Project\_R

Team\_3

June 15, 2023

#a  
#setting library  
#setwd("~/Desktop/SIP690/Project\_R")  
#load data  
patients <- read.csv("patients.csv")  
#head   
head(patients, n=30)

## Pregnancies Glucose BloodPressure SkinThickness Insulin BMI Pedigree Age  
## 1 6 148 72 35 0 33.6 0.627 50  
## 2 1 85 66 29 0 26.6 0.351 31  
## 3 8 183 64 0 0 23.3 0.672 32  
## 4 1 89 66 23 94 28.1 0.167 21  
## 5 0 137 40 35 168 43.1 2.288 33  
## 6 5 116 74 0 0 25.6 0.201 30  
## 7 3 78 50 32 88 31.0 0.248 26  
## 8 10 115 0 0 0 35.3 0.134 29  
## 9 2 197 70 45 543 30.5 0.158 53  
## 10 8 125 96 0 0 0.0 0.232 54  
## 11 4 110 92 0 0 37.6 0.191 30  
## 12 10 168 74 0 0 38.0 0.537 34  
## 13 10 139 80 0 0 27.1 1.441 57  
## 14 1 189 60 23 846 30.1 0.398 59  
## 15 5 166 72 19 175 25.8 0.587 51  
## 16 7 100 0 0 0 30.0 0.484 32  
## 17 0 118 84 47 230 45.8 0.551 31  
## 18 7 107 74 0 0 29.6 0.254 31  
## 19 1 103 30 38 83 43.3 0.183 33  
## 20 1 115 70 30 96 34.6 0.529 32  
## 21 3 126 88 41 235 39.3 0.704 27  
## 22 8 99 84 0 0 35.4 0.388 50  
## 23 7 196 90 0 0 39.8 0.451 41  
## 24 9 119 80 35 0 29.0 0.263 29  
## 25 11 143 94 33 146 36.6 0.254 51  
## 26 10 125 70 26 115 31.1 0.205 41  
## 27 7 147 76 0 0 39.4 0.257 43  
## 28 1 97 66 15 140 23.2 0.487 22  
## 29 13 145 82 19 110 22.2 0.245 57  
## 30 5 117 92 0 0 34.1 0.337 38  
## Diagnosis  
## 1 1  
## 2 0  
## 3 1  
## 4 0  
## 5 1  
## 6 0  
## 7 1  
## 8 0  
## 9 1  
## 10 1  
## 11 0  
## 12 1  
## 13 0  
## 14 1  
## 15 1  
## 16 1  
## 17 1  
## 18 1  
## 19 0  
## 20 1  
## 21 0  
## 22 0  
## 23 1  
## 24 1  
## 25 1  
## 26 1  
## 27 1  
## 28 0  
## 29 0  
## 30 0

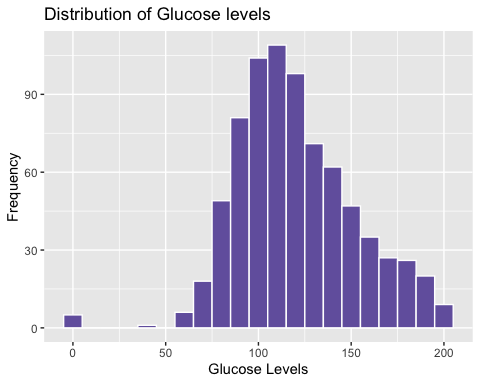
#b)  
#Summary statistics  
summary(patients[, c("Pregnancies", "Glucose", "BloodPressure", "SkinThickness", "Insulin", "BMI", "Pedigree", "Age")])

## Pregnancies Glucose BloodPressure SkinThickness   
## Min. : 0.000 Min. : 0.0 Min. : 0.00 Min. : 0.00   
## 1st Qu.: 1.000 1st Qu.: 99.0 1st Qu.: 62.00 1st Qu.: 0.00   
## Median : 3.000 Median :117.0 Median : 72.00 Median :23.00   
## Mean : 3.845 Mean :120.9 Mean : 69.11 Mean :20.54   
## 3rd Qu.: 6.000 3rd Qu.:140.2 3rd Qu.: 80.00 3rd Qu.:32.00   
## Max. :17.000 Max. :199.0 Max. :122.00 Max. :99.00   
## Insulin BMI Pedigree Age   
## Min. : 0.0 Min. : 0.00 Min. :0.0780 Min. :21.00   
## 1st Qu.: 0.0 1st Qu.:27.30 1st Qu.:0.2437 1st Qu.:24.00   
## Median : 30.5 Median :32.00 Median :0.3725 Median :29.00   
## Mean : 79.8 Mean :31.99 Mean :0.4719 Mean :33.24   
## 3rd Qu.:127.2 3rd Qu.:36.60 3rd Qu.:0.6262 3rd Qu.:41.00   
## Max. :846.0 Max. :67.10 Max. :2.4200 Max. :81.00

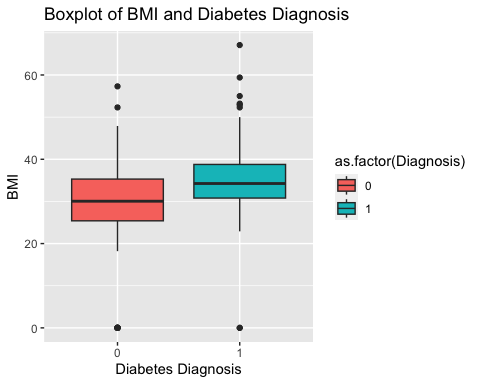
#Calculate mean, median, standard deviation, and quartiles for each variable   
summary\_stats <- data.frame(   
 Variable = names(patients),   
 Mean = colMeans(patients),   
 Median = apply(patients, 2, median),   
 Standard\_Deviation = apply(patients, 2, sd),   
 Q1 = apply(patients, 2, quantile, 0.25),   
 Q3 = apply(patients, 2, quantile, 0.75)   
)   
   
print(summary\_stats)

## Variable Mean Median Standard\_Deviation Q1  
## Pregnancies Pregnancies 3.8450521 3.0000 3.3695781 1.00000  
## Glucose Glucose 120.8945312 117.0000 31.9726182 99.00000  
## BloodPressure BloodPressure 69.1054688 72.0000 19.3558072 62.00000  
## SkinThickness SkinThickness 20.5364583 23.0000 15.9522176 0.00000  
## Insulin Insulin 79.7994792 30.5000 115.2440024 0.00000  
## BMI BMI 31.9925781 32.0000 7.8841603 27.30000  
## Pedigree Pedigree 0.4718763 0.3725 0.3313286 0.24375  
## Age Age 33.2408854 29.0000 11.7602315 24.00000  
## Diagnosis Diagnosis 0.3489583 0.0000 0.4769514 0.00000  
## Q3  
## Pregnancies 6.00000  
## Glucose 140.25000  
## BloodPressure 80.00000  
## SkinThickness 32.00000  
## Insulin 127.25000  
## BMI 36.60000  
## Pedigree 0.62625  
## Age 41.00000  
## Diagnosis 1.00000

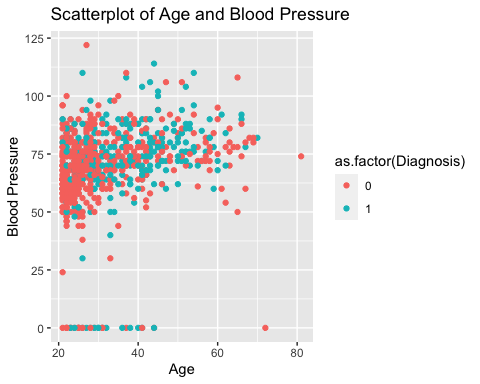
#c visualizations  
#1.distribution of glucose levels among the patients  
library(ggplot2)   
   
ggplot(data = patients, aes(x = Glucose)) +   
geom\_histogram(binwidth = 10, fill = "#7463ac", color = "white") +   
 labs(title = "Distribution of Glucose levels",   
 x = "Glucose Levels",   
 y = "Frequency")



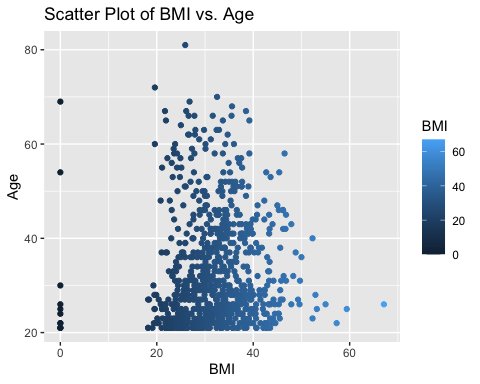
#2.Distribution of BMI between patients with and without a diabetes diagnosis  
ggplot(data = patients, aes(x = as.factor(Diagnosis), y = BMI, fill = as.factor(Diagnosis))) +   
 geom\_boxplot() +   
 labs(title = "Boxplot of BMI and Diabetes Diagnosis",   
 x = "Diabetes Diagnosis",   
 y = "BMI")



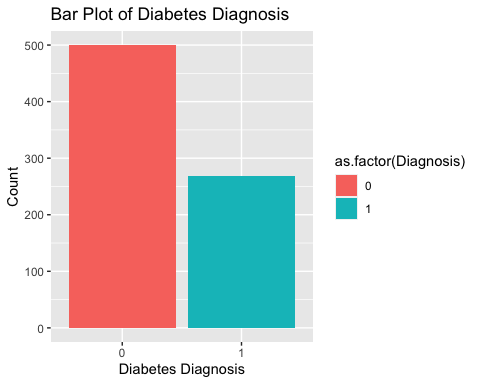
#3.relationship between age and blood pressure.  
ggplot(data = patients, aes(x = Age, y = BloodPressure, color = as.factor(Diagnosis))) +   
 geom\_point() +   
 labs(title = "Scatterplot of Age and Blood Pressure",   
 x = "Age",   
 y = "Blood Pressure")



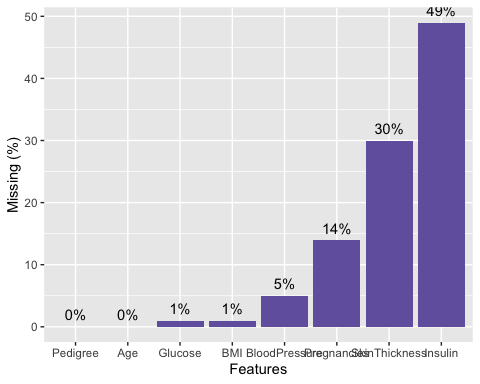
#4.Relationship between BMI and Age  
ggplot(patients, aes(x = BMI, y = Age, color = BMI)) +  
 geom\_point() +  
 labs(x = "BMI", y = "Age") +  
 ggtitle("Scatter Plot of BMI vs. Age")



#5.Count or proportion of patients with and without a diabetes diagnosis  
ggplot(data = patients, aes(x = as.factor(Diagnosis), fill = as.factor(Diagnosis))) +   
 geom\_bar() +   
 labs(title = "Bar Plot of Diabetes Diagnosis",   
 x = "Diabetes Diagnosis",   
 y = "Count")



#d) handling Missing values  
#visualization of missing values  
patients$Glucose[patients$Glucose %in% 0] <- NA  
patients$BloodPressure[patients$BloodPressure %in% 0] <- NA  
patients$SkinThickness[patients$SkinThickness %in% 0] <- NA  
patients$Insulin[patients$Insulin %in% 0] <- NA  
patients$BMI[patients$BMI %in% 0] <- NA  
patients$Pregnancies[patients$Pregnancies %in% 0] <- NA  
patients$Age[patients$Age %in% 0] <- NA  
patients$Pedigree[patients$Pedigree %in% 0] <- NA  
mis\_1 <- data.frame(val=apply(patients[-9],2,function(x){round(sum(is.na(x))/nrow(patients),2)\*100}),names = names(apply(patients[-9],2,function(x){sum(is.na(x))})))  
mis\_1 <- mis\_1[order(mis\_1$val),]  
mis\_1$names <- factor(mis\_1$names,levels = mis\_1$names)  
ggplot(mis\_1)+   
 geom\_bar(mapping = aes(x = names, y = val),  
 stat = "identity", fill = '#7463AC')+  
 geom\_text(aes(x = names, y = val,label=paste0(val,"%")),vjust=-0.65)+ylab("Missing (%)")+xlab("Features")



## Identify missing values (coded as 0) in each independent variable (excluding "Diagnosis")   
missing\_values\_1 <- sapply(patients[, -which(names(patients) == "Diagnosis")], function(x) sum(x == 0))   
print(missing\_values\_1)

## Pregnancies Glucose BloodPressure SkinThickness Insulin   
## NA NA NA NA NA   
## BMI Pedigree Age   
## NA 0 0

#d)replacing missing values  
patients\_1 <- c("Pregnancies", "Glucose", "BloodPressure", "SkinThickness", "Insulin", "BMI", "Pedigree", "Age")

# d)  
#Iterate over each column (excluding the "Diagnosis" column)  
for (col in names(patients\_1)[-which(names(patients) == "Diagnosis")]) {  
 # Find the indices of missing values (coded as 0)  
 missing\_indices <- which(patients[[col]] == 0)  
   
 # Calculate the median excluding the missing values  
 median\_value <- median(patients[[col]][patients[[col]] != 0], na.rm = TRUE)  
   
 # Replace the missing values with the median  
 patients[missing\_indices, col] <- median\_value  
}  
patients

## Pregnancies Glucose BloodPressure SkinThickness Insulin BMI Pedigree Age  
## 1 6 148 72 35 NA 33.6 0.627 50  
## 2 1 85 66 29 NA 26.6 0.351 31  
## 3 8 183 64 NA NA 23.3 0.672 32  
## 4 1 89 66 23 94 28.1 0.167 21  
## 5 NA 137 40 35 168 43.1 2.288 33  
## 6 5 116 74 NA NA 25.6 0.201 30  
## 7 3 78 50 32 88 31.0 0.248 26  
## 8 10 115 NA NA NA 35.3 0.134 29  
## 9 2 197 70 45 543 30.5 0.158 53  
## 10 8 125 96 NA NA NA 0.232 54  
## 11 4 110 92 NA NA 37.6 0.191 30  
## 12 10 168 74 NA NA 38.0 0.537 34  
## 13 10 139 80 NA NA 27.1 1.441 57  
## 14 1 189 60 23 846 30.1 0.398 59  
## 15 5 166 72 19 175 25.8 0.587 51  
## 16 7 100 NA NA NA 30.0 0.484 32  
## 17 NA 118 84 47 230 45.8 0.551 31  
## 18 7 107 74 NA NA 29.6 0.254 31  
## 19 1 103 30 38 83 43.3 0.183 33  
## 20 1 115 70 30 96 34.6 0.529 32  
## 21 3 126 88 41 235 39.3 0.704 27  
## 22 8 99 84 NA NA 35.4 0.388 50  
## 23 7 196 90 NA NA 39.8 0.451 41  
## 24 9 119 80 35 NA 29.0 0.263 29  
## 25 11 143 94 33 146 36.6 0.254 51  
## 26 10 125 70 26 115 31.1 0.205 41  
## 27 7 147 76 NA NA 39.4 0.257 43  
## 28 1 97 66 15 140 23.2 0.487 22  
## 29 13 145 82 19 110 22.2 0.245 57  
## 30 5 117 92 NA NA 34.1 0.337 38  
## 31 5 109 75 26 NA 36.0 0.546 60  
## 32 3 158 76 36 245 31.6 0.851 28  
## 33 3 88 58 11 54 24.8 0.267 22  
## 34 6 92 92 NA NA 19.9 0.188 28  
## 35 10 122 78 31 NA 27.6 0.512 45  
## 36 4 103 60 33 192 24.0 0.966 33  
## 37 11 138 76 NA NA 33.2 0.420 35  
## 38 9 102 76 37 NA 32.9 0.665 46  
## 39 2 90 68 42 NA 38.2 0.503 27  
## 40 4 111 72 47 207 37.1 1.390 56  
## 41 3 180 64 25 70 34.0 0.271 26  
## 42 7 133 84 NA NA 40.2 0.696 37  
## 43 7 106 92 18 NA 22.7 0.235 48  
## 44 9 171 110 24 240 45.4 0.721 54  
## 45 7 159 64 NA NA 27.4 0.294 40  
## 46 NA 180 66 39 NA 42.0 1.893 25  
## 47 1 146 56 NA NA 29.7 0.564 29  
## 48 2 71 70 27 NA 28.0 0.586 22  
## 49 7 103 66 32 NA 39.1 0.344 31  
## 50 7 105 NA NA NA NA 0.305 24  
## 51 1 103 80 11 82 19.4 0.491 22  
## 52 1 101 50 15 36 24.2 0.526 26  
## 53 5 88 66 21 23 24.4 0.342 30  
## 54 8 176 90 34 300 33.7 0.467 58  
## 55 7 150 66 42 342 34.7 0.718 42  
## 56 1 73 50 10 NA 23.0 0.248 21  
## 57 7 187 68 39 304 37.7 0.254 41  
## 58 NA 100 88 60 110 46.8 0.962 31  
## 59 NA 146 82 NA NA 40.5 1.781 44  
## 60 NA 105 64 41 142 41.5 0.173 22  
## 61 2 84 NA NA NA NA 0.304 21  
## 62 8 133 72 NA NA 32.9 0.270 39  
## 63 5 44 62 NA NA 25.0 0.587 36  
## 64 2 141 58 34 128 25.4 0.699 24  
## 65 7 114 66 NA NA 32.8 0.258 42  
## 66 5 99 74 27 NA 29.0 0.203 32  
## 67 NA 109 88 30 NA 32.5 0.855 38  
## 68 2 109 92 NA NA 42.7 0.845 54  
## 69 1 95 66 13 38 19.6 0.334 25  
## 70 4 146 85 27 100 28.9 0.189 27  
## 71 2 100 66 20 90 32.9 0.867 28  
## 72 5 139 64 35 140 28.6 0.411 26  
## 73 13 126 90 NA NA 43.4 0.583 42  
## 74 4 129 86 20 270 35.1 0.231 23  
## 75 1 79 75 30 NA 32.0 0.396 22  
## 76 1 NA 48 20 NA 24.7 0.140 22  
## 77 7 62 78 NA NA 32.6 0.391 41  
## 78 5 95 72 33 NA 37.7 0.370 27  
## 79 NA 131 NA NA NA 43.2 0.270 26  
## 80 2 112 66 22 NA 25.0 0.307 24  
## 81 3 113 44 13 NA 22.4 0.140 22  
## 82 2 74 NA NA NA NA 0.102 22  
## 83 7 83 78 26 71 29.3 0.767 36  
## 84 NA 101 65 28 NA 24.6 0.237 22  
## 85 5 137 108 NA NA 48.8 0.227 37  
## 86 2 110 74 29 125 32.4 0.698 27  
## 87 13 106 72 54 NA 36.6 0.178 45  
## 88 2 100 68 25 71 38.5 0.324 26  
## 89 15 136 70 32 110 37.1 0.153 43  
## 90 1 107 68 19 NA 26.5 0.165 24  
## 91 1 80 55 NA NA 19.1 0.258 21  
## 92 4 123 80 15 176 32.0 0.443 34  
## 93 7 81 78 40 48 46.7 0.261 42  
## 94 4 134 72 NA NA 23.8 0.277 60  
## 95 2 142 82 18 64 24.7 0.761 21  
## 96 6 144 72 27 228 33.9 0.255 40  
## 97 2 92 62 28 NA 31.6 0.130 24  
## 98 1 71 48 18 76 20.4 0.323 22  
## 99 6 93 50 30 64 28.7 0.356 23  
## 100 1 122 90 51 220 49.7 0.325 31  
## 101 1 163 72 NA NA 39.0 1.222 33  
## 102 1 151 60 NA NA 26.1 0.179 22  
## 103 NA 125 96 NA NA 22.5 0.262 21  
## 104 1 81 72 18 40 26.6 0.283 24  
## 105 2 85 65 NA NA 39.6 0.930 27  
## 106 1 126 56 29 152 28.7 0.801 21  
## 107 1 96 122 NA NA 22.4 0.207 27  
## 108 4 144 58 28 140 29.5 0.287 37  
## 109 3 83 58 31 18 34.3 0.336 25  
## 110 NA 95 85 25 36 37.4 0.247 24  
## 111 3 171 72 33 135 33.3 0.199 24  
## 112 8 155 62 26 495 34.0 0.543 46  
## 113 1 89 76 34 37 31.2 0.192 23  
## 114 4 76 62 NA NA 34.0 0.391 25  
## 115 7 160 54 32 175 30.5 0.588 39  
## 116 4 146 92 NA NA 31.2 0.539 61  
## 117 5 124 74 NA NA 34.0 0.220 38  
## 118 5 78 48 NA NA 33.7 0.654 25  
## 119 4 97 60 23 NA 28.2 0.443 22  
## 120 4 99 76 15 51 23.2 0.223 21  
## 121 NA 162 76 56 100 53.2 0.759 25  
## 122 6 111 64 39 NA 34.2 0.260 24  
## 123 2 107 74 30 100 33.6 0.404 23  
## 124 5 132 80 NA NA 26.8 0.186 69  
## 125 NA 113 76 NA NA 33.3 0.278 23  
## 126 1 88 30 42 99 55.0 0.496 26  
## 127 3 120 70 30 135 42.9 0.452 30  
## 128 1 118 58 36 94 33.3 0.261 23  
## 129 1 117 88 24 145 34.5 0.403 40  
## 130 NA 105 84 NA NA 27.9 0.741 62  
## 131 4 173 70 14 168 29.7 0.361 33  
## 132 9 122 56 NA NA 33.3 1.114 33  
## 133 3 170 64 37 225 34.5 0.356 30  
## 134 8 84 74 31 NA 38.3 0.457 39  
## 135 2 96 68 13 49 21.1 0.647 26  
## 136 2 125 60 20 140 33.8 0.088 31  
## 137 NA 100 70 26 50 30.8 0.597 21  
## 138 NA 93 60 25 92 28.7 0.532 22  
## 139 NA 129 80 NA NA 31.2 0.703 29  
## 140 5 105 72 29 325 36.9 0.159 28  
## 141 3 128 78 NA NA 21.1 0.268 55  
## 142 5 106 82 30 NA 39.5 0.286 38  
## 143 2 108 52 26 63 32.5 0.318 22  
## 144 10 108 66 NA NA 32.4 0.272 42  
## 145 4 154 62 31 284 32.8 0.237 23  
## 146 NA 102 75 23 NA NA 0.572 21  
## 147 9 57 80 37 NA 32.8 0.096 41  
## 148 2 106 64 35 119 30.5 1.400 34  
## 149 5 147 78 NA NA 33.7 0.218 65  
## 150 2 90 70 17 NA 27.3 0.085 22  
## 151 1 136 74 50 204 37.4 0.399 24  
## 152 4 114 65 NA NA 21.9 0.432 37  
## 153 9 156 86 28 155 34.3 1.189 42  
## 154 1 153 82 42 485 40.6 0.687 23  
## 155 8 188 78 NA NA 47.9 0.137 43  
## 156 7 152 88 44 NA 50.0 0.337 36  
## 157 2 99 52 15 94 24.6 0.637 21  
## 158 1 109 56 21 135 25.2 0.833 23  
## 159 2 88 74 19 53 29.0 0.229 22  
## 160 17 163 72 41 114 40.9 0.817 47  
## 161 4 151 90 38 NA 29.7 0.294 36  
## 162 7 102 74 40 105 37.2 0.204 45  
## 163 NA 114 80 34 285 44.2 0.167 27  
## 164 2 100 64 23 NA 29.7 0.368 21  
## 165 NA 131 88 NA NA 31.6 0.743 32  
## 166 6 104 74 18 156 29.9 0.722 41  
## 167 3 148 66 25 NA 32.5 0.256 22  
## 168 4 120 68 NA NA 29.6 0.709 34  
## 169 4 110 66 NA NA 31.9 0.471 29  
## 170 3 111 90 12 78 28.4 0.495 29  
## 171 6 102 82 NA NA 30.8 0.180 36  
## 172 6 134 70 23 130 35.4 0.542 29  
## 173 2 87 NA 23 NA 28.9 0.773 25  
## 174 1 79 60 42 48 43.5 0.678 23  
## 175 2 75 64 24 55 29.7 0.370 33  
## 176 8 179 72 42 130 32.7 0.719 36  
## 177 6 85 78 NA NA 31.2 0.382 42  
## 178 NA 129 110 46 130 67.1 0.319 26  
## 179 5 143 78 NA NA 45.0 0.190 47  
## 180 5 130 82 NA NA 39.1 0.956 37  
## 181 6 87 80 NA NA 23.2 0.084 32  
## 182 NA 119 64 18 92 34.9 0.725 23  
## 183 1 NA 74 20 23 27.7 0.299 21  
## 184 5 73 60 NA NA 26.8 0.268 27  
## 185 4 141 74 NA NA 27.6 0.244 40  
## 186 7 194 68 28 NA 35.9 0.745 41  
## 187 8 181 68 36 495 30.1 0.615 60  
## 188 1 128 98 41 58 32.0 1.321 33  
## 189 8 109 76 39 114 27.9 0.640 31  
## 190 5 139 80 35 160 31.6 0.361 25  
## 191 3 111 62 NA NA 22.6 0.142 21  
## 192 9 123 70 44 94 33.1 0.374 40  
## 193 7 159 66 NA NA 30.4 0.383 36  
## 194 11 135 NA NA NA 52.3 0.578 40  
## 195 8 85 55 20 NA 24.4 0.136 42  
## 196 5 158 84 41 210 39.4 0.395 29  
## 197 1 105 58 NA NA 24.3 0.187 21  
## 198 3 107 62 13 48 22.9 0.678 23  
## 199 4 109 64 44 99 34.8 0.905 26  
## 200 4 148 60 27 318 30.9 0.150 29  
## 201 NA 113 80 16 NA 31.0 0.874 21  
## 202 1 138 82 NA NA 40.1 0.236 28  
## 203 NA 108 68 20 NA 27.3 0.787 32  
## 204 2 99 70 16 44 20.4 0.235 27  
## 205 6 103 72 32 190 37.7 0.324 55  
## 206 5 111 72 28 NA 23.9 0.407 27  
## 207 8 196 76 29 280 37.5 0.605 57  
## 208 5 162 104 NA NA 37.7 0.151 52  
## 209 1 96 64 27 87 33.2 0.289 21  
## 210 7 184 84 33 NA 35.5 0.355 41  
## 211 2 81 60 22 NA 27.7 0.290 25  
## 212 NA 147 85 54 NA 42.8 0.375 24  
## 213 7 179 95 31 NA 34.2 0.164 60  
## 214 NA 140 65 26 130 42.6 0.431 24  
## 215 9 112 82 32 175 34.2 0.260 36  
## 216 12 151 70 40 271 41.8 0.742 38  
## 217 5 109 62 41 129 35.8 0.514 25  
## 218 6 125 68 30 120 30.0 0.464 32  
## 219 5 85 74 22 NA 29.0 1.224 32  
## 220 5 112 66 NA NA 37.8 0.261 41  
## 221 NA 177 60 29 478 34.6 1.072 21  
## 222 2 158 90 NA NA 31.6 0.805 66  
## 223 7 119 NA NA NA 25.2 0.209 37  
## 224 7 142 60 33 190 28.8 0.687 61  
## 225 1 100 66 15 56 23.6 0.666 26  
## 226 1 87 78 27 32 34.6 0.101 22  
## 227 NA 101 76 NA NA 35.7 0.198 26  
## 228 3 162 52 38 NA 37.2 0.652 24  
## 229 4 197 70 39 744 36.7 2.329 31  
## 230 NA 117 80 31 53 45.2 0.089 24  
## 231 4 142 86 NA NA 44.0 0.645 22  
## 232 6 134 80 37 370 46.2 0.238 46  
## 233 1 79 80 25 37 25.4 0.583 22  
## 234 4 122 68 NA NA 35.0 0.394 29  
## 235 3 74 68 28 45 29.7 0.293 23  
## 236 4 171 72 NA NA 43.6 0.479 26  
## 237 7 181 84 21 192 35.9 0.586 51  
## 238 NA 179 90 27 NA 44.1 0.686 23  
## 239 9 164 84 21 NA 30.8 0.831 32  
## 240 NA 104 76 NA NA 18.4 0.582 27  
## 241 1 91 64 24 NA 29.2 0.192 21  
## 242 4 91 70 32 88 33.1 0.446 22  
## 243 3 139 54 NA NA 25.6 0.402 22  
## 244 6 119 50 22 176 27.1 1.318 33  
## 245 2 146 76 35 194 38.2 0.329 29  
## 246 9 184 85 15 NA 30.0 1.213 49  
## 247 10 122 68 NA NA 31.2 0.258 41  
## 248 NA 165 90 33 680 52.3 0.427 23  
## 249 9 124 70 33 402 35.4 0.282 34  
## 250 1 111 86 19 NA 30.1 0.143 23  
## 251 9 106 52 NA NA 31.2 0.380 42  
## 252 2 129 84 NA NA 28.0 0.284 27  
## 253 2 90 80 14 55 24.4 0.249 24  
## 254 NA 86 68 32 NA 35.8 0.238 25  
## 255 12 92 62 7 258 27.6 0.926 44  
## 256 1 113 64 35 NA 33.6 0.543 21  
## 257 3 111 56 39 NA 30.1 0.557 30  
## 258 2 114 68 22 NA 28.7 0.092 25  
## 259 1 193 50 16 375 25.9 0.655 24  
## 260 11 155 76 28 150 33.3 1.353 51  
## 261 3 191 68 15 130 30.9 0.299 34  
## 262 3 141 NA NA NA 30.0 0.761 27  
## 263 4 95 70 32 NA 32.1 0.612 24  
## 264 3 142 80 15 NA 32.4 0.200 63  
## 265 4 123 62 NA NA 32.0 0.226 35  
## 266 5 96 74 18 67 33.6 0.997 43  
## 267 NA 138 NA NA NA 36.3 0.933 25  
## 268 2 128 64 42 NA 40.0 1.101 24  
## 269 NA 102 52 NA NA 25.1 0.078 21  
## 270 2 146 NA NA NA 27.5 0.240 28  
## 271 10 101 86 37 NA 45.6 1.136 38  
## 272 2 108 62 32 56 25.2 0.128 21  
## 273 3 122 78 NA NA 23.0 0.254 40  
## 274 1 71 78 50 45 33.2 0.422 21  
## 275 13 106 70 NA NA 34.2 0.251 52  
## 276 2 100 70 52 57 40.5 0.677 25  
## 277 7 106 60 24 NA 26.5 0.296 29  
## 278 NA 104 64 23 116 27.8 0.454 23  
## 279 5 114 74 NA NA 24.9 0.744 57  
## 280 2 108 62 10 278 25.3 0.881 22  
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## 750 6 162 62 NA NA 24.3 0.178 50  
## 751 4 136 70 NA NA 31.2 1.182 22  
## 752 1 121 78 39 74 39.0 0.261 28  
## 753 3 108 62 24 NA 26.0 0.223 25  
## 754 NA 181 88 44 510 43.3 0.222 26  
## 755 8 154 78 32 NA 32.4 0.443 45  
## 756 1 128 88 39 110 36.5 1.057 37  
## 757 7 137 90 41 NA 32.0 0.391 39  
## 758 NA 123 72 NA NA 36.3 0.258 52  
## 759 1 106 76 NA NA 37.5 0.197 26  
## 760 6 190 92 NA NA 35.5 0.278 66  
## 761 2 88 58 26 16 28.4 0.766 22  
## 762 9 170 74 31 NA 44.0 0.403 43  
## 763 9 89 62 NA NA 22.5 0.142 33  
## 764 10 101 76 48 180 32.9 0.171 63  
## 765 2 122 70 27 NA 36.8 0.340 27  
## 766 5 121 72 23 112 26.2 0.245 30  
## 767 1 126 60 NA NA 30.1 0.349 47  
## 768 1 93 70 31 NA 30.4 0.315 23  
## Diagnosis  
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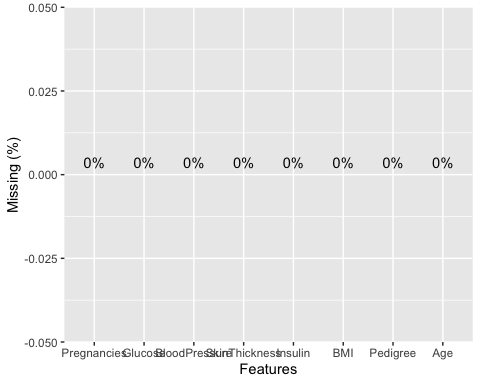
#d)  
# Now calculate the median for each independent variable.  
  
median\_values <- sapply(patients[, patients\_1], median, na.rm = TRUE)  
print(median\_values)

## Pregnancies Glucose BloodPressure SkinThickness Insulin   
## 4.0000 117.0000 72.0000 29.0000 125.0000   
## BMI Pedigree Age   
## 32.3000 0.3725 29.0000

# After calculating the median values, now fill the missing values with median values.  
for (attr in patients\_1) {  
  
 patients[is.na(patients[[attr]]), attr] <- median\_values[attr]  
  
}  
# Let's check whether the NA values have been replaced by median.  
head(patients)

## Pregnancies Glucose BloodPressure SkinThickness Insulin BMI Pedigree Age  
## 1 6 148 72 35 125 33.6 0.627 50  
## 2 1 85 66 29 125 26.6 0.351 31  
## 3 8 183 64 29 125 23.3 0.672 32  
## 4 1 89 66 23 94 28.1 0.167 21  
## 5 4 137 40 35 168 43.1 2.288 33  
## 6 5 116 74 29 125 25.6 0.201 30  
## Diagnosis  
## 1 1  
## 2 0  
## 3 1  
## 4 0  
## 5 1  
## 6 0

#d)  
#plot of missing values after replacing it with median (check)  
patients$Glucose[patients$Glucose %in% 0] <- NA  
patients$BloodPressure[patients$BloodPressure %in% 0] <- NA  
patients$SkinThickness[patients$SkinThickness %in% 0] <- NA  
patients$Insulin[patients$Insulin %in% 0] <- NA  
patients$BMI[patients$BMI %in% 0] <- NA  
patients$Pregnancies[patients$Pregnancies %in% 0] <- NA  
patients$Age[patients$Age %in% 0] <- NA  
patients$Pedigree[patients$Pedigree %in% 0] <- NA  
mis\_2 <- mis\_1  
mis\_2 <- data.frame(val=apply(patients[-9],2,function(x){round(sum(is.na(x))/nrow(patients),2)\*100}),names = names(apply(patients[-9],2,function(x){sum(is.na(x))})))  
mis\_2 <- mis\_2[order(mis\_2$val),]  
mis\_2$names <- factor(mis\_2$names,levels = mis\_2$names)  
ggplot(mis\_2)+   
 geom\_bar(mapping = aes(x = names, y = val),  
 stat = "identity", fill = '#7463AC')+  
 geom\_text(aes(x = names, y = val,label=paste0(val,"%")),vjust=-0.65)+ylab("Missing (%)")+xlab("Features")



#e)  
#Define a function to detect outliers using the IQR rule   
detect\_outliers <- function(x) {   
 q1 <- quantile(x, 0.25)   
 q3 <- quantile(x, 0.75)   
 iqr <- q3 - q1   
 lower\_bound <- q1 - 1.5 \* iqr   
 upper\_bound <- q3 + 1.5 \* iqr   
 outliers <- x[x < lower\_bound | x > upper\_bound]   
 return(outliers)   
}   
   
# Find outliers for each independent variable   
outliers <- lapply(patients[, -which(names(patients) == "Diagnosis")], detect\_outliers)   
   
# Print the outliers for each variable   
for (i in seq\_along(outliers)) {   
 variable <- names(patients[, -which(names(patients) == "Diagnosis")])[i]   
 cat("Outliers for", variable, ":")   
 if (length(outliers[[i]]) == 0) {   
 cat(" None\n")   
 } else {   
 cat("\n")   
 print(outliers[[i]])   
 }   
}

## Outliers for Pregnancies :  
## [1] 13 13 13 15 17 13 14 13 13 14 13 13 13 13  
## Outliers for Glucose : None  
## Outliers for BloodPressure :  
## [1] 30 110 108 122 30 110 108 110 24 38 106 106 106 114  
## Outliers for SkinThickness :  
## [1] 45 47 11 47 11 10 60 13 13 54 51 56 14 13 50 44 12 46 44 13 44 54 14 7 50  
## [26] 52 10 44 43 45 14 10 11 12 43 13 12 48 43 43 8 13 14 12 49 46 46 11 8 12  
## [51] 63 12 45 13 48 13 10 45 7 52 49 43 14 47 99 46 11 50 45 14 13 13 47 12 48  
## [76] 43 46 46 45 10 46 49 11 13 46 44 48  
## Outliers for Insulin :  
## [1] 94 168 88 543 846 175 230 83 96 235 146 140 110 245 54 192 207 70  
## [19] 240 82 36 23 300 342 304 110 142 38 100 90 140 270 71 71 110 176  
## [37] 48 64 228 76 64 220 40 152 140 18 36 495 37 175 51 100 100 99  
## [55] 94 145 168 225 49 140 50 92 325 63 284 204 155 485 94 53 105 285  
## [73] 156 78 48 55 92 23 495 58 160 94 210 48 99 318 44 190 280 87  
## [91] 175 271 478 190 56 32 744 53 370 37 45 192 88 176 194 680 402 55  
## [109] 258 375 150 67 56 45 57 278 155 545 220 49 75 40 74 182 194 360  
## [127] 215 184 42 105 148 180 205 148 96 85 94 64 140 231 29 168 156 68  
## [145] 52 58 255 171 105 73 108 83 74 43 167 54 249 325 293 83 66 140  
## [163] 465 89 66 94 158 325 84 75 72 82 182 59 110 50 285 81 196 415  
## [181] 87 275 88 165 579 176 310 61 167 474 170 76 78 210 277 180 145 180  
## [199] 85 60 50 14 70 92 64 63 95 210 105 71 237 60 56 49 105 36  
## [217] 100 140 191 110 75 328 49 250 480 265 66 76 145 193 71 79 90 170  
## [235] 76 210 86 105 165 326 66 82 105 188 106 65 56 210 155 215 190 56  
## [253] 76 225 207 166 67 106 44 215 274 77 54 88 18 165 44 330 63 600  
## [271] 156 140 230 185 25 293 41 272 182 158 194 321 144 15 160 54 90 183  
## [289] 66 91 46 105 152 440 144 159 100 106 77 540 90 200 70 231 190 100  
## [307] 168 49 240 265 45 105 205 180 180 95 480 155 200 100 335 160 387 22  
## [325] 291 392 185 178 200 105 180 79 165 160 150 94 140 105 57 200 74 510  
## [343] 110 16 180 112  
## Outliers for BMI :  
## [1] 53.2 55.0 67.1 52.3 52.3 52.9 59.4 57.3  
## Outliers for Pedigree :  
## [1] 2.288 1.441 1.390 1.893 1.781 1.222 1.400 1.321 1.224 2.329 1.318 1.213  
## [13] 1.353 1.224 1.391 1.476 2.137 1.731 1.268 1.600 2.420 1.251 1.699 1.258  
## [25] 1.282 1.698 1.461 1.292 1.394  
## Outliers for Age :  
## [1] 69 67 72 81 67 67 70 68 69

patients\_2 <- patients  
summary(patients\_2)

## Pregnancies Glucose BloodPressure SkinThickness   
## Min. : 1.000 Min. : 44.00 Min. : 24.00 Min. : 7.00   
## 1st Qu.: 2.000 1st Qu.: 99.75 1st Qu.: 64.00 1st Qu.:25.00   
## Median : 4.000 Median :117.00 Median : 72.00 Median :29.00   
## Mean : 4.423 Mean :121.66 Mean : 72.39 Mean :29.11   
## 3rd Qu.: 6.000 3rd Qu.:140.25 3rd Qu.: 80.00 3rd Qu.:32.00   
## Max. :17.000 Max. :199.00 Max. :122.00 Max. :99.00   
## Insulin BMI Pedigree Age   
## Min. : 14.0 Min. :18.20 Min. :0.0780 Min. :21.00   
## 1st Qu.:121.5 1st Qu.:27.50 1st Qu.:0.2437 1st Qu.:24.00   
## Median :125.0 Median :32.30 Median :0.3725 Median :29.00   
## Mean :140.7 Mean :32.46 Mean :0.4719 Mean :33.24   
## 3rd Qu.:127.2 3rd Qu.:36.60 3rd Qu.:0.6262 3rd Qu.:41.00   
## Max. :846.0 Max. :67.10 Max. :2.4200 Max. :81.00   
## Diagnosis   
## Min. :0.000   
## 1st Qu.:0.000   
## Median :0.000   
## Mean :0.349   
## 3rd Qu.:1.000   
## Max. :1.000

#f) Approach for replacing outlier with lower and upper bound  
for (i in seq\_along(outliers)) {   
 variable <- names(patients\_2[, -which(names(patients\_2) == "Diagnosis")])[i]   
   
 if (variable != "Diagnosis" && length(outliers[[i]]) > 0) {   
 q1 <- quantile(patients\_2[[variable]], 0.25)   
 q3 <- quantile(patients\_2[[variable]], 0.75)   
 iqr <- q3 - q1   
 lower\_bound <- q1 - 1.5 \* iqr   
 upper\_bound <- q3 + 1.5 \* iqr   
 outliers\_indices <- which(patients\_2[[variable]] %in% outliers[[i]])   
   
for (index in outliers\_indices) {   
 if (patients\_2[[variable]][index] < lower\_bound || patients\_2[[variable]][index] > upper\_bound) {   
 if (patients\_2[[variable]][index] < lower\_bound) {   
 patients\_2[[variable]][index] <- max(patients\_2[[variable]][patients\_2[[variable]] >= lower\_bound])   
 } else {   
 patients\_2[[variable]][index] <- min(patients\_2[[variable]][patients\_2[[variable]] <= upper\_bound])   
 }   
 }   
 }   
 }   
}   
summary(patients\_2)

## Pregnancies Glucose BloodPressure SkinThickness   
## Min. : 1.000 Min. : 44.00 Min. : 24.00 Min. : 7.00   
## 1st Qu.: 2.000 1st Qu.: 99.75 1st Qu.: 64.00 1st Qu.:24.00   
## Median : 4.000 Median :117.00 Median : 72.00 Median :29.00   
## Mean : 4.194 Mean :121.66 Mean : 71.74 Mean :30.94   
## 3rd Qu.: 6.000 3rd Qu.:140.25 3rd Qu.: 80.00 3rd Qu.:32.00   
## Max. :12.000 Max. :199.00 Max. :122.00 Max. :99.00   
## Insulin BMI Pedigree Age   
## Min. : 14.0 Min. :18.20 Min. :0.0780 Min. :21.00   
## 1st Qu.:121.5 1st Qu.:27.40 1st Qu.:0.2298 1st Qu.:24.00   
## Median :125.0 Median :32.15 Median :0.3425 Median :29.00   
## Mean :262.4 Mean :32.06 Mean :0.4165 Mean :32.67   
## 3rd Qu.:127.2 3rd Qu.:36.30 3rd Qu.:0.5823 3rd Qu.:40.00   
## Max. :846.0 Max. :50.00 Max. :1.1910 Max. :66.00   
## Diagnosis   
## Min. :0.000   
## 1st Qu.:0.000   
## Median :0.000   
## Mean :0.349   
## 3rd Qu.:1.000   
## Max. :1.000

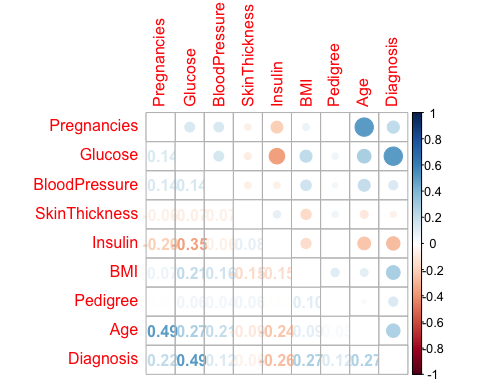
#g) Best performing variables   
#install.packages("corrplot")  
library(corrplot)

## corrplot 0.92 loaded

#correlation\_matrix <- cor(patients\_2)  
  
# Select the variables of interest  
variables\_of\_interest <- c("Pregnancies", "Glucose", "BloodPressure", "SkinThickness", "Insulin", "BMI", "Pedigree", "Age")  
  
# Subset the dataset to include only the selected variables  
subset\_data <- patients\_2[, variables\_of\_interest]  
  
# Calculate the correlation matrix  
correlation\_matrix <- cor(subset\_data)  
correlation\_matrix

## Pregnancies Glucose BloodPressure SkinThickness Insulin  
## Pregnancies 1.000000000 0.1399936 0.13936843 -0.06298979 -0.204870619  
## Glucose 0.139993641 1.0000000 0.14116470 -0.07105640 -0.353492066  
## BloodPressure 0.139368432 0.1411647 1.00000000 -0.06595801 -0.062186128  
## SkinThickness -0.062989790 -0.0710564 -0.06595801 1.00000000 0.081282996  
## Insulin -0.204870619 -0.3534921 -0.06218613 0.08128300 1.000000000  
## BMI 0.068621274 0.2113101 0.16261972 -0.15481849 -0.149806784  
## Pedigree 0.007682696 0.0594190 0.04338879 0.05956421 -0.004158563  
## Age 0.493599637 0.2708325 0.20860921 -0.09271900 -0.239555893  
## BMI Pedigree Age  
## Pregnancies 0.06862127 0.007682696 0.49359964  
## Glucose 0.21131013 0.059419001 0.27083249  
## BloodPressure 0.16261972 0.043388788 0.20860921  
## SkinThickness -0.15481849 0.059564213 -0.09271900  
## Insulin -0.14980678 -0.004158563 -0.23955589  
## BMI 1.00000000 0.103138457 0.09084778  
## Pedigree 0.10313846 1.000000000 0.02730916  
## Age 0.09084778 0.027309161 1.00000000

#g)  
# Install and load the ggplot2 package  
#install.packages("ggplot2")  
library(ggplot2)  
library(corrplot)  
  
# Create the correlation plot using a heatmap  
  
#corrplot(correlation\_matrix, method = "color")  
#corMat = cor (patients\_2[, -9])  
corMat = cor (patients\_2)  
diag (corMat) = 0 #Remove self correlations  
corrplot.mixed(corMat,tl.pos = "lt")

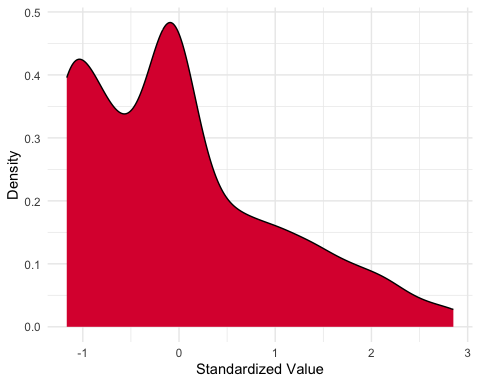


#h) Standardizing variables  
  
# Standardize the selected variables to Gaussian distribution   
standardized\_data <- scale(patients\_2[, -9])  
   
# Convert the standardized data back to a data frame   
standardized\_data <- as.data.frame(standardized\_data)   
   
# View the standardized data   
print(standardized\_data)

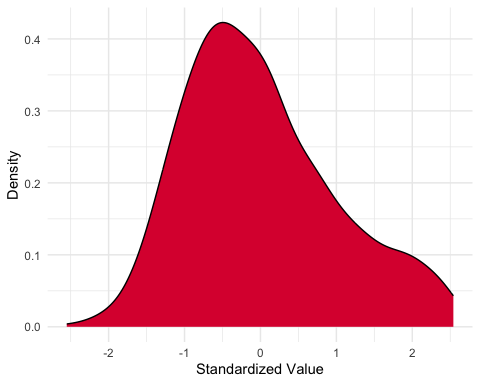
## Pregnancies Glucose BloodPressure SkinThickness Insulin BMI  
## 1 0.65970694 0.86548074 0.02019889 0.231037804 -0.4319919 0.234598938  
## 2 -1.16673476 -1.20428102 -0.45227063 -0.110296662 -0.4319919 -0.831417366  
## 3 1.39028362 2.01534838 -0.60976047 -0.110296662 -0.4319919 -1.333967909  
## 4 -1.16673476 -1.07286758 -0.45227063 -0.451631129 1.8351701 -0.602985301  
## 5 -0.07086974 0.50409376 -2.49963854 0.231037804 -0.7810279 1.681335350  
## 6 0.29441860 -0.18582682 0.17768873 -0.110296662 -0.4319919 -0.983705409  
## 7 -0.43615808 -1.43425455 -1.71218934 0.060370571 1.8351701 -0.161349975  
## 8 2.12086030 -0.21868019 0.02019889 -0.110296662 -0.4319919 0.493488611  
## 9 -0.80144642 2.47529544 -0.13729095 -1.361856372 -0.7810279 -0.237493997  
## 10 1.39028362 0.10985343 1.91007696 -0.110296662 -0.4319919 0.036624481  
## 11 -0.07086974 -0.38294699 1.59509729 -0.110296662 -0.4319919 0.843751111  
## 12 2.12086030 1.52254796 0.17768873 -0.110296662 -0.4319919 0.904666329  
## 13 2.12086030 0.56980048 0.65015825 -0.110296662 -0.4319919 -0.755273344  
## 14 -1.16673476 2.21246855 -0.92474014 -0.451631129 -0.7810279 -0.298409214  
## 15 0.29441860 1.45684124 0.02019889 -0.679187440 -0.7810279 -0.953247801  
## 16 1.02499528 -0.71148060 0.02019889 -0.110296662 -0.4319919 -0.313638019  
## 17 -0.07086974 -0.12012010 0.96513793 -1.361856372 -0.7810279 2.092513067  
## 18 1.02499528 -0.48150708 0.17768873 -0.110296662 -0.4319919 -0.374553236  
## 19 -1.16673476 -0.61292052 3.95744488 0.401705037 1.8351701 1.711792959  
## 20 -1.16673476 -0.21868019 -0.13729095 -0.053407585 1.8351701 0.386886981  
## 21 -0.43615808 0.14270679 1.28011761 0.572372270 -0.7810279 1.102640785  
## 22 1.39028362 -0.74433397 0.96513793 -0.110296662 -0.4319919 0.508717416  
## 23 1.02499528 2.44244208 1.43760745 -0.110296662 -0.4319919 1.178784807  
## 24 1.75557196 -0.08726674 0.65015825 0.231037804 -0.4319919 -0.465926062  
## 25 2.48614864 0.70121393 1.75258713 0.117259648 -0.7810279 0.691463068  
## 26 2.12086030 0.10985343 -0.13729095 -0.280963896 -0.4634365 -0.146121171  
## 27 1.02499528 0.83262737 0.33517857 -0.110296662 -0.4319919 1.117869589  
## 28 -1.16673476 -0.81004069 -0.45227063 -0.906743751 -0.7810279 -1.349196714  
## 29 -1.16673476 0.76692065 0.80764809 -0.679187440 1.8351701 -1.501484757  
## 30 0.29441860 -0.15297346 1.59509729 -0.110296662 -0.4319919 0.310742959  
## 31 0.29441860 -0.41580035 0.25643365 -0.280963896 -0.4319919 0.600090242  
## 32 -0.43615808 1.19401435 0.33517857 0.287926882 -0.7810279 -0.069977149  
## 33 -0.43615808 -1.10572094 -1.08222998 3.871938778 1.8351701 -1.105535844  
## 34 0.65970694 -0.97430749 1.59509729 -0.110296662 -0.4319919 -1.851747257  
## 35 2.12086030 0.01129334 0.49266841 0.003481493 -0.4319919 -0.679129323  
## 36 -0.07086974 -0.61292052 -0.92474014 0.117259648 -0.7810279 -1.227366279  
## 37 2.48614864 0.53694712 0.33517857 -0.110296662 -0.4319919 0.173683720  
## 38 1.75557196 -0.64577388 0.33517857 0.344815959 -0.4319919 0.127997307  
## 39 -0.80144642 -1.04001422 -0.29478079 0.629261348 -0.4319919 0.935123937  
## 40 -0.07086974 -0.35009363 0.02019889 -1.361856372 -0.7810279 0.767607090  
## 41 -0.43615808 1.91678830 -0.60976047 -0.337852973 1.8351701 0.295514155  
## 42 1.02499528 0.37268032 0.96513793 -0.110296662 -0.4319919 1.239700024  
## 43 1.02499528 -0.51436044 1.59509729 -0.736076517 -0.4319919 -1.425340735  
## 44 1.75557196 1.62110804 -3.75955725 -0.394742051 -0.7810279 2.031597850  
## 45 1.02499528 1.22686771 -0.60976047 -0.110296662 -0.4319919 -0.709586931  
## 46 -0.07086974 1.91678830 -0.45227063 0.458594115 -0.4319919 1.513818502  
## 47 -1.16673476 0.79977401 -1.23971982 -0.110296662 -0.4319919 -0.359324432  
## 48 -0.80144642 -1.66422808 -0.13729095 -0.224074818 -0.4319919 -0.618214105  
## 49 1.02499528 -0.61292052 -0.45227063 0.060370571 -0.4319919 1.072183176  
## 50 1.02499528 -0.54721380 0.02019889 -0.110296662 -0.4319919 0.036624481  
## 51 -1.16673476 -0.61292052 0.65015825 3.871938778 1.8351701 -1.927891278  
## 52 -1.16673476 -0.67862724 -1.71218934 -0.906743751 1.8351701 -1.196908670  
## 53 0.29441860 -1.10572094 -0.45227063 -0.565409284 1.8351701 -1.166451061  
## 54 1.39028362 1.78537485 1.43760745 0.174148726 -0.7810279 0.249827742  
## 55 1.02499528 0.93118746 -0.45227063 0.629261348 -0.7810279 0.402115785  
## 56 -1.16673476 -1.59852136 -1.71218934 3.871938778 -0.4319919 -1.379654322  
## 57 1.02499528 2.14676182 -0.29478079 0.458594115 -0.7810279 0.858979916  
## 58 -0.07086974 -0.71148060 1.28011761 -1.361856372 1.8351701 2.244801110  
## 59 -0.07086974 0.79977401 0.80764809 -0.110296662 -0.4319919 1.285386437  
## 60 -0.07086974 -0.54721380 -0.60976047 0.572372270 -0.7810279 1.437674480  
## 61 -0.80144642 -1.23713438 0.02019889 -0.110296662 -0.4319919 0.036624481  
## 62 1.39028362 0.37268032 0.02019889 -0.110296662 -0.4319919 0.127997307  
## 63 0.29441860 -2.55126883 -0.76725030 -0.110296662 -0.4319919 -1.075078235  
## 64 -0.80144642 0.63550721 -1.08222998 0.174148726 -0.4225585 -1.014163018  
## 65 1.02499528 -0.25153355 -0.45227063 -0.110296662 -0.4319919 0.112768503  
## 66 0.29441860 -0.74433397 0.17768873 -0.224074818 -0.4319919 -0.465926062  
## 67 -0.07086974 -0.41580035 1.28011761 -0.053407585 -0.4319919 0.067082090  
## 68 -0.80144642 -0.41580035 1.59509729 -0.110296662 -0.4319919 1.620420132  
## 69 -1.16673476 -0.87574741 -0.45227063 3.871938778 1.8351701 -1.897433670  
## 70 -0.07086974 0.79977401 1.04388285 -0.224074818 1.8351701 -0.481154866  
## 71 -0.80144642 -0.71148060 -0.45227063 -0.622298362 1.8351701 0.127997307  
## 72 0.29441860 0.56980048 -0.60976047 0.231037804 -0.7810279 -0.526841279  
## 73 -1.16673476 0.14270679 1.43760745 -0.110296662 -0.4319919 1.727021763  
## 74 -0.07086974 0.24126687 1.12262777 -0.622298362 -0.7810279 0.463031003  
## 75 -1.16673476 -1.40140119 0.25643365 -0.053407585 -0.4319919 -0.009061932  
## 76 -1.16673476 -0.15297346 -1.86967918 -0.622298362 -0.4319919 -1.120764648  
## 77 1.02499528 -1.95990833 0.49266841 -0.110296662 -0.4319919 0.082310894  
## 78 0.29441860 -0.87574741 0.02019889 0.117259648 -0.4319919 0.858979916  
## 79 -0.07086974 0.30697359 0.02019889 -0.110296662 -0.4319919 1.696564154  
## 80 -0.80144642 -0.31724027 -0.45227063 -0.508520206 -0.4319919 -1.075078235  
## 81 -0.43615808 -0.28438691 -2.18465886 3.871938778 -0.4319919 -1.471027148  
## 82 -0.80144642 -1.56566800 0.02019889 -0.110296662 -0.4319919 0.036624481  
## 83 1.02499528 -1.26998775 0.49266841 -0.280963896 1.8351701 -0.420239649  
## 84 -0.07086974 -0.67862724 -0.53101555 -0.167185740 -0.4319919 -1.135993453  
## 85 0.29441860 0.50409376 -3.75955725 -0.110296662 -0.4319919 2.549377197  
## 86 -0.80144642 -0.38294699 0.17768873 -0.110296662 -0.4319919 0.051853286  
## 87 -1.16673476 -0.51436044 0.02019889 -1.361856372 -0.4319919 0.691463068  
## 88 -0.80144642 -0.71148060 -0.29478079 -0.337852973 1.8351701 0.980810350  
## 89 -1.16673476 0.47124040 -0.13729095 0.060370571 1.8351701 0.767607090  
## 90 -1.16673476 -0.48150708 -0.29478079 -0.679187440 -0.4319919 -0.846646170  
## 91 -1.16673476 -1.36854783 -1.31846474 -0.110296662 -0.4319919 -1.973577691  
## 92 -0.07086974 0.04414670 0.65015825 -0.906743751 -0.7810279 -0.009061932  
## 93 1.02499528 -1.33569447 0.49266841 0.515483193 1.8351701 2.229572306  
## 94 -0.07086974 0.40553368 0.02019889 -0.110296662 -0.4319919 -1.257823888  
## 95 -0.80144642 0.66836057 0.80764809 -0.736076517 1.8351701 -1.120764648  
## 96 0.65970694 0.73406729 0.02019889 -0.224074818 -0.7810279 0.280285351  
## 97 -0.80144642 -0.97430749 -0.76725030 -0.167185740 -0.4319919 -0.069977149  
## 98 -1.16673476 -1.66422808 -1.86967918 -0.736076517 1.8351701 -1.775603235  
## 99 0.65970694 -0.94145413 -1.71218934 -0.053407585 1.8351701 -0.511612475  
## 100 -1.16673476 0.01129334 1.43760745 -1.361856372 -0.7810279 2.686436436  
## 101 -1.16673476 1.35828115 0.02019889 -0.110296662 -0.4319919 1.056954372  
## 102 -1.16673476 0.96404082 -0.92474014 -0.110296662 -0.4319919 -0.907561388  
## 103 -0.07086974 0.10985343 1.91007696 -0.110296662 -0.4319919 -1.455798344  
## 104 -1.16673476 -1.33569447 0.02019889 -0.736076517 1.8351701 -0.831417366  
## 105 -0.80144642 -1.20428102 -0.53101555 -0.110296662 -0.4319919 1.148327198  
## 106 -1.16673476 0.14270679 -1.23971982 -0.110296662 -0.7810279 -0.511612475  
## 107 -1.16673476 -0.84289405 -3.75955725 -0.110296662 -0.4319919 -1.471027148  
## 108 -0.07086974 0.73406729 -1.08222998 -0.167185740 -0.7810279 -0.389782040  
## 109 -0.43615808 -1.26998775 -1.08222998 0.003481493 1.8351701 0.341200568  
## 110 -0.07086974 -0.87574741 1.04388285 -0.337852973 1.8351701 0.813293503  
## 111 -0.43615808 1.62110804 0.02019889 0.117259648 -0.4005472 0.188912525  
## 112 1.39028362 1.09545426 -0.76725030 -0.280963896 -0.7810279 0.295514155  
## 113 -1.16673476 -1.07286758 0.33517857 0.174148726 1.8351701 -0.130892366  
## 114 -0.07086974 -1.49996127 -0.76725030 -0.110296662 -0.4319919 0.295514155  
## 115 1.02499528 1.25972107 -1.39720966 0.060370571 -0.7810279 -0.237493997  
## 116 -0.07086974 0.79977401 1.59509729 -0.110296662 -0.4319919 -0.130892366  
## 117 0.29441860 0.07700007 0.17768873 -0.110296662 -0.4319919 0.295514155  
## 118 0.29441860 -1.43425455 -1.86967918 -0.110296662 -0.4319919 0.249827742  
## 119 -0.07086974 -0.81004069 -0.92474014 -0.451631129 -0.4319919 -0.587756497  
## 120 -0.07086974 -0.74433397 0.33517857 -0.906743751 1.8351701 -1.349196714  
## 121 -0.07086974 1.32542779 0.33517857 -1.361856372 1.8351701 -2.110636930  
## 122 0.65970694 -0.35009363 -0.60976047 0.458594115 -0.4319919 0.325971764  
## 123 -0.80144642 -0.48150708 0.17768873 -0.053407585 1.8351701 0.234598938  
## 124 0.29441860 0.33982696 0.65015825 -0.110296662 -0.4319919 -0.800959757  
## 125 -0.07086974 -0.28438691 0.33517857 -0.110296662 -0.4319919 0.188912525  
## 126 -1.16673476 -1.10572094 3.95744488 0.629261348 1.8351701 -2.110636930  
## 127 -0.43615808 -0.05441338 -0.13729095 -0.053407585 -0.4005472 1.650877741  
## 128 -1.16673476 -0.12012010 -1.08222998 0.287926882 1.8351701 0.188912525  
## 129 -1.16673476 -0.15297346 1.28011761 -0.394742051 -0.7810279 0.371658177  
## 130 -0.07086974 -0.54721380 0.96513793 -0.110296662 -0.4319919 -0.633442910  
## 131 -0.07086974 1.68681477 -0.13729095 3.871938778 -0.7810279 -0.359324432  
## 132 1.75557196 0.01129334 -1.23971982 -0.110296662 -0.4319919 0.188912525  
## 133 -0.43615808 1.58825468 -0.60976047 0.344815959 -0.7810279 0.371658177  
## 134 1.39028362 -1.23713438 0.17768873 0.003481493 -0.4319919 0.950352742  
## 135 -0.80144642 -0.84289405 -0.29478079 3.871938778 1.8351701 -1.669001605  
## 136 -0.80144642 0.10985343 -0.92474014 -0.622298362 -0.7810279 0.265056546  
## 137 -0.07086974 -0.71148060 -0.13729095 -0.280963896 1.8351701 -0.191807584  
## 138 -0.07086974 -0.94145413 -0.92474014 -0.337852973 1.8351701 -0.511612475  
## 139 -0.07086974 0.24126687 0.65015825 -0.110296662 -0.4319919 -0.130892366  
## 140 0.29441860 -0.54721380 0.02019889 -0.110296662 -0.7810279 0.737149481  
## 141 -0.43615808 0.20841351 0.49266841 -0.110296662 -0.4319919 -1.669001605  
## 142 0.29441860 -0.51436044 0.80764809 -0.053407585 -0.4319919 1.133098394  
## 143 -0.80144642 -0.44865371 -1.55469950 -0.280963896 1.8351701 0.067082090  
## 144 2.12086030 -0.44865371 -0.45227063 -0.110296662 -0.4319919 0.051853286  
## 145 -0.07086974 1.06260090 -0.76725030 0.003481493 -0.7810279 0.112768503  
## 146 -0.07086974 -0.64577388 0.25643365 -0.451631129 -0.4319919 0.036624481  
## 147 1.75557196 -2.12417514 0.65015825 0.344815959 -0.4319919 0.112768503  
## 148 -0.80144642 -0.51436044 -0.60976047 0.231037804 -0.4508587 -0.237493997  
## 149 0.29441860 0.83262737 0.49266841 -0.110296662 -0.4319919 0.249827742  
## 150 -0.80144642 -1.04001422 -0.13729095 -0.792965595 -0.4319919 -0.724815736  
## 151 -1.16673476 0.47124040 0.17768873 -1.361856372 -0.7810279 0.813293503  
## 152 -0.07086974 -0.25153355 -0.53101555 -0.110296662 -0.4319919 -1.547171170  
## 153 1.75557196 1.12830763 1.12262777 -0.167185740 -0.7810279 0.341200568  
## 154 -1.16673476 1.02974754 0.80764809 0.629261348 -0.7810279 1.300615241  
## 155 1.39028362 2.17961519 0.49266841 -0.110296662 -0.4319919 2.412317958  
## 156 1.02499528 0.99689418 1.28011761 -1.361856372 -0.4319919 2.732122849  
## 157 -0.80144642 -0.74433397 -1.55469950 -0.906743751 1.8351701 -1.135993453  
## 158 -1.16673476 -0.41580035 -1.23971982 -0.565409284 -0.4005472 -1.044620627  
## 159 -0.80144642 -1.10572094 0.17768873 -0.679187440 1.8351701 -0.465926062  
## 160 -1.16673476 1.35828115 0.02019889 0.572372270 -0.4665810 1.346301654  
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## 380 2.380242690 0.20981915  
## 381 1.592673699 -0.77932826  
## 382 -0.710965601 -0.95917324  
## 383 2.088842163 -1.04909573  
## 384 -1.333145105 -0.68940577  
## 385 -0.770033276 -0.68940577  
## 386 -0.833038795 -0.77932826  
## 387 0.958680661 0.20981915  
## 388 -0.699152066 1.10904406  
## 389 0.139608910 2.27803645  
## 390 2.096717853 -0.41963829  
## 391 0.108106150 0.83927659  
## 392 -0.301429726 -0.50956078  
## 393 -0.108475323 -1.04909573  
## 394 0.182925204 0.38966413  
## 395 1.521792490 -0.14987082  
## 396 -1.333145105 -0.68940577  
## 397 2.077028629 0.56950911  
## 398 -0.868479400 -0.95917324  
## 399 -0.108475323 -0.68940577  
## 400 -0.691276376 -0.68940577  
## 401 -1.006303973 -0.14987082  
## 402 -1.045682423 2.00826897  
## 403 -0.514073353 0.20981915  
## 404 -0.537700423 0.47958662  
## 405 -1.108687942 0.74935409  
## 406 0.407382367 -0.59948328  
## 407 -0.159667307 1.19896655  
## 408 -0.317181106 -0.68940577  
## 409 3.049676333 0.56950911  
## 410 1.124070149 -0.41963829  
## 411 1.013810490 -0.41963829  
## 412 0.438885126 -0.68940577  
## 413 2.596824163 -0.95917324  
## 414 -0.632208702 -1.04909573  
## 415 0.462512196 -1.04909573  
## 416 -0.624333012 -0.95917324  
## 417 2.671643217 -0.95917324  
## 418 0.541269095 0.38966413  
## 419 0.816918242 -0.50956078  
## 420 -0.777908966 -0.41963829  
## 421 0.356190382 -0.59948328  
## 422 0.568834010 -1.04909573  
## 423 0.312874088 -1.04909573  
## 424 0.017535716 -1.04909573  
## 425 0.391630987 0.29974164  
## 426 -0.600705942 -0.14987082  
## 427 -0.632208702 -0.68940577  
## 428 -0.348683865 0.47958662  
## 429 -0.521949043 -0.59948328  
## 430 -0.722779136 0.92919908  
## 431 -1.215009756 -0.86925075  
## 432 0.529455560 0.47958662  
## 433 0.434947281 -0.95917324  
## 434 -0.982676903 -0.32971580  
## 435 2.840970550 0.29974164  
## 436 -0.833038795 -0.32971580  
## 437 -0.679462842 0.74935409  
## 438 0.068727700 -0.41963829  
## 439 -1.061433802 -1.04909573  
## 440 1.222516273 -0.14987082  
## 441 0.072665545 0.74935409  
## 442 0.316811933 -0.95917324  
## 443 -0.734592671 -0.77932826  
## 444 2.120344923 0.02997416  
## 445 -0.143915927 -0.23979331  
## 446 -1.333145105 -0.68940577  
## 447 0.950804971 -0.41963829  
## 448 -0.340808175 -0.59948328  
## 449 0.368003917 -0.95917324  
## 450 -0.518011198 -0.59948328  
## 451 -0.006091354 -0.86925075  
## 452 0.494014956 -0.86925075  
## 453 -0.139978082 -0.68940577  
## 454 1.635989993 -1.04909573  
## 455 0.320749778 -0.77932826  
## 456 -0.805473880 0.47958662  
## 457 1.065002474 2.63772641  
## 458 -0.206921447 -0.77932826  
## 459 2.301485791 1.64857901  
## 460 0.171111669 -1.04909573  
## 461 1.246143343 1.37881153  
## 462 -0.002153509 -0.59948328  
## 463 1.135883684 0.56950911  
## 464 -0.624333012 0.38966413  
## 465 2.384180535 0.11989666  
## 466 0.139608910 -1.04909573  
## 467 -0.581016718 -0.95917324  
## 468 0.722409963 -0.68940577  
## 469 -0.919671384 0.47958662  
## 470 0.608212459 -0.50956078  
## 471 0.749974878 -0.41963829  
## 472 -0.970863368 -0.95917324  
## 473 -0.620395167 -0.95917324  
## 474 -0.813349570 1.55865652  
## 475 -1.144128547 -0.77932826  
## 476 -0.730654826 2.36795894  
## 477 1.159510753 -0.32971580  
## 478 0.194738739 -0.14987082  
## 479 -1.002366128 0.56950911  
## 480 0.009660026 2.72764891  
## 481 -0.285678346 0.20981915  
## 482 -0.864541555 -0.32971580  
## 483 -0.435316454 -0.41963829  
## 484 -0.722779136 -0.86925075  
## 485 0.840545312 -0.14987082  
## 486 -0.202983602 -0.77932826  
## 487 0.470387886 -1.04909573  
## 488 2.923665294 2.27803645  
## 489 -0.482570594 -0.41963829  
## 490 0.529455560 -1.04909573  
## 491 0.836607467 -0.77932826  
## 492 -0.490446284 0.83927659  
## 493 -1.069309492 0.02997416  
## 494 2.864597620 1.10904406  
## 495 -0.955111989 -0.95917324  
## 496 -0.443192144 2.99741638  
## 497 -0.490446284 -0.23979331  
## 498 0.513704180 -0.68940577  
## 499 -0.998428283 2.00826897  
## 500 1.663554908 0.56950911  
## 501 -0.407751540 -1.04909573  
## 502 -0.588892408 -0.41963829  
## 503 1.222516273 0.74935409  
## 504 1.265832567 0.74935409  
## 505 -0.703089911 0.65943160  
## 506 -0.604643787 0.47958662  
## 507 -0.403813695 0.20981915  
## 508 1.084691699 -1.04909573  
## 509 2.171536907 -1.04909573  
## 510 -0.029718424 2.81757140  
## 511 -0.470757059 1.19896655  
## 512 -0.825163105 -1.04909573  
## 513 -0.852728020 2.27803645  
## 514 0.427071591 -0.95917324  
## 515 -1.033868888 -0.77932826  
## 516 -0.584954563 -0.41963829  
## 517 1.395781451 1.82842399  
## 518 -0.443192144 1.64857901  
## 519 -0.931484919 0.74935409  
## 520 0.651528754 2.45788143  
## 521 -0.903920004 -0.68940577  
## 522 -0.439254299 -0.59948328  
## 523 -0.896044314 -0.59948328  
## 524 0.927177901 1.10904406  
## 525 -1.045682423 -0.77932826  
## 526 0.108106150 -1.04909573  
## 527 -0.462881369 -1.04909573  
## 528 -1.218947601 -0.77932826  
## 529 0.301060553 -0.95917324  
## 530 0.958680661 -0.14987082  
## 531 1.183137823 -0.95917324  
## 532 1.061064630 -0.77932826  
## 533 1.970706815 -0.32971580  
## 534 0.332563312 -0.14987082  
## 535 -1.333145105 -0.77932826  
## 536 -0.451067834 -0.86925075  
## 537 -0.864541555 1.19896655  
## 538 1.254019032 -1.04909573  
## 539 1.525730334 -0.86925075  
## 540 2.171536907 -0.05994833  
## 541 0.962618506 0.92919908  
## 542 0.521579870 -0.50956078  
## 543 1.608425079 2.09819147  
## 544 -1.014179663 -0.68940577  
## 545 -0.202983602 -0.32971580  
## 546 0.025411406 0.38966413  
## 547 2.431434675 1.82842399  
## 548 -1.010241818 -0.41963829  
## 549 -0.297491881 1.55865652  
## 550 1.037437560 0.38966413  
## 551 -0.836976640 -1.04909573  
## 552 0.686969359 -0.68940577  
## 553 -0.667649307 2.99741638  
## 554 0.021473561 -0.86925075  
## 555 0.214427964 -0.41963829  
## 556 -1.006303973 0.38966413  
## 557 -0.781846811 -0.23979331  
## 558 -0.707027756 2.27803645  
## 559 -1.144128547 0.83927659  
## 560 -0.458943524 0.20981915  
## 561 -1.163817771 1.91834648  
## 562 0.336501157 -0.41963829  
## 563 -0.061221183 -0.77932826  
## 564 0.316811933 -0.05994833  
## 565 0.726347808 -0.50956078  
## 566 1.305211017 -0.95917324  
## 567 -0.017904889 -1.04909573  
## 568 -1.305580190 1.19896655  
## 569 -0.309305416 0.38966413  
## 570 -0.840914485 0.02997416  
## 571 -0.577078873 0.56950911  
## 572 -0.584954563 -1.04909573  
## 573 0.052976320 -0.95917324  
## 574 -0.860603710 -0.95917324  
## 575 1.872260691 -0.86925075  
## 576 -0.537700423 -0.68940577  
## 577 1.561170939 0.20981915  
## 578 1.088629544 -1.04909573  
## 579 -0.675524997 0.29974164  
## 580 0.623963839 2.63772641  
## 581 -0.179356532 -1.04909573  
## 582 -0.829100950 -0.50956078  
## 583 -0.620395167 2.63772641  
## 584 -0.892106469 0.83927659  
## 585 1.065002474 1.73850150  
## 586 0.001784336 -0.95917324  
## 587 -1.132315012 0.74935409  
## 588 -0.659773617 -0.32971580  
## 589 2.903976070 1.73850150  
## 590 -0.293554036 -0.68940577  
## 591 2.002209574 1.10904406  
## 592 -0.951174144 -0.77932826  
## 593 -0.057283338 1.01912157  
## 594 -1.333145105 -0.68940577  
## 595 1.246143343 0.11989666  
## 596 1.045313250 -0.95917324  
## 597 -0.876355089 1.19896655  
## 598 0.560958320 -1.04909573  
## 599 -1.293766655 0.47958662  
## 600 -0.037594114 -0.59948328  
## 601 -0.065159028 -0.77932826  
## 602 -0.892106469 -0.41963829  
## 603 -1.246512515 -0.23979331  
## 604 1.084691699 1.91834648  
## 605 -0.805473880 0.29974164  
## 606 0.383755297 -1.04909573  
## 607 -1.333145105 -0.95917324  
## 608 0.257744258 -0.68940577  
## 609 -0.577078873 -0.50956078  
## 610 -1.096874407 -0.86925075  
## 611 -0.490446284 -0.77932826  
## 612 0.694845048 0.29974164  
## 613 1.458786970 0.65943160  
## 614 1.817130861 -0.59948328  
## 615 0.553082630 1.55865652  
## 616 -0.825163105 -0.50956078  
## 617 -1.022055353 -0.23979331  
## 618 -0.628270857 -0.86925075  
## 619 -1.333145105 1.55865652  
## 620 -1.085060872 -0.77932826  
## 621 -0.671587152 -0.41963829  
## 622 -1.333145105 -0.41963829  
## 623 -1.333145105 1.10904406  
## 624 -0.273864811 -1.04909573  
## 625 -1.018117508 -1.04909573  
## 626 -0.214797137 -0.32971580  
## 627 -0.829100950 -1.04909573  
## 628 -0.092723943 -1.04909573  
## 629 -1.073247337 1.10904406  
## 630 -1.057495958 -1.04909573  
## 631 1.242205498 0.11989666  
## 632 -0.703089911 -0.77932826  
## 633 -0.289616191 -0.86925075  
## 634 -1.187444841 -0.95917324  
## 635 -0.982676903 -0.14987082  
## 636 0.190800894 0.47958662  
## 637 -1.037806733 1.37881153  
## 638 0.915364366 -0.86925075  
## 639 1.789565947 -0.05994833  
## 640 -1.053558113 -0.41963829  
## 641 1.096505234 -0.50956078  
## 642 -0.447129989 -0.77932826  
## 643 -0.939360609 1.55865652  
## 644 0.761788413 -0.14987082  
## 645 1.234329808 -0.50956078  
## 646 -1.112625787 -0.23979331  
## 647 0.119919685 0.02997416  
## 648 0.151422444 -0.95917324  
## 649 -0.616457322 0.83927659  
## 650 -1.116563632 -0.86925075  
## 651 -0.718841291 -0.86925075  
## 652 0.194738739 -0.50956078  
## 653 -0.581016718 -0.41963829  
## 654 0.151422444 -0.50956078  
## 655 -1.081123027 -0.95917324  
## 656 -0.695214221 -0.68940577  
## 657 -1.029931043 -0.95917324  
## 658 2.935478829 0.74935409  
## 659 -0.892106469 1.64857901  
## 660 -1.333145105 -0.50956078  
## 661 -0.923609229 1.91834648  
## 662 -1.333145105 -0.95917324  
## 663 -0.990552593 0.92919908  
## 664 0.868110227 0.65943160  
## 665 -0.675524997 0.65943160  
## 666 -0.785784655 -0.77932826  
## 667 -0.714903446 -1.04909573  
## 668 -1.085060872 0.65943160  
## 669 0.052976320 0.92919908  
## 670 -0.994490438 1.10904406  
## 671 0.844483157 1.46873403  
## 672 0.529455560 -1.04909573  
## 673 -0.518011198 1.28888904  
## 674 1.825006551 -0.95917324  
## 675 0.671217979 -1.04909573  
## 676 -0.348683865 -0.14987082  
## 677 -0.734592671 1.82842399  
## 678 -0.604643787 -0.68940577  
## 679 -1.140190702 -0.68940577  
## 680 0.777539793 -0.86925075  
## 681 -0.332932485 -0.95917324  
## 682 -0.206921447 -0.59948328  
## 683 -0.199045757 -0.95917324  
## 684 0.470387886 -0.50956078  
## 685 0.879923761 -1.04909573  
## 686 0.686969359 -0.68940577  
## 687 -0.403813695 -0.95917324  
## 688 -0.927547074 -0.32971580  
## 689 1.620238613 -0.86925075  
## 690 -0.321118951 1.19896655  
## 691 1.730498272 0.11989666  
## 692 -0.628270857 1.01912157  
## 693 1.848633621 -0.86925075  
## 694 0.088416925 0.92919908  
## 695 -0.888168624 -0.68940577  
## 696 -1.136252857 0.92919908  
## 697 -0.584954563 -0.14987082  
## 698 -0.644022237 -0.95917324  
## 699 0.714534273 -0.41963829  
## 700 1.919514830 -0.59948328  
## 701 0.261682103 -0.59948328  
## 702 0.584585390 1.46873403  
## 703 1.923452675 1.73850150  
## 704 -0.443192144 0.74935409  
## 705 -1.175631306 -0.50956078  
## 706 -0.943298454 -0.41963829  
## 707 -0.612519477 -0.23979331  
## 708 -0.947236299 -0.95917324  
## 709 -1.057495958 1.10904406  
## 710 1.013810490 -0.86925075  
## 711 -0.478632749 -0.77932826  
## 712 0.088416925 0.65943160  
## 713 0.096292615 0.47958662  
## 714 -0.254175586 -1.04909573  
## 715 -1.163817771 -0.05994833  
## 716 1.612362924 0.11989666  
## 717 2.179412597 -0.14987082  
## 718 0.702720738 2.09819147  
## 719 -0.006091354 -0.77932826  
## 720 -0.151791617 1.73850150  
## 721 -0.392000160 0.11989666  
## 722 -0.502259819 -1.04909573  
## 723 -0.265989121 0.83927659  
## 724 -0.651897927 0.83927659  
## 725 -0.596768098 1.10904406  
## 726 -0.710965601 0.47958662  
## 727 0.312874088 -0.68940577  
## 728 0.064789855 -0.95917324  
## 729 -0.356559555 -0.95917324  
## 730 -1.085060872 -0.95917324  
## 731 -0.368373090 0.11989666  
## 732 -0.620395167 -0.95917324  
## 733 0.903550831 -0.77932826  
## 734 0.037224941 -0.95917324  
## 735 0.564896165 1.82842399  
## 736 -0.521949043 -0.41963829  
## 737 0.387693142 -1.04909573  
## 738 0.722409963 0.83927659  
## 739 0.143546754 -1.04909573  
## 740 -0.486508439 0.83927659  
## 741 1.450911280 1.37881153  
## 742 -0.065159028 -0.59948328  
## 743 -0.777908966 -0.95917324  
## 744 1.250081187 1.10904406  
## 745 2.982732969 0.56950911  
## 746 0.281371328 1.19896655  
## 747 -0.230548516 -0.50956078  
## 748 2.675581062 -0.05994833  
## 749 -0.033656269 0.29974164  
## 750 -0.939360609 1.55865652  
## 751 3.014235728 -0.95917324  
## 752 -0.612519477 -0.41963829  
## 753 -0.762157586 -0.68940577  
## 754 -0.766095431 -0.59948328  
## 755 0.104168305 1.10904406  
## 756 2.522005109 0.38966413  
## 757 -0.100599633 0.56950911  
## 758 -0.624333012 1.73850150  
## 759 -0.864541555 -0.59948328  
## 760 -0.545576113 2.99741638  
## 761 1.376092226 -0.95917324  
## 762 -0.053345493 0.92919908  
## 763 -1.081123027 0.02997416  
## 764 -0.966925524 2.72764891  
## 765 -0.301429726 -0.50956078  
## 766 -0.675524997 -0.23979331  
## 767 -0.265989121 1.28888904  
## 768 -0.399875850 -0.86925075

#h)  
#Guassian distribution - density plots for standardized data features  
plots <- lapply(standardized\_data, function(var) {   
 ggplot(data = standardized\_data, aes(x = var)) +  
 geom\_density(fill = "#DC143C", color = "black") +  
 theme\_minimal() +  
 labs(x = "Standardized Value", y = "Density")  
})  
plots

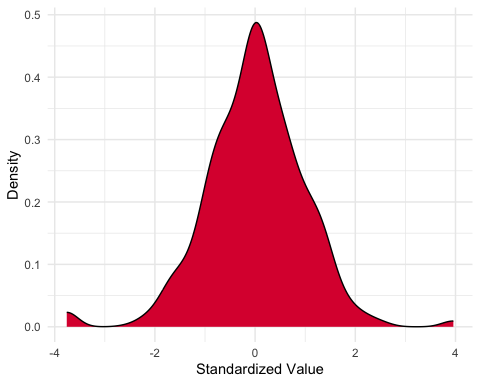
## $Pregnancies



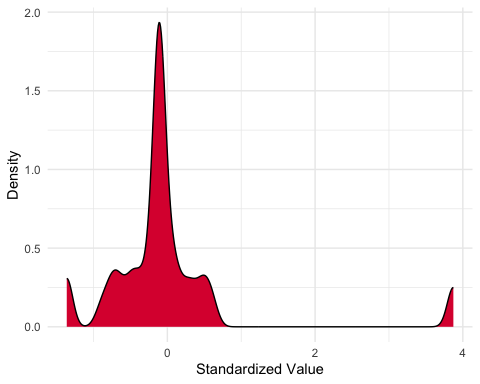
##   
## $Glucose



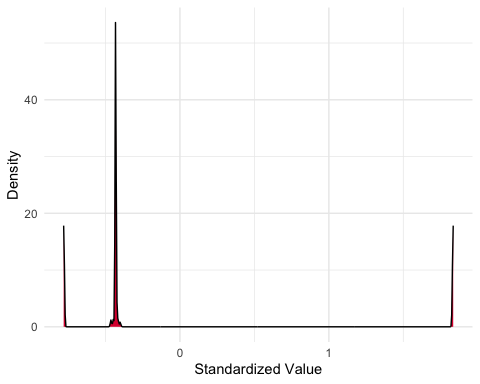
##   
## $BloodPressure



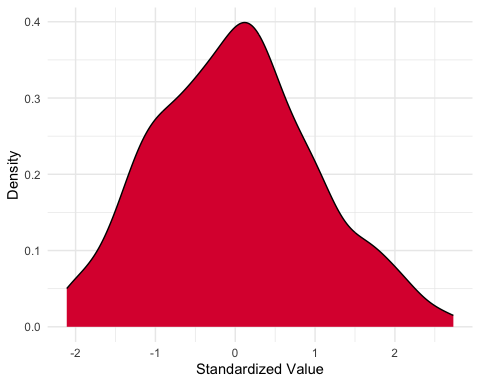
##   
## $SkinThickness



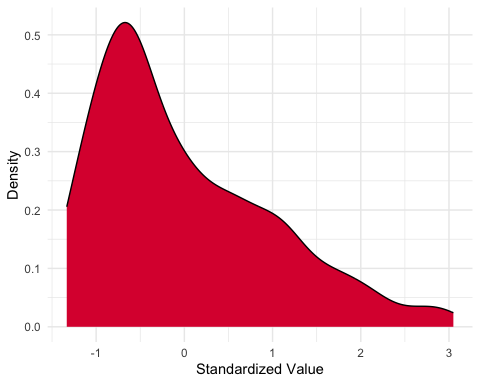
##   
## $Insulin



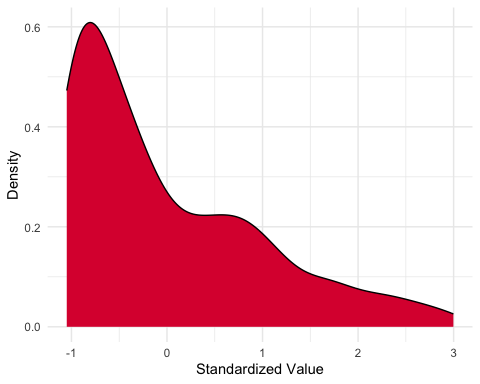
##   
## $BMI



##   
## $Pedigree



##   
## $Age



# Arrange the density plots in a grid  
#grid.arrange(grobs = plots, ncol = 3)

#h) Add a Diagnosis column to standardized\_dataset   
standardized\_data$Diagnosis <- patients\_2$Diagnosis  
standardized\_data

## Pregnancies Glucose BloodPressure SkinThickness Insulin BMI  
## 1 0.65970694 0.86548074 0.02019889 0.231037804 -0.4319919 0.234598938  
## 2 -1.16673476 -1.20428102 -0.45227063 -0.110296662 -0.4319919 -0.831417366  
## 3 1.39028362 2.01534838 -0.60976047 -0.110296662 -0.4319919 -1.333967909  
## 4 -1.16673476 -1.07286758 -0.45227063 -0.451631129 1.8351701 -0.602985301  
## 5 -0.07086974 0.50409376 -2.49963854 0.231037804 -0.7810279 1.681335350  
## 6 0.29441860 -0.18582682 0.17768873 -0.110296662 -0.4319919 -0.983705409  
## 7 -0.43615808 -1.43425455 -1.71218934 0.060370571 1.8351701 -0.161349975  
## 8 2.12086030 -0.21868019 0.02019889 -0.110296662 -0.4319919 0.493488611  
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## 11 -0.07086974 -0.38294699 1.59509729 -0.110296662 -0.4319919 0.843751111  
## 12 2.12086030 1.52254796 0.17768873 -0.110296662 -0.4319919 0.904666329  
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## 14 -1.16673476 2.21246855 -0.92474014 -0.451631129 -0.7810279 -0.298409214  
## 15 0.29441860 1.45684124 0.02019889 -0.679187440 -0.7810279 -0.953247801  
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## 25 2.48614864 0.70121393 1.75258713 0.117259648 -0.7810279 0.691463068  
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## 27 1.02499528 0.83262737 0.33517857 -0.110296662 -0.4319919 1.117869589  
## 28 -1.16673476 -0.81004069 -0.45227063 -0.906743751 -0.7810279 -1.349196714  
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## 38 1.75557196 -0.64577388 0.33517857 0.344815959 -0.4319919 0.127997307  
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## 47 -1.16673476 0.79977401 -1.23971982 -0.110296662 -0.4319919 -0.359324432  
## 48 -0.80144642 -1.66422808 -0.13729095 -0.224074818 -0.4319919 -0.618214105  
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## 53 0.29441860 -1.10572094 -0.45227063 -0.565409284 1.8351701 -1.166451061  
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## 66 0.29441860 -0.74433397 0.17768873 -0.224074818 -0.4319919 -0.465926062  
## 67 -0.07086974 -0.41580035 1.28011761 -0.053407585 -0.4319919 0.067082090  
## 68 -0.80144642 -0.41580035 1.59509729 -0.110296662 -0.4319919 1.620420132  
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## 456 -0.805473880 0.47958662 1  
## 457 1.065002474 2.63772641 0  
## 458 -0.206921447 -0.77932826 0  
## 459 2.301485791 1.64857901 1  
## 460 0.171111669 -1.04909573 0  
## 461 1.246143343 1.37881153 0  
## 462 -0.002153509 -0.59948328 0  
## 463 1.135883684 0.56950911 0  
## 464 -0.624333012 0.38966413 0  
## 465 2.384180535 0.11989666 0  
## 466 0.139608910 -1.04909573 0  
## 467 -0.581016718 -0.95917324 0  
## 468 0.722409963 -0.68940577 0  
## 469 -0.919671384 0.47958662 1  
## 470 0.608212459 -0.50956078 0  
## 471 0.749974878 -0.41963829 0  
## 472 -0.970863368 -0.95917324 0  
## 473 -0.620395167 -0.95917324 0  
## 474 -0.813349570 1.55865652 0  
## 475 -1.144128547 -0.77932826 0  
## 476 -0.730654826 2.36795894 0  
## 477 1.159510753 -0.32971580 1  
## 478 0.194738739 -0.14987082 0  
## 479 -1.002366128 0.56950911 0  
## 480 0.009660026 2.72764891 0  
## 481 -0.285678346 0.20981915 1  
## 482 -0.864541555 -0.32971580 0  
## 483 -0.435316454 -0.41963829 0  
## 484 -0.722779136 -0.86925075 0  
## 485 0.840545312 -0.14987082 1  
## 486 -0.202983602 -0.77932826 1  
## 487 0.470387886 -1.04909573 0  
## 488 2.923665294 2.27803645 0  
## 489 -0.482570594 -0.41963829 0  
## 490 0.529455560 -1.04909573 0  
## 491 0.836607467 -0.77932826 0  
## 492 -0.490446284 0.83927659 0  
## 493 -1.069309492 0.02997416 0  
## 494 2.864597620 1.10904406 1  
## 495 -0.955111989 -0.95917324 0  
## 496 -0.443192144 2.99741638 0  
## 497 -0.490446284 -0.23979331 0  
## 498 0.513704180 -0.68940577 0  
## 499 -0.998428283 2.00826897 1  
## 500 1.663554908 0.56950911 0  
## 501 -0.407751540 -1.04909573 0  
## 502 -0.588892408 -0.41963829 0  
## 503 1.222516273 0.74935409 1  
## 504 1.265832567 0.74935409 0  
## 505 -0.703089911 0.65943160 0  
## 506 -0.604643787 0.47958662 0  
## 507 -0.403813695 0.20981915 1  
## 508 1.084691699 -1.04909573 0  
## 509 2.171536907 -1.04909573 0  
## 510 -0.029718424 2.81757140 0  
## 511 -0.470757059 1.19896655 1  
## 512 -0.825163105 -1.04909573 0  
## 513 -0.852728020 2.27803645 0  
## 514 0.427071591 -0.95917324 0  
## 515 -1.033868888 -0.77932826 0  
## 516 -0.584954563 -0.41963829 1  
## 517 1.395781451 1.82842399 1  
## 518 -0.443192144 1.64857901 0  
## 519 -0.931484919 0.74935409 0  
## 520 0.651528754 2.45788143 0  
## 521 -0.903920004 -0.68940577 0  
## 522 -0.439254299 -0.59948328 0  
## 523 -0.896044314 -0.59948328 0  
## 524 0.927177901 1.10904406 1  
## 525 -1.045682423 -0.77932826 0  
## 526 0.108106150 -1.04909573 0  
## 527 -0.462881369 -1.04909573 0  
## 528 -1.218947601 -0.77932826 0  
## 529 0.301060553 -0.95917324 0  
## 530 0.958680661 -0.14987082 0  
## 531 1.183137823 -0.95917324 0  
## 532 1.061064630 -0.77932826 0  
## 533 1.970706815 -0.32971580 0  
## 534 0.332563312 -0.14987082 0  
## 535 -1.333145105 -0.77932826 0  
## 536 -0.451067834 -0.86925075 1  
## 537 -0.864541555 1.19896655 0  
## 538 1.254019032 -1.04909573 0  
## 539 1.525730334 -0.86925075 0  
## 540 2.171536907 -0.05994833 1  
## 541 0.962618506 0.92919908 1  
## 542 0.521579870 -0.50956078 1  
## 543 1.608425079 2.09819147 1  
## 544 -1.014179663 -0.68940577 0  
## 545 -0.202983602 -0.32971580 0  
## 546 0.025411406 0.38966413 1  
## 547 2.431434675 1.82842399 1  
## 548 -1.010241818 -0.41963829 0  
## 549 -0.297491881 1.55865652 0  
## 550 1.037437560 0.38966413 0  
## 551 -0.836976640 -1.04909573 0  
## 552 0.686969359 -0.68940577 0  
## 553 -0.667649307 2.99741638 0  
## 554 0.021473561 -0.86925075 0  
## 555 0.214427964 -0.41963829 0  
## 556 -1.006303973 0.38966413 0  
## 557 -0.781846811 -0.23979331 0  
## 558 -0.707027756 2.27803645 0  
## 559 -1.144128547 0.83927659 0  
## 560 -0.458943524 0.20981915 0  
## 561 -1.163817771 1.91834648 1  
## 562 0.336501157 -0.41963829 1  
## 563 -0.061221183 -0.77932826 0  
## 564 0.316811933 -0.05994833 0  
## 565 0.726347808 -0.50956078 0  
## 566 1.305211017 -0.95917324 0  
## 567 -0.017904889 -1.04909573 0  
## 568 -1.305580190 1.19896655 0  
## 569 -0.309305416 0.38966413 0  
## 570 -0.840914485 0.02997416 1  
## 571 -0.577078873 0.56950911 0  
## 572 -0.584954563 -1.04909573 0  
## 573 0.052976320 -0.95917324 0  
## 574 -0.860603710 -0.95917324 0  
## 575 1.872260691 -0.86925075 0  
## 576 -0.537700423 -0.68940577 0  
## 577 1.561170939 0.20981915 0  
## 578 1.088629544 -1.04909573 1  
## 579 -0.675524997 0.29974164 0  
## 580 0.623963839 2.63772641 1  
## 581 -0.179356532 -1.04909573 1  
## 582 -0.829100950 -0.50956078 0  
## 583 -0.620395167 2.63772641 0  
## 584 -0.892106469 0.83927659 0  
## 585 1.065002474 1.73850150 1  
## 586 0.001784336 -0.95917324 0  
## 587 -1.132315012 0.74935409 1  
## 588 -0.659773617 -0.32971580 0  
## 589 2.903976070 1.73850150 1  
## 590 -0.293554036 -0.68940577 0  
## 591 2.002209574 1.10904406 1  
## 592 -0.951174144 -0.77932826 0  
## 593 -0.057283338 1.01912157 1  
## 594 -1.333145105 -0.68940577 0  
## 595 1.246143343 0.11989666 0  
## 596 1.045313250 -0.95917324 1  
## 597 -0.876355089 1.19896655 0  
## 598 0.560958320 -1.04909573 0  
## 599 -1.293766655 0.47958662 1  
## 600 -0.037594114 -0.59948328 0  
## 601 -0.065159028 -0.77932826 0  
## 602 -0.892106469 -0.41963829 0  
## 603 -1.246512515 -0.23979331 0  
## 604 1.084691699 1.91834648 1  
## 605 -0.805473880 0.29974164 1  
## 606 0.383755297 -1.04909573 0  
## 607 -1.333145105 -0.95917324 1  
## 608 0.257744258 -0.68940577 0  
## 609 -0.577078873 -0.50956078 0  
## 610 -1.096874407 -0.86925075 0  
## 611 -0.490446284 -0.77932826 0  
## 612 0.694845048 0.29974164 1  
## 613 1.458786970 0.65943160 1  
## 614 1.817130861 -0.59948328 0  
## 615 0.553082630 1.55865652 1  
## 616 -0.825163105 -0.50956078 0  
## 617 -1.022055353 -0.23979331 0  
## 618 -0.628270857 -0.86925075 0  
## 619 -1.333145105 1.55865652 1  
## 620 -1.085060872 -0.77932826 1  
## 621 -0.671587152 -0.41963829 0  
## 622 -1.333145105 -0.41963829 0  
## 623 -1.333145105 1.10904406 0  
## 624 -0.273864811 -1.04909573 0  
## 625 -1.018117508 -1.04909573 0  
## 626 -0.214797137 -0.32971580 0  
## 627 -0.829100950 -1.04909573 0  
## 628 -0.092723943 -1.04909573 0  
## 629 -1.073247337 1.10904406 0  
## 630 -1.057495958 -1.04909573 0  
## 631 1.242205498 0.11989666 1  
## 632 -0.703089911 -0.77932826 0  
## 633 -0.289616191 -0.86925075 0  
## 634 -1.187444841 -0.95917324 0  
## 635 -0.982676903 -0.14987082 0  
## 636 0.190800894 0.47958662 1  
## 637 -1.037806733 1.37881153 0  
## 638 0.915364366 -0.86925075 0  
## 639 1.789565947 -0.05994833 1  
## 640 -1.053558113 -0.41963829 0  
## 641 1.096505234 -0.50956078 0  
## 642 -0.447129989 -0.77932826 0  
## 643 -0.939360609 1.55865652 1  
## 644 0.761788413 -0.14987082 0  
## 645 1.234329808 -0.50956078 0  
## 646 -1.112625787 -0.23979331 0  
## 647 0.119919685 0.02997416 1  
## 648 0.151422444 -0.95917324 1  
## 649 -0.616457322 0.83927659 1  
## 650 -1.116563632 -0.86925075 0  
## 651 -0.718841291 -0.86925075 0  
## 652 0.194738739 -0.50956078 0  
## 653 -0.581016718 -0.41963829 0  
## 654 0.151422444 -0.50956078 0  
## 655 -1.081123027 -0.95917324 0  
## 656 -0.695214221 -0.68940577 1  
## 657 -1.029931043 -0.95917324 0  
## 658 2.935478829 0.74935409 0  
## 659 -0.892106469 1.64857901 0  
## 660 -1.333145105 -0.50956078 1  
## 661 -0.923609229 1.91834648 0  
## 662 -1.333145105 -0.95917324 1  
## 663 -0.990552593 0.92919908 1  
## 664 0.868110227 0.65943160 1  
## 665 -0.675524997 0.65943160 1  
## 666 -0.785784655 -0.77932826 0  
## 667 -0.714903446 -1.04909573 1  
## 668 -1.085060872 0.65943160 1  
## 669 0.052976320 0.92919908 0  
## 670 -0.994490438 1.10904406 0  
## 671 0.844483157 1.46873403 0  
## 672 0.529455560 -1.04909573 0  
## 673 -0.518011198 1.28888904 0  
## 674 1.825006551 -0.95917324 0  
## 675 0.671217979 -1.04909573 0  
## 676 -0.348683865 -0.14987082 1  
## 677 -0.734592671 1.82842399 1  
## 678 -0.604643787 -0.68940577 0  
## 679 -1.140190702 -0.68940577 1  
## 680 0.777539793 -0.86925075 0  
## 681 -0.332932485 -0.95917324 0  
## 682 -0.206921447 -0.59948328 1  
## 683 -0.199045757 -0.95917324 0  
## 684 0.470387886 -0.50956078 1  
## 685 0.879923761 -1.04909573 0  
## 686 0.686969359 -0.68940577 0  
## 687 -0.403813695 -0.95917324 0  
## 688 -0.927547074 -0.32971580 0  
## 689 1.620238613 -0.86925075 0  
## 690 -0.321118951 1.19896655 1  
## 691 1.730498272 0.11989666 0  
## 692 -0.628270857 1.01912157 1  
## 693 1.848633621 -0.86925075 0  
## 694 0.088416925 0.92919908 1  
## 695 -0.888168624 -0.68940577 0  
## 696 -1.136252857 0.92919908 1  
## 697 -0.584954563 -0.14987082 1  
## 698 -0.644022237 -0.95917324 0  
## 699 0.714534273 -0.41963829 0  
## 700 1.919514830 -0.59948328 0  
## 701 0.261682103 -0.59948328 0  
## 702 0.584585390 1.46873403 1  
## 703 1.923452675 1.73850150 1  
## 704 -0.443192144 0.74935409 0  
## 705 -1.175631306 -0.50956078 0  
## 706 -0.943298454 -0.41963829 0  
## 707 -0.612519477 -0.23979331 1  
## 708 -0.947236299 -0.95917324 0  
## 709 -1.057495958 1.10904406 1  
## 710 1.013810490 -0.86925075 1  
## 711 -0.478632749 -0.77932826 0  
## 712 0.088416925 0.65943160 0  
## 713 0.096292615 0.47958662 1  
## 714 -0.254175586 -1.04909573 0  
## 715 -1.163817771 -0.05994833 0  
## 716 1.612362924 0.11989666 1  
## 717 2.179412597 -0.14987082 1  
## 718 0.702720738 2.09819147 0  
## 719 -0.006091354 -0.77932826 0  
## 720 -0.151791617 1.73850150 1  
## 721 -0.392000160 0.11989666 0  
## 722 -0.502259819 -1.04909573 0  
## 723 -0.265989121 0.83927659 1  
## 724 -0.651897927 0.83927659 0  
## 725 -0.596768098 1.10904406 0  
## 726 -0.710965601 0.47958662 0  
## 727 0.312874088 -0.68940577 0  
## 728 0.064789855 -0.95917324 0  
## 729 -0.356559555 -0.95917324 0  
## 730 -1.085060872 -0.95917324 0  
## 731 -0.368373090 0.11989666 1  
## 732 -0.620395167 -0.95917324 1  
## 733 0.903550831 -0.77932826 1  
## 734 0.037224941 -0.95917324 0  
## 735 0.564896165 1.82842399 0  
## 736 -0.521949043 -0.41963829 0  
## 737 0.387693142 -1.04909573 0  
## 738 0.722409963 0.83927659 0  
## 739 0.143546754 -1.04909573 0  
## 740 -0.486508439 0.83927659 1  
## 741 1.450911280 1.37881153 1  
## 742 -0.065159028 -0.59948328 0  
## 743 -0.777908966 -0.95917324 0  
## 744 1.250081187 1.10904406 1  
## 745 2.982732969 0.56950911 0  
## 746 0.281371328 1.19896655 0  
## 747 -0.230548516 -0.50956078 1  
## 748 2.675581062 -0.05994833 0  
## 749 -0.033656269 0.29974164 1  
## 750 -0.939360609 1.55865652 1  
## 751 3.014235728 -0.95917324 1  
## 752 -0.612519477 -0.41963829 0  
## 753 -0.762157586 -0.68940577 0  
## 754 -0.766095431 -0.59948328 1  
## 755 0.104168305 1.10904406 1  
## 756 2.522005109 0.38966413 1  
## 757 -0.100599633 0.56950911 0  
## 758 -0.624333012 1.73850150 1  
## 759 -0.864541555 -0.59948328 0  
## 760 -0.545576113 2.99741638 1  
## 761 1.376092226 -0.95917324 0  
## 762 -0.053345493 0.92919908 1  
## 763 -1.081123027 0.02997416 0  
## 764 -0.966925524 2.72764891 0  
## 765 -0.301429726 -0.50956078 0  
## 766 -0.675524997 -0.23979331 0  
## 767 -0.265989121 1.28888904 1  
## 768 -0.399875850 -0.86925075 0

#i)   
#splitting the dataset into training and testing data (70:30)  
#install.packages("caret")  
library(caret)

## Loading required package: lattice

set.seed(1234)  
dindex <- createDataPartition(standardized\_data$Diagnosis, p=0.7, list=FALSE)  
train\_data <- standardized\_data[dindex,]  
test\_data <- standardized\_data[-dindex,]

#i)Model\_1 using correlation plot  
  
best\_features <- c( "BMI", "Age", "Glucose","Pregnancies")  
best\_features\_subset\_data <- train\_data[, c("Diagnosis", best\_features)]   
#View(best\_features\_subset\_data)  
  
#LRM1 - using best features  
LRM1 <- glm(Diagnosis ~ ., data = best\_features\_subset\_data , family = binomial)   
   
# Print the summary of the model   
summary(LRM1)

##   
## Call:  
## glm(formula = Diagnosis ~ ., family = binomial, data = best\_features\_subset\_data)  
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -0.9540 0.1165 -8.189 2.63e-16 \*\*\*  
## BMI 0.4542 0.1140 3.985 6.74e-05 \*\*\*  
## Age 0.2465 0.1192 2.067 0.03869 \*   
## Glucose 1.1568 0.1322 8.748 < 2e-16 \*\*\*  
## Pregnancies 0.3731 0.1271 2.937 0.00332 \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for binomial family taken to be 1)  
##   
## Null deviance: 680.18 on 537 degrees of freedom  
## Residual deviance: 496.89 on 533 degrees of freedom  
## AIC: 506.89  
##   
## Number of Fisher Scoring iterations: 5

#j & k  
#install.packages("pROC") # Install the pROC package  
library(pROC) # Load the pROC package

## Type 'citation("pROC")' for a citation.

##   
## Attaching package: 'pROC'

## The following objects are masked from 'package:stats':  
##   
## cov, smooth, var

predictions <- predict(LRM1, newdata = test\_data, type = "response")  
predicted.classes <- ifelse(predictions> 0.5, 1, 0)  
predicted.classes

## 3 5 6 7 8 9 16 17 20 21 24 26 27 32 37 38 44 46 47 48   
## 1 1 0 0 0 1 0 0 0 0 0 1 1 1 1 0 1 1 0 0   
## 52 56 62 65 69 72 73 78 80 81 82 89 91 92 93 96 99 109 110 111   
## 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1   
## 112 114 115 117 119 124 129 130 134 137 139 140 144 148 153 158 167 172 173 180   
## 1 0 1 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1   
## 193 196 197 200 202 209 213 217 220 225 226 230 232 233 236 239 244 245 246 247   
## 1 1 0 0 0 0 1 0 0 0 0 0 1 0 1 1 0 1 1 0   
## 253 257 261 264 266 267 268 279 282 283 287 288 289 290 292 299 300 301 304 311   
## 0 0 1 1 0 0 0 0 1 0 1 0 0 0 0 0 0 1 0 0   
## 312 314 315 316 317 322 327 329 342 348 354 355 356 359 368 369 372 373 377 384   
## 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0   
## 385 386 387 392 396 398 404 410 412 415 416 418 419 436 437 443 445 446 447 448   
## 0 0 0 1 0 0 0 1 0 0 1 1 0 1 1 0 0 1 0 0   
## 453 455 458 462 472 473 483 487 490 492 496 498 500 503 506 507 516 520 521 524   
## 0 0 0 0 0 0 0 0 1 0 1 0 1 0 0 1 1 0 0 1   
## 531 533 536 537 544 546 550 553 555 557 558 559 568 571 579 583 589 591 593 594   
## 0 0 0 0 0 1 1 0 0 0 0 1 0 0 0 1 1 1 0 0   
## 596 599 604 606 607 616 617 622 625 626 628 630 631 636 640 656 659 660 662 664   
## 1 1 1 0 1 0 0 0 0 0 0 0 0 0 0 1 1 0 1 1   
## 666 668 669 671 673 674 679 681 691 694 700 702 707 709 711 714 717 724 732 734   
## 0 0 0 1 0 0 0 0 0 1 0 0 0 1 1 0 1 0 0 0   
## 737 739 741 744 746 748 749 760 761 767   
## 0 0 1 1 0 0 1 1 0 0

library(caret)  
confusion\_matrix <- table(predicted.classes, test\_data$Diagnosis)  
confusion\_matrix

##   
## predicted.classes 0 1  
## 0 120 44  
## 1 18 48

precision <- confusion\_matrix[2, 2] / sum(confusion\_matrix[, 2])  
recall <- confusion\_matrix[2, 2] / sum(confusion\_matrix[2, ])  
f1\_score <- 2 \* precision \* recall / (precision + recall)  
support <- rowSums(confusion\_matrix)  
  
# Print the classification report  
cat("Precision: ", precision, "\n")

## Precision: 0.5217391

cat("Recall: ", recall, "\n")

## Recall: 0.7272727

cat("F1-Score: ", f1\_score, "\n")

## F1-Score: 0.6075949

cat("Support: ", support)

## Support: 164 66

#l  
#accuracy of model1- LRM1   
accuracy <- sum(diag(confusion\_matrix)) / sum(confusion\_matrix)  
cat("Accuracy: ", accuracy, "\n")

## Accuracy: 0.7304348

#m)model 2  
#LRM2 - using all features  
LRM2 <- glm(Diagnosis ~ ., data = train\_data , family = binomial)   
#print the summary of the model  
summary(LRM2)

##   
## Call:  
## glm(formula = Diagnosis ~ ., family = binomial, data = train\_data)  
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.00696 0.12209 -8.247 < 2e-16 \*\*\*  
## Pregnancies 0.35768 0.12977 2.756 0.005848 \*\*   
## Glucose 1.10812 0.13685 8.097 5.61e-16 \*\*\*  
## BloodPressure -0.01123 0.11834 -0.095 0.924385   
## SkinThickness -0.04104 0.14038 -0.292 0.770031   
## Insulin -0.28553 0.14137 -2.020 0.043408 \*   
## BMI 0.40429 0.11767 3.436 0.000591 \*\*\*  
## Pedigree 0.30510 0.11119 2.744 0.006069 \*\*   
## Age 0.24668 0.12232 2.017 0.043740 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for binomial family taken to be 1)  
##   
## Null deviance: 680.18 on 537 degrees of freedom  
## Residual deviance: 485.31 on 529 degrees of freedom  
## AIC: 503.31  
##   
## Number of Fisher Scoring iterations: 5

#m)  
predictions\_model2 <- predict(LRM2, newdata = test\_data, type = "response")  
predicted.classes\_model2 <- ifelse(predictions\_model2> 0.5, 1, 0)  
#predicted.classes\_model2

library(caret)  
confusion\_matrix\_model2 <- table(predicted.classes\_model2, test\_data$Diagnosis)  
confusion\_matrix\_model2

##   
## predicted.classes\_model2 0 1  
## 0 120 42  
## 1 18 50

precision <- confusion\_matrix\_model2[2, 2] / sum(confusion\_matrix\_model2[, 2])  
recall <- confusion\_matrix\_model2[2, 2] / sum(confusion\_matrix\_model2[2, ])  
f1\_score <- 2 \* precision \* recall / (precision + recall)  
support <- rowSums(confusion\_matrix\_model2)  
  
# Print the classification report  
cat("Precision: ", precision, "\n")

## Precision: 0.5434783

cat("Recall: ", recall, "\n")

## Recall: 0.7352941

cat("F1-Score: ", f1\_score, "\n")

## F1-Score: 0.625

#Accuracy of model2 - lRM2  
accuracy <- sum(diag(confusion\_matrix\_model2)) / sum(confusion\_matrix\_model2)  
cat("Accuracy: ", accuracy, "\n")

## Accuracy: 0.7391304

#Model-3   
#LRM3 model based on features from literature review  
  
features\_model3 <- c( "BMI", "Pedigree", "Glucose", "Age")  
model3\_features\_subset\_data <- train\_data[, c("Diagnosis", features\_model3)]   
  
#LRM3  
LRM3 <- glm(Diagnosis ~ ., data = model3\_features\_subset\_data , family = binomial)   
   
# Print the summary of the model   
summary(LRM3)

##   
## Call:  
## glm(formula = Diagnosis ~ ., family = binomial, data = model3\_features\_subset\_data)  
##   
## Coefficients:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -0.9741 0.1170 -8.323 < 2e-16 \*\*\*  
## BMI 0.4194 0.1129 3.715 0.000203 \*\*\*  
## Pedigree 0.2956 0.1096 2.698 0.006974 \*\*   
## Glucose 1.1414 0.1316 8.672 < 2e-16 \*\*\*  
## Age 0.4258 0.1088 3.912 9.14e-05 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for binomial family taken to be 1)  
##   
## Null deviance: 680.18 on 537 degrees of freedom  
## Residual deviance: 498.29 on 533 degrees of freedom  
## AIC: 508.29  
##   
## Number of Fisher Scoring iterations: 5

predictions\_model3 <- predict(LRM3, newdata = test\_data, type = "response")  
predicted.classes\_model3 <- ifelse(predictions\_model3> 0.5, 1, 0)  
predicted.classes\_model3

## 3 5 6 7 8 9 16 17 20 21 24 26 27 32 37 38 44 46 47 48   
## 1 0 0 0 0 1 0 0 0 0 0 0 1 1 0 0 1 1 0 0   
## 52 56 62 65 69 72 73 78 80 81 82 89 91 92 93 96 99 109 110 111   
## 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0 1   
## 112 114 115 117 119 124 129 130 134 137 139 140 144 148 153 158 167 172 173 180   
## 1 0 1 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1   
## 193 196 197 200 202 209 213 217 220 225 226 230 232 233 236 239 244 245 246 247   
## 1 1 0 0 0 0 1 0 0 0 0 0 1 0 1 1 0 1 1 0   
## 253 257 261 264 266 267 268 279 282 283 287 288 289 290 292 299 300 301 304 311   
## 0 0 1 1 0 1 1 0 0 0 1 1 0 0 0 0 0 1 0 0   
## 312 314 315 316 317 322 327 329 342 348 354 355 356 359 368 369 372 373 377 384   
## 0 0 1 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0   
## 385 386 387 392 396 398 404 410 412 415 416 418 419 436 437 443 445 446 447 448   
## 0 0 0 1 0 0 0 1 0 0 1 1 0 1 1 0 0 0 0 0   
## 453 455 458 462 472 473 483 487 490 492 496 498 500 503 506 507 516 520 521 524   
## 0 0 0 0 0 0 0 0 1 0 1 0 1 0 0 1 1 0 0 1   
## 531 533 536 537 544 546 550 553 555 557 558 559 568 571 579 583 589 591 593 594   
## 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 1 1 0 0   
## 596 599 604 606 607 616 617 622 625 626 628 630 631 636 640 656 659 660 662 664   
## 1 1 1 0 1 0 0 0 0 0 0 0 0 0 0 1 1 0 1 1   
## 666 668 669 671 673 674 679 681 691 694 700 702 707 709 711 714 717 724 732 734   
## 0 0 0 1 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0   
## 737 739 741 744 746 748 749 760 761 767   
## 0 0 1 1 0 0 1 1 0 0

library(caret)  
confusion\_matrix\_model3 <- table(predicted.classes\_model3, test\_data$Diagnosis)  
confusion\_matrix\_model3

##   
## predicted.classes\_model3 0 1  
## 0 124 44  
## 1 14 48

accuracy <- sum(diag(confusion\_matrix\_model3)) / sum(confusion\_matrix\_model3)  
precision <- confusion\_matrix\_model3[2, 2] / sum(confusion\_matrix\_model3[, 2])  
recall <- confusion\_matrix\_model3[2, 2] / sum(confusion\_matrix\_model3[2, ])  
f1\_score <- 2 \* precision \* recall / (precision + recall)  
support <- rowSums(confusion\_matrix\_model3)  
  
# Print the classification report  
cat("Accuracy: ", accuracy, "\n")

## Accuracy: 0.7478261

cat("Precision: ", precision, "\n")

## Precision: 0.5217391

cat("Recall: ", recall, "\n")

## Recall: 0.7741935

cat("F1-Score: ", f1\_score, "\n")

## F1-Score: 0.6233766

cat("Support: ", support)

## Support: 168 62

#n  
# Three models are developed namely LRM1,LRM2, LRM3 based on features selected from correlegram, all independent features and features based on literature review respectively.The model1 i.e, LRM1 is a better fit as it has highest accuracy compared to others.

#o)  
#Coefficients:  
 #Estimate Std. Error z value Pr(>|z|)   
#(Intercept) -0.9540 0.1165 -8.189 2.63e-16 \*\*\*  
#BMI 0.4542 0.1140 3.985 6.74e-05 \*\*\*  
#Age 0.2465 0.1192 2.067 0.03869 \*   
#Pregnancies 0.3731 0.1271 2.937 0.00332 \*\*   
#Glucose 1.1568 0.1322 8.748 < 2e-16

#p) Wald tests for individual tests  
confint(LRM3)

## Waiting for profiling to be done...

## 2.5 % 97.5 %  
## (Intercept) -1.18774742 -0.7303279  
## BMI 0.23373304 0.6814291  
## Age 0.01242514 0.4810833  
## Glucose 0.90602038 1.4253871  
## Pregnancies 0.12544346 0.6245783

confint.default(LRM3)

## 2.5 % 97.5 %  
## (Intercept) -1.18228832 -0.7256486  
## BMI 0.23080665 0.6775445  
## Age 0.01281884 0.4801644  
## Glucose 0.89762121 1.4159548  
## Pregnancies 0.12408351 0.6221243

#install.packages("lmtest")  
#install.packages("aod")  
library(lmtest)

## Loading required package: zoo

##   
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':  
##   
## as.Date, as.Date.numeric

library(zoo)  
library(aod)

#Wald test for BMI variable  
wald.test(b = coef(LRM3), Sigma = vcov(LRM3), Terms = 2)

## Wald test:  
## ----------  
##   
## Chi-squared test:  
## X2 = 13.8, df = 1, P(> X2) = 2e-04

#Wald test for Age variable  
wald.test(b = coef(LRM3), Sigma = vcov(LRM3), Terms = 3)

## Wald test:  
## ----------  
##   
## Chi-squared test:  
## X2 = 7.3, df = 1, P(> X2) = 0.007

#Wald test for Pregnancies variable  
wald.test(b = coef(LRM3), Sigma = vcov(LRM3), Terms = 4)

## Wald test:  
## ----------  
##   
## Chi-squared test:  
## X2 = 75.2, df = 1, P(> X2) = 0.0

#Wald test for Glucose variable  
wald.test(b = coef(LRM3), Sigma = vcov(LRM3), Terms = 5)

## Wald test:  
## ----------  
##   
## Chi-squared test:  
## X2 = 15.3, df = 1, P(> X2) = 9.1e-05

#q)   
# Obtain the p-values for your hypothesis tests  
p\_values <- c(2e-04 ,0.007, 0.0,9.1e-05)  
  
# Determine the desired significance level  
significance\_level <- 0.05  
  
# Calculate the Bonferroni-adjusted significance level  
adjusted\_significance\_level <- significance\_level / length(p\_values)  
  
# Compare individual p-values with the Bonferroni-adjusted significance level  
significant\_variables <- p\_values <= adjusted\_significance\_level  
  
# Print the significant variables  
significant\_variables

## [1] TRUE TRUE TRUE TRUE