 255 43 1 asymptomatic 115 303 0 0 181 0 1.2 2 0  
## 256 42 0 nonanginal 120 209 0 0 173 0 0.0 2 0  
## 257 67 0 asymptomatic 106 223 0 0 142 0 0.3 1 2  
## 258 76 0 nonanginal 140 197 0 1 116 0 1.1 2 0  
## 259 70 1 nontypical 156 245 0 2 143 0 0.0 1 0  
## 260 57 1 nontypical 124 261 0 0 141 0 0.3 1 0  
## 261 44 0 nonanginal 118 242 0 0 149 0 0.3 2 1  
## 262 58 0 nontypical 136 319 1 2 152 0 0.0 1 2  
## 263 60 0 typical 150 240 0 0 171 0 0.9 1 0  
## 264 44 1 nonanginal 120 226 0 0 169 0 0.0 1 0  
## 265 61 1 asymptomatic 138 166 0 2 125 1 3.6 2 1  
## 266 42 1 asymptomatic 136 315 0 0 125 1 1.8 2 0  
## 267 52 1 asymptomatic 128 204 1 0 156 1 1.0 2 0  
## 268 59 1 nonanginal 126 218 1 0 134 0 2.2 2 1  
## 269 40 1 asymptomatic 152 223 0 0 181 0 0.0 1 0  
## 270 42 1 nonanginal 130 180 0 0 150 0 0.0 1 0  
## 271 61 1 asymptomatic 140 207 0 2 138 1 1.9 1 1  
## 272 66 1 asymptomatic 160 228 0 2 138 0 2.3 1 0  
## 273 46 1 asymptomatic 140 311 0 0 120 1 1.8 2 2  
## 274 71 0 asymptomatic 112 149 0 0 125 0 1.6 2 0  
## 275 59 1 typical 134 204 0 0 162 0 0.8 1 2  
## 276 64 1 typical 170 227 0 2 155 0 0.6 2 0  
## 277 66 0 nonanginal 146 278 0 2 152 0 0.0 2 1  
## 278 39 0 nonanginal 138 220 0 0 152 0 0.0 2 0  
## 279 57 1 nontypical 154 232 0 2 164 0 0.0 1 1  
## 280 58 0 asymptomatic 130 197 0 0 131 0 0.6 2 0  
## 281 57 1 asymptomatic 110 335 0 0 143 1 3.0 2 1  
## 282 47 1 nonanginal 130 253 0 0 179 0 0.0 1 0  
## 283 55 0 asymptomatic 128 205 0 1 130 1 2.0 2 1  
## 284 35 1 nontypical 122 192 0 0 174 0 0.0 1 0  
## 285 61 1 asymptomatic 148 203 0 0 161 0 0.0 1 1  
## 286 58 1 asymptomatic 114 318 0 1 140 0 4.4 3 3  
## 287 58 0 asymptomatic 170 225 1 2 146 1 2.8 2 2  
## 288 58 1 nontypical 125 220 0 0 144 0 0.4 2 0  
## 289 56 1 nontypical 130 221 0 2 163 0 0.0 1 0  
## 290 56 1 nontypical 120 240 0 0 169 0 0.0 3 0  
## 291 67 1 nonanginal 152 212 0 2 150 0 0.8 2 0  
## 292 55 0 nontypical 132 342 0 0 166 0 1.2 1 0  
## 293 44 1 asymptomatic 120 169 0 0 144 1 2.8 3 0  
## 294 63 1 asymptomatic 140 187 0 2 144 1 4.0 1 2  
## 295 63 0 asymptomatic 124 197 0 0 136 1 0.0 2 0  
## 296 41 1 nontypical 120 157 0 0 182 0 0.0 1 0  
## 297 59 1 asymptomatic 164 176 1 2 90 0 1.0 2 2  
## 298 57 0 asymptomatic 140 241 0 0 123 1 0.2 2 0  
## 299 45 1 typical 110 264 0 0 132 0 1.2 2 0  
## 300 68 1 asymptomatic 144 193 1 0 141 0 3.4 2 2  
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## 303 38 1 nonanginal 138 175 0 0 173 0 0.0 1 0  
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## 1 No 0  
## 2 Yes 1  
## 3 Yes 2  
## 4 No 1  
## 5 No 1  
## 6 No 1  
## 7 Yes 1  
## 8 No 1  
## 9 Yes 2  
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## 11 No 0  
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## 39 Yes 2  
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## 90 No 1  
## 91 No 1  
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## 106 No 2  
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## 295 Yes 1  
## 296 No 1  
## 297 Yes 0  
## 298 Yes 2  
## 299 Yes 2  
## 300 Yes 2  
## 301 Yes 2  
## 302 Yes 1  
## 303 No 1

cp\_normalized=cp\_completed%>% mutate(RestBP1=scale(RestBP), MaxHR1=scale(MaxHR), Chol1=scale(Chol), Oldpeak1=scale(Oldpeak))  
   
  
cp\_final = cp\_normalized%>%select(-RestBP, -MaxHR, -Chol, -Oldpeak, )  
cp\_final

## Age Sex ChestPain Fbs RestECG ExAng Slope Ca AHD Thal\_new RestBP1  
## 1 63 1 typical 1 2 0 3 0 No 0 0.75627397  
## 2 67 1 asymptomatic 0 2 1 2 3 Yes 1 1.60855891  
## 3 67 1 asymptomatic 0 2 1 2 2 Yes 2 -0.66420094  
## 4 37 1 nonanginal 0 0 0 3 0 No 1 -0.09601098  
## 5 41 0 nontypical 0 2 0 1 0 No 1 -0.09601098  
## 6 56 1 nontypical 0 0 0 1 0 No 1 -0.66420094  
## 7 62 0 asymptomatic 0 2 0 3 2 Yes 1 0.47217899  
## 8 57 0 asymptomatic 0 0 1 1 0 No 1 -0.66420094  
## 9 63 1 asymptomatic 0 2 0 2 1 Yes 2 -0.09601098  
## 10 53 1 asymptomatic 1 2 1 3 0 Yes 2 0.47217899  
## 11 57 1 asymptomatic 0 0 0 2 0 No 0 0.47217899  
## 12 56 0 nontypical 0 2 0 2 0 No 1 0.47217899  
## 13 56 1 nonanginal 1 2 1 2 1 Yes 0 -0.09601098  
## 14 44 1 nontypical 0 0 0 1 0 No 2 -0.66420094  
## 15 52 1 nonanginal 1 0 0 1 0 No 2 2.29038686  
## 16 57 1 nonanginal 0 0 0 1 0 No 1 1.04036895  
## 17 48 1 nontypical 0 0 0 3 0 Yes 2 -1.23239090  
## 18 54 1 asymptomatic 0 0 0 1 0 No 1 0.47217899  
## 19 48 0 nonanginal 0 0 0 1 0 No 1 -0.09601098  
## 20 49 1 nontypical 0 0 0 1 0 No 1 -0.09601098  
## 21 64 1 typical 0 2 1 2 0 No 1 -1.23239090  
## 22 58 0 typical 1 2 0 1 0 No 1 1.04036895  
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## 24 58 1 nonanginal 0 2 0 1 2 Yes 2 0.01762702  
## 25 60 1 asymptomatic 0 2 1 2 2 Yes 2 -0.09601098  
## 26 50 0 nonanginal 0 0 0 2 0 No 1 -0.66420094  
## 27 58 0 nonanginal 0 0 0 1 0 No 1 -0.66420094  
## 28 66 0 typical 0 0 0 3 0 No 1 1.04036895  
## 29 43 1 asymptomatic 0 0 0 1 0 No 1 1.04036895  
## 30 40 1 asymptomatic 0 2 1 2 0 Yes 2 -1.23239090  
## 31 69 0 typical 0 0 0 1 2 No 1 0.47217899  
## 32 60 1 asymptomatic 1 0 1 1 2 Yes 2 -0.83465793  
## 33 64 1 nonanginal 0 0 0 1 0 Yes 1 0.47217899  
## 34 59 1 asymptomatic 0 0 0 2 0 No 2 0.18808400  
## 35 44 1 nonanginal 0 0 1 1 0 No 1 -0.09601098  
## 36 42 1 asymptomatic 0 0 0 1 0 No 1 0.47217899  
## 37 43 1 asymptomatic 0 2 1 2 0 Yes 2 -0.66420094  
## 38 57 1 asymptomatic 0 2 1 2 1 Yes 0 1.04036895  
## 39 55 1 asymptomatic 0 0 1 2 1 Yes 2 0.01762702  
## 40 61 1 nonanginal 1 0 1 2 0 No 1 1.04036895  
## 41 65 0 asymptomatic 0 2 0 2 3 Yes 2 1.04036895  
## 42 40 1 typical 0 0 1 1 0 No 2 0.47217899  
## 43 71 0 nontypical 0 0 0 1 2 No 1 1.60855891  
## 44 59 1 nonanginal 1 0 0 1 0 No 1 1.04036895  
## 45 61 0 asymptomatic 0 2 0 1 0 Yes 1 -0.09601098  
## 46 58 1 nonanginal 0 2 0 2 1 Yes 2 -1.11875291  
## 47 51 1 nonanginal 0 0 0 1 0 No 1 -1.23239090  
## 48 50 1 asymptomatic 0 2 0 2 0 Yes 2 1.04036895  
## 49 65 0 nonanginal 1 2 0 1 1 No 1 0.47217899  
## 50 53 1 nonanginal 1 2 0 3 0 No 1 -0.09601098  
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## 53 44 1 asymptomatic 0 2 0 1 1 Yes 1 -1.11875291  
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## 55 60 1 asymptomatic 0 0 1 1 1 Yes 2 -0.09601098  
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## 57 50 1 nonanginal 0 0 0 2 1 Yes 2 0.47217899  
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## 59 54 1 nonanginal 0 2 0 3 1 No 1 -0.38010596  
## 60 51 1 typical 0 2 1 1 1 No 1 -0.38010596  
## 61 51 0 asymptomatic 0 0 1 2 0 Yes 2 -0.09601098  
## 62 46 0 nonanginal 0 2 1 3 0 No 1 0.58581698  
## 63 58 1 asymptomatic 0 2 1 2 3 Yes 2 -0.20964897  
## 64 54 0 nonanginal 1 0 0 1 0 No 1 0.18808400  
## 65 54 1 asymptomatic 0 0 0 2 1 Yes 2 -0.66420094  
## 66 60 1 asymptomatic 0 2 1 2 2 Yes 2 0.75627397  
## 67 60 1 nonanginal 0 2 0 2 0 Yes 1 0.47217899  
## 68 54 1 nonanginal 0 2 0 1 0 No 2 1.04036895  
## 69 59 1 asymptomatic 0 2 1 3 0 Yes 2 2.17674887  
## 70 46 1 nonanginal 0 0 0 2 0 Yes 1 1.04036895  
## 71 65 0 nonanginal 0 0 0 1 0 No 1 1.32446393  
## 72 67 1 asymptomatic 1 0 0 2 2 Yes 2 -0.38010596  
## 73 62 1 asymptomatic 0 0 1 2 2 Yes 2 -0.66420094  
## 74 65 1 asymptomatic 0 2 0 1 2 Yes 0 -1.23239090  
## 75 44 1 asymptomatic 0 2 0 1 1 Yes 1 -1.23239090  
## 76 65 0 nonanginal 0 2 0 1 0 No 1 1.60855891  
## 77 60 1 asymptomatic 0 2 1 2 1 Yes 2 -0.38010596  
## 78 51 0 nonanginal 0 2 0 1 1 No 1 0.47217899  
## 79 48 1 nontypical 0 2 0 2 0 No 1 -0.09601098  
## 80 58 1 asymptomatic 0 2 1 1 0 Yes 2 1.04036895  
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## 83 39 1 nonanginal 0 2 0 1 0 No 1 0.47217899  
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## 96 52 1 asymptomatic 0 0 1 1 1 Yes 2 -0.20964897  
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## 100 48 1 asymptomatic 0 2 0 1 0 No 1 -0.55056295  
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## 110 39 1 asymptomatic 0 0 0 2 0 Yes 2 -0.77783893  
## 111 61 0 asymptomatic 0 2 1 2 0 Yes 2 0.75627397  
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## 122 63 0 asymptomatic 0 2 0 2 3 Yes 2 1.04036895  
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## 124 55 1 asymptomatic 0 0 1 3 0 Yes 2 0.47217899  
## 125 65 1 typical 1 2 0 2 1 Yes 1 0.35854099  
## 126 45 0 nontypical 0 2 0 2 0 No 1 -0.09601098  
## 127 56 0 asymptomatic 1 2 1 3 2 Yes 2 3.88131876  
## 128 54 1 asymptomatic 0 0 1 2 1 Yes 2 -1.23239090  
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## 138 62 1 nontypical 0 2 0 2 1 Yes 2 -0.66420094  
## 139 35 1 asymptomatic 0 0 1 2 0 Yes 2 -0.66420094  
## 140 51 1 nonanginal 1 2 0 2 0 No 1 -0.38010596  
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## 144 64 1 nonanginal 0 0 1 2 0 Yes 2 -0.38010596  
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## 147 57 1 asymptomatic 1 2 0 2 3 Yes 2 1.89265389  
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## 149 45 1 nontypical 0 2 0 1 0 No 1 -0.20964897  
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## 156 70 1 asymptomatic 0 2 0 2 3 Yes 1 -0.09601098  
## 157 51 1 asymptomatic 0 0 1 1 0 Yes 2 0.47217899  
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## 159 60 1 asymptomatic 0 2 0 2 2 Yes 2 0.47217899  
## 160 68 1 nonanginal 0 0 0 1 1 No 2 -0.77783893  
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## 170 45 0 nontypical 0 0 0 2 0 No 1 -1.11875291  
## 171 70 1 nonanginal 0 0 1 2 1 Yes 2 1.60855891  
## 172 53 1 asymptomatic 0 2 1 1 0 No 2 0.58581698  
## 173 59 0 asymptomatic 0 0 1 2 0 Yes 1 2.40402486  
## 174 62 0 asymptomatic 0 2 0 2 0 No 1 0.47217899  
## 175 64 1 asymptomatic 0 2 0 2 2 Yes 0 0.75627397  
## 176 57 1 asymptomatic 0 0 1 2 1 Yes 2 1.15400694  
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## 181 48 1 asymptomatic 0 2 0 2 0 Yes 2 -0.43692495  
## 182 56 0 asymptomatic 0 2 1 2 2 Yes 2 0.13126501  
## 183 42 1 typical 0 2 0 1 2 No 1 0.92673096  
## 184 59 1 typical 0 2 0 3 0 No 2 2.63130084  
## 185 60 0 asymptomatic 0 2 0 1 0 Yes 1 1.49492092  
## 186 63 0 nontypical 0 0 0 1 2 No 1 0.47217899  
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## 193 43 1 asymptomatic 1 2 1 2 0 Yes 2 0.01762702  
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## 196 67 1 asymptomatic 0 2 1 2 2 Yes 1 -1.80058086  
## 197 69 1 typical 1 2 0 2 1 No 1 1.60855891  
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## 208 50 1 asymptomatic 0 2 1 2 0 Yes 2 0.69945497  
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## 210 62 0 asymptomatic 0 0 1 2 0 Yes 1 1.04036895  
## 211 37 0 nonanginal 0 0 0 1 0 No 1 -0.66420094  
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## 213 41 1 nonanginal 0 2 0 2 0 No 1 -0.09601098  
## 214 66 0 asymptomatic 1 0 1 2 2 Yes 2 2.63130084  
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## 218 46 0 asymptomatic 0 2 1 2 0 No 1 0.35854099  
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## 235 54 0 nonanginal 0 0 0 1 1 No 1 1.60855891  
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## 240 42 1 nontypical 0 0 0 1 0 No 1 -0.66420094  
## 241 41 1 nontypical 0 0 0 1 0 No 1 -1.23239090  
## 242 41 0 nontypical 0 0 0 1 0 No 1 -0.32328696  
## 243 49 0 asymptomatic 0 0 0 1 0 No 1 -0.09601098  
## 244 61 1 typical 0 0 0 2 2 Yes 1 0.13126501  
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## 246 67 1 asymptomatic 0 0 0 2 0 Yes 1 -0.66420094  
## 247 58 1 asymptomatic 0 0 0 1 1 Yes 2 -1.80058086  
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## 270 42 1 nonanginal 0 0 0 1 0 No 1 -0.09601098  
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## 283 55 0 asymptomatic 0 1 1 2 1 Yes 2 -0.20964897  
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## 141 0.62919070 -0.496226321 -0.89538052  
## 142 0.41061149 0.797786594 -0.72312637  
## 143 1.50350751 -0.805244331 -0.89538052  
## 144 -0.81343205 1.203372732 0.65490690  
## 145 0.19203229 -0.129267435 -0.37861805  
## 146 0.10460061 -0.071326558 -0.89538052  
## 147 -1.11944293 0.817100220 -0.03410973  
## 148 1.28492831 0.063868821 -0.89538052  
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## 150 0.45432733 1.377195362 -0.89538052  
## 151 1.24121247 0.990922850 0.13814442  
## 152 -1.20687461 0.353573205 -0.37861805  
## 153 0.45432733 6.128347259 0.48265274  
## 154 -0.20141028 0.817100220 -0.20636389  
## 155 -2.34348647 -0.013385681 0.99941521  
## 156 -1.77518054 1.454449864 1.17166937  
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## 162 0.54175902 1.106804604 -0.89538052  
## 163 0.36689565 -0.631421700 0.48265274  
## 164 -1.20687461 0.025241570 -0.03410973  
## 165 1.11006495 0.160436949 -0.89538052  
## 166 0.80405406 -0.766617079 -0.89538052  
## 167 0.84776990 -0.457599070 -0.89538052  
## 168 0.41061149 0.797786594 -0.89538052  
## 169 0.27946397 0.681904840 -0.89538052  
## 170 -0.50742116 -1.674357482 -0.89538052  
## 171 -1.64403302 0.430827708 1.60230476  
## 172 -1.68774886 -0.399658193 -0.89538052  
## 173 -0.28884196 0.044555196 -0.89538052  
## 174 0.32317981 2.845030907 0.13814442  
## 175 -0.76971621 -0.670048951 0.82716105  
## 176 -2.69321320 0.527395836 0.13814442  
## 177 -0.11397859 -0.264462814 -0.80925344  
## 178 -1.95004391 -1.210830468 0.91328813  
## 179 0.54175902 1.319254485 0.74103398  
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## 184 -0.20141028 0.450141333 2.72195679  
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## 197 -0.81343205 -0.245149188 -0.80925344  
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## 223 1.28492831 -0.921126084 -0.89538052  
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## 229 -1.81889638 -0.785930705 -0.89538052  
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## 244 -0.20141028 -0.245149188 1.34392353  
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## 246 -3.43638249 -0.187208311 -0.03410973  
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## 263 0.93520158 -0.129267435 -0.12023681  
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## 265 -1.07572709 -1.558475729 2.20519432  
## 266 -1.07572709 1.319254485 0.65490690  
## 267 0.27946397 -0.824557956 -0.03410973  
## 268 -0.68228452 -0.554167198 0.99941521  
## 269 1.37235999 -0.457599070 -0.89538052  
## 270 0.01716893 -1.288084971 -0.89538052  
## 271 -0.50742116 -0.766617079 0.74103398  
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## 274 -1.07572709 -1.886807364 0.48265274  
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## 276 0.23574813 -0.380344567 -0.37861805  
## 277 0.10460061 0.604650338 -0.89538052  
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## 291 0.01716893 -0.670048951 -0.20636389  
## 292 0.71662238 1.840722376 0.13814442  
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## 302 1.06634911 -0.206521937 -0.89538052  
## 303 1.02263326 -1.384653099 -0.89538052

## removing AHD because it will be used for prediction and Age because age shouldnt be dummy coded  
cp\_temp=cp\_final%>%select(-Age, -AHD)  
cp\_temp

## Sex ChestPain Fbs RestECG ExAng Slope Ca Thal\_new RestBP1  
## 1 1 typical 1 2 0 3 0 0 0.75627397  
## 2 1 asymptomatic 0 2 1 2 3 1 1.60855891  
## 3 1 asymptomatic 0 2 1 2 2 2 -0.66420094  
## 4 1 nonanginal 0 0 0 3 0 1 -0.09601098  
## 5 0 nontypical 0 2 0 1 0 1 -0.09601098  
## 6 1 nontypical 0 0 0 1 0 1 -0.66420094  
## 7 0 asymptomatic 0 2 0 3 2 1 0.47217899  
## 8 0 asymptomatic 0 0 1 1 0 1 -0.66420094  
## 9 1 asymptomatic 0 2 0 2 1 2 -0.09601098  
## 10 1 asymptomatic 1 2 1 3 0 2 0.47217899  
## 11 1 asymptomatic 0 0 0 2 0 0 0.47217899  
## 12 0 nontypical 0 2 0 2 0 1 0.47217899  
## 13 1 nonanginal 1 2 1 2 1 0 -0.09601098  
## 14 1 nontypical 0 0 0 1 0 2 -0.66420094  
## 15 1 nonanginal 1 0 0 1 0 2 2.29038686  
## 16 1 nonanginal 0 0 0 1 0 1 1.04036895  
## 17 1 nontypical 0 0 0 3 0 2 -1.23239090  
## 18 1 asymptomatic 0 0 0 1 0 1 0.47217899  
## 19 0 nonanginal 0 0 0 1 0 1 -0.09601098  
## 20 1 nontypical 0 0 0 1 0 1 -0.09601098  
## 21 1 typical 0 2 1 2 0 1 -1.23239090  
## 22 0 typical 1 2 0 1 0 1 1.04036895  
## 23 1 nontypical 0 2 0 2 0 1 -0.66420094  
## 24 1 nonanginal 0 2 0 1 2 2 0.01762702  
## 25 1 asymptomatic 0 2 1 2 2 2 -0.09601098  
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## 29 1 asymptomatic 0 0 0 1 0 1 1.04036895  
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## 32 1 asymptomatic 1 0 1 1 2 2 -0.83465793  
## 33 1 nonanginal 0 0 0 1 0 1 0.47217899  
## 34 1 asymptomatic 0 0 0 2 0 2 0.18808400  
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## 36 1 asymptomatic 0 0 0 1 0 1 0.47217899  
## 37 1 asymptomatic 0 2 1 2 0 2 -0.66420094  
## 38 1 asymptomatic 0 2 1 2 1 0 1.04036895  
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## 42 1 typical 0 0 1 1 0 2 0.47217899  
## 43 0 nontypical 0 0 0 1 2 1 1.60855891  
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## 74 1 asymptomatic 0 2 0 1 2 0 -1.23239090  
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## 215 1 asymptomatic 0 0 0 1 1 1 -1.11875291  
## 216 1 typical 0 2 0 2 0 2 -0.66420094  
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## 218 0 asymptomatic 0 2 1 2 0 1 0.35854099  
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## 235 0 nonanginal 0 0 0 1 1 1 1.60855891  
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## 239 0 nontypical 0 0 0 2 0 1 0.13126501  
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## 4 1.63465503 0.063868821 2.11906724  
## 5 0.97891742 -0.824557956 0.31039858  
## 6 1.24121247 -0.206521937 -0.20636389  
## 7 0.45432733 0.411514082 2.20519432  
## 8 0.58547486 2.072485883 -0.37861805  
## 9 -0.11397859 0.141123324 0.31039858  
## 10 0.23574813 -0.843871582 1.77455892  
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## 15 0.54175902 -0.921126084 -0.46474513  
## 16 1.06634911 -1.519848478 0.48265274  
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## 18 0.45432733 -0.148581060 0.13814442  
## 19 -0.46370532 0.546709461 -0.72312637  
## 20 0.93520158 0.372886831 -0.37861805  
## 21 -0.24512612 -0.689362577 0.65490690  
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## 26 0.36689565 -0.534853572 0.48265274  
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## 36 1.24121247 -0.399658193 -0.89538052  
## 37 -1.29430629 -1.346025847 1.25779645  
## 38 -1.64403302 0.566023087 -0.37861805  
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## 272 -0.50742116 -0.361030942 1.08554229  
## 273 -1.29430629 1.241999983 0.65490690  
## 274 -1.07572709 -1.886807364 0.48265274  
## 275 0.54175902 -0.824557956 -0.20636389  
## 276 0.23574813 -0.380344567 -0.37861805  
## 277 0.10460061 0.604650338 -0.89538052  
## 278 0.10460061 -0.515539947 -0.89538052  
## 279 0.62919070 -0.283776439 -0.89538052  
## 280 -0.81343205 -0.959753335 -0.37861805  
## 281 -0.28884196 1.705526997 1.68843184  
## 282 1.28492831 0.121809698 -0.89538052  
## 283 -0.85714789 -0.805244331 0.82716105  
## 284 1.06634911 -1.056321463 -0.89538052  
## 285 0.49804318 -0.843871582 -0.89538052  
## 286 -0.41998948 1.377195362 2.89421095  
## 287 -0.15769444 -0.418971819 1.51617769  
## 288 -0.24512612 -0.515539947 -0.55087221  
## 289 0.58547486 -0.496226321 -0.89538052  
## 290 0.84776990 -0.129267435 -0.89538052  
## 291 0.01716893 -0.670048951 -0.20636389  
## 292 0.71662238 1.840722376 0.13814442  
## 293 -0.24512612 -1.500534852 1.51617769  
## 294 -0.24512612 -1.152889591 2.54970263  
## 295 -0.59485284 -0.959753335 -0.89538052  
## 296 1.41607583 -1.732298359 -0.89538052  
## 297 -2.60578152 -1.365339473 -0.03410973  
## 298 -1.16315877 -0.109953809 -0.72312637  
## 299 -0.76971621 0.334259580 0.13814442  
## 300 -0.37627364 -1.037007838 2.03294016  
## 301 -1.51288550 -2.234452625 0.13814442  
## 302 1.06634911 -0.206521937 -0.89538052  
## 303 1.02263326 -1.384653099 -0.89538052

## Dummy Coding

## Converting the categorical variables to numeric variables  
  
##install.packages('caret')  
require(caret)

## Loading required package: caret

## Loading required package: lattice

##   
## Attaching package: 'caret'

## The following object is masked from 'package:purrr':  
##   
## lift

dmv = dummyVars('~.' , data = cp\_temp)  
cp\_temp=data.frame(predict(dmv,newdata = cp\_temp))  
cp\_temp

## Sex ChestPainasymptomatic ChestPainnonanginal ChestPainnontypical  
## 1 1 0 0 0  
## 2 1 1 0 0  
## 3 1 1 0 0  
## 4 1 0 1 0  
## 5 0 0 0 1  
## 6 1 0 0 1  
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## ChestPaintypical Fbs RestECG ExAng Slope Ca Thal\_new RestBP1  
## 1 1 1 2 0 3 0 0 0.75627397  
## 2 0 0 2 1 2 3 1 1.60855891  
## 3 0 0 2 1 2 2 2 -0.66420094  
## 4 0 0 0 0 3 0 1 -0.09601098  
## 5 0 0 2 0 1 0 1 -0.09601098  
## 6 0 0 0 0 1 0 1 -0.66420094  
## 7 0 0 2 0 3 2 1 0.47217899  
## 8 0 0 0 1 1 0 1 -0.66420094  
## 9 0 0 2 0 2 1 2 -0.09601098  
## 10 0 1 2 1 3 0 2 0.47217899  
## 11 0 0 0 0 2 0 0 0.47217899  
## 12 0 0 2 0 2 0 1 0.47217899  
## 13 0 1 2 1 2 1 0 -0.09601098  
## 14 0 0 0 0 1 0 2 -0.66420094  
## 15 0 1 0 0 1 0 2 2.29038686  
## 16 0 0 0 0 1 0 1 1.04036895  
## 17 0 0 0 0 3 0 2 -1.23239090  
## 18 0 0 0 0 1 0 1 0.47217899  
## 19 0 0 0 0 1 0 1 -0.09601098  
## 20 0 0 0 0 1 0 1 -0.09601098  
## 21 1 0 2 1 2 0 1 -1.23239090  
## 22 1 1 2 0 1 0 1 1.04036895  
## 23 0 0 2 0 2 0 1 -0.66420094  
## 24 0 0 2 0 1 2 2 0.01762702  
## 25 0 0 2 1 2 2 2 -0.09601098  
## 26 0 0 0 0 2 0 1 -0.66420094  
## 27 0 0 0 0 1 0 1 -0.66420094  
## 28 1 0 0 0 3 0 1 1.04036895  
## 29 0 0 0 0 1 0 1 1.04036895  
## 30 0 0 2 1 2 0 2 -1.23239090  
## 31 1 0 0 0 1 2 1 0.47217899  
## 32 0 1 0 1 1 2 2 -0.83465793  
## 33 0 0 0 0 1 0 1 0.47217899  
## 34 0 0 0 0 2 0 2 0.18808400  
## 35 0 0 0 1 1 0 1 -0.09601098  
## 36 0 0 0 0 1 0 1 0.47217899  
## 37 0 0 2 1 2 0 2 -0.66420094  
## 38 0 0 2 1 2 1 0 1.04036895  
## 39 0 0 0 1 2 1 2 0.01762702  
## 40 0 1 0 1 2 0 1 1.04036895  
## 41 0 0 2 0 2 3 2 1.04036895  
## 42 1 0 0 1 1 0 2 0.47217899  
## 43 0 0 0 0 1 2 1 1.60855891  
## 44 0 1 0 0 1 0 1 1.04036895  
## 45 0 0 2 0 1 0 1 -0.09601098  
## 46 0 0 2 0 2 1 2 -1.11875291  
## 47 0 0 0 0 1 0 1 -1.23239090  
## 48 0 0 2 0 2 0 2 1.04036895  
## 49 0 1 2 0 1 1 1 0.47217899  
## 50 0 1 2 0 3 0 1 -0.09601098  
## 51 0 0 0 0 1 1 1 -1.51648588  
## 52 0 0 0 0 1 0 2 -0.66420094  
## 53 0 0 2 0 1 1 1 -1.11875291  
## 54 0 0 2 0 1 0 1 -0.09601098  
## 55 0 0 0 1 1 1 2 -0.09601098  
## 56 0 0 2 1 2 1 2 -0.43692495  
## 57 0 0 0 0 2 1 2 0.47217899  
## 58 0 0 2 0 1 0 2 -1.23239090  
## 59 0 0 2 0 3 1 1 -0.38010596  
## 60 1 0 2 1 1 1 1 -0.38010596  
## 61 0 0 0 1 2 0 2 -0.09601098  
## 62 0 0 2 1 3 0 1 0.58581698  
## 63 0 0 2 1 2 3 2 -0.20964897  
## 64 0 1 0 0 1 0 1 0.18808400  
## 65 0 0 0 0 2 1 2 -0.66420094  
## 66 0 0 2 1 2 2 2 0.75627397  
## 67 0 0 2 0 2 0 1 0.47217899  
## 68 0 0 2 0 1 0 2 1.04036895  
## 69 0 0 2 1 3 0 2 2.17674887  
## 70 0 0 0 0 2 0 1 1.04036895  
## 71 0 0 0 0 1 0 1 1.32446393  
## 72 0 1 0 0 2 2 2 -0.38010596  
## 73 0 0 0 1 2 2 2 -0.66420094  
## 74 0 0 2 0 1 2 0 -1.23239090  
## 75 0 0 2 0 1 1 1 -1.23239090  
## 76 0 0 2 0 1 0 1 1.60855891  
## 77 0 0 2 1 2 1 2 -0.38010596  
## 78 0 0 2 0 1 1 1 0.47217899  
## 79 0 0 2 0 2 0 1 -0.09601098  
## 80 0 0 2 1 1 0 2 1.04036895  
## 81 0 0 2 1 2 0 1 -1.57330488  
## 82 0 0 2 0 2 0 1 -0.09601098  
## 83 0 0 2 0 1 0 1 0.47217899  
## 84 0 1 2 1 2 0 2 2.74493883  
## 85 0 0 0 0 1 0 1 -0.66420094  
## 86 0 0 2 0 1 0 1 0.47217899  
## 87 0 0 2 0 1 0 1 0.35854099  
## 88 0 0 2 0 1 0 1 -0.20964897  
## 89 0 0 2 0 1 0 1 0.35854099  
## 90 0 0 2 0 1 0 1 -0.09601098  
## 91 0 0 2 0 2 0 1 -0.66420094  
## 92 0 0 2 0 3 3 2 1.60855891  
## 93 0 0 0 0 2 3 2 -0.09601098  
## 94 0 0 0 0 2 0 1 -1.34602889  
## 95 0 0 2 0 1 0 1 0.18808400  
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## 97 0 0 2 1 2 1 2 -1.23239090  
## 98 0 0 2 0 2 2 2 1.04036895  
## 99 0 0 0 0 1 1 1 0.13126501  
## 100 0 0 2 0 1 0 1 -0.55056295  
## 101 0 0 2 0 1 0 1 -0.94829592  
## 102 1 0 2 0 1 0 1 -0.77783893  
## 103 0 0 2 0 1 1 1 -0.20964897  
## 104 0 1 2 0 1 1 1 -1.23239090  
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## 106 0 0 0 0 1 0 2 -1.34602889  
## 107 0 0 0 1 1 1 2 0.47217899  
## 108 0 0 2 0 2 1 2 -0.20964897  
## 109 0 0 0 1 2 1 2 -0.66420094  
## 110 0 0 0 0 2 0 2 -0.77783893  
## 111 0 0 2 1 2 0 2 0.75627397  
## 112 0 1 2 1 2 1 1 -0.38010596  
## 113 1 0 2 0 2 0 0 -0.77783893  
## 114 0 1 2 1 2 0 2 0.01762702  
## 115 0 0 0 0 2 1 2 -0.09601098  
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## 121 0 1 2 1 1 2 2 -0.09601098  
## 122 0 0 2 0 2 3 2 1.04036895  
## 123 0 0 0 1 2 0 1 -1.80058086  
## 124 0 0 0 1 3 0 2 0.47217899  
## 125 1 1 2 0 2 1 1 0.35854099  
## 126 0 0 2 0 2 0 1 -0.09601098  
## 127 0 1 2 1 3 2 2 3.88131876  
## 128 0 0 0 1 2 1 2 -1.23239090  
## 129 0 0 0 0 1 0 1 -0.66420094  
## 130 0 0 0 0 1 0 1 -0.43692495  
## 131 0 0 2 0 2 0 2 -0.66420094  
## 132 0 0 0 1 1 1 2 -2.14149484  
## 133 0 0 2 0 1 0 1 -0.09601098  
## 134 0 0 2 1 1 0 1 0.47217899  
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## 136 0 0 2 0 2 0 1 0.18808400  
## 137 0 0 0 1 3 0 2 0.75627397  
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## 139 0 0 0 1 2 0 2 -0.66420094  
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## 141 0 0 0 1 1 0 1 0.47217899  
## 142 1 0 2 0 2 0 2 2.17674887  
## 143 0 1 0 0 1 0 1 -0.20964897  
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## 145 0 0 2 1 2 0 2 -1.51648588  
## 146 0 0 0 0 1 0 1 -1.34602889  
## 147 0 1 2 0 2 3 2 1.89265389  
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## 149 0 0 2 0 1 0 1 -0.20964897  
## 150 0 0 0 0 1 1 1 -1.68694287  
## 151 1 1 0 0 2 0 2 1.15400694  
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## 154 0 0 2 1 2 1 2 1.60855891  
## 155 0 0 2 1 3 1 1 -0.66420094  
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## 170 0 0 0 0 2 0 1 -1.11875291  
## 171 0 0 0 1 2 1 2 1.60855891  
## 172 0 0 2 1 1 0 2 0.58581698  
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## 174 0 0 2 0 2 0 1 0.47217899  
## 175 0 0 2 0 2 2 0 0.75627397  
## 176 0 0 0 1 2 1 2 1.15400694  
## 177 0 1 0 0 1 3 2 -1.34602889  
## 178 0 0 2 1 2 1 0 0.01762702  
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## 184 1 0 2 0 3 0 2 2.63130084  
## 185 0 0 2 0 1 0 1 1.49492092  
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## 187 0 1 0 0 3 0 2 -0.66420094  
## 188 0 0 0 1 2 3 0 1.60855891  
## 189 0 0 2 0 1 1 2 3.42676679  
## 190 0 0 2 0 2 3 2 0.47217899  
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## 193 0 1 2 1 2 0 2 0.01762702  
## 194 0 1 0 0 2 3 1 0.35854099  
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## 196 0 0 2 1 2 2 1 -1.80058086  
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## 203 0 1 0 0 1 1 2 1.04036895  
## 204 0 0 0 0 1 0 2 0.47217899  
## 205 0 0 0 0 1 0 2 -1.23239090  
## 206 0 0 2 1 2 3 2 0.58581698  
## 207 0 0 2 1 2 2 2 -0.20964897  
## 208 0 0 2 1 2 0 2 0.69945497  
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## 213 0 0 2 0 2 0 1 -0.09601098  
## 214 0 1 0 1 2 2 2 2.63130084  
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## 217 0 0 0 0 1 0 1 -1.51648588  
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## 227 0 0 0 0 1 0 1 -1.11875291  
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## 230 0 0 2 1 1 1 1 -1.11875291  
## 231 0 0 2 0 2 0 1 0.24490300  
## 232 0 0 1 1 2 0 1 2.74493883  
## 233 0 0 2 0 1 3 1 -0.77783893  
## 234 0 0 2 1 1 1 1 -0.66420094  
## 235 0 0 0 0 1 1 1 1.60855891  
## 236 0 0 2 1 2 2 1 -0.55056295  
## 237 0 1 2 1 3 0 2 -0.09601098  
## 238 0 0 2 0 1 0 2 -0.66420094  
## 239 0 0 0 0 2 0 1 0.13126501  
## 240 0 0 0 0 1 0 1 -0.66420094  
## 241 0 0 0 0 1 0 1 -1.23239090  
## 242 0 0 0 0 1 0 1 -0.32328696  
## 243 0 0 0 0 1 0 1 -0.09601098  
## 244 1 0 0 0 2 2 1 0.13126501  
## 245 0 1 0 0 1 0 1 -0.66420094  
## 246 0 0 0 0 2 0 1 -0.66420094  
## 247 0 0 0 0 1 1 2 -1.80058086  
## 248 0 0 2 1 2 1 1 -1.23239090  
## 249 0 0 0 0 1 2 2 -0.38010596  
## 250 0 1 2 0 1 0 1 -0.20964897  
## 251 0 0 0 1 2 0 0 -1.23239090  
## 252 0 0 0 0 2 1 2 0.81309296  
## 253 0 0 0 1 2 1 2 -0.20964897  
## 254 0 0 2 0 1 0 1 -0.66420094  
## 255 0 0 0 0 2 0 1 -0.94829592  
## 256 0 0 0 0 2 0 1 -0.66420094  
## 257 0 0 0 0 1 2 1 -1.45966689  
## 258 0 0 1 0 2 0 1 0.47217899  
## 259 0 0 2 0 1 0 1 1.38128292  
## 260 0 0 0 0 1 0 2 -0.43692495  
## 261 0 0 0 0 2 1 1 -0.77783893  
## 262 0 1 2 0 1 2 1 0.24490300  
## 263 1 0 0 0 1 0 1 1.04036895  
## 264 0 0 0 0 1 0 1 -0.66420094  
## 265 0 0 2 1 2 1 1 0.35854099  
## 266 0 0 0 1 2 0 0 0.24490300  
## 267 0 1 0 1 2 0 2 -0.20964897  
## 268 0 1 0 0 2 1 0 -0.32328696  
## 269 0 0 0 0 1 0 2 1.15400694  
## 270 0 0 0 0 1 0 1 -0.09601098  
## 271 0 0 2 1 1 1 2 0.47217899  
## 272 0 0 2 0 1 0 0 1.60855891  
## 273 0 0 0 1 2 2 2 0.47217899  
## 274 0 0 0 0 2 0 1 -1.11875291  
## 275 1 0 0 0 1 2 1 0.13126501  
## 276 1 0 2 0 2 0 2 2.17674887  
## 277 0 0 2 0 2 1 1 0.81309296  
## 278 0 0 0 0 2 0 1 0.35854099  
## 279 0 0 2 0 1 1 1 1.26764493  
## 280 0 0 0 0 2 0 1 -0.09601098  
## 281 0 0 0 1 2 1 2 -1.23239090  
## 282 0 0 0 0 1 0 1 -0.09601098  
## 283 0 0 1 1 2 1 2 -0.20964897  
## 284 0 0 0 0 1 0 1 -0.55056295  
## 285 0 0 0 0 1 1 2 0.92673096  
## 286 0 0 1 0 3 3 0 -1.00511492  
## 287 0 1 2 1 2 2 0 2.17674887  
## 288 0 0 0 0 2 0 2 -0.38010596  
## 289 0 0 2 0 1 0 2 -0.09601098  
## 290 0 0 0 0 3 0 1 -0.66420094  
## 291 0 0 2 0 2 0 2 1.15400694  
## 292 0 0 0 0 1 0 1 0.01762702  
## 293 0 0 0 1 3 0 0 -0.66420094  
## 294 0 0 2 1 1 2 2 0.47217899  
## 295 0 0 0 1 2 0 1 -0.43692495  
## 296 0 0 0 0 1 0 1 -0.66420094  
## 297 0 1 2 0 2 2 0 1.83583489  
## 298 0 0 0 1 2 0 2 0.47217899  
## 299 1 0 0 0 2 0 2 -1.23239090  
## 300 0 1 0 0 2 2 2 0.69945497  
## 301 0 0 0 1 2 1 2 -0.09601098  
## 302 0 0 2 0 2 1 1 -0.09601098  
## 303 0 0 0 0 1 0 1 0.35854099  
## MaxHR1 Chol1 Oldpeak1  
## 1 0.01716893 -0.264462814 1.08554229  
## 2 -1.81889638 0.759159343 0.39652566  
## 3 -0.90086373 -0.341717316 1.34392353  
## 4 1.63465503 0.063868821 2.11906724  
## 5 0.97891742 -0.824557956 0.31039858  
## 6 1.24121247 -0.206521937 -0.20636389  
## 7 0.45432733 0.411514082 2.20519432  
## 8 0.58547486 2.072485883 -0.37861805  
## 9 -0.11397859 0.141123324 0.31039858  
## 10 0.23574813 -0.843871582 1.77455892  
## 11 -0.07026275 -1.056321463 -0.55087221  
## 12 0.14831645 0.913668348 0.22427150  
## 13 -0.33255780 0.179750575 -0.37861805  
## 14 1.02263326 0.314945954 -0.89538052  
## 15 0.54175902 -0.921126084 -0.46474513  
## 16 1.06634911 -1.519848478 0.48265274  
## 17 0.80405406 -0.341717316 -0.03410973  
## 18 0.45432733 -0.148581060 0.13814442  
## 19 -0.46370532 0.546709461 -0.72312637  
## 20 0.93520158 0.372886831 -0.37861805  
## 21 -0.24512612 -0.689362577 0.65490690  
## 22 0.54175902 0.701218466 -0.03410973  
## 23 0.45432733 0.720532092 0.65490690  
## 24 1.02263326 -0.438285444 1.86068600  
## 25 -0.76971621 -0.785930705 1.17166937  
## 26 0.36689565 -0.534853572 0.48265274  
## 27 0.97891742 1.802095125 -0.89538052  
## 28 -1.55660134 -0.399658193 1.34392353  
## 29 0.93520158 0.005927944 0.39652566  
## 30 -1.55660134 -1.539162103 0.82716105  
## 31 0.06088477 -0.148581060 0.65490690  
## 32 0.45432733 -0.322403691 0.31039858  
## 33 0.36689565 1.705526997 -0.89538052  
## 34 0.49804318 -0.245149188 -0.46474513  
## 35 1.28492831 -0.264462814 -0.55087221  
## 36 1.24121247 -0.399658193 -0.89538052  
## 37 -1.29430629 -1.346025847 1.25779645  
## 38 -1.64403302 0.566023087 -0.37861805  
## 39 -0.76971621 2.053172258 0.13814442  
## 40 -0.55113700 -0.071326558 -0.03410973  
## 41 -1.55660134 -0.418971819 -0.03410973  
## 42 1.24121247 -0.921126084 0.31039858  
## 43 0.54175902 1.068177352 -0.55087221  
## 44 0.32317981 -0.670048951 0.48265274  
## 45 0.84776990 1.608958869 -0.89538052  
## 46 0.67290654 -0.322403691 1.25779645  
## 47 -1.16315877 -1.384653099 -0.37861805  
## 48 -0.94457957 -0.071326558 1.34392353  
## 49 0.32317981 3.289244296 -0.20636389  
## 50 0.10460061 -0.959753335 0.13814442  
## 51 0.80405406 -0.940439710 -0.89538052  
## 52 -0.41998948 -1.346025847 -0.55087221  
## 53 0.14831645 0.836413845 -0.89538052  
## 54 1.67837088 -0.534853572 -0.89538052  
## 55 -0.24512612 0.121809698 0.31039858  
## 56 -1.77518054 0.372886831 0.99941521  
## 57 0.58547486 -0.264462814 -0.37861805  
## 58 0.36689565 -1.442593975 -0.89538052  
## 59 0.10460061 0.508082210 -0.46474513  
## 60 -1.07572709 -0.650735326 0.31039858  
## 61 -0.33255780 1.126118229 0.13814442  
## 62 0.45432733 -1.346025847 0.31039858  
## 63 -0.81343205 -0.592794449 0.99941521  
## 64 0.89148574 1.106804604 -0.89538052  
## 65 -1.60031718 -1.133575966 0.31039858  
## 66 -0.33255780 0.681904840 1.51617769  
## 67 0.23574813 -1.191516843 1.68843184  
## 68 0.67290654 -0.283776439 0.48265274  
## 69 -0.41998948 1.531704367 2.03294016  
## 70 -0.11397859 -0.303090065 2.20519432  
## 71 -0.07026275 0.430827708 -0.20636389  
## 72 0.58547486 0.141123324 -0.72312637  
## 73 -2.21233895 0.392200456 0.65490690  
## 74 0.36689565 0.025241570 -0.37861805  
## 75 1.19749663 -0.959753335 -0.89538052  
## 76 0.06088477 2.188367637 -0.20636389  
## 77 -0.37627364 0.218377826 1.51617769  
## 78 -0.33255780 1.184059106 0.39652566  
## 79 1.32864415 -0.032699307 -0.72312637  
## 80 -1.68774886 0.450141333 -0.20636389  
## 81 -0.07026275 -0.747303454 1.68843184  
## 82 -0.28884196 0.334259580 -0.55087221  
## 83 1.41607583 1.435136239 -0.89538052  
## 84 0.01716893 0.527395836 0.48265274  
## 85 0.97891742 1.512390741 -0.72312637  
## 86 1.32864415 -0.225835563 -0.89538052  
## 87 0.27946397 0.199064200 -0.89538052  
## 88 -1.51288550 -0.592794449 -0.89538052  
## 89 0.45432733 -0.245149188 -0.89538052  
## 90 -0.02654691 0.179750575 -0.46474513  
## 91 0.06088477 1.068177352 -0.55087221  
## 92 -0.20141028 -1.597102980 4.44449837  
## 93 -0.15769444 -0.303090065 0.65490690  
## 94 1.11006495 -2.041316369 -0.37861805  
## 95 0.97891742 0.102496072 -0.89538052  
## 96 0.49804318 0.160436949 -0.89538052  
## 97 -0.33255780 -0.148581060 0.13814442  
## 98 0.32317981 0.218377826 1.34392353  
## 99 0.36689565 -0.882498833 -0.20636389  
## 100 1.59093919 -0.476912695 -0.89538052  
## 101 1.54722335 0.257005077 -0.89538052  
## 102 1.06634911 -1.249457719 -0.89538052  
## 103 0.41061149 1.087490978 -0.89538052  
## 104 -0.85714789 0.353573205 -0.89538052  
## 105 -0.46370532 -1.133575966 0.82716105  
## 106 0.27946397 1.203372732 -0.89538052  
## 107 0.54175902 -1.346025847 -0.89538052  
## 108 0.01716893 -0.341717316 -0.55087221  
## 109 -0.41998948 0.257005077 2.20519432  
## 110 -0.41998948 -0.534853572 0.13814442  
## 111 -0.15769444 1.164745480 -0.03410973  
## 112 -0.24512612 0.044555196 0.13814442  
## 113 1.76580256 -1.172203217 -0.89538052  
## 114 -0.59485284 1.821408751 1.68843184  
## 115 -2.29977063 0.314945954 0.13814442  
## 116 -0.76971621 -0.843871582 -0.89538052  
## 117 0.67290654 -0.689362577 -0.89538052  
## 118 1.41607583 -1.230144094 0.31039858  
## 119 -0.76971621 1.608958869 0.65490690  
## 120 -0.98829541 0.141123324 1.51617769  
## 121 0.01716893 0.179750575 -0.89538052  
## 122 0.19203229 3.096108040 2.54970263  
## 123 -0.28884196 -0.476912695 0.13814442  
## 124 -1.68774886 -0.573480823 3.92773589  
## 125 1.06634911 0.681904840 0.31039858  
## 126 1.11006495 -0.245149188 -0.37861805  
## 127 -0.72600036 0.797786594 2.54970263  
## 128 -1.03201125 -0.148581060 1.51617769  
## 129 0.89148574 -0.515539947 -0.89538052  
## 130 0.58547486 -0.727989828 -0.89538052  
## 131 -0.11397859 0.218377826 -0.55087221  
## 132 0.19203229 -0.380344567 -0.89538052  
## 133 2.29039265 -0.824557956 -0.89538052  
## 134 1.59093919 0.276318703 -0.89538052  
## 135 0.67290654 -0.650735326 -0.72312637  
## 136 0.49804318 0.063868821 0.31039858  
## 137 -1.07572709 -1.403966724 1.34392353  
## 138 -2.03747559 0.662591215 0.31039858  
## 139 -0.85714789 -0.940439710 0.48265274  
## 140 0.71662238 -0.032699307 1.17166937  
## 141 0.62919070 -0.496226321 -0.89538052  
## 142 0.41061149 0.797786594 -0.72312637  
## 143 1.50350751 -0.805244331 -0.89538052  
## 144 -0.81343205 1.203372732 0.65490690  
## 145 0.19203229 -0.129267435 -0.37861805  
## 146 0.10460061 -0.071326558 -0.89538052  
## 147 -1.11944293 0.817100220 -0.03410973  
## 148 1.28492831 0.063868821 -0.89538052  
## 149 0.89148574 1.184059106 -0.89538052  
## 150 0.45432733 1.377195362 -0.89538052  
## 151 1.24121247 0.990922850 0.13814442  
## 152 -1.20687461 0.353573205 -0.37861805  
## 153 0.45432733 6.128347259 0.48265274  
## 154 -0.20141028 0.817100220 -0.20636389  
## 155 -2.34348647 -0.013385681 0.99941521  
## 156 -1.77518054 1.454449864 1.17166937  
## 157 1.02263326 1.010236476 0.48265274  
## 158 0.93520158 1.029550101 -0.89538052  
## 159 0.89148574 0.894354722 0.13814442  
## 160 0.06088477 0.585336712 -0.03410973  
## 161 0.27946397 -0.959753335 -0.89538052  
## 162 0.54175902 1.106804604 -0.89538052  
## 163 0.36689565 -0.631421700 0.48265274  
## 164 -1.20687461 0.025241570 -0.03410973  
## 165 1.11006495 0.160436949 -0.89538052  
## 166 0.80405406 -0.766617079 -0.89538052  
## 167 0.84776990 -0.457599070 -0.89538052  
## 168 0.41061149 0.797786594 -0.89538052  
## 169 0.27946397 0.681904840 -0.89538052  
## 170 -0.50742116 -1.674357482 -0.89538052  
## 171 -1.64403302 0.430827708 1.60230476  
## 172 -1.68774886 -0.399658193 -0.89538052  
## 173 -0.28884196 0.044555196 -0.89538052  
## 174 0.32317981 2.845030907 0.13814442  
## 175 -0.76971621 -0.670048951 0.82716105  
## 176 -2.69321320 0.527395836 0.13814442  
## 177 -0.11397859 -0.264462814 -0.80925344  
## 178 -1.95004391 -1.210830468 0.91328813  
## 179 0.54175902 1.319254485 0.74103398  
## 180 1.02263326 -0.013385681 -0.89538052  
## 181 0.71662238 0.527395836 -0.46474513  
## 182 0.01716893 3.134735291 0.74103398  
## 183 1.24121247 -0.052012932 -0.20636389  
## 184 -0.20141028 0.450141333 2.72195679  
## 185 0.49804318 1.126118229 -0.89538052  
## 186 1.28492831 -0.998380587 -0.89538052  
## 187 1.94066592 -0.129267435 -0.20636389  
## 188 -1.29430629 -0.013385681 -0.89538052  
## 189 1.98438176 0.701218466 -0.89538052  
## 190 -0.15769444 0.141123324 0.82716105  
## 191 0.58547486 -0.979066961 -0.89538052  
## 192 -1.20687461 0.990922850 2.72195679  
## 193 -0.28884196 0.005927944 -0.80925344  
## 194 -1.90632806 0.913668348 0.74103398  
## 195 -1.51288550 -0.689362577 0.39652566  
## 196 -1.07572709 1.010236476 -0.12023681  
## 197 -0.81343205 -0.245149188 -0.80925344  
## 198 0.10460061 -0.206521937 -0.72312637  
## 199 0.54175902 -0.052012932 0.05201734  
## 200 -1.07572709 0.508082210 -0.89538052  
## 201 0.41061149 0.141123324 -0.89538052  
## 202 0.19203229 1.512390741 -0.89538052  
## 203 1.02263326 -2.331020753 -0.72312637  
## 204 -0.72600036 1.280627234 -0.72312637  
## 205 0.49804318 -0.689362577 -0.89538052  
## 206 -0.11397859 1.203372732 -0.89538052  
## 207 -0.85714789 0.237691452 1.68843184  
## 208 -1.03201125 -0.901812459 -0.12023681  
## 209 0.23574813 0.295632328 -0.89538052  
## 210 0.19203229 -0.052012932 0.31039858  
## 211 0.89148574 -0.612108075 -0.89538052  
## 212 1.41607583 -0.303090065 2.37744847  
## 213 0.80405406 -0.631421700 0.82716105  
## 214 0.67290654 -0.361030942 -0.03410973  
## 215 0.45432733 -0.322403691 -0.89538052  
## 216 0.54175902 -1.037007838 0.74103398  
## 217 0.97891742 -0.824557956 -0.89538052  
## 218 0.10460061 -0.071326558 -0.89538052  
## 219 -1.20687461 1.087490978 0.82716105  
## 220 1.41607583 0.469454959 -0.89538052  
## 221 0.97891742 0.411514082 -0.89538052  
## 222 0.76033822 0.392200456 -0.89538052  
## 223 1.28492831 -0.921126084 -0.89538052  
## 224 -2.38720231 0.681904840 0.82716105  
## 225 0.84776990 0.430827708 0.65490690  
## 226 1.85323424 -0.708676203 -0.29249097  
## 227 -0.28884196 -0.824557956 -0.80925344  
## 228 0.97891742 0.585336712 -0.89538052  
## 229 -1.81889638 -0.785930705 -0.89538052  
## 230 -0.76971621 -0.670048951 -0.80925344  
## 231 0.84776990 -0.979066961 -0.80925344  
## 232 -1.42545382 1.551017992 2.03294016  
## 233 -1.03201125 -1.886807364 -0.20636389  
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## 235 0.58547486 -0.882498833 -0.89538052  
## 236 -1.46916966 0.759159343 1.86068600  
## 237 -2.03747559 0.701218466 0.48265274  
## 238 -0.24512612 0.044555196 -0.20636389  
## 239 0.54175902 0.469454959 -0.89538052  
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## 241 0.14831645 -0.225835563 -0.89538052  
## 242 0.58547486 1.145431855 -0.89538052  
## 243 0.58547486 0.430827708 -0.89538052  
## 244 -0.20141028 -0.245149188 1.34392353  
## 245 -2.34348647 -1.326712222 -0.89538052  
## 246 -3.43638249 -0.187208311 -0.03410973  
## 247 0.27946397 -0.245149188 -0.80925344  
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## 249 0.80405406 -0.670048951 -0.03410973  
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## 251 -1.03201125 -0.882498833 0.39652566  
## 252 -1.95004391 -0.554167198 0.82716105  
## 253 -1.95004391 0.314945954 -0.72312637  
## 254 0.32317981 0.932981973 -0.37861805  
## 255 1.37235999 1.087490978 0.13814442  
## 256 1.02263326 -0.727989828 -0.89538052  
## 257 -0.33255780 -0.457599070 -0.63699929  
## 258 -1.46916966 -0.959753335 0.05201734  
## 259 -0.28884196 -0.032699307 -0.89538052  
## 260 -0.37627364 0.276318703 -0.63699929  
## 261 -0.02654691 -0.090640183 -0.63699929  
## 262 0.10460061 1.396508987 -0.89538052  
## 263 0.93520158 -0.129267435 -0.12023681  
## 264 0.84776990 -0.399658193 -0.89538052  
## 265 -1.07572709 -1.558475729 2.20519432  
## 266 -1.07572709 1.319254485 0.65490690  
## 267 0.27946397 -0.824557956 -0.03410973  
## 268 -0.68228452 -0.554167198 0.99941521  
## 269 1.37235999 -0.457599070 -0.89538052  
## 270 0.01716893 -1.288084971 -0.89538052  
## 271 -0.50742116 -0.766617079 0.74103398  
## 272 -0.50742116 -0.361030942 1.08554229  
## 273 -1.29430629 1.241999983 0.65490690  
## 274 -1.07572709 -1.886807364 0.48265274  
## 275 0.54175902 -0.824557956 -0.20636389  
## 276 0.23574813 -0.380344567 -0.37861805  
## 277 0.10460061 0.604650338 -0.89538052  
## 278 0.10460061 -0.515539947 -0.89538052  
## 279 0.62919070 -0.283776439 -0.89538052  
## 280 -0.81343205 -0.959753335 -0.37861805  
## 281 -0.28884196 1.705526997 1.68843184  
## 282 1.28492831 0.121809698 -0.89538052  
## 283 -0.85714789 -0.805244331 0.82716105  
## 284 1.06634911 -1.056321463 -0.89538052  
## 285 0.49804318 -0.843871582 -0.89538052  
## 286 -0.41998948 1.377195362 2.89421095  
## 287 -0.15769444 -0.418971819 1.51617769  
## 288 -0.24512612 -0.515539947 -0.55087221  
## 289 0.58547486 -0.496226321 -0.89538052  
## 290 0.84776990 -0.129267435 -0.89538052  
## 291 0.01716893 -0.670048951 -0.20636389  
## 292 0.71662238 1.840722376 0.13814442  
## 293 -0.24512612 -1.500534852 1.51617769  
## 294 -0.24512612 -1.152889591 2.54970263  
## 295 -0.59485284 -0.959753335 -0.89538052  
## 296 1.41607583 -1.732298359 -0.89538052  
## 297 -2.60578152 -1.365339473 -0.03410973  
## 298 -1.16315877 -0.109953809 -0.72312637  
## 299 -0.76971621 0.334259580 0.13814442  
## 300 -0.37627364 -1.037007838 2.03294016  
## 301 -1.51288550 -2.234452625 0.13814442  
## 302 1.06634911 -0.206521937 -0.89538052  
## 303 1.02263326 -1.384653099 -0.89538052

## Putting Age and AHD again into dataset  
  
cp1=cp\_final%>%select(Age, AHD)  
  
cp1=cp1%>%mutate(id=row\_number())  
cp\_temp=cp\_temp%>%mutate(id=row\_number())  
  
cp=cp\_temp%>%left\_join(cp1, by=c('id'='id'))  
cp

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## 16 0 0 0 0 1 0 1 1.04036895  
## 17 0 0 0 0 3 0 2 -1.23239090  
## 18 0 0 0 0 1 0 1 0.47217899  
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## 1 0.01716893 -0.264462814 1.08554229 1 63 No  
## 2 -1.81889638 0.759159343 0.39652566 2 67 Yes  
## 3 -0.90086373 -0.341717316 1.34392353 3 67 Yes  
## 4 1.63465503 0.063868821 2.11906724 4 37 No  
## 5 0.97891742 -0.824557956 0.31039858 5 41 No  
## 6 1.24121247 -0.206521937 -0.20636389 6 56 No  
## 7 0.45432733 0.411514082 2.20519432 7 62 Yes  
## 8 0.58547486 2.072485883 -0.37861805 8 57 No  
## 9 -0.11397859 0.141123324 0.31039858 9 63 Yes  
## 10 0.23574813 -0.843871582 1.77455892 10 53 Yes  
## 11 -0.07026275 -1.056321463 -0.55087221 11 57 No  
## 12 0.14831645 0.913668348 0.22427150 12 56 No  
## 13 -0.33255780 0.179750575 -0.37861805 13 56 Yes  
## 14 1.02263326 0.314945954 -0.89538052 14 44 No  
## 15 0.54175902 -0.921126084 -0.46474513 15 52 No  
## 16 1.06634911 -1.519848478 0.48265274 16 57 No  
## 17 0.80405406 -0.341717316 -0.03410973 17 48 Yes  
## 18 0.45432733 -0.148581060 0.13814442 18 54 No  
## 19 -0.46370532 0.546709461 -0.72312637 19 48 No  
## 20 0.93520158 0.372886831 -0.37861805 20 49 No  
## 21 -0.24512612 -0.689362577 0.65490690 21 64 No  
## 22 0.54175902 0.701218466 -0.03410973 22 58 No  
## 23 0.45432733 0.720532092 0.65490690 23 58 Yes  
## 24 1.02263326 -0.438285444 1.86068600 24 58 Yes  
## 25 -0.76971621 -0.785930705 1.17166937 25 60 Yes  
## 26 0.36689565 -0.534853572 0.48265274 26 50 No  
## 27 0.97891742 1.802095125 -0.89538052 27 58 No  
## 28 -1.55660134 -0.399658193 1.34392353 28 66 No  
## 29 0.93520158 0.005927944 0.39652566 29 43 No  
## 30 -1.55660134 -1.539162103 0.82716105 30 40 Yes  
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## 32 0.45432733 -0.322403691 0.31039858 32 60 Yes  
## 33 0.36689565 1.705526997 -0.89538052 33 64 Yes  
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## 36 1.24121247 -0.399658193 -0.89538052 36 42 No  
## 37 -1.29430629 -1.346025847 1.25779645 37 43 Yes  
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## 56 -1.77518054 0.372886831 0.99941521 56 54 Yes  
## 57 0.58547486 -0.264462814 -0.37861805 57 50 Yes  
## 58 0.36689565 -1.442593975 -0.89538052 58 41 Yes  
## 59 0.10460061 0.508082210 -0.46474513 59 54 No  
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## 61 -0.33255780 1.126118229 0.13814442 61 51 Yes  
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## 63 -0.81343205 -0.592794449 0.99941521 63 58 Yes  
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## 75 1.19749663 -0.959753335 -0.89538052 75 44 Yes  
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## 157 1.02263326 1.010236476 0.48265274 157 51 Yes  
## 158 0.93520158 1.029550101 -0.89538052 158 58 Yes  
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## 303 1.02263326 -1.384653099 -0.89538052 303 38 No

## Predict

Please use random train/split for your prediction, Use 60/40 split

##install.packages('e1071')  
require(e1071)

## Loading required package: e1071

set.seed(123)  
train=runif(nrow(cp))>.6  
cp\_train=cp[train,]  
cp\_test=cp[!train,]  
  
require(class)

## Loading required package: class

##prediction   
predict\_cp= knn(train=cp\_train[,-18 ], test=cp\_test[,-18], cl=cp\_train$AHD, k=21, prob=TRUE)  
predict\_cp

## [1] No No No No No No No No No No No No No No No No No No   
## [19] Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes  
## [37] Yes No Yes Yes Yes Yes Yes Yes No Yes Yes No Yes Yes Yes Yes Yes Yes  
## [55] Yes Yes No Yes No No No No No No No No No No No No No No   
## [73] No No No No No No No No No No No No No No No No No No   
## [91] No No No No No No No No No No No Yes Yes No No No No No   
## [109] No No No Yes Yes Yes No Yes Yes Yes Yes Yes No No No Yes No No   
## [127] No No Yes No No No No No No No No No No No Yes Yes Yes Yes  
## [145] Yes Yes No No No Yes Yes Yes Yes Yes No Yes Yes Yes Yes Yes No No   
## [163] Yes No No Yes Yes Yes Yes Yes Yes No Yes No No No No No No No   
## [181] Yes No Yes No   
## attr(,"prob")  
## [1] 0.5714286 0.5714286 0.5714286 0.5714286 0.5714286 0.5714286 0.5714286  
## [8] 0.5714286 0.5714286 0.5714286 0.5714286 0.5714286 0.5714286 0.5714286  
## [15] 0.5714286 0.5714286 0.5238095 0.5238095 0.5238095 0.5238095 0.5714286  
## [22] 0.5238095 0.5238095 0.5714286 0.5714286 0.5714286 0.5714286 0.5714286  
## [29] 0.6190476 0.6666667 0.6190476 0.6666667 0.5714286 0.6190476 0.5714286  
## [36] 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095  
## [43] 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095  
## [50] 0.5238095 0.5238095 0.5714286 0.5238095 0.5238095 0.5238095 0.5714286  
## [57] 0.5238095 0.5714286 0.5238095 0.5238095 0.5714286 0.6190476 0.5714286  
## [64] 0.6190476 0.5714286 0.5714286 0.6190476 0.6190476 0.6190476 0.5238095  
## [71] 0.5238095 0.5238095 0.5238095 0.5238095 0.5714286 0.5714286 0.5714286  
## [78] 0.5714286 0.5714286 0.6190476 0.6190476 0.5714286 0.6190476 0.6666667  
## [85] 0.5714286 0.6666667 0.6190476 0.7142857 0.6666667 0.7142857 0.6190476  
## [92] 0.6190476 0.6190476 0.5714286 0.6190476 0.6190476 0.6190476 0.5714286  
## [99] 0.5714286 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095  
## [106] 0.5238095 0.5714286 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095  
## [113] 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095  
## [120] 0.5238095 0.5238095 0.5238095 0.5238095 0.5714286 0.5714286 0.5238095  
## [127] 0.5238095 0.5238095 0.5238095 0.5714286 0.5714286 0.5714286 0.5714286  
## [134] 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095  
## [141] 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095  
## [148] 0.5238095 0.5238095 0.5238095 0.5238095 0.5714286 0.5238095 0.5238095  
## [155] 0.5238095 0.5238095 0.5238095 0.5714286 0.5238095 0.5238095 0.5714286  
## [162] 0.5238095 0.5714286 0.5714286 0.5714286 0.5714286 0.5238095 0.6190476  
## [169] 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095  
## [176] 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095 0.5238095  
## [183] 0.5238095 0.5238095  
## Levels: No Yes

##evaluation  
confusionMatrix(predict\_cp, reference = as.factor(cp\_test$AHD), positive = 'No')

## Confusion Matrix and Statistics  
##   
## Reference  
## Prediction No Yes  
## No 61 49  
## Yes 41 33  
##   
## Accuracy : 0.5109   
## 95% CI : (0.4363, 0.5851)  
## No Information Rate : 0.5543   
## P-Value [Acc > NIR] : 0.8961   
##   
## Kappa : 5e-04   
##   
## Mcnemar's Test P-Value : 0.4606   
##   
## Sensitivity : 0.5980   
## Specificity : 0.4024   
## Pos Pred Value : 0.5545   
## Neg Pred Value : 0.4459   
## Prevalence : 0.5543   
## Detection Rate : 0.3315   
## Detection Prevalence : 0.5978   
## Balanced Accuracy : 0.5002   
##   
## 'Positive' Class : No   
##

## True negative: 61, True Positive: 33, False negative:49, False Positive: 41  
## Prediction for "No" : 110 and true value: 102  
## Prediction for "Yes": 74 and true value: 82

seq(1,22,2)

## [1] 1 3 5 7 9 11 13 15 17 19 21

rs=list()  
for (i in seq(1,22,2)){  
 predict\_cp= knn(train=cp\_train[,-18], test=cp\_test[,-18], cl=cp\_train$AHD, k=i, prob=TRUE)  
 results=confusionMatrix(predict\_cp, reference = as.factor(cp\_test$AHD), positive = 'Yes')  
 results=results$overall  
 rs[[as.character(i)]]=results  
}  
  
  
final\_results=rs%>%as\_tibble()%>%t()  
final\_results=final\_results[,1:2]  
results\_df=data.frame(final\_results)  
names(results\_df)<-c('Accuracy','Kappa')  
row.names(results\_df)

## [1] "1" "3" "5" "7" "9" "11" "13" "15" "17" "19" "21"

results\_df$k=as.numeric(row.names(results\_df))  
results\_df%>%arrange(desc(Accuracy))

## Accuracy Kappa k  
## 1 0.5760870 0.1521739130 13  
## 2 0.5652174 0.1072295002 3  
## 3 0.5652174 0.1179290508 5  
## 4 0.5652174 0.1304347826 9  
## 5 0.5652174 0.1304347826 11  
## 6 0.5489130 0.0924649394 7  
## 7 0.5380435 0.0502793296 1  
## 8 0.5326087 0.0562977099 15  
## 9 0.5163043 0.0245413391 19  
## 10 0.5108696 0.0004828585 21  
## 11 0.4945652 -0.0217339384 17

## The best value for k is 13

ggplot(results\_df)+geom\_line(aes(x=k, y=Accuracy))

