DM_projekt

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```
#Regresja liniowa
```

#1. Biblioteki potrzebne do analizy

```
library(Hmisc)
```

```
## Warning: pakiet 'Hmisc' został zbudowany w wersji R 4.2.3
```

```
##
## Dołączanie pakietu: 'Hmisc'
```

```
## Następujące obiekty zostały zakryte z 'package:base':
##
##     format.pval, units
```

```
library(corrplot)
```

```
## Warning: pakiet 'corrplot' został zbudowany w wersji R 4.2.3
```

```
## corrplot 0.92 loaded
```

#2. Wczytanie danych z pliku

```
data <- read.table("C:/Users/micha/Desktop/semest_letni6/data_mining/zajecia/CaseStudy/CaseStudy_MS/sere
```

3. Obróbka danych - preprocessing

```
#Nastepnie musze dokonac usuniecia pierwszej kolumny, ze wzgledu na powtarzajacy sie nr indexu dla dany
data <- data[, -which(names(data) == "V1")]
# Pierwsza kolumna została usunięta, zobaczmy jak wygląda :)
data
```

```
##     V2 V3 V4  V5  V6 V7 V8  V9 V10 V11 V12 V13 V14 V15
## 1   63  1  3 145 233  1  0 150   0 2.3   0   0   1   1
## 2   37  1  2 130 250  0  1 187   0 3.5   0   0   2   1
## 3   41  0  1 130 204  0  0 172   0 1.4   2   0   2   1
```

```
## 4    56  1  1 120 236  0  1 178   0 0.8   2  0  2  1
## 5    57  0  0 120 354  0  1 163   1 0.6   2  0  2  1
## 6    57  1  0 140 192  0  1 148   0 0.4   1  0  1  1
## 7    56  0  1 140 294  0  0 153   0 1.3   1  0  2  1
## 8    44  1  1 120 263  0  1 173   0 0.0   2  0  3  1
## 9    52  1  2 172 199  1  1 162   0 0.5   2  0  3  1
## 10   57  1  2 150 168  0  1 174   0 1.6   2  0  2  1
## 11   54  1  0 140 239  0  1 160   0 1.2   2  0  2  1
## 12   48  0  2 130 275  0  1 139   0 0.2   2  0  2  1
## 13   49  1  1 130 266  0  1 171   0 0.6   2  0  2  1
## 14   64  1  3 110 211  0  0 144   1 1.8   1  0  2  1
## 15   58  0  3 150 283  1  0 162   0 1.0   2  0  2  1
## 16   50  0  2 120 219  0  1 158   0 1.6   1  0  2  1
## 17   58  0  2 120 340  0  1 172   0 0.0   2  0  2  1
## 18   66  0  3 150 226  0  1 114   0 2.6   0  0  2  1
## 19   43  1  0 150 247  0  1 171   0 1.5   2  0  2  1
## 20   69  0  3 140 239  0  1 151   0 1.8   2  2  2  1
## 21   59  1  0 135 234  0  1 161   0 0.5   1  0  3  1
## 22   44  1  2 130 233  0  1 179   1 0.4   2  0  2  1
## 23   42  1  0 140 226  0  1 178   0 0.0   2  0  2  1
## 24   61  1  2 150 243  1  1 137   1 1.0   1  0  2  1
## 25   40  1  3 140 199  0  1 178   1 1.4   2  0  3  1
## 26   71  0  1 160 302  0  1 162   0 0.4   2  2  2  1
## 27   59  1  2 150 212  1  1 157   0 1.6   2  0  2  1
## 28   51  1  2 110 175  0  1 123   0 0.6   2  0  2  1
## 29   65  0  2 140 417  1  0 157   0 0.8   2  1  2  1
## 30   53  1  2 130 197  1  0 152   0 1.2   0  0  2  1
## 31   41  0  1 105 198  0  1 168   0 0.0   2  1  2  1
## 32   65  1  0 120 177  0  1 140   0 0.4   2  0  3  1
## 33   44  1  1 130 219  0  0 188   0 0.0   2  0  2  1
## 34   54  1  2 125 273  0  0 152   0 0.5   0  1  2  1
## 35   51  1  3 125 213  0  0 125   1 1.4   2  1  2  1
## 36   46  0  2 142 177  0  0 160   1 1.4   0  0  2  1
## 37   54  0  2 135 304  1  1 170   0 0.0   2  0  2  1
## 38   54  1  2 150 232  0  0 165   0 1.6   2  0  3  1
## 39   65  0  2 155 269  0  1 148   0 0.8   2  0  2  1
## 40   65  0  2 160 360  0  0 151   0 0.8   2  0  2  1
## 41   51  0  2 140 308  0  0 142   0 1.5   2  1  2  1
## 42   48  1  1 130 245  0  0 180   0 0.2   1  0  2  1
## 43   45  1  0 104 208  0  0 148   1 3.0   1  0  2  1
## 44   53  0  0 130 264  0  0 143   0 0.4   1  0  2  1
## 45   39  1  2 140 321  0  0 182   0 0.0   2  0  2  1
## 46   52  1  1 120 325  0  1 172   0 0.2   2  0  2  1
## 47   44  1  2 140 235  0  0 180   0 0.0   2  0  2  1
## 48   47  1  2 138 257  0  0 156   0 0.0   2  0  2  1
## 49   53  0  2 128 216  0  0 115   0 0.0   2  0  0  1
## 50   53  0  0 138 234  0  0 160   0 0.0   2  0  2  1
## 51   51  0  2 130 256  0  0 149   0 0.5   2  0  2  1
## 52   66  1  0 120 302  0  0 151   0 0.4   1  0  2  1
## 53   62  1  2 130 231  0  1 146   0 1.8   1  3  3  1
## 54   44  0  2 108 141  0  1 175   0 0.6   1  0  2  1
## 55   63  0  2 135 252  0  0 172   0 0.0   2  0  2  1
## 56   52  1  1 134 201  0  1 158   0 0.8   2  1  2  1
## 57   48  1  0 122 222  0  0 186   0 0.0   2  0  2  1
```

```
## 58   45  1  0 115 260  0  0 185   0 0.0   2   0   2   1
## 59   34  1  3 118 182  0  0 174   0 0.0   2   0   2   1
## 60   57  0  0 128 303  0  0 159   0 0.0   2   1   2   1
## 61   71  0  2 110 265  1  0 130   0 0.0   2   1   2   1
## 62   54  1  1 108 309  0  1 156   0 0.0   2   0   3   1
## 63   52  1  3 118 186  0  0 190   0 0.0   1   0   1   1
## 64   41  1  1 135 203  0  1 132   0 0.0   1   0   1   1
## 65   58  1  2 140 211  1  0 165   0 0.0   2   0   2   1
## 66   35  0  0 138 183  0  1 182   0 1.4   2   0   2   1
## 67   51  1  2 100 222  0  1 143   1 1.2   1   0   2   1
## 68   45  0  1 130 234  0  0 175   0 0.6   1   0   2   1
## 69   44  1  1 120 220  0  1 170   0 0.0   2   0   2   1
## 70   62  0  0 124 209  0  1 163   0 0.0   2   0   2   1
## 71   54  1  2 120 258  0  0 147   0 0.4   1   0   3   1
## 72   51  1  2  94 227  0  1 154   1 0.0   2   1   3   1
## 73   29  1  1 130 204  0  0 202   0 0.0   2   0   2   1
## 74   51  1  0 140 261  0  0 186   1 0.0   2   0   2   1
## 75   43  0  2 122 213  0  1 165   0 0.2   1   0   2   1
## 76   55  0  1 135 250  0  0 161   0 1.4   1   0   2   1
## 77   51  1  2 125 245  1  0 166   0 2.4   1   0   2   1
## 78   59  1  1 140 221  0  1 164   1 0.0   2   0   2   1
## 79   52  1  1 128 205  1  1 184   0 0.0   2   0   2   1
## 80   58  1  2 105 240  0  0 154   1 0.6   1   0   3   1
## 81   41  1  2 112 250  0  1 179   0 0.0   2   0   2   1
## 82   45  1  1 128 308  0  0 170   0 0.0   2   0   2   1
## 83   60  0  2 102 318  0  1 160   0 0.0   2   1   2   1
## 84   52  1  3 152 298  1  1 178   0 1.2   1   0   3   1
## 85   42  0  0 102 265  0  0 122   0 0.6   1   0   2   1
## 86   67  0  2 115 564  0  0 160   0 1.6   1   0   3   1
## 87   68  1  2 118 277  0  1 151   0 1.0   2   1   3   1
## 88   46  1  1 101 197  1  1 156   0 0.0   2   0   3   1
## 89   54  0  2 110 214  0  1 158   0 1.6   1   0   2   1
## 90   58  0  0 100 248  0  0 122   0 1.0   1   0   2   1
## 91   48  1  2 124 255  1  1 175   0 0.0   2   2   2   1
## 92   57  1  0 132 207  0  1 168   1 0.0   2   0   3   1
## 93   52  1  2 138 223  0  1 169   0 0.0   2   4   2   1
## 94   54  0  1 132 288  1  0 159   1 0.0   2   1   2   1
## 95   45  0  1 112 160  0  1 138   0 0.0   1   0   2   1
## 96   53  1  0 142 226  0  0 111   1 0.0   2   0   3   1
## 97   62  0  0 140 394  0  0 157   0 1.2   1   0   2   1
## 98   52  1  0 108 233  1  1 147   0 0.1   2   3   3   1
## 99   43  1  2 130 315  0  1 162   0 1.9   2   1   2   1
## 100 53  1  2 130 246  1  0 173   0 0.0   2   3   2   1
## 101 42  1  3 148 244  0  0 178   0 0.8   2   2   2   1
## 102 59  1  3 178 270  0  0 145   0 4.2   0   0   3   1
## 103 63  0  1 140 195  0  1 179   0 0.0   2   2   2   1
## 104 42  1  2 120 240  1  1 194   0 0.8   0   0   3   1
## 105 50  1  2 129 196  0  1 163   0 0.0   2   0   2   1
## 106 68  0  2 120 211  0  0 115   0 1.5   1   0   2   1
## 107 69  1  3 160 234  1  0 131   0 0.1   1   1   2   1
## 108 45  0  0 138 236  0  0 152   1 0.2   1   0   2   1
## 109 50  0  1 120 244  0  1 162   0 1.1   2   0   2   1
## 110 50  0  0 110 254  0  0 159   0 0.0   2   0   2   1
## 111 64  0  0 180 325  0  1 154   1 0.0   2   0   2   1
```

```
## 112 57  1  2 150 126  1  1 173   0 0.2   2  1  3  1
## 113 64  0  2 140 313  0  1 133   0 0.2   2  0  3  1
## 114 43  1  0 110 211  0  1 161   0 0.0   2  0  3  1
## 115 55  1  1 130 262  0  1 155   0 0.0   2  0  2  1
## 116 37  0  2 120 215  0  1 170   0 0.0   2  0  2  1
## 117 41  1  2 130 214  0  0 168   0 2.0   1  0  2  1
## 118 56  1  3 120 193  0  0 162   0 1.9   1  0  3  1
## 119 46  0  1 105 204  0  1 172   0 0.0   2  0  2  1
## 120 46  0  0 138 243  0  0 152   1 0.0   1  0  2  1
## 121 64  0  0 130 303  0  1 122   0 2.0   1  2  2  1
## 122 59  1  0 138 271  0  0 182   0 0.0   2  0  2  1
## 123 41  0  2 112 268  0  0 172   1 0.0   2  0  2  1
## 124 54  0  2 108 267  0  0 167   0 0.0   2  0  2  1
## 125 39  0  2  94 199  0  1 179   0 0.0   2  0  2  1
## 126 34  0  1 118 210  0  1 192   0 0.7   2  0  2  1
## 127 47  1  0 112 204  0  1 143   0 0.1   2  0  2  1
## 128 67  0  2 152 277  0  1 172   0 0.0   2  1  2  1
## 129 52  0  2 136 196  0  0 169   0 0.1   1  0  2  1
## 130 74  0  1 120 269  0  0 121   1 0.2   2  1  2  1
## 131 54  0  2 160 201  0  1 163   0 0.0   2  1  2  1
## 132 49  0  1 134 271  0  1 162   0 0.0   1  0  2  1
## 133 42  1  1 120 295  0  1 162   0 0.0   2  0  2  1
## 134 41  1  1 110 235  0  1 153   0 0.0   2  0  2  1
## 135 41  0  1 126 306  0  1 163   0 0.0   2  0  2  1
## 136 49  0  0 130 269  0  1 163   0 0.0   2  0  2  1
## 137 60  0  2 120 178  1  1  96   0 0.0   2  0  2  1
## 138 62  1  1 128 208  1  0 140   0 0.0   2  0  2  1
## 139 57  1  0 110 201  0  1 126   1 1.5   1  0  1  1
## 140 64  1  0 128 263  0  1 105   1 0.2   1  1  3  1
## 141 51  0  2 120 295  0  0 157   0 0.6   2  0  2  1
## 142 43  1  0 115 303  0  1 181   0 1.2   1  0  2  1
## 143 42  0  2 120 209  0  1 173   0 0.0   1  0  2  1
## 144 67  0  0 106 223  0  1 142   0 0.3   2  2  2  1
## 145 76  0  2 140 197  0  2 116   0 1.1   1  0  2  1
## 146 70  1  1 156 245  0  0 143   0 0.0   2  0  2  1
## 147 44  0  2 118 242  0  1 149   0 0.3   1  1  2  1
## 148 60  0  3 150 240  0  1 171   0 0.9   2  0  2  1
## 149 44  1  2 120 226  0  1 169   0 0.0   2  0  2  1
## 150 42  1  2 130 180  0  1 150   0 0.0   2  0  2  1
## 151 66  1  0 160 228  0  0 138   0 2.3   2  0  1  1
## 152 71  0  0 112 149  0  1 125   0 1.6   1  0  2  1
## 153 64  1  3 170 227  0  0 155   0 0.6   1  0  3  1
## 154 66  0  2 146 278  0  0 152   0 0.0   1  1  2  1
## 155 39  0  2 138 220  0  1 152   0 0.0   1  0  2  1
## 156 58  0  0 130 197  0  1 131   0 0.6   1  0  2  1
## 157 47  1  2 130 253  0  1 179   0 0.0   2  0  2  1
## 158 35  1  1 122 192  0  1 174   0 0.0   2  0  2  1
## 159 58  1  1 125 220  0  1 144   0 0.4   1  4  3  1
## 160 56  1  1 130 221  0  0 163   0 0.0   2  0  3  1
## 161 56  1  1 120 240  0  1 169   0 0.0   0  0  2  1
## 162 55  0  1 132 342  0  1 166   0 1.2   2  0  2  1
## 163 41  1  1 120 157  0  1 182   0 0.0   2  0  2  1
## 164 38  1  2 138 175  0  1 173   0 0.0   2  4  2  1
## 165 38  1  2 138 175  0  1 173   0 0.0   2  4  2  1
```

```
## 166 67  1  0 160 286  0  0 108   1 1.5   1   3   2   0
## 167 67  1  0 120 229  0  0 129   1 2.6   1   2   3   0
## 168 62  0  0 140 268  0  0 160   0 3.6   0   2   2   0
## 169 63  1  0 130 254  0  0 147   0 1.4   1   1   3   0
## 170 53  1  0 140 203  1  0 155   1 3.1   0   0   3   0
## 171 56  1  2 130 256  1  0 142   1 0.6   1   1   1   0
## 172 48  1  1 110 229  0  1 168   0 1.0   0   0   3   0
## 173 58  1  1 120 284  0  0 160   0 1.8   1   0   2   0
## 174 58  1  2 132 224  0  0 173   0 3.2   2   2   3   0
## 175 60  1  0 130 206  0  0 132   1 2.4   1   2   3   0
## 176 40  1  0 110 167  0  0 114   1 2.0   1   0   3   0
## 177 60  1  0 117 230  1  1 160   1 1.4   2   2   3   0
## 178 64  1  2 140 335  0  1 158   0 0.0   2   0   2   0
## 179 43  1  0 120 177  0  0 120   1 2.5   1   0   3   0
## 180 57  1  0 150 276  0  0 112   1 0.6   1   1   1   0
## 181 55  1  0 132 353  0  1 132   1 1.2   1   1   3   0
## 182 65  0  0 150 225  0  0 114   0 1.0   1   3   3   0
## 183 61  0  0 130 330  0  0 169   0 0.0   2   0   2   0
## 184 58  1  2 112 230  0  0 165   0 2.5   1   1   3   0
## 185 50  1  0 150 243  0  0 128   0 2.6   1   0   3   0
## 186 44  1  0 112 290  0  0 153   0 0.0   2   1   2   0
## 187 60  1  0 130 253  0  1 144   1 1.4   2   1   3   0
## 188 54  1  0 124 266  0  0 109   1 2.2   1   1   3   0
## 189 50  1  2 140 233  0  1 163   0 0.6   1   1   3   0
## 190 41  1  0 110 172  0  0 158   0 0.0   2   0   3   0
## 191 51  0  0 130 305  0  1 142   1 1.2   1   0   3   0
## 192 58  1  0 128 216  0  0 131   1 2.2   1   3   3   0
## 193 54  1  0 120 188  0  1 113   0 1.4   1   1   3   0
## 194 60  1  0 145 282  0  0 142   1 2.8   1   2   3   0
## 195 60  1  2 140 185  0  0 155   0 3.0   1   0   2   0
## 196 59  1  0 170 326  0  0 140   1 3.4   0   0   3   0
## 197 46  1  2 150 231  0  1 147   0 3.6   1   0   2   0
## 198 67  1  0 125 254  1  1 163   0 0.2   1   2   3   0
## 199 62  1  0 120 267  0  1  99   1 1.8   1   2   3   0
## 200 65  1  0 110 248  0  0 158   0 0.6   2   2   1   0
## 201 44  1  0 110 197  0  0 177   0 0.0   2   1   2   0
## 202 60  1  0 125 258  0  0 141   1 2.8   1   1   3   0
## 203 58  1  0 150 270  0  0 111   1 0.8   2   0   3   0
## 204 68  1  2 180 274  1  0 150   1 1.6   1   0   3   0
## 205 62  0  0 160 164  0  0 145   0 6.2   0   3   3   0
## 206 52  1  0 128 255  0  1 161   1 0.0   2   1   3   0
## 207 59  1  0 110 239  0  0 142   1 1.2   1   1   3   0
## 208 60  0  0 150 258  0  0 157   0 2.6   1   2   3   0
## 209 49  1  2 120 188  0  1 139   0 2.0   1   3   3   0
## 210 59  1  0 140 177  0  1 162   1 0.0   2   1   3   0
## 211 57  1  2 128 229  0  0 150   0 0.4   1   1   3   0
## 212 61  1  0 120 260  0  1 140   1 3.6   1   1   3   0
## 213 39  1  0 118 219  0  1 140   0 1.2   1   0   3   0
## 214 61  0  0 145 307  0  0 146   1 1.0   1   0   3   0
## 215 56  1  0 125 249  1  0 144   1 1.2   1   1   2   0
## 216 43  0  0 132 341  1  0 136   1 3.0   1   0   3   0
## 217 62  0  2 130 263  0  1  97   0 1.2   1   1   3   0
## 218 63  1  0 130 330  1  0 132   1 1.8   2   3   3   0
## 219 65  1  0 135 254  0  0 127   0 2.8   1   1   3   0
```

```
## 220 48   1   0 130 256   1   0 150    1 0.0    2    2    3    0
## 221 63   0   0 150 407   0   0 154    0 4.0    1    3    3    0
## 222 55   1   0 140 217   0   1 111    1 5.6    0    0    3    0
## 223 65   1   3 138 282   1   0 174    0 1.4    1    1    2    0
## 224 56   0   0 200 288   1   0 133    1 4.0    0    2    3    0
## 225 54   1   0 110 239   0   1 126    1 2.8    1    1    3    0
## 226 70   1   0 145 174   0   1 125    1 2.6    0    0    3    0
## 227 62   1   1 120 281   0   0 103    0 1.4    1    1    3    0
## 228 35   1   0 120 198   0   1 130    1 1.6    1    0    3    0
## 229 59   1   3 170 288   0   0 159    0 0.2    1    0    3    0
## 230 64   1   2 125 309   0   1 131    1 1.8    1    0    3    0
## 231 47   1   2 108 243   0   1 152    0 0.0    2    0    2    0
## 232 57   1   0 165 289   1   0 124    0 1.0    1    3    3    0
## 233 55   1   0 160 289   0   0 145    1 0.8    1    1    3    0
## 234 64   1   0 120 246   0   0  96    1 2.2    0    1    2    0
## 235 70   1   0 130 322   0   0 109    0 2.4    1    3    2    0
## 236 51   1   0 140 299   0   1 173    1 1.6    2    0    3    0
## 237 58   1   0 125 300   0   0 171    0 0.0    2    2    3    0
## 238 60   1   0 140 293   0   0 170    0 1.2    1    2    3    0
## 239 77   1   0 125 304   0   0 162    1 0.0    2    3    2    0
## 240 35   1   0 126 282   0   0 156    1 0.0    2    0    3    0
## 241 70   1   2 160 269   0   1 112    1 2.9    1    1    3    0
## 242 59   0   0 174 249   0   1 143    1 0.0    1    0    2    0
## 243 64   1   0 145 212   0   0 132    0 2.0    1    2    1    0
## 244 57   1   0 152 274   0   1  88    1 1.2    1    1    3    0
## 245 56   1   0 132 184   0   0 105    1 2.1    1    1    1    0
## 246 48   1   0 124 274   0   0 166    0 0.5    1    0    3    0
## 247 56   0   0 134 409   0   0 150    1 1.9    1    2    3    0
## 248 66   1   1 160 246   0   1 120    1 0.0    1    3    1    0
## 249 54   1   1 192 283   0   0 195    0 0.0    2    1    3    0
## 250 69   1   2 140 254   0   0 146    0 2.0    1    3    3    0
## 251 51   1   0 140 298   0   1 122    1 4.2    1    3    3    0
## 252 43   1   0 132 247   1   0 143    1 0.1    1    4    3    0
## 253 62   0   0 138 294   1   1 106    0 1.9    1    3    2    0
## 254 67   1   0 100 299   0   0 125    1 0.9    1    2    2    0
## 255 59   1   3 160 273   0   0 125    0 0.0    2    0    2    0
## 256 45   1   0 142 309   0   0 147    1 0.0    1    3    3    0
## 257 58   1   0 128 259   0   0 130    1 3.0    1    2    3    0
## 258 50   1   0 144 200   0   0 126    1 0.9    1    0    3    0
## 259 62   0   0 150 244   0   1 154    1 1.4    1    0    2    0
## 260 38   1   3 120 231   0   1 182    1 3.8    1    0    3    0
## 261 66   0   0 178 228   1   1 165    1 1.0    1    2    3    0
## 262 52   1   0 112 230   0   1 160    0 0.0    2    1    2    0
## 263 53   1   0 123 282   0   1  95    1 2.0    1    2    3    0
## 264 63   0   0 108 269   0   1 169    1 1.8    1    2    2    0
## 265 54   1   0 110 206   0   0 108    1 0.0    1    1    2    0
## 266 66   1   0 112 212   0   0 132    1 0.1    2    1    2    0
## 267 55   0   0 180 327   0   2 117    1 3.4    1    0    2    0
## 268 49   1   2 118 149   0   0 126    0 0.8    2    3    2    0
## 269 54   1   0 122 286   0   0 116    1 3.2    1    2    2    0
## 270 56   1   0 130 283   1   0 103    1 1.6    0    0    3    0
## 271 46   1   0 120 249   0   0 144    0 0.8    2    0    3    0
## 272 61   1   3 134 234   0   1 145    0 2.6    1    2    2    0
## 273 67   1   0 120 237   0   1  71    0 1.0    1    0    2    0
```

```
## 274 58   1   0 100  234   0   1  156    0  0.1    2    1    3    0
## 275 47   1   0 110  275   0   0  118    1  1.0    1    1    2    0
## 276 52   1   0 125  212   0   1  168    0  1.0    2    2    3    0
## 277 58   1   0 146  218   0   1  105    0  2.0    1    1    3    0
## 278 57   1   1 124  261   0   1  141    0  0.3    2    0    3    0
## 279 58   0   1 136  319   1   0  152    0  0.0    2    2    2    0
## 280 61   1   0 138  166   0   0  125    1  3.6    1    1    2    0
## 281 42   1   0 136  315   0   1  125    1  1.8    1    0    1    0
## 282 52   1   0 128  204   1   1  156    1  1.0    1    0    0    0
## 283 59   1   2 126  218   1   1  134    0  2.2    1    1    1    0
## 284 40   1   0 152  223   0   1  181    0  0.0    2    0    3    0
## 285 61   1   0 140  207   0   0  138    1  1.9    2    1    3    0
## 286 46   1   0 140  311   0   1  120    1  1.8    1    2    3    0
## 287 59   1   3 134  204   0   1  162    0  0.8    2    2    2    0
## 288 57   1   1 154  232   0   0  164    0  0.0    2    1    2    0
## 289 57   1   0 110  335   0   1  143    1  3.0    1    1    3    0
## 290 55   0   0 128  205   0   2  130    1  2.0    1    1    3    0
## 291 61   1   0 148  203   0   1  161    0  0.0    2    1    3    0
## 292 58   1   0 114  318   0   2  140    0  4.4    0    3    1    0
## 293 58   0   0 170  225   1   0  146    1  2.8    1    2    1    0
## 294 67   1   2 152  212   0   0  150    0  0.8    1    0    3    0
## 295 44   1   0 120  169   0   1  144    1  2.8    0    0    1    0
## 296 63   1   0 140  187   0   0  144    1  4.0    2    2    3    0
## 297 63   0   0 124  197   0   1  136    1  0.0    1    0    2    0
## 298 59   1   0 164  176   1   0   90    0  1.0    1    2    1    0
## 299 57   0   0 140  241   0   1  123    1  0.2    1    0    3    0
## 300 45   1   3 110  264   0   1  132    0  1.2    1    0    3    0
## 301 68   1   0 144  193   1   1  141    0  3.4    1    2    3    0
## 302 57   1   0 130  131   0   1  115    1  1.2    1    1    3    0
## 303 57   0   1 130  236   0   0  174    0  0.0    1    1    2    0
```

```r
# Nadanie nazw dla poszczególnych kolumn
colnames(data) <- c("age", "sex", "cp", "trestbps", "chol", "fbs", "restecg", "thalach", "exang", "oldp
```

4. Sprawdzenie danych i analiza rokladu danych

```r
# Wyświetlenie wczytanych danych
print(data)
```

```
##      age sex cp trestbps chol fbs restecg thalach exang oldpeak slope ca thal
## 1     63   1  3      145  233   1       0     150     0     2.3     0  0    1
## 2     37   1  2      130  250   0       1     187     0     3.5     0  0    2
## 3     41   0  1      130  204   0       0     172     0     1.4     2  0    2
## 4     56   1  1      120  236   0       1     178     0     0.8     2  0    2
## 5     57   0  0      120  354   0       1     163     1     0.6     2  0    2
## 6     57   1  0      140  192   0       1     148     0     0.4     1  0    1
## 7     56   0  1      140  294   0       0     153     0     1.3     1  0    2
## 8     44   1  1      120  263   0       1     173     0     0.0     2  0    3
## 9     52   1  2      172  199   1       1     162     0     0.5     2  0    3
## 10    57   1  2      150  168   0       1     174     0     1.6     2  0    2
## 11    54   1  0      140  239   0       1     160     0     1.2     2  0    2
```

```
## 12    48   0  2      130  275  0      1     139     0     0.2     2  0     2
## 13    49   1  1      130  266  0      1     171     0     0.6     2  0     2
## 14    64   1  3      110  211  0      0     144     1     1.8     1  0     2
## 15    58   0  3      150  283  1      0     162     0     1.0     2  0     2
## 16    50   0  2      120  219  0      1     158     0     1.6     1  0     2
## 17    58   0  2      120  340  0      1     172     0     0.0     2  0     2
## 18    66   0  3      150  226  0      1     114     0     2.6     0  0     2
## 19    43   1  0      150  247  0      1     171     0     1.5     2  0     2
## 20    69   0  3      140  239  0      1     151     0     1.8     2  2     2
## 21    59   1  0      135  234  0      1     161     0     0.5     1  0     3
## 22    44   1  2      130  233  0      1     179     1     0.4     2  0     2
## 23    42   1  0      140  226  0      1     178     0     0.0     2  0     2
## 24    61   1  2      150  243  1      1     137     1     1.0     1  0     2
## 25    40   1  3      140  199  0      1     178     1     1.4     2  0     3
## 26    71   0  1      160  302  0      1     162     0     0.4     2  2     2
## 27    59   1  2      150  212  1      1     157     0     1.6     2  0     2
## 28    51   1  2      110  175  0      1     123     0     0.6     2  0     2
## 29    65   0  2      140  417  1      0     157     0     0.8     2  1     2
## 30    53   1  2      130  197  1      0     152     0     1.2     0  0     2
## 31    41   0  1      105  198  0      1     168     0     0.0     2  1     2
## 32    65   1  0      120  177  0      1     140     0     0.4     2  0     3
## 33    44   1  1      130  219  0      0     188     0     0.0     2  0     2
## 34    54   1  2      125  273  0      0     152     0     0.5     0  1     2
## 35    51   1  3      125  213  0      0     125     1     1.4     2  1     2
## 36    46   0  2      142  177  0      0     160     1     1.4     0  0     2
## 37    54   0  2      135  304  1      1     170     0     0.0     2  0     2
## 38    54   1  2      150  232  0      0     165     0     1.6     2  0     3
## 39    65   0  2      155  269  0      1     148     0     0.8     2  0     2
## 40    65   0  2      160  360  0      0     151     0     0.8     2  0     2
## 41    51   0  2      140  308  0      0     142     0     1.5     2  1     2
## 42    48   1  1      130  245  0      0     180     0     0.2     1  0     2
## 43    45   1  0      104  208  0      0     148     1     3.0     1  0     2
## 44    53   0  0      130  264  0      0     143     0     0.4     1  0     2
## 45    39   1  2      140  321  0      0     182     0     0.0     2  0     2
## 46    52   1  1      120  325  0      1     172     0     0.2     2  0     2
## 47    44   1  2      140  235  0      0     180     0     0.0     2  0     2
## 48    47   1  2      138  257  0      0     156     0     0.0     2  0     2
## 49    53   0  2      128  216  0      0     115     0     0.0     2  0     0
## 50    53   0  0      138  234  0      0     160     0     0.0     2  0     2
## 51    51   0  2      130  256  0      0     149     0     0.5     2  0     2
## 52    66   1  0      120  302  0      0     151     0     0.4     1  0     2
## 53    62   1  2      130  231  0      1     146     0     1.8     1  3     3
## 54    44   0  2      108  141  0      1     175     0     0.6     1  0     2
## 55    63   0  2      135  252  0      0     172     0     0.0     2  0     2
## 56    52   1  1      134  201  0      1     158     0     0.8     2  1     2
## 57    48   1  0      122  222  0      0     186     0     0.0     2  0     2
## 58    45   1  0      115  260  0      0     185     0     0.0     2  0     2
## 59    34   1  3      118  182  0      0     174     0     0.0     2  0     2
## 60    57   0  0      128  303  0      0     159     0     0.0     2  1     2
## 61    71   0  2      110  265  1      0     130     0     0.0     2  1     2
## 62    54   1  1      108  309  0      1     156     0     0.0     2  0     3
## 63    52   1  3      118  186  0      0     190     0     0.0     1  0     1
## 64    41   1  1      135  203  0      1     132     0     0.0     1  0     1
## 65    58   1  2      140  211  1      0     165     0     0.0     2  0     2
```

```
## 66   35  0  0   138  183  0   1   182  0   1.4  2  0  2
## 67   51  1  2   100  222  0   1   143  1   1.2  1  0  2
## 68   45  0  1   130  234  0   0   175  0   0.6  1  0  2
## 69   44  1  1   120  220  0   1   170  0   0.0  2  0  2
## 70   62  0  0   124  209  0   1   163  0   0.0  2  0  2
## 71   54  1  2   120  258  0   0   147  0   0.4  1  0  3
## 72   51  1  2    94  227  0   1   154  1   0.0  2  1  3
## 73   29  1  1   130  204  0   0   202  0   0.0  2  0  2
## 74   51  1  0   140  261  0   0   186  1   0.0  2  0  2
## 75   43  0  2   122  213  0   1   165  0   0.2  1  0  2
## 76   55  0  1   135  250  0   0   161  0   1.4  1  0  2
## 77   51  1  2   125  245  1   0   166  0   2.4  1  0  2
## 78   59  1  1   140  221  0   1   164  1   0.0  2  0  2
## 79   52  1  1   128  205  1   1   184  0   0.0  2  0  2
## 80   58  1  2   105  240  0   0   154  1   0.6  1  0  3
## 81   41  1  2   112  250  0   1   179  0   0.0  2  0  2
## 82   45  1  1   128  308  0   0   170  0   0.0  2  0  2
## 83   60  0  2   102  318  0   1   160  0   0.0  2  1  2
## 84   52  1  3   152  298  1   1   178  0   1.2  1  0  3
## 85   42  0  0   102  265  0   0   122  0   0.6  1  0  2
## 86   67  0  2   115  564  0   0   160  0   1.6  1  0  3
## 87   68  1  2   118  277  0   1   151  0   1.0  2  1  3
## 88   46  1  1   101  197  1   1   156  0   0.0  2  0  3
## 89   54  0  2   110  214  0   1   158  0   1.6  1  0  2
## 90   58  0  0   100  248  0   0   122  0   1.0  1  0  2
## 91   48  1  2   124  255  1   1   175  0   0.0  2  2  2
## 92   57  1  0   132  207  0   1   168  1   0.0  2  0  3
## 93   52  1  2   138  223  0   1   169  0   0.0  2  4  2
## 94   54  0  1   132  288  1   0   159  1   0.0  2  1  2
## 95   45  0  1   112  160  0   1   138  0   0.0  1  0  2
## 96   53  1  0   142  226  0   0   111  1   0.0  2  0  3
## 97   62  0  0   140  394  0   0   157  0   1.2  1  0  2
## 98   52  1  0   108  233  1   1   147  0   0.1  2  3  3
## 99   43  1  2   130  315  0   1   162  0   1.9  2  1  2
## 100  53  1  2   130  246  1   0   173  0   0.0  2  3  2
## 101  42  1  3   148  244  0   0   178  0   0.8  2  2  2
## 102  59  1  3   178  270  0   0   145  0   4.2  0  0  3
## 103  63  0  1   140  195  0   1   179  0   0.0  2  2  2
## 104  42  1  2   120  240  1   1   194  0   0.8  0  0  3
## 105  50  1  2   129  196  0   1   163  0   0.0  2  0  2
## 106  68  0  2   120  211  0   0   115  0   1.5  1  0  2
## 107  69  1  3   160  234  1   0   131  0   0.1  1  1  2
## 108  45  0  0   138  236  0   0   152  1   0.2  1  0  2
## 109  50  0  1   120  244  0   1   162  0   1.1  2  0  2
## 110  50  0  0   110  254  0   0   159  0   0.0  2  0  2
## 111  64  0  0   180  325  0   1   154  1   0.0  2  0  2
## 112  57  1  2   150  126  1   1   173  0   0.2  2  1  3
## 113  64  0  2   140  313  0   1   133  0   0.2  2  0  3
## 114  43  1  0   110  211  0   1   161  0   0.0  2  0  3
## 115  55  1  1   130  262  0   1   155  0   0.0  2  0  2
## 116  37  0  2   120  215  0   1   170  0   0.0  2  0  2
## 117  41  1  2   130  214  0   0   168  0   2.0  1  0  2
## 118  56  1  3   120  193  0   0   162  0   1.9  1  0  3
## 119  46  0  1   105  204  0   1   172  0   0.0  2  0  2
```

```
## 120  46  0  0    138  243  0     0    152   1    0.0   1  0   2
## 121  64  0  0    130  303  0     1    122   0    2.0   1  2   2
## 122  59  1  0    138  271  0     0    182   0    0.0   2  0   2
## 123  41  0  2    112  268  0     0    172   1    0.0   2  0   2
## 124  54  0  2    108  267  0     0    167   0    0.0   2  0   2
## 125  39  0  2     94  199  0     1    179   0    0.0   2  0   2
## 126  34  0  1    118  210  0     1    192   0    0.7   2  0   2
## 127  47  1  0    112  204  0     1    143   0    0.1   2  0   2
## 128  67  0  2    152  277  0     1    172   0    0.0   2  1   2
## 129  52  0  2    136  196  0     0    169   0    0.1   1  0   2
## 130  74  0  1    120  269  0     0    121   1    0.2   2  1   2
## 131  54  0  2    160  201  0     1    163   0    0.0   2  1   2
## 132  49  0  1    134  271  0     1    162   0    0.0   1  0   2
## 133  42  1  1    120  295  0     1    162   0    0.0   2  0   2
## 134  41  1  1    110  235  0     1    153   0    0.0   2  0   2
## 135  41  0  1    126  306  0     1    163   0    0.0   2  0   2
## 136  49  0  0    130  269  0     1    163   0    0.0   2  0   2
## 137  60  0  2    120  178  1     1     96   0    0.0   2  0   2
## 138  62  1  1    128  208  1     0    140   0    0.0   2  0   2
## 139  57  1  0    110  201  0     1    126   1    1.5   1  0   1
## 140  64  1  0    128  263  0     1    105   1    0.2   1  1   3
## 141  51  0  2    120  295  0     0    157   0    0.6   2  0   2
## 142  43  1  0    115  303  0     1    181   0    1.2   1  0   2
## 143  42  0  2    120  209  0     1    173   0    0.0   1  0   2
## 144  67  0  0    106  223  0     1    142   0    0.3   2  2   2
## 145  76  0  2    140  197  0     2    116   0    1.1   1  0   2
## 146  70  1  1    156  245  0     0    143   0    0.0   2  0   2
## 147  44  0  2    118  242  0     1    149   0    0.3   1  1   2
## 148  60  0  3    150  240  0     1    171   0    0.9   2  0   2
## 149  44  1  2    120  226  0     1    169   0    0.0   2  0   2
## 150  42  1  2    130  180  0     1    150   0    0.0   2  0   2
## 151  66  1  0    160  228  0     0    138   0    2.3   2  0   1
## 152  71  0  0    112  149  0     1    125   0    1.6   1  0   2
## 153  64  1  3    170  227  0     0    155   0    0.6   1  0   3
## 154  66  0  2    146  278  0     0    152   0    0.0   1  1   2
## 155  39  0  2    138  220  0     1    152   0    0.0   1  0   2
## 156  58  0  0    130  197  0     1    131   0    0.6   1  0   2
## 157  47  1  2    130  253  0     1    179   0    0.0   2  0   2
## 158  35  1  1    122  192  0     1    174   0    0.0   2  0   2
## 159  58  1  1    125  220  0     1    144   0    0.4   1  4   3
## 160  56  1  1    130  221  0     0    163   0    0.0   2  0   3
## 161  56  1  1    120  240  0     1    169   0    0.0   0  0   2
## 162  55  0  1    132  342  0     1    166   0    1.2   2  0   2
## 163  41  1  1    120  157  0     1    182   0    0.0   2  0   2
## 164  38  1  2    138  175  0     1    173   0    0.0   2  4   2
## 165  38  1  2    138  175  0     1    173   0    0.0   2  4   2
## 166  67  1  0    160  286  0     0    108   1    1.5   1  3   2
## 167  67  1  0    120  229  0     0    129   1    2.6   1  2   3
## 168  62  0  0    140  268  0     0    160   0    3.6   0  2   2
## 169  63  1  0    130  254  0     0    147   0    1.4   1  1   3
## 170  53  1  0    140  203  1     0    155   1    3.1   0  0   3
## 171  56  1  2    130  256  1     0    142   1    0.6   1  1   1
## 172  48  1  1    110  229  0     1    168   0    1.0   0  0   3
## 173  58  1  1    120  284  0     0    160   0    1.8   1  0   2
```

```
## 174  58   1  2      132  224  0       0     173     0     3.2      2  2     3
## 175  60   1  0      130  206  0       0     132     1     2.4      1  2     3
## 176  40   1  0      110  167  0       0     114     1     2.0      1  0     3
## 177  60   1  0      117  230  1       1     160     1     1.4      2  2     3
## 178  64   1  2      140  335  0       1     158     0     0.0      2  0     2
## 179  43   1  0      120  177  0       0     120     1     2.5      1  0     3
## 180  57   1  0      150  276  0       0     112     1     0.6      1  1     1
## 181  55   1  0      132  353  0       1     132     1     1.2      1  1     3
## 182  65   0  0      150  225  0       0     114     0     1.0      1  3     3
## 183  61   0  0      130  330  0       0     169     0     0.0      2  0     2
## 184  58   1  2      112  230  0       0     165     0     2.5      1  1     3
## 185  50   1  0      150  243  0       0     128     0     2.6      1  0     3
## 186  44   1  0      112  290  0       0     153     0     0.0      2  1     2
## 187  60   1  0      130  253  0       1     144     1     1.4      2  1     3
## 188  54   1  0      124  266  0       0     109     1     2.2      1  1     3
## 189  50   1  2      140  233  0       1     163     0     0.6      1  1     3
## 190  41   1  0      110  172  0       0     158     0     0.0      2  0     3
## 191  51   0  0      130  305  0       1     142     1     1.2      1  0     3
## 192  58   1  0      128  216  0       0     131     1     2.2      1  3     3
## 193  54   1  0      120  188  0       1     113     0     1.4      1  1     3
## 194  60   1  0      145  282  0       0     142     1     2.8      1  2     3
## 195  60   1  2      140  185  0       0     155     0     3.0      1  0     2
## 196  59   1  0      170  326  0       0     140     1     3.4      0  0     3
## 197  46   1  2      150  231  0       1     147     0     3.6      1  0     2
## 198  67   1  0      125  254  1       1     163     0     0.2      1  2     3
## 199  62   1  0      120  267  0       1      99     1     1.8      1  2     3
## 200  65   1  0      110  248  0       0     158     0     0.6      2  2     1
## 201  44   1  0      110  197  0       0     177     0     0.0      2  1     2
## 202  60   1  0      125  258  0       0     141     1     2.8      1  1     3
## 203  58   1  0      150  270  0       0     111     1     0.8      2  0     3
## 204  68   1  2      180  274  1       0     150     1     1.6      1  0     3
## 205  62   0  0      160  164  0       0     145     0     6.2      0  3     3
## 206  52   1  0      128  255  0       1     161     1     0.0      2  1     3
## 207  59   1  0      110  239  0       0     142     1     1.2      1  1     3
## 208  60   0  0      150  258  0       0     157     0     2.6      1  2     3
## 209  49   1  2      120  188  0       1     139     0     2.0      1  3     3
## 210  59   1  0      140  177  0       1     162     1     0.0      2  1     3
## 211  57   1  2      128  229  0       0     150     0     0.4      1  1     3
## 212  61   1  0      120  260  0       1     140     1     3.6      1  1     3
## 213  39   1  0      118  219  0       1     140     0     1.2      1  0     3
## 214  61   0  0      145  307  0       0     146     1     1.0      1  0     3
## 215  56   1  0      125  249  1       0     144     1     1.2      1  1     2
## 216  43   0  0      132  341  1       0     136     1     3.0      1  0     3
## 217  62   0  2      130  263  0       1      97     0     1.2      1  1     3
## 218  63   1  0      130  330  1       0     132     1     1.8      2  3     3
## 219  65   1  0      135  254  0       0     127     0     2.8      1  1     3
## 220  48   1  0      130  256  1       0     150     1     0.0      2  2     3
## 221  63   0  0      150  407  0       0     154     0     4.0      1  3     3
## 222  55   1  0      140  217  0       1     111     1     5.6      0  0     3
## 223  65   1  3      138  282  1       0     174     0     1.4      1  1     2
## 224  56   0  0      200  288  1       0     133     1     4.0      0  2     3
## 225  54   1  0      110  239  0       1     126     1     2.8      1  1     3
## 226  70   1  0      145  174  0       1     125     1     2.6      0  0     3
## 227  62   1  1      120  281  0       0     103     0     1.4      1  1     3
```

```
## 228  35  1  0    120  198  0    1    130    1    1.6    1  0    3
## 229  59  1  3    170  288  0    0    159    0    0.2    1  0    3
## 230  64  1  2    125  309  0    1    131    1    1.8    1  0    3
## 231  47  1  2    108  243  0    1    152    0    0.0    2  0    2
## 232  57  1  0    165  289  1    0    124    0    1.0    1  3    3
## 233  55  1  0    160  289  0    0    145    1    0.8    1  1    3
## 234  64  1  0    120  246  0    0     96    1    2.2    0  1    2
## 235  70  1  0    130  322  0    0    109    0    2.4    1  3    2
## 236  51  1  0    140  299  0    1    173    1    1.6    2  0    3
## 237  58  1  0    125  300  0    0    171    0    0.0    2  2    3
## 238  60  1  0    140  293  0    0    170    0    1.2    1  2    3
## 239  77  1  0    125  304  0    0    162    1    0.0    2  3    2
## 240  35  1  0    126  282  0    0    156    1    0.0    2  0    3
## 241  70  1  2    160  269  0    1    112    1    2.9    1  1    3
## 242  59  0  0    174  249  0    1    143    1    0.0    1  0    2
## 243  64  1  0    145  212  0    0    132    0    2.0    1  2    1
## 244  57  1  0    152  274  0    1     88    1    1.2    1  1    3
## 245  56  1  0    132  184  0    0    105    1    2.1    1  1    1
## 246  48  1  0    124  274  0    0    166    0    0.5    1  0    3
## 247  56  0  0    134  409  0    0    150    1    1.9    1  2    3
## 248  66  1  1    160  246  0    1    120    1    0.0    1  3    1
## 249  54  1  1    192  283  0    0    195    0    0.0    2  1    3
## 250  69  1  2    140  254  0    0    146    0    2.0    1  3    3
## 251  51  1  0    140  298  0    1    122    1    4.2    1  3    3
## 252  43  1  0    132  247  1    0    143    1    0.1    1  4    3
## 253  62  0  0    138  294  1    1    106    0    1.9    1  3    2
## 254  67  1  0    100  299  0    0    125    1    0.9    1  2    2
## 255  59  1  3    160  273  0    0    125    0    0.0    2  0    2
## 256  45  1  0    142  309  0    0    147    1    0.0    1  3    3
## 257  58  1  0    128  259  0    0    130    1    3.0    1  2    3
## 258  50  1  0    144  200  0    0    126    1    0.9    1  0    3
## 259  62  0  0    150  244  0    1    154    1    1.4    1  0    2
## 260  38  1  3    120  231  0    1    182    1    3.8    1  0    3
## 261  66  0  0    178  228  1    1    165    1    1.0    1  2    3
## 262  52  1  0    112  230  0    1    160    0    0.0    2  1    2
## 263  53  1  0    123  282  0    1     95    1    2.0    1  2    3
## 264  63  0  0    108  269  0    1    169    1    1.8    1  2    2
## 265  54  1  0    110  206  0    0    108    1    0.0    1  1    2
## 266  66  1  0    112  212  0    0    132    1    0.1    2  1    2
## 267  55  0  0    180  327  0    2    117    1    3.4    1  0    2
## 268  49  1  2    118  149  0    0    126    0    0.8    2  3    2
## 269  54  1  0    122  286  0    0    116    1    3.2    1  2    2
## 270  56  1  0    130  283  1    0    103    1    1.6    0  0    3
## 271  46  1  0    120  249  0    0    144    0    0.8    2  0    3
## 272  61  1  3    134  234  0    1    145    0    2.6    1  2    2
## 273  67  1  0    120  237  0    1     71    0    1.0    1  0    2
## 274  58  1  0    100  234  0    1    156    0    0.1    2  1    3
## 275  47  1  0    110  275  0    0    118    1    1.0    1  1    2
## 276  52  1  0    125  212  0    1    168    0    1.0    2  2    3
## 277  58  1  0    146  218  0    1    105    0    2.0    1  1    3
## 278  57  1  1    124  261  0    1    141    0    0.3    2  0    3
## 279  58  0  1    136  319  1    0    152    0    0.0    2  2    2
## 280  61  1  0    138  166  0    0    125    1    3.6    1  1    2
## 281  42  1  0    136  315  0    1    125    1    1.8    1  0    1
```

```
## 282  52   1  0       128  204  1        1     156     1     1.0      1  0     0
## 283  59   1  2       126  218  1        1     134     0     2.2      1  1     1
## 284  40   1  0       152  223  0        1     181     0     0.0      2  0     3
## 285  61   1  0       140  207  0        0     138     1     1.9      2  1     3
## 286  46   1  0       140  311  0        1     120     1     1.8      1  2     3
## 287  59   1  3       134  204  0        1     162     0     0.8      2  2     2
## 288  57   1  1       154  232  0        0     164     0     0.0      2  1     2
## 289  57   1  0       110  335  0        1     143     1     3.0      1  1     3
## 290  55   0  0       128  205  0        2     130     1     2.0      1  1     3
## 291  61   1  0       148  203  0        1     161     0     0.0      2  1     3
## 292  58   1  0       114  318  0        2     140     0     4.4      0  3     1
## 293  58   0  0       170  225  1        0     146     1     2.8      1  2     1
## 294  67   1  2       152  212  0        0     150     0     0.8      1  0     3
## 295  44   1  0       120  169  0        1     144     1     2.8      0  0     1
## 296  63   1  0       140  187  0        0     144     1     4.0      2  2     3
## 297  63   0  0       124  197  0        1     136     1     0.0      1  0     2
## 298  59   1  0       164  176  1        0      90     0     1.0      1  2     1
## 299  57   0  0       140  241  0        1     123     1     0.2      1  0     3
## 300  45   1  3       110  264  0        1     132     0     1.2      1  0     3
## 301  68   1  0       144  193  1        1     141     0     3.4      1  2     3
## 302  57   1  0       130  131  0        1     115     1     1.2      1  1     3
## 303  57   0  1       130  236  0        0     174     0     0.0      1  1     2
##     target
## 1        1
## 2        1
## 3        1
## 4        1
## 5        1
## 6        1
## 7        1
## 8        1
## 9        1
## 10       1
## 11       1
## 12       1
## 13       1
## 14       1
## 15       1
## 16       1
## 17       1
## 18       1
## 19       1
## 20       1
## 21       1
## 22       1
## 23       1
## 24       1
## 25       1
## 26       1
## 27       1
## 28       1
## 29       1
## 30       1
## 31       1
```

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## 32          1
## 33          1
## 34          1
## 35          1
## 36          1
## 37          1
## 38          1
## 39          1
## 40          1
## 41          1
## 42          1
## 43          1
## 44          1
## 45          1
## 46          1
## 47          1
## 48          1
## 49          1
## 50          1
## 51          1
## 52          1
## 53          1
## 54          1
## 55          1
## 56          1
## 57          1
## 58          1
## 59          1
## 60          1
## 61          1
## 62          1
## 63          1
## 64          1
## 65          1
## 66          1
## 67          1
## 68          1
## 69          1
## 70          1
## 71          1
## 72          1
## 73          1
## 74          1
## 75          1
## 76          1
## 77          1
## 78          1
## 79          1
## 80          1
## 81          1
## 82          1
## 83          1
## 84          1
## 85          1
```

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## 86          1
## 87          1
## 88          1
## 89          1
## 90          1
## 91          1
## 92          1
## 93          1
## 94          1
## 95          1
## 96          1
## 97          1
## 98          1
## 99          1
## 100         1
## 101         1
## 102         1
## 103         1
## 104         1
## 105         1
## 106         1
## 107         1
## 108         1
## 109         1
## 110         1
## 111         1
## 112         1
## 113         1
## 114         1
## 115         1
## 116         1
## 117         1
## 118         1
## 119         1
## 120         1
## 121         1
## 122         1
## 123         1
## 124         1
## 125         1
## 126         1
## 127         1
## 128         1
## 129         1
## 130         1
## 131         1
## 132         1
## 133         1
## 134         1
## 135         1
## 136         1
## 137         1
## 138         1
## 139         1
```

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## 140          1
## 141          1
## 142          1
## 143          1
## 144          1
## 145          1
## 146          1
## 147          1
## 148          1
## 149          1
## 150          1
## 151          1
## 152          1
## 153          1
## 154          1
## 155          1
## 156          1
## 157          1
## 158          1
## 159          1
## 160          1
## 161          1
## 162          1
## 163          1
## 164          1
## 165          1
## 166          0
## 167          0
## 168          0
## 169          0
## 170          0
## 171          0
## 172          0
## 173          0
## 174          0
## 175          0
## 176          0
## 177          0
## 178          0
## 179          0
## 180          0
## 181          0
## 182          0
## 183          0
## 184          0
## 185          0
## 186          0
## 187          0
## 188          0
## 189          0
## 190          0
## 191          0
## 192          0
## 193          0
```

```
## 194          0
## 195          0
## 196          0
## 197          0
## 198          0
## 199          0
## 200          0
## 201          0
## 202          0
## 203          0
## 204          0
## 205          0
## 206          0
## 207          0
## 208          0
## 209          0
## 210          0
## 211          0
## 212          0
## 213          0
## 214          0
## 215          0
## 216          0
## 217          0
## 218          0
## 219          0
## 220          0
## 221          0
## 222          0
## 223          0
## 224          0
## 225          0
## 226          0
## 227          0
## 228          0
## 229          0
## 230          0
## 231          0
## 232          0
## 233          0
## 234          0
## 235          0
## 236          0
## 237          0
## 238          0
## 239          0
## 240          0
## 241          0
## 242          0
## 243          0
## 244          0
## 245          0
## 246          0
## 247          0
```

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## 248          0
## 249          0
## 250          0
## 251          0
## 252          0
## 253          0
## 254          0
## 255          0
## 256          0
## 257          0
## 258          0
## 259          0
## 260          0
## 261          0
## 262          0
## 263          0
## 264          0
## 265          0
## 266          0
## 267          0
## 268          0
## 269          0
## 270          0
## 271          0
## 272          0
## 273          0
## 274          0
## 275          0
## 276          0
## 277          0
## 278          0
## 279          0
## 280          0
## 281          0
## 282          0
## 283          0
## 284          0
## 285          0
## 286          0
## 287          0
## 288          0
## 289          0
## 290          0
## 291          0
## 292          0
## 293          0
## 294          0
## 295          0
## 296          0
## 297          0
## 298          0
## 299          0
## 300          0
## 301          0
```

```
## 302      0
## 303      0
```

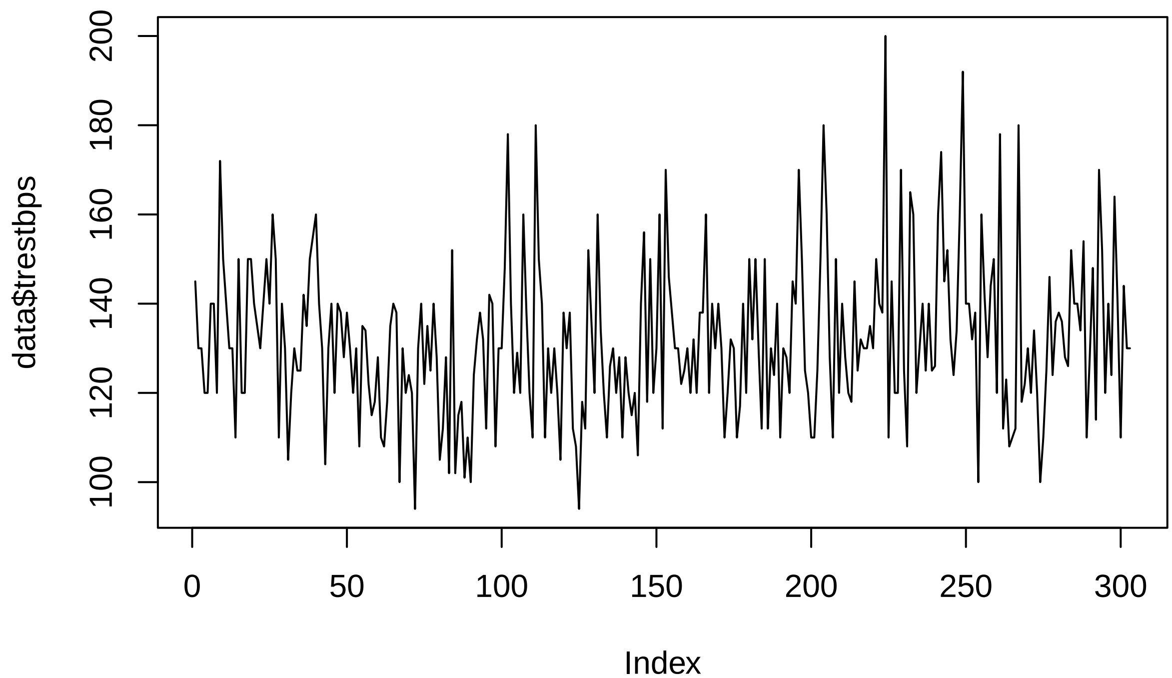
```
#wyswietlenie struktury obiektów naszych danych - za pomocą funkcji str
str(data)
```

```
## 'data.frame':    303 obs. of  14 variables:
##  $ age     : int  63 37 41 56 57 57 56 44 52 57 ...
##  $ sex     : int  1 1 0 1 0 1 0 1 1 1 ...
##  $ cp      : int  3 2 1 1 0 0 1 1 2 2 ...
##  $ trestbps: int  145 130 130 120 120 140 140 120 172 150 ...
##  $ chol    : int  233 250 204 236 354 192 294 263 199 168 ...
##  $ fbs     : int  1 0 0 0 0 0 0 0 1 0 ...
##  $ restecg : int  0 1 0 1 1 1 0 1 1 1 ...
##  $ thalach : int  150 187 172 178 163 148 153 173 162 174 ...
##  $ exang   : int  0 0 0 0 1 0 0 0 0 0 ...
##  $ oldpeak : num  2.3 3.5 1.4 0.8 0.6 0.4 1.3 0 0.5 1.6 ...
##  $ slope   : int  0 0 2 2 2 1 1 2 2 2 ...
##  $ ca      : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ thal    : int  1 2 2 2 2 1 2 3 3 2 ...
##  $ target  : int  1 1 1 1 1 1 1 1 1 1 ...
```

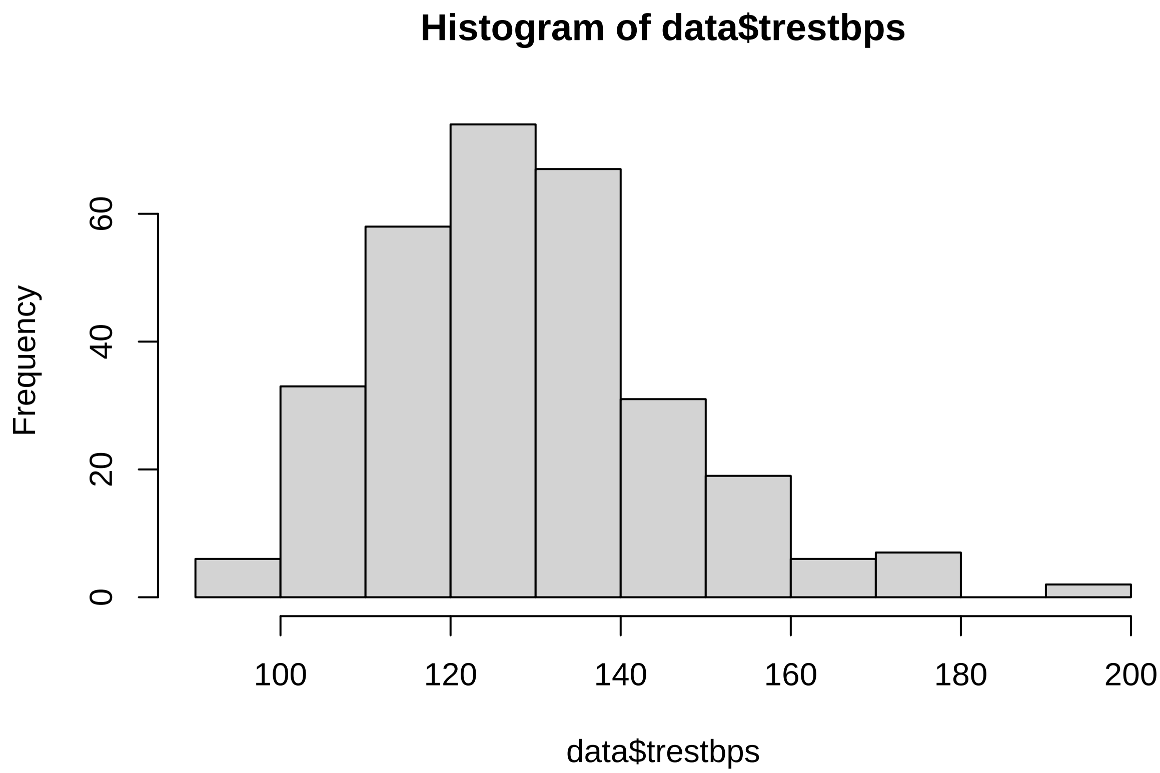
```
#Wygenerowanie podstawowych statystyk dla naszych danych
summary(data)
```

```
##       age             sex               cp            trestbps    
##  Min.   :29.00   Min.   :0.0000   Min.   :0.000   Min.   : 94.0  
##  1st Qu.:47.50   1st Qu.:0.0000   1st Qu.:0.000   1st Qu.:120.0  
##  Median :55.00   Median :1.0000   Median :1.000   Median :130.0  
##  Mean   :54.37   Mean   :0.6832   Mean   :0.967   Mean   :131.6  
##  3rd Qu.:61.00   3rd Qu.:1.0000   3rd Qu.:2.000   3rd Qu.:140.0  
##  Max.   :77.00   Max.   :1.0000   Max.   :3.000   Max.   :200.0  
##       chol            fbs            restecg          thalach     
##  Min.   :126.0   Min.   :0.0000   Min.   :0.0000   Min.   : 71.0  
##  1st Qu.:211.0   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:133.5  
##  Median :240.0   Median :0.0000   Median :1.0000   Median :153.0  
##  Mean   :246.3   Mean   :0.1485   Mean   :0.5281   Mean   :149.6  
##  3rd Qu.:274.5   3rd Qu.:0.0000   3rd Qu.:1.0000   3rd Qu.:166.0  
##  Max.   :564.0   Max.   :1.0000   Max.   :2.0000   Max.   :202.0  
##      exang           oldpeak         slope             ca        
##  Min.   :0.0000   Min.   :0.00   Min.   :0.000   Min.   :0.0000  
##  1st Qu.:0.0000   1st Qu.:0.00   1st Qu.:1.000   1st Qu.:0.0000  
##  Median :0.0000   Median :0.80   Median :1.000   Median :0.0000  
##  Mean   :0.3267   Mean   :1.04   Mean   :1.399   Mean   :0.7294  
##  3rd Qu.:1.0000   3rd Qu.:1.60   3rd Qu.:2.000   3rd Qu.:1.0000  
##  Max.   :1.0000   Max.   :6.20   Max.   :2.000   Max.   :4.0000  
##       thal           target      
##  Min.   :0.000   Min.   :0.0000  
##  1st Qu.:2.000   1st Qu.:0.0000  
##  Median :2.000   Median :1.0000  
##  Mean   :2.314   Mean   :0.5446  
##  3rd Qu.:3.000   3rd Qu.:1.0000  
##  Max.   :3.000   Max.   :1.0000
```

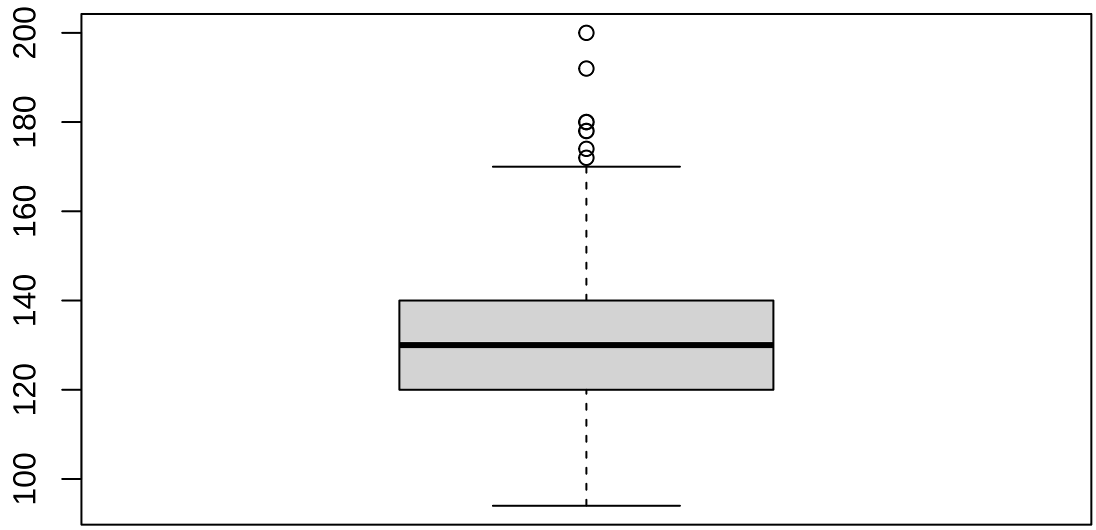
```r
#sporządzenie podstawowych wykresów do sprawdzenia, czy dane są poprawne oraz czy nie ma błędów grubych
plot(data$trestbps, type="l")
```




```r
#Histogram dla wartosci trestbps
hist(data$trestbps, breaks=8)
```




```
# Wykresy ramka-wąsy
boxplot(data$trestbps)
```




```r
#Macierz korelacji liniowej
cor_matrix <- cor(data)
print(cor_matrix)
```

```
##                  age         sex          cp    trestbps         chol
## age       1.00000000 -0.09844660 -0.06865302  0.27935091  0.213677957
## sex      -0.09844660  1.00000000 -0.04935288 -0.05676882 -0.197912174
## cp       -0.06865302 -0.04935288  1.00000000  0.04760776 -0.076904391
## trestbps  0.27935091 -0.05676882  0.04760776  1.00000000  0.123174207
## chol      0.21367796 -0.19791217 -0.07690439  0.12317421  1.000000000
## fbs       0.12130765  0.04503179  0.09444403  0.17753054  0.013293602
## restecg  -0.11621090 -0.05819627  0.04442059 -0.11410279 -0.151040078
## thalach  -0.39852194 -0.04401991  0.29576212 -0.04669773 -0.009939839
## exang     0.09680083  0.14166381 -0.39428027  0.06761612  0.067022783
## oldpeak   0.21001257  0.09609288 -0.14923016  0.19321647  0.053951920
## slope    -0.16881424 -0.03071057  0.11971659 -0.12147458 -0.004037770
## ca        0.27632624  0.11826141 -0.18105303  0.10138899  0.070510925
## thal      0.06800138  0.21004110 -0.16173557  0.06220989  0.098802993
## target   -0.22543872 -0.28093658  0.43379826 -0.14493113 -0.085239105
##                  fbs     restecg      thalach       exang      oldpeak
## age       0.121307648 -0.11621090 -0.398521938  0.09680083  0.210012567
## sex       0.045031789 -0.05819627 -0.044019908  0.14166381  0.096092877
## cp        0.094444035  0.04442059  0.295762125 -0.39428027 -0.149230158
## trestbps  0.177530542 -0.11410279 -0.046697728  0.06761612  0.193216472
## chol      0.013293602 -0.15104008 -0.009939839  0.06702278  0.053951920
## fbs       1.000000000 -0.08418905 -0.008567107  0.02566515  0.005747223
```

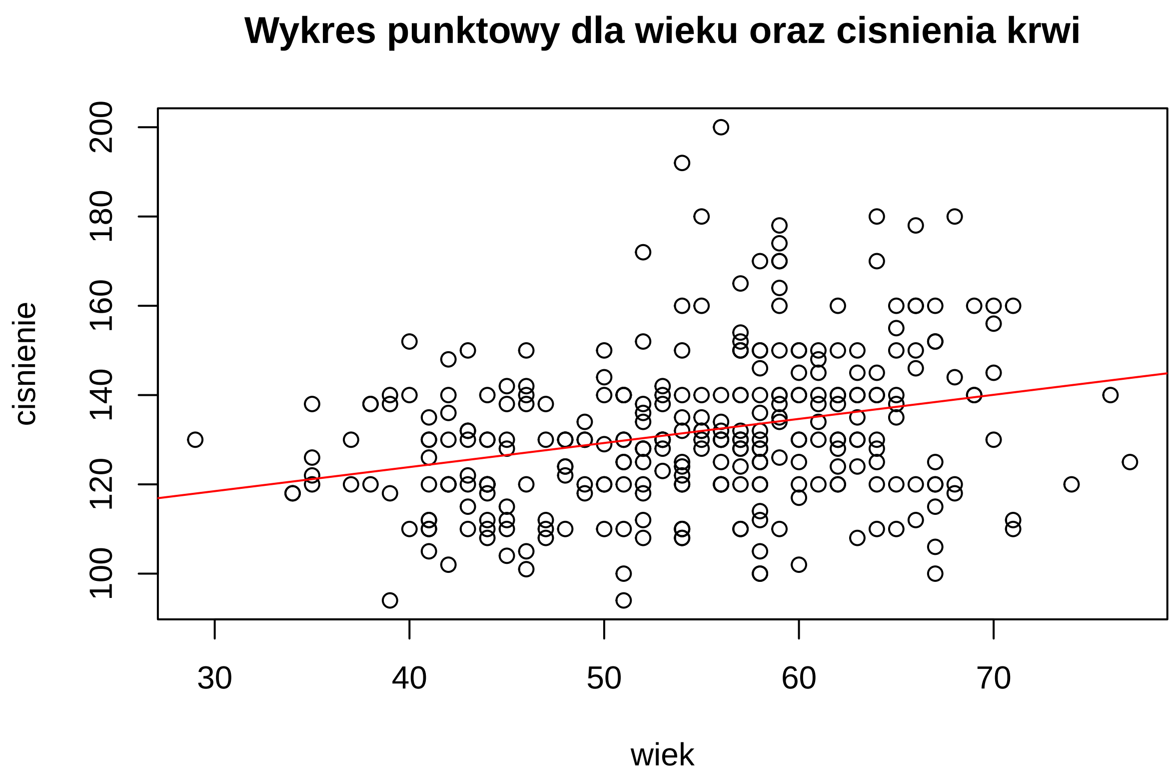
```
## restecg  -0.084189054  1.00000000  0.044123444 -0.07073286 -0.058770226
## thalach  -0.008567107  0.04412344  1.000000000 -0.37881209 -0.344186948
## exang     0.025665147 -0.07073286 -0.378812094  1.00000000  0.288222808
## oldpeak   0.005747223 -0.05877023 -0.344186948  0.28822281  1.000000000
## slope    -0.059894178  0.09304482  0.386784410 -0.25774837 -0.577536817
## ca        0.137979327 -0.07204243 -0.213176928  0.11573938  0.222682322
## thal     -0.032019339 -0.01198140 -0.096439132  0.20675379  0.210244126
## target   -0.028045760  0.13722950  0.421740934 -0.43675708 -0.430696002
##                slope          ca        thal      target
## age      -0.16881424  0.27632624  0.06800138 -0.22543872
## sex      -0.03071057  0.11826141  0.21004110 -0.28093658
## cp        0.11971659 -0.18105303 -0.16173557  0.43379826
## trestbps -0.12147458  0.10138899  0.06220989 -0.14493113
## chol     -0.00403777  0.07051093  0.09880299 -0.08523911
## fbs      -0.05989418  0.13797933 -0.03201934 -0.02804576
## restecg   0.09304482 -0.07204243 -0.01198140  0.13722950
## thalach   0.38678441 -0.21317693 -0.09643913  0.42174093
## exang    -0.25774837  0.11573938  0.20675379 -0.43675708
## oldpeak  -0.57753682  0.22268232  0.21024413 -0.43069600
## slope     1.00000000 -0.08015521 -0.10476379  0.34587708
## ca       -0.08015521  1.00000000  0.15183213 -0.39172399
## thal     -0.10476379  0.15183213  1.00000000 -0.34402927
## target    0.34587708 -0.39172399 -0.34402927  1.00000000
```

```
# Macierz korelacji nieparametrycznej
corr_matrix1 <- rcorr(as.matrix(data))
print(corr_matrix1$r)
```

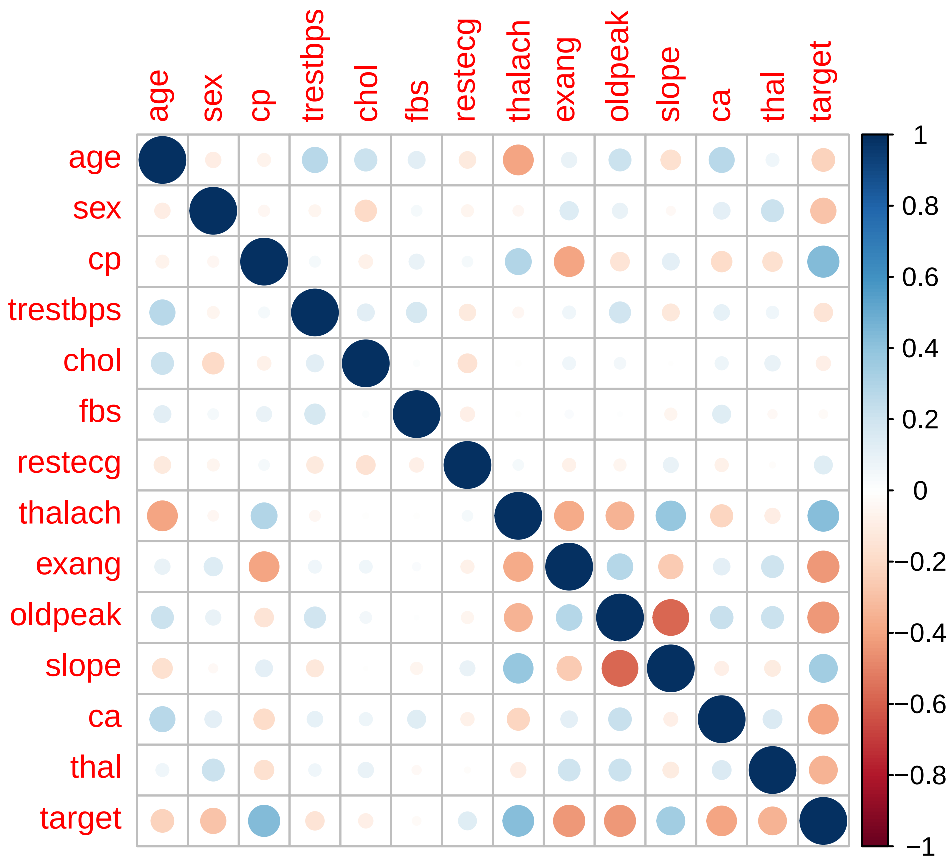
```
##                  age         sex          cp    trestbps         chol
## age       1.00000000 -0.09844660 -0.06865302  0.27935091  0.213677957
## sex      -0.09844660  1.00000000 -0.04935288 -0.05676882 -0.197912174
## cp       -0.06865302 -0.04935288  1.00000000  0.04760776 -0.076904391
## trestbps  0.27935091 -0.05676882  0.04760776  1.00000000  0.123174207
## chol      0.21367796 -0.19791217 -0.07690439  0.12317421  1.000000000
## fbs       0.12130765  0.04503179  0.09444403  0.17753054  0.013293602
## restecg  -0.11621090 -0.05819627  0.04442059 -0.11410279 -0.151040078
## thalach  -0.39852194 -0.04401991  0.29576212 -0.04669773 -0.009939839
## exang     0.09680083  0.14166381 -0.39428027  0.06761612  0.067022783
## oldpeak   0.21001257  0.09609288 -0.14923016  0.19321647  0.053951920
## slope    -0.16881424 -0.03071057  0.11971659 -0.12147458 -0.004037770
## ca        0.27632624  0.11826141 -0.18105303  0.10138899  0.070510925
## thal      0.06800138  0.21004110 -0.16173557  0.06220989  0.098802993
## target   -0.22543872 -0.28093658  0.43379826 -0.14493113 -0.085239105
##                   fbs     restecg      thalach       exang      oldpeak
## age       0.121307648 -0.11621090 -0.398521938  0.09680083  0.210012567
## sex       0.045031789 -0.05819627 -0.044019908  0.14166381  0.096092877
## cp        0.094444035  0.04442059  0.295762125 -0.39428027 -0.149230158
## trestbps  0.177530542 -0.11410279 -0.046697728  0.06761612  0.193216472
## chol      0.013293602 -0.15104008 -0.009939839  0.06702278  0.053951920
## fbs       1.000000000 -0.08418905 -0.008567107  0.02566515  0.005747223
## restecg  -0.084189054  1.00000000  0.044123444 -0.07073286 -0.058770226
## thalach  -0.008567107  0.04412344  1.000000000 -0.37881209 -0.344186948
## exang     0.025665147 -0.07073286 -0.378812094  1.00000000  0.288222808
## oldpeak   0.005747223 -0.05877023 -0.344186948  0.28822281  1.000000000
```

```
## slope    -0.059894178  0.09304482  0.386784410 -0.25774837 -0.577536817
## ca        0.137979327 -0.07204243 -0.213176928  0.11573938  0.222682322
## thal     -0.032019339 -0.01198140 -0.096439132  0.20675379  0.210244126
## target   -0.028045760  0.13722950  0.421740934 -0.43675708 -0.430696002
##                slope          ca         thal      target
## age      -0.16881424  0.27632624  0.06800138 -0.22543872
## sex      -0.03071057  0.11826141  0.21004110 -0.28093658
## cp        0.11971659 -0.18105303 -0.16173557  0.43379826
## trestbps -0.12147458  0.10138899  0.06220989 -0.14493113
## chol     -0.00403777  0.07051093  0.09880299 -0.08523911
## fbs      -0.05989418  0.13797933 -0.03201934 -0.02804576
## restecg   0.09304482 -0.07204243 -0.01198140  0.13722950
## thalach   0.38678441 -0.21317693 -0.09643913  0.42174093
## exang    -0.25774837  0.11573938  0.20675379 -0.43675708
## oldpeak  -0.57753682  0.22268232  0.21024413 -0.43069600
## slope     1.00000000 -0.08015521 -0.10476379  0.34587708
## ca       -0.08015521  1.00000000  0.15183213 -0.39172399
## thal     -0.10476379  0.15183213  1.00000000 -0.34402927
## target    0.34587708 -0.39172399 -0.34402927  1.00000000
```

```
#Wykresy korelacji
plot(data$age, data$trestbps, main = "Wykres punktowy dla wieku oraz cisnienia krwi", xlab = "wiek", yl
abline(lm(data$trestbps ~ data$age), col = "red")
```



```
#korelacja
corrplot(cor_matrix)
```




```
cor_matrix
```

```
##                  age         sex          cp    trestbps         chol
## age       1.00000000 -0.09844660 -0.06865302  0.27935091  0.213677957
## sex      -0.09844660  1.00000000 -0.04935288 -0.05676882 -0.197912174
## cp       -0.06865302 -0.04935288  1.00000000  0.04760776 -0.076904391
## trestbps  0.27935091 -0.05676882  0.04760776  1.00000000  0.123174207
## chol      0.21367796 -0.19791217 -0.07690439  0.12317421  1.000000000
## fbs       0.12130765  0.04503179  0.09444403  0.17753054  0.013293602
## restecg  -0.11621090 -0.05819627  0.04442059 -0.11410279 -0.151040078
## thalach  -0.39852194 -0.04401991  0.29576212 -0.04669773 -0.009939839
## exang     0.09680083  0.14166381 -0.39428027  0.06761612  0.067022783
## oldpeak   0.21001257  0.09609288 -0.14923016  0.19321647  0.053951920
## slope    -0.16881424 -0.03071057  0.11971659 -0.12147458 -0.004037770
## ca        0.27632624  0.11826141 -0.18105303  0.10138899  0.070510925
## thal      0.06800138  0.21004110 -0.16173557  0.06220989  0.098802993
## target   -0.22543872 -0.28093658  0.43379826 -0.14493113 -0.085239105
##                  fbs     restecg      thalach       exang     oldpeak
## age      0.121307648 -0.11621090 -0.398521938  0.09680083  0.210012567
## sex      0.045031789 -0.05819627 -0.044019908  0.14166381  0.096092877
## cp       0.094444035  0.04442059  0.295762125 -0.39428027 -0.149230158
## trestbps 0.177530542 -0.11410279 -0.046697728  0.06761612  0.193216472
```

```
## chol      0.013293602 -0.15104008 -0.009939839  0.06702278  0.053951920
## fbs       1.000000000 -0.08418905 -0.008567107  0.02566515  0.005747223
## restecg  -0.084189054  1.00000000  0.044123444 -0.07073286 -0.058770226
## thalach  -0.008567107  0.04412344  1.000000000 -0.37881209 -0.344186948
## exang     0.025665147 -0.07073286 -0.378812094  1.00000000  0.288222808
## oldpeak   0.005747223 -0.05877023 -0.344186948  0.28822281  1.000000000
## slope    -0.059894178  0.09304482  0.386784410 -0.25774837 -0.577536817
## ca        0.137979327 -0.07204243 -0.213176928  0.11573938  0.222682322
## thal     -0.032019339 -0.01198140 -0.096439132  0.20675379  0.210244126
## target   -0.028045760  0.13722950  0.421740934 -0.43675708 -0.430696002
##                slope          ca        thal      target
## age      -0.16881424  0.27632624  0.06800138 -0.22543872
## sex      -0.03071057  0.11826141  0.21004110 -0.28093658
## cp        0.11971659 -0.18105303 -0.16173557  0.43379826
## trestbps -0.12147458  0.10138899  0.06220989 -0.14493113
## chol     -0.00403777  0.07051093  0.09880299 -0.08523911
## fbs      -0.05989418  0.13797933 -0.03201934 -0.02804576
## restecg   0.09304482 -0.07204243 -0.01198140  0.13722950
## thalach   0.38678441 -0.21317693 -0.09643913  0.42174093
## exang    -0.25774837  0.11573938  0.20675379 -0.43675708
## oldpeak  -0.57753682  0.22268232  0.21024413 -0.43069600
## slope     1.00000000 -0.08015521 -0.10476379  0.34587708
## ca       -0.08015521  1.00000000  0.15183213 -0.39172399
## thal     -0.10476379  0.15183213  1.00000000 -0.34402927
## target    0.34587708 -0.39172399 -0.34402927  1.00000000
```

```r
#Najwieksze korelacje dla wieku i tresbps[0.27935091] oraz cp i target i [0.43379826]
#Najmniejsze dla slope i oldpeak [-0.57753682]
```

```r
#Celem jest analiza danych oraz wybór zmiennych do modelu regresyjnego. Zmienna, którą
#chcemy zamodelować to trestbps z danych data.
#"Trestbps" to skrót od angielskiego terminu "Resting Blood Pressure", który w języku polskim można tłu
#Jest to pomiar ciśnienia krwi, który jest wykonywany w spoczynku, gdy osoba nie jest fizycznie aktywna
# "RBP" powinno wynosić w 120/80, wybrałem osobiscie ten wariant, ze względu na to iż jestem niezwykle
```

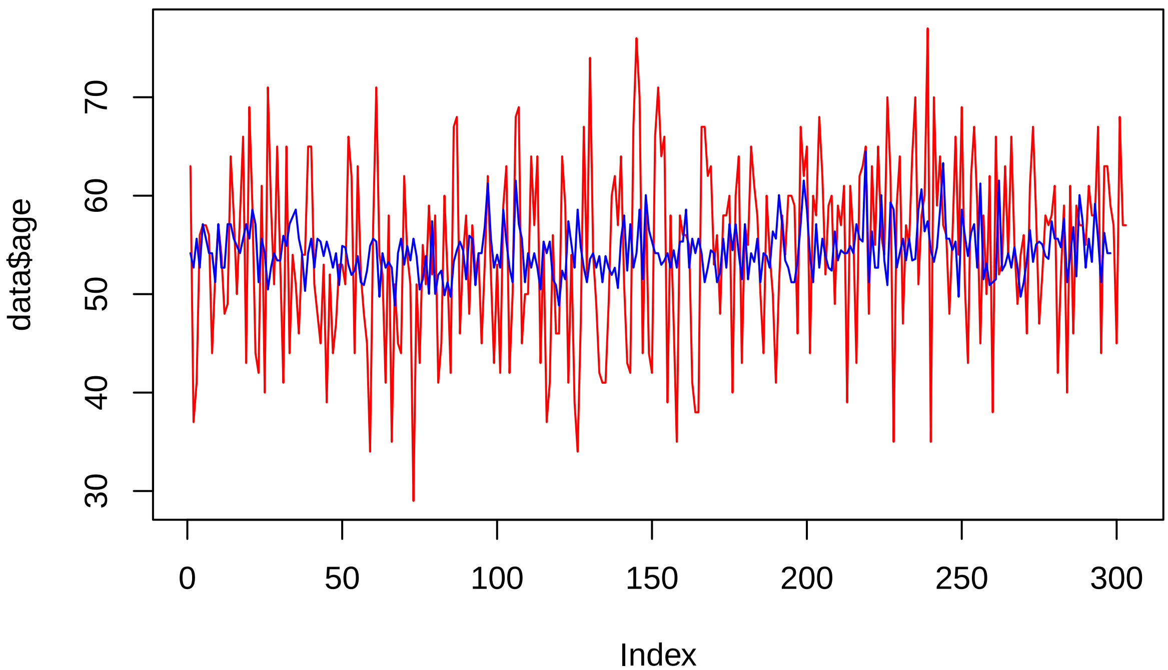
#5. Modele

```r
#Wybor celowy
train<-data[-c(1, 3, 5, 7, 9),]
test<-data[c(1, 3, 5, 7, 9),]

#Losowy
sets <- sample(1:nrow(data), 0.9 * nrow(data))
train2<- data [sets,]
test2<- data[-sets,]
#model 1: Regresja liniowa
m1<-lm(age ~ trestbps, train)
summary(m1)
```

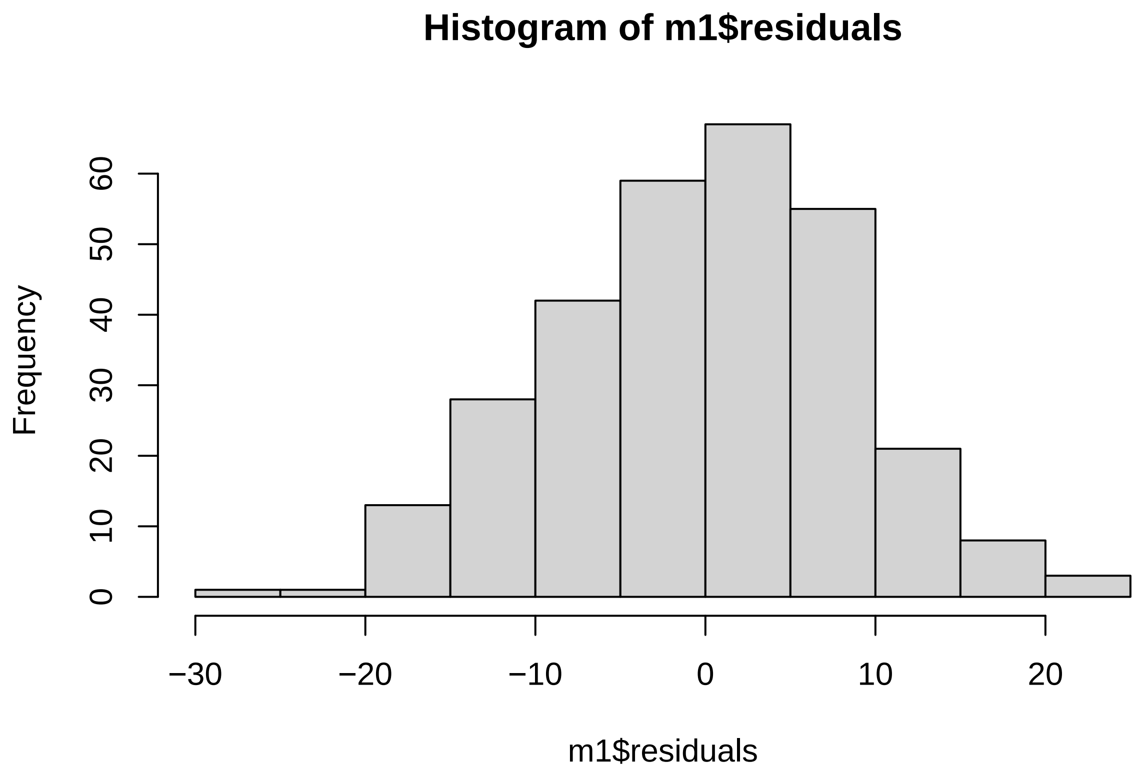
```
##
## Call:
## lm(formula = age ~ trestbps, data = train)
##
```

```
## Residuals:
##      Min       1Q   Median       3Q      Max
## -25.1604  -6.1604   0.5611   6.3349  23.5777
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 34.96994    3.84939   9.085  < 2e-16 ***
## trestbps     0.14762    0.02903   5.086 6.52e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 8.75 on 296 degrees of freedom
## Multiple R-squared:  0.08035,    Adjusted R-squared:  0.07725
## F-statistic: 25.86 on 1 and 296 DF,  p-value: 6.515e-07
```

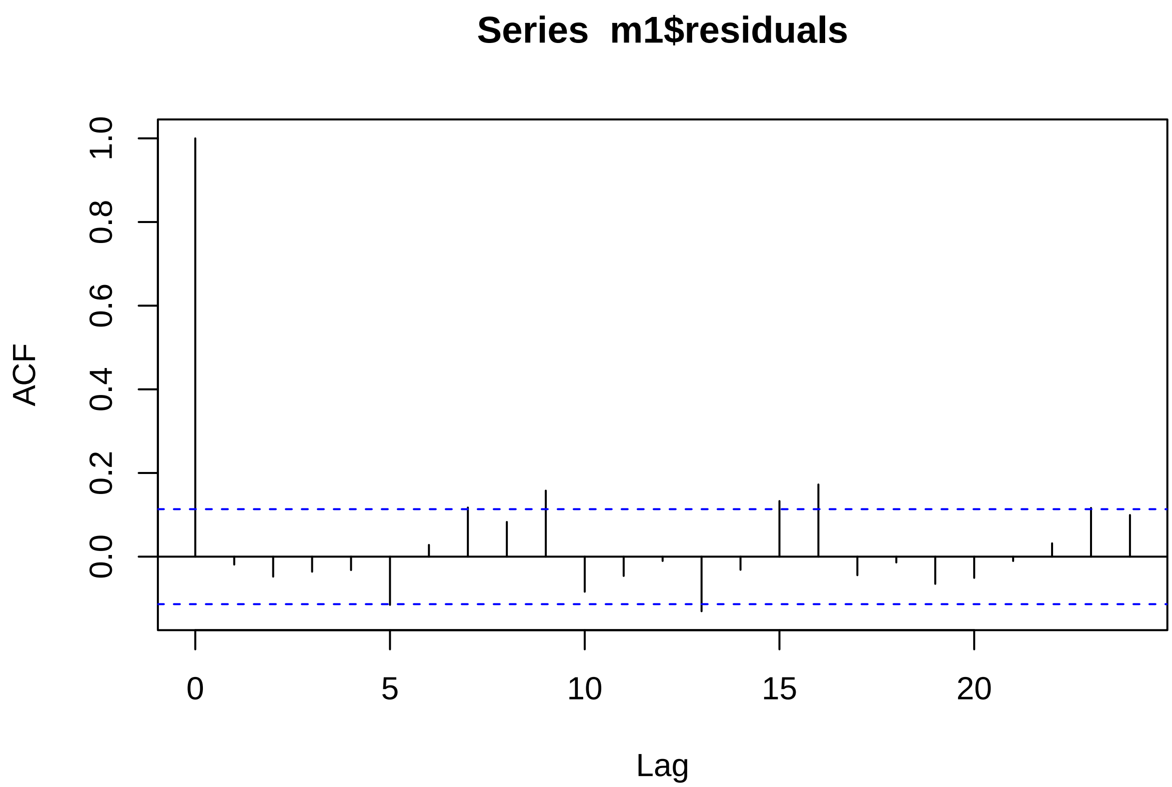
```
#Najmniejsza wartość resztek wynosi -25.1604.
#1Q: Pierwszy kwartyl (25% obserwacji) ma reszty o wartości -6.1604 lub niższej.
#Median: Mediana reszt wynosi 0.5611, co oznacza, że 50% reszt ma wartość mniejszą lub równą 0.5611.
#3Q: Trzeci kwartyl (75% obserwacji) ma reszty o wartości 6.3349 lub niższej.
#Max: Największa wartość resztek wynosi 23.5777.
#Wartość R-kwadrat wynosi 0.08035, co oznacza, że około 8.035% zmienności zmiennej age jest wyjaśnione p
#Szacowana wartość wyrazu wolnego wynosi 34.96994. Oznacza to, że dla trestbps równego 0, szacowana war
#Residual standard error: W tym przypadku wynosi 8.75, co oznacza, że typowe reszty mają średni błąd st
#p-wartość wynosi 6.515e-07. Jest to test statystyczny, który ocenia istotność ogólnego wpływu modelu n

#Wykres dla wizualizacji wyników.
plot(data$age, type="l", col="red")
lines(m1$fitted.values, type="l", col="blue")
```



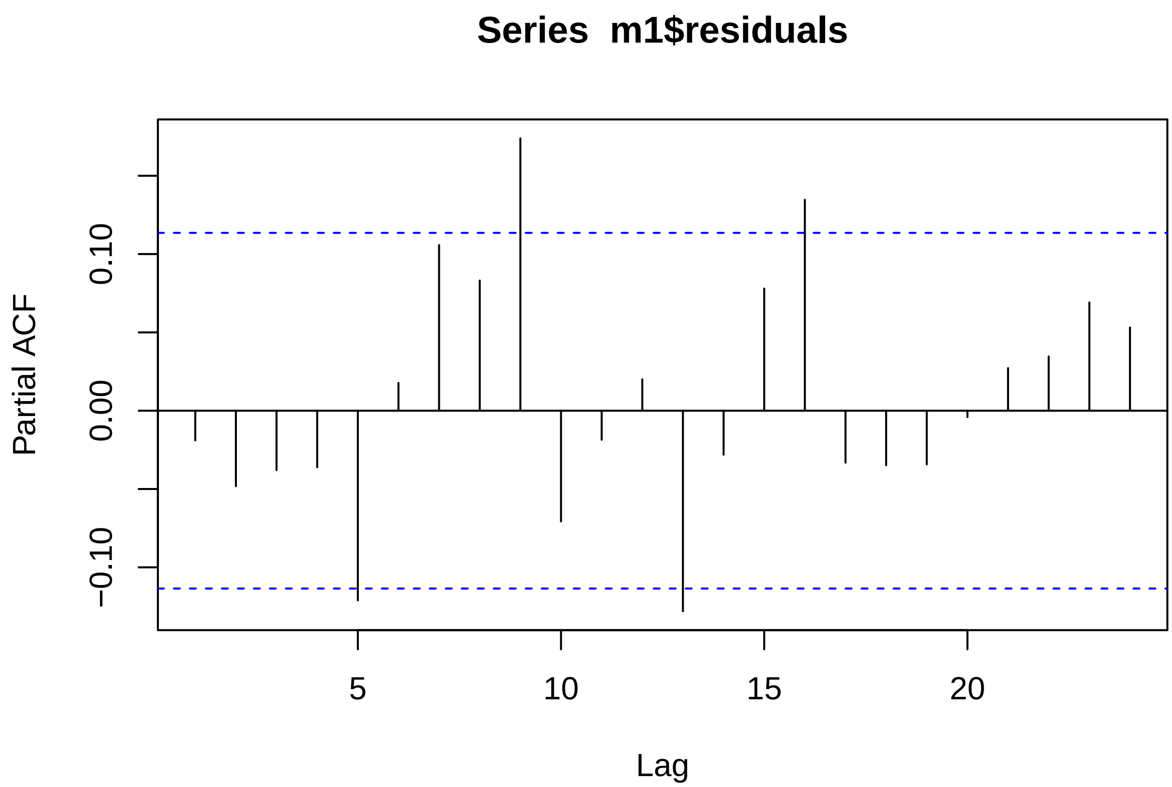

```
#reszty
hist(m1$residuals)
```



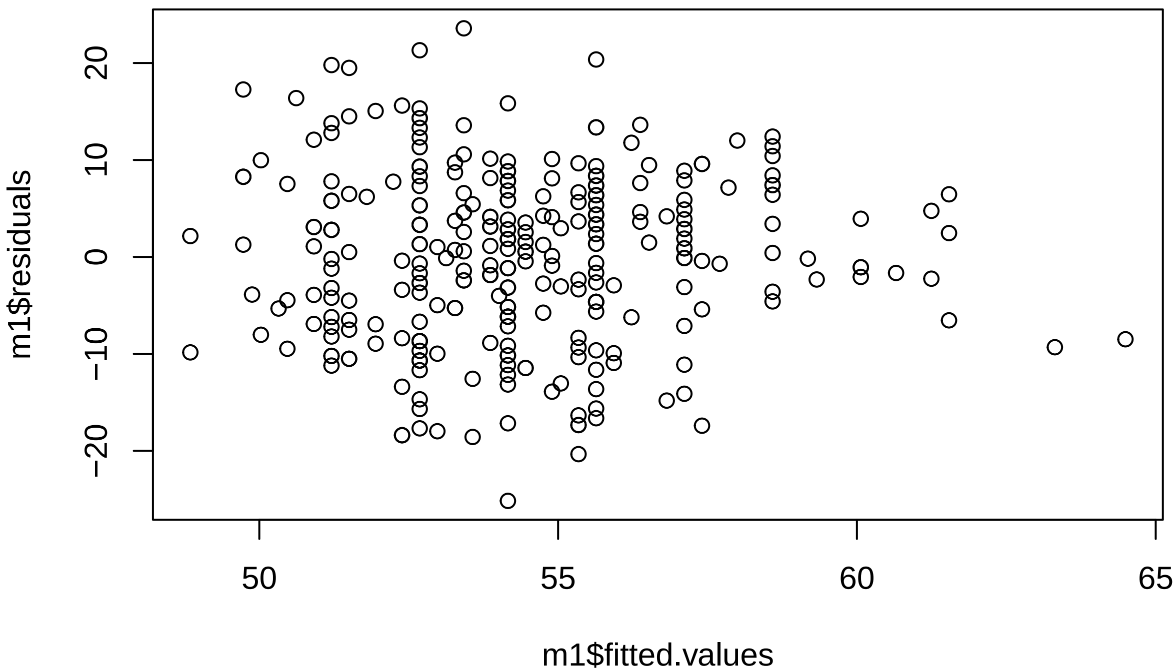

```
#funkcja, ktora sluzy do wygenerowania wykresu autokorelacji (ACF - Autocorrelation Function) dla daneg
acf(m1$residuals)
```




```
#funkcja służy do generowania wykresu cząstkowej autokorelacji (PACF - Partial Autocorrelation Function
pacf(m1$residuals)
```




```
#generuje wykres rozrzutu (scatter plot) między resztami modelu a wartościami dopasowanymi przez model.
plot(m1$residuals~m1$fitted.values)
```



#Podsumowując, w tym modelu regresji liniowej zmienna trestbps ma statystycznie istotny wpływ na zmienną age. Jednak R-kwadrat wskazuje, #że tylko niewielka część zmienności age jest wyjaśniona przez trestbps, co sugeruje, że inne zmienne mogą mieć większy wpływ na age.

#model b - regresja wieloraka

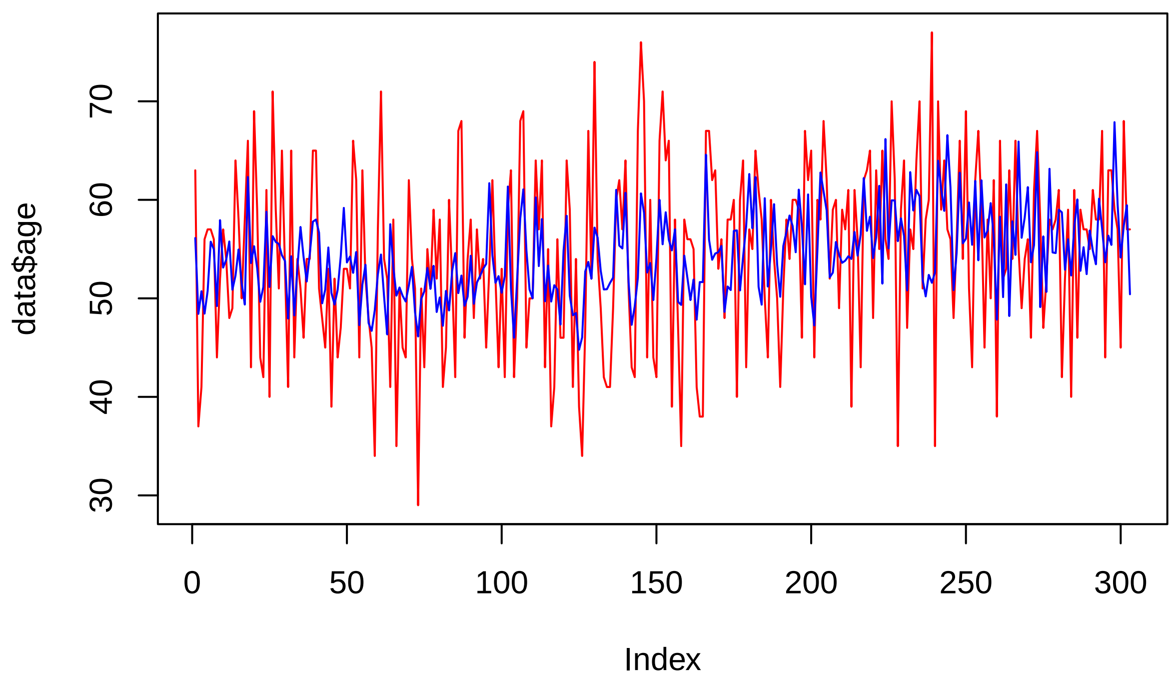
```
# Dopasowanie modelu regresji wielorakiej
train1<-data[-c(1, 3, 5, 7, 9),]
test1<-data[c(1, 3, 5, 7, 9),]

#Losowy
sets1 <- sample(1:nrow(data), 0.9 * nrow(data))
train21<- data [sets,]
test21<- data[-sets,]
#model 1: Regresja wieloraka
model <- lm(data$age ~ data$trestbps + data$thalach, data = train1)
summary(model)
```

```
##
## Call:
## lm(formula = data$age ~ data$trestbps + data$thalach, data = train1)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -20.803  -5.795   0.425   5.865  25.422
##
## Coefficients:
```

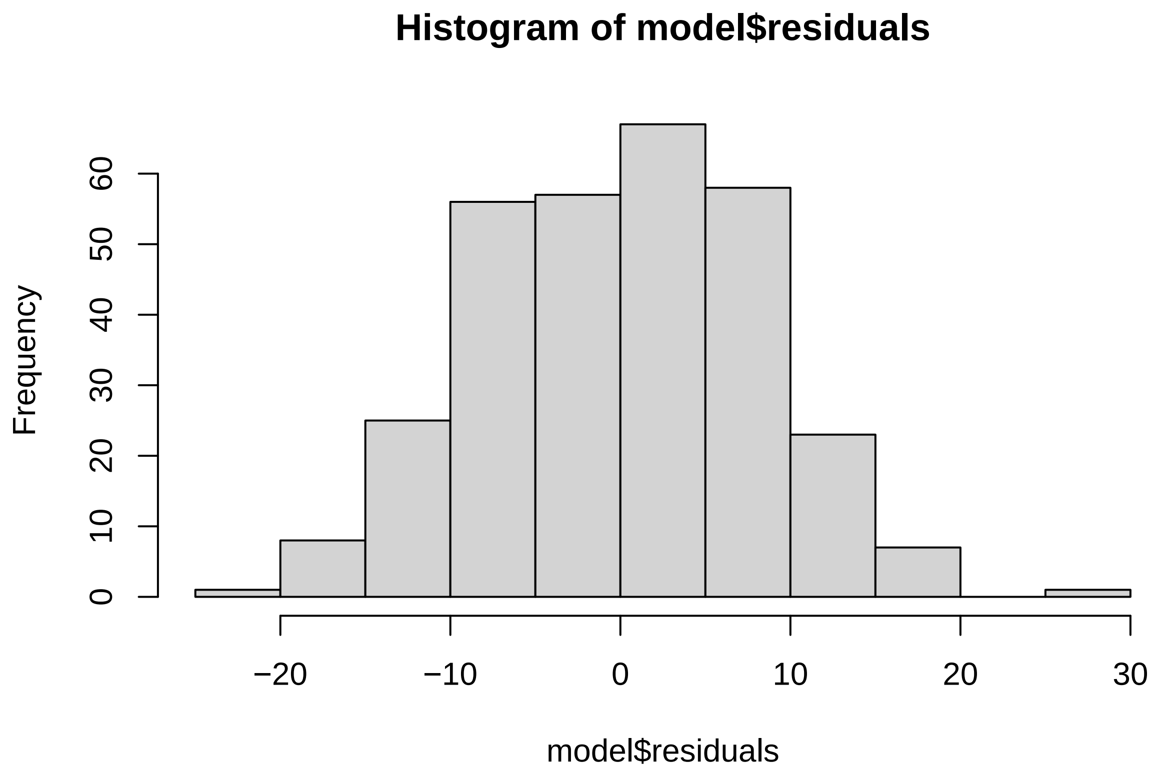
```
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)   59.47786    4.71991  12.601  < 2e-16 ***
## data$trestbps  0.13532    0.02632   5.142 4.91e-07 ***
## data$thalach  -0.15318    0.02015  -7.602 3.76e-13 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 8.012 on 300 degrees of freedom
## Multiple R-squared:  0.227,  Adjusted R-squared:  0.2218
## F-statistic: 44.04 on 2 and 300 DF,  p-value: < 2.2e-16
```

```
#wnioski
#Intercept wynosi 59.47786. Oznacza to, że dla trestbps i thalach równej 0, przewidywana średnia wartoś
#Wartości p dla współczynników (Pr(>|t|)) są bardzo niskie (mniejsze niż 0.001), co oznacza, że współcz
#Wartość R-kwadrat wynosi 0.227, co oznacza, że około 22.7% zmienności zmiennej age jest wyjaśnione prz
#Wykres dla wizualizacji wyników.
```

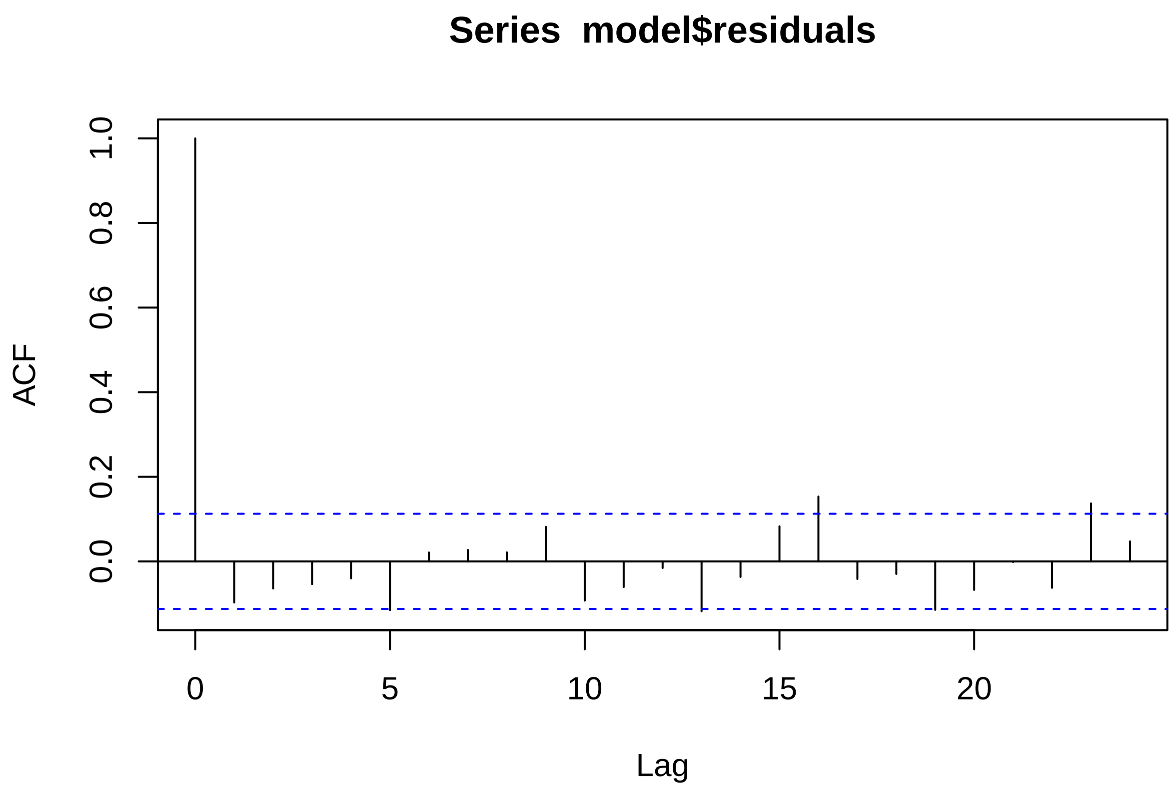
```
plot(data$age, type="l", col="red")
lines(model$fitted.values, type="l", col="blue")
```



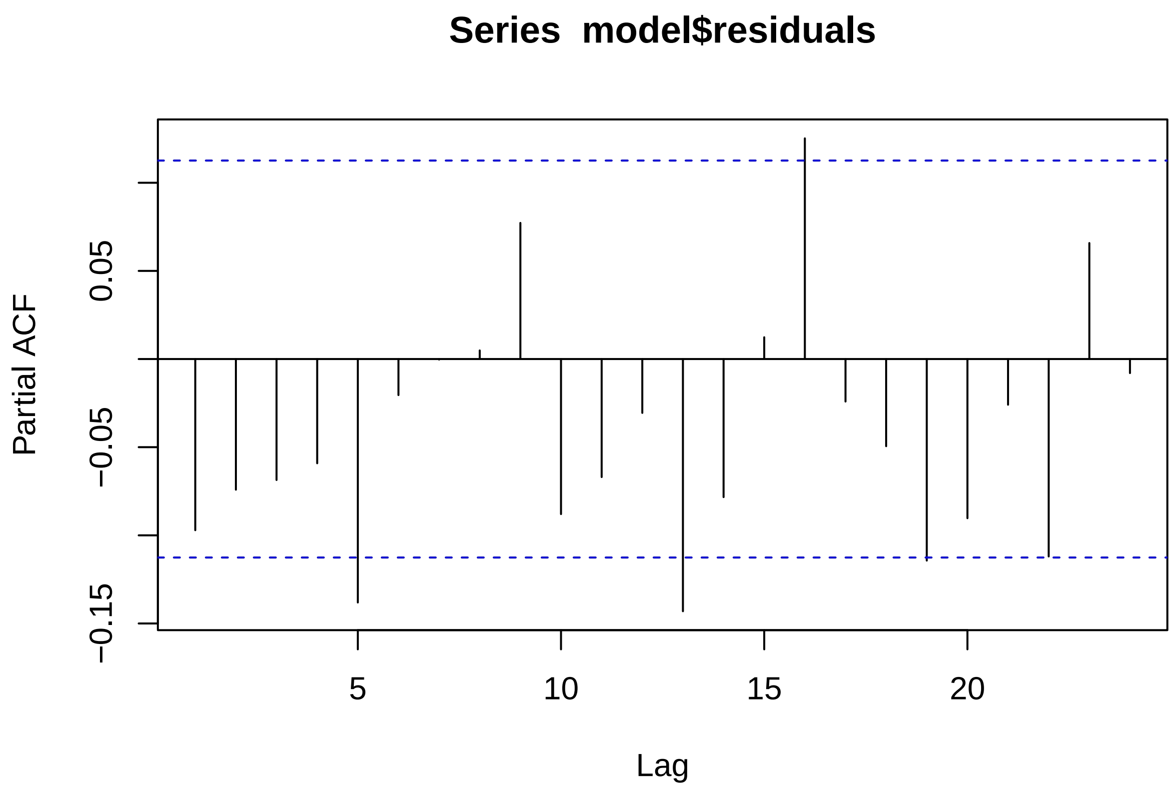

```
#reszty
hist(model$residuals)
```



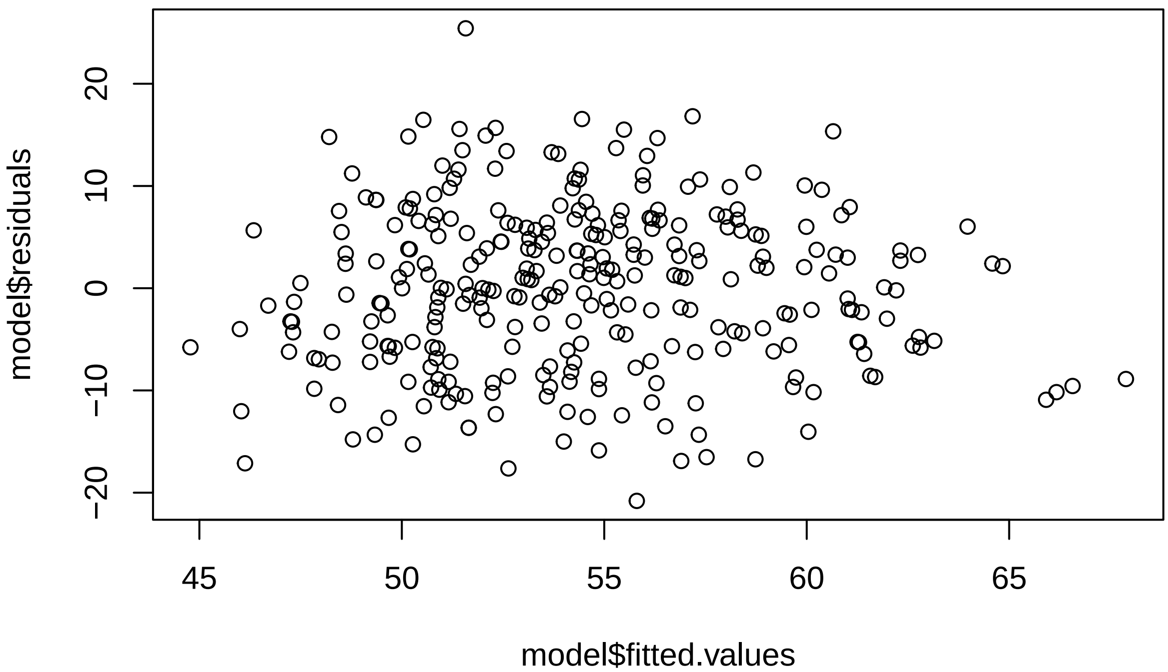

```
#funkcja, ktora sluzy do wygenerowania wykresu autokorelacji (ACF - Autocorrelation Function) dla daneg
acf(model$residuals)
```




```
#funkcja służy do generowania wykresu cząstkowej autokorelacji (PACF - Partial Autocorrelation Function
pacf(model$residuals)
```




```
#generuje wykres rozrzutu (scatter plot) między resztami modelu a wartościami dopasowanymi przez model.
plot(model$residuals~model$fitted.values)
```




```
#Podsumowując, w analizowanym modelu regresji wielorakiej zmienne trestbps i thalach mają statystycznie
#R-kwadrat wskazuje, że te zmienne wyjaśniają około 22.7% zmienności age.
#Zmienna thalach ma ujemny wpływ na age, co sugeruje, że wyższe wartości thalach są związane z niższym
```

#7 Podsumowanie

```
#Model 2 (data$trestbps + data$thalach) ma wyższy współczynnik determinacji (R^2) i
#skorygowany współczynnik determinacji (Adjusted R^2) w porównaniu do Modelu 1 (trestbps).
#Oznacza to, że Model 2 lepiej wyjaśnia zmienność zmiennej zależnej age.
#W obu modelach współczynnik data$trestbps jest istotny statystycznie (p-value < 0.05),
#co sugeruje, że zmienna ta ma istotny wpływ na zmienną age.
#Jednak w Modelu 1 dodatkowo zmienna data$thalach również jest istotna statystycznie.
#Residual standard error (błąd standardowy reszt) w Modelu 2 (8.012) jest niższy niż w Modelu 1 (8.75),
#co wskazuje na lepsze dopasowanie danych do Modelu 2.
#Statystyka F-statistic dla Modelu 1 jest również wyższa niż dla Modelu 1, a p-value jest bardzo niskie
#co potwierdza istotność statystyczną Modelu 2.
#Wnioskiem jest to, że Model 2 (data$trestbps + data$thalach) jest lepszym modelem regresji
#w porównaniu do Modelu 1 (trestbps).
#Model 2 uwzględnia obie zmienne data$trestbps i data$thalach,
#które mają istotny wpływ na zmienną age, podczas gdy Model 1 uwzględnia tylko zmienną trestbps.
```